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# The effects of saving-investment gap on economic growth in developing countries: A clustering and panel data analysis

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**Abstract.** *In this study, the effect of saving-investment gap on economic growth was analyzed on sample of 65 developing countries for 1981-2014 period. Firstly, these countries were categorized into sub-groups according to their saving-investment gap data by using clustering analysis. Then, panel unit root were performed for each cluster and overall panel, and panel coefficients were estimated. In conclusion; it was determined that while the effect of saving on economic growth is positive and statistically significant in developing countries which have savings over investment, this effect is negative and statistically insignificant in developing countries which have investment over savings. It was considered that this study will bring novelty to literature since it combined panel data analysis and clustering analysis together.*

**Keywords:** Saving-Investment Gap, Sustainable Economic Growth, Developing Countries, Clustering Analysis, Panel Data Analysis.

**JEL Classification:** D92, E21, O16.

## 1. Introduction

A known fact is that domestic savings reinforce to higher investment and accordingly higher growth rate (Solow, 1956; Cass, 1965; Koopmans, 1965; Romer, 1986; Bacha, 1990; DeGregorio, 1992; Jappelli and Pagano, 1994; Deaton and Paxson, 2000; Van, Nguyen and Tuan, 2014). Domestic saving is an essential resource for developing countries extremely sensitive to external shocks effect economic growth and development. Common traits of developing countries are; the low per capita income and therewith cannot finance their investments with national savings and an unstable macroeconomic indicators. The Saving-Investment Gap is one of the most important subject in developing countries in terms of being reference to the macroeconomic indicators. Developing countries need to close financing gap in investment, R&D and innovation with their domestic savings. Otherwise, these countries open their economy to foreign inflows to finance this gap. Because of unstable macroeconomic indicators, these inflows are usually short-term and this is not enough to sustain stable economic growth. On the other hand, short-term foreign inflows and debt increase the external debt of developing countries, causing the current account deficit (Brissimis et al., 2012, Gocer et al., 2013, Bayraktar-Saglam and Yalta, 2015). In this case countries are becoming more vulnerable against the exchange rate and foreign economic shocks (Ornek, 2008; Gente et al., 2014, Ahmed and Zlate, 2014). Economic growth of less-saving developing countries is strongly linked to quantitative easing policies in the United States and other high-income countries. Federal Reserve Bank announced in May 2013 that he would reduce monthly asset purchases and then developing countries include Turkey have extremely response to this situation.

Saving behaviors vary across in each country. Demographic and financial factors affect individual's saving behavior and so saving rates vary across in each country. We expect from the results of our study that the relationship between saving-investment gap and economic growth is insignificant and negative in countries with negative saving rates. For instance, Korea, in 1960s, have handled high economic growth in spite of low domestic saving rates (Mason, 1988). Dowling and Hiemenz (1983) analyzed poor countries in Asian Region and found that there is a negative and insignificant relationship between savings and growth. Because of more effective use of foreign aid in these countries, higher growth rate was observed despite negative or low saving rates.

On the other hand, it is expected that countries with positive saving rates would invest their resources to reach stable and sufficient economic growth rate and so the relationship between saving-investment gap and growth is positive and significant (Romer, 1987).

Using annual data from 1981 to 2014, the IMF World Economic Outlook Database updated April 14, 2015 attempted to analyze the relationship between saving-investment gap ((S-I)/GDP)) and economic growth in 65 developing countries whose GDP per capita was in the range of 1.000 USD and 20.000 USD in 2013. To examine the data from these countries for period 2000-2014, the IMF country grouping system was taken into account.

**Table 1.** *Economic Growth and Saving-Investment/GDP Ratio in Sub-Saharan Africa Countries, 2000-2014 (%)*

| | 2000 | | 2005 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub-Saharan Africa Countries | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G |
| Botswana | 9.42 | 5.89 | 16.29 | 4.56 | -6.01 | 8.59 | -0.54 | 6.18 | -3.45 | 4.26 | 10.38 | 5.89 | 17.12 | 4.94 |
| Cabo Verde | -9.70 | 7.27 | -3.12 | 5.81 | -12.43 | 1.47 | -16.29 | 3.97 | -11.42 | 1.20 | -3.96 | 0.52 | -9.11 | 1.00 |
| Cameroon | -3.80 | 4.15 | -3.41 | 2.30 | -2.76 | 3.27 | -2.72 | 4.14 | -3.61 | 4.60 | -3.78 | 5.58 | -4.21 | 5.14 |
| Chad | -17.70 | -0.88 | 1.05 | 7.94 | -8.96 | 13.55 | -5.64 | 0.08 | -8.69 | 8.88 | -9.03 | 5.69 | -8.74 | 6.89 |
| Cote D'Ivoire | -2.24 | -4.63 | 0.23 | 1.72 | 1.86 | 2.02 | 10.49 | -4.39 | -1.18 | 10.67 | -4.92 | 8.70 | -3.28 | 7.48 |
| Gabon | 15.89 | -1.88 | 20.87 | -0.79 | 7.81 | 6.27 | 13.07 | 6.94 | 21.25 | 5.49 | 14.89 | 5.60 | 11.16 | 5.09 |
| Ghana | -6.86 | 4.19 | -7.00 | 6.02 | -6.13 | 7.90 | -7.65 | 14.03 | -15.13 | 8.02 | -8.24 | 7.33 | -9.22 | 4.16 |
| Kenya | -1.68 | 0.60 | -1.20 | 5.67 | -5.92 | 8.41 | -9.13 | 6.12 | -8.45 | 4.45 | -8.67 | 5.74 | -9.22 | 5.28 |
| Lesotho | -3.89 | 5.66 | 12.79 | 3.11 | -7.73 | 6.88 | -9.27 | 4.52 | -2.84 | 5.30 | -4.35 | 3.49 | -6.81 | 2.17 |
| Mauritius | 0.88 | 7.20 | -4.38 | 1.45 | -9.46 | 4.10 | -12.90 | 3.89 | -6.34 | 3.22 | -8.89 | 3.19 | -5.66 | 3.24 |
| Nigeria | 14.42 | 7.70 | 19.43 | 8.68 | 3.87 | 9.97 | 3.00 | 4.89 | 4.36 | 4.28 | 3.86 | 5.39 | 2.21 | 6.31 |
| South Africa | -0.13 | 4.16 | -3.13 | 5.28 | -1.50 | 3.04 | -2.16 | 3.21 | -4.96 | 2.22 | -5.77 | 2.21 | -5.44 | 1.53 |
| Swaziland | -3.01 | 2.04 | -3.97 | 2.46 | -9.98 | 1.87 | -8.15 | -0.61 | 3.82 | 1.86 | 6.29 | 2.80 | 0.92 | 1.71 |
| Zambia | -16.73 | 3.58 | -7.19 | 7.24 | 5.95 | 10.30 | 2.97 | 6.37 | 3.20 | 6.76 | 0.00 | 6.69 | -0.23 | 5.42 |

**Note:** S-I represents gross national savings percentage GDP- total investment percentage GDP, G represents GDP growth %.
**Source:** IMF World Economic Outlook Database updated April 14, 2015.

Common trait of Sub-Saharan African Countries is lying on rich natural reserves. Almost all developed and developing countries has led to rapid investment in this region because of the importance of its economic and strategic perspective. On the one hand, 33 of 48 the world's least developed countries are located in this area; on the other hand, the world's fastest developing countries contain in itself. Table 1 portrays that countries with positive growth rate; conversely, Botswana, Gabon, Nigeria and Swaziland, have negative saving-investment ratio on the dates specified.

**Table 2.** *Economic Growth and Saving-Investment/GDP Ratio in Middle East and North Africa Countries and Pakistan, 2000-2014 (%)*

| | 2000 | | 2005 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Middle East and North Africa Countries and Pakistan | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G |
| Algeria | 16.70 | 3.80 | 20.53 | 5.90 | 7.54 | 3.62 | 9.93 | 2.83 | 5.92 | 3.30 | 0.40 | 2.76 | -4.34 | 4.13 |
| Egypt | -1.17 | 5.38 | 3.25 | 4.47 | -1.97 | 5.15 | -2.58 | 1.78 | -3.87 | 2.22 | -2.35 | 2.10 | -0.82 | 2.16 |
| Islamic Republic of Iran | 5.11 | 5.14 | 2.42 | 4.21 | 2.00 | 6.58 | 8.53 | 3.75 | 1.19 | -6.61 | 7.35 | -1.91 | 3.81 | 2.97 |
| Jordan | 0.70 | 4.25 | -18.05 | 8.14 | -7.13 | 2.31 | -10.26 | 2.59 | -15.23 | 2.65 | -10.27 | 2.83 | -7.02 | 3.10 |
| Libya | 21.73 | 3.68 | 36.81 | 11.87 | 19.49 | 5.02 | 9.14 | -62.08 | 29.10 | 104.48 | 13.58 | -13.55 | -30.11 | -24.03 |
| Morocco | -1.29 | 1.59 | 1.79 | 2.98 | -4.13 | 3.64 | -8.05 | 4.99 | -9.75 | 2.67 | -7.58 | 4.38 | -5.85 | 2.92 |
| Pakistan | 0.76 | 3.91 | -0.17 | 8.96 | -2.22 | 2.58 | 0.10 | 3.62 | -2.07 | 3.84 | -1.07 | 3.70 | -1.24 | 4.14 |
| Sudan | 0.06 | 23.64 | -10.04 | 0.43 | -2.05 | 3.01 | -0.43 | -1.15 | -9.32 | -3.48 | -8.65 | 3.71 | -5.15 | 3.39 |
| Tunisia | -3.82 | 4.30 | -0.93 | 4.00 | -4.78 | 2.62 | -7.40 | -1.92 | -8.19 | 3.75 | -8.31 | 2.26 | -8.92 | 2.30 |

**Note:** S-I represents gross national savings percentage GDP- total investment percentage GDP, G represents GDP growth %.
**Source:** IMF World Economic Outlook Database updated April 14, 2015.

Table 2 exhibits that the North Africa countries (Algeria, Egypt, Libya, Morocco, Sudan and Tunisia) and Pakistan have negative saving-investment ratio and small growth rate.

Especially, economic situation of Libya has continued to worsen over time and has yielded substantially negative indicators since 2012. The developed and developing countries have been forced to withdraw their investment from this region because of civil war and political instability. Islamic Republic of Iran has posed better economic view with respect to the North African countries.

**Table 3.** *Economic Growth and Saving-Investment/GDP Ratio in Latin America and the Caribbean Countries, 2000-2014 (%)*

| | 2000 | | 2005 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latin America and the Caribbean Countries | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G |
| Argentina | -2.64 | -0.79 | 2.03 | 9.23 | -0.41 | 9.45 | -0.72 | 8.39 | -0.24 | 0.80 | -0.81 | 2.89 | -0.87 | 0.47 |
| Belize | -19.42 | 13.02 | -13.57 | 2.97 | -2.44 | 3.08 | -1.07 | 2.10 | -1.21 | 3.26 | -4.44 | 1.53 | -5.72 | 3.38 |
| Bolivia | -7.12 | 2.51 | 5.62 | 4.42 | 7.96 | 4.13 | 5.77 | 5.17 | 8.06 | 5.18 | 4.90 | 6.78 | 2.35 | 5.40 |
| Brazil | -3.69 | 4.38 | 1.57 | 3.15 | -2.14 | 7.57 | -2.01 | 3.92 | -2.25 | 1.76 | -3.40 | 2.74 | -3.88 | 0.15 |
| Chile | -1.18 | 4.47 | 1.55 | 6.31 | 1.75 | 5.74 | -1.22 | 5.75 | -3.63 | 5.53 | -3.70 | 4.32 | -1.17 | 1.84 |
| Colombia | 0.71 | 2.93 | -1.42 | 4.71 | -3.18 | 3.97 | -3.05 | 6.59 | -3.21 | 4.04 | -3.39 | 4.94 | -5.01 | 4.55 |
| Costa Rica | -4.50 | 1.80 | -4.91 | 5.89 | -3.53 | 4.95 | -5.40 | 4.52 | -5.32 | 5.17 | -5.05 | 3.44 | -4.47 | 3.50 |
| Dominica | -17.81 | 3.99 | -20.54 | -0.13 | -16.27 | 1.08 | -13.36 | -0.07 | -17.69 | -1.40 | -13.06 | -0.88 | -13.01 | 1.10 |
| Dominican Republic | -4.01 | 5.65 | -1.52 | 9.22 | -7.45 | 8.30 | -7.48 | 2.82 | -6.56 | 2.63 | -4.07 | 4.78 | -3.13 | 7.30 |
| Ecuador | 3.90 | 1.09 | 1.14 | 5.29 | -2.28 | 3.53 | -0.33 | 7.87 | -0.19 | 5.22 | -1.04 | 4.64 | -0.83 | 3.64 |
| El Salvador | -3.01 | 2.15 | -3.64 | 3.56 | -2.49 | 1.37 | -4.81 | 2.22 | -5.41 | 1.88 | -6.50 | 1.68 | -5.02 | 2.00 |
| Grenada | -16.94 | 6.22 | -26.26 | 13.27 | -22.10 | -0.51 | -21.78 | 0.77 | -19.25 | -1.16 | -27.03 | 2.42 | -23.64 | 1.52 |
| Guatemala | -6.10 | 2.53 | -4.56 | 3.26 | -1.36 | 2.87 | -3.36 | 4.16 | -2.60 | 2.97 | -2.51 | 3.68 | -2.31 | 4.00 |
| Guyana | -6.68 | -1.35 | -9.15 | -1.94 | -9.62 | 4.37 | -13.06 | 5.44 | -11.58 | 4.82 | -13.26 | 5.22 | -15.90 | 3.83 |
| Honduras | -7.16 | 5.75 | -3.00 | 6.05 | -4.33 | 3.73 | -6.43 | 3.84 | -8.35 | 4.13 | -11.35 | 2.79 | -7.62 | 3.09 |
| Jamaica | -7.19 | 0.78 | -11.91 | 0.89 | -6.78 | -1.45 | -12.89 | 1.40 | -9.19 | -0.47 | -9.34 | 0.20 | -5.84 | 0.52 |
| Mexico | -2.74 | 5.30 | -1.03 | 3.03 | -0.47 | 5.11 | -1.14 | 4.05 | -1.34 | 4.01 | -2.35 | 1.39 | -2.07 | 2.13 |
| Panama | -5.93 | 2.72 | -4.99 | 7.19 | -11.37 | 7.45 | -15.94 | 10.85 | -9.82 | 10.67 | -12.18 | 8.39 | -12.01 | 6.20 |
| Paraguay | -16.66 | -2.31 | -15.18 | 2.13 | 12.96 | 13.09 | 15.05 | 4.34 | 41.33 | -1.24 | 24.00 | 14.23 | 6.15 | 4.39 |
| Peru | -3.03 | 2.70 | 1.55 | 6.28 | -2.38 | 8.45 | -1.86 | 6.45 | -2.72 | 5.95 | -4.36 | 5.77 | -4.06 | 2.35 |
| St. Kitts and Nevis | -15.78 | 6.49 | -11.92 | 8.72 | -20.79 | -3.83 | -15.90 | -1.88 | -9.81 | -0.86 | -6.67 | 3.82 | -10.73 | 6.96 |
| St. Lucia | -12.07 | 0.25 | -13.77 | -2.49 | -16.22 | -0.17 | -18.73 | 1.26 | -13.98 | 0.61 | -7.48 | -0.46 | -8.75 | -1.11 |
| St. Vincent and the Grenadines | -6.04 | 2.01 | -18.56 | 3.03 | -30.58 | -2.34 | -29.35 | 0.19 | -27.43 | 1.09 | -31.17 | 2.39 | -29.37 | 1.09 |
| Uruguay | -2.48 | -1.78 | 0.24 | 6.81 | -1.89 | 8.40 | -2.91 | 7.34 | -5.38 | 3.68 | -5.24 | 4.40 | -4.74 | 3.32 |
| Venezuela | 10.12 | 3.69 | 17.49 | 10.32 | 2.98 | -1.49 | 7.71 | 4.18 | 2.89 | 5.63 | 1.48 | 1.34 | 1.78 | -4.00 |

**Note:** S-I represents gross national savings percentage GDP- total investment percentage GDP, G represents GDP growth %.

**Source:** IMF World Economic Outlook Database updated April 14, 2015.

We observed the similar situation with the one mentioned above for Latin American and Caribbean countries in Table 3 which exhibits negative saving-investment ratio for all except Bolivia, Paraguay and Venezuela.

**Table 4.** *Economic Growth and Saving-Investment/GDP Ratio in Emerging and Developing Europe Countries, 2000-2014 (%)*

| | 2000 | | 2005 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emerging and Developing European Countries | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G |
| Albania | -6.77 | 6.63 | -8.97 | 5.77 | -11.35 | 3.71 | -13.23 | 2.55 | -10.22 | 1.62 | -10.66 | 1.39 | -13.86 | 2.10 |
| Bulgaria | -5.25 | 5.39 | -11.47 | 5.96 | -1.45 | 0.66 | 0.08 | 1.98 | -1.12 | 0.49 | 2.25 | 1.07 | 0.05 | 1.71 |
| Hungary | -7.18 | 4.24 | -7.04 | 4.26 | 0.28 | 0.79 | 0.75 | 1.81 | 1.90 | -1.48 | 4.14 | 1.53 | 4.24 | 3.64 |
| Turkey | -3.72 | 6.77 | -4.44 | 8.40 | -6.19 | 9.16 | -9.68 | 8.77 | -6.15 | 2.13 | -7.87 | 4.12 | -5.69 | 2.90 |

**Note:** S-I represents gross national savings percentage GDP- total investment percentage GDP, G represents GDP growth %.
**Source:** IMF World Economic Outlook Database updated April 14, 2015.

Table 4 supports that Albania was ranked as the first according to saving-investment gap in Emerging and Developing Europe countries, and it was followed by Turkey with -5.69% ratios in 2014. The political uncertainty in Turkey resulted in an increase in country risk and its consequence was that the net capital inflow/GDP ratio declined to 1.5%. For such reasons, Turkey's growth rate decreased to 1.7 % in 3.trimester in 2015.

**Table 5.** *Economic Growth and Saving-Investment/GDP Ratio in Emerging and Developing Asia Countries, 2000-2014 (%)*

| | 2000 | | 2005 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emerging and Developing Asia Countries | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G | S-I | G |
| Bangladesh | -0.98 | 5.60 | 1.14 | 6.30 | 2.27 | 6.03 | 1.51 | 6.49 | 1.76 | 6.26 | 1.87 | 6.07 | 0.70 | 6.11 |
| Bhutan | -26.25 | 6.48 | -26.77 | 6.53 | -28.59 | 9.33 | -26.01 | 10.07 | -28.36 | 6.51 | -28.66 | 4.95 | -33.01 | 6.35 |
| China | 1.71 | 8.40 | 5.79 | 11.30 | 4.00 | 10.41 | 1.86 | 9.30 | 2.57 | 7.76 | 1.93 | 7.75 | 2.02 | 7.36 |
| India | -0.56 | 3.98 | -1.19 | 9.29 | -2.81 | 10.26 | -4.24 | 6.64 | -4.80 | 5.08 | -1.73 | 6.90 | -1.44 | 7.17 |
| Indonesia | -0.18 | 4.98 | -5.01 | 5.69 | 0.75 | 6.38 | 0.20 | 6.17 | -2.78 | 6.03 | -3.34 | 5.58 | -2.95 | 5.03 |
| Malaysia | 9.05 | 8.68 | 14.42 | 4.98 | 10.94 | 7.43 | 11.57 | 5.19 | 5.78 | 5.64 | 4.04 | 4.75 | 4.63 | 6.02 |
| Mongolia | -7.56 | 1.15 | 1.02 | 6.22 | -15.21 | 20.86 | -27.71 | 17.29 | -28.21 | 12.32 | -25.95 | 11.65 | -7.70 | 7.82 |
| Papua New Guinea | 7.53 | -2.46 | 13.95 | 3.92 | -21.52 | 7.68 | -23.61 | 10.67 | -53.56 | 8.09 | -30.82 | 5.53 | -12.12 | 5.84 |
| Philippines | -2.75 | 4.41 | 1.93 | 4.78 | 3.60 | 7.63 | 2.52 | 3.66 | 2.78 | 6.80 | 4.18 | 7.18 | 4.44 | 6.10 |
| Solomon Islands | -14.52 | -14.28 | -6.72 | 12.85 | -33.29 | 6.89 | -8.60 | 12.95 | 1.53 | 4.65 | -4.46 | 3.02 | -8.50 | 1.49 |
| Sri Lanka | -6.30 | 6.02 | -2.48 | 6.24 | -2.17 | 8.02 | -7.80 | 8.25 | -6.71 | 6.34 | -3.86 | 7.30 | -3.74 | 7.40 |
| Thailand | 7.60 | 4.75 | -4.33 | 4.64 | 3.14 | 7.81 | 2.57 | 0.08 | -0.40 | 6.49 | -0.63 | 2.89 | 3.81 | 0.71 |
| Vietnam | 3.11 | 6.79 | -1.37 | 7.55 | -3.79 | 6.42 | 0.17 | 6.24 | 5.96 | 5.25 | 5.55 | 5.42 | 5.42 | 5.98 |

**Note:** S-I represents gross national savings percentage GDP- total investment percentage GDP, G represents GDP growth %.
**Source:** IMF World Economic Outlook Database updated April 14, 2015.

China is the second largest economy in the World (see CEBR World Economic League Table; December, 2014) but still he is considered as one of the emerging and developing countries of Asia (see, in Table 5) due to low per capita income, etc. The low-cost labor and natural resources are currently attractive for foreign investor. But slowdown on growth rate has been observed since 2011 in China's economy. This situation has impressed developing economies and commodity-linked currencies have lost their value. India and Indonesia, countries with saving gap, are more related to foreign capital flows

to support economic growth. Unfortunately Fed's contractionary monetary policies are directly associated with their economic vulnerabilities.

To ensure sustainable high economic growth is known to be important in the share of investment and savings. Therefore, understanding significance of saving-investment gap for countries is very important to comprehend their economic growth. In this context, the purpose of the study is to explore the empirical relationship between saving-investment gap and growth rate using annual data for period 1981 to 2014. The rest of the paper is organized as follows. In Section 2, the relevant literature summary presented, In Section 3 provides information about our database and methodology used to identify the relationship between saving-investment gap and growth rate. Next, we analyze the empirical modeling framework. Section 5 concludes.

## 2. Literature Overview

Many empirical and academic publications view the detection of short-run and long-run relationship between savings and economic growth in developing countries. An argument starting with Lewis (1955) that higher saving rate motives higher invest rate which amplifies higher economic growth (Solow, 1956; Romer, 1986).

De Gregorio (1992) analyzed growth determinants in 12 Latin American countries for periods 1950-1985 by using Ordinary Least Squares regression method and studied out higher saving rate led to higher economic growth.

Carroll and Weil (1994), using Granger causality method on OECD sample found unidirectional causality running from growth to savings. Also Sinha and Sinha (1998) reported same conclusion for Mexico.

Attanasio, Picci and Scorco (2000) analyzed the long and short-run relationships among saving, investment and growth for 123 countries throughout period 1960-1994. Authors used Granger causality method to investigate the relationship between growth and saving; and in the end, they concluded that growth seems to be positively Granger-causing saving purely the effect is relatively weak.

Yenturk et al. (2009) argued that the GNP growth rate of Turkey caused an increase in savings in the medium-to-long term, but reverse causality was found delimited. Accordingly, saving and investment were not effective on the growth rate based on the impulse response functions together with the variance decomposition analysis.

On the other hand Singh (2010) examined the long-run effects of domestic savings on income by using annual data for 1950-2002 periods in India; and tested the null of non-causality between savings and growth. The author detected a bi-directional causality and concluded that higher saving reinforces the acceleration of income and growth.

Tang and Chua (2012) used Toda & Yamamoto and Dolado and Lütkepohl Granger causality test for the sample period from 1971:Q1 and 2008:Q4 in Malaysia. The cointegration results indicated that the variables were correlated in the long-run; and the relationship between saving and growth was bilateral.

Samantraya and Patra (2014) argued that understanding the behavior of savings has critical role to sustain higher economic growth. For this reason, they analyzed the determinants of household saving in India from the period 1971-1972 to 2011-2012 by using the ARDL framework. After all is said and done the empirical results exposed that the GDP has positive effect on household saving and the spiral interlinkages between saving and economic growth.

## 3. Model Specification and Data

This study utilizes clustering and panel data analysis in order to examine the relationship between economic growth and savings in a sample of 65 countries(1) in the period from 1981 to 2014. The variables used in the study are GDP growth (GRO) (%) as a proxy for economic growth and saving investment gap (SIG) (gross national savings percentage GDP- total investment percentage GDP) as a proxy for savings. The annual data covering the period 1981-2014 for 65 countries, restricted by the availability of the number of countries and the time period, is compiled from the IMF World Economic Outlook Database updated on April 14, 2015.

In order to assess impact of savings on economic growth, we estimated the model below:

$$GRO_{it} = \theta_0 + \theta_1 SIG_{it} + u_{it} \quad (1)$$

## 4. Methods and Findings

The empirical modeling framework consists of four steps. First of all, countries are categorized by using clustering analysis(2). Secondly, cross- sectional dependence is examined. Thirdly, stationarity of variables are investigated by using panel unit root tests. Lastly, coefficients are estimated.

### 4.1. Clustering Analysis

Clustering analysis is a group of multivariate techniques whose primary purpose is to group objects based on the characteristics they possess. The resulting clusters should exhibit high internal (within-cluster) homogeneity and high external (between-cluster) heterogeneity. Cluster analysis is not a statistical inference technique. The requirements of normality, linearity and homoscedasticity that are so important in other techniques really have little bearing on cluster analysis (Hair et. al., 1995: 481).

There are two major clustering methods in the literature: Hierarchical clustering method and nonhierarchical clustering methods. Hierarchical clustering techniques proceed by either a series of successive mergers or a series of successive divisions. On the other hand, nonhierarchical methods start from either an initial partition of items into groups or an initial set of seed points which will form the nuclei of clusters. These procedures are also frequently referred as K-means clustering, since K-means method is the most popular nonhierarchical procedures. In contrast to hierarchical techniques, the number of clusters must be defined in advance. Criteria for K-means is to minimize sum of squares of the cluster (Mohammadi and Prasanna, 2003: 1239; Johnson and Wichern, 2007: 680).

In this study, countries were categorized into the two groups by using K-means clustering procedure and the results were reported in Table 6.

**Table 6.** *Results of Clustering Analysis*

| Cluster 1 | | | Cluster 2 | | |
|---|---|---|---|---|---|
| Albania | Belize | Bhutan | Algeria | Argentina | Bangladesh |
| Cabo Verde | Cameroon | Chad | Bolivia | Botswana | Brazil |
| Chile | Costa Rica | Cote D'Ivoire | Bulgaria | China | Colombia |
| Dominica | Dom. Rep. | El Salvador | Ecuador | Egypt | Gabon |
| Ghana | Grenada | Guyana | Guatemala | Hungary | India |
| Honduras | Jamaica | Jordan | Indonesia | Islam R. Iran | Libya |
| Kenya | Lesotho | Mauritius | Malaysia | Mexico | Nigeria |
| Mongolia | Morocco | Panama | Pakistan | Paraguay | Philippines |
| Papua New G. | Peru | Solomon I. | Swaziland | Thailand | Venezuela |
| South Africa | Sri Lanka | St. Kitts N. | Vietnam | Zambia | |
| St. Lucia | St. Vincent | Sudan | | | |
| Tunisia | Turkey | Uruguay | | | |
| 36 Countries | | | 29 Countries | | |
| Total: 65 Countries | | | | | |

**Note:** Country membership is classified based on saving investment gap in 2013. Of course, we classified countries based on saving investment gap in 2014, 2013, 2012, 2011 and 2010 but we obtained better classification results for 2013.

The results show that while first cluster consists of 36 countries such as Albania, Kenya, Peru and Turkey which exhibit substantial (or relatively high compared with other countries used in this empirical analysis) negative saving investment gap; there are 29 countries such as Algeria, Argentina, Mexico and Paraguay which exhibit substantial (or relatively high compared with other countries used in this empirical analysis) positive saving investment gap in the second cluster. As a result of clustering analysis, countries were categorized into two groups:

- Countries with negative saving investment gap in 2013 (total investment percentage GDP – gross national savings percentage GDP changes from -30.81 to -3.70)
- Countries with positive (sometimes negative but relatively low) saving investment gap in 2013 (total investment percentage GDP – gross national savings percentage GDP changes from -3.39 to 23.99)

The most important advantages of this analysis are that clusters consist of more homogenous countries and the effect of saving on economic growth can be decomposed in terms of saving investment gap.

Hence, our models[(3)] turned into the following forms:

- Cluster 1: $GRO1_{it} = \beta_{1i} + \beta_{2i} SIG1_{it} + u1_{it}$ (2)
- Cluster 2: $GRO2_{it} = \beta_{3i} + \beta_{4i} SIG2_{it} + u2_{it}$ (3)
- Cluster 3: $GRO3_{it} = \beta_{5i} + \beta_{6i} SIG3_{it} + u3_{it}$ (4)

### 4.2. Cross-Sectional Dependence

There exists a growing literature on econometric methods for representing and measuring cross sectional dependence through panel data regression models. Conditioning on variables specific to the cross section units alone typically does not deliver cross section

error independence and it is well known that neglecting cross sectional dependence can lead to biased estimates and spurious inference (Chudik et al., 2009: 6).

$CD_{LM}$ is applicable even if $N$ and $T$ are large, it is likely to exhibit substantial size distortions if $N$ is large and $T$ is small. Thus, Pesaran (2004) proposed the following cross-sectional dependence test when $N$ is large and $T$ is small (Pesaran, 2004: 4).

$$CD_{LM} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \left(\hat{\rho}_{ij}^2\right) \sim N(0,1) \quad (5)$$

Statistic have the following hypothesis:
$H_0: no\ cross-\ sectional\ dependence$
$H_1: cross-\ sectional\ dependence$

**Table 7.** *Cross-Sectional Dependence Test*

| Variables | $CD_{LM}$ |
|---|---|
| GRO1 | -2.961*** (0.002) |
| GRO2 | 1.416* (0.078) |
| GRO3 | 0.115 (0.454) |
| SIG1 | 1.880** (0.030) |
| SIG2 | -2.918** (0.014) |
| SIG3 | 0.998 (0.159) |

**Note:** *, ** and *** denote, respectively, cross sectional dependence at the 10%, 5% and 1% levels. Numbers in brackets are p-values.

It is clearly seen that the null of no cross-sectional dependence across variables (GRO1, GRO2, SIG1 and SIG2) is strongly rejected. The results from cross sectional dependence test indicate that a shock in a country spillovers on other countries due to high degree of international trade and financial liberalization. This is an expected result due to relatively high homogeneity between countries in cluster 1 and 2. Hence, we can expect that GRO1, GRO2, SIG1 and SIG2 have cross sectional dependence. On the other hand, null of no cross-sectional dependence across variables (GRO3 and SIG3) is strongly accepted. This is also expected result due to relatively high heterogeneity between countries in cluster 3.

### 4.3. Panel Unit Root Test

Having determined of clusters and cross sectional dependence, we are interested in testing for unit roots of variables in clusters. In this context, we implement Pesaran (2007), hereafter CADF, Hadri and Kurozumi (2012), hereafter HK, panel unit root tests which allows cross sectional dependence. In addition to this, we employ Levin, Lin and Chu (2002), hereafter LLC, and Im, Pesaran and Shin (2003), hereafter IPS[4], which do not allow cross sectional dependence[5].

Pesaran (2007) proposes a simple unit root test where standard augmented Dickey Fuller (ADF) regressions are augmented with the cross section averages of lagged levels and first differences of the individual series. The panel unit root test of Pesaran yields the following cross sectionally augmented Dickey Fuller (CADF) regression:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \overline{y_{t-1}} + d_i \overline{\Delta y_t} + e_{it} \quad (6)$$

Hadri and Kurozumi (2012) developed a simple Pesaran (2007) for the null hypothesis of stationarity in heterogeneous panel data with cross sectional dependence in the form of a common factor in the disturbance. They also allowed for serial correlation.

The panel unit root test of LLC (2002) yields the following model:

$$\Delta y_{it} = \mu_i + \rho y_{it-1} + \sum_{j=1}^{k} \alpha_j \Delta y_{it-j} + \delta_i t + \theta_t + \varepsilon_{it} \quad (7)$$

LLC (2002) argued that individual unit root tests have limited power against alternative hypotheses with highly persistent deviations from equilibrium. Simulation exercises also indicate that this problem is particularly severe small samples. Hence, LLC suggest a more powerful panel unit root test than performing individual unit root tests for each cross section. The test procedures are designed to evaluate the null hypothesis that each individual in the panel has integrated time series versus the alternative hypothesis that all individuals' time series are stationary (Levin et. al, 2002: 2; Baltagi, 2005: 240).

The strong assumption of homogenous $\rho$ in the LLC test is difficult to satisfy due to the fact that cross-sectional units may have different speed of adjustment process towards the long run equilibrium. Hence IPS proposes an alternative testing procedure based on averaging individual unit root test statistics. IPS suggests an average of the ADF tests and the null hypothesis is that each series in the panel contains a unit root (Baltagi, 2005: 240; Nazlioglu and Soytas, 2012: 1101).

The panel unit root test of IPS (2003) yields estimation of the following panel model:

$$\Delta y_{it} = \mu_i + \rho_i y_{it-1} + \sum_{j=1}^{k} \alpha_j \Delta y_{it-j} + \delta_i t + \theta_t + \varepsilon_{it} \quad (8)$$

IPS (2003) propose a panel unit root test which allows $\rho$ to vary across all $i$. The null hypothesis of $\rho_i = 0$ for all $i$ is tested against the alternative hypothesis of $\rho < 0$ for at least one $i$. Panel unit root test results are reported in Table 8 and Table 9.

**Table 8.** *Results for Panel Unit Root Tests*

| Variables | CADF | HK | |
|---|---|---|---|
| | | $\mathbf{Z}\mathbf{A}^{\mathbf{SPC}}$ | $\mathbf{Z}\mathbf{A}^{\mathbf{LA}}$ |
| GRO1 | -3.147* | 1.849**<br>(0.032) | 2.168**<br>(0.015) |
| GRO2 | 3.373** | 1.085<br>(0.138) | 0.875<br>(0.190) |
| SIG1 | -2.495 | -1.661<br>(0.951) | -2.170<br>(0.985) |
| SIG2 | -2.563 | -0.917<br>(0.820) | -1.040<br>(0.851) |

**Note:** *, ** and *** denote, respectively, significance at the 10%, 5% and 1% levels. Numbers in brackets are p-values. CADF statistic is computed as the simple average of the individual specific CADF statistics. While null hypothesis for HK is that variable has no unit root, null hypothesis for CADF is that variable has unit root. The maximum lag lengths were set to 4.

**Table 9.** *Results for Panel Unit Root Tests*

| Variables | LLC | | IPS | |
|---|---|---|---|---|
| | Constant | Constant and Trend | Constant | Constant and Trend |
| GRO3 | -23.403*** (0.000) | -22.755*** (0.000) | -24.952*** (0.000) | -24.463*** (0.000) |
| SIG3 | -17.691*** (0.000) | -17.060*** (0.000) | -14.486*** (0.000) | -12.464*** (0.000) |

**Note:** *, ** and *** denote, respectively, significance at the 10%, 5% and 1% levels. Numbers in brackets are p-values. Null hypothesis for Levin, Lin & Chu test and Im, Pesaran and Shin is that variable has unit root. Schwarz Info Criterion was used in order to determine optimum lag length. Newey- West band with selection with Barlett Kernel was used for the LLC test and the maximum lag lengths were set to 3.

The panel unit root test results reported in Table 8 for GRO1, GRO2, SIG1 and SIG2 show that levels of the variables have no unit root. Besides that, the panel unit root test results for GRO3 and SIG3 are reported in Table 9. The results show that the null hypothesis can be rejected for the levels of the variables. Hence, we can conclude that the variables are *I(0)* and levels of the variables can be utilized in an OLS regression.

### 4.4. Empirical Results

Panel data analysis that combines time series and cross sections allows researchers great flexibility in modeling differences. The basic model of panel data analysis takes the following form;

$$y_{it} = x_{it}^{'}\beta + z_i^{'}\alpha_i + \varepsilon_{it} \quad (9)$$

$z_i^{'}\alpha$ contains a constant term and set of individual or group specific variables which may be observed (race, sex, location) or unobserved (family specific characteristics). If $z_i$ is observed for all individuals, the entire model can be treated as an ordinary linear model and fits by least squares. We can consider various cases (Greene, 2002: 285):

- Fixed Effects: if $z_i$ unobserved, but correlated with $x_{it}$, fixed effects takes $\alpha_i$to be a group specific constant term in the regression model. It should be noted that the term fixed indicates that the term does not vary over time.
- Random Effects: if the unobserved individual heterogeneity can be assumed to be uncorrelated with the included variables, the model can be formulated as

$$y_{it} = x_{it}^{'}\beta + E\left[z_i^{'}\alpha\right] + \left\{z_i^{'}\alpha - E\left[z_i^{'}\alpha\right]\right\} + \varepsilon_{it} \quad (10)$$

$$y_{it} = x_{it}^{'}\beta + \alpha + u_i + \varepsilon_{it} \quad (11)$$

Random effects approach specifies that $u_i$ is a group specific random element except that from each group, there is but a single draw that enters the regression identically in each period (Greene, 2002: 285).

The fixed effects model is an appropriate specification if specific set of N firms, N OECD countries or N American states are concentrated on. On the other hand, the random effects model is an appropriate specification if N individuals randomly are drawn from a large population(6) (Baltagi, 2005: 12). Results of model specification and diagnostic tests for fixed and random effects model is illustrated in Table 10 and Table 11.

**Table 10.** *Model Specification and Diagnostic Tests (Fixed Effects Models)*

| Tests | Cluster (1) | Cluster (2) | Cluster (3) |
|---|---|---|---|
| $F_{group}$ | 2.929<br>(0.000) | 4.273<br>(0.000) | 3.639<br>(0.000) |
| $F_{time}$ | 2.627<br>(0.000) | 1.551<br>(0.025) | 3.073<br>(0.000) |
| $F_{group+time}$ | 2.795<br>(0.000) | 2.826<br>(0.000) | 3.469<br>(0.000) |
| $LM_{heteroscedasticity}$ | 699.799<br>(0.000) | 3599.522<br>(0.000) | 6258.483<br>(0.000) |
| $LM_{autocorrelation}$ | 125.901<br>(0.000) | 9.452<br>(0.002) | 19.175<br>(0.000) |

**Note:** Numbers in brackets are p-values.

**Table 11.** *Model Specification and Diagnostic Tests (Random Effects Models)*

| Tests | Cluster (1) | Cluster (2) | Cluster (3) |
|---|---|---|---|
| $LM_{group}$ | 46.835<br>(0.000) | 112.351<br>(0.000) | 167.630<br>(0.000) |
| $LM_{time}$ | 31.436<br>(0.000) | 2.406<br>(0.120) | 52.225<br>(0.000) |
| $LM_{group+time}$ | 78.272<br>(0.000) | 114.757<br>(0.000) | 219.855<br>(0.000) |
| $HONDA_{group}$ | 6.843<br>(0.000) | 10.599<br>(0.000) | 12.947<br>(0.000) |
| $HONDA_{time}$ | 5.606<br>(0.000) | 1.551<br>(0.060) | 7.226<br>(0.000) |
| $HONDA_{group+time}$ | 8.803<br>(0.000) | 8.591<br>(0.000) | 14.265<br>(0.000) |
| $Hausman$ | 1.773<br>(0.182) | 0.732<br>(0.392) | 2.347<br>(0.125) |
| $LM_{heteroscedasticity}$ | 653.254<br>(0.000) | 3084.342<br>(0.000) | 5444.483<br>(0.000) |
| $LM_{autocorrelation}$ | 143.956<br>(0.000) | 112.620<br>(0.000) | 169.260<br>(0.000) |

**Note:** Numbers in brackets are p-values.

The Haussmann test confirms that there is no correlation between individual random effects and explanatory variables, indicating that the Random Effects Model is consistent and efficient(7). Furthermore, test result for heteroskedasticity and autocorrelation shows that the null of homoscedasticity and no autocorrelation is rejected at the %1 level. We therefore estimate our model under the heteroskedasticity and autocorrelation by using White's correction.

**Table 12.** *Estimates of Cluster (1) Through (3)*

| | Fixed Effects Model | | Random Effects Model |
|---|---|---|---|
| | Cluster (1) | Cluster (2) | Cluster (3) |
| Constant | 3.9093<br>(0.000)*** | 3.9507<br>(0.000)*** | 4.0199<br>(0.000)*** |
| SI | -0.0111<br>(0.398) | 0.0805<br>(0.009)*** | 0.0143<br>(0.225) |

**Note:** *, ** and *** denote, respectively, significance at the 10%, 5% and 1% levels. Numbers in brackets are p-values.

Table 12 contains the principal results from panel data. The results reveal that the impact of savings on economic growth negative and statistically insignificant in cluster 1. On the other hand, the impact of savings on economic growth is positive and statistically significant in cluster 2. Lastly, the impact of savings on economic growth is positive but statistically insignificant in cluster 3. At first glance, it is effortlessly noticed that all results are different from each other.

Estimate of cluster 1 shows that the impact of savings on economic growth in countries which have negative saving investment gap is negative and statistically insignificant. This is an expected result. There might be number of reasons to explain this negative and statistically insignificant relationship in these countries. The first and the most important reason is that these developing countries (investment over savings) fail to channel savings into investment. They have insufficient savings and also fail to put their insufficient savings to good use. The second reason is that institutional structure in these countries is insufficient and weak in order to increase the level of national savings and economic growth. The last reason is that economic growth of these countries is most likely related with other determinants such as education, health, and telecommunication. Hence, it would be natural to expect that the relationship between savings and economic growth in cluster 1 is negative and statistically insignificant.

Estimate of cluster 2 indicates that the impact of savings on economic growth in developing countries with positive saving investment gap (savings over investment) is positive. The fixed effects coefficient estimate of savings suggests that a 1% increase in savings elevates the economic growth by 0.08%. This is also expected result in this study and conforms to studies of De Gregorio (1992) and Samantraya and Patra (2014). In contrast to results of cluster 1, cluster 2 consists of countries which possess savings over investment. Thus, positive and statistically significant relationship can be plausible. Since, these countries can channel savings into investment, and savings and economic growth may be directly related.

On the other hand, cluster 3 consists of 65 countries covering all countries used in this study. In this cluster, coefficient is positive and statistically insignificant. This is also an expected result which shows the importance of clustering analysis. Due to the fact that cluster 3 consists of 65 countries including countries which have savings over investment and investment over savings, coefficient is statistically insignificant. If we prefer analyzing all countries in same cluster, we would have obtained the results of cluster 3 revealing that the effect of savings on economic growth is positive and statistically insignificant. To overcome this disadvantage, in this study, we have only focused on developing countries and classified countries in terms of their saving-investment gap. As a result, we have succeeded in estimating accurate effect of savings on economic growth and abstaining from misleading inferences. When viewed from this aspect, this study differs from other studies related this subject.

## 5. Discussion and Implications

Capital accumulation and invested capital are most substantial determinants of economic growth, employment and welfare. However, capitalism is established on consumption and

based on "higher consumption is key to prosperity". Solow (1956) suggests the golden rule of saving rate which maximizes growth of consumption and which can be a guiding principle in this respect. According to this theory, countries maximize growth of consumption. On the other hand, they need investment and savings to ensure sustainable economic growth. As a consequence of economic integration, individuals have access to goods and services produced all over the world in the 21st Century. While developed countries benefit from this experience, less developed and developing countries consume more than they produce; and yield current account deficit. As a result, vulnerability of debtor countries to economic crisis and external shocks goes up. When analyzing the fragile-five among emerging market nations introduced by Morgan Stanley (2013), it can be clearly seen that the most important features of these countries are high debt stock and low saving rates.

In this study, the effects of saving-investment gap caused by the low saving rate on economic growth were investigated by using panel data analysis methods in a sample of 65 countries for 1981-2014 periods. In conclusion, based on our first empirical result, countries differences have been increasing in last three decades and countries with huge negative saving investment (Cluster 1) have negative coefficient and statistically insignificant. Second result is that countries with nearly positive saving investment gap (Cluster 2) have positive relationship between saving investment gap and economic growth and statistically one percentage increase in saving-investment gap leads to 0.08 percent decrease in economic growth.

In summary, it can be said that developing countries are required to take precautions to enhance saving rate to get sustainable debt structure and economic growth. It is substantially important that policymakers should pursue incentive policies on household savings and financial institutions should develop reliable investment instruments for household savings.

## Notes

(1) Countries are selected from country group - emerging market and developing economies – of World Economic Outlook Database, April 2015 according to their GDP per capita in 2013. Countries with GDP per capita between 1.000-20.000 USD were preferred.

(2) Instead of country classification previously calculated by some organizations such as World Bank, we prefer to use clustering analysis in order to classify countries. Since it is considered that when we performed clustering analysis by using our data, we can obtain better classification results representing our data's characteristics and distinctive features and classify countries depending on their saving investment gap.

(3) Cluster 1 and 2 are reported in Table 6. On the other hand, cluster 3 consists of 65 countries covering all countries used in this study.

(4) See Pesaran (2007), Hadri and Kurozumi (2012), Levin et. al. (2002) and Im et. al. (2003) for the details of panel unit root tests.

(5) Cross sectional dependence test shows that there is no cross sectional dependence in GRO3 and SIG3. Thus, we employ LLC (2002) and IPS (2003) only for them. On the other hand, there is cross sectional dependence in GRO, GRO2, SIG1 and SIG2. Hence, we employ HK (2012) and CADF (2007) for them.

(6) On the other hand, some researchers suggest Hausman test designed to assess whether there is a significant difference between estimates of the two models (Greene, 2002). A significant

difference is taken as evidence of bias in the random effects estimate, and the researchers are consequently guided to employ fixed effects model. In this study, we believe that the Hausman test is not reliable tool for identifying bias in typically-sized samples (cluster 1 and 2 are examples of this case in our study); nor does it aid in evaluating the balance of bias and variance implied by the two modeling approaches. Hence, cluster 1 and 2 can be estimated by fixed effects model; cluster 3 can be estimated by random effects model (Clark and Linzer, 2012).

(7) At this point, cluster 1 and 2 can be estimated by fixed effects model (Table 12). Since, the fixed effects model is an appropriate specification if we focus on a specific set of countries. On the other hand, cluster 3 can be estimated by random effects model (Table 12). Since, the random effects model is an appropriate specification if we draw N individuals randomly from a large population.

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