The Impact of Appalachian Highway Corridors on the Scope of Small Business Activity: Evidence from Corridor G

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Abstract: This study performs an analysis of the productivity enhancing impacts of highways at the firm and regional levels. Three modeling efforts are displayed. First, a firm level production function incorporating physical infrastructure is employed on over 7,000 firms operating within 5 miles of Corridor G (US 119) in West Virginia. Using Euclidean distances of these firms, this study finds a small positive impact on productivity caused by proximity to the highway. This finding occurs in rural, not urban areas and is sensitive to firm size and industry. The second model, a regional production function, finds modest impacts of the highway construction for counties in which construction has been completed. Conterminous counties experience productivity declines, a finding that strongly supports that of Chandra and Thompson, 2000. Finally, a model of regional sustainability suggests that economic diversity is achieved through the highway construction, primarily at the rural terminus of the road.

Introduction

Advocates of additional highway construction face a daunting set of recent research findings regarding the efficacy of public expenditures on new highways. The exuberance of the growth enhancing possibilities of infrastructure that was so apparent in the late 1980's and early 1990's has given way to a more cautious interpretation of the data. This caution that arises in the newer studies manifests itself both in finding limited benefits to highway construction and in broadly calling for additional research.[1] This paper summarizes some additional findings resulting from more disaggregated research into the impacts of highway construction. The paper proceeds as follows: a review of new growth theory and the contribution of infrastructure in endogenous growth models, three models of highway impacts: firm level productivity, regional productivity and sustainability measures. Each are tested, in turn and are followed by summary and conclusions.

New Growth Theory and Public Infrastructure

A broadly hypothesized part of *New Growth Theory* is the existence of constant or increasing returns to scale inherent in public infrastructure and human capital.[2] This is an important departure from neoclassical growth theory's reliance on diminishing returns to scale for all inputs. The *New Growth Theory* models growth as a result of firm behavior when faced with constant or increasing returns to public investment. The optimal firm behavior generates growth through the input-substitution effect in which the individual firm reduces production costs without additional private capital investment. While the genesis of the modeling was in the elucidation of macroeconomic convergence, the inference for a non-neutral capital investment policy is apparent.

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[1] The most recent empirical work that best corrects for spatial and time series endogeneity rejects positive growth impacts of physical infrastructure (e.g. Holtz-Eakin, 1994; Chandra & Thompson, 2000). These findings ought to present concern to policymakers considering the application of infrastructure investment as a means of generating broad regional economic growth. This concern should focus research into the microeconomic relationship of public infrastructure to growth, at very low levels of aggregation or at the firm level. That is what this research, in part, seeks to answer.

[2] For a fuller review of endogenous growth theory see Button, 2000. For original articles see Lucas, 1998, Romer, 1990 and Mankiw, Romer and Weil, 1992.

The theoretical underpinnings of the models are well established. It is in the empirical evaluation of returns to scale generated by capital investment that continuing research is greatly needed. Also, simple growth correlation, which has received mixed empirical support is of interest. While it will not be addressed in this paper, we place no strict assumptions on the transmission mechanism for productivity impacts of infrastructure. These may be demand side arising from reduced customer costs and higher levels of output per worker. Or, more likely they may be supply side that is reflected in the use of production functions as the dual of cost functions. It is likely that the differentials in demand and supply side impacts are industry specific which may be reflected through specification adjustments for individual industries.

This paper seeks to outline a method for testing the microeconomic foundations of growth theory with special application to a spatial setting. The focus here is on physical infrastructure – primarily highways.

Approach 1: A Regional Growth Model

A common regional production function model is employed in this analysis. This differs in form from the firm production function presented later in two respects: the level of aggregation and the empirical specification. The model presented is a pooled Spatial Vector Autoregression with exogenous variables. The model is thus:

$$\frac{NCIncome}{pop} = \alpha + \beta_1\left(\frac{NCIncome}{pop}\right)_{t-n} + \beta_2\left(\frac{Edu}{pop}\right)_{t-n} + \beta_3\left(Construct\ \ income\right)_{t-n} + \beta_4\left(W * \frac{Emp_i}{pop_j}\right)_{t-n} + \beta_5\left(Trend\right)_t + \beta_6\left(HWY\,119\right) + \varepsilon_t^i$$

In this form, the dependent variables are a function of lagged dependent variables, exogenous variables and a spatial autocorrelation component regressed on panel data. The dependent variables are the components of a basic growth model: income growth, human capital and physical capital. The exogenous variables are the trend and Highway presence dummy, and I will refer to the spatial autocorrelation variable in a separate category for technical reasons.[3] This is a fairly contemporary specification.

In order to fully populate this model with data the use of a number of common proxies and econometric adjustments is helpful. All variables are for each of the West Virginia and Kentucky counties contiguous to Hwy 119, of Corridor G, the highway under investigation in this study. The data are from 1978 through 1998. The dependent variables are: years of education per capita in the counties as a proxy for human capital; Real construction income as a proxy for physical capital. The independent variables are a time/presence dummies for the construction and completion of the West Virginia segment of the highway.

The human capital variable is the total years of education. A few comments are warranted for this common proxy variable. Human capital measurements are difficult to make across regions that suffer great variability in culture, educational attainment, or health care access. But, for states like West Virginia and Kentucky more simple measures are likely to provide sufficient variability to reflect actual human capital differences. That is the goal of employing a proxy variable in this type of model. This approach is especially acceptable since this study is not intended to directly estimate human capital impacts.

The model includes a trend component that provides for a correction necessary for observing changes over time in a model that does not include random or time varying effects (Baltagi, 1996). The use of a common intercept is appropriate due to the necessity of including spatial interaction terms. This differs from earlier studies of this type that used a fixed effects model (Holtz-Eakin, 1993). The selection of the appropriate panel model has been subject to much debate in the literature beyond even the spatial and autoregressive issues of the estimators (see Baltagi, 1996). A panel model with a common intercept appeared to be most appropriate specification. This specification permits both cross sectional and time varying components to be estimated. A longer set of observations will likely be necessary for alternative models to be fruitfully employed.

[3] A fuller technical explanation of this approach, which will appear in the final report, requires testing for strict exogeneity of the variables. A more loose definition of exogeneity is used in this specification which fails to preclude statistical bias in a few applications. It is unlikely this presents qualitative problems in this

These choices were rather easy in this instance since a fixed effects model is incompatible with spatial interaction terms (Anselin, 2001). Standard errors were White-washed with White's heteroscedasticity invariant variance-covariance matrix.

A comment on the spatial autocorrelation function is also warranted. This spatial component is a common technique in regional analysis. The estimation of a spatial component involves the use of a weighted and normalized set of observations of the dependent variable in contiguous counties in time *t*. This accounts for the regional impact of contiguous counties in the model. The interpretation of this component is not important in this setting, its inclusion does correct for the very real problem of spatial autocorrelation (Anselin, 2001).

The choice of appropriate lag lengths is also a much debated point in the literature. The use of a vector autoregressive model is recommended when the theoretical structure of the model contains doubt as to the timing of impacts. This is a clear case where that is appropriate. The model is not sensitive to variation in lag length, and indeed, the Akaike Information Criterion is minimized with one lag. This leaves a single lag as the appropriate selection, though it seems to matter little in terms of magnitude or significance of the estimates as different specifications illustrated.

The choice of pooling the estimates or permitting them to vary by individual cross section is another choice in panel models that has not received consensus opinion in the econometric literature. In this case, permitting at least the highway construction impacts to vary at the individual cross section seemed warranted. The magnitudes and significance of the other variables were unaffected by pooling or allowing for cross sectional variation. A chose to pool them was arguably arbitrary, but not of much difference in the final results. The first differences of the variables were used. These reduce the explanatory power of the model, and would oftentimes recommend the use of a cointegrating equation which is not feasible here for a variety of reasons, primarily related to sample size (though clearly here, application has outstripped method in econometrics). The only real concern that motivated the use of first differences is the failure to reject at high levels of significance stationarity in many of the variables in

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model. More clearly, the spatial autocorrelation function and construction income may well not be strictly exogenous (though construction income has been omitted from the growth component).

common unit root tests. Again, the choice here is made on the side of caution, trading an excessive amount of explanatory power for assuredness that a spurious result is not the result.

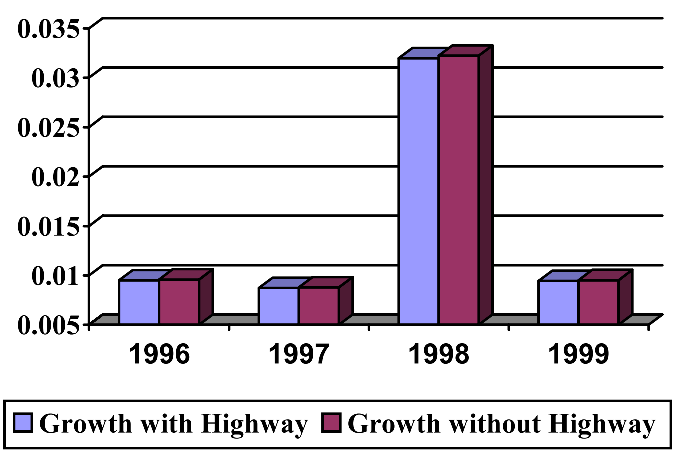
Table 1, County Level Growth Models, Change in non-construction per capita income is dependent variable, t-statistics in parenthesis.

Variable	Spatial VEC-Growth model	Spatial VEC-Growth w/ highway presence dummy	Fixed effects treatment model w/ highway presence dummy
C	-0.023418 (-2.27)	-0.033963 (-2.56)	----
) non-construction income, t-1	-1.819008 (-1.14)	-2.861410 (-1.73)	----
) education per capita, t-1	4.247465 (2.43)	2.657269 (1.80)	----
) construction income, t-1	3.62E-07 (1.69)	-4.98E-07 (-1.49)	----
) spatial matrix, t-1	-1.495424 (-1.49)	-2.534525 (-1.54)	----
) non-construction income, t-2	-0.718482 (-0.57)	-1.105772 (-0.96)	----
) education per capita, t-2	1.146541 (0.62)	0.736243 (0.399)	----
) construction income, t-2	5.46E-07 (2.755)	4.96E-07 (2.98)	----
) spatial matrix, t-2	4.008781 (2.003)	3.069631 (1.81)	----
BOONE--TREND	----	0.002721 (1.33)	----
KANAWHA--TREND	----	0.005195 (3.19)	----
LINCOLN--TREND	----	0.003009 (3.03)	----
LOGAN--TREND	----	0.000555 (0.41)	----
MINGO--TREND	----	-0.000246 (-0.18)	----
PIKE--TREND	----	0.000161 (0.10)	----
BOONE--HWY119 Completion	----	0.001684 (0.036)	0.01 (1.00)
KANAWHA--HWY119 Completion	----	-0.053586 (-2.20)	-0.008 (-1.79)
LINCOLN--HWY119 Completion	----	0.000462 (0.033)	0.016 (2.85)
LOGAN--HWY119 Completion	----	0.010228 (0.36)	-0.02 (-1.31)
MINGO--HWY119 Completion	----	0.009209 (0.29)	-0.02 (-1.31)
PIKE--HWY119 Completion	----	0.042195 (1.20)	0.016 (1.41)
Adjusted R-squared	0.30	0.43	0.04
F-statistic	2.800	3.27	3.31

Interpretation of the results for the first of these models is straightforward. First, the education coefficients are consistent with other studies in its direction and magnitude. Education per capita is the proxy for human capital. These results hold also for the construction income coefficient, the proxy for physical capital. Non-construction income (the lagged dependent variable illustrated here) and the spatial matrix are neither important in terms of interpretation for the purposes of this paper.

The second model, which includes the highway presence dummy and trend within the growth model tell much the same story. The difference of note is the absence of statistical significance of the first lag of the construction income. This is likely due to the use of the highway presence dummy that sweeps construction income changes from the model. In this model, the highway presence dummy resulted in reduced incomes in Kanawha County (the urban terminus of the highway). No other counties enjoyed impacts that were of statistical significance.

The final model is a limited 'treatment' model of the highway impact on income growth. In this model, the negative impact of Corridor G on Kanawha County persisted, but with Lincoln County enjoying positive and statistically significant impacts.



The magnitude of the highway contribution was, in every instance small. In Kanawha County, the impact on growth was a roughly 5 percent reduction in the actual growth rate. Growth enhancement attributable to Corridor G was likewise negligible at the county level. These findings are consistent with earlier work (Holtz-Eakin and Schwartz, 1994: Chandra and Thompson, 2000) in finding little specific support for infrastructure types. It does however suggest that humanc and private capital play a significant role in growth.

Though this modeling effort directly addresses spatial autocorrelation, a problem not fully address in earlier research, it still fails to address some of the key concerns of these earlier studies, namely the level of aggregation remains quite high. In essence,this model does not get at the basic questions regarding firm level productivity changes attributable to highway construction. This recommends another approach to modeling the impact of highway impact at the firm level.

Approach 2: A Model of the Productivity Impact of Infrastructure at the Firm level

The direction of formal modeling of *New Growth Theory* reflects more recent concerns with research and development and human capital. One direction of interest in this research is to evaluate the productivity enhancing value of public infrastructure. A full treatment of new growth theory would include a formal treatment of technological change and increasing returns to investment. The exploratory analysis offered in this paper will present an ambitious modeling effort that addresses empirical questions of interest. The basic growth model offered here is a production function:

$$Y = f(K, G, L)$$

where output per worker is a function of exogenously determined infrastructure and firm capital. The exogeneity of public infrastructure rests on the assumption that the marginal cost of providing local infrastructure is largely unnoticed by firms.[4]

Assuming an explicit functional form to this production function is fraught with challenges. However, for flexibility and ease of exposition, and with an eye towards empirical specification the assumption of a constant elasticity of substitution function of the form:

$$Y = G^{\alpha}\left[w_{L,i,j}L_{i,j}^{\rho} + w_{K,i,j}K_{i,j}^{\rho}\right]^{\frac{1}{\rho}}$$

The CES parameter, Δ, will vary by industry in an empirical specification, and provides justification for industry control variables that will be included in the several empirical specifications. For simplicity we normalize Δ=1. Similarly, the form of substitution of capital for labor will vary significantly, only by industry. This permits the adoption of

[4] Exogeneity in the theoretical section is not strict exogeneity that will be discussed in later empirical sections.

linear substitution technology of the form $K_i = PL_i$. Normalizing P permits the reduction of the CES function to:

$$\frac{Y}{2L} = G^{\alpha} \qquad \forall \rho = \psi = 1$$

In modified logarithmic form[5] this is:

$$\ln\left(\frac{Y}{L}\right) = \alpha \ln G$$

This clearly lends itself to estimation of the sensitivity of output per worker in individual firms to public infrastructure investment. These types of specifications are commonly employed (e.g. Hall and Jones, 1999). A benefit of a generalized specification is that it permits empirical controls for industry specific variation in the CES and substitution parameters. We examine the specification (dropping logarithmic notation) of:

$$\frac{Y}{L} = a + b\phi + e$$

where

$$\phi = \delta K_i + \beta G + u_i$$

The specification of this empirical model permits the estimating of the average product of labor for firm *i* in industry *j* on a matrix of control variables *K* and public infrastructure, *G*. This process permits an evaluation of the robustness of the assumptions underlying equation 2 and 3, as well as the all-important parametric evaluation of infrastructure. This econometric specification will be tested on a novel set of data. This model presents only a basic framework for firm level response to infrastructure. Of additional interest is the regional response.

The Data

The Robert C. Byrd Appalachian Development Corridor (Rte. 119 or corridor G) offers a useful area for examining the impact of a development corridor. We will examine firms located in zip codes that are within 5 miles of the corridor. This permits the examination of roughly 7,500 firms. Data includes revenues, employment, 6-digit SIC classification, ownership type and tenure of firm. Roughly 15 percent of firms lack the full set of necessary data (primarily employment) and so are omitted from the testing. To these data we add regional demographic data at the zip code level as well as a number of count variables for particular amenities in six classifications (e.g. number of hospitals, number or retails centers, etc. in zip code). These are treated as controls for other types of infrastructure.

These data populate a standard production empirical specification outlined in equations (5) and (6) above. To this we proxy the efficiency of public infrastructure, ∀, as the proximity, measured by Euclidean distance from the firm to Corridor G. The Center is currently estimating the shortest travel distance, to Corridor G. These estimates will be completed by late autumn 2002. These later data will be estimated using a GIS-T algorithm on latitude and longitude estimates of firm location provided by the Dun and Bradstreet Marketplace database. The standard West Virginia mercator projection was employed. The process for estimating these travel distances involves overlaying the firm spatially on a digital commercial map. These maps are similar to those used by the logistics and delivery industries. These maps include nodes that distinguish changes in road characteristics such as intersections, curbs, pavement types and additional lanes in public roadways. The routing algorithm measures the distance from the firm, to the nearest node, and subsequently the distance to Corridor G by the shortest route. Geographic omissions due to obvious errors in these data were under 2 percent. Summary statistics for selected data appear in Table 2. Empirical results on selected rural zip codes and industries appear in Tables 3 and 4 respectively.

[5] Note that per capita production (Y/L) is treated as an integer in this and most economic analysis, this explains the treatment of this variable when performing the log transformation.

Table 2, Example Summary Statistics of Sample Firms (7,062 observations)

	Employees	Sales ($1,000)	Average Product of Labor ($1,000's)	Euclidean Distance (feet)
Mean	11.61	735.54	89.82	15,977.16
Median	3	100	50	10,820.63
Maximum	1,800	668,600.0	88,333.33	60,590.63
Standard Deviation	45.07	9,960.5	1,181.49	0.314
Skewness	20.8	47.46	62.98	13,456.51
Kurtosis	647	2,866.09	4,495.0	2.42

Table 3, Results of the Spatial Productivity Model: Rural Counties Only, Euclidean Distance, t-statistics in parenthesis

Variable	Rural, 1 Emp	Rural, < 5 Emp	Rural, < 10 Emp	Rural, < 25 Emp	Rural, < 50 Emp	Rural, < 500 Emp
Intercept	12.8	11.6	11.59	11.73	11.78	11.76
	(11.16)	(25.12)	(26.65)	(28.25)	(28.21)	(28.41)
Log of distance in feet	-0.13	-0.057	-0.0058	-0.07*	-0.078*	-0.07*
	(-1.12)	(-1.18)	(-1.28)	(-1.63)	(-1.79)	(-1.74)
Square of log distance	1.05E-10	1.47E-10*	1.46E-10*	1.26E-10*	1.52E-10**	1.45E-10**
	(0.93)	(1.88)	(1.98)	(1.79)	(2.16)	(2.06)
Branch binary	0.012	0.02	0.011	-0.004	-0.03	-0.04
	(0.25)	(0.24)	(0.15)	(-0.06)	(-0.53)	(-0.60)
Cemeteries	0.00015	-0.0072	-0.009	-0.01	-0.009	-0.0088
	(0.068)	(-1.49)	(-2.05)	(-2.36)	(-2.03)	(-1.97)
Churches	-0.014	0.017	0.01	0.01	0.01	0.01
	(-1.78)	(1.95)	(2.11)	(2.11)	(1.94)	(1.74)
Hospitals	0.027	-0.18	-0.18	-0.16	-0.144	-0.11
	(0.56)	(-1.88)	(-2.01)	(2.11)	(-1.62)	(-1.26)
Malls	0.28	-0.28	-0.28	-0.31	-0.30	-0.33
	(1.30)	(-1.43)	(-2.10)	(-1.83)	(-1.82)	(-2.02)
Schools	0.011	0.004	0.008	0.014	0.011	0.01
	(1.14)	(0.40)	(-1.54)	(1.17)	(1.12)	(1.27)
Adj-R^2	0.04	0.009	0.019	0.09	0.01	0.01
F-Statistic	2.15	1.82	2.12	2.05	2.2	2.24
Observations	194	663	815	900	929	948

* denotes statistical significance at the 0.10 level, ** denotes statistical significance at the 0.05 level and *** denotes statistical significance at the 0.01 level

Table 4, Selected Industry Regressions, Rural Counties Only, Euclidean Distance, t-statistics in parenthesis

Variable	Rural gasoline stations	Rural Retail (multi-type)	Rural Manufacturing
Intercept	21.78***	11.733***	7238634***
	(6.14)	(32.00)	(1.23)
Log of distance in feet	-1.319***	-8.75E-05***	-768135
	(-3.14)	(-2.38)	(-1.22)
Square of distance	-3.22E-11	1.68E-09**	0.000711
	(-0.02)	(2.30)	(1.24)
Branch binary	0.97	0.15	-807609
	(2.95)	(0.67)	(-1.10)
Cemeteries	-0.06	-0.004	-422
	(-1.44)	(-0.32)	(-0.10)
Churches	0.46**	-0.002	-1747
	(2.31)	(-0.10)	(-0.14)
Hospitals	4.00	0.15	-131656
	(1.23)	(0.62)	(-0.76)
Malls	-20.82*	-0.516	144603
	(-1.72)	(-1.52)	(0.57)
Schools	0.06	0.02	-12590.75
	(0.63)	(0.65)	(-0.823)
Adj-R^2	0.70	0.06	0.18
F-Statistic	4.53	1.98	4.95
Observations	13	110	137

* denotes statistical significance at the 0.10 level, ** denotes statistical significance at the 0.05 level and *** denotes statistical significance at the 0.01 level

Interpretation of these models is also straightforward but warrants some discussion. In the first model (not shown) a sample of over 7,100 West Virginia firms including a relatively urban Kanawha County finds no statistical significance of the highway. The does not provide support for increasing returns to infrastructure in an urban area. The models illustrated above remove Kanawha County from the estimation (though it is partially rural). In these models, illustrated in Table 3, the models separating firm size, show an increasing level of significance and remarkable robustness for all the small businesses observed. Similarly, this disaggregated model strongly supports an interpretation of increasing returns as exhibited by the significance of the squared term. This provides support for the hypothesis that public infrastructure enjoys increasing returns in a rural setting.

The amenity control variables are not important in this context, but will be analyzed in more detail in the full report. There's little direct theory to guide the interpretation of the coefficient estimate on the number of cemeteries in a zip code.

Though, the number of malls and the schools, hospitals and branch binary all do permit interpretation regarding certain industries.

The industry specific regressions are illustrated here to present information on the range of results obtained when smaller, industry specifics. Also, increasing returns is implied for some industries.

Additional Research

The specific question outlined above provides the basis for estimation that should answer a wide variety of questions related to development policy. These include the impact of related amenities on firm productivity, concentration and market power potential by industry in small regions, impact of various factors on regional unemployment and a host of others. This model cannot capture the dynamic spatial impact of infrastructure. To understand the time impact of the infrastructure, and its impact across broad space and time we will have to rely on different data sets and different modeling approaches. One is detailed below:

Models of Sustainability

Sustainable growth is a much studied phenomenon in the development literature. It has not, in the context discussed here, appeared extensively in research conducted by economists. The potential empirical components of sustainability are too numerous to review here, instead a narrow focus will ensue.

The first area of sustainability that matters is whether firms survive longer due to expose to infrastructure. Since our data on individual firms includes tenure, examining the correlation between age and proximity to the new highway offers a first test of sustainability. Using the rural model illustrated in Table 3 we estimate the ageing impact of highways. This estimate revealed no correlation between the age of the firm and its Euclidean distance to the highway.

A second concern of sustainability is the existence of structural change in the regional economy that may be correlated with the infrastructure investment. In order to test this, a similarity index for each county was constructed. This method measures the difference from the state mean of each county's per capita income in each of the ten 1-

digit SIC codes. The absolute value of the difference is summed and subtracted from the base index of the state (which is 100). The result of this is a county index of difference from the state which is bounded [0, 100]. It is based on Bernat and Repice [2000] and takes the form:

$$S_{i,t} = \left[1 - \left(\sum_{i=1}^{n} \left| S_{i,s} - S_{i,n} \right|\right)\right] * 100$$

where the similarity index for each county, *i* in time *t*, is the sum of the absolute deviation in the county share of income in industry, s from the state share. This is indexed to 100.

The similarity index is then incorporated into a spatial vector autoregression similar to that outlined in the first approach model. I include in this model a presence dummy for Corridor G along with the spatial term. The results of this sustainability model permit estimates of the influence of the highway on structural differentiation in each county. This sustainability measure derives its name from the convergence hypothesis in macroeconomic theory. Results appear in Table 5.

Table 5, Sustainability Regression

	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Intercept	0.481978***	0.122611	3.930936	0.0002
Boone	**Sim t-1**	-0.010777***	0.004032	-2.672595	0.0088
Kanawha		-0.005319***	0.001263	-4.212780	0.0001
Lincoln		-0.004519	0.003738	-1.208965	0.2296
Logan		-0.005831*	0.003294	-1.770053	0.0798
Mingo		-0.006903***	0.002182	-3.164011	0.0021
Boone	**Spatial N**	0.022406***	0.004903	4.569554	0.0000
Kanawha		0.000133***	5.63E-05	2.352554	0.0206
Lincoln		-0.000465	0.003985	-0.116697	0.9073
Logan		0.004040	0.005180	0.779893	0.4373
Mingo		-0.001823***	0.000774	-2.354300	0.0205
Boone	**Spatial N t-1**	-0.015452***	0.006125	-2.522716	0.0132
Kanawha		-0.000164***	5.29E-05	-3.092003	0.0026
Lincoln		-0.001735	0.003193	-0.543399	0.5881
Logan		-0.000652	0.007329	-0.088975	0.9293
Mingo		-0.000730	0.000749	-0.975621	0.3316
Boone	**Per Capita Income**	-1.147564	1.329590	-0.863096	0.3902
Kanawha		0.105572***	0.012806	8.244041	0.0000
Lincoln		0.518074	2.354796	0.220008	0.8263
Logan		-3.169532*	1.825321	-1.736424	0.0856
Mingo		1.883405*	0.917917	2.051825	0.0428
Boone	**Per Capita Income t-1**	1.615680*	0.962064	1.679390	0.0962
Kanawha		-0.063391	0.004491	-14.11449	0.0000
Lincoln		2.111150	2.798866	0.754287	0.4525
Logan		2.898644	1.935435	1.497671	0.1374
Mingo		-0.946908	0.668508	-1.416451	0.1598
Boone	**Population**	3.31E-05	2.42E-05	1.367141	0.1747
Kanawha		4.94E-07***	4.58E-08	10.79293	0.0000
Lincoln		-2.75E-05	2.83E-05	-0.971170	0.3338
Logan		-4.31E-06	2.12E-05	-0.202869	0.8397
Mingo		2.40E-05***	7.90E-06	3.042848	0.0030
Boone	**Population t-1**	-4.25E-05*	2.54E-05	-1.671157	0.0978
Kanawha		-3.46E-07***	7.17E-09	-48.26141	0.0000
Lincoln		2.07E-05	1.81E-05	1.148112	0.2537
Logan		6.70E-07	2.06E-05	0.032612	0.9741
Mingo		-1.73E-05***	5.37E-06	-3.231579	0.0017
Boone	**Corridor G**	-0.025441	0.027540	-0.923796	0.3578
Kanawha		7.27E-06	0.000302	0.024078	0.9808
Lincoln		-0.016403	0.016303	-1.006135	0.3168
Logan		-0.023176	0.016426	-1.410922	0.1614
Mingo		0.018900***	0.007542	2.505905	0.0138

R-squared	0.542184	Mean dependent var	0.002953
Adjusted R-squared	0.357208	S.D. dependent var	0.035956
S.E. of regression	0.028828	Sum squared resid	0.082273
Log likelihood	407.7130	F-statistic	2.931101
Durbin-Watson stat	2.164474	Prob(F-statistic)	0.000008

* denotes statistical significance at the 0.10 level, ** denotes statistical significance at the 0.05 level and *** denotes statistical significance at the 0.01 level

These results require some interpretation. First, the analysis contemporaneous and lagged dependent variables in the spatial vector autoregression (similarity index, population and per capita income) speak little to sustainability in this context. The spatial variable, N, serves as a correction for spatial autocorrelation. What emerges as important in this context is that the Corridor G presence dummy was positive and strongly significant for Mingo County. This means that the completion of Corridor G strongly influenced the similarity index (a measure of economic diversification) for Mingo County. This strongly suggests a long-term impact on the county's economy in the presence of the Appalachian Corridor Highway. However, to better understand this relationship it is important to understand what economic diversity does, and does not do to regional economies.

Economic Similarity, Growth and Fluctuations.

Regional sustainability implies many things. Among these are a stable economic growth rate and the convergence of growth. Public capital may influence these factors as the preceding empirics illustrate. Notably there is no correlation between growth rates and similarity, thus economic diversity is not a useful policy goal solely due to growth benefits that may arise from it. Economic diversity may however, reduce the magnitude of cyclical fluctuations. This may be exemplified by the skewness of the similarity index. Skewness is the higher moment that describes the 'tail' of the distribution of a sample. Negative skewness suggests a thick negative tail, while a positive skewness suggests a thick or elongated positive tail. In terms of growth it is clear that a negatively skewed distribution leads to deeper recessions. Analogous dips in the skewness of the similarity index may occur as regions become less similar to the mean (hence becoming less diverse). This, in turn leads to potentially greater cyclical fluctuations or regionally hard recessions. Clearly the completion of Corridor G has made the economy of Mingo County more like that of West Virginia as a whole. This reversed a 25 year trend and is likely to result in a more stable regional economy. There was no affect on the other counties.

Summary and Conclusions

The findings presented in this paper offer three distinctly different techniques of infrastructure analysis. The first, a cross county growth regression, extended the methods of earlier research by Holtz-Eakin and Schwartz [1994] and Chandra and Thompson [2000]. These dominant papers provided little support for the claims that productivity growth ensues from highway construction. The first model in this paper substantially supports these findings for Corridor G. However, the potentially obscuring factors of aggregation warranted more detailed research. This was performed in the second model.

The second approach used cross sectional data in a regional production function to test the impact of highway presence on productivity. These results were startling. In rural counties firms with more than 25 employees experienced a significant and positive increase in productivity due to proximity to Corridor G. This spatial measure was accomplished by measuring the Euclidean distance from each firm to the highway using GIS-T methods. The results were more profound in industries with transportation and time costs were present for either producers or consumers. The results were important since they imply a 1 percent productivity increase with each 5,000 ft closer proximity to the road.

Finally a sustainability model was employed at the county level to evaluate the impact of the road on regional economic diversity. There was strong evidence that the rural terminus of completed construction (Mingo county) enjoyed considerable increase in its economic diversity, reversing a 25-year trend.

This research answers an important question regarding highway productivity impacts. Several other factors remain unknown. Among these are the impact of other types of infrastructure such as water, sewer, gas and electricity on regional growth. This has important implications for the follow on road construction in regions. Also, we do not yet know how employment dynamics are affected by Corridor G. This would be especially important in understanding how the regional economy will expand along the Corridor.

References

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