DOES RAILWAY LINES INVESTMENTS MATTER FOR ECONOMIC GROWTH?

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Outline

- Introduction
- Objectives
- Literature review
- Methodology
- Results
- Conclusions
- Direction for future research

Introduction

- Infrastructure is the backbone of every nation's growth and prosperity (Canning & Pedroni, 2004; Holtz-Eakin & Schwartz, 1995).

- McBride & Moss (2020) indicated that 1% increase in infrastructure spending adds 1.5 million jobs to the US economy

- Globally, spending on infrastructure amounts to $2.7 trillion a year when it should be $3.7 trillion (World Economic Forum report, 2016).

- In the United States, the infrastructure gap is largely seen in almost all the sectors of the economy (American Society of Civil Engineers, 2017)

Introduction, con't.

- McKinsey researchers have indicated that the US requires about $150 billion per year between 2017 and 2030 to meet the country's infrastructure needs (McBride & Moss, 2020)

- For example, public spending on transportation and water as a share of GDP in the US declined from 3.0% in 1959 to 2.4% of GDP in 2014 (Sherraden, 2011)

- Also, the railway industry in the US alone requires $200 billion in investment by 2035 to meet projected future demand (Dovell, 2012)

- Bloomberg report (2016) indicated that China spends more on infrastructure than the US and other Western European Countries combined

Figure 1: Actual and projected infrastructure spending as a percent of GDP for G-20 countries.

- Actual infrastructure spending covers (2010-2015)
- Projected infrastructure spending covers (2016-2040).
- Source: Bloomberg (2016)

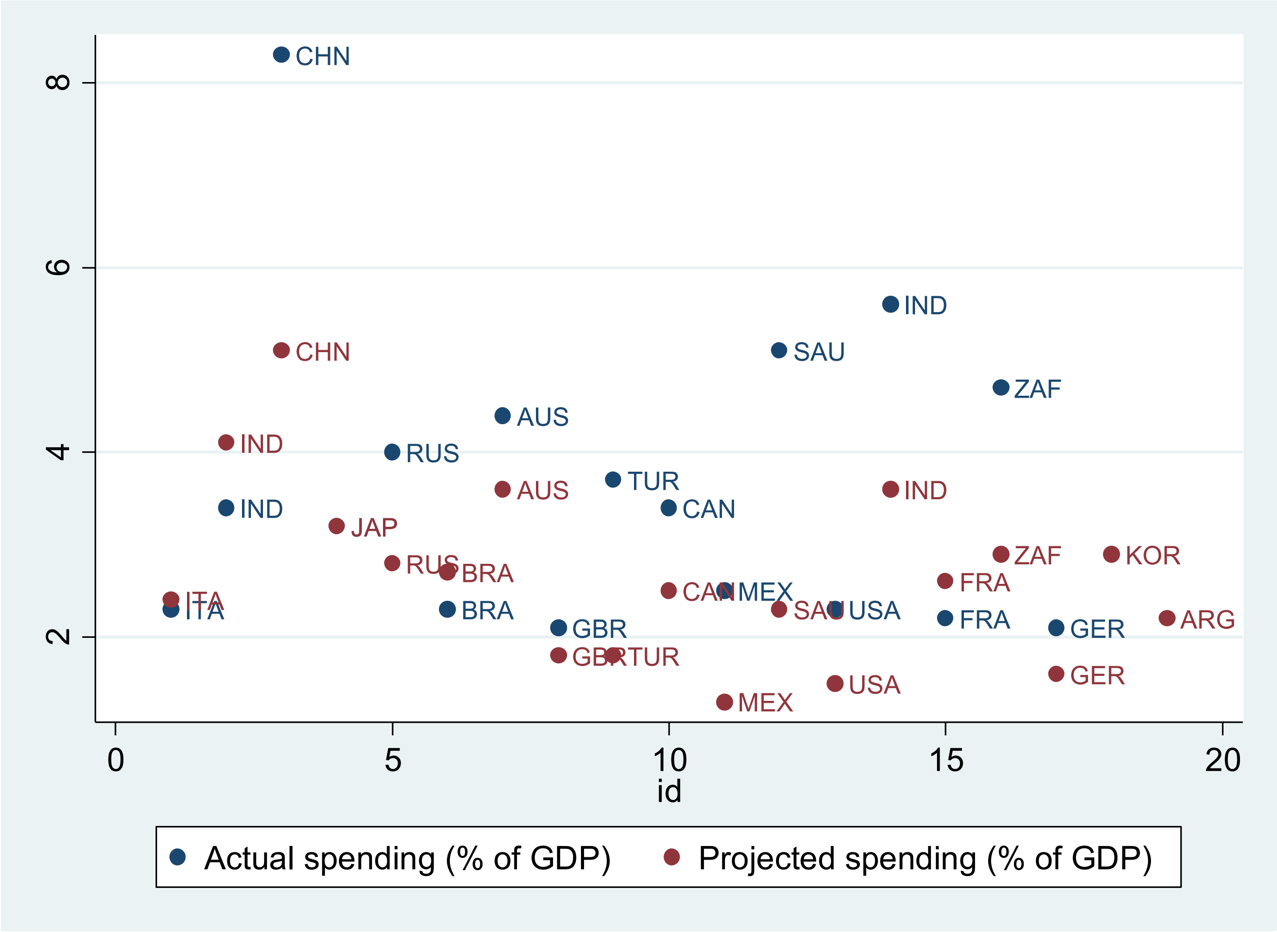
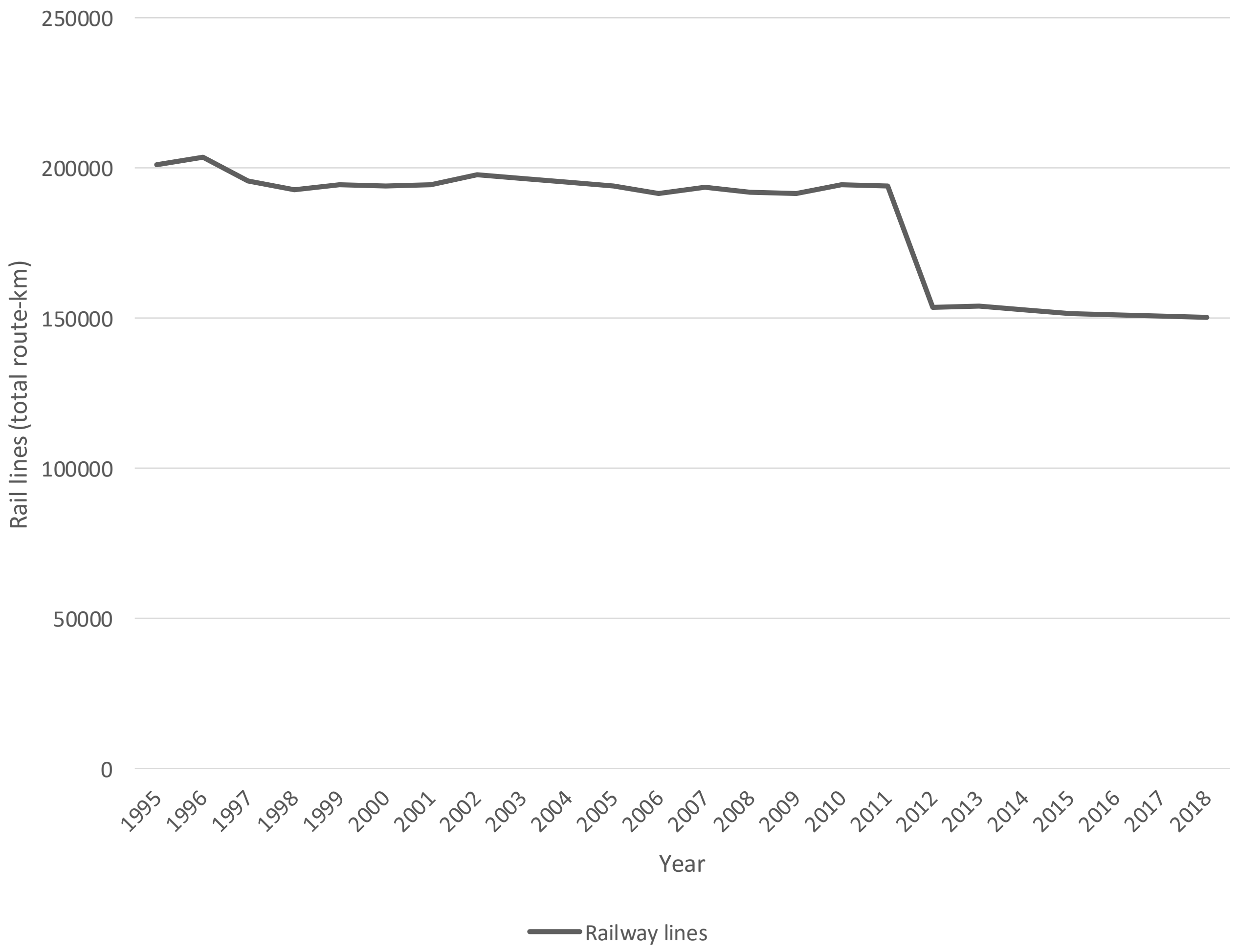


Figure 2. Trends in Rail lines (total route-km) in the U.S. from 1995 to 2018

- The total rail lines (km) in the US has declined from **201,284** km in 1995 to **150462.29** km in 2018 (ASCE, 2012)

- The declining trend in railway lines calls for the need to examine its effect on economic growth



Objectives

1. To examine the effect of railway lines on economic growth in the US

2. To examine how shocks to railway lines affect economic growth

3. To examine the proportion of railway lines to the variations in economic growth overtime

Literature review

- **Canning and Pedroni (2004)-**panel, 1950-1992
  - infrastructure does induce long-run growth effects

- **Alam et al. (2020) –**Pakistan, ARDL, 1971-2017
  - transport infrastructure positively impact on economic growth

- **Esfahani and Ramirez (2003)** -cross-country analysis
  - **i**nfrastructure services contributed significantly to GDP more than the cost of provision of those services

- **Czernich, Kretschmer, and Woessmann (2011)-**OECD countries, 1996-2007
  - 10%-point increase in broadband penetration increases annual GDP per capita growth by 0.9-1.5%

- **Cronin et al. (1991) –US,** 1958-1988
  - bi-causality between economic activity and telecommunications investment

- **Sahoo and Dash (2009) –India,** 1970-2006
  - infrastructure stocks play an important role in economic growth.
  - infrastructure development impact growth more than infrastructure investments.
  - unidirectional causality running from infrastructure development to output growth.

- **Aschauer (1989)**
  - infrastructure of streets, highways, airports, mass transit, sewers, and water systems has most explanatory power for productivity

Model

- The Solow-Swan growth model was employed:

$$Y_t = K_t^{\alpha} L_t^{1-\alpha} A_t \qquad (1)$$

- Where Y is economic growth, K is capital, L is labor or population growth, A is productivity, and t is time

- It is assumed that productivity can be influenced by available railway lines

$$A_t = \varphi RAIL_t^{\delta} Z_t^{\mu} \qquad (2)$$

- where A is technology, RAIL is railway lines, and Z is other exogenous factors that may influence productivity.

- Putting Eq (2) into Eq (1), Eq (3) is obtained:

$$Y_t = \varphi RAIL_t^{\delta} K_t^{\alpha} L_t^{1-\alpha} Z_t^{\mu} \qquad (3)$$

Model

- By taking logs, Equation (3) can be linearized as follows:

$$Y_t = \vartheta_0 + \vartheta_1 K_t + \vartheta_2 L_t + \vartheta_3 RAIL_t + \mu_t \qquad (4)$$

- I adapt Eq 4 and specified the empirical model as follows:

$$lnY_t = \pi_0 + \pi_1 lnPOP_t + \pi_2 lnRAIL_t + \pi_3 lnINF_t + \varepsilon_t \qquad (5)$$

- Where Y is real GDP per capita growth rates, POP is population, RAIL is railway lines, and INF is inflation.

Data

Variable	Description	Measurement	Source	Expected Sign
GDP	Gross Domestic Growth	log of real GDP per capita growth	WDI	
POP	Population	Log of population, total	WDI	+
RAIL	Railway lines	Railway lines (total-route km)	WDI and Canning (1998)	+
INF	Inflation	Consumer Prices Index, inflation (annual %) (2010=100)	WDI	-

Estimation

- To examine the dynamic interactions among the variables, the vector autoregressive analysis (VAR) was employed.

- The mathematical representation of the VAR model is specified below:

    - $Y_t = \emptyset + \varsigma t + \eta_1 Y_{t-1} + \cdots + \eta_p Y_{t-p} + \mu_1 X_{t-1} + \cdots + \mu_p X_{t-p} + \epsilon_t$ (6)

Results

- **Table 1: Summary Statistics**

	GDP	RAIL	POP	INF
Mean	41440.12	204620.0	2.75E+08	4.280994
Median	42292.89	213258.1	2.76E+08	4.314222
Maximum	52364.24	265841.9	3.23E+08	4.701089
Minimum	28362.49	157515.3	2.27E+08	3.632006
Std. Dev.	7625.379	34615.45	30343204	0.310222
Skewness	-0.233529	-0.012794	-0.011560	-0.375592
Kurtosis	1.683221	1.642415	1.663814	2.012558
Jarque-Bera	3.009411	2.842359	2.753306	2.373120
Probability	0.222083	0.241429	0.252422	0.305270
Sum	1533285.	7570940.	1.02E+10	158.3968
Sum Sq. Dev.	2.09E+09	4.31E+10	3.31E+16	3.464549

Results

- **Table 2: Unit Root Test-Augmented Dickey-Fuller (Levels)**
- Note: D indicates first differenced. O.I. indicates order of integration

Var	ADF		Var	ADF		OI
	Statistic	P-Value		Statistic	P-Value	
GDP	- 1.575061	0.4844	DGDP	-4.071916	0.0032***	I(1)
INF	-1.285550	0.6256	DINF	-5.229337	0.0001***	I(1)
RAIL	-1.740028	0.4032	DRAIL	-5.151709	0.0002***	I(1)
POP	-2.087603	0.2507	DPOP	-2.514300	0.0023***	I(1)

Results

- **Table 3: Unit Root Test-Phillip-Perron (Levels)**
- Note: D indicates the first difference. O.I. indicates the order of integration.

Var	P.P.		Var	PP		OI
	Statistic	P-Value		Statistic	P-Value	
GDP	-1.730613	0.4078	DGDP	-3.980499	0.0041***	I(1)
INF	-1.212191	0.6585	DINF	-5.225837	0.0001***	I(1)
RAIL	-1.803546	0.3729	D RAIL	-5.170156	0.0002***	I(1)
POP	0.028257	0.9551	DPOP	-1.481248	0.0031***	I(1)

Results

Table 4: Lag Order Selection Criteria
*indicates lag order selected by the criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	202.9778	NA	9.70e-11	-11.70458	-11.52501	-11.64334
1	472.9480	460.5373	3.18e-17	-26.64400	-25.74614	-26.33780
2	501.3922	41.82975*	1.60e-17	-27.37601	-25.75987*	-26.82486*
3	520.1817	23.21054	1.52e-17*	-27.54010*	-25.20567	-26.74399

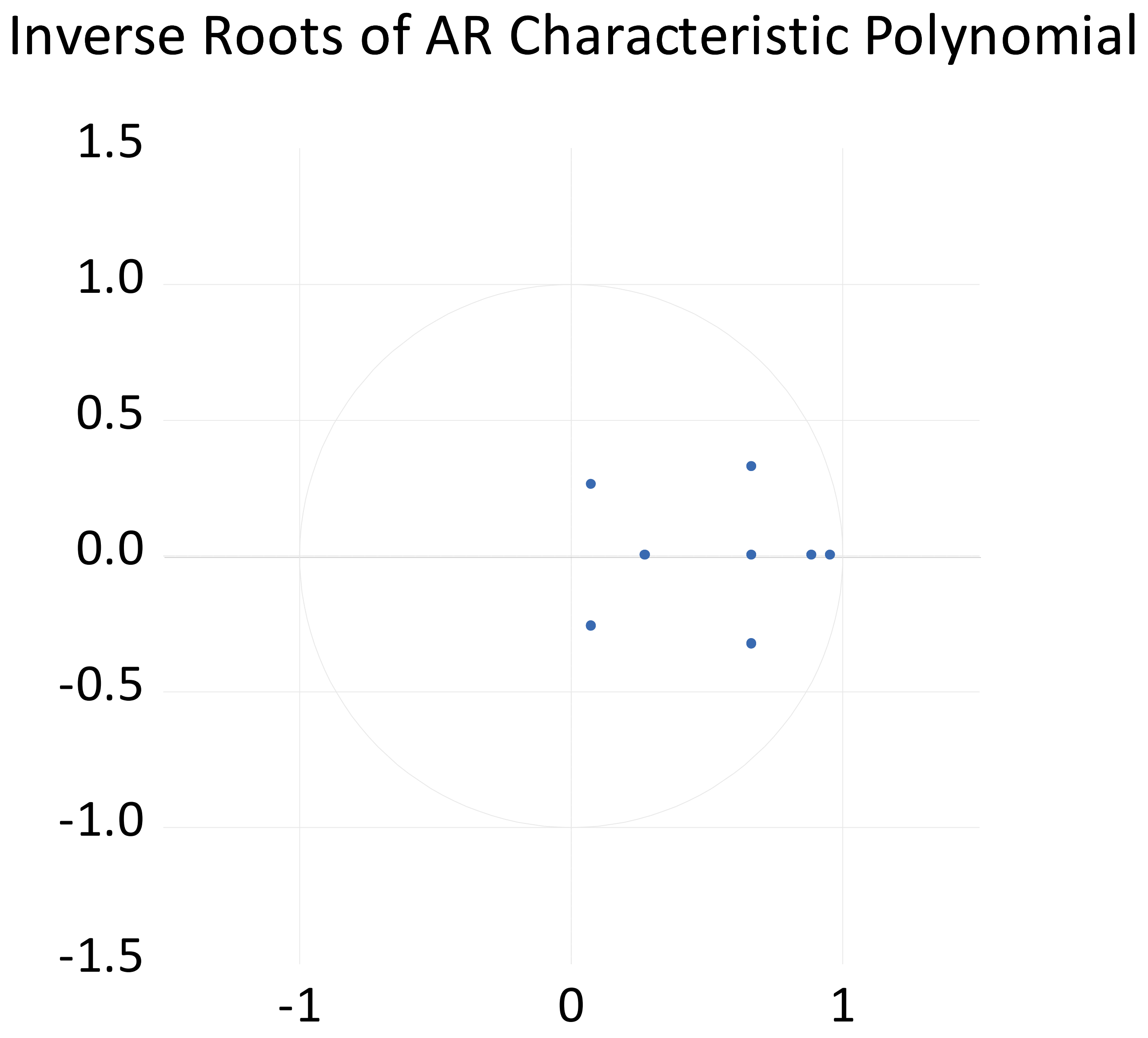
Table 5: VAR Results

Note: *t-Statistic in bracket.*

	GDP	POP	RAIL	INF
GDP(-1)	0.787182	0.001321	-0.059251	0.169337
	[6.76773]	[0.21966]	[-0.07819]	[1.47723]
GDP(-2)	-0.173112	0.000802	0.143704	-0.060777
	[-1.63832]	[0.14686]	[0.20876]	[-0.58363]
POP(-1)	-5.382995	1.533608	-6.770448	-0.120946
	[-2.61649]	[14.4203]	[-0.50515]	[-0.05965]
POP(-2)	5.605462	-0.595563	7.495027	0.068383
	[2.91687]	[-5.99516]	[0.59867]	[0.03611]
RAIL (-1)	0.009688	-0.000883	0.829539	0.008404
	[0.33126]	[-0.58374]	[4.35384]	[0.29158]
RAIL (-2)	-0.102516	-0.000112	0.004492	-0.003304
	[-3.14963]	[-0.06631]	[0.02118]	[-0.10300]
INF(-1)	-0.672325	0.035036	0.881448	1.130302
	[-3.56764]	[3.59655]	[0.71797]	[6.08588]
INF(-2)	0.756679	-0.014652	-1.118515	-0.199743
	[5.36658]	[-2.01024]	[-1.21768]	[-1.43742]
C	0.639147	1.109239	-11.89236	0.125355
	[0.15178]	[5.09584]	[-0.43351]	[0.03021]

Results

Figure 3: Inverse Roots of AR Characteristic Polynomial



Results

- **Table 6: Unrestricted Cointegration Rank Test (Trace)**
- Trace test shows 4 cointegrating eqn(s) at the 0.05 level

Hypothesized		Trace	0.05	
			Critical	
No. of C.E. (s)	Eigenvalue	Statistic	Value	Prob.**
None *	0.657648	87.97117	47.85613	0.0000
At most 1 *	0.521600	51.52606	29.79707	0.0000
At most 2 *	0.410952	26.45758	15.49471	0.0008
At most 3 *	0.220355	8.463174	3.841465	0.0036

Results

- **Table 7: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**
- Max-eigenvalue test shows 2 cointegrating eqn(s) at the 0.05 level

Hypothesized		Max-Eigen	0.05	
			Critical	
No. of C.E. (s)	Eigenvalue	Statistic	Value	Prob.**
None *	0.657648	36.44511	27.58434	0.0028
At most 1 *	0.521600	25.06848	21.13162	0.0132
At most 2 *	0.410952	17.99441	14.26460	0.0123
At most 3 *	0.220355	8.463174	3.841465	0.0036

Results-Long run

- $GROWTH_{t-1} = 13.53295 - 1.381406POP_{t-1} + 0.194654RAIL_{t-1} + \ 0.072326INF_{t-1}$

  [-2.51472] [5.45629] [0.36844]

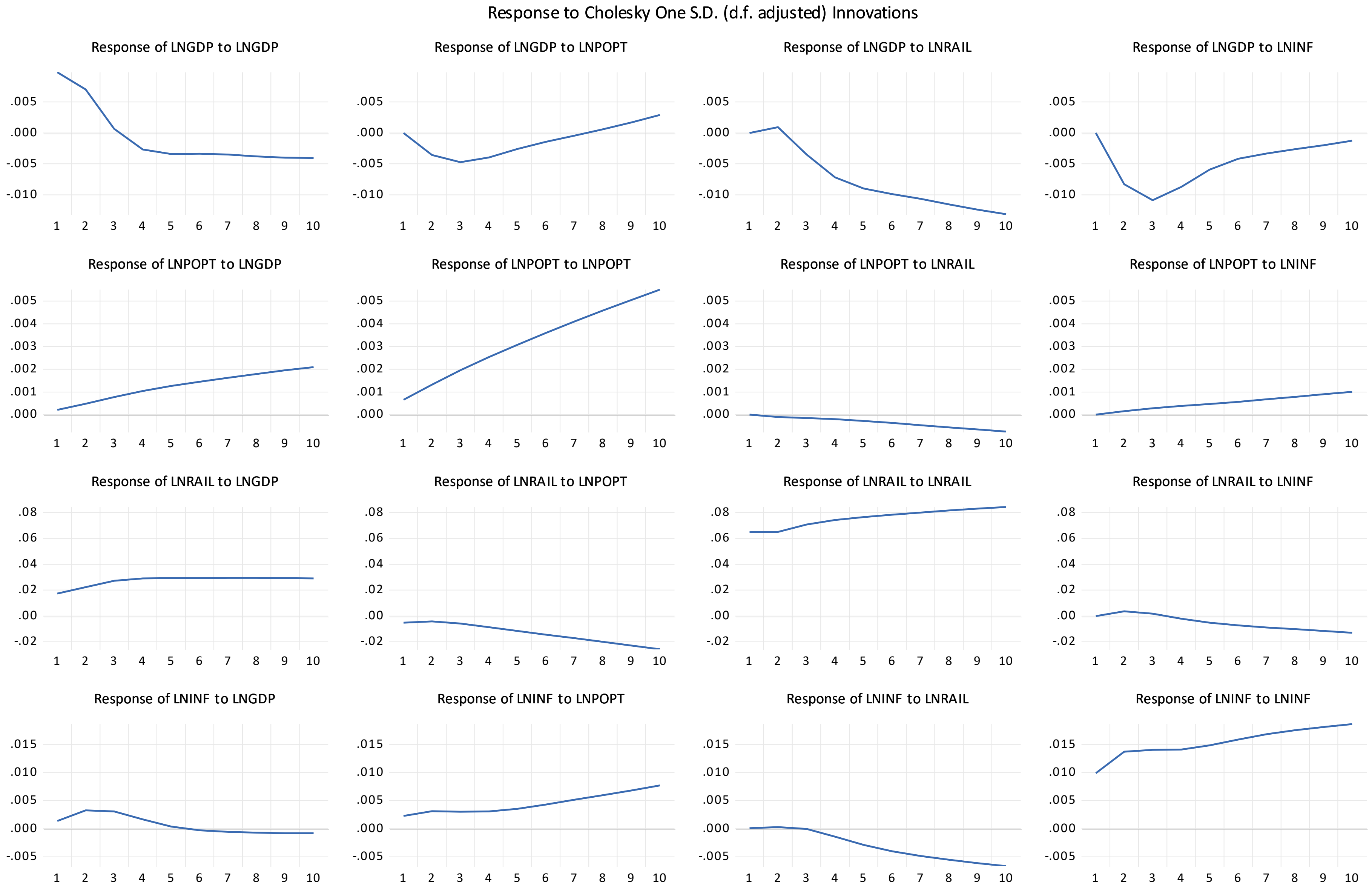
- A 1% increase in railway lines leads to about 0.195% increase in economic growth in the long run

- Suggesting that investments in railway network promote economic growth.

Table 9: VECM Results (Short-Run Estimates)

- Note*: t-Statistic in bracket*

Variable	DGDP	DPOP	DRAIL	DINF
CointEq(-1)	-0.350648	0.002963	0.418280	-0.044181
	[-8.00128]	[0.96712]	[1.39168]	[-0.96310]
DGDP(-1)	0.206608	0.004668	0.024373	0.181570
	[2.26004]	[0.73042]	[0.03887]	[1.89743]
DPOP(-1)	-2.891140	0.969226	0.958083	-0.080036
	[-2.72978]	[13.0899]	[0.13190]	[-0.07219]
DRAIL(-1)	0.084434	-0.002117	-0.078778	0.010591
	[2.76482]	[-0.99138]	[-0.37613]	[0.33132]
DINF(-1)	-0.813770	0.014882	0.341342	0.389960
	[-7.27621]	[1.90339]	[0.44502]	[3.33101]
C	0.066578	-0.000310	-0.024381	0.013729
	[5.75080]	[-0.38343]	[-0.30707]	[1.13293]
R^2	0.766348	0.888065	0.085103	0.472838


Response to Cholesky One S.D. (d.f. adjusted) Innovations
Response of LNGDP to LNGDP
Response of LNGDP to LNPOPT
Response of LNGDP to LNRAIL
Response of LNGDP to LNINF
Response of LNPOPT to LNGDP
Response of LNPOPT to LNPOPT
Response of LNPOPT to LNRAIL
Response of LNPOPT to LNINF
Response of LNRAIL to LNGDP
Response of LNRAIL to LNPOPT
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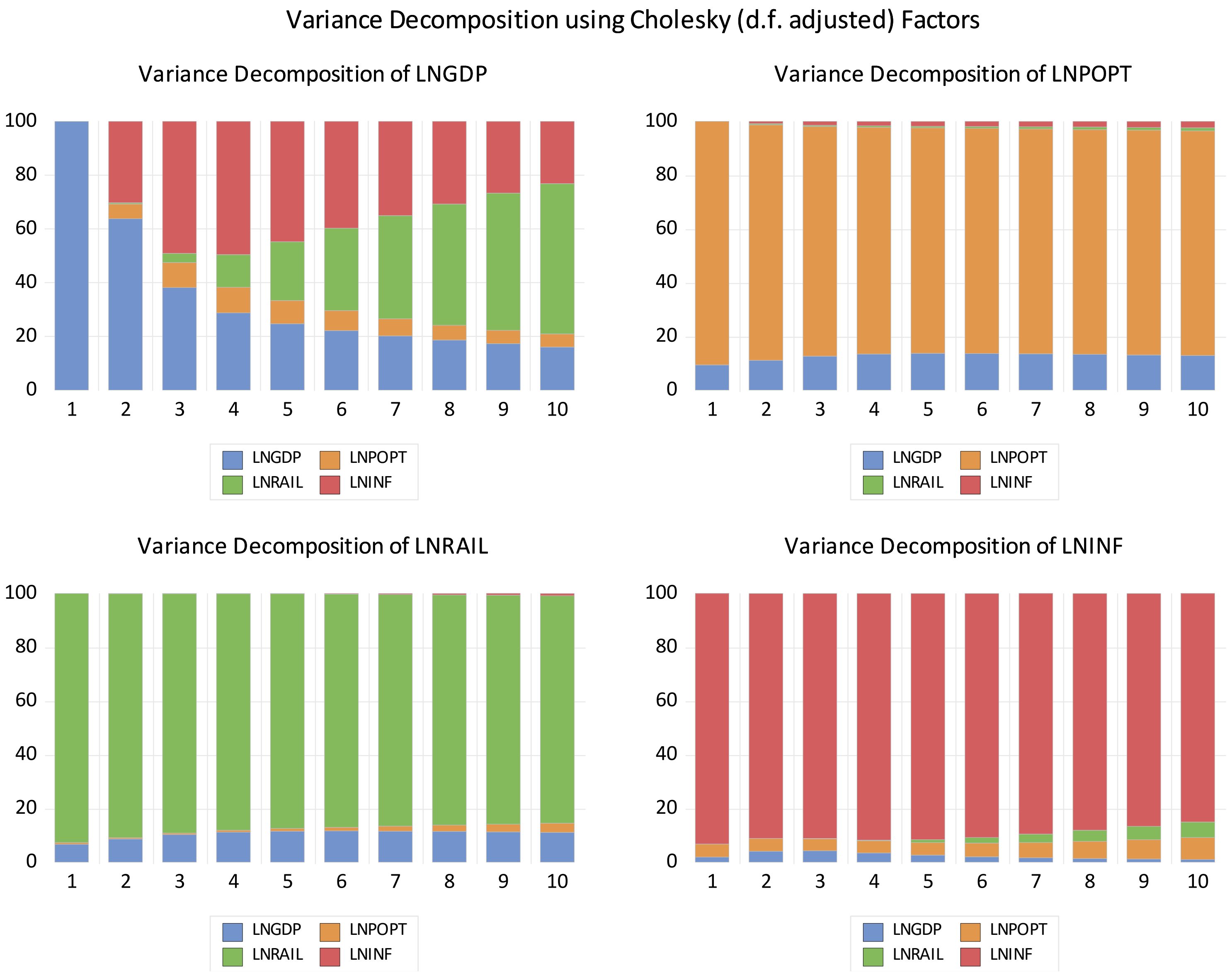
Response of LNINF to LNRAIL
Response of LNINF to LNINF



Variance Decomposition using Cholesky (d.f. adjusted) Factors
Variance Decomposition of LNGDP
Variance Decomposition of LNPOPT
Variance Decomposition of LNRAIL
Variance Decomposition of LNINF
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
LNGDP
LNPOPT
LNRAIL
LNINF

Conclusions

- The main objective of this paper was to examine the effect of railway lines on economic growth in the U.S. using annual data from 1980-2016 and cointegration analysis.
- The results from the study revealed a positive and statistically significant effect of railway lines on economic growth in the long run and short run
- The IRF indicates that shocks to railway lines initially cause GDP growth rates to increase and then continuously decrease.
- The VDA showed that railway lines contribute nearly 60% to the total variations in economic growth hence, suggesting that railway lines matter for economic growth
- The study recommends increased investments in railway lines to increase economic growth in the US.

Direction for further research

- It is likely that state-level variations in railway spending could explain why some states in the US do better economically than others.

- As a result, the study recommends future studies to use US state-level data and panel analysis to examine the effect of railway lines on economic growth.