
Andrey Fendyur
PhD Student, Operations Management
University of Calgary
Haskayne School of Business, Operations Management Department
2500 University Drive, Scurfield Hall
Calgary, AB, T3L 2C4, Canada
Tel: +1.403.6077295
Fax: +1.403.2205685
e-mail: afendyur@ucalgary.ca
Abstract.

Contemporary, the global energy mix is mainly constituted by fossil fuels – coal, oil, gas and wood. Solar energy has the biggest potential by year 2100, up to 70% of global energy mix. Risks (social, health – related, geopolitical, industrial) incorporated in solar energy use growth exist indeed and should be addressed before consequences happen. Surprisingly, extremely little research addresses systemic risks pertaining to the wide spread of solar energy. The novelty of the current research is in (i) identifying geopolitical risks associated with solar energy use proliferation; (ii) quantifying some of those (geopolitical) risks while analyzing statistically. Knowing those risks might help policy-makers, industry and international organizations prevent possible conflicts for solar energy control.

Introduction: Energy Crisis, Climate Change & Solar Energy.

Energy is a must for our civilization. It cannot function without computers, motors, healthcare technology, heating or air conditioning today.

Energy as an industry passed through a number of stages in its development. An early fuel and source of energy was wood. Then, the era of coal stepped in, marking the arrival of Industrial Revolution. Coal had been dominating as fuel until the mankind discovered convenience and advantages of oil (end of 19th – early 20th century). Since that time, and up to nowadays, the Oil Age is lasting (Tertziakian, 2005).

Meanwhile, oil deposits are located in certain geological formations, and accessibility of oil reservoirs progressively complicates (Defuyes, 2005). A phenomenon called Hubbert’s peak (peak of oil extraction, followed by decline and consequent price hike) has already happened in the US and about to take place worldwide (Defuyes, 2005). Therefore, the trend for oil is to become more and more expensive, and then – oil would be a chemical raw material, but not a fossil fuel (Defuyes, 2005). That metamorphose calls for another energy cycle change – to switch from fossil fuels as main source of energy to something else (Tertziakian, 2005). Therefore, humans should select prospective energy options and pursue them hard to make those sources commercially efficient. According to BWGS, a German energy think tank, the most prospective and potentially efficient source of energy is solar radiation. According to BWGS forecast, published in the Survey of Energy Resources (SER, 2007), the solar energy would acquire a 70% share in the global energy mix by 2100.

Solar Energy: Key Facts.

Solar energy is the largest category of energy present on the Earth. In fact, many other energy categories originate from the solar energy – to name a few – fossil fuels, wind energy, tides energy, bio-energy. The Sun is a powerful source of (in humans’ time framework) endless energy: it emits, in a form of radiation, energy equivalent to 3.8 x 10^23 kW (Goswami, SER, 2007). That enormous amount of energy is dispersed, however, all around the Sun. The Earth portion of solar energy is some 1.8 x 10^{14} kW. According to a model by World Energy Council, should the mankind manage to convert 0.1% of that energy amount at 10% efficiency rate – it
would be 4-fold the total global power generating capacity as of 2007 (estimated as 3,000 GW) (Goswami, SER, 2007).

The energy of Sun bypasses (1) accumulation in plants, animals, (2) transformation into oil and gas, (3) extraction of fossil fuels and (4) polluting fossil fuels power generation stages. Conversion of solar energy into electricity happens in direct, without intermediary stages, and gives advantages of being non-polluting and happening on spot (solar energy can be absorbed into a grid, and, if needed, utilized right on spot – off-grid).

The amount of energy the Sun sends to the Earth, varies according to year season and day time. Assume we distribute that amount of that energy all across the Earth sphere. In that case, it must be reduced by 4. Also, on its way to the surface, sun radiation passes through atmosphere, which reduces it by 2. From that (SER, 2007), the annual average horizontal surface irradiance is about 170 W/m². Next, the SER quotes: “when 170 W/m² is integrated over 1 year, the resulting 5.4GJ that incident on 1m² at ground level is approximately the energy that can be extracted from one barrel of oil, 200 kg of coal, or 140 m³ of natural gas”.

In the same way as certain areas are rich in fossil fuel and other are not, the amount of solar energy in reality varies across the Globe. According to SER, the most powerful annual mean irradiance of 300 W/m² is pertaining to certain areas around the Red Sea. Average parameters for selected countries are: Australia – 200 W/m², USA – 185 W/m², UK – 105 W/m². What is important from that data is the practical significance of solar energy not only for Southern nations, but also for even Northern Europe countries, like Norway, Sweden, Finland, Canada.

**Solar Energy Technology.**

There is a wide variety of solar energy producing equipment. It can be classified into certain types: solar thermal collectors, solar thermal power plants, photovoltaic devices, window glasses, etc. They all differ in specifications and applications. It is good to give a brief overview of those types to comprehend prospects of solar energy use in industry and residential environment.

Solar thermal collectors, as its name suggests, are exactly devices for heating air, water, other liquids and gases or solid elements. Normally, they are used in individual or small business locations for hot water supply, heating buildings etc. There is a subgroup called high-temperature solar thermal collectors. Their job is to generate power in connection with turbines. High-temperature devices generate heat of up to 2,000 C, usually they are solar thermal power plants (mid-range: 100 – 400 C, and low range equipment heats up to 100 C).

Photovoltaic (PV) equipment are typically solid-base elements, pretty durable and easy in maintenance (almost not required, therefore, saves substantial costs). There are several types of PV elements according to material they are made from: silicon (Si), cadmium telluride (CaTe), copper indium diselenide (CIS), and other experimental types. PV panels vary in efficiency, too: most popular on market ones have that of around 12-15%, while so-called multi-junction and concentrating PVs can deliver 40% efficiency rate. A good sign is the decline in solar panel...
prices (from some 30 USD/W to 3 USD/W within a period of 30 years), that makes them feasible as an alternative to fossil fuels (SER, Goswami, 2007).

Initially, when PV panels were just invented, they took so much energy for their manufacturing, that they were loss-generating due to lack of ability to produce enough energy for payback during all their lifetime. However, for the last 15 years, manufacturing technology and life-span of PV panels tremendously improved. That gives payback period of 2 – 4 years, while they function for up to 25 years (Goswami, SER, 2007). Even more impressive, for multijunction thin-film concentrating PV panels (CPV), the payback period is expected to be about 1 year (Goswami, SER, 2007). In areas with high direct insolation, CPV can generate at an efficiency rate of 39%, comparing to 12 – 15% for typical silicon panels. Therefore, they can reduce the price of power generated by half (SER, Goswami, 2007).

Solar energy industry is so far in its early stage of development. Nevertheless attempts to make efficient solar panels track back to circa 1950 – the birth of space technology, only in the last decade, apparent success was achieved in developing and commercializing those. The major success solar manufacturing is in Japan (Sanyo), followed by USA, Germany, China. In general, the industry is saturated, no dominant design or player has emerged. That industry offers a plenty of opportunities for entrance and development. Analysts consider solar energy equipment industry a very attractive investment target. No coincidence but due to that, such a prominent companies, as BP, Sanyo, Kyocera established their stakes within the industry.

**Solar Energy Risks Assessment.**

Risks implied in conversion of global power generation to mainly solar energy use. When the mankind was changing from Coal Age to Oil Age (Tertziakian, 2005), only advantages were seen. Risks of conversion to oil were not obvious at that time (pollution, climate change, wars for oil reserves control etc.). For an exploratory mindset, that looks like the contemporary challenge of converting to solar energy: at the moment, there are only supportive voices, promising solution of numerous oil-related problems, while no claims of risks humans could face after that conversion is done.

The concept of “no free lunch”, however, is so generalizable, that keeps its footprints even in solar energy analysis of systemic threats. All those can be classified as geopolitical, industrial (operational), social, health-related. From our subsequent analysis, the major category of risks is geopolitical risks. We will analyze it after providing an insight on health-related risks, industrial (operational), social, and geopolitical.

**I. Health-Related Risks.**

1. While producing power, electromagnetic waves emerge. The health impact of photovoltaic power plants, and, more important, panels for household use, is not researched in depth. It is known, however, that continuous exposure to electromagnetic fields can affect the brain, elevate blood pressure etc (Ahlbom, 2001; Blazka, et al., 1994; Cao et al., 2006; Feychting et al., 2003; Hayes, 2007; Håkansson et al., 2003; Lee et al., 2002; Li et al. 2002; Tanaka, et al., 2002; Tynes et al., 2003).
That issue needs to be addressed to clarify safety or set up appropriate electromagnetic hygiene measures.

2. Cadmium, selenium, indium are widely used in PVs. In pure, those chemical elements are considered to be dangerous for health, for example, causing pneumonitis, pulmonary edema, immune distress (Hayes, A.W., 2007), cancer (11th Report on Carcinogens. U.S. Department of Health and Human Services). Medical research into that shows controversy and needs advancements. No health risk assessment was performed so far for Ca, In, Se - containing PV panels impact on human health, nevertheless Cadmium, for example, is one of a very few number of six chemical elements banned by the EU (through its Restriction on Hazardous Substances (RoHS) directive). Selenium poisoning can result in selenosis – a disease that can lead to liver cirrhosis and pulmonary edema ("Public Health Statement: Health Effects". Agency for Toxic Substances and Disease Registry). Nevertheless Indium in itself is considered a non-toxic substance, some its salts, for example, Indium phosphide, is both toxic and is believed to be a carcinogen (Tanaka, A., et al., 2002; Blazka, M.E., et al., 1994).

II. Industrial and Economy Risks.

Re-allocation of power generation industry can result in strategies of moving manufacturing operations (at least, high energy consuming, for instance the case of aluminum plants today) closer to sources of electricity, like contemporary is the case of low-cost labour pursuit and shift of manufacturing to low labour cost countries. That could be particularly true for new power generation regions that are densely populated: due to improvement in revenues stream coming from power plants, local economies might grow as well as disposable income of residents. Therefore, it would make sense to move production of goods closer to consumers. That is good for emerging commerce centers.

However, changing plant locations implies decline in local economies from where they are moved away, i.e., manufacturing centers of today. That process can create tensions among population of those losing jobs countries. That threat is pretty serious – because, as a consequence, should a populist government take office, it could impose protectionism policies, jeopardizing free trade and free market fundamentals. In its turn, that can produce more intervention of the government into the economy, and initiate even more tensions with pertaining declines in revenue, social unrest, recession and global (or regional) crises.

III. Social risks.

In itself, the solar energy does not constitute apparent social risks. Meanwhile, those could be implicit given improper social concept employed by authorities of countries advancing heavily in deployment of solar power generation facilities. Those risks have several dimensions. First of all, for accommodating space-needed solar power generating facilities, large spots of terrain required. In many countries, Gini index is already high – signalling about unequal disbursement of wealth. The wealthy class, capitalizing from the opportunity of hosting solar energy plants, can become wealthier, while ordinary citizens not necessarily would benefit from that. Thus, Gini index will climb up.
Need in land surface for accommodating solar power plants can motivate landowners to expel people residing currently on the land. That can cause territorial conflicts, rebel movements, damage to solar plants and power transportation grids.

IV. Geopolitical risks.

(1) From now and further, from science’s development and prospects, materials for solar panels production are silicon (Si), cadmium telluride (CaTe), copper indium diselenide (CIS), and other experimental type materials. None of them is as much wide-spread and feasible as water or sand or other basic elements. Therefore, should the mankind switch to mass use of solar energy and install tens of millions of m² solar generation capacity, that would create a severe competition for silicon, cadmium, indium, selenide and other rare chemical elements. There is a very tiny boundary between severe competition and geopolitical or even military attempts to fight for scare resources.

a. Cadmium and Indium. Cadmium is located between mercury and zinc within the periodical table of chemical elements. The dominating amount of cadmium (and indium, too) in nature can be found out as substitution for zinc in zinc minerals. However, it constitutes a very low portion - 1% of the mineral. Per se, cadmium (and indium) minerals are extremely rare, and the most common of them is greenockite (cadmium sulfide, CdS) (http://www.eoearth.org/article/Cadmium, 24.10.2009). Usually, cadmium and indium can be recovered from phosphate ores, but most of cadmium is derived sphalerite (zinc sulfide), which is the most common ore for zinc deposits. Usually and on average, the ratio of zinc content to that of cadmium is 1/400. That shows how rare cadmium is, and a future trend of tremendous jump in demand for it could cause competition resulting in confrontation. Cadmium is extracted at zinc refineries, at any country where they are located. China, Australia, Peru, USA, Mexico, Ireland, India, Kazakhstan, Sweden are top-10 producers. Among them, Ireland, India, Sweden do not have substantial ore deposits. Meanwhile, below them in the table, there are many ore-extracting nations, which ship out zinc ore (containing cadmium and indium) to refineries: Bolivia, Iran, Morocco, Namibia, Vietnam, Thailand, S.Africa, Chile, argentina, Myanmar. Many of them do not have a stable political tradition. Combined with their richness in minerals, they are attractive targets for geopolitical and military re-split of influence zones between key global players in century XXI. Confrontations among global super-players often end up in conflicts.

b. Selenium is a rare metal, neighbouring to sulphur and gallium in the periodic table. Most of selenium is rectified from sulphur, silver, copper, lead ores. Geographic distribution of selenium deposits is similar to that of cadmium and indium. Geopolitical risks pertaining to Ca and In, are applicable to Se as well.

(2) Reallocation of power production toward sun radiation rich regions of the world can ignite competition for controlling those regions with high solar radiation received (Central America, substantial portions of South America – in Western hemisphere; Africa, Middle East, South and South-East Asia – in Eastern hemisphere). The way it could start will resemble the present days struggle for control over oil-reach areas). However, unlike fossil fuels (located underneath the surface) fuels, the solar energy is
collected right on the surface. The Earth surface, therefore, can be the crucial resource. That can give birth to fight for – literally – space under the Sun, since some densely populated southern regions can experience completion for space between humans and solar power generation plants. In its light form, that can generate random local Luddite-style conflicts between angry population on one side and power production industry/governments on the other side. Extreme scenarios can suggest direct military interventions from more powerful neighbouring nations (or even global powers) to seize control over “new oil” (sun radiation) reach territories.

(3) Due to its natural surface exposure to sun, solar power plants are pretty vulnerable to terroristic acts from radical movements operating in certain regions and countries. Comparing to compact oil extraction wells and underground pipelines, photovoltaic power plants are an easy and fragile target. Even a simple machine-gun can cause substantial damage, both output-wise and capital-wise.

(4) Fragility of solar power plants against terroristic activities can generate requirements for almost ultimate peace in the areas of photovoltaic plants location. Given that many such areas still lack peace, a consequence could be surge of attempts to militarily fix the issues, sometimes through expelling or even vanishing local population. That scenario could be overrun should local governments confess to share profits with broad mass of population. However, that pattern is typical for democratic (by content, not by form) systems.

(5) Global confrontation risk. A common denominator for geopolitical risks is a possibility of military confrontation for control over resources associated with solar energy generation: rare metals used for PV equipment production, insolation-rich areas, locations of grid deployment to transport power to consumers etc. Given the fact of leadership in solar energy development and deployment by richer economically and in general stronger military countries, that could generate an assumption on strong engagement of military and economically advanced countries in extracting more benefits from conversion to solar energy. That could be a case unless a sustained international framework is developed for future cooperation in solar energy. Contemporary, a proposition of wars for “space under the Sun” sounds unrealistic. Hopefully, it will stay so. But there are some facts we should consider in order to prevent that scenario from execution.

The next section will give theory and statistics support to possible existence of geopolitical and military confrontation risks associated with solar energy development.

_Hypothesis 1: nations are interested in securing stable supply of solar energy in future and severing competition for energy could make nations compete for solar energy and related resources (rare metal deposits, areas of high insolation etc.) by all means, including commercial and military interventions (as the case of control over oil). Nations with higher ISC/capita could be in stronger military positions than others._

**Methods, Analysis and Results.**

In the paper, there are certain variables used. They come from open sources, such as World Energy Council (Installed solar capacity (ISC), Population, Innovation Index), UN (Human Development Index (HDI), Tertiary Educated Percentage), CIA Factbook (Military Expenditure, % of GDP). The rest of variables are calculated from those inputs (for example, ISC/capita etc.). The number of countries that provided Installed Solar Capacity data along with
all other indicators used in the paper was 37. That limits sample size for further statistics analysis, but some methods could be applied.

The correlation study was performed to identify relationships between developments in solar energy deployment, GDP/capita and military expenditures/capita. Both parametric and non-parametric correlations were studied. The reason for use of them both was that non-parametric tests are more robust against normality of distribution assumption violation (Field, 2009). Parametric correlation coefficient study results are presented in Table 1. Variables used were: GDP/capita, military expenditures (ME)/capita in % and USD, installed solar capacity (ISC)/capita.

Pearson’s correlation coefficients for ISC/capita were significant (at the robust p<0.01 level, 2-tailed) with GDP/capita (r=0.64). Military expenditures/capita (r=0.51, significant at p<0.01 level) also correlated with GDP/capita. Nevertheless the direct correlation of ME/capita with ISC/capita was not significant (perhaps, due to the limited sample size – the problem of data availability, and deviations from normality in the small sample size), the indirect (through GDP/capita) correlation between ISC/capita and ME/capita was in line with a general empirical concept that rich countries (more advanced in solar energy and with higher energy needs per capita) spend more per capita for military expense.

Results of non-parametric correlation coefficient study are presented in Table 2. Non-parametric correlation study produced different findings from parametric study’s results in a number of ways, including that they were based on ranks derived from numerical values (Field, 2009), and therefore were more reluctant to normality of distribution assumption possible violations.

Both non-parametric correlation coefficients – Spearman’s rho and Kendall’s tau b - indicated significance of correlation between GDP/capita and military expenditures/capita (Kendall’s tau= 0.52, significant at p<0.01 level; Spearman’s rho= 0.78, significant at p<0.01 level); GDP/capita and ISC/capita (Kendall’s tau= 0.53, significant at p<0.01 level; Spearman’s rho= 0.77, significant at p<0.01 level), and ISC/capita with ME/capita (Kendall’s tau= 0.33, significant at p<0.01 level; Spearman’s rho= 0.51, significant at p<0.01 level). Those coefficients indicated that richer countries could have competitive advantages (including military ones) in competing for solar energy resources.

The regression study was then performed to research predictive capacity of selected variables toward the solar energy use. First, the simultaneous regression was performed. The predictor variables were GDP/capita and ME/capita. The regression model (Table 3) produced $R^2$ of 0.48 (the amount of variance in the criterion variable explained by the predictor variables was 48%), model fit F change=15.64 significant at p<0.01 level. That indicated that ISC/capita could be substantially predicted through the use of independent variables GDP/capita and ME/capita. Both independent variables had significant effect on the dependent variable (t-tests were significant for both GDP/capita and ME/capita at p<0.05 level, see Table 4).

To check parsimony of the model, the stepwise regression was performed (Table 5). The stepwise regression also included both predictor variables to explain ISC/capita: GDP/capita and ME/capita. For both independent variables, F values were significant at p<0.05 level. Thus, the
relationship of ISC/capita with both GDP/capita and ME/capita was confirmed as significant and parsimonious.

Those findings confirmed **Hypothesis 1**: nations need sustained supply of energy for development, therefore, might interested in securing stable supply of solar energy in future, should it take a large share in energy mix. If that would be the case, should competition for solar energy get more severe, nations would be in position to compete for solar energy and related resources (rare metal deposits, areas of high insolation etc.) by all means, including commercial and military interventions (as the case of control over oil). Nations with higher ISC/capita, more interested in leading in solar energy development, could be in stronger military positions than less developed countries.

However, we expect that raising early the question of geo-policy risks pertaining to solar energy development, will help to prevent the final conclusion from our hypothesis to happen and strike the mankind. That awareness could trigger elaboration of an international legal and other-side framework for sustainable and peaceful solar energy development.

**Future Research and Applications.**

The study had certain statistical assumptions to be accepted (assuming robustness of the tests used) nevertheless there were deviations observed. They were a result of a small sample size. That gives an opportunity for future research to analyze findings and conclusions achieved in the paper while using a bigger number of cases. Other determinants of solar energy development could be researched, too.

Directions for future research definitely encompass extension of the current study through incorporating more data points (more countries should start reporting on ISC over the course of time), introduction of new statistical methods (especially nonparametric and longitudinal) in the current research, research for more independent variables (predictors) to incorporate into the model, and development of new models for both the issues studied here and the new issues.

The study aimed at investigating systemic risks pertaining to the solar energy. As an example, conversion to oil was viewed as a positive step in civilization progress. No analysis of risks was done and systemic risks were not addressed. They came out of control and produced a lot of damage and disbalances, such as confrontation over oil resources control etc. Starting conversion to solar energy, the humans should think in advance in terms of risk analysis and forecasting. The paper adds to that. Identification of systemic risks should help international organizations, such as UNO, World Energy Council etc. develop preventive policies and international agreements to eradicate risks of confrontation etc. National governments can benefit from this paper’s findings, too: the paper points at out possible shortage resources. That shows in exploration of what deposits to invest, and what resource-saving technologies to develop. Non-government organizations can use this paper’s findings to shape their efforts in influencing governments and international organizations activities for prevention of those risks. Academia can use findings of the paper to continue research in that area. Industry can utilize analysis of scarcity in solar energy-related resources for investing in relevant technologies or extraction of rare metals used in photovoltaic elements production. Finally, the civil society can use the paper for navigating the way to sustainable future.
Appendices.

Table 1. Parametric Correlations.

<table>
<thead>
<tr>
<th>Variable</th>
<th>GDP/capita</th>
<th>ME/capita %</th>
<th>ME/capita</th>
<th>ISC/capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP/capita</td>
<td>1</td>
<td>-0.25</td>
<td>0.51(**)</td>
<td>0.64(**)</td>
</tr>
<tr>
<td>ME/capita %</td>
<td>-0.25</td>
<td>1</td>
<td>0.60(**)</td>
<td>-0.23</td>
</tr>
<tr>
<td>ME/capita</td>
<td>0.51(**)</td>
<td>0.60(**)</td>
<td>1</td>
<td>0.09</td>
</tr>
<tr>
<td>ISC/capita</td>
<td>0.64(**)</td>
<td>-0.23</td>
<td>0.09</td>
<td>1</td>
</tr>
</tbody>
</table>

** p<0.01

Table 2. Non-Parametric Correlations.

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Variable</th>
<th>GDP/capita</th>
<th>ME/capita %</th>
<th>ME/capita</th>
<th>ISC/capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kendall's tau_b</td>
<td>GDP/capita</td>
<td>1.00</td>
<td>-0.25(*)</td>
<td>0.52(**)</td>
<td>0.53(**)</td>
</tr>
<tr>
<td>ME/capita %</td>
<td>-0.25(*)</td>
<td>1.00</td>
<td>.24(*)</td>
<td>-0.22</td>
<td></td>
</tr>
<tr>
<td>ME/capita</td>
<td>0.52(**)</td>
<td>0.24(*)</td>
<td>1.00</td>
<td>0.33(**)</td>
<td></td>
</tr>
<tr>
<td>ISC/capita</td>
<td>0.53(**)</td>
<td>-0.22</td>
<td>0.33(**)</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spearman's rho</th>
<th>Variable</th>
<th>GDP/capita</th>
<th>ME/capita %</th>
<th>ME/capita</th>
<th>ISC/capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP/capita</td>
<td>1.00</td>
<td>-0.34(*)</td>
<td>0.73(**)</td>
<td>0.77(**)</td>
<td></td>
</tr>
<tr>
<td>ME/capita %</td>
<td>-0.34(*)</td>
<td>1.00</td>
<td>0.32</td>
<td>-0.32</td>
<td></td>
</tr>
<tr>
<td>ME/capita</td>
<td>0.73(**)</td>
<td>0.32</td>
<td>1.00</td>
<td>0.51(**)</td>
<td></td>
</tr>
<tr>
<td>ISC/capita</td>
<td>0.77(**)</td>
<td>-0.32</td>
<td>0.51(**)</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

* p<0.05
** p<0.01

TABLE 3. Simultaneous Regression Model.

<table>
<thead>
<tr>
<th>Predictors in the model</th>
<th>R²</th>
<th>F Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP/capita, ME/capita</td>
<td>0.48</td>
<td>15.64</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Table 4. Simultaneous Regression Model Coefficients.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE</th>
<th>Beta</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME/capita</td>
<td>-0.01</td>
<td>0.00</td>
<td>-0.32</td>
<td>-2.20</td>
<td>0.02</td>
</tr>
<tr>
<td>GDP/capita</td>
<td>0.00</td>
<td>0.00</td>
<td>0.77</td>
<td>5.55</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Table 5. Stepwise Regression Model.

<table>
<thead>
<tr>
<th>Predictors in the Model</th>
<th>R²</th>
<th>F Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP/capita</td>
<td>.41</td>
<td>23.84</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>GDP/capita, ME/capita</td>
<td>.48</td>
<td>4.83</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>
References: