Replication Paper: Urban Growth and Transportation Duranton and Turner 2012

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1 Abstract

Throughout the 20th century, rail travel ceded its dominance of urban transportation to the automobile, and the interstate highway system emerged as critical infrastructure. We ask the question: how does a city's initial stock of highways affect the growth of U.S. cities between 1983 and 2003. In our research, which draws from that of Duranton and Turner 2012, we find that at the national scale a 10% increase in initial road stock leads to a 1.5% increase in employment during the time period. We extend this study by conducting individual regressions at the census region level and find some evidence that the results of this research vary based upon an area's region.

2 Introduction

Through much of the last century, we have seen the importance of automotive transportation influence countless aspects of American society. Whether it be relying on cars for daily commutes or the emergence of logistics as a key economic sector in centrally located cities such as Memphis, TN and Louisville, KY as evidenced by the investments of industry leaders FedEx and UPS in these cities respectively, automotive transportation is ever-present in our daily lives. When considering the dominance of automotive transportation, it is a disservice to ignore the influence of the interstate highway system. Considering this, it is of interest to evaluate the system's impact on the growth of metropolitan statistical areas (MSAs) as this can inform future decisions to construct new highways and roads. Further, this also provides a foundation for estimating related externalities that occur after road expansion. These externalities, for example, could include developments in the workforce and changes in preferred leisure activities because of increased or decreased convenience.

This research asks the question: how does a city's initial stock of highways affect the growth of U.S. cities between 1983 and 2003. Our replication investigates the impact of additional interstate highway stock on US city employment levels. Additionally, we extend their research by creating models that illustrate the isolated effect in different census regions.

Prior to the contributions of Duranton and Turner 2012, economic research highlighting determinants of urban growth failed to focus on transportation due to limitations in the availability of data. Instead, the research primarily highlights topics such as agglomeration, human capital, and the climate. Beyond the literature on urban growth determinants, the research also added to the investigation of theoretical urban models. These theoretical models mostly did not focus on the interstate highway system but rather centered around land prices and use. However, Baum-Snow 2007 used instrumental variables (IVs) to estimate the effects of the interstate highway system on suburbanization. This found that populations in downtown areas decrease when new highways are implemented that pass through a central city.

Previous research on infrastructure investment is also relevant to our study, as Fernald 1999 highlighted the positive impacts of roads on productivity, particularly in industries that have a higher vehicle use. The research in this area is now focused on more granular areas and has shifted its measurements to modeling population distribution and economic activity instead of productivity. Additionally, research has addressed the shortcomings of early work's reliance on likely exogenous variables.

Since Duranton and Turner published their work in 2012, urban economic research regarding roads has continued to mature. In 2024, Rauch and Brandily evaluated how with-in city roads fostered growth in cities and towns in Sub-Saharan Africa. This found that high road density and evenness led to city centers growing faster. Though the sample used by Rauch and Brandily differs from our own, this work continues to underscore the importance of transportation networks in fostering growth. Earlier this year, researchers, Hope, Prah, and Adukpo, found that transportation investment has a higher correlation with urban economic growth when compared to investments in broadband and utilities. This further shows the relative value of our study in the broader topic of infrastructure investment.

Our model estimates the relationship between population growth and road stock, using employment growth as a proxy for population growth and the distance of interstate miles in an MSA as a proxy for road stock. Additional model were included to account for regional within the nation. Furthermore, the model uses three instrument variables (IVs) to remove the endogenous relationship between road building and employment rates (higher employment rates are correlated with having more roads) by establishing a baseline road stock for each respective MSA. These IVs are the 1947 Interstate system plan, the 1898 US railroad stock, and early exploration routes. These are based upon the ease of building roads rather than the economic activity generated in an MSA.

3 Theoretical Framework

Using instrument variables, our estimating model predicts the causal effect of increases in a city's initial road stock on employment levels in that city. This estimating model is derived from a series of component models that describe elements of resident utility and markets that inform resident utility, employment growth, and road growth. This theoretical framework establishes an understanding of the effect of road growth on a city's employment levels. Our empirical framework acknowledges the reverse causation endemic to road growth and employment and identifies the need for exogenous instrument variables.

Duranton and Turner lay the groundwork for their model with a unique specification of a resident's utility. This utility function and corresponding value function capture an index of amenity quality, consumption of a composite good (including housing), distance traveled, and consumption of land as the main parameters. Notably, the index of amenity quality seeks to capture value from aspects of a city that a resident does not directly pay for. The resulting value function is a ratio of the amenity index and budget constraint to the cost of driving and the price of land. This model of resident utility is notable for separating out four individual parameters of resident utility. Additionally, their model does not impose geographical restrictions on cities nor does it restrict itself to only commuting trips, which comprise less than 20% of private vehicle travel in the US (Small and Verhoef, 2007).

To flesh out the resident utility model, an understanding of the cost of driving and supply of land is necessary. Given that roads are inherently congestible and generally unpriced in the US, the cost of driving is a function of the quantity of a given type of roadway and the aggregate vehicle travel in a city. The aggregate vehicle travel in a city can be understood as a function of city employment and distance traveled, implying that aggregate vehicle travel expresses the congestion in a city. As quantity of roadways increases, the cost of driving decreases. As congestion increases, the cost of driving increases. In turn with standard theoretical models, Duranton and Turner specify the supply of land as a function of one's willingness to live away from the city center rather than the price of land. In this way, the cost of land is a function of distance traveled.

In order to infer the causal relationship of a city's road stock on employment levels, a model of employment must be understood. To understand equilibrium employment in cities, it is important to understand that cities function as agglomeration economies, meaning individual wages increase as total employment increases (Rosenthal and Strange, 2004; Melo, Graham and Noland, 2009; Puga, 2010). Additionally, based on demographic trends during the time of this study, we assume that employment growth in cities is primarily driven by migration of the rural population and foreigners to US cities. This follows a standard "open city" assumption. This assumption underpins the theoretical model's treatment of cities as individual units of observation, by implying that cities are not part of an interconnected system with respect to migration to cities. The model of a city's steady state equilibrium employment can be described as a function of road stock after two conditions are met. First, the land and travel markets are in equilibrium and arranged in terms of road stock. Second, the utility of current residents and non-residents, or potential migrants, is in equilibrium. Steady state equilibrium employment is a function of road stock given resident and nonresident utility.

As local conditions change, we can estimate employment levels in the next time period as a function of the steady state equilibrium and current employment rates. Due to the structural friction of migration, the model expects a stickiness when it comes to corrections. That is, the model will likely never reach a steady state equilibrium, but will make corrections towards it. Because the steady state employment equilibrium is a function of road stock, we can also consider the prediction of employment levels in the next time period as a function of road stock.

4 Data and Descriptive Statistics

In order to replicate and extend the work of Duranton and Turner, we obtained data from the replication package attached to their work in *The Review of Economic Studies*. This provided us with the clean data the original authors utilized in their research. Table 1 provides the summary statistics of mean and standard deviation on key variables in this dataset where the unit of observation is an American MSA.

Table 1: Summary Statistics

	Mean	Std. Dev.
1983 Employment	250548.5	588448
2003 Employment	410742.7	861862.6
83-03 Annual employment growth (%)	2.8342	.0122656
1983 Interstate Highways (km)	243.4075	296.9723
2003 Interstate Highways (km)	255.2435	309.3828
1983 Highways per 10,000 population (km)	6.369037	6.776407
2003 Highways per 10,000 population (km)	5.053752	4.010553
Instruments:		
Planned 1947 highways (km)	117.6205	128.0571
1898 Railroads (km)	286.11	298.237
Exploration Route Index	3031.947	4270.736

The original authors gathered this data from a variety of sources. Their sources include the United States Census Bureau's County Business Patterns which was used to create the dependent variable for the employment growth models, the change in log employment over the 20 years that the study focuses on, 1983 to 2003. The dependent variable for the road growth models, the change in log kilometers of interstate highways in the same 20 year period, was made using data from the Highway Performance Monitoring System (HPMS). Additionally this source provided the variable of interest kilometers of interstate highway in 1983. Other elements in the replication dataset account for geographic controls which impact both road growth and employment. These account for the share of an MSA's land that overlays an aquifer, the elevation of an MSA, and controls for the area's climate.

Though these data are useful, instruments are needed to allow for causal inference. The three instruments utilized by the original authors were also included in the replication dataset. The first instrument was created using a digitized image of a 1947 interstate highway plan. The number of planned highway kilometers was then calculated for each MSA and used as the instrument. This instrument and the endogenous variable, log of 1983 interstate highway kilometers were seen to have a 0.62 correlation and predicts the 1983 level of roads conditional on the other controls. This shows the instrument is appropriately relevant for the model. Since the 1947 highway plan does not account for employment growth which was confirmed by regressing the log planned highway kilometers on log 1950 population conditioned on geography and populations from the 1920s, 1930s, and 1940s. Since the 1947 plan assigned more road kilometers to larger cities and larger cities typically grow slower, this introduces potential relation between the instrument and error, but historic population controls account for this. It is also logical to assume that this map only impacted road growth at the beginning of the period and did not impact road growth after 1983. If this was not the case then factors that potentially impact original road stock and future growth should be relevant in the models. However, our results indicate that the geographic controls which fit this description does not significantly impact the results of the research.

The second instrument used is a map of 1898 national railroad routes. Similar to the first instrument Duranton and Turner digitized the map and assigned railway distance to each MSA. This potential instrument had 0.53 correlation with the endogenous variable. This is unsurprising as the authors detail that both railroad and road construction require leveling and grading. This allows for areas with a greater presence of railroads to be more likely to have the necessary conditions to build roads. Due to the time period that these railways were built it is difficult to imagine that they are related to changes in employment nearly 100 years in the future. Similar logic to why the first instrument is unrelated to road growth outside of impacting the initial amount of road can be applied to this instrument also.

The final instrument used in this research was also created by digitizing historic maps. In this case, Duranton and Turner digitized maps of expeditions and explorations that occurred over five time periods from 1528 to 1850. 1 km by 1 km pixels were created and assigned to MSAs. The instrument was then made numeric with an index that summed the count of the pixels in an MSA. Additional weights were included for routes that were used over a longer time period. Minor route variation was also accounted for since this suggests a route was frequently utilized. Since exploration routes seek to find easy paths to travel with, the idea that highways will eventually follow a similar path is reasonable. The data showed a 0.43 correlation between the final instrument and 1983 highway kilometers. The amount of time between the timeframe in the study and the motivation for the explorations suggest that relation to the error terms are extremely improbable.

The only variable not included in the replication package needed for our research was the focus of our extension: the categorical indicator that assigned regions to each MSA observation. We did not utilize an additional dataset to create this variable and instead created the variable manually. This was done by utilizing the Census Bureau's boundaries for the Northeast, South, Midwest, and West regions of the United States. If an MSA extended into multiple regions then the regional location of the principal city for the area was used to determine the region. The only instance of variables being withheld from the dataset occurred when conducting the instrumental variable analysis for specific regions. In this case, only observations within the region were utilized and other observations were omitted.

5 Empirical Framework

In order to determine how road stock causes changes to city employment levels, we base our estimates on a theoretical system of equations estimating future employment levels, future stock of roads, and the initial level of roads. This system of equations describes the models used to generate our results. As discussed in our results sections, the models vary based on control specifications. Additionally, our extension models isolate observations to specific census regions but use the same empirical framework. To assist in capturing the appropriate coefficients as part of a linear model, the equations use log employment level and log road stock and estimate a difference. Finally, we note that the first two equations estimate the difference in city employment levels and road stock between years t and $t+1$.

$$n_{it+1} - n_{it} = A_1 + \alpha r_{it} + \lambda n_{it} + c_1 x_i + \epsilon_{1it} \tag{1}$$

$$r_{it+1} - r_{it} = A_2 + \theta r_{it} + \eta n_{it} + c_2 x_i + \epsilon_{2it} \tag{2}$$

$$r_{it} = A_3 + c_3 n_{it} + c_4 x_i + c_5 z_i + \epsilon_{3it} \tag{3}$$

This system is identified only if the instruments z_i satisfy:

$$c_5 \neq 0 \tag{4}$$

$$Cov(z, \epsilon_1) = 0 \tag{5}$$

$$Cov(z, \epsilon_2) = 0 \tag{6}$$

In this system, n_{it} refers to log employment levels in a given MSA, i, and a given year, t. A is the intercept, with the subscript referring to its respective equation. α is the coefficient describing the rate at which city employment responds to road provision. r_{it} is the log highway interstate miles in a given MSA and year. λ is a coefficient describing the rate at which current log city employment in the next year responds to log city employment in the current year. c_1, c_2, c_4 are coefficient vectors describing the control vectors for their respective models. x_i is a vector of our control variables. c_3 is a coeffecient describing the response of r_{it} to e_{it}, that is how current road stock responds to current employment levels. c_5 is a coefficient vector describing the relationship of our instrumental variables to r_{it}. z_i is a vector of three instrumental variables for r_{it}. ϵ is the unobserved error of its respective equation.

Equation 3 introduces our instrumental variables and is necessary because employment levels and road stock levels are likely subject to reverse causality. High employment may drive increases in road stock, e.g. increased employment causes increased congestion and signals that more roads will be used, so a city builds more roads. Alternately–and inefficiently–road stock may increase as an attempted stimulus response to low employment. The current political system for funding highway building often favors MSAs with decreased levels of employment, expecting new roads to trigger employment growth. The premise of this attempted stimulus is often counterfactual to reality and an inefficient use of resources. Given this information, it is likely that current interstate highway stock is endogenous to our estimating equation.

Equations 4, 5, and 6 are the criteria that must be met to treat our selected instruments as exogenous. Equation 4 is a relevancy condition indicating that an instrument does in fact have a relationship with our endogenous variable. Equations 5 and 6 are exogeneity conditions, indicating that our instruments are not correlated with the unobservable error component of equations 1 and 2.

As stated in the foregoing section, our three instrument variables are 1528-1850 exploration routes, 1898 railroad routes, and planned 1947 highway routes. While interstate highway stock in year t likely has reverse causality with employment levels in year t, these instrument variables are plausibly exogenous. These three routes, particularly given their creation at times when road construction technology was limited, are generally derived from terrain elements. Early exploration routes, the railroads, and the planned 1947 highway route, were largely dictated based on how easily one could navigate or clear a specific corridor for transportation, how well these routes intersected with commercial nodes such as cities and rivers, and how well these routes could drive benefits for the non-municipal entities that created them.

Our estimation requires IV estimation to establish a causal inference, but we also conduct a descriptive OLS estimation. This descriptive estimation is useful in understanding the nature of the relationships described by our empirical model. Additionally, the differences between OLS and IV estimation provide additional evidence confirming the existence of endogeneity in a city's interstate highway stock.

In our estimations, the variables most important to our research question are the change in a city's log employment and the city's log interstate highway stock. These are our outcome and treatment variables, representing the causal chain underpinning this research. The identifying variation in X_i comes after using our instruments. Our instruments establish a baseline level of roads unique to MSAs that allows for additional interstate highway stock to be as good as random. Additionally, applying population controls to our observation MSAs improves identification. Multiple iterations of our model add geographic, socioeconomic, and census division controls. However, estimation appears robust in models foregoing the use of these additional controls.

To interpret our empirical results as a causal, we make the following assumptions. First, causal inference depends on the relevance of our instruments to the r_{it} variable and exogeneity to equations 1 and 2. Second, we assume the treatment effect is conditionally independent of individual unobservable characteristics that could bias our causal estimation. Based on intuition, we assess that we appropriately control for individual variation.

6 Results

We first utilized ordinary least squares regressions to estimate equations 1 and 2 where we obtained identical results to the original authors. The equation 1 coefficients indicates how a 1% increase in initial road stock impacts the percent change in employment between 1983 and 2003. Equation 2 predicts how a 1% increase in original highway stock impacts the percent change of growth of highways between 1983 and 2003. Since these OLS models fail to account for the endogeneity in the model, the results fail to provide causal inference and instead are included for descriptive purposes. These models also indicate whether any of our initial assumptions are correct based on the signs of the coefficients.

The regression results are shown in Table 2 below and the table is separated into Panel A and Panel B. Panel A shows the results from equation 1 estimations while Panel B presents equation 2 results. Column 1 can be thought of as our naive hypothesis, and only controls for initial highway stock and initial employment. Column 2 adds regressors for the decennial populations and Column 3 accounts for geographic factors. Column 4 includes interaction terms and squares the geographic controls for percent of an MSA over an aquifer, elevation, and ruggedness. Column 5 includes covariates for socioeconomic factors from 1980. Column 6 adds indicators for census divisions. Column 7 utilizes near identical specifications to Column 3; however, the initial road measurement utilizes measurements from a 1980 United States Geological Survey (USGS) road map. Column 8 does have identical controls to Column 3, but the dependent variable does not measure road or employment growth, but rather population growth.

Table 2: OLS Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Employment or Population Growth								
ln(Int. Hwy km_83)	0.073***	0.074***	0.061***	0.060***	0.042***	0.030**		0.056***
	(0.017)	(0.013)	(0.014)	(0.014)	(0.014)	(0.015)		(0.014)
ln(Emp_83)	-0.086***	-0.239	-0.258	-0.263	-0.258	-0.254	-0.272	0.260***
	(0.020)	(0.192)	(0.192)	(0.193)	(0.218)	(0.226)	(0.189)	(0.077)
ln(USGS maj. roads_80)							0.174***	
							(0.030)	
N	227	227	227	227	227	227	227	227
R^2	0.115	0.434	0.467	0.476	0.528	0.587	0.459	0.644
Panel B: Road Growth								
ln(Int. Hwy km_83)	-0.518***	-0.527***	-0.541***	-0.546***	-0.558***	-0.544***		
	(0.101)	(0.104)	(0.108)	(0.109)	(0.104)	(0.089)		
ln(Emp_83)	0.337***	0.306**	0.287**	0.276**	0.186*	0.121	0.254*	
	(0.067)	(0.119)	(0.117)	(0.119)	(0.106)	(0.098)	(0.148)	
ln(USGS maj. roads_80)							-0.224	
							(0.138)	
N	227	227	227	227	227	227	227	
R^2	0.538	0.547	0.562	0.566	0.592	0.628	0.060	

Although the OLS results are informative, the primary focus of the work is to find causal effects using instrument variables. Our work differs from the initial author's in that we utilize two stage least squares (2SLS) instead of limited information maximum likelihood (LIML) to conduct our IV analysis. Despite the change from the original work, our IV estimates are nearly identical to the LIML results. The 2SLS results are shown in Table 3 and the columns for this table correspond with Table 2's columns. It should be noted that the authors' preferred specification is the Column 3 specification, so all results refer to these columns.

Table 3: IV Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Employment or Population Growth								
ln(Int. Hwy km_83)	0.118**	0.154***	0.149***	0.154***	0.124**	0.093*		0.126***
	(0.050)	(0.037)	(0.043)	(0.046)	(0.053)	(0.051)		(0.029)
ln(Emp_83)	-0.110***	-0.256	-0.267	-0.268	-0.272	-0.276	-0.303	0.244***
	(0.034)	(0.190)	(0.188)	(0.187)	(0.209)	(0.211)	(0.187)	(0.075)
ln(USGS maj. roads_80)							0.283***	
							(0.066)	
N	227	227	227	227	227	227	227	227
R^2	0.094	0.371	0.398	0.399	0.474	0.560	0.428	0.589
Panel B: Road Growth								
ln(Int. Hwy km_83)	-0.278***	-0.291**	-0.267**	-0.269**	-0.285**	-0.252*		
	(-3.37)	(-3.23)	(-2.78)	(-2.84)	(-2.85)	(-2.46)		
ln(Emp_83)	0.212***	0.255*	0.258*	0.261*	0.138	0.0175	0.336*	
	(4.41)	(2.30)	(2.30)	(2.25)	(1.53)	(0.18)	(1.97)	
ln(USGS maj. roads_80)							-0.514*	
							(-2.38)	
N	227	227	227	227	227	227	227	
R^2	0.427	0.445	0.437	0.442	0.478	0.519	0.018	

The most important result from Table 3 shows that a 1% increase in initial roads leads to approximately a 1.5% increase in employment in the years from 1983 to 2003. However, this is not where out study concluded. We then extended the previous work by considering how the IV results differ based on different regions. The four regions in the model include the South, Northeast, Midwest, and West. Table 4 presents the results of these regressions with the employment growth model. Column 1 presents our South region results while Column 2 reports Midwest results. Columns 3 and 4 include Northeast and West region results respectively. All of the regional IV models utilized the author's preferred Table 3 Column 3 specifications.

Table 4: Regional IV Log Growth

	South	Midwest	Northeast	West
ln(Int. Hwy km_83)	0.152	0.111*	0.0158	0.0615
	(1.34)	(1.71)	(0.67)	(0.73)
ln(Emp_83)	-0.0586	-0.610***	-0.0156	-0.0509
	(-0.48)	(-2.73)	(-0.15)	(-0.41)
Observations	92	64	31	40
R^2	0.457	0.561	0.754	0.604

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

When looking at the impact of highways on employment at the regional level, most results are statistically insignificant. The one regional exception is in the Midwest. Reported coefficients for the log of 1983 highways and log of 1983 employment are significant at the 90% level and 99% level respectively. These coefficients indicate that a 10% increase in a Midwestern MSA's initial road stock leads to a 1.11% increase in employment in the following 20 years. A 10% increase in initial employment levels leads to a 6.1% decrease in subsequent employment over the next 20 years. The first result is smaller and the second result is more negative than the national results presented in Table 3. It seems plausible that both these results can be partially explained by factors occurring in the Midwest at the time. With the study focusing on the year of 1983 to 2003, these figures are almost certainly impacted by the overlap of this research with the decline of the manufacturing sector in this region.

Our extension also highlighted the second dependent variable of the log change in roads that the study highlighted. The results from these IV models are in Table 5. The columns are identical to those in table 4. Once again, these estimates utilize the Table 3 Column 3 specification that the authors prefer for this model.

Table 5: Regional IV Log Road Growth

	South	Midwest	Northeast	West
ln(Int. Hwy km_83)	-0.278*	-0.258*	-0.694***	-0.338**
	(-1.95)	(-1.91)	(-3.50)	(-2.53)
ln(Emp_83)	0.143	0.167	0.406	0.159
	(0.90)	(1.31)	(0.53)	(0.72)
Observations	92	64	31	40
R^2	0.456	0.468	0.862	0.546

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The results of our Table 5 extension present statistically significant figures for all regional coefficients for the log of initial roads. The results for the South and Midwest are extremely similar to the national results in Table 3 column 3. However, the magnitude for the Northeast and West regions is much larger and more negative than the same coefficient for all US cities. The size of the Northeastern coefficient was particularly notable and is the only result in Table 5 that is statistically significant at the 99% level. This result suggests that a 10% increase in initial highway stock for an MSA in this area leads to 6.94% decrease in road growth from the base year of 1983 to 2003. This figure, though large, does make sense because many Northeastern cities are much less reliant on highway infrastructure for commuting. An example of this is metro systems in Boston and New York that residents can rely on as an alternative to driving. No results regarding initial employment were statistically indistinguishable from zero.

7 Conclusion

Using the work of Duranton and Turner to better understand the impact of the interstate highway system on city and MSA growth, we set out to replicate and expand on their results. Due to endogeneity concerns with the covariate of the initial highway stock, we implemented instrumental variables to enable causal inference in our models. In doing so we produced near identical results to the authors at the national-level with the differences being a result of our decision to utilize two-stage least squares in place of limited information maximum likelihood. The most significant result at the national scale indicated that a 10% increase in initial highways caused employment to grow by approximately 1.5% in the study's timeframe. By evaluating how these results varied by region we indicated that this growth is different in the Midwest which is likely a result of regional economic trends. Further, our extension also indicated that an increase in initial road stock led to a sharp decrease in the growth of future roads in the Northeast which reflects the variety of commuting options available in this region. As future researchers draw from the original work of Duranton and Turner and our extension, we believe that other measures of growth can be informative. Particularly, measuring the impact of initial road stock on GDP growth while also considering employment growth can account for the quality of jobs that are being created as a result of the highway system.

References

[1] BAUM-SNOW, N. (2007), "Did Highways Cause Suburbanization?", *Quarterly Journal of Economics*, 122, 775–805.

[2] BRANDILY, P., RAUCH, F. (2024). Within-city roads and urban growth. *Journal of Regional Science*, 64, 1236–1264. https://doi.org/10.1111/jors.12699

[3] FERNALD, J. G. (1999), "Roads to Prosperity? Assessing the Link Between Public Capital and Productivity", *American Economic Review*, 89, 619–638.

[4] GILLES DURANTON, MATTHEW A. TURNER, Urban Growth and Transportation, *The Review of Economic Studies*, Volume 79, Issue 4, October 2012, Pages 1407–1440, https://doi.org/10.1093/restud/rds010180-191. 10.9734/ajeba/2025/v25i51793.

[5] HOPE, JEMIMA PRAH, LIN Adukpo, TOBIAS. (2025). Urban Infrastructure Investments and Economic Growth: Examining the Impact of Transportation, Utilities, and Broadband Expansion in the United States. *Asian Journal of Economics Business and Accounting*. 25. 180-191. 10.9734/ajeba/2025/v25i51793.

[6] MELO, P. C., GRAHAM, D. J. and NOLAND, R. B. (2009), “A Meta-analysis of Estimates of Urban Agglomeration Economies”, *Regional Science and Urban Economics*, 39, 332–342.

[7] PUGA, D. (2010), “The Magnitude and Causes of Agglomeration Economies”, *Journal of Regional Science*, 50, 203–219.

[8] ROSENTHAL, S. S. and STRANGE, W. C. (2004), “Evidence on the Nature and Sources of Agglomeration Economies”, in Vernon Henderson, J. and Thisse, J.-F. (eds) *Handbook of Regional and Urban Economics*, Vol. 4 (Amsterdam: North-Holland) 2119–2171.

[9] SMALL, K. A. and VERHOEF, E. T. (2007), *The Economics of Urban Transportation* (New York: Routledge).