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Does Financial Penetration Cause Transportation and Economic Growth

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Abstract

The study brings the interactions between financial penetration, transportation infrastructure and economic growth in G-20 countries during 1961-2016. The focus is to know the causality between these variables, one way, both ways, or not at all. The empirical results show that both financial penetration and transportation infrastructure causes economic growth in the G-20 countries.

Keywords: Financial penetration, transportation infrastructure, economic growth, G-20 countries

1. Introduction

The importance of transportation and economic growth has received much attention in the development literature (see, for instance, WDR, 1994; Banister, 2012). Whether transportation infrastructure and economic growth should go together has long been debated. There is a copious amount of empirical literature that scrutinizes the experiences of the relationship between transportation infrastructure and economic growth in both developed and developing

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countries (see, for instance, Achour and Belloumi, 2016; Hakim and Merkert, 2016; Mohmand et al., 2016; Calderon et al., 2015; Farhadi, 2015; Vidyarthi and Sharma, 2014; Deng et al., 2014; Ding, 2013; Button and Yuan, 2013; Chi and Back, 2013; Hulten et al., 2006; Phang, 2003; Jiang, 2001; Oster et al., 1997; Gillen, 1996; WDR, 1994; Munnell, 1992). There are at least three ways we can justify the linkage between transport infrastructure and economic growth. Firstly, transportation infrastructure can enter in the production process as direct input and in many cases as an unpaid factor of production. Secondly, transportation infrastructure may make other existing inputs more productive. Third, transport infrastructure can act as magnet of regional economic growth by attracting resources from other regions, which is called agglomeration (see, for instance, Loo and Banister, 2016; Pradhan and Bagchi, 2013; Kayode et al., 2013; Meerman and Van de Voorde, 2013; Yao and Yang, 2012; Yu et al., 2012; Hong et al., 2011; Marazzo et al., 2010; Khadaroo and Seetanath, 2008; Yamaguchi, 2007; Kasarda et al., 2005; Kawakami and Doi, 2004; Wang, 2002; Nakamura, 2000; Njoh, 2000; Fernald, 1999; Linneker and Spence, 1996).

Empirically, majority of literature use production function approach to examine this linkage and in maximum occasions, the impact is observed from transport infrastructure to economic growth. However, in reality, they have feedback relationship, i.e., the bidirectional causality between the two. Additionally, development literature supports that financial penetration is an important factor that can affect the nexus between transport infrastructure and economic growth. Hence, the objective of this paper is to check how financial penetration can affect the nexus between transport infrastructure and economic growth.

2. Literature Review

The objective of the paper is to know the direction of causality among financial penetration, transportation infrastructure and economic growth. Therefore, we can have here three strands of literature.

The first strand is between financial penetration and economic growth. There can be four equally possible complementary hypotheses between the two: the *supply-leading hypothesis* (SLH[1]) of financial penetration-economic growth nexus, where financial penetration Granger causes economic growth; the *demand-following hypothesis* (*DF*H[1]) of financial penetration-economic growth nexus, where economic growth Granger causes financial penetration; third, the *feedback hypothesis* (FBH[1]) of financial penetration-economic growth nexus, suggests that both financial penetration and economic growth Granger cause each other; and the *neutrality hypothesis* (NEH^{1}) of financial penetration-economic growth nexus, where both financial penetration and economic growth do not Granger cause each other. Pradhan et al. (2017) provides the brief summary of various studies where we find the support of these four hypotheses.

The second strand of literature is between transport infrastructure and economic growth. There can be four equally possible complementary hypotheses between the two: the *supply-leading hypothesis* (SLH^{2}) of transportation infrastructure-economic growth nexus, where transport infrastructure Granger causes economic growth; the *demand-following hypothesis* (*DF*H^{2}) of transport infrastructure-economic growth nexus, where economic growth Granger causes transport infrastructure; third, the *feedback hypothesis* (FBH^{2}) of transport infrastructure-economic growth nexus, suggests that both transport infrastructure and economic growth Granger cause each other; and the *neutrality hypothesis* (NEH^{2}) of transport infrastructure-economic growth nexus, where both transport infrastructure and economic growth do not Granger cause each other. Pradhan and Bagchi (2013) provides the brief summary of the studies where we find the support of these four hypotheses.

The third strand of literature is between financial penetration and transport infrastructure. There can be four equally possible complementary hypotheses between the two: the *supply-leading hypothesis* (SLH^{3}) of financial penetration- transport infrastructure nexus, where financial penetration Granger causes transport infrastructure; the *demand-following hypothesis* (*DF*H^{3}) of financial penetration- transport infrastructure nexus, where financial penetration Granger causes transport infrastructure; third, the *feedback hypothesis* (FBH^{3}) of financial penetration-transport infrastructure nexus, suggests that both financial penetration and transportation infrastructure Granger cause each other; and the *neutrality hypothesis* (NEH^{3}) of financial penetration- transport infrastructure nexus, where both financial penetration and transport infrastructure do not Granger cause each other. To the best of our knowledge, there is scarcity of literature that support these four hypotheses.

2. Hypotheses, Data, Variables, and Empirical Model

This study looks to test the following hypotheses:

H_{1A}: Financial penetration (FIP) Granger causes economic growth (PEG). This is named FIP-led PEG hypothesis.

H_{1B}: Economic growth Granger causes financial penetration. This is termed PEG-led FIP hypothesis.

H_{2A}: Transportation infrastructure (TRI) Granger causes economic growth. This is named TRI-led PEG hypothesis.

H_{2B}: Economic growth Granger causes transportation infrastructure. This is termed PEG-led TRI hypothesis.

H_{3A}: Financial penetration Granger causes transportation infrastructure. This is termed FIP-led TRI hypothesis.

H_{3B}: Transportation infrastructure Granger causes financial penetration. This is named TRI-led FIP hypothesis.

Figure 1 presents these three hypotheses, relating to the causal nexus between transportation infrastructure, financial penetration and economic growth.

The study uses annual data from 1961 to 2016[†] for *G-20* countries were obtained from the *World Development Indicators* of the World Bank. The G-20 contains 19 member countries and the European Union. Thus, though we look at the G-20, within this group of both developed and emerging economies, we observe only 19 member countries, which are used for this investigation. This group has two divisions, based on the World Bank purchasing power parity of their per capita income. First, the developing group of G-20, which entails Argentina, Brazil, China, India, Indonesia, Mexico, the Russian Federation, Saudi Arabia, South Africa, and Turkey. Second, the developed group of G-20, which entails Australia, Canada, France, Germany, Italy, Japan, the Korean Republic, the United Kingdom, and the United States. Figure A.1 represents the map of these countries, while Table A.1 provides their macroeconomic profiles. The choice of this group is due to mix of both developed and developing countries.

The study uses seven different indicators of financial penetration (FIP), namely, commercial bank branches (CBB), depositors with commercial banks (DCB), borrowers from commercial banks (BCB), automated teller machines (ATM), bank accounts (BAA), bank concentration (BAC), and bank branches (BAB). The study uses five

[†] It involves unbalanced panel since data on these variables is not uniformly available for all countries and for all the years during the study period.

indicators of transport infrastructure (TRI), namely, goods carried by air transport (GAT), passengers carried by air transport (PAT), goods carried by railways (GRA), passengers carried by railways (PRA), and rain lines (RAL). The study also uses two composite indices, namely, composite index of financial penetration (CIF) and composite index of transport infrastructure (CIT). CIF is the weighted average seven different indicators of financial penetration (CBB/DCB/BCB/BCB/ATM/BAA/BAC/BAB), while CIT is the weighted average of five different transport infrastructure indicators (GAT/PAT/GRA/PRA/RAL). We use principal component analysis (PCA) to have this composite index. The detailed description of this index formulation is available in Pradhan et al. (2016, 2018). Additionally, we use per capita gross domestic product as an indicator of economic growth.

The study considers eight specifications and six cases, covering different indicators of financial penetration and transport infrastructure. The following vector error correction model (VECM) is deployed to investigate the possible directions of causality among financial penetration, transport infrastructure and economic growth.

$$\begin{bmatrix} \Delta \ln PEG_{it} \\ \Delta FIP_{it} \\ \Delta \ln TRI_{it} \end{bmatrix} = \begin{bmatrix} \alpha_{1j} \\ \alpha_{2j} \\ \alpha_{3j} \end{bmatrix} + \sum_{k=1}^{m} \begin{bmatrix} \mu_{11ik}(L)\mu_{12ik}(L)\mu_{13ik}(L) \\ \mu_{21ik}(L)\mu_{22ik}(L)\mu_{23ik}(L) \\ \mu_{31ik}(L)\mu_{32ik}(L)\mu_{33ik}(L) \end{bmatrix} \begin{bmatrix} \Delta \ln PEG_{it-k} \\ \Delta \ln FIP_{it-k} \\ \Delta \ln TRI_{it-k} \end{bmatrix} + \begin{bmatrix} \delta_{1i} ECT_{it-1} \\ \delta_{2i} ECT_{it-1} \\ \delta_{3i} ECT_{it-1} \end{bmatrix} + \begin{bmatrix} \xi_{1it} \\ \xi_{2it} \\ \xi_{3it} \end{bmatrix} \quad \textbf{(1)}$$

where *i* is the country specification; *t* is the time specification; and ε is the error term. *FIP* is defined as CBB, DCB, BCB, ATM, BAA, BAC, BAB, or CIF; and *TRI* is defined as GAT, PAT, GRA, PRA, RAL, or CIT.

ECT_{-1} is lagged error-correction term, which represents the long-run dynamics among the variables. However, the inclusion of ECT in the model depends upon the specification of the time series variables, which need to be integrated of order one (I (1)) and cointegrated. The null hypotheses of this study are to test the followings:

H_{1A}: $\mu_{12ik} \neq 0$; $\mu_{13ik} \neq 0$; and $\delta_{1i} \neq 0$ **for** $k = 1, 2, 3, ..., m$

H_{1B}: $\mu_{21ik} \neq 0$; $\mu_{23ik} \neq 0$; and $\delta_{2i} \neq 0$ **for** $k = 1, 2, 3, ..., m$

H_{1C}: $\mu_{31ik} \neq 0$; $\mu_{32ik} \neq 0$; and $\delta_{3i} \neq 0$ **for** $k = 1, 2, 3, ..., m$

For knowing the direction of causality between financial penetration, transport infrastructure and economic growth, there exist a number of possible situations. For example, in the first occasion, financial penetration and transport infrastructure can cause economic growth, if $\mu 12ik$ and $\mu 13ik$ are significantly different from zero. Second, economic growth and transport infrastructure Granger-causes financial penetration, if $\mu 21ik$ and $\mu 23ik$ are statistically different from zero. Third, financial penetration and economic growth Granger-causes transportation infrastructure, if $\mu 31ik$ and $\mu 32ik$ are statistically different from zero.

3. Empirical Results and Discussion

We first report the order of integration [‡] and cointegration [§] among financial penetration, transport infrastructure, and economic growth.

The panel unit root tests[**] are used at three levels[††] to examine the order of integration of the variables, while Pedroni panel cointegration is used to know the existence of cointegration between FIP, TRI and PEG in our panel setting. The test results confirm that all the variables are integrated of order one and having cointegration among them. This is accurate for all the eight specifications and six cases in each specification, depending upon the inclusion of different financial penetration and transport infrastructure indicators.

The above findings allow us to apply VECM to examine the Granger causal relationships among these three variables. The results of VECM are reported in Table 2 for the six specifications and five cases we consider.

We first refer to long-run results, discovered by examining the statistical significance of the ECT_{-1} coefficients. Table 2 shows that when ΔFID is the dependent variable, the coefficients are statistically significant at a 1% level.

[‡] This is done by deploying panel unit root tests, which ensure whether a time series variable is non-stationary using VECM.

[§] Cointegration ensures the existence of long-run equilibrium relationship between variables even though short-term departures from equilibrium may exist.

[**] These are Levine-Lin-Chu, Im-Pessaran-Shin, Augmented Dickey Fuller, and Phillips and Perron.

[††] These are *with a constant and deterministic trend, with intercept only*, and *no trend and no intercept*.

This implies that financial depth tends to converge to its long-run equilibrium path in response to change in both banking competition and banking stability. This is true for all the six specifications and five cases that we consider for this investigation process. Therefore, the overall conclusion is that economic growth in G-20 countries is significantly influenced by both financial penetration and transport infrastructure. In other words, to excite economic growth, the requirement is to enhance both financial penetration and transport infrastructure in the G-20 countries.

In the short run, however, the results are mostly non-uniform and varies specification to specification and case to case within a particular case. From these non-uniform results, we find the following important results.

For specification 1 (CBB), the common finding is the bidirectional causality between transportation infrastructure and economic growth; and the unidirectional causality from economic growth to financial penetration. These findings support our both $H_{2A,B}$, and H_{1B}.

For specification 2 (DCB), the common finding is the bidirectional causality financial penetration and economic growth. This finding supports our $H_{1A,B}$.

For specification 3 (BCB), the common finding is the unidirectional causality from economic growth to financial penetration; and the bidirectional causality between transport infrastructure and economic growth. These findings support our both $H_{2A,B}$, and H_{1B}.

For specification 4 (ATM), the common finding is the bidirectional causality financial penetration and economic growth. This finding supports our $H_{1A,B}$.

For specification 5 (BAA), the common finding is the bidirectional causality financial penetration and transport infrastructure. This supports both H_{1A} and H_{1B}.

For specification 6 (BAC), the common finding is the bidirectional causality between transportation infrastructure and economic growth. This finding support our both $H_{2A,B.}$

For specification 7 (BAB), the common finding is the unidirectional causality from economic growth to financial penetration. This finding supports our H_{1B}.

For specification 8 (CIF), the common finding is the bidirectional causality financial penetration and economic growth. This finding support our $H_{1A,B}$.

4. Conclusion

The study aims to examine causal relationships between financial penetration, transport infrastructure, and economic growth simultaneously. We find that they are cointegrated, indicating the existence of long-run relationship. Most importantly, there is clear evidence that both financial penetration and transportation infrastructure matter in the determination of long-run economic growth. The empirical results suggest that to stimulate economic growth in the G-20 countries, policy-makers should give priority to both financial penetration and economic growth in the economy.

Appendix A: G-20 Profile

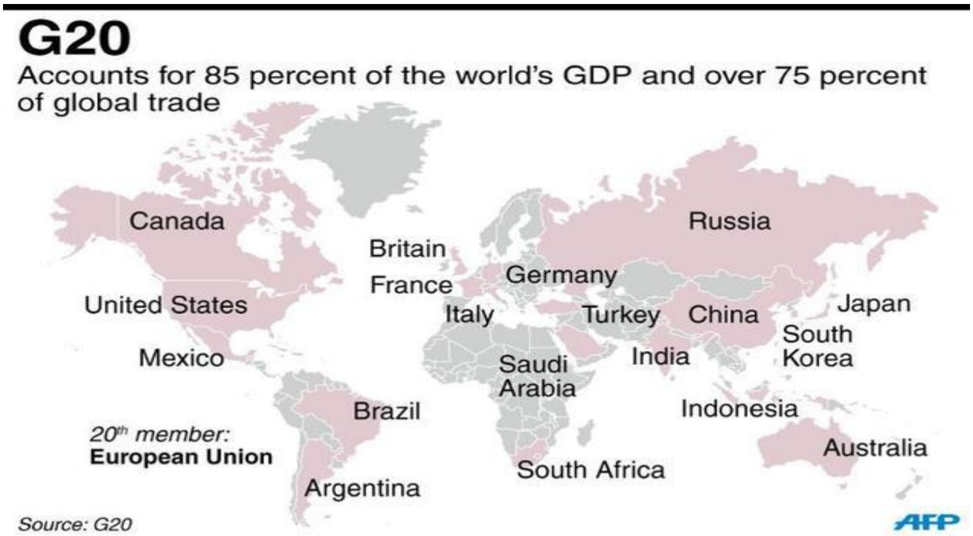

Figure A.1: Mapping of the G-20 Countries

Table A. 1. Macroeconomic Profiles of the G-20 Countries

Countries	POP	GDP+	GDP++	PGDP+	PGDP++	TT	HDI
G-20 Developed Countries							
Australia	24.3	1.26	1.19	51850	48899	0.50	0.939
Canada	36.2	1.53	1.68	42210	46437	0.95	0.920
France	64.6	2.46	2.73	38128	42314	1.21	0.897
Germany	82.7	3.47	3.98	41902	48111	2.87	0.926
Italy	60.7	1.85	2.23	30507	36833	0.95	0.887
Japan	126.9	4.94	5.24	38917	41275	1.52	0.903
Korean Republic	51.2	1.41	1.93	27539	37740	1.17	0.901
United Kingdom	65.6	2.63	2.79	40096	42481	1.19	0.909
United States	323.3	18.6	18.6	57436	57436	3.94	0.920
G-20 Developing Countries							
Argentina	43.6	0.55	0.87	12503	20047	0.14	0.827
Brazil	206.1	1.80	3.14	8727	15242	0.48	0.754
China	1382.7	11.2	21.3	8113	15399	4.20	0.738
India	1346.3	2.26	10.7	1723	7716	0.85	0.624
Indonesia	258.7	0.93	3.03	3604	11720	0.35	0.689
Mexico	122.2	1.05	2.32	8555	18938	0.81	0.762
Russian Federation	146.9	1.52	4.15	10630	28918	0.84	0.804
Saudi Arabia	31.7	0.64	1.75	20150	55158	0.52	0.847
South Africa	55.9	0.29	0.74	5261	13225	0.20	0.666
Turkey	79.82	0.86	1.99	10743	24912	0.42	0.767

Note 1: POP is population; GDP is gross domestic product; PGDP is per capita gross domestic product; PPP is purchasing power parity; TT is total trade; and HDI is human development index.

Note 2: POP is in millions; GDP+ is in trillion USD; GDP++ is in trillion USD; PCGDP+ is in USD; PCGDP++ is in USD; TT is in trillion USD; and HDI figure is in number.

Note 3: + stands GDP and PGDP in PPP; and ++ stands GDP and PGDP in nominal.

References

Achour, H., and Belloumi, M. (2016). Investigating the Causal Relationship between Transport Infrastructure, Transport Energy Consumption and Economic Growth in Tunisia. *Renewable and Sustainable Energy Reviews*, *56*, 988-998.

Banister, D. (2012). Transport and Economic Development: Reviewing the Evidence. *Transport Reviews: A Transnational Transdisciplinary Journal*, 32(1): 1-2.

Button, K. and Yuan, J. (2013). Airfreight Transport and Economic Development: An Examination of Causality. *Urban Studies*, *50*(2), 329-340.

Calderon, C., Moral-Bemito, E., and Serven, L. (2015). Is Infrastructure Capital Productive? A Dynamic Heterogeneous Approach. *Journal of Applied Econometrics*, 30 (2): 177-198.

Chi, J. and Baek, J. (2013). Dynamic Relationship between Air Transport Demand and Economic Growth in the United States: A New Look. *Transport Policy*, *29*, 257-260.

Deng, T., Shao, S., Yang, L. and Zhang, X. (2014). Has the Transport-Led Economic Growth Effect Reached a Peak in China? A Panel Threshold Regression Approach. *Transportation*, 41(3): 567-587.

Ding, C. (2013). Transport Development, Regional Concentration and Economic Growth. *Urban Studies*, *50* (2): 312-328.

Farhadi, M. (2015). Transport infrastructure and long-run economic growth in OECD countries. *Transportation Research Part A: Policy and Practice*, *74*, 73-90.

Fernald, J. G. (1999). Roads to prosperity? Assessing the link between public capital and productivity. The American Economic Review. 89: 619-638.

Gillen, D. W. (1996). Transportation Infrastructure and Economic Development: A Review of Recent Literature. *Logistics and Transportation Review*, 32 (1): 39-62.

Hakim, M. M. and Merkert, R. (2016). The Causal Relationship between Air Transport and Economic Growth: Empirical Evidence from South Asia. *Journal of Transport Geography*, *56*, 120-127.

Hong, J., Chu, Z. and Wang, Q. (2011). Transport Infrastructure and Regional Economic Growth: Evidence from China. *Transportation*, 38 (5), 737-752.

Hulten, C. R., Bennathan, E. and Srinivasan, S. (2006). Infrastructure, Externalities, and Economic Development: A Study of the Indian Manufacturing Industry. *World Bank Economic Review*, 20 (2): 291-308.

Jiang, B. (2001). A Review of Studies on the Relationship between Transport Infrastructure Investments and Economic Growth. Canada Transportation Act Review, British Columbia, Vancouver.

Kasarda, J. D. and Green, J. D. (2005). Air Cargo as an Economic Development Engine: A Note on Opportunities and Constraints. *Journal of Air Transport Management*, 11 (6): 459-462.

Kawakami, T. and Doi, M. (2004). Port Capital Formation and Economic Development in Japan: A Vector Autoregression Approach. *Papers in Regional Science*, 83 (4), 723-732.

Kayode, O., Babatunde, O. and Abiodun, F. (2013). An Empirical Analysis of Transport Infrastructure Investment and Economic Growth in Nigeria. *Social science*, *2*(6): 179-188.

Khadaroo, J. and Seetanah, B. (2008). Transport and Economic Performance: The Case of Mauritius. Journal of Transport Economics and Policy, 42(2): 255-267.

Linneker, B. and Spence, N. (1996). Road Transport Infrastructure and Regional Economic Development: The Regional Development Effects of the M25 London Orbital Motorway. *Journal of Transport Geography*, *4*(2): 77-92.

Loo, B. P. and Banister, D. (2016). Decoupling Transport from Economic Growth: Extending the Debate to Include Environmental and

Social Externalities. *Journal of Transport Geography*, *57*, 134-144.

Marazzo, M., Scherre, R. and Fernandes, E. (2010). Air Transport Demand and Economic Growth in Brazil: A Time Series Analysis. *Transportation Research Part E: Logistics and Transportation Review*, *46*(2): 261-269.

Meersman, H. and Van de Voorde, E. (2013). The Relationship between Economic Activity and Freight Transport. In *Freight Transport Modelling Emerald Group Publishing Limited*, 15-43.

Mohmand, Y. T., Wang, A., and Saeed, A. (2016). The Impact of Transportation Infrastructure on Economic Growth: Empirical Evidence from Pakistan. *Transportation Letters*, 1-7.

Munnell, A. H. (1992). Infrastructure Investment and economic Growth. Journal of Economic Perspectives. 6, 189-198.

Nakamura, H. (2000). The Economic Evaluation of Transport Infrastructure: Needs for International Comparisons. *Transport Policy*, *7*(1): 3-6.

Njoh, A. J. (2000). Transportation Infrastructure and Economic Development in Sub-Saharan Africa. *Public Works Management and Policy*, *4*(4): 286-296.

Oster, C. V., Rubin, B. M. and Strong, J. S. (1997). Economic Impacts of Transportation Investments: The Case of Federal Express. *Transportation Journal*, *37*(2): 34-44.

Phang, S. (2003). Strategic Development of Airport and Rail Infrastructure: The Case of Singapore. *Transport Policy*, 10: 27-33.

Pradhan, R. P. and Bagchi, T. P. (2013). Effect of Transportation Infrastructure on Economic Growth in India: The VECM Approach. *Research in Transportation Economics*, 38 (1): 139-148.

Pradhan, R. P., Arvin, M. B., Bahmani, S., Hall, J. H. and Norman, N. R. (2017). Finance and Growth: Evidence from the ARF Countries. *Quarterly Review of Economics and Finance*, 59 (2): 25-35.

Vidyarthi, H. and Sharma, C. (2014). Estimating Impact of Infrastructure Development on Economic Growth in India. International Journal of Business Community and Risk Management, 5 (4): 261-271.

Wang, E. C. (2002). Public Infrastructure and Economic Growth: A New Approach Applied to East Asian Economies. *Journal of Policy Modelling*, 24, 411-435.

WDR (1994). World Development Report, World Bank. Oxford University Press, Oxford.

Yamaguchi, K. (2007). Inter-Regional Air Transport Accessibility and Macro-Economic Performance in Japan. *Transportation Research Part E: Logistics and Transportation Review*, *43*(3): 247-258.

Yao, S. and Yang, X. (2012). Air Transport and Regional Economic Growth in China. *Asia-Pacific Journal of Accounting & Economics*, *19* (3): 318-329.

Yu, N., De Jong, M., Storm, S. and Mi, J. (2012). Transport Infrastructure, Spatial Clusters and Regional Economic Growth in China. *Transport Reviews*, *32*(1): 3-28.

Table 1. Results of Panel Granger Causality Test

Dependent Variable — **Independent variables and ECT_{-1}**

Specification 1: PEG, CBB, TRI

	Case 1				**Case 2**				**Case 3**			
	ΔPEG	**ΔCBB**	**ΔGAT**	**ECT_{-1}**	**ΔPEG**	**ΔCBB**	**ΔPAT**	**ECT_{-1}**	**ΔPEG**	**ΔCBB**	**ΔGRA**	**ECT_{-1}**
ΔPEG	------	0.72	5.11*	-0.71*	------	0.42	4.58*	-0.78*	------	7.49*	6.54*	-0.87*
ΔCBB	6.10*	------	4.60*	-0.12	7.87*	------	12.9*	-0.10	5.53*	------	1.01	-0.10
ΔTRI	3.96**	0.70	------	-0.34	4.19**	1.04	------	-0.02	5.94*	9.66*	------	-0.04

	Case 4				**Case 5**				**Case 6**			
	ΔPEG	**ΔCBB**	**ΔPRA**	**ECT_{-1}**	**ΔPEG**	**ΔCBB**	**ΔRAL**	**ECT_{-1}**	**ΔPEG**	**ΔCBB**	**ΔCIT**	**ECT_{-1}**
ΔPEG	------	0.02	6.24*	-0.90*	------	0.89	4.23**	-0.74*	------	0.91	2.09	-0.84*
ΔCBB	6.91*	------	0.71	-0.10	3.99**	------	0.61	-0.09	5.46*	------	2.65	-0.07
ΔTRI	5.05*	4.12**	------	-0.04	4.43**	1.03	------	-0.05	1.43	2.59	------	-0.003

Specification 2: PEG, DCB, TRI

	Case 1				**Case 2**				**Case 3**			
	ΔPEG	**ΔDCB**	**ΔGAT**	**ECT_{-1}**	**ΔPEG**	**ΔDCB**	**ΔPAT**	**ECT_{-1}**	**ΔPEG**	**ΔDCB**	**ΔGRA**	**ECT_{-1}**
ΔPEG	------	4.23**	4.23*	-0.59*	------	4.19*	2.63	-0.70*	------	3.94**	1.61	-0.75*
ΔDCB	7.39*	------	3.66**	-0.08	4.37*	------	0.79	-0.06	4.69*	------	5.14*	-0.09
ΔTRI	4.14*	1.30	------	-0.11	6.88*	5.15*	------	-0.11	0.67	1.37	------	-0.03

	Case 4				**Case 5**				**Case 6**			
	ΔPEG	**ΔDCB**	**ΔPRA**	**ECT_{-1}**	**ΔPEG**	**ΔDCB**	**ΔRAL**	**ECT_{-1}**	**ΔPEG**	**ΔDCB**	**ΔCIT**	**ECT_{-1}**
ΔPEG	------	4.92*	4.54*	-0.54*	------	3.94**	1.02	-0.53*	------	7.97*	6.83*	-0.65*
ΔDCB	6.57*	------	0.27	-0.08	5.40*	------	2.75	-0.08	3.97**	------	16.3*	-0.17
ΔTRI	1.85	5.74*	------	-0.01	4.18**	0.73	------	-0.05	7.53*	3.58**	------	-0.003

Specification 3: PEG, BCB, TRI

	Case 1				**Case 2**				**Case 3**			
	ΔPEG	**ΔBCB**	**ΔGAT**	**ECT_{-1}**	**ΔPEG**	**ΔBCB**	**ΔPAT**	**ECT_{-1}**	**ΔPEG**	**ΔBCB**	**ΔGRA**	**ECT_{-1}**
ΔPEG	------	1.06	3.73**	-0.53*	------	0.67	6.05*	-0.73*	------	1.43	4.27*	-0.07*
ΔCBB	3.86**	------	0.36	-0.03	3.94**	------	0.59	-0.08	1.09	------	2.76	-0.05
ΔTRI	3.23**	0.94	------	-0.22	3.69**	0.85	------	-0.04	1.64	9.95*	------	-0.09

	Case 4				**Case 5**				**Case 6**			
	ΔPEG	**ΔBCB**	**ΔPRA**	**ECT_{-1}**	**ΔPEG**	**ΔBCB**	**ΔRAL**	**ECT_{-1}**	**ΔPEG**	**ΔBCB**	**ΔCIT**	**ECT_{-1}**
ΔPEG	------	0.62	3.23**	-0.46*	------	0.87	4.17**	-0.71*	------	4.75*	2.80	-0.23*
ΔBCB	0.66	------	1.27	-0.06	4.93*	------	1.49	-0.01	1.97	------	2.80	-0.012
ΔTRI	8.22*	1.07	------	-0.10	4.45*	0.71	------	-0.02	4.28**	9.18*	------	-0.01

Specification 4: PEG, ATM, TRI

	Case 1				Case 2				Case 3			
	ΔPEG	**ΔATM**	**ΔGAT**	**ECT$_{-1}$**	**ΔPEG**	**ΔATM**	**ΔPAT**	**ECT$_{-1}$**	**ΔPEG**	**ΔATM**	**ΔGRA**	**ECT$_{-1}$**
ΔPEG	------	3.63**	4.41*	-0.72*	------	32.6*	4.99*	-0.75*	------	4.16*	4.72*	-0.11*
ΔATM	13.2*	------	25.2*	-0.22	20.6*	------	24.5*	-0.19	13.3*	------	0.71	-0.16
ΔTRI	2.83	7.28*	------	-0.14	5.83*	2.48	------	-0.02	2.71	0.28	------	-0.05

	Case 4				Case 5				Case 6			
	ΔPEG	**ΔATM**	**ΔPRA**	**ECT$_{-1}$**	**ΔPEG**	**ΔATM**	**ΔRAL**	**ECT$_{-1}$**	**ΔPEG**	**ΔATM**	**ΔCIT**	**ECT$_{-1}$**
ΔPEG	------	4.66*	3.53*	-0.52*	------	6.29*	0.84	-0.36*	------	6.14*	0.72	-0.54*
ΔATM	7.68*	------	1.77	-0.14	15.5*	------	0.81	-0.21	5.19*	------	0.67	-0.14
ΔTRI	8.38*	2.17	------	-0.01	2.85	1.88	------	-0.04	1.27	5.78*	------	-0.002

Specification 5: PEG, BAA, TRI

	Case 1				Case 2				Case 3			
	ΔPEG	**ΔBAA**	**ΔGAT**	**ECT$_{-1}$**	**ΔPEG**	**ΔCBB**	**ΔPAT**	**ECT$_{-1}$**	**ΔPEG**	**ΔCBB**	**ΔGRA**	**ECT$_{-1}$**
ΔPEG	------	0.43	4.39*	-0.93*	------	0.71	4.71*	-0.91*	------	8.08*	2.25	-0.94*
ΔBAA	1.56	------	10.9*	-0.09	1.30	------	3.97*	-0.10	0.89	------	2.07	-0.09
ΔTRI	3.51**	6.36*	------	-0.21	1.23	9.61*	------	-0.22	3.97**	2.28	------	-0.02

	Case 4				Case 5				Case 6			
	ΔPEG	**ΔCBB**	**ΔPRA**	**ECT$_{-1}$**	**ΔPEG**	**ΔBAA**	**ΔRAL**	**ECT$_{-1}$**	**ΔPEG**	**ΔBAA**	**ΔCIT**	**ECT$_{-1}$**
ΔPEG	------	4.05*	0.24	-0.95*	------	4.72*	0.11	-0.91*	------	0.25	2.52	-0.13*
ΔBAA	3.93*	------	3.82**	-0.17	3.46*	------	3.72**	-0.05	6.97*	------	2.80	-0.17
ΔTRI	2.85	3.69**	------	-0.22	2.22	3.77**	------	-0.09	5.01*	7.13*	------	-0.002

Specification 6: PEG, BAC, TRI

	Case 1				Case 2				Case 3			
	ΔPEG	**ΔBAA**	**ΔGAT**	**ECT$_{-1}$**	**ΔPEG**	**ΔBAA**	**ΔPAT**	**ECT$_{-1}$**	**ΔPEG**	**ΔBAA**	**ΔGRA**	**ECT$_{-1}$**
ΔPEG	------	1.48	4.18*	-0.70*	------	1.18	8.35*	-0.72*	------	3.87**	4.19**	-0.59*
ΔBAA	0.16	------	0.25	-0.07	0.18	------	2.39	-0.06	1.77	------	1.92	-0.06
ΔTRI	5.55*	1.77	------	-0.13	1.91	3.89**	------	-0.13	3.89**	1.28	------	-0.01

	Case 4				Case 5				Case 6			
	ΔPEG	**ΔBAA**	**ΔPRA**	**ECT$_{-1}$**	**ΔPEG**	**ΔBAA**	**ΔRAL**	**ECT$_{-1}$**	**ΔPEG**	**ΔBAA**	**ΔCIT**	**ECT$_{-1}$**
ΔPEG	------	4.03**	4.45**	-0.46*	------	2.48	3.98**	-0.38*	------	3.67*	2.93	-0.54*
ΔBAA	0.97	------	1.03	-0.10	1.41	------	0.35	-0.12	0.40	------	1.90	-0.14
ΔTRI	15.4*	0.30	------	-0.08	8.25*	0.21	------	-0.32	3.64*	1.28	------	-0.01

Specification 7: PEG, BAB, TRI

	Case 1				Case 2				Case 3			
	ΔPEG	**ΔBAB**	**ΔGAT**	**ECT$_{-1}$**	**ΔPEG**	**ΔBAB**	**ΔPAT**	**ECT$_{-1}$**	**ΔPEG**	**ΔBAB**	**ΔGRA**	**ECT$_{-1}$**
ΔPEG	------	0.52	5.24*	-0.95*	------	0.13	9.32*	-0.91*	------	0.37	4.42*	-0.96*
ΔBAB	5.23*	------	3.30	-0.13	3.23	------	3.91**	-0.12	5.56*	------	0.04	-0.14
ΔTRI	3.84**	2.01	------	-0.23	2.09	3.33**	------	-0.13	1.17	0.89	------	-0.05

	Case 4				Case 5				Case 6			
	ΔPEG	**ΔBAB**	**ΔPRA**	**ECT_{-1}**	**ΔPEG**	**ΔBAB**	**ΔRAL**	**ECT_{-1}**	**ΔPEG**	**ΔBAB**	**ΔCIT**	**ECT_{-1}**
ΔPEG	------	0.09	4.49*	-0.90*	------	0.54	4.27*	-0.80*	------	0.01	2.15	-0.77*
ΔBAB	3.80*	------	0.29	-0.11	5.05*	------	0.97	-0.10	9.29*	------	2.28	-0.09
ΔTRI	4.41**	3.59**	------	-0.02	0.64	0.67	------	-0.05	1.70	2.50	------	-0.004

Specification 8: PEG, CIF, TRI

	Case 1				Case 2				Case 3			
	ΔPEG	**ΔCIF**	**ΔGAT**	**ECT_{-1}**	**ΔPEG**	**ΔCIF**	**ΔPAT**	**ECT_{-1}**	**ΔPEG**	**ΔCIF**	**ΔGRA**	**ECT_{-1}**
ΔPEG	------	8.47*	1.58	-0.66*	------	3.52*	6.73*	-0.72*	------	15.3*	3.62**	-0.64*
ΔCIF	6.41*	------	2.74	-0.01	6.19*	------	0.57	-0.01	7.97*	------	1.19	-0.01
ΔTRI	3.16	3.13	------	-0.08	8.50*	2.53	------	-0.11	0.12	0.23	------	-0.09

	Case 4				Case 5				Case 6			
	ΔPEG	**ΔCIF**	**ΔPRA**	**ECT_{-1}**	**ΔPEG**	**ΔCIF**	**ΔRAL**	**ECT_{-1}**	**ΔPEG**	**ΔCIF**	**ΔCIT**	**ECT_{-1}**
ΔPEG	------	14.9*	1.02	-0.70*	------	14.1*	0.86	-0.68*	------	9.11*	1.47	-0.88*
ΔCIF	7.25*	------	0.52	-0.01	10.4*	------	7.56	-0.01	8.74*	------	2.80	-0.03
ΔTRI	5.59*	6.11*	------	-0.003	1.80	9.82*	------	-0.03	4.84	1.51	------	-0.08

Note 1: PEG is per capita economic growth, FIP is financial penetration, TRI is transport infrastructure, CBB is commercial bank branches, DCB is depositors with commercial banks, BCB is borrowers from commercial banks, ATM is automated teller machines, BAA is bank accounts, BAC is bank concentration, BAB is bank branches, CIF is composite index of financial penetration, GAT is goods carried by air transport, Pat is passengers carried by air transport, GRA is goods carried by railways, PRA is passengers carried by railways, RAL is railways lines, CIT is composite index of transport infrastructure, and $ECT_{-1:}$ lagged error-correction term.

***Note 2*:** FIP indicates CBB, DCB, BCB, ATM, BAA, BAC, BAB, IFB, or CIF; and TRI indicates GAT, PAT, GRA, PRA, RAL, or CIT.

***Note 3*:** * and ** indicate that parameter estimates are significant at the 5% and 10% levels, respectively.

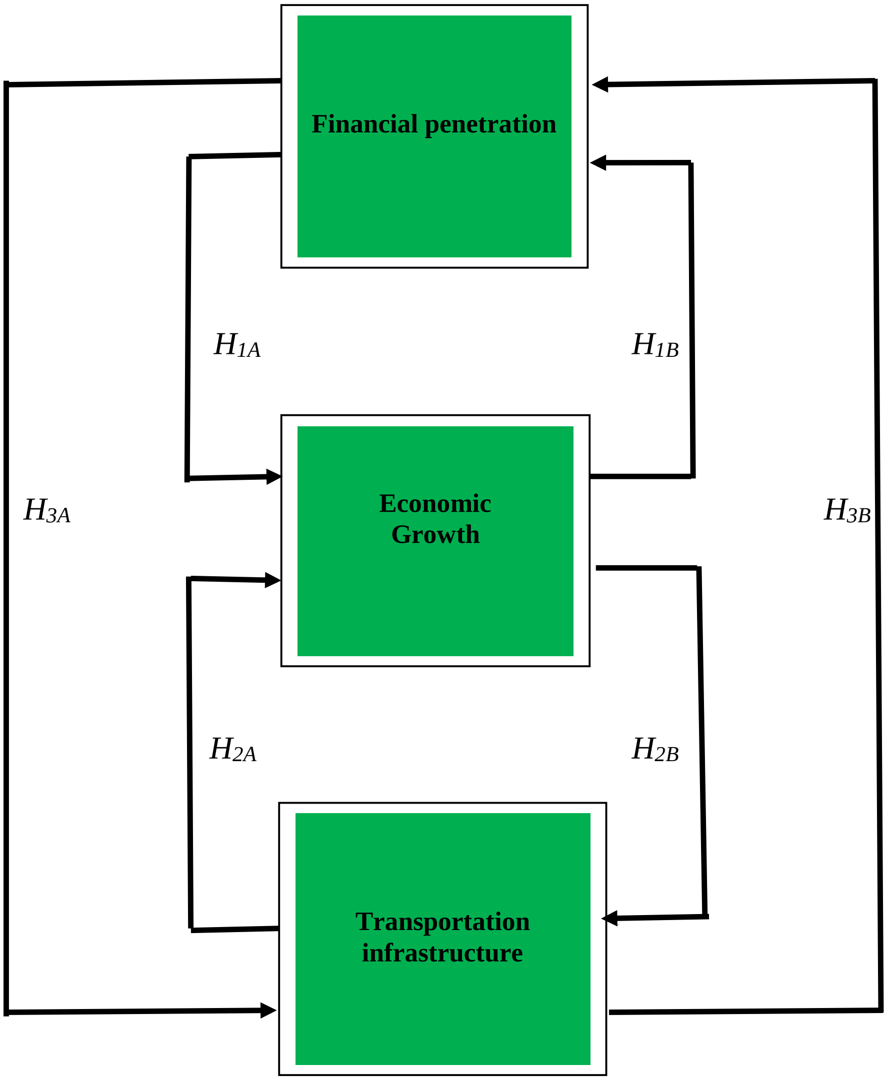

Figure 1. Proposed Hypotheses