The Spatial Dimension Of Take-Offs And Sustainability: The Case Of East Asian Countries

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ABSTRACT

This study examines the relationship between the size of a country and its "take-off" for economic development. We find that most countries which experienced economic upheavals in the past decades are relatively small in terms of area. Specifically, take-offs appear to be quicker for smaller landmasses with larger potential workforce and higher population density, controlled for financial markets maturity, corporate governance, economic openness, and human capital development. We also find that take-offs are not sustainable by nature as most countries in East Asia that which experience take-offs are currently facing slow-downs of their economies. Through this finding, we predict that China may experience a slow-down at around 36% and may reach to the 50-60% of income level of the U.S.

Keywords: Economic Development; Spatial Development Factors; Corporate Governance; Economic Openness; Human Capital

1. INTRODUCTION

Development processes are heterogeneous across countries and regions (Table 1). Some have continuously been in the stage of developed countries for more than half a century (e.g. Western Europe, the U.S. and Canada), while some have risen rapidly during the past decades (e.g. four East Asian "tigers," such as Korea, Taiwan, Hong Kong, and Singapore). On the other hand, some countries have been left behind from the developed club (e.g. Argentina and Uruguay), while others have been caught in the poverty trap and have never experienced growth (e.g. Sub-Saharan African countries). In 1955, there were 18 countries whose per capita incomes were more than 50% of the U.S., and 15 of them are currently still maintaining their stata (Penn World Table 6.1).[1] In comparison, 29 countries whose per capita income is more than 50% of the U.S. in 2007 have joined this club between 1970 and 2000.

What makes these countries different from each other? How come some countries have shown rapid developments while others have not? Recently, geographical explanations for the process of economic development have drawn attention. Krugman (1991, 1998) argues that development is made in the interaction between centrifugal and centripetal forces in the core and periphery, thus making geography play a vital role in economic development. World Bank's World Development Report (2009) puts emphasis on spatial policies (spatially blind, connective, and targeted) in each stage of incipient, intermediate, and advanced urbanization, and argues that successful urbanization and economic development can be achieved by "reshaping" the economic geography.

This study starts from geographical perspectives. In particular, this paper investigates the size of a country as a determinant for its take-off. There has been a group of articles in the literature that used the population of a country as a development factor: Milner and Westaway (1993), Briguglio (1995), Alesina and Spolaore (1997), Alesina and Wacziarg (1998), Armstrong and Read (1998), Briguglio (1998), and Easterly and Kraay (2000). In addition to population, we employed the actual geographical size (land area) of a country, and investigated whether small-sized is a necessary or sufficient condition for economic development.

[1] See Table 7, Appendix A, for a summary.

Table 1. List of countries whose per capita income is above 50% of that of the U.S.

KOR (South Korea), CYP (Cyprus), TWN (Taiwan), BHS (Bahamas), PRI (Puerto Rico), GRC (Greece, JPN (Japan), GER (Germany), ESP (Spain), CHL (Chile), IRL (Ireland), HKG (Hong Kong, ARE (United Arab Emirates), BMU (Bermuda), BRN (Brunei), KWT (Kuwait), MAC (Macao), QAT (Qatar), SGP (Singapore), ISR (Israel), BRB (Barbados), NZL (New Zealand), ITA (Italy), FRA (France), FIN (Finland), SWE (Sweden), DNK (Denmark), BEL (Belgium), NLD (Netherlands), AUT (Austria), AUS (Australia, CAN (Canada, ISL (Iceland), LUZ (Luxenburg), NOR (Norway), USA (United States).

Year	**1955**	**1960**	**1965**	**1970**	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2007**
No. of countries	**18**	**19**	**19**	**22**	**34**	**39**	**37**	**35**	**38**	**36**	**41**	**44**
Country	ARG	ARG	ARG	ARG	ARG	ARG	*	*	*	*	*	*
	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS
	AUT	AUT	AUT	AUT	AUT	AUT	AUT	AUT	AUT	AUT	AUT	AUT
	BEL	BEL	BEL	BEL	BEL	BEL	BEL	BEL	BEL	BEL	BEL	BEL
	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN
	CHE	CHE	CHE	CHE	CHE	CHE	CHE	CHE	CHE	CHE	CHE	CHE
	DNK	DNK	DNK	DNK	DNK	DNK	DNK	DNK	DNK	DNK	DNK	DNK
	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN
	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA
	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
	ISL	ISL	ISL	ISL	ISL	ISL	ISL	ISL	ISL	ISL	ISL	ISL
	LUX	LUX	LUX	LUX	LUX	LUX	LUX	LUX	LUX	LUX	LUX	LUX
	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD
	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR
	NZL	NZL	NZL	NZL	NZL	NZL	NZL	NZL	NZL	NZL	NZL	NZL
	SWE	SWE	SWE	SWE	SWE	SWE	SWE	SWE	SWE	SWE	SWE	SWE
	URY	*	*	*	*	*	*	*	*	*	*	*
	VEN	VEN	*	*	*	*	*	*	*	*	*	*
		ISR	ISR	ISR	ISR	ISR	ISR	ISR	ISR	ISR	ISR	ISR
		ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA
			BRB	BRB	BRB	BRB	BRB	BRB	BRB	BRB	BRB	BRB
				ESP	ESP	ESP	ESP	ESP	ESP	ESP	ESP	ESP
				GRC	GRC	GRC	GRC	GRC	GRC	GRC	GRC	GRC
				JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN
					ARE	ARE	ARE	ARE	ARE	ARE	ARE	ARE
					BHR	BHR	BHR	BHR	BHR	*	BHR	BHR
					BMU	BMU	BMU	BMU	BMU	BMU	BMU	BMU
					BRN	BRN	BRN	BRN	BRN	BRN	BRN	BRN
					GER	GER	GER	GER	GER	GER	GER	GER
					IRL	IRL	IRL	IRL	IRL	IRL	IRL	IRL
					KWT	KWT	KWT	KWT	KWT	KWT	KWT	KWT
					LBY	LBY	LBY	*	*	*	*	LBY
					PLW	PLW	PLW	PLW	*	*	*	*
					QAT	QAT	QAT	QAT	QAT	QAT	QAT	QAT
					SAU	SAU	SAU	SAU	*	*	*	*
					TTO	TTO	*	*	*	*	TTO	TTO
						BHS	BHS	BHS	BHS	BHS	BHS	BHS
						HKG	HKG	HKG	HKG	HKG	HKG	HKG
						MAC	MAC	MAC	MAC	MAC	MAC	MAC
						OMN	OMN	*	*	*	OMN	OMN
						SGP	SGP	SGP	SGP	SGP	SGP	SGP
									CYP	CYP	CYP	CYP
									KOR	*	KOR	KOR
									PRI	PRI	PRI	PRI
									TWN	TWN	TWN	TWN
											GNQ	*
											SVN	SVN
												BLR
												CZE
												MLT

Source: Penn World Table 6.1

We argue that small countries (in terms of land area and population) are not necessarily efficient in taking off. However, most countries that experienced the "take-off" and have been "flying" for the past decades were relatively small. We will examine this by conducting panel regrssions. For robustness tests, we consider several control variables that may also affect development. La Porta et al. (1998) and Djankov et al. (2008) argue that the degrees of financial investor protection and governance enforcement are strongly and positively correlated with sustainable economic development. Lucas (2009) claims that open countries perform better in economic growth. In addition, Eichengreen et al. (2013) find that countries with highly educated people are advantageous in economic growth. In this research, the empirical implication is that an average economy grows faster the smaller the landmass, and/or the larger the potential workforce, and/or the higher the population density, controlled for the quality indices of capital markets, economic regime, openness, and human capital.

However, take-off is not sustainable by nature and an economy may slow-down after a certain period of rapid growth regardless of its size. In this aspect, his study also examines a non-linear relationship between income levels and growth rates. Japan, South Korea and Taiwan are paid extra attendtions, as they all went through successful take-offs and are good fits of the model that we suggest. Lessons of these countries are applied to China which is now undergoing a take-off to see when the economy is expected to slow-down.

This paper is organized as follows: Section 2 provides data description; Section 3 examines spatial factors that determine the take-off of an economy, controlled for other variables. Section 4 investigates the sustainability of take-off by examing a non-linear relationship between income levels and growth rates. Section 5 concludes the study.

2. DATA

We source Penn World Table 6.1 for the per capita of real GDPs of 190 countries relative to the U.S. between 1950 and 2007. Except for the year of 1950 when there were substantial missing values, we referred to the countries whose income is above 50% of that of the U.S. as relatively rich or developed ones (Tables 1 and 7). This is a key variable in this study, as it will be used as a dependent variable in examining the determinants for take-off and as an explanatory variable in examining its sustainability.

There are 17 countries that were listed, and these countries are named the "old-rich", and summarized as Group 2 in Table 2. More importantly, there are 19 countries that were not listed in 1955, but later on listed in 2007. To confirm that our selection for countries have sustainable growths, this paper has outlined the following rules. Countries that satisfy these rules are named "take-offs", and listed as Group 1 in Table 2. For 148 countries in Group 3, the average area is 683,879 square kilometers, average population is 34.2 million, and average density is 296.

For 148 countries in Group 3, average area is 683,879 (sq. km), average population is 34,228 ('000s), and average density is 296.

Table 2. Descriptive statistics of countries in each group

Group 1 (19 take-offs)	Land Area (sq. km)	Population (2005, '000s)	Population density (2005)	Group 2 (17 old riches)	Land Area (sq. km)	Population (2005, '000s)	Population density (2005)
Bahamas	10,070	325	23	Australia	7,617,930	20,395	3
Bermuda	53	64	1,211	Austria	82,444	8,232	98
Brunei	5,270	370	64	Barbados	431	253	589
Chile	748,800	16,297	22	Belgium	30,278	10,415	341
Cyprus	9,240	836	90	Canada	9,093,507	32,307	3
Germany	349,223	82,409	231	Denmark	42,394	5,417	126
Greece	130,800	11,064	84	Finland	304,473	5,244	16
Hong Kong	1,042	6,883	6,263	France	640,053	61,013	111
Ireland	68,890	4,187	60	Iceland	100,250	296	3
Japan	374,744	127,449	337	Israel	20,330	6,692	302
South Korea	98,190	47,566	478	Italy	294,020	58,645	195
Kuwait	17,820	2,700	152	Luxembourg	2,586	464	179
Macao	28	488	18,755	Netherlands	33,883	16,316	393
Puerto Rico	8,870	3,913	441	New Zealand	268,021	4,111	15
Qatar	11,437	885	80	Norway	307,442	4,635	12
Singapore	683	4,267	6,247	Sweden	410,934	9,066	20
Spain	499,542	43,060	85	United States	9,161,923	302,741	31
Taiwan	32,260	22,653	702				
UAE	83,600	4,089	49				
Average	128,977	19,974	1,862	Average	1,671,229	32,132	143

Some countries are filtered out from our sample according to the following criteria:

- Even though a country is listed in year 2007, if its name is not shown at least three times or more in the past, it is ruled out. Development should be sustainable, thus Libya, Oman, and Trinidad and Tobago are ruled out.
- A country must show its name at least three times, including for 2007. It is hard to judge whether a country is really growing if its name is listed only once or twice, thus Belarus, Slovenia, Czech Republic, and Malta are ruled out.
- A country whose name is not listed in 2007 is ruled out. Developments should be currently on-going, thus Argentina, Palau, Saudi Arabia, Uruguay, and Venezuela are ruled out.

According to Table 2, countries in Group 1 (successful "take-offs") are significantly smaller with an average land area of 128,977 square kilometers than those of Group 2 ("old riches") with an average of 1,671,229. The average land area of all 190 countries is 683,879 square kilometers. In sum, the "old-rich" countries, on average, possess significantly larger territorries than the "take-off" countries as well as when compared to other average countries. It can be argued from this finding that both large and small states can experience economic development, but the "take-off" countries in Group 1 have relatively fewer populations than others. Specifically, the average population in Group 1 is almost half of Group 2 according to the entire sample and density: Countries which experienced rapid development have, on average, less population. This finding is consistent with that of Easterly and Kraay (2000), who report that "small states (in terms of population) have higher per capita GDP than other states." Finally, the difference of density in each group is striking: The density in Group 1 is 10 times higher than that of Group 2, and six times higher than that of the entire world.

On top of these variables, we consider several control variables that may affect take-off for an economy. There are many suggestions from previous papers for these variables. There is a sizable literature of documented claims regarding a positive association between economic developments and the "maturity" of capital markets and private sector corporate governance. La Porta et al. (1998) and Djankov et al. (2008) argue that the degrees of financial

investor protection and governance enforcement are strongly and positively correlated with sustainable economic developments. The spatial determinants of economic growth may be overstated if factors which proxy for such concern are not controlled for. In this regard, we use a number of well-cited variables from the law and economics literature: For sovereign legal system indicators, we source accounting standards (AS) from La Porta, et al. (1998) and anti-director rights (AD), which proxies for the degree of shareholder protections, from Djankov et al. (2008). We also calculate the ratio of stock market capitalization to GDP (SMCTG) as a relative measure of country-specific capital market development, also suggested by Djankov et al. (2008). Table 3 summarizes these variables.

Lucas (2009) finds that "open" countries have shown better performance in terms of economic growth. We sourced the openness indicator as suggested by Sachs and Warner (1995), which defines an open (as opposed to "closed") country as a sovereign jurisdiction that satisfies the following criteria: (1) have effective protection rates less than 40 percent; (2) have quotas for less than 40 percent of imports, (3) have no currency controls or black markets in currency; (4) have no export marketing boards; and (5) are not socialist (Kornai, 1992). Eichengreen et al. (2013) showed that the ratio of "high" education positively affects economic growth. Our proxies for the degree of human capital are suggested by Barro and Lee (2012) which defines education-level indicators by measuring the proportions of graduates from the secondary and/or tertiary education programs among the population over the age of 25.

This table presents various measures of nation-specific corporate governance. Accounting Standards (AS) is from La Porta, et al. (1998) whereas Antidirector Rights (AD), a proxy for degree of shareholder protection, and Stock Market Capitalization to GDP (SMCTG), a measure of equity market development, are suggested by Djankov, et al. (2008). Governance is considered "high" if a rating is higher than the median.

Table 3. Sovereign corporate governance measures

Group 1 (19 take-offs)	AD	AS	SMCTG	Group 2 (17 old riches)	AD	AS	SMCTG
Bahamas				Australia	4	75	5
Bermuda				Austria	3	54	2.797
Brunei				Barbados			
Chile	4	52	4.496	Belgium	3	61	4.208
Cyprus				Canada	4	74	4.665
Germany	4	62	4.002	Denmark	4	62	4.071
Greece	2	55	4.515	Finland	4	77	5.177
Hong Kong	5	69	5.889	France	4	69	4.494
Ireland	5		4.214	Iceland			
Japan	5	65	4.237	Israel			
South Korea	5	62	3.991	Italy	2	62	3.967
Kuwait				Luxembourg	2		4.974
Macao				Netherlands	3	64	4.881
Puerto Rico				New Zealand	4	70	3.691
Qatar				Norway	4	74	3.681
Singapore	5	78	5.105	Sweden	4	83	4.721
Spain	5	64	4.381	United States	3	71	4.957
Taiwan	3	65	4.624				
UAE							

Against this backdrop, we consider the maturity proxies of capital markets (SMCTG: stock market capitalization to GDP) and sovereign-level governance (AD and AS), openness dummy variable (Openness), proportions on completion of secondary education and higher (Tertiary) education among the population over the age of 25.

3. SIZE AND TAKE-OFF: CORRELATION ANALYSIS AND PANEL REGRESSIONS

In Table 4, the above findings are further examined by a correlation coefficient analysis: All three size variables (Area, Population, and Density) are negatively correlated with per capita GDP in Group 1 countries with statistical significances on the area. On the other hand, we find strong positive associations between area and population, and per capital income for countries in Group 2. There appears to be stratified economic relations between the size factors and the economic status of a country, whether as a "take-off" or "old-rich." We further examined these differences by implementing panel regression analyses with control variables.[2]

The numerical values below are correlation coefficients with the relative per capita GDP for each country group for the following variables: Area, Population, and Density. ***, **, and * stand for statistical significance based on two-sided tests at the 1%, 5%, and 10% level, respectively. The observations are in country-years from 1955 until 2005.

Table 4. Correlations with per capita GDP

Group	Area	Population	Density
All	0.063**	-0.051**	0.141***
Group 1	-0.206***	-0.122	-0.039
Group 2	0.177**	0.209***	-0.029

With control variables mentioned in the previous section, this study conducts panel regressions covering 184 countries (19, 17, and 148 countries in Groups 1, 2, and 3, respectively) and 11 five-year periods (from 1955 to 2005):

$$Growth_{it} = \alpha_i + \beta \cdot Size_{it} + \gamma \cdot Control_{it} + \epsilon_{it}, \quad (1)$$

where the GDP growth rate (*Growth*) is regressed onto the key explanatory variables (*Size*: population, density and area), controlled for accounting standards, anti-director rights, the ratio of stock market capitalization to GDP, openness dummy variable and the respective proportions of secondary and higher education among the population of age over 25 for country i and period t.

In Table 5, seven panel regression models of GDP growth rate are identified with aforementioned explanatory variables. In Model 1, regressed with fixed effects, the economic values of population and density are reflected in the growth rate of an average economy, although the statistical significance of density is not conspicuous. In Models 2, 3, and 4, the spatial dimension of economic growth is augmented and regressed with generalized least squares (GLS) effects assuming heteroskedasticity,[3] controlled for development proxies for capital markets (SMCTG) and capitalism (AD and AS), and further for the 1955 real GDP (Model 3) and for Groups 1 and 2 dummies (Model 4). We find that economic growth is higher the smaller the country size holding other key and control variables constant. We also observe that an economy grows faster the more mature the capitalism in terms of investor protection (AD) and accounting standards (AS). Although the negative association of economic growth and relative stock market size (SMCTG) is economically unintuitive, it can be ascribed to the real-financial lag effects.

The dependent variable is the GDP growth rate of each country. The explanatory variables are as follows: Population is in the unit of trillions. Density is the average headcound in the unit of millions per 1,000 square kilometers. Area is in the unit of billion square kilometers. For sovereign legal system indicators, we source accounting standards (AS) from La Porta et al. (1998) and anti-director rights (AD), which proxies for the degree of shareholder protection, from Djankov et al. (2008). STMCTG is the ratio of stock market capitalization to GDP as a relative measure of country-specific equity market development, suggested by Djankov et al. (2008). Openness is a dummy variable per Sachs and Warner (1995). Secondary and Tertiary variables are the respective proportions of secondary and higher education among the population of age over 25 from Barro and Lee (2012). The panel dataset is constructed per Dempster et al. (1977) and van Dyk and Meng (2001) to minimize information loss from missing

[2] The dataset used for panel regression analyses is constructed per Dempster et al. (1977) and van Dyk and Meng (2001) to minimize information loss from missing estimates and observations.

[3] These models are fitted by GLS allowing for heteroskedasticity. Additional relaxation of autocorrelation and contemporaneous correlation leaves the fitted results qualitatively equivalent.

estimates and observations. The numerical value below an estimate is the t or z-statistic. ***, **, and * stand for statistical significance based on two-sided tests at the 1%, 5%, and 10% level, respectively. The observations are in country-years from 1955 until 2005.

Table 5. Panel regressions of economic growth.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	0.017*** 33.470	-0.026*** -4.980	-0.019*** -3.230	-0.012* -1.850	-0.012** -2.180	-0.012** -1.980	-0.014** -2.040
Population ($\times 10^9$)	0.068*** 3.890	0.070*** 4.490	0.076*** 4.710	0.069*** 4.360	0.061*** 3.730	0.062*** 3.720	0.061*** 3.730
Density ($\times 10^6$ / 10^3 km^2)	1.167 1.070	1.742** 2.340	1.410** 2.000	1.801** 2.400	1.659** 2.390	1.603** 2.340	1.887*** 2.580
Area ($\times 10^9$ km2)		-1.023** -2.400	-1.338*** -2.990	-1.198*** -2.620	-0.879* -1.820	-0.916* -1.860	-1.030** -2.060
AD		0.015*** 8.650	0.018*** 8.990	0.016*** 8.640	0.020*** 10.850	0.020*** 10.140	0.020*** 10.560
AS		0.001*** 6.280	0.001*** 4.110	0.001*** 3.530	0.001*** 3.860	0.001*** 3.530	0.001*** 3.270
SMCTG		-0.022*** -7.950	-0.024*** -8.380	-0.022*** -7.520	-0.028*** -9.500	-0.028*** -9.290	-0.027*** -9.020
Openness					0.018*** 8.840	0.018*** 8.540	0.019*** 8.530
Secondary					0.001*** 9.320	0.001*** 9.120	0.001*** 9.160
Tertiary					-0.001*** -3.650	-0.001*** -3.570	-0.001*** -3.610
Fixed effects	Yes	No	No	No	No	No	No
GLS effects	No	Yes	Yes	Yes	Yes	Yes	Yes
1955 real GDP dummy	No	No	Yes	No	No	Yes	No
Group 1 dummy	No	No	No	Yes	No	No	Yes
Group 2 dummy	No	No	No	Yes	No	No	Yes
Number of observations	1,958	1,958	1,958	1,958	1,958	1,958	1,958
R^2	0.005	0.087	0.092	0.092	0.120	0.121	0.121

The spatial effect findings of economic growth are robust to the country-level degrees of economic openness and education level as exhibited in Models 5, 6, 7, which are fitted with GLS effects and additionally controlled for the 1955 real GDP (Model 6) and for Groups 1 and 2 dummies (Model 7). A country experiences a more accelerated economic growth the more it is internationally open, and/or the higher its relative population in secondary education. Over-education may explain the negative association between economic growth and tertiary education.

In sum, on average, an economy appears to grow faster the smaller the landmass, and/or the larger the potential workforce, and/or the higher the population density, controlled for the quality indices of capital markets, economic regime, openness, and human capital. We now turn to discussing the transition from take-off to slow-down by considering the non-linear aspects of economic growth in the next section.

4. SUSTAINABILITY OF TAKE-OFF AND SLOW-DOWN OF AN ECONOMY

Take-off is not sustainable by nature and an economy may slow down after a certain period of rapid growth regardless of its size. While we looked at the overall relationship between economic growth and its determinants in Section 3, this section focuses on Group 1 countries, or the so-called "take-offs," specifically their economic propulsions and sequential contractions. A typical Group 1 country will not grow fast for good: Like an athlete who leaps in a long jump game will land after a short flight, an economy will decelerate after a certain period of high

degree of growth. According to Kuznets's "inverted U hypothesis," a country's growth rate tends to rise as its income increases, but decreases as its income exceeds a certain threshold.

For the sample countries in Group 1, this paper tests this hypothesis. In order to facilitate the concave nature of the hypothesis, we propose a non-linear model as follows:

$$G = y^{\alpha} e^{-\beta y} \tag{2}$$

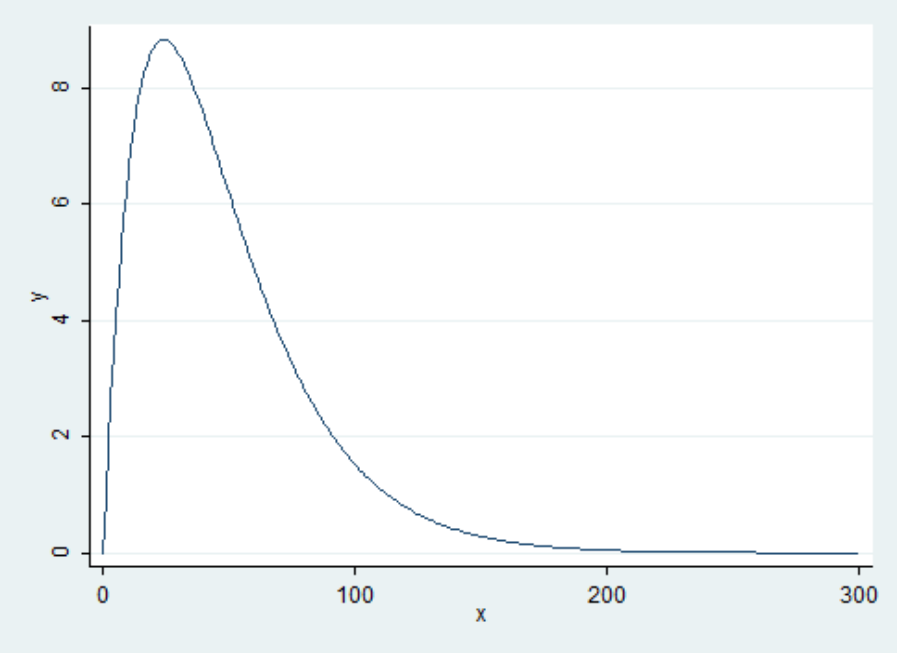
where G is the growth rate of each country, and y is the per capita GDP relative[4] to that of the U.S. which was used in previous section as an explanatory variable. Non-linear model in equation (2) has an important mathematical advantage in that it can detect the point of reflection when an economy starts its slow-down, which cannot be captured by a typical quadratic equation. Visual shapes of each model are provided in Figure 1.

Table 6 provides the regression results of selected Group 1 countries.[5] Out of 19 countries, seven has positive coefficient estimates for both α and β. Singapore is chosen since it is one of the typical take-off examples. Moreover, its coefficient of α is significant, and that of β is nearly significant with a p-value equal to 0.118.

Equation (2) appears to well capture the growth patterns of selected countries. These countries appear to show a wide range of variations in relative income: (Japan: 20 → 90%; Korea: 11 → 55%; Taiwan: 8 → 61%). These noticeable performances indicate their successful take-offs, and with these wide ranges, Equation (2) is deemed to provide a desirable fit to these countries. Detailed discussions on some of the prominent take-off countries are followed.

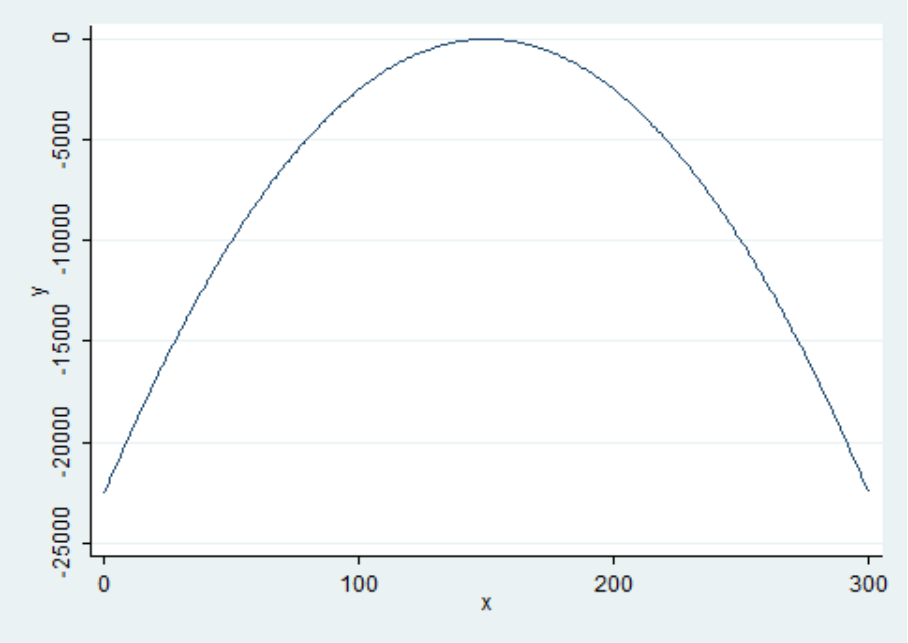
Figure 1. Comparison of our non-linear model and standard quadratic non-linear model

Panel A. Our non-linear model



[4] The U.S. is a numéraire country used to compare various per capita GDPs of sample countries.
[5] The results for the entire countries are available upon request.

Panel B. Standard quadratic model



The non-linear model is as follows:

$$G = I^{\alpha} e^{-\beta I}$$

where G is the growth rate of each country, and I is the per capita GDP relative to that of the U.S. The numerical values below coefficient estimates are the t-statistics. ***, **, and * stand for statistical significance based on two-sided tests at the 1%, 5%, and 10% level, respectively.

Table 6. Non-linear regressions for Group 1 countries

Country		β	Country		β
Bahamas	-2.756 1.969	-0.175 0.000	South Korea	0.785 *** 0.115	0.028 ** 0.000
Bermuda	-0.646 1.235	-0.032 0.000	Kuwait	0.536 4.400	0.032 0.000
Brunei	-2.165 2.336	-0.051 0.000	Macao	-0.214 0.202	-0.036 *** 0.000
Chile	-0.271 0.730	-0.055 0.000	Puerto Rico	0.907 *** 0.220	0.048 *** 0.000
Cyprus	0.623 * 0.320	0.019 0.000	Qatar	1.571 3.474	0.075 0.000
Germany	0.085 1.145	-0.004 0.000	Singapore	0.604 *** 0.123	0.013 0.000
Greece	0.808 *** 0.244	0.037 * 0.000	Spain	0.944 *** 0.181	0.044 *** 0.000
Hong Kong	0.836 *** 0.100	0.027 *** 0.000	Taiwan	0.926 *** 0.056	0.039 *** 0.000
Ireland	0.165 0.148	-0.011 0.000	UAE	0.232 0.800	-0.013 0.000
Japan	1.002 *** 0.076	0.042 *** 0.000			

Japan, South Korea, and Taiwan are selected based on their relatively high model fit and similarity in terms of development processes. We begin with Japan.

4.1. Japan

Japan is the first country in East Asia that experienced the "take-off." Ever since its opening in the Meiji Revolution, Japan's policies differentiated from its neighboring countries by actively accepting systems and cultures of the West (脱亜入欧, だつあにゅうおう: Leave Asia and Enter Europe). Even though its economy was destroyed at the end of World War II, it was revived by taking advantage of the Korean War. Its relative income in 1950 was already 20% of the U.S., which was the highest among all neighboring countries as China was 2.6% in 1952, Korea was 10.6% in 1953, the Philippines was 12.9% in 1950, and Taiwan was 7.7% in 1951.

A full-fledged take off began around 1958 when its income was 32.3% of the U.S. It took eight years (1950 → 1958) for its income to increase from 20% to 30%, but only three years (1958 → 1961) from 30% to 40%. Remarkably, after the golden era of the 1960s and having hosted the Olympics, its income leaped to 70% of the U.S. in 1970.

However, as shown in Panel A of Figure 2, the steep increase stagnated since 1970, mainly due to the first Oil Shock. It took 12 years to reach the 80% level (1970 → 1982). In the 1980s (until 1988), the relative income level had almost stagnated (81% in 1982 and 82% in 1988). An interesting phenomenon was observed between 1988 and 1991 when the income level surged from 82% to 90.3%, thus reminding us of Japan's golden era in the 1960s. However, this is mainly due to the yen appreciation, not to the economic growth. Since the Plaza Accord in 1985, yen against dollar had appreciated more than 50%, so the nominal value of Japan's income level, expressed in terms of dollars, has increased without "real" growth. In other words, it was a temporary bubble. The evidence of this argument is the trend since 1991: The income level soon went back to 80% in 1997. However, coupled with a deep recession, Japan's relative income is now only 70% of the U.S., which is the same level as in 1970.

Figure 2. Panel A. Japan

Panel A. Japan

Panel B. South Korea

Panel C. Taiwan

4.2. South Korea

Korea showed no progress in the 1950s and early 1960s. Its relative income in 1953 was 10.6% of the U.S. and the income in 1962 was 10.4% of the U.S. However, since General Park Chung Hee overtook presidency through a military coup in 1961, its economy took off and its income had exceeded 20% of the U.S. in 1977 (Panel B, Figure 2). Its upward trend had continued in the 1980s and 1990s as its income exceeded 30%, 40%, and 50% in 1986,

1990, and 1994, respectively. Due to the unprecedented currency depreciation after the financial crisis and IMF bailout in the late 1990's, its relative income dropped from 52.8% in 1997 to 46.6% in 1998. However, it recovered from the aftermath of the crisis, and exceeded the 50% level in 2002. Unlike Japan, the relative income of Korea is still in an increasing phase; Japan is at around 70% with a decreasing trend, while Korea is around 55% and still increasing. It may be premature to predict, but it is likely that these two economies' relative income level may converge in a decade or so. The PPP based per capita income of the two countries had already converged at around $28,000.

To South Korea, potential reunification with North Korea may also poses a big external shock to its economy. With a successful transition to a merged entity, the unified Korea's economy may undergo a second round of rapid growth and become a leading economy in Asia.

4.3. Taiwan

Taiwan's development pattern is similar to that of Korea's, but with a more stable trend. After being stagnated at around 10% of U.S. income, its take-off began in mid 1960s due to implementations of its reform and open economy policy. Its income achieved 20%, 30%, 40%, and 50% relative to that of the U.S. in 1973, 1982, 1988, and 1993, respectively (Panel C, Figure 2). Up to this point, Taiwan's development pattern is very similar to that of Korea's. However, unlike Korea that was devastated in the financial crisis in 1997, Taiwan was not much affected and its relative income levels did not experience sudden shrinkages. Due to the stable growth, its income level has achieved 60% of the U.S.

4.4 Predictions of Future Take-Offs: Special Reference to China

Descriptions on countries that have already experienced "take-offs" may be useful for predicting the growth patterns of developing countries that are about to take off and join Group 1. Given that most countries in Group 1 are small in terms of area and population, those small developing countries with the potentials to take-off will be good candidates. However, it appears that current rapidly growing countries are mostly large in terms of area and population: Consider China, for example. According to Table 7 China has shown a double-digit growth rate since 2004, and its relative income has doubled in less than 10 years. China is deemed a likely candidate for the next Group 1 member country. Performances of other large countries, such as Brazil, Russia, and India as so-called "BRICS," are not as conspicuous as China: The income of Brazil has increased to 22% of the U.S. in 2007 from 16% in 1950; India from 6% to 9% in the last half century. Russian income records an overall decrease. Emerging markets in Southeast Asia, such as Malaysia, Indonesia, Thailand, and Vietnam have also shown increasing trends of relative income, but the process is not as impressive as the countries in Group 1 and China. Moreover, among the current developing economies, China shows a very significant non-linear regression result according to our untabulated report.[6]

For this reason, this section focuses on China. More specifically, by looking at the data of several Group 1 countries, we attempted to predict how long the Chinese economy will remain "airborne" until when it will eventually slow down. First, consider the fitted result of China and the shape of Equation (2) in Figure 3. Mathematically, this function has a relatively long tail, meaning that its decreasing part is initially concave but becomes convex at a certain point. The decreasing rate is diminishing at a certain point, and the reflection point may be a starting point for the economy's slowdown.

[6] The non-linear regression results are available upon request.

Per capita income of eight countries in Group 1 and prospective countries (BRICS, Malaysia, Indonesia, Thailand, and Vietnam) for the group relative to the U.S in percent.

Table 7. Per capita income of eight countries in Group 1 and selected countries

Panel A: Japan-Greece

Year	Japan	Korea	Tai-wan	Hong Kong	Singapore	Spain	Greece
1952	23.473		8.422			30.840	28.017
1953	23.861	10.612	8.821			29.059	30.445
1954	25.818	11.018	9.348			33.798	31.352
1955	26.099	10.892	9.115			32.967	31.232
1956	27.661	10.709	8.970			35.122	33.807
1957	29.592	11.654	9.446			36.738	36.222
1958	32.263	12.046	10.054			39.472	39.176
1959	33.504	11.301	9.934			35.693	38.418
1960	37.180	10.899	10.337	23.419	26.833	38.898	38.200
1961	41.023	11.069	10.791	23.907	27.084	43.243	42.311
1962	42.471	10.392	10.961	24.793	27.280	45.197	40.685
1963	44.152	11.041	11.669	28.609	26.724	47.600	43.328
1964	47.035	11.102	12.427	30.174	24.838	47.532	44.767
1965	46.809	10.771	12.386	33.483	24.083	47.324	45.984
1966	49.077	11.304	12.730	33.875	24.607	48.498	46.457
1967	53.469	11.617	13.600	34.186	25.720	49.957	48.022
1968	57.701	12.142	14.001	33.465	27.419	50.609	48.825
1969	62.855	13.310	14.786	36.047	28.202	53.880	52.522
1970	70.330	14.426	16.463	38.832	30.914	56.033	57.481
1971	71.495	15.044	18.009	41.081	33.560	56.562	60.308
1972	72.741	15.272	19.553	43.189	35.877	58.309	62.838
1973	73.130	16.256	20.416	44.457	38.624	59.381	64.334
1974	71.957	17.132	19.611	43.451	41.876	62.539	61.061
1975	73.842	18.016	20.894	44.957	43.183	63.287	64.505
1976	72.557	19.844	22.914	49.621	43.849	61.451	64.894
1977	72.757	21.391	24.060	52.774	44.762	60.080	63.573
1978	73.538	22.593	25.544	53.767	46.282	58.049	64.535
1979	74.170	23.522	26.282	56.155	49.251	56.673	64.216
1980	76.193	22.104	27.656	63.135	54.780	57.858	65.321
1981	77.305	22.719	28.559	65.319	56.268	55.116	63.274
1982	80.980	25.328	30.399	69.662	61.902	57.114	63.018
1983	78.365	26.757	31.536	68.903	65.095	55.054	59.330
1984	75.254	27.273	32.475	71.382	63.327	52.335	55.705
1985	76.972	27.909	32.956	71.235	57.938	52.048	55.094
1986	78.049	30.837	36.612	74.281	56.222	53.661	54.686
1987	79.055	34.101	39.565	81.640	58.438	55.603	52.079
1988	81.991	36.628	40.203	84.544	61.632	57.038	53.088
1989	83.868	37.727	41.603	85.220	65.134	58.413	53.021
1990	86.010	40.311	43.049	87.357	68.443	60.166	52.423
1991	90.326	44.617	46.598	93.852	73.319	62.823	54.804
1992	89.488	45.893	48.646	97.403	75.093	62.146	53.410
1993	87.516	47.744	50.770	100.661	80.977	59.472	51.587
1994	84.809	50.213	52.068	99.068	84.723	58.706	51.048
1995	84.919	53.500	53.635	94.585	89.270	59.754	51.415
1996	84.027	54.370	55.590	94.303	91.215	59.354	51.194
1997	81.282	52.780	56.756	94.348	92.648	59.119	51.041
1998	76.073	46.636	57.035	86.302	81.820	59.918	50.872
1999	72.698	48.074	57.191	83.609	80.574	60.775	50.841
2000	72.601	48.805	57.403	86.316	89.541	61.678	51.253
2001	72.761	49.697	56.210	86.689	81.894	64.606	53.406
2002	72.118	52.220	58.205	88.419	82.222	66.586	55.666
2003	71.832	52.363	58.291	87.272	79.949	68.060	58.395
2004	71.535	53.089	58.569	88.254	88.786	68.308	59.793
2005	71.125	52.659	58.703	91.129	91.810	69.621	60.824

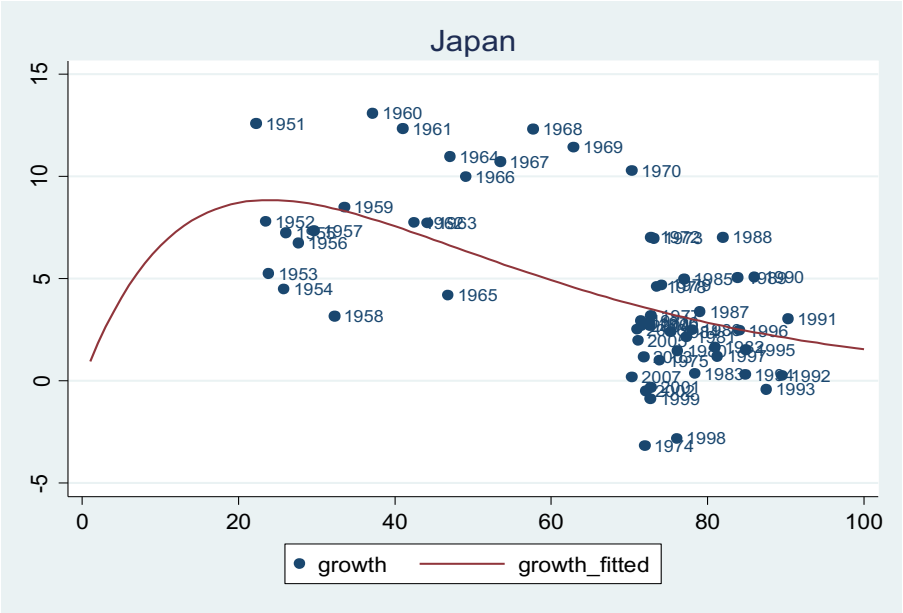
(Table 7 continued)

Panel B: China-Vietnam

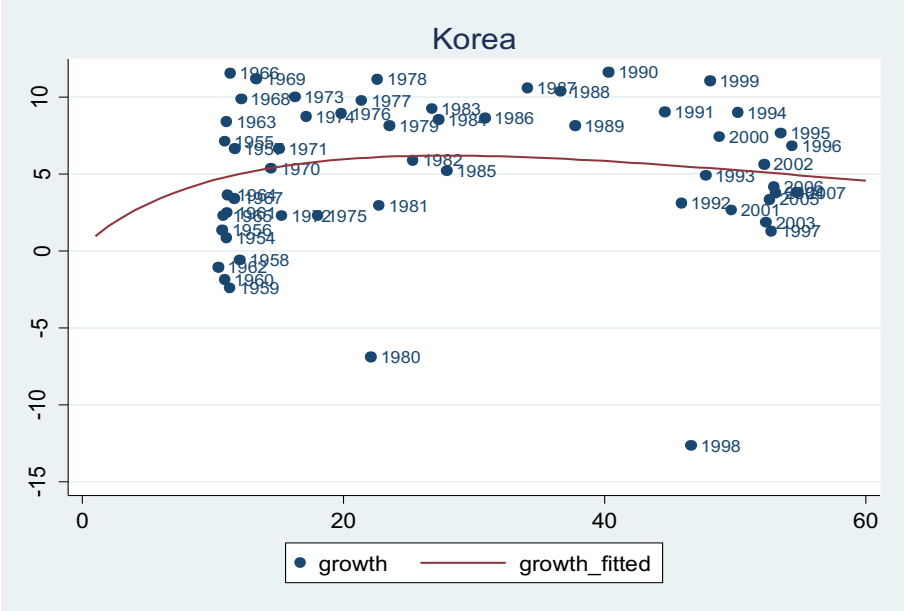
Year	China	Brazil	India	Russia	Malaysia	Indonesia	Thai-land	Vietnam
1952	2.644	17.040	6.103				8.400	
1953	2.718	16.688	6.163				7.480	
1954	2.807	18.319	6.461				8.004	
1955	2.725	17.583	6.026		14.773		7.000	
1956	2.922	17.563	6.102		14.337		7.016	
1957	3.014	18.838	6.032		13.635		7.730	
1958	3.394	20.111	6.549		13.173		7.936	
1959	3.241	20.083	6.282		14.775		8.205	
1960	3.155	20.940	6.525		15.679	5.238	8.820	
1961	2.714	23.137	6.638		15.165	5.230	8.951	
1962	2.596	22.488	6.493		14.671	5.234	9.004	
1963	2.609	22.635	6.627		14.356	4.772	9.206	
1964	2.705	21.920	6.633		14.146	4.562	9.157	
1965	2.782	21.677	6.065		14.253	4.161	9.108	
1966	2.793	20.882	5.634		13.897	3.826	9.551	
1967	2.661	21.434	5.902		13.484	3.849	10.052	
1968	2.410	22.216	5.829		12.960	4.207	10.281	
1969	2.518	21.953	6.161		13.600	4.222	10.530	
1970	2.726	24.455	6.232		14.020	4.603	11.210	4.549
1971	2.787	26.065	6.237		15.885	4.745	10.846	4.492
1972	2.673	27.167	5.853		15.526	4.934	10.436	4.276
1973	2.709	28.746	5.591		17.349	5.363	11.206	3.923
1974	2.799	31.038	5.540		19.008	6.388	11.324	4.015
1975	2.966	31.773	5.869		17.936	6.543	11.598	4.073
1976	2.833	33.219	5.793		20.007	6.560	11.796	4.214
1977	2.847	32.785	5.809		20.700	6.983	12.295	4.506
1978	3.013	31.841	5.826		20.560	7.083	12.982	4.265
1979	3.241	32.683	5.499		22.436	8.024	12.739	4.393
1980	3.573	35.165	5.797		24.576	9.384	13.393	4.280
1981	3.725	31.834	5.956		23.791	9.767	13.678	4.341
1982	4.247	32.643	6.259		25.072	10.088	14.326	4.726
1983	4.421	29.920	6.210		25.216	10.096	14.286	4.752
1984	4.599	28.927	5.959		25.665	9.870	14.162	4.706
1985	4.978	28.317	6.044		23.590	9.722	13.797	4.701
1986	5.185	30.122	6.161		20.657	9.352	13.986	4.647
1987	5.523	29.560	6.252		21.704	9.406	14.694	4.595
1988	5.685	28.117	6.387		22.767	9.279	15.754	4.543
1989	5.610	26.574	6.397		23.504	9.749	16.786	4.491
1990	5.917	25.585	6.557	41.356	24.801	10.603	18.456	4.802
1991	6.507	25.687	6.571	42.138	26.808	11.420	20.309	5.101
1992	7.099	24.720	6.553	37.388	28.162	11.798	21.704	5.263
1993	8.052	24.772	6.583	29.367	29.741	12.074	22.742	5.277
1994	8.673	24.893	6.619	23.807	30.992	12.249	23.438	5.308
1995	9.274	25.198	6.922	21.936	33.277	12.821	24.669	5.618
1996	9.758	24.635	6.844	20.395	34.992	13.226	25.123	5.792
1997	9.838	24.084	6.864	19.337	35.001	13.348	23.046	5.979
1998	9.976	22.843	6.967	17.365	32.079	12.074	19.360	6.050
1999	10.257	21.623	7.260	18.634	32.486	11.048	18.793	6.111
2000	10.570	21.544	7.098	21.607	33.655	11.214	18.557	6.171
2001	11.408	21.530	7.296	21.540	32.847	11.336	18.700	6.485
2002	12.377	21.850	7.316	22.094	34.009	11.299	19.436	6.713
2003	13.280	21.385	7.531	23.604	35.811	11.673	20.521	6.894
2004	14.081	21.662	7.686	25.529	37.466	11.465	20.978	7.200
2005	15.483	21.496	8.038	27.703	39.363	11.664	20.698	7.777

Figure 3. Scatter plots and non-linear fitted growth curves of Japan, South Korea, Taiwan, and China

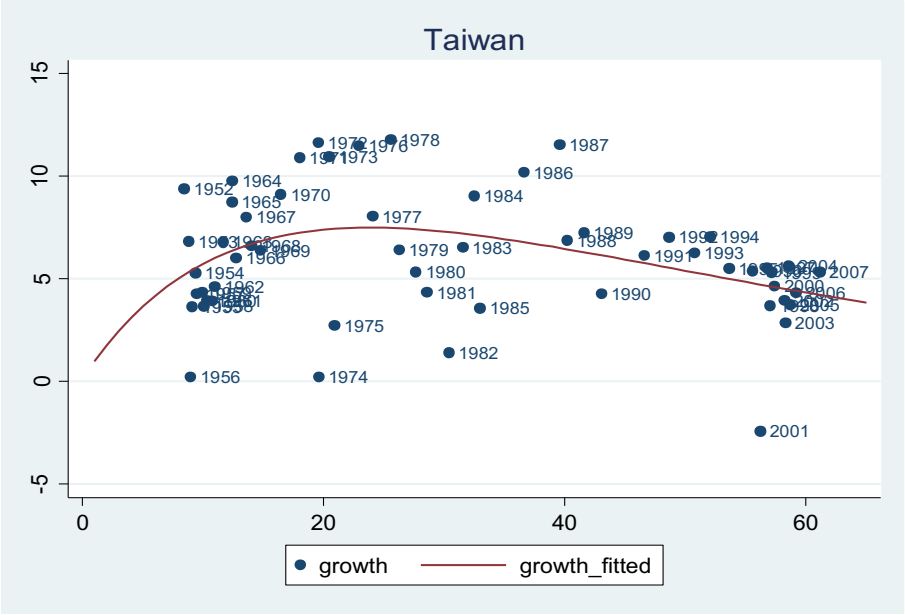
Panel A. Japan



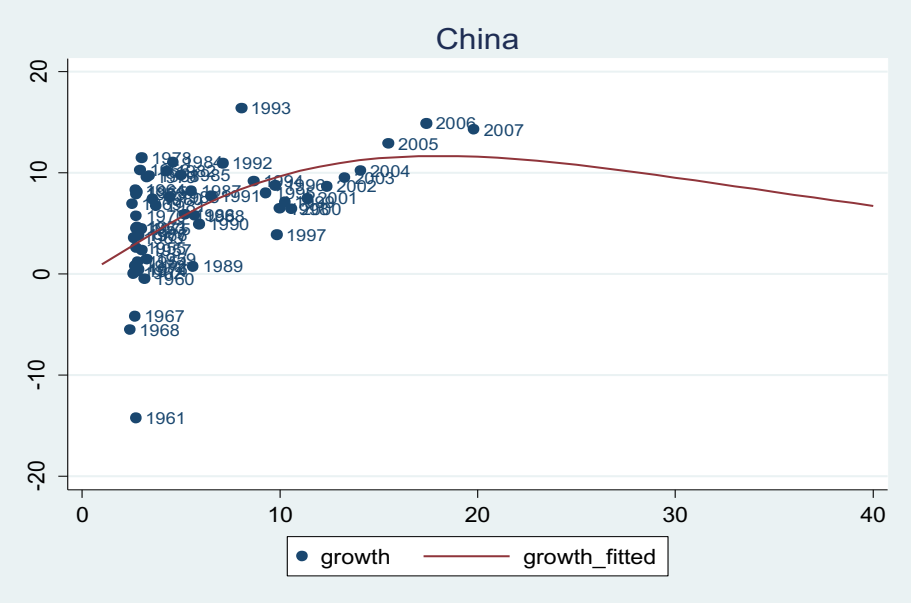
Panel B. South Korea



Panel C. Taiwan



Panel D. China



A slowdown does not prescribe a perpetual halt in the economic growth. In other words, it tells us that the economy tends to progress further. At the reflection point, Japan's income is 50% relative to that of the U.S. which undermines the reality to a certain extent as Japan undergoes a conspicuous growth phase at this stage. However, given that the Japanese economy stagnated at around 70% of U.S.'s income in the past 40 years (except during the bubble period of the late 1980's), and its relative income may shrink even further due to a series of economic recessions and natural disasters, such as the strong tsunami shock in 2011, this estimate is deemed reasonable. South Korea, Taiwan, and Hong Kong are predicted to slow down at 62%, 51%, and 67% respectively.

China's reflection point is at around 36%. This means that China's slowdown period may arrive earlier than other countries. Considering that the Japanese economy bottlenecked at around 70% of U.S.'s income even though its reflection point was 50%, we may predict that the Chinese economy will sustain a high growth even though it reaches the reflection point, and will stay in a "warm" status for approximately additional 20% until it becomes 50-60% relative to the U.S. This is unprecedented for there has been no large size economy which made such a rapid growth so far. However, in the current stage where China's per capita income is 19.8% of the U.S. and is expected to rise sharply, it is reasonable to identify a "cooling point" for its economy. Moreover, given that China's double digit growth may be partly due to the low price level, its growing inflation rate (5% in the first quarter of 2011) coupled with the overall global price increase in raw materials may lead to an early deceleration for its rapid growth (Barboza, 2008).

5. CONCLUSION

This study examined the relationship between the size of a country and its "take-off" for economic development. We find that small countries are not necessarily efficient in taking off. However, most countries that experienced the economic upheavals and have been under accelerated growth for the past decades were relatively small in terms of land size and population. Specifically, economic growth appears to be quicker the smaller the landmass, the larger the potential workforce, and the higher the population density, controlled for capital markets maturity, corporate governance, economic openness, and human capital development. The cases of Japan, South Korea, and Taiwan are examined with implications for the future growth prospect of China.

Future research agenda can include providing prescriptions for extending the sustained high growth period. Readers may focus on examining policies that may lead to the successful completion of long jumps of currently developing countries. They can be spatial urban policies, as discussed in World Bank's World Development Report 2009. A closer investigation of past long jumpers in Group 1 economies may provide answers for better policy prescriptions toward on-going jumpers.

AUTHOR'S NOTE

Standard disclaimer rules apply and all errors are of our own.

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