TELECOMMUNICATIONS & ECONOMIC GROWTH:

ECONOMETRIC EVIDENCE

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TELECOMMUNICATIONS & ECONOMIC GROWTH: ECONOMETRIC EVIDENCE

ABSTRACT

The World Bank's *The East Asian Miracle* explores the inequality in economic growth among developing East Asian Countries during the last two decades. In the above mentioned study, the World Bank identified the essential drivers for economic growth: education, investment per gross domestic product (GDP), and fertility growth. However, telecommunications was an essential growth factor which the World Bank failed to identify in its study.

The evidence of this research suggests that telecommunications in developing countries contributes in a major way to economic development. Telecommunications is a crucial driver, maybe more important than education. Therefore, expansion of the telecommunications infrastructure should be encouraged to promote economic growth.

1. INTRODUCTION

The World Bank study focuses primarily on Seven Asian Countries known as Seven Tigers. The economic levels of seven countries are highly diverse in natural resource, culture, and political institution.[1] Despite the differences, these economies have much in common. Their post war experience distinguish them as a group. The common characteristics are the rapid increase in economic growth and the reduction in inequality. These two outcomes -- rapid growth and reduced inequality -- are the defining characteristic of what has come to be known as the East Asian Miracle.

[1] For example, Korean policy makers have intervened heavily in industrial, labor and credit markets, while policy makers in Hong Kong consistently keep their hands-off the markets.

The economies of Seven Tigers share six other characteristics in contrast with most other developing economies, all have had:[2]

- More rapid output and productivity growth in agriculture.
- Higher rates of growth of manufactured exports.
- Earlier and steeper declines in fertility.
- Higher growth rates of physical capital, supported by higher rates of domestic savings.
- Higher initial levels and higher growth rates of human capital.
- Generally higher rates of productivity growth.

Experts argue that economic development policies in the industrial countries increasingly include telecommunications as an essential component of the economic infrastructure.[3] This realization has been initiated by industry's demand for advanced telecommunications equipment for competitive reasons. The lesser developed countries have begun to recognize that inadequate telecommunications services will be a disincentive to new investment and place existing industry at a competitive disadvantage.

However, as found in the earlier studies, telecommunications is not a sole driver of economic growth in the Seven East Asian countries; in order to achieve growth, other necessary conditions must exist.[4] Telecommunications was an essential growth factor which the World Bank failed to identify in its study. The evidence suggests that telecommunications is a crucial driver, maybe more important than education.

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[2] These characteristic are all related to their rapid and equitable growth. Some are sources of growth, outcomes of growth and unique features of growth.

[3] NTIA, 1991; Schmandt *et al*, 1988

[4] See Park and the references cited therein, 1994.

This finding is applicable to nearly all economies in the world. In order to achieve economic development, a country must encourage expansion of telecommunications infrastructure through telecommunications investment.

2. SCOPE OF THE RESEARCH

This study focuses on one result found by the World Bank study which was used to support its conclusions on the relevant economic drivers which was based not only on the Seven East Asian Countries, but based on a 113 countries data base. It includes a country like Rwanda where virtually no telecommunications infrastructure exists and the United States where the level of telephone penetration is one of the highest in the world.[5] The purpose of this study is to affirm telecommunications as a driver of economic growth.

This study utilizes the same data set the World Bank's used.[6] The observations are from 1960 to 1985. This data set was augmented by telecommunications data, Direct Exchange Lines (DEL) and Telecommunications Investment (T_inv) obtained from International Telecommunications Union (ITU).

The *East Asian Miracle* found seven variables to be growth drivers using comprehensive but diversified approaches.[7] We only focus on one section of the study -- the econometric, macroeconomics approach to investigate causality between the economic growth and telecommunications.

The objective of this study is to explain the link between telecommunications and the economic growth. These results should help address the fundamental question of how to reduce the economic imbalance in the world.

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[5] Hereafter, telecommunications exclusively refer to telephone system. Broadcasting, CATV and other means of telecommunications are beyond the scope of the research.

[6] See Park, Appendix D for the data description.

[7] Seven variables were INV, $R_{GDP}60$, $G_{POP,}$ EQINV, ED60, Prim60 and Sec60.

This research examines macroeconomics determinant of growth as well as the effect of telecommunications on the growth.

3. METHODOLOGY

3.1 Hypothesis

Previous research has indicted that telecommunications promote economic growth.[8] Our hypothesis continues the research in the context of the World Bank study, in particular, the Bank has ignored other potential growth drivers in its methodology. We find that, statistically, telecommunications is a significant driver of economic growth.

This study introduces two telecommunications variables, DEL and T_inv in the World Bank's regressions. Because it is believed to be influential, and empirically has better explanatory power in the context of economic growth.

3.2 World Bank's Methodology

In order to achieve economic development, although pinpointing exact conditions is difficult, certain conditions must be presented. The necessary drivers are: education, investment, and population growth, according to the World Bank's study.

The World Bank study provides a convenient estimation and systematic framework for examining cross-national economic growth. The analysis includes variables from theoretical models of the aggregate economy and well-specified, well-developed data set for 113 economies from 1960 to 1985.[9]

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[8] See Alleman, *et. al*, 1992 and Park, 1994 and the references cited therein.

[9] Summers and Heston. " A New Set of International Comparisons of Real Product and Price Levels Estimates for 130 Countries, 1950 - 1985," *The Review of Income and Wealth*. A new set of international comparisons covering the period 1950 - 85 is developed for 121 market and 9 centrally planned economies. For the 121 market economies, the table gives annually, in addition to population and exchange rates, real product and price level estimates for four different national income concepts.

The World Bank estimated the following generic regression:

$$GDP_G = f(INV, ED, G_{POP}, R_{GDP}) \qquad (1)$$

This equation estimates and statistically tests the variables influence on growth. The regression are estimated using different time periods, education population or investment variables. The growth of the economical active population is used in all regressions. A linear functional form is used in the regressions.

The first sub-model (1-1)[10] uses two education variables, PRIM60 and SEC60 for K-12 education (primary and secondary education levels) from 1960 to 1985. The second and the third sub-models (1-2 and 1-3) estimate the relationships during the periods, 1960 - 1970 and 1970 - 1985. The fourth sub-model (1-4) replacing the investment variable with an equipment investment variable. The fifth and the sixth regressions (1-5 and 1-6) use a general education variable.

Generally, the overall fit of the regression indicates positive relationship with the variable of interest and growth. The coefficients of the variables are significant at conventional 0.05 level and positive.

The Table 3-1 contains description of each variable utilized in the regression equations. A summary of the estimates is shown in Table 3-2.

[10] The notion (1 - x) identifies the sub-model. The results of each sub-model is list Table 3-2 under the corresponding column.

Table 3-1

Description of the Variables

Variable	Explanation
GDP_G6085	Average rate of real capita income growth using Heston-Summer's measures from 1960 to 1985.
INV	Average share of investment in GDP.
EQINV	Average share of equipment investment in GDP.
ED60	Measure of educational attainment.
PRIM60	Primary education attainment rate.
SEC60	Secondary education attainment rate.
G_{POP}	Rate of growth of the economical active population.
$R_{GDP}60$	Relative gap between per capital income in 1960 (at 1980 U.S. dollar prices) and U.S. per capita income in 1960.

*The time range of all variables is from 1960 to 1985.

Table 3-2

Summary of World Bank Results

	1- 1 GDPG6085	1- 2 GDPG6070	1- 3 GDPG7085	1- 4 GDPG6085	1- 5 GDPG6085	1- 6 GDPG6085
RGDP60	-0.043**	-0.0444**	-0.0422*	-0.0408**	-0.0292*	-0.0251
(t-stat)	0.0118	0.0137	0.0163	0.0146	0.0133	0.016
PRIM60	0.00264**	0.0169*	0.0324**	0.0247**		
(t-stat)	0.0065	0.0076	0.009	0.0082		
SEC60	0.00262	0.0192	0.0309	0.0078		
(t-stat)	0.0139	0.0162	0.0192	0.018		
ED60					0.0013	-0.0002
(t-stat)					0.001	0.0013
GPOP60	0.01015	-0.1638	0.2738	-0.045	-0.3135	-0.429
(t-stat)	0.2235	0.2592	0.0309	0.2891	0.2351	0.2654
INV6085	0.0578*	0.1153**	0.0201		0.0864**	
(t-stat)	0.0224	0.026	0.0309		0.0245	
EQINV				0.305**		0.31**
(t-stat)				0.0721		0.0743
Constant	-0.007	0.0064	-0.0156	-0.0034	0.0141	0.0243*
(t-stat)	0.0079	0.0092	0.0109	0.0113	0.0084	0.0094
R^2	0.37713	0.37172	0.22815	0.41754	0.22265	0.31719
Adjusted R^2	0.348	0.3424	0.1921	0.3646	0.1893	0.2614
SE	0.01518	0.01761	0.2093	0.0136	0.01638	0.01429
F	12.95688	12.66121	6.32577	7.88558	6.65913	5.6906

Each column corresponds to the each equation.
** Statistically significant at the 0.01 level.
* Statistically significant at the 0.05 level.
Coefficient is in top in each cell. Value of t - statistic is underneath.
Source: *The East Asian Miracle*

3.3 Additions of Telecommunications Variables

3.3.1 Effect on Growth with Direct Exchange Lines

Our strategy is to estimate each of the World Bank's regression equations with a telecommunications proxy to determine the role of telecommunications in macroeconomics growth. This study uses the same models for 113 economies across nations from 1960 to 1985. The proxies for telecommunications are DEL

and T_inv. In one set of models, the World Bank estimations are added to the functional form. In the other, we replace the education variable with the telecommunications variable.

The re-estimation of the World Bank's regression with a telecommunications variable is:

$$GDP_G = f(INV, ED, G_{POP}, R_{GDP}, TEL) \qquad (2)$$

where TEL is the telecommunications variable.
The purpose of equation (2) is to estimate the impact of telecommunications on economic growth. Equation (2) is divided into five sub-models which adds the mean growth rate of main stations (DELs) in the World Bank equations. Each sub-model equation corresponds to the columns on Table 3-3.

The telecommunications variables are the mean growth rate of the DELs from 1960 to 1985, DEL6085 and telecommunications investment per GDP, T_inv.

Variable	Explanation
DEL6085	Mean growth rate of DELs from 1960 to 1985
T_inv	Telecommunications investment per GDP

Overall fit of regression has improved, and coefficients estimate on DEL6085 are significant at 0.01 level and positive. This extraordinary improvement has occurred due to inclusion of telecommunications variable , DEL6085 (Table 3-3). The coefficient determinants on DEL appear to dominate other variables.

Diminution of explanatory power on education variables is notable; specially, the coefficients of ED60 on equation 5 and 6 fell to 0.00037 from the highest 0.0013 (column 1-5 on Table 3-2). The R^2 s of the regressions improves with the inclusion of due to telecommunications infrastructure variable as compared to the equations without DEL. With the statistics cannot "prove" that DEL is a significant driver for economic growth, it does suggest that the World Bank's may be he ignored significant influences. Moreover, the same statistical logic that

inhibits us from making strong statements regarding the definitive drivers of economic growth, also constrains the World Bank results.

The data in Table 3-3 does not invalidate Delong and Summers's proposition, the EQINV instead of INV improves the fit of the regressions. (Compared with the results on Table 3-2, the proposition also holds true in our equation models. See R^2 and t - values in column 5 and 7 of Table 3-3).

The outcome of this research is consistent with the recent theoretical advances about indeterminate relationship between income and fertility or the complicated interaction between economic growth and the variable. In contrast to this result, Koremendi-Meguire[11] found a positive role of population growth in the context of economic growth, but substantially less than a coefficient equal to 1.0 The relationship between fertility and economic growth is contradictory.

[11] Roger Kormendi and Phillip Meguire, "Macroeconomic Determinant of Growth", *Journal of Monetary Economics* 16 (September 1985): 141-63.

Table 3-3

Summary of Telecommunications Results

	1 GDPG6085	2 GDPG6070	3 GDPG7085	4 GDPG6085	5 GDPG6085	6 GDPG6085
RGDP60	-0.0136	-0.01402	-0.013413	-0.018533	0.007176	0.00301
(t-stat)	-1.094	-0.926	-0.719	-1.207	0.525	0.20700
PRIM60	0.022354*	0.005791	0.033096**	0.019816*		
(t-stat)	2.728	0.58	2.69	2.046		
SEC60	0.018146	0.015485	0.020191	0.002659		
(t-stat)	1.372	0.961	1.017	0.165		
ED60					0.0003795	0.00037
(t-stat)					0.395	0.35500
GPOP60	-0.088804	-0.516109	0.191156	-0.044925	-0.442574	-0.41519
(t-stat)	-0.328	-1.566	0.47	-0.138	-1.74	-1.78500
INV6085	0.004297	0.066558	-0.037133		0.022292	
(t-stat)	0.134	1.704	-0.771		0.677	
EQINV				0.173391		0.07272
(t-stat)				1.836		0.88600
DEL6085	0.285767**	0.32803**	0.258732*	0.175915	0.400282**	0.40380**
(t-stat)	3.761	3.545	2.268	1.809	5.059	5.27700
Constant	-0.017299	-0.001727	-0.027376	-0.009077	-0.007013	-0.00554
(t-stat)		-0.135	-1.742	-0.817	-0.678	-0.60600
R^2	0.49932	0.49302	0.28235	0.5304	0.49145	0.63974
Adjusted R^2	0.45087	0.44395	0.2129	0.4499	0.44348	0.57762
SE	0.01294	0.01576	0.01943	0.01079	0.01276	0.00950
F	10.30541	10.04868	4.06552	6.58863	10.24369	10.29936

** Statistically significant at the 0.01 level.
* Statistically significant at the 0.05 level.
Coefficient is in top in each cell. Value of t - statistics is underneath.

3.3.2 Effect on Growth with Telecommunications Investment

The other telecommunications variable used to re-estimate the equations was the telecommunication investment as a percent of GDP deflated by the GNP.

While we would have like to used this variable, it was not available for entire period of study (it was only available from 1980 to 1992).[12] As an alternative, we used the change in DELs (ΔDEL) as a proxy for this variable.[13]

3.4 Telecommunications Variables Substituted for Education Variables

The second method used to test the World Bank hypothesis was to remove all education variables[14] and replace them with telecommunications variables. Although the World Bank study indicates that education is an important driver of economic growth, statistical results of equation (2) indicate that, statistically, the role of telecommunications is more significant.

$$GDP_G = f(INV, G_{POP}, R_{GDP}, DEL) \qquad (3)$$

The purpose of this equation is to identify telecommunications is a significant growth driver by exclusion of education driver from the model. This improved the fit of the regression equations and explanatory power of telecommunications variable.

The equation examines the different specifications. The first sub-model (3-1 on Table 3-4) examines the basic relationship for the entire period. The second and third estimate the relationship for two sub-periods (1960-70 and 1970-85). The last model estimates the share of equipment investment, rather than the investment share in GDP. The regressions parallel those of the World Bank study.

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[12] Data deficiency in telecommunications investment (T_inv) was a constraint in the context of this research. Telecommunications investment figures from 1960 to 1980 are not attainable in a of majority countries. In most cases, only available time series start from 1980 to 1992. Especially, in case of Africa and Asia, the figures are not even available today. A convincing argument would be that policy makers in underdeveloped countries still consider telephones as luxury goods.

[13] A regression between telecommunications investment (T_inv) and DEL (ΔDEL) was estimated for all sample countries for the available years to determine the strength of the relationship. The regression confirms the strong relationship between telecommunications investment and DELs. See the Appendix for the details of this procedure.

[14] Hereafter, education variables refer to ED60, Prim60, and Sec60.

3.4 Results

Overall fit of regressions is generally positive, indicating a positive impact of telecommunications on growth. The coefficients of DELs are significant at 0.01 level. Therefore, these statistical evidences indicates that telecommunications is a significant driver of economic growth which confirms the hypothesis of this paper.

The basic results of equations reported on Table 3 - 4. Overall R^2s of the equations are high and coefficient estimates on DEL are higher than the previous equations (2). Nevertheless, the parameter estimates have similar values and significance levels.

The regression equation (3-4) estimates the changing basic investment variable, examining impact of equipment investment rather than investment share. The explanatory power has improved, and the coefficient on EQINV is significant.

The data on Table 3-4 raises an important point. It shows drastic increase of G_{POP} values, including coefficient determinants and t-statistics. Once the education variables are excluded, the magnitude of G_{POP} becomes robust by showing -0.046,
-0.6878 and so on. This outcome also contradicts with the Kormendi-Meguire's proposition which population growth have a positive impact on economic development. The coefficients are negative.

Table 3-4

Summary of Telecommunications Results

	EQ. 3-1 **GDPG6085**	EQ. 3-2 **GDPG6070**	EQ. 3-3 **GDPG7085**	EQ. 3-4 **GDPG6085**
RGDP60	0.006306	-0.003651	0.012832	-3.26E-04
(t-stat)	0.589	-0.299	0.806	-0.028
GPOP60	-0.463517	-0.687873*	-0.317385	-0.47284
(t-stat)	-1.813	-2.357	-0.834	-1.957
INV6085	0.046415	0.083444*	0.021525	
(t-stat)	1.498	2.359	0.467	
EQINV				0.131889
(t-stat)				1.581
DEL6085	0.325578**	0.338725**	0.317435**	0.289629**
(t-stat)	4.111	3.746	2.693	3.546
Constant	-0.004482	0.003234	-0.009416	0.003731
(t-stat)	-0.437	0.276	-0.617	0.401
R^2	0.418	0.4818	0.18015	0.47304
Adjusted R^2	0.38162	0.44942	0.12891	0.41607
SE	0.01373	0.01568	0.02044	0.01111
F	11.49122	14.87638	3.5158	8.30355

** Statistically significant at the 0.01 level.
* Statistically significant at the 0.05 level.
Coefficient is in top in each cell. Value of t - statistics is right underneath.

4. CONCLUSION

This study suggests that an under-developed telecommunications infrastructure is among the reasons parts of the world have not developed. Telecommunications induce the efficiency and expedite information processing, subsequently triggering the economic development the authors feel.

The World Bank's important lessons is that education, investment, and population growth are inter-related and these factors are necessary conditions for a country to manage its own growth. This research showed that telecommunications is a crucial driver in addition to those factors suggested by the World Bank's finding.

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APPENDIX

The regression equation to determine the proxy for telecommunications investment is:

$$Ln(\Delta DEL_i) = \alpha + \beta\ Ln\ (T\_inv_i) \qquad (4)$$

where:

ΔDEL_i is the change in DELs from the previous year in country i and

T_inv is the annual telecommunications investment in country i.

The assumption for this model is that should have instantaneous impact on telecommunications investment, or vice versa. This equation allows to proxy the pattern of T_inv in 1960s and 70s, where data are unavailable.

The data in Table A-1 are coefficients of equation 4. Except countries where highly developed (e.g. USA) or politically insatiable (e.g. Ethiopia), most countries show positive coefficients.

The strong positive correlation coefficient allows not only extrapolation of the equation but confirms the hypothesis of the relationship. Since T_inv has a strong, positively correlation with DEL, the effects on equation (3) analyzing growth and telecommunications, would give similar results to equation (2) which assessing growth and DEL.

The data in Table A-1 reveal positive correlation coefficients (r) between DEL and T_inv.

Table A - 1[15]

Summary of DEL T_inv Regression Results

Country	R coefficient	Country	R coefficient	Country	R coefficient
AGO	.	GRACE	-0.16592	NIL	0.08131
RAG	0.44605	GMT	-0.16592	PAK	.
AUS	0.33908	GUY	.	PAN	-0.74037
AUT	0.54205	HKG	0.65277	PER	0.16942
BDI	0.14046	HND	-0.15118	PHL	.
BEL	-0.34357	HTI	.	PNG	0.48271
BEN	0.01469	IDN	0.67598	PRT	0.94761
BGD	.	IND	0.87185	PRY	0.38989
BGR	0.03950	IRL	-0.50684	RWA	0.81092
BOL	.	IRN	-0.50222	SDN	.
BRA	-0.01820	IRQ	.	SEN	0.75907
BRB	0.20780	ISL	-0.31301	SGP	0.14963
BWA	0.55826	ISR	0.77234	SLE	-0.74540
CAF	-0.52777	ITA	-0.01060	SLV	0.49529
CAN	-0.09913	JAM	0.68301	SOM	.
CHE	0.72854	JOR	0.28241	SUR	0.15735
CHL	0.87489	JPN	0.11036	SWE	0.19563
CIV	0.66613	KEN	0.37947	SWZ	0.42322
CMR	.	KOR	0.24964	SYR	0.84780
COG	-0.45386	LBR	.	TCD	-0.11632
COL	0.53466	LKA	0.07573	TGO	0.79953
CRI	0.20878	LSO	0.18517	THA	0.88755
CYP	-0.21796	LUX	0.80729	TTO	-0.18700
DEU	0.50129	MAR	0.87584	TUN	0.12959
DNK	0.19173	MDG	.	TUR	0.67543
DOM	-	MEX	0.72591	TZA	0.16568
DZA	-0.23137	MLI	0.14976	UGA	0.99989
ECU	0.66795	MLT	0.10761	URY	0.70959
EGY	0.11328	MOZ	.	USA	-0.41446
ESP	0.61693	MRT	.	VEN	-0.73305
ETH	-0.29365	MUS	0.86590	ZAF	-0.05950
FIN	-0.13971	MWI	0.10721	ZAR	.
FJI	0.02597	MYS	-0.21068	ZMB	0.21985
FRA	0.12833	NER	-0.69871	ZWE	0.23231
GAB	.	NGA	0.93250		
GBR	0.25281	NIC	0.99875		
GHA	0.03542	NLD	0.80228		
GMB	0.62045	NOR	0.46421		
GNB	.	NPL	0.32934		

*(Insufficient observations are removed from the table: shaded areas)

Source: International Telecommunications Union

(See Park, 1994, Appendix C for additional details)

[15] Some countries where extremely lack in data series were removed For example, a country like "MRT" only has two years of telecommunications data available in 30 years period.