An Empirical Study on Economic Prosperity and Peace

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Given that the world is a more integrated global system than ever before, trading is recognized as a fundamentally important component of economic prosperity. However, economic prosperity of a particular country can also depend heavily on the peacefulness of a given country. Peacefulness may only serve as the key component that permits a country to achieve economic prosperity. Moreover, it is possible that peacefulness has a mechanical impact on economic prosperity. The motivation of this research was to investigate the permissive and the potential mechanical influence of peacefulness in economic prosperity. Economic prosperity and peacefulness were measured quantitatively using the Multiple-Variable Log-Linear Regression Model and the Discrimination Analysis statistical methods. The first approach showed an overall trend asserting a significant positive correlation between economic prosperity and peace. The second approach was an attempt to classify countries into groups. Further examination of shared characteristics within each group affirmed the classification results of this approach and the positive correlation from the Multiple-Variable Log-Linear Regression Model. The results generated by the two methods were integrated by combining the residuals generated by the first approach and the colored labels generated by the second approach. The integration stated a fair challenge to the Neoclassical Modern Growth Theory's assumption that exogenous forces do not have any mechanical impact on economic development.

RESEARCH

INTRODUCTION

Economic factors are likely part of the forces that help explain why conflicts develop, or on the contrary, why peaceful societies exist. The principle economic reason for countries to fight is to secure more resources. Conversely, countries have incentives to avoid engaging in wars and military disputes with their trading partner countries in order to maintain their commercial interests. The Capitalist Peace Theory asserts that economic development increases interdependence of commerce among nations and as a result, the profits generated provide strong incentives to avoid wars (Weede, 1996). The relationship between economic development and war can take one of two forms: the Capitalist Peace Theory (economic prosperity decreases wars) or its converse (wars decrease economic prosperity). The roots of the Capitalist Peace Theory can be traced back to German philosopher Immanuel Kant when he wrote "the spirit of commerce that sooner or later takes hold of every nation and is incompatible with war" (Butler, 1939). John Maynard Keynes also wrote about the interplay of economics and peace. In his book "The Economic Consequences of the Peace after World War I," he presented his criticisms of the Versailles Treaty, stating that the economic terms of the treaty prevented Europe from prospering by failing to provide an equitable, effective, and integrated economic system (Keynes, 1919).

Nevertheless, empirical studies and the literature in economics and social science show contradicting "results in the discussion of the relationship between peace and economic prosperity. Erik Gartzke argued that capitalism leads to peace (Gartzke, 2007). The word capitalism in Gartzke's work indicated economic freedom, including economic development, financial markets and monetary policy coordination (Gartzke and Li, 2003). In a 2012 case study of Palestine, Raul Caruso and Evelina Gavrilova investigated the qualitative association between Palestine's internal violence and the economic variable unemployment rate among male and female youth. Unemployment of among male youth was identified to be a significant component of Palestinian violence (Caruso and Gavrilova, 2012). The contradicting results in these empirical studies demonstrate that the role of peacefulness on economic prosperity remains ambiguous.

The Neoclassical Growth Model has been one of the most important economic frameworks that underline long-run economic growth. In the Solow Growth Model, economic development or prosperity are driven by labor, capital, and technology under the assumption that firms in the economy are competitive (Solow, 1956). Labor, capital, and technology serve as endogenous forces that determine economic development (Solow, 1956). Based on this model, Cass, Koopmans, Lucas, and Romer formed the modern Neoclassical Growth Theory in which technology and capital are the endogenous driving forces of long-run economic growth (Solow, 1956; Cass, 1956; Koopmans, 1963; Lucas, 1988; Romer, 1991). The Neoclassical Growth Theory assumes that exogenous factors, i.e. factors other than labor, capital, and technology, have neither mechanical nor deterministic effects on economic development. The exogenous factors, including peacefulness, policies, history, and culture, only serve as a necessary framework or suitable environment that permit an economy to prosper (Harberger, 2005). In essence, under the Neoclassical Growth Theory, labor, capital, and technology are the prerequisites for economic growth, while peacefulness serves as an element that contributes to economic growth rather than being a prerequisite. Despite the fact that international trade generally was not present in Solow's original model, Lucas and Romer expanded the analysis to include international trade across the borders of close economies because of the growing importance of commerce in the globalized world. The inclusion of international trade was crucial to this paper because it begged the question of whether "the spirit of commerce" is compatible with war (Butler, 1939). If labor is assumed to be mobile, that it can move from country to country, the wage rate of labor for a given skill level will enhance the wealth of the country if and only if trade of capital goods is included in the model (Lucas, 1988). Lucas supported his argument with the growth miracles of Korea, Taiwan, Hong Kong, and Singapore by suggesting that increases in exports were associated with economic development (Lucas, 1988).

Compared to the endogenous forces, exogenous forces such as policy, historical events, and social structure provide a suitable environment for economic prosperity. In other words, economic growth is not guaranteed if a given country maintains efficient policies and peaceful conditions. However, the absence of such an environment hinders prosperity. Peacefulness is a complicated state influenced by policy, history, social structure, and many other exogenous forces. The purpose of this present paper is to investigate whether peacefulness has real effects on a country's economic state beyond merely providing a suitable environment for economic prosperity to occur. This paper discusses empirical analyses carried by the Multiple-Variable Log-Linear regression model and the Discrimination Analysis to see whether economic prosperity and peace interact with each other.

MATERIALS AND METHODS

DATA

The data in this research came from the following sources. For the Log-Linear Model, Global Peace Index (GPI) and Global Competitiveness Index (GCI) was provided by the Institute of Economics and Peace and the World Economic Forum accordingly (Institute of Economics and Peace, 2012; World Economic Forum, 2010). The exports and imports data came from the United Nations Statistics Commodity Trade Statistics Database (United Nations Statistics Commodity Trade Statistics Database, 2012). The remaining data, exports and imports as a percentage of Gross Domestic Product (GDP), in the Log-Linear Model was provided the World Bank (World Bank, 2012a; World Bank, 2012b). The data used in this study is available from 2007-2011 (2011 data was partially incomplete when this study was conducted). The Log-Linear Model and the Discrimination Analysis of data from 2007-2011 yielded similar results. This manuscript only presented the result of 2010 by the Log-Linear Model and the results of 2010 and 2011 by the Discrimination Analysis.

SELECTION OF VARIABLES AND MODELS

Economic prosperity in this research was captured quantitatively by variables including the Global Competitiveness Index (GCI), exports, and imports with exports as a fraction of GDP and imports as a fraction of GDP. International trade is a crucial component in economic prosperity and it is well represented by these variables. GCI is a quantitative component of over 110 variables, including the nature of comparative advantage, productivity, and technological innovation (Sala-i-Martin et al., 2010). The index is a synthesis from macroeconomic and microeconomic perspectives. In addition, peacefulness was captured quantitatively by the variable Global Peace Index (GPI) by the Institute for Economics and Peace (IEP) which had 23 indicators, including neighboring country relations, access to weapons, and violent demonstrations. As a frequently-used measurement of national peacefulness, Global Peace Index (GPI) is used by governments and institutions all over the world including the World Bank, the OECD, and the United Nations. As a frequently-used measurement of national peacefulness, Global Peace Index (GPI) is used by governments and institutions all over the world including the World Bank, the OECD and the United Nations. A higher value of GPI indicates an
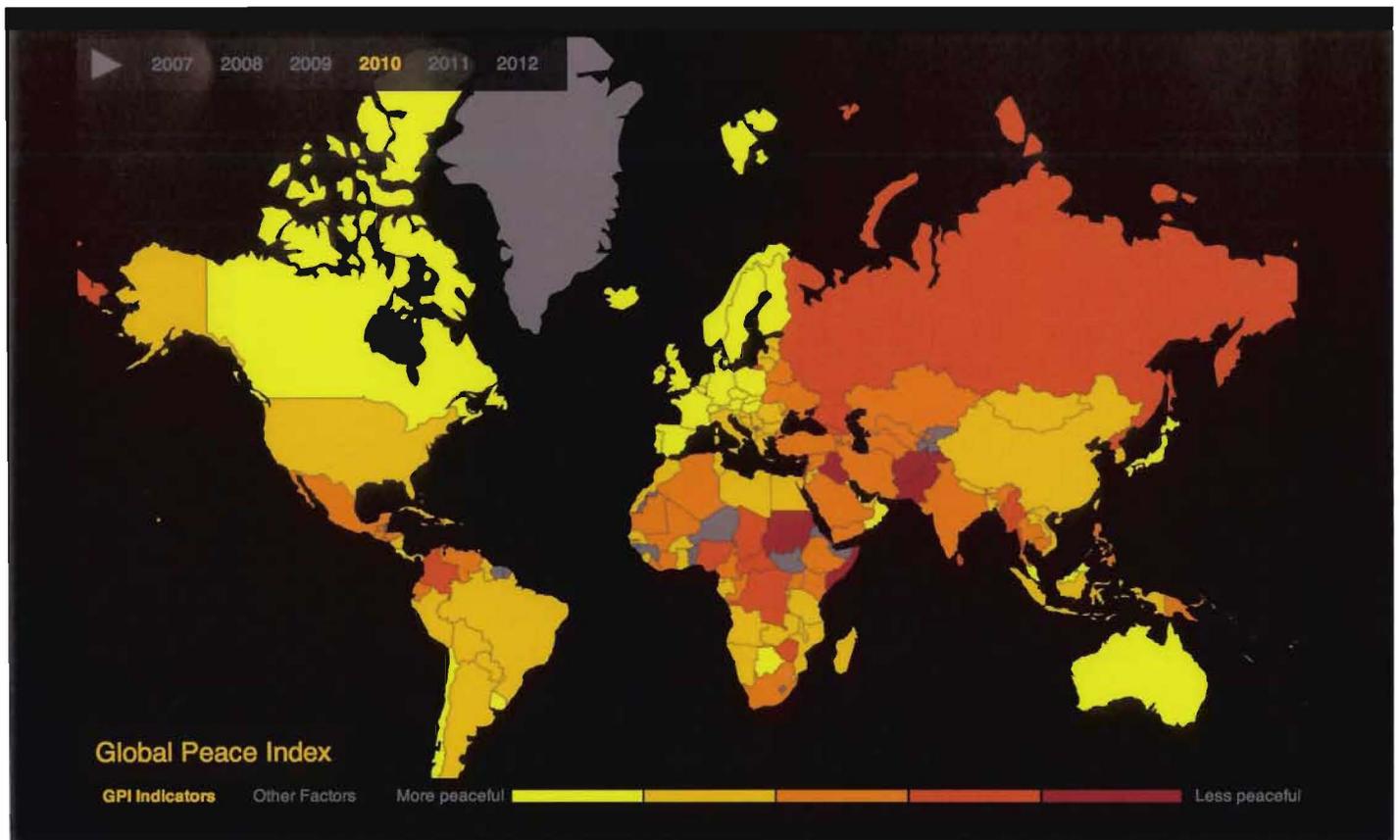

Figure 1. 2010 Global Peace Index (GPI) Map, courtesy Institute for Economics and Peace. Countries in green had smaller values of GPI scores, meaning they tended to be more peaceful. More red colored countries indicated larger GPI values, or countries more prone to conflicts. Reprinted 2012 Global Peace Index Map with permission from the Institute for Economics and Peace.

increased presence of wars, disputes, or internal conflicts (Figure 1). For example, Europe was the most peaceful continent in the world in 2010 and consequently had the lowest GPI score (Figure 2). The variable GCI was included in this study for two reasons. First, like the Solow Growth Model, this research assumes firms in the economy are competitive, and thus the implications of economic successes need to be examined (Solow, 1956). Second, the variable GCI took the influential components of economic prosperity such as commerce, technology, and productivity into account. The variable mu2 was used in this model because countries with high Muslim populations were involved in a disproportionately high number of civil wars from 1940 to 2000 (Toft, 2007).

The Log-Linear Regression Model and the Discrimination Analysis were the two approaches utilized in order to explore the questions on hand. After comparing the regular linear model, the Log-Linear Model and the Logistic Regression Model, the Log-Linear Model was determined to be the best fit to the data. It is believed that the Log-Linear Model performed better because the values of variables spanned several orders of

magnitude and this model was able to capture this data more effectively. For example, 10, 100, and 1000 are the values of a variable that span several orders of magnitude. The logarithm of 10, 100, and 1000 to base 10 are 1, 2, and 3 respectively. In order to meet the linear-regression-assumption that the relationship between the explanatory variables and the respond variable is linear, variables that span several orders of magnitude need to be transformed by the logarithm function. Hence, the log transformation was applied in this paper. Due to values of variables spanning several orders of magnitude and the observation of the wide-range correlations, it was reasonable to predict that observations in this study could be separated into different groups. Hence, the Discrimination Analysis was applied as the second approach.

The integration result of these two approaches was an attempt to challenge the assumption of the Neoclassical Growth Model that the exogenous forces do not mechanically influence economic development in advance. Additionally, the integration was able to connect the two approaches illustrated in this paper.
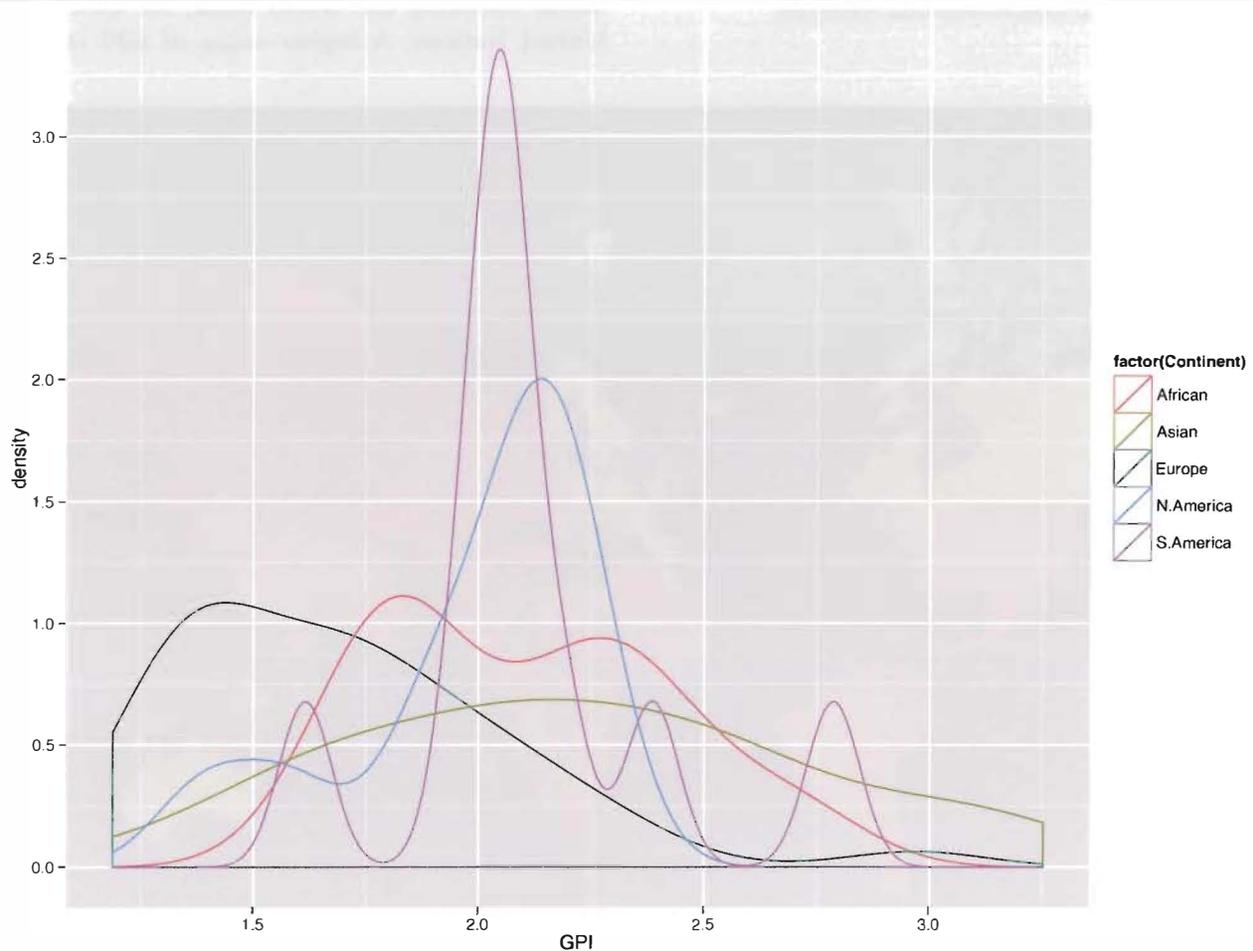

Figure 2. Global Peace Index (GPI) 2010 by continent. Each of the five colors illustrated on the right hand side of the figure, represented Africa, Asia, Europe, North America and South American respectively.

The role of the residual, ε, in the Log-Linear Regression Model was an estimate of factors that the model did not embrace. For instance, some factors of the residual include historical events, economic policy, and beliefs that people collectively share in society. The Discrimination Analysis, on the other hand, classified countries into colored labels according to values of GCI and GPI. Since both the residual and the colored labels were engendered numerically so they could be compared, it may prove beneficial to combine the two. Therefore, this study presented the integration of the two approaches.

THE MULTIPLE-VARIABLE LOG-LINEAR REGRESSION MODEL

$$\log(GPI) = \beta_0 + \beta_1 GCI + \beta_2 Mu2 + \beta_3 \log(Military) + \beta_4 \log(Trade) + \varepsilon$$

In the above Multiple-Variable Log-Linear Regression Model, log was the mathematical logarithmic function, GPI (Global Peace Index) was the response variable, GCI was the Global Competitiveness Index, mu2 (dummy variable) was the population proportion that self-identified itself as a percentage of Muslim population, military was military expenditures as a fraction of Gross Domestic Products (GDP), trade was total imports and exports per capita $(trade = \frac{exports+imports}{population})$, and ε was the residual or the error term. Table 1 presents some selected data from the Log-Linear Model. Assumptions of the Log-Linear Model had to be checked before the model was applied to the data. Major assumptions of the Log-Linear Model include homoscedasticity, normality, the independence of errors, and linearity. First, homoscedasticity asserts all variables have the same variance. Second, normality means that variables are normally distributed because relationships and significance tests can be distorted if distributions are highly skewed. Third, independence of errors assumes errors of observations are uncorrelated. Lastly, linearity states that an accurate linear relationship between the explanatory variables and the response variable exists. There were no violations of homoscedasticity (Figure 3A) or normality (Figure 3B). The two additional assumptions, the independence of errors and linearity, were further examined to ensure that the linear regression model is a good fit to the data.

THE DISCRIMINATION ANALYSIS

The second method, the Discrimination Analysis, classifies countries into different groups in order to further investigate the relationship between economic prosperity and peace. Traditional discrimination analysis attempts to minimize type I and type II errors in order to exclude them. A type I error is a false positive while a type II error represents a false negative. This paper

Country	GPI	GCI	Exports	Imports	Mu2	Military	Population
Argentina	1.962	3.95	68,134,075,417	56,501,293,106	1	0.9	40,518,951
Cyprus	2.013	4.5	1,506,457,953	8,644,721,987	2	2.2	801,851
Georgia	2.97	3.86	1,583,337,030	5,095,248,806	2	3.9	4,436,000
Norway	1.322	5.14	131,395,434,340	77,251,682,439	1	1.6	4,896,700
Russia	3.013	4.24	400,100,000,000	248,700,000,000	2	4	141,927,297

Table 1. Select countries in the Multi-variable Log-Linear Model. In the Log-Linear Model, the variables GPI, GCI, exports, imports, Mu2, military and population indicated peacefulness, competitiveness, exports, and imports of all categories of commodities, Muslim population proportion, military expenditure as a fraction of GDP, and population respectively. All available data for each country was included from the Institute of Economics and Peace, World Economic Forum, the World Bank and the United Nations Statistics Division. GPI was the response variable.
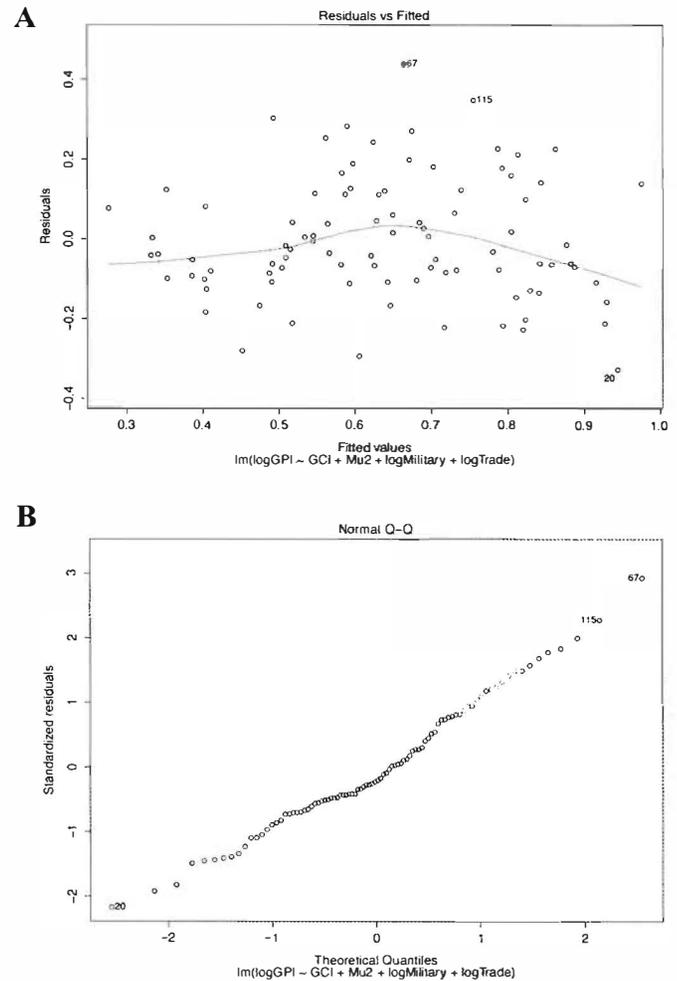
A

B

Figure 3. Checking assumptions for the Log-Linear Model. (A) The Residual vs. Fitted-Value Plot. There were no identifiable patterns in this plot so the standard deviation error was constant with respect to predictors that the assumption of homoscedasticity held. (B) This QQ-Plot indicated that residuals were approximately normally distributed.

presented a different approach: high values of type I and type II errors were allowed as a means to further examine observations that fell into these groups. Including the type I and type II errors groups, there were four groups of countries classified by the Discrimination Analysis in total.

The Discrimination Analysis consisted of two steps of classifications that are analogous to cutting a cake into two pieces and then further cutting each piece into two. This would separate countries into four groups by the classification strategy of the Discrimination Analysis: in the data from 2011, the median GCI was 4.72. If GCI > 4.72, a country was classified as True, otherwise it was classified as False (Table 2). This classification rule was also used for data from 2010. This process separated countries into two distributions (Figure 4). The intersection of these two distributions under GPI was the next splitting-point for further classification, which was approximately GPI = 1.68. Let the next splitting-point be χ, if GPI < χ that particular country was classified to be labeled True, otherwise it was classified to be Labeled False (Figure 4). If GPI < 1.68, the country was classified as labeled True, otherwise it was classified labeled False. Therefore, a country could be classified as True or False in the first step, and the very same country could also be classified to be labeled True or False in the second step. Two-by-two matrices were created by this classification strategy in order to capture each country's designation (Table 3).

The terms "more/less competitive" and "more/less peaceful" were used for convenience to describe countries in this paper. A country was "more competitive" if GCI was larger than 4.72 and "less competitive" otherwise. This classification rule was noted as "the first classification" in the present paper. A country was "more peaceful" if GPI was larger than the intersection point of the two distributions in the first classification. The colored labels were used to clarify classifications. With lower GCI and higher GPI scores, "yellow" represented "less competitive, less peaceful" countries. "Green" represented "more competitive, more peaceful" countries. "Blue" represented "less competitive, more peaceful" countries. "Red" represented "more competitive, less peaceful" countries (Table 3). For instance, in 2010, the United States' GCI and GPI were 5.43 and 2.06 respectively. Since GCI = 5.43, the country was classified to be True or more competitive in the first step. The intersection point of the intersection point of the two distributions generated in the first classification was 1.68. Since GCI = 2.06, the country was classified to be labeled False or less peaceful in the second step. Hence, United States was classified as a "red" country in the year 2010. Lastly, the two methods displayed in this paper were integrated by analyzing the role of residuals generated in the first approach on colored labels generated by the second approach.

More data was missing for 2011 compared to that of 2010 because the 2011 data was incomplete when this research was conducted. The missing values of 2011

Country classification conditions		Classification (Labeling)	
		True	False
Index	GCI (Competitiveness)	GCI > 4.72 (Median GCI = 4.72)	GCI ≤ 4.72
	GPI (Peace)	GPI < x	GPI ≥ x

Table 2. The classification strategy of the Discrimination Analysis. If GCI > 4.72, a country was classified as True, otherwise it was classified as False. This classification was based on GCI being equal to a certain value, i.e. GCI = 4.72, generating two distributions. Let the intersection of these distributions be χ. A country was claimed to be Labeled True if GPI < χ, otherwise it is claimed to be Labeled False.
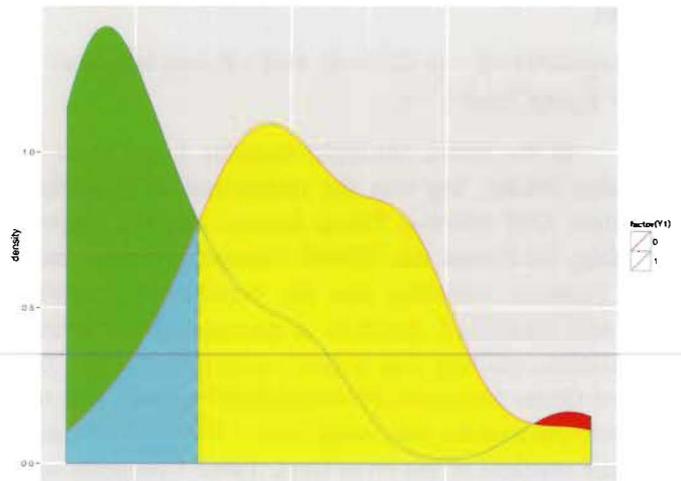

Figure 4. Discrimination Analysis 2011. The Median of Global Competitiveness Index (GCI) was 4.72. If GCI > 4.72, a country was classified as True (the green distribution as factor Y1=1 illustrated in the plot), otherwise it was classified as False (the red distribution as factor Y1=0 illustrated in the plot). In this figure, both the green and the red distributions were plotted under the Global Peace Index (GPI). The intersection was approximately GPI = 1.68. If GPI < 1.68, the country was classified as labeled True, otherwise it was classified as labeled False. Type I error was filled with red color while type II error was filled with blue color. The four colors represented four groups of countries classified by the Discrimination Analysis.

Table 3. The Discrimination Analysis of the year 2011 and 2010. In this paper, a country was "more competitive" if GCI was larger than 4.72 and "less competitive" otherwise. A country was "more peaceful" if GPI was larger than the intersection point of the two distributions generated in the first classification. With lower GCI and higher GPI scores, "yellow" represented "less competitive, less peaceful" countries. "Green" represented "more competitive, more peaceful" countries. "Blue" represented "less competitive, more peaceful" countries. "Red" represented "more competitive, less peaceful countries." (A) Two-by-two matrix (2011) created by the mechanism in Figure 3. (B) Two-by-two matrix (2010) created by the mechanism in Figure 3. The first splitting point in the classification was GCI=4.72 (same as the median of GCI in the analysis of 2011) instead of the median of GCI in the 2010 data for convenience.

distorted a few classification results produced by the Discrimination Analysis compared to the 2010 results. For instance, the country Botswana's GPI and GCI are respectively 1.641 and 4.05 in 2010, and 1.69 and 4.05 in 2011. The country was classified to be a "blue" country in 2010, yet with similar values of GPI and GCI it was classified to be a "yellow" country in 2011. This is because the "yellow" countries tended to have more missing values on the variable GCI. Despite the distortion by the missing values, the conclusions from analyses of both years yielded similar results, which strengthened the overall conclusion since similar results are given regardless of number of observations in the classification.

THE INTEGRATION OF THE LOG-LINEAR MODEL AND THE DISCRIMINATION ANALYSIS

The set of observations in the integration result is a proper subset of the set of observations in the Discrimination Analysis. There were unequal numbers of countries of different colors in the integration part compared to the previous Discrimination Analysis part. For instance, there were 16 "blue" countries in the Discrimination Analysis, while the numbers of the "blue" countries dropped to 13 in the integration part. It is because a country was qualified to be an observation in the Discrimination Analysis if there were no missing values in GPI and GCI. In comparison, a country was qualified to be an observation in the integration part only if there were no missing values in GPI, GCI, mu2, military, exports, imports, and population, which were necessary for the Log-Linear Regression Model. The colored labels for each country produced by the Discrimination Analysis were paired up with the residuals ε produced by the Log-Linear Model. The residuals were ranked in descending order in order to inquire whether there was a numerical relationship or pattern between the colored labels and the residuals. These patterns revealed the interaction between the outside forces represented by the residuals and economic prosperity.

RESULTS

THE MULTIPLE-VARIABLE LOG-LINEAR MODEL ASSERTED AN OVERALL TREND OF A POSITIVE CORRELATION BETWEEN ECONOMIC PROSPERITY AND PEACE

As an example calculation, in 2010, the GPI, intercept GCI, mu2, military, trade, and the residual ε of United States were 2.06, 1.57, 5.43, 0, 4.8 10464.09 and -0.503 respectively as shown in the equation below.

$$\log(2.06) = 1.57 - 0.108 * 5.43 + 0.00112 * 0 + 0.122 * \log(4.8) - 0.0624 * \log(10464.09) - 0.5$$
$$= 0.313$$

Estimating the result of the Log-Linear Model regression function was as follows:

$$\log(GPI) = 1.57 + 0.108\ GCI + 0.00112\ Mu2 + 0.122\ \log(Military) + 0.0624\ \log(Trade) + \varepsilon$$

The p-values of the explanatory variables GCI, mu2, military, and trade were 0.0250, 0.899, 2.82 and 0.00223 respectively. Except for mu2, all the explanatory variations were statistically significant at the significance level of 0.05. For every unit increased in GCI, GPI tended to decrease by 0.108%. For every percentage increased in military expenditure, GPI tended to increase by 0.122%. For every percentage increased in the United States' trade, GPI tended to decrease by 0.0624%. Upon expanding this calculation to all the countries for which data was available, this model indicated that 55% ($R^2 = 0.55$) of the variability of peacefulness (GPI) was explained by the four independent variables in the Log-Linear Model.

THE DISCRIMINATION ANALYSIS CLASSIFIED COUNTRIES INTO FOUR TYPES IN WHICH THE POSITIVE RELATIONSHIP BETWEEN ECONOMIC PROSPERITY AND PEACE WAS FURTHER ILLUSTRATED

The relationship between economic prosperity and peacefulness was further investigated by the Discrimination Analysis, in which the corresponding variables Global Competiveness Index (GCI) and Global Peace Index (GPI) were studied. The classifying mechanism in Figure 4 generated the matrices in Table 3. The type I and type II errors were quite high in this analysis. There were four groups of countries, i.e. "yellow," "green," "blue," and "red" countries produced by the Discrimination Analysis (Figure 4 and Table 3). The "yellow" and the "green" countries indicated positive correlations between economic prosperity and peacefulness, or in other words, a negative correlation between Global Peace Index and Global Competitiveness Index. It is because a larger GPI value indicated less peace while a larger GCI value indicated greater economic competition. In both the 2010 and the 2011 analyses, the number of the "yellow" and the "green" countries exceeded the number of the "red" and the "blue" countries (Table 3). From both the Log-Linear Regression Model and the Discrimination Analysis, there are clear associations between economic prosperity and peace among the "yellow" and the "green" countries. The "red" and the "blue" countries would be further investigated.

FURTHER INVESTIGATION OF THE DISCRIMINATION ANALYSIS RESULTS OF THE "RED" AND THE "BLUE" COUNTRIES CONSOLIDATED THE POSITIVE CORRELATION OF ECONOMIC PROSPERITY AND PEACE

In 2011, Israel, South Korea, France, United States, and China were the only five "red" countries produced by the analysis. The ongoing Israeli-Palestinian conflict, poor relations between North and South Korea, United States' and France's war with Afghanistan, and China's participation in disputes in Pacific Asia were all elements that would help to explain the negative correlations between economic prosperity and peacefulness among these "red" countries (Table 4A). The "blue" countries were Slovenia, Portugal, Slovakia, Hungary, and Poland in 2011 (Table 4B). The ranking of GDP by capita of the countries in Table 4B were 36, 39, 44, 49, and 51 out of 194 respectively. Exports and imports constituted a large proportion of GDP in these countries. In fact, Table 4B showed the medians of exports and imports as percentage of GDP were 72 and 71 accordingly. Except for Poland, all the four countries were considered developed countries. There are different definitions and criteria in terms of determining a developed country. Including income per capita, GDP per capita, and industrialization, these economic criteria dominate in developed countries. The index used in this paper was World Bank High-Income Economies (WB HIE). In 2010, there were 16 countries classified as "blue" (Table 4C). These 16 countries were considered less competitive by the classification strategy in Figure 4, yet they were very competitive compared to the 16 countries with the highest GPI in terms of exports and imports as a fraction of GDP (Table 4D). Interestingly, the median of exports (% of GDP) and imports (% of

A

Country	Examples in 2011 Data
Yellow	Rwanda, Pakistan, Panama, Russia and Mexico
Green	New Zealand, Canada, Singapore, Finland and Iceland
Blue	Slovenia, Portugal, Slovakia, Hungary and Poland (all)
Red	Israel, South Korea, France, United States and China (all)

B

"Blue" Country (2011)	Exports (% of GDP)	Imports (% of GDP)	GPI
Slovenia	72	71	1.36
Portugal	36	39	1.45
Slovakia	89	86	1.58
Hungary	92	85	1.5
Poland	40	42	1.54
Median	72	71	1.5

C

"Blue" Country (2010)	Exports (% of GDP)	Imports (% of GDP)	GPI
Iceland	56	46	1.212
Italy	24	24	1.701
Spain	27	29	1.588
Oman	56	39	1.561
Slovenia	65	65	1.358
Portugal	31	38	1.366
Czech Republic	66	63	1.360
Slovakia	81	83	1.536
Croatia	39	40	1.707
Chile	38	32	1.616
Hungary	87	80	1.495
Poland	42	43	1.618
Lithuania	69	70	1.713
Botswana	33	40	1.641
Costa Rica	38	40	1.590
Tunisia	49	54	1.678
Median	40.5	43	1.589

D

Country 2010	Exports (% of GDP)	Imports (% of GDP)	GPI
Afghanistan	20	67	3.252
Pakistan	14	19	3.050
Israel	37	35	3.019
Russia	30	22	3.013
Georgia	35	53	2.970
Colombia	16	18	2.787
Nigeria	35	30	2.756
Zimbabwe	48	78	2.678
Lebanon	22	50	2.639
Sri Lanka	22	31	2.621
Myanmar	N.A.	N.A.	2.580
Burundi	6	37	2.577
Philippines	35	37	2.574
India	23	27	2.516
Ethiopia	14	33	2.444
Turkey	21	27	2.420
Median	22	33	2.678

Table 4. Examples of the four types of countries and the "Blue" countries investigation in terms of exports & imports (% of GDP). (A) Examples of the "yellow," "green," "blue," and "red" countries in 2010. All countries were listed for the "blue" and the "red" countries. (B) The five "blue" countries and their corresponding exports (% of GDP), imports (% of GDP), and GPI in 2010. (C) The 16 "blue" countries and their corresponding exports (% of GDP), imports (% of GDP), and Global Peace Index. (D) 16 countries with highest Global Peace Index (GPI) in 2010 and their corresponding exports and imports (% of GDP).

GDP) of the more peaceful "blue" countries were 40.5 and 43 accordingly, while for the non-peaceful countries (countries with highest GPI scores of the year) they were 22 and 33. The data from "red" countries implies that political concerns may outweigh economic incentives to avoid wars in order to trade. Along with the "yellow" and the "green" countries, a positive relationship between economic prosperity and peace can be consolidated among the "blue" countries when economic competitiveness was measured by some different criteria such as imports and exports as a fraction of GDP. The results complemented the initial prediction that observations can be nicely classified into groups.

Moreover, the data of GPI was expanded to additional new countries in a more rapid pace than the data of GCI each year. As a result, the number of missing values for GCI increased every year. In 2011, there were 25 "new" countries that had their GPI score available, but not the corresponding GCI scores. The median of GPI scores (154 countries) was 1.92 while within the 25 "new" countries, 22 had their GPI scores larger than the overall median of 1.92. The average GPI score indicated that these missing values of GCI might not be at random. The newly investigated countries tended to be less peaceful and had missing values on GCI. A missing value on GCI reflected that the country was paid less attention to in terms of competiveness. With these missing values on GCI, the Discrimination Analysis between GCI and GPI could not be performed and the positive relationship between economic prosperity and peacefulness was underestimated: if there were less missing values on GCI, the statistical evidences of the finding of the significant positive association between economic prosperity and peace would be even stronger.

The integration of the discrimination analysis and the log-linear regression model connected the two approaches

In Table 5, the first column displayed the colored labels produced by the Discrimination Analysis while the second column displayed the residuals ε produced by the Log-Linear Regression Model of all the observations (without missing values in any variables) in the year 2010. In the second column, the residuals ε were ranked in descending order in terms of absolute values. Interesting patterns can be discovered in the observation of the two columns of 92 observations: since the residuals ε were ranked in the table, the "location" of a country (top or bottom in Table 5) indicated some information about the group that the particular country belonged to. Let observation No.23 (Syria) be the 25th percentile, observation No.46 (Austria) be the 50th percentile, and observation No.69 (Belgium) be the 75th percentile. All the "red" countries located at the bottom of the table above 75th percentile. Twelve out of thirteen (92.31%)

"blue" countries located from 0 to 50th percentile. Fifteen out of twenty (75%) "green" countries were located from 50th to 100th percentile. Lastly, the "yellow" countries were uniformly distributed in the table (Table 5). In other words, the "red" and "green" countries tended to attach with smaller residuals ε in absolute values while the "blue" countries tended to attach with bigger residuals ε in absolute values of the Log-Linear Model.

	Country and colored labels generated by the Discrimination Analysis (2010)	Residual ε generated by the Log-linear model (2010)
1	Burkina Faso	-0.838488888
2	Nepal	-0.777859031
3	Zambia	-0.770664654
4	Portugal	-0.749459608
5	Uganda	-0.744212689
6	Egypt	-0.74268386
7	Mali	-0.739995253
8	Botswana	-0.738069924
9	Madagascar	-0.73397731
10	Morocco	-0.731671492
11	Senegal	-0.727057482
12	Ghana	-0.717736967
13	Slovenia	-0.711872332
14	New Zealand	-0.710279302
15	Cameroon	-0.700457679
16	Bolivia	-0.70020084
17	Jordan	-0.699096101
18	Bosnia and Herzegovina	-0.696172691
19	Ecuador	-0.693202297
20	Nicaragua	-0.69314794
21	Armenia	-0.690522306
22	Croatia	-0.69003018
23	Syria	-0.688728014
24	Albania	-0.685593049
25	Czech Republic	-0.682888998
26	Greece	-0.682543538
27	Chile	-0.675182256
28	Kenya	-0.673635341
29	Paraguay	-0.673112612
30	Ukraine	-0.664684744
31	Romania	-0.663928797
32	Poland	-0.662193962
33	Hungary	-0.661920027
34	Slovakia	-0.656723093
35	Bulgaria	-0.656331974
36	Algeria	-0.643262107
37	Zimbabwe	-0.642506804
38	Japan	-0.640830624
39	Italy	-0.638164307
40	Tunisia	-0.63670312
41	Spain	-0.63593585
42	Norway	-0.630789828
43	Argentina	-0.628588437
44	Malaysia	-0.625316101
45	Australia	-0.624558694

46	Austria	-0.622574966
47	Peru	-0.619982959
48	Lithuania	-0.619828529
49	Pakistan	-0.619751638
50	Latvia	-0.619643946
51	Ireland	-0.617636351
52	Brazil	-0.615980286
53	Indonesia	-0.614703808
54	Dominican Republic	-0.61308299
55	Denmark	-0.605234014
56	Finland	-0.60517572
57	Moldova	-0.603529228
58	Jamaica	-0.601440669
59	Canada	-0.601016058
60	Korea, South	-0.590524482
61	United Arab Emirates	-0.590398316
62	Venezuela	-0.590062787
63	Estonia	-0.589380311
64	Nigeria	-0.586004394
65	France	-0.584610943
66	Germany	-0.583247315
67	India	-0.582879501
68	United Kingdom	-0.580627276
69	Belgium	-0.579763858
70	Azerbaijan	-0.577769581
71	Lebanon	-0.576958747
72	Cyprus	-0.568180606
73	Kazakhstan	-0.568127929
74	China	-0.567955326
75	Sweden	-0.566953398
76	El Salvador	-0.563322614
77	Saudi Arabia	-0.562615095
78	Sri Lanka	-0.561799269
79	Georgia	-0.556425391
80	Turkey	-0.55466939
81	Colombia	-0.54444227
82	Guatemala	-0.532323246
83	Philippines	-0.530681061
84	Singapore	-0.520847537
85	South Africa	-0.52037432
86	Switzerland	-0.513120965
87	Netherlands	-0.511242085
88	United States	-0.502818952
89	Mexico	-0.501622457
90	Thailand	-0.492189886
91	Russia	-0.480385385
92	Israel	-0.399848629

Table 5. Integration result of the Discrimination Analysis and the Log-Linear Model (2010). The first column manifested the colored labels of all the observations that did not have any missing values on any variables by the Discrimination Analysis and the second column manifested the residual ε in the Log-linear model in year 2010. The residuals were ranked in descending order in absolute values. The "red" and the "green" countries tended to locate at the bottom while the "blue" countries tended to locate at the top of this table. Observation No.23 (Syria) was the 25th percentile, observation No.46 (Austria) was the 50th percentile, and observation No.69 (Belgium) was the 75th percentile.

DISCUSSION

The Discrimination Analysis was presented to complement the Log-Linear Model because of the limitation of the regression function. Inserting a regression to the data means that the connection between a particular explanatory variable and the response variable is represented by one single coefficient. However, that coefficient represents the overall trend of the data but is not necessarily representative of an individual country's data. This limitation of a regression in investigating the relationship between the explanatory variables and the response variable of an individual country gives incentives to further examine correlations for individual countries. For instance, for the 2010 data of North America, the range of the correlation between the variable GPI and GCI was -0.94 to 0.96, while the range of the correlation between GPI and exports was -0.59 to 0.95. Suppose the coefficient of GCI were 0.01 (the average of -0.94 and 0.96), then the coefficient 0.01 would be representative of the overall trend, i.e. when the coefficient for individual countries between GPI and GCI was close to 0.01. However, for countries with extreme values of coefficient (close to either -0.94 or 0.96), the value 0.01 could not be considered representative in helping to explain the relationship between GPI and GCI. Many more inconsistent relationships between variables could be found and these details given by the study of correlations suggested that a different model other than the Log-Linear Regression Model is necessary.

Robert Solow's article "A Contribution to the Theory of Economic Growth" is known as the cornerstone of the modern Neoclassical Growth Model in which economic growth is separated into technical progress, capital, and labor (Solow, 1956). In his calculation, four-fifths of the growth in the United States output was derived by technical progress (Solow, 1956). Understanding that labor, capital, and technical process are the ingredients that generate economic growth helps to explain why the between economic prosperity and peace in the Log-Linear Model was 0.55. Under the assumption of the Neoclassical Growth Model, economic growth is driven by technology, capital, and labor, but not exogenous factors such as history, policy, and social structure that could ultimately shape the condition of peacefulness (Harberger, 2005). However, the purpose of the present study is not to argue that peace should be a new variable to be added to the Neoclassical Growth Model. Instead, it is to enhance the understanding about the interaction between economic prosperity and peace and to state a challenge to the assumptions of the Neoclassical Growth Model.

In addition, the original Neoclassical Growth

Theory assumed that capital was subject to diminishing returns in a closed economy. Diminishing returns implies that marginal or per-unit output of production decreases as the amount of production increases. A closed economy is a self-sufficient system without international trade or external assistance. A model capturing economic growth in a closed economy may not be sufficient for discussion of the present empirical study because in real life international trade is a significant component in the world economy. Therefore, it was necessary to take Lucas (1988) and Romer's (1991) expansion with international trade into consideration. Economic prosperity in this study was captured by the variables trade, GCI, and exports/imports as a percentage of GDP. The selection of these variables in the two approaches was justified by Lucas's finding of the positive association between exports and economic development (Lucas, 1988). The variables in the Log-Linear Model were representative of the endogenous factors including labor, wage rate of labor, capital, technology, and international trade in an open economy. The underlying justification was that large amounts of exports and imports entailed correspondingly large amounts of labor, capital, and technology as long as international trade, an indicator that the Log-Linear Model was a good candidate to represent elementary components of the Neoclassical Growth Model, was present. The interaction between the explanatory variables and the response variable GPI provided helpful insights into the interaction between economic prosperity and peace. The Log-Linear Model presented an overall statistically significant trend between economic prosperity and peace.

The Discrimination Analysis presented a further investigation between economic prosperity and peace by dividing countries into four types. The results of the "yellow" and the "green" countries complemented the finding in the Log-Linear Model such that economic prosperity and peacefulness have a positive association, or alternatively a negative correlation between GCI and GPI. In addition, the discussions of the "red" and the "blue" countries revealed that each set of countries shared some characteristics, for instance the "red" countries tended to involve in certain armed conflicts. In this approach, the classification method, without intentionally maximizing the success rate in the analysis, fitted the evidence of similar characteristics between countries that fell into the same group. Shared characteristics, such as engagements in conflicts, could be found by further investigation among different groups of countries implied that these countries truly belonged to the same group. For example, based on the numerical values of GCI and GPI, France and the United States in 2011 were classified to be "red" countries, both of which

were simultaneously involved in the armed conflict in Afghanistan. Furthermore, this classification exposed that the overall trend of the Log-Linear Model could be interpreted as four distinct groups. The four groups, i.e. four performance groups distinguished by colors, demonstrated how economic prosperity and peace interacted with each other at a certain level of competitiveness and peacefulness.

In the integration part, the "red" and the "green" countries had a tendency to have smaller values of residuals ε compared to other countries, which implied that the statistically significant variables GCI, military, and trade explained a larger proportion of peace within the "red" and the "green" countries. A small residual in a regression indicated that the geometric distance between the point of the observation and the fitting straight line of the linear model. One common characteristic of the "red" and the "green" countries was that they were more competitive relative to other countries with a GCI > 4.72, meaning that these economies are prosperous or would potentially become prosperous. These more competitive economies were equipped with sufficient labor, capital, technology, population, and other endogenous elements that determined economic growth according to the mechanisms of the Neoclassical Modern Growth Model. In the present study, these endogenous elements were represented by the variables GCI, exports, imports, and population. To compare, correlating with larger residuals ε within the "blue" countries, the endogenous forces of the growth theory explained the smaller proportion of peacefulness. In other words, the exogenous forces such as history, policy, and other factors beyond the endogenous mechanisms of economic development played a larger role in explaining peacefulness for the "blue" countries. When the endogenous forces (for example trading and competitiveness) of the growth mechanism were more active, they contributed more in terms of explaining economic prosperity; when they were less active, the exogenous forces entered the fray and played a more important role in explaining economic prosperity. If the exogenous forces serve as criteria that enable growth, then there should not be any discernible differences of residuals among different types of countries.

Table 5 compared the color labels produced by the Discrimination Analysis and the residuals produced by the Log-Linear Model. The four colors were classified according to GCI and GPI, which reflected both endogenous and exogenous forces. On the other hand, the residuals overwhelmingly reflected exogenous forces. The result of the integration of the two approaches showed that less competitive countries were usually attached to larger residuals. The difference in magnitude

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of the residuals implied that the exogenous forces' potentially present a mechanical impact on economic prosperity. The integration result stated a fair challenge to the model Neoclassical Growth Theory's assumption that the exogenous forces do not have any mechanical impact on growth. The different residuals among various types of countries were not produced by luck because observations were classified according to the variables GCI and GPI in magnitude instead of any random classification rules.

In conclusion, this study explored the relationship that peacefulness, as a condition shaped by exogenous factors, interacted with economic growth or prosperity—there was a clear association between economic prosperity and peacefulness. Peaceful countries participated more in trading activities and achieved greater economic prosperity. The endogenous forces including trading and competitiveness explained the larger proportion of peace in more competitive economies, while the proportion became smaller in less competitive economies. This result challenges the Neoclassical Modern Growth Theory's assumption that exogenous forces do not have any mechanical impact on growth. Moreover, this study paved the way for future research on the interactions between economic prosperity and peace and the interplay between the endogenous and exogenous factors of economic growth. However, the linear association determined in this research does not necessarily indicate causality. Further studies are important in determining true causality. If significant and valid findings of the causality are found, these results could change the foundation of the Neoclassical Modern Growth Theory.

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