The Impact of Geographic Surroundings on Economic Growth: A Panel Data Approach

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Abstract

Spatial economics being one of the most intriguing areas of contemporary economics is concerned with where and why economic activities occur. We want to investigate whether an ocean in a country’s immediate surroundings impacts its economic growth. Over time, the satellite programs orbiting earth have sent images of night that show the temperate zones of the planet are better lit. In addition, countries that have ocean surroundings within the temperate zones are brighter. These images trigger the compelling idea that countries with ocean surroundings have economies better off than others. We employ random effects estimation techniques for a panel data set of 38 countries in the North and South temperate zones over the period from 1996 to 2014. Our results show that an ocean in the immediate surroundings of a country has a positive impact on its GDP per capita. This finding leaves some room for interpretations justifying it. The work finally indicates how connectivity can translate our life into productivity and higher per capita income.

JEL Code: F43, C23
Keywords: Geography, temperate zone, ocean, GDP per capita

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1. Introduction

The difference in the level of economic growth of different countries is a widely researched arena in the field of economics. A closer look reveals an interesting pattern about the economic conditions of countries and their geographic positions. Most developed countries are located in the temperate zone. The countries in this zone have two types of geographic surroundings, land and water-body. We want to see if this difference of geographic surroundings explained economic growth of the countries. The position of any country in the world map is a unique one. No one country has the exact same location-characteristic as any other. However, there are some characteristics that are common in some. Those commonalities can put a country in a certain group. We categorized countries with an ocean in their immediate surroundings connecting them with other countries through that ocean in one group and the rest in another.

In the next section we highlighted literature to identify the macro-economic variable to measure economic growth, to find the determinants of economic growth and to emphasize the argument of correlation between economic growth and geographic surroundings. In the third section of the paper we elaborated on our methodology and data. In the fourth section we illustrated our estimation results discussed our findings and scope of further study and the last section is the conclusion.

2. Literature Review

The theory of economic growth has evolved over the years. Measurement of economic growth is basically measuring the relationship between total resource inputs and total economic outputs. Therefore, measuring economic growth in terms of GDP is a logical extension of the idea. Number of works on the determinants of GDP per capita is large and very diverse. Growth was explained by factor inputs, labor and capital, in the classical growth theory. It argues for diminishing marginal productivity; that increasing one factor input holding the other one constant will increase output at a decreasing rate. In the classical theory of growth technology is assumed to be held constant and also that there are no economies of scale.

The neo-classical theory of growth began with the notion that positive savings will play a significant role in economic growth. It incorporated technological growth as an exogenous determinant of growth. The neo-classical Solow-Swan model became the primary model to explain economic growth due to the very flexible and adaptive nature of the model. Afterwards, the endogenous growth theories incorporated the ‘technological innovation’ factor into the model explicitly.

One of the implications of the neoclassical growth model is the conditional convergence hypothesis. The convergence hypothesis states that real GDP per capita of a country converges to the steady-state level. However, the growth rate is conditional on the difference between the initial level of GDP per capita and the GDP per capita at the steady-state level. A Larger gap between the two levels of GDP per capita is associated with a faster growth rate.

Barro (1996) takes measures of education, health, the legal system, terms of trade changes, government spending as a fraction of GDP, fertility, and political freedom to control for cross-country differences in steady-state levels of GDP per capita. Barro argued that according to the neo-classical model without technological innovation growth stops at the steady state but in empirical evidence it did not. Hence, the neoclassical growth model does not actually explain long-run growth. Alternatively argued, the development of the steady-state growth model does one of the two assumptions that, either returns to investment do not diminish or there are intentional investments in research and development that continuously advance technology.

Barro illustrates with data that more schooling, better health, lower fertility rates, less government consumption relative to GDP, greater adherence to uncorrupted rule of law, improvements in terms of trade, and lower inflation impact rates of economic growth positively. Moreover, data in his book suggests that there is a nonlinear relationship between democracy and growth. Barro explains that for a
country under low level of political freedom, increase in political rights means lower level of government interference. On the other hand, a country which is already enjoying substantial level of political freedom, an increase in political rights result in policies, like income redistribution that are growth retarding. Therefore, a marginal increase in political freedom in countries with low level of political freedom entails acceleration in growth and compared to that of the country with a substantial level of political freedom.

Ricardo (1817) notes in his study that trade increased the output of products for which the country has comparative advantage in and that it yields in higher national wealth for the country. In his theory of comparative advantage Ricardo says that expansion of export contributes to economic growth by increasing the percentage of gross fixed capital formation as well as productivity of factors. Given that there are incentives for investment growth and technological advancement, export is expected to enhance the marginal productivity of factors. Tyler (1981) examines a sample of 55 developing countries and found exports and investments to be the main determinants of economic growth.

The causal relationship among exports, gross capital formation, foreign direct investments and economic growth is examined empirically by Dritsakis, Varelas and Adamopoulos (2006). The results of cointegration test suggest only one cointegrated vector between the variables. Granger causality tests show a unidirectional causal relationship between exports and gross fixed capital formation. Granger causality tests also showed that there is a unidirectional causal relationship between foreign direct investments and economic growth.

Emphasis is put on the importance of investments, human and physical capital for long-run economic growth in new growth theories. Mankiw, Romar and Weil (1990) argue that an augmented Solow model that incorporates human capital shows greater impact of physical capital and population growth on income. Works of Sala-i-Martin, Romer, Barro and Lee (2004) also present evidence on the importance of human capital on economic growth. The theories of energy consumption and growth claim that rates of energy consumption is positively related to accumulation of global economic wealth and that energy efficiency is positively related to total factor productivity. Morimoto and Hope (2004) find a bidirectional causal relationship between gross domestic product and electricity consumption.

Theories of institution and growth bring forth environmental conditions to explain institution. Acemoglu, Johnson and Robinson (2000) examined the impact of colonial institutions on the GDP per capita of the colonized countries. The European countries adopted very different colonization policies in the different colonies they occupied. In the colonial areas where they could not settle down due to high mortality rates, they formed extractive institutions to exploit the resources of those colonies. In the paper, once they controlled for the impact of institutions, the African countries and the countries closer to the equator do not have lower incomes anymore.

Arvis, Marteau, and Raballand (2007) highlight the cost of a country being landlocked. They show that a landlocked country bears not only high cost of freight services but also cost of unpredictable transportation time, widespread rent activities and severe flaws in the implementation of the transit systems.

Gallup, Sachs and Mellinger (1999) introduced the concept of ‘GDP density’. GDP density is calculated by multiplying GDP per capita by the number of people per square kilometer. Following is the
image they produced indicating GDP density of the countries of the world.

**Figure 1: GDP density in the world**

The darker regions that indicate highest GDP Density appear in the temperate zone and the areas near ocean. 
Source: Econbrowser, Analysis of current economic conditions and policy, 2016.

Even though, the differences in income across countries are often explained by factors such as the capital stock, education level and institutions defining property rights; factors that the government could influence with good institutions. It can be argued from Gallup et al.’s paper that, pictures as the one above inevitably strikes the notion that there appear to be other very important and purely physical determinants of GDP. The near ocean areas have more intense economic activity going on and in case of inland countries economic activity appears more intense along navigable rivers where transportation by ship is feasible. One other criteria accompanying intense economic activities are temperate climate with adequate rainfall; most likely because it is favorable for productivity of agriculture and for mitigating disease. The following image is a collection of images from the DMSP (Defense Meteorological

**Figure 2: Earth at night from the satellites**

Satellites (Program) satellite programs orbiting the earth. The stark similarity between the two images is
evidence to the case in point.

Feyrer and Sacerdote (2009) of Dartmouth College develop new data on 80 ocean islands in their
paper. They argued that the more years those islands spent as a European colony the higher their GDP is
today. The authors explained the date of initial colonization partially by the magnitude of the prevailing
winds. They argued that, since before 20th century, wind was the most important determinant of the
course of a ship; islands positioned in locations with strong east-west wind were likely to be discovered
early and hence colonized early as well. The criterion was only applicable until further development in
technology, which was around 1900s. They predicted how long an island had been a European colony
based on that criteria and estimated correlation with GDP per capita. They found positive correlation.

Their approach isolated a factor that could not have influenced GDP per capita in any other way. This
finding suggests that institution makes a difference for GDP per capita on its own. However, this does
not refute the argument that the incidence of the arrival of the first ship on the island could have been a
determinant of when the second ship would arrive. Therefore, a more logical explanation can be that
historically the natural factors were important for accumulation of capital and then afterwards the
economy flourished based on that accumulated capital.

3. Methodology and Data

We wanted to find out how much difference it made for the GDP per capita of a country if the
country had an ocean in its immediate surroundings. We categorized a country with an ocean in its
immediate surroundings that gives the country connectivity with other countries through that ocean as
oceanic. Our key interest variable was a dummy variable, oceanic. Oceanic takes the value 1 when the
country has ocean in its immediate surrounding and 0 otherwise. We also divided the country
surroundings into 360 degrees of a circle assigning numbers 1-8 for the 45 degree segment; for example
if a country has access to ocean in its immediate surrounding about the length of one 45 degree segment
it would have the number 1, for two 45 degree segments it would be 2 and so forth. We found that
countries with more exposure to ocean shore seem to have higher per capita GDP (Figure 2 in Appendix).

For control variables we took merchandise exports per capita; since exports is representative of factor
productivity of the factor most abundant in an economy. We took gross capital formation as proxy of
investment; since investment is a major determinant of economic growth. We took the country’s
percentile ranking of governance efficiency to account for the effectiveness of its institutions; since
institution is also an important determinant of economic growth. We also included a trend variable to
isolate the impact of any trend effect present in data from the impact of other variables.

To explore the overtime impact of our key variable of interest on GDP per capita we worked with a
panel data set. We collected data from the data bank of the World Bank. Measurements units and method
of data is mentioned in Table 2 of appendix. We have data for 38 countries for the temperate zones of the
North and South hemisphere. We started from the year 1996 as data for governance index was not
available for earlier periods. The data set is an unbalanced panel data set as a few of the observations are
missing for the variable governance index. It is better to use a panel data set than a simple cross section
or simple time series data set because we can capture both across country and over time dynamics of the
data with a panel data set. Moreover, a panel data set accounts for country specific heterogeneities as
well. For an unobserved effects model

\[ y_{it} = \beta_0 + \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + \alpha_i + u_{it} \]  

\[ i = 1, 2, \ldots, N; t = 1, 2, \ldots, T \]

\[ y_{it} \] is the dependent variable that has data for the ith cohort for tth period. Similarly the explanatory
variables, \( x_{itk} \), also have data for the ith cohort for tth period and there are k numbers of explanatory
variables. \( \alpha_i \) is the time invariant unobserved factor for the \( i \)th cohort. \( u_{it} \) is the time variant unobserved effect for the \( r \)th cohort for \( r \)th period.

Since our key variable of interest is a dummy variable which remains the same over time, fixed effects estimation will cancel out the variable as a whole.\(^ {13} \) Therefore we chose random effects model.

\[
y_{it} = \beta_0 + \beta_1 x_{i1t} + \ldots + \beta_k x_{itk} + \nu_{it} \tag{2}
\]

In the equation (i) \( \text{Cov}(x_{itk}, \alpha_i) = 0 \); the time invariant unobserved effect and other explanatory variables are assumed to be uncorrelated. However, the presence of \( \alpha_i \) in the composite error term \( \nu_{it} = u_{it} + \alpha_i \) in equation (i) makes it serially correlated. Therefore, simple OLS estimation will produce incorrect standard errors. GLS estimation can be run to solve this problem of serial correlation. The equation is demeaned by a fraction for the GLS transformation.

\[
y_{it} - \bar{y}_i = \beta_0 (1 - \lambda) + \beta_1 x_{i1t} - \lambda \bar{x}_{it1} + \ldots + \beta_k x_{itk} - \lambda \bar{x}_{itk} + \nu_{it} - \lambda \bar{\nu}_i \tag{3}
\]

Here, the overbars denote the time averages. Equation (ii) is quasi-demeaned on each variable as it subtracts a multiple of the time averages of each variable. The GLS estimators will be simple pooled OLS estimator of equation (ii). This transformation solves the problem of serial correlation. The fraction, \( \lambda = 1 - \left( \frac{\hat{\sigma}_u^2}{\hat{\sigma}_u^2 + T \hat{\sigma}_e^2} \right)^{\frac{1}{2}} \), is never known. It can be calculated based on estimated values of \( \sigma_u \) and \( \sigma_e \).

\[
\hat{\lambda} = 1 - \left( \frac{\hat{\sigma}_u^2}{\hat{\sigma}_u^2 + T \hat{\sigma}_e^2} \right)^{\frac{1}{2}} \text{ where } \hat{\sigma}_u \text{ and } \hat{\sigma}_e \text{ consistent estimators of are } \sigma_u \text{ and } \sigma_e \text{ based on the residuals of pooled OLS or fixed effects estimation.}
\]

Many statistical model supports random effects estimation and automatically calculates some version of \( \hat{\lambda} \). We used the statistical software STATA to estimate our model. The feasible GLS estimator that uses \( \hat{\lambda} \) in place of \( \lambda \) is called the random effects estimator. We estimated the following model:

\[
y_{it} = \beta_0 + \beta_1 x_{i1t} + \ldots + \beta_k x_{itk} + \gamma_i z_i + \alpha_i + u_{it} \tag{4}
\]

\[i = 1, 2, \ldots, N; \; t = 1, 2, \ldots, T\]

Here, \( N = 38 \) and \( T = 16 \). \( y_{it} \) is the dependent variable GDP per capita. We took the log of GDP per capita measured in current US Dollars. \( x_{it1} \) is Merchandise exports per capita, \( x_{it2} \) is Gross capital formation as percentage of GDP, \( x_{it3} \) is the country’s percentile ranking of Government effectiveness and \( x_{it4} \) is the time trend. \( z_i \) is the dummy variable ‘Oceanic’ which is invariant across time periods. It is ‘1’ if the country has ocean in its immediate surroundings and ‘0’ otherwise.

4. Estimation and Scope

In this paper we wanted to see the impact of geographic surroundings of a country on its per-capita GDP. We expected the impact of the dummy ‘Oceanic’ to be positive. The following table contains the random effects estimators of our random effects model.
Table 1: Random Effects Estimation

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variable: log (GDP Per Capita)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceanic</td>
<td>0.263 (0.150)*</td>
</tr>
<tr>
<td>Export</td>
<td>0.662 (0.021)***</td>
</tr>
<tr>
<td>Investment</td>
<td>0.009 (0.001)***</td>
</tr>
<tr>
<td>Governance Index</td>
<td>0.004 (0.001)***</td>
</tr>
<tr>
<td>Trend</td>
<td>0.015 (0.002)***</td>
</tr>
<tr>
<td>Constant</td>
<td>3.052 (0.174)***</td>
</tr>
</tbody>
</table>

Note: The values in parentheses are standard errors.
*** Significant at 1 percent level of significance. * Significant at 10 percent level of significance.

We found that other things remaining constant an ocean in a country’s immediate surroundings has a positive impact on its GDP per capita. An oceanic country is more likely to have a higher GDP per capita compared to a landlocked country. The coefficient is significant at the 1 percent level. The impact of Governance Index, Investment, Export and Trend factor on GDP per capita is also positive and significant as theory suggests.

We tested for no random effect. The result suggests that we can reject the null at below 1 percent. We also tested for serial correlation and found no serial correlation. Result of the test is given in Table 3 of appendix.

Our result supports the common intuition that having ocean access means the country has comparative advantage in trade, can exploit ocean resources etc. According to UNCTAD publication of 2014, “About half of the world’s population, most of its largest cities and industries along with critical value chains tend to be concentrated in coastal areas to ensure access to transport routes and continuous flows of resources and products. Between 80 and 90 per cent of the volume of global trade is transported by sea.”

Our analysis is a cursory view of the impact of the geographic position. There is a lot of scope of delving deeper into the matter. At the present time we live in a world where connectivity is much more than actual physical connectivity. If we could avail data for earlier periods we might be able to find something new. Also the phase of a country’s economic development and political reign are important variables to have influence on its GDP per capita. Analysis with segmented data of different time periods might reveal something new. Moreover, accounting for the factors such as, time period when the data went under some structural change worldwide; the growth of a certain variable that became faster or slower after a certain level; some incident that is common for the seas across the world; could exhibit a non-linear relationship of the oceanic dummy and the GDP per capita.

5. Conclusion

Ocean surroundings can be a positive influence on a country’s economy. With an ocean in the surrounding the country gains easy connectivity with a lot of other countries. This entitles the economy with easy access to intermediate goods and larger markets. It gives access to natural sources of income such as fishery, tourists’ spots such as beaches, easy access to ports etc. However, an oceanic country can
be at a disadvantageous position due to its geographic location as well. It is more prone to many natural calamities. It might also not be naturally entitled to many spillover effects and positive externalities of its neighboring economy. We found that our data reveals the advantages overcome the disadvantages.

On an average the countries with oceans in their immediate surroundings have a higher per capita GDP than those with land surroundings (Figure 3 in Appendix). However, Austria and Switzerland have a very high per capita GDP even in comparison with the average per capita GDP of the oceanic countries. An in dept study of these two economies comparing them with countries which have ocean in their immediate surrounding might reveal factors that can compensate the presence of ocean for landlocked countries.

One more intriguing work that can be an extension of this work is inclusion of countries bordering the temperate zones. Assigning a numeric code for proximity to zone boundaries, we can examine if there if any optimal position within the zones in favor of per capita GDP.
References


APPENDIX

**Figure 1**: Temperate Zones in the World Map

![Temperate Zones in the World Map](image)

The image indicates the Temperate Zones in the World Map.

**Table 1**: Country List

<table>
<thead>
<tr>
<th>Oceanic</th>
<th>Country</th>
<th>Country</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Albania</td>
<td>Georgia</td>
<td>Russian Federation</td>
</tr>
<tr>
<td></td>
<td>Azerbaijan</td>
<td>Germany</td>
<td>South Africa</td>
</tr>
<tr>
<td></td>
<td>Bangladesh</td>
<td>Ireland</td>
<td>Sweden</td>
</tr>
<tr>
<td></td>
<td>Belgium</td>
<td>Italy</td>
<td>Ukraine</td>
</tr>
<tr>
<td></td>
<td>Bulgaria</td>
<td>Japan</td>
<td>United Kingdom</td>
</tr>
<tr>
<td></td>
<td>Chile</td>
<td>Latvia</td>
<td>United States</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>Lithuania</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Denmark</td>
<td>Netherlands</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finland</td>
<td>New Zealand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>France</td>
<td>Romania</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other than Oceanic</th>
<th>Country</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Afghanistan</td>
<td>Serbia</td>
</tr>
<tr>
<td></td>
<td>Armenia</td>
<td>Switzerland</td>
</tr>
<tr>
<td></td>
<td>Austria</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Belarus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bhutan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Czech Republic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hungary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moldova</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poland</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2: Data Description

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Measurement Unit</th>
<th>Our Calculation</th>
<th>Data Description (Quoted from World Bank: Data Bank)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita</td>
<td>US Dollar in unit</td>
<td>We took log of the level form of GDP per capita</td>
<td>GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes.</td>
</tr>
<tr>
<td>Export</td>
<td>US Dollar in unit</td>
<td>We divided merchandise exports by population.</td>
<td>Merchandise exports show the f.o.b. value of goods provided to the rest of the world valued in current US Dollar.</td>
</tr>
<tr>
<td>Investment</td>
<td>In Percent of GDP</td>
<td>We took data of gross capital formation to proxy for Investment</td>
<td>Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories.</td>
</tr>
<tr>
<td>Governance Index</td>
<td>In percentile rank</td>
<td></td>
<td>Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government’s commitment to such policies. Percentile rank indicates the country’s rank among all countries covered by the aggregate indicator with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.</td>
</tr>
<tr>
<td>Population</td>
<td>Number of people</td>
<td>We used population to get per capita export</td>
<td>Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. The values shown are midyear estimates.</td>
</tr>
</tbody>
</table>

Table 3: Test for error component

\[
\text{GDP per capita}_{\text{code},t} = X_b + u_{\text{code}} + v_{\text{code},t} \\
v_{\text{code},t} = \lambda v_{\text{code},(t-1)} + e_{\text{code},t}
\]

<table>
<thead>
<tr>
<th>Estimated results</th>
<th>Variance</th>
<th>Standard Deviation = \sqrt{\text{Var}}</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita</td>
<td>2.224147</td>
<td>1.491357</td>
</tr>
<tr>
<td>(e)</td>
<td>0.0238137</td>
<td>0.15431702</td>
</tr>
<tr>
<td>(u)</td>
<td>0.1521106</td>
<td>0.39001361</td>
</tr>
</tbody>
</table>

Tests
Random Effects, Two Sided:
\[\text{ALM(Var(u)=0)} = 2003.19 \text{ Pr} > \chi^2(1) = 0.0000\]
Random Effects, One Sided:
\[\text{ALM(Var(u)=0)} = 44.76 \text{ Pr} > N(0,1) = 0.0000\]
Serial Correlation:
\[\text{ALM(}\lambda=0) = 1.18 \text{ Pr} > \chi^2(1) = 0.2775\]
Joint Test:
\[\text{LM(Var(u)=0, }\lambda=0) = 2336.20 \text{ Pr} > \chi^2(2) = 0.0000\]


Figure 2: The extent of access to ocean shore and GDP per capita

**Figure 3:** Per capita GDP for Oceanic (Olive) and countries than Oceanic (Army Green)

Figure 4: Average GDP per capita (in current US dollar) for Oceanic (Blue) and countries than Oceanic (Brown)

Figure 5: Average GDP per capita (in current US dollar) for all Oceanic (Blue) countries, Austria and Switzerland