Testing the Empirical Validity of the Feldstein-Horioka Puzzle for Gambia Using the Gregory Hansen Cointegration Test and ADRL

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ABSTRACT

The paper tests the empirical validity between investment and saving for the Gambia by employing co-integration test with structural break and regimes shifts. The data was obtained from WDI. The ARDL model with dummies and interaction variables is used to determine the short run, long run and effect of structural breaks in the investment saving relationship to test the empirical validity for The Gambia. The results showed the existence of break points at 1983 and 2005 and no co-integration at the break points. The absolute values of ADF, Z, Z are all less than 5% critical values, therefore we failed to reject the null hypothesis of no co-integration at the break points. ADRL with break dummies shows that the long run coefficient for saving (saving retention coefficient) is negative and significant but openness is positive and not significant. The break dummy is negative and highly significant which shows that the break is important in modeling the relationship between investments and saving. The interaction term of investment is positive and highly significant at 5%, but the interaction term for saving is positive and not significant. In the Short run, the coefficient of saving to output is positive (β = .5493598) and significant at 1% and trade is also positive and significant at 5%. ADRL without break dummies shows that the long run coefficient for saving and openness are positive and not significant and in the short run they are positive and significant.

Keywords: Gregory-Hansen; saving; investment; The Gambia; Feldstein and Horioka.

1. INTRODUCTION

Savings and Investment are important determinants of economic growth and development. It is assumed that when increase in saving corresponds to increase in investment in productive areas growth will occur as a result. In most cases this does not happen because investment is put into unproductive areas.

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Interests in the saving and investment relationship started with the famous Feldstein and Horioka [1] paper. They showed using cross-sectional data of 16 OECD countries for the period 1960-1974, that investment and saving ratios are highly correlated (Feldstein-Horioka puzzle).

In a closed economy (low degree of capital mobility), all domestic saving finances domestic investment \((S=I)\), i.e. domestic savings and investment should be perfectly correlated. In an open economy (high degree of capital mobility), domestic saving finances investments with higher rates of return.

Understanding the saving-investment link is important for at least two reasons as suggested by Schmidt-Hebbel et al. [2]. First, it may hold the key to the positive correlation between saving and growth. Second, if capital accumulation is in fact the centerpiece of growth engine, the interaction between saving and investment is crucial for assessing the validity of traditional thinking that raising savings is in essence increasing growth. It is however important to note that in order to realize growth as a result of increase in savings depends on the ability of an economy to channel adequate savings into productive investment via financial intermediation (Hitiris and Wiseman, 1982).

The objective of this paper is to investigate the empirical validity of the Feldstein-Horioka puzzle for The Gambia using the Gregory and Hansen (1996) cointegration test with structural break and regimes shift and the Error Correction and Autoregressive Distributed Lag Model (ECM ARDL) model. Once the existence of the cointegration between domestic savings and investment is ensured by allowing for structural breaks, an autoregressive Distributed Lag model (ARDL) estimation procedure is implemented to obtain reliable inferences from the cointegrating relationships. The rest of the study is organized as follows. Section 2 reviews the theoretical and empirical literature on the FH puzzle, while section 3 describes the data and econometric methodology employed. The empirical results are discussed in section 4 and finally section 5 concludes the study.

2. LITERATURE REVIEW

2.1 Theoretical Literature

The relationship between investment and saving is extensively discussed in the literature. In the case of perfect capital mobility, increasing the rate of savings in country \(i\) will cause an increase in investment in all countries, where the distribution of increased capital among countries will vary positively with the initial mass of each country's capital. In the extreme case where country \(i\) is very small compared to the global economy, the value of \(\beta\) will be zero (domestic investment is financed with foreign capital, i.e. perfect capital mobility). But even for relatively large countries the value of \(\beta\) will be solely determined by the size of their share in the world economy, although on average it will be lower than 0.10. Conversely, estimates of \(\beta\) close to 1 indicate that most of the increased savings in one country remain there (financial autarky, i.e., capital mobility is zero).

2.2 Empirical Literature

The empirical literature on the relationship between investment and saving is mixed. FH conducted a cross-sectional analysis for 16 OECD countries over the period 1960-1974 using regressions of the ratio of investment to GDP on the ratio of saving to GDP and found that the coefficient of the saving ratio, known as the saving retention coefficient (\(\beta\)), was almost unity. Penati and Dooley (1984), Vos (1988) and Dooley et al. [3] also used cross-sectional data and found that savings and investment were integrated and hence capital is mobile.

Other studies use time series or panel data estimation. Sinn (1992) made an empirical test for 23 OECD countries for the period 1960-1988 using time-series technique, found saving retention coefficient (\(\beta\) values) that vary from year to year between 0.4 and 0.9. Studies, adopting time series methods, mainly focus on the role of policy regime changes. Sarno and Taylor (1998), De Vita and Abbott [4] and Mastroyiannis [5], among others, argue that policy regime changes might introduce structural breaks into the relationship between savings and investment.

Apergis and Tsoumas [6] surveyed the empirical literature on the FH puzzle and concluded that the majority of the empirical studies do not support the original strong results of FH but found that this correlation still exists in a weaker form in that \(\beta\) seems to have decreased and significantly less than unity. This is supported by studies that do not accept that the high correlation between domestic savings and investment indicates low capital mobility.
Researchers also use panel data to analyze the FH puzzle. Many of these studies, however, provide a high saving-investment correlation for developed countries which suggests low capital mobility according to the FH approach, e.g. Corbin (2001), Chakrabarti [9], Adedeji and Thornton (2008), and Pelgrin and Schich [10]. On the other hand, Murthy (2009), in a panel of 14 Latin American and 5 Caribbean countries, show that the FH argument is not valid, which is consistent with the recent developments (e.g. increased financial integration, deregulation of banking sector, and weakening of the capital controls) that the sampling countries have witnessed.

Sinha and Sinha [11] examine the short and long run relationships between S-I for 123 countries using an error correction framework and show that there is evidence for capital mobility for only 16 countries, and most of these are developing countries. Pelgrin and Schich [10] apply panel error correction techniques to data for 20 OECD countries from 1960 to 1999 and find a long run S-I relationship with an increase in the persistency of the deviations from this long run relation, which suggests that capital mobility has increased.

2.3 Gaps in the Literature

The saving-investment dynamics may vary country to country due to differences in the structure of an economy, government policies, and country-specific financial shocks. As underlined by Caporale et al. [12], Narayan (2005a), and Mastroyiannis [5], ignoring these differences and expecting the saving-investment relationship to be same for the countries in the sample might lead to unreliable inferences on the main question of how much of an increase in savings is truly reflected into domestic investment.

There is no study in The Gambia investigating the FH puzzle. This study will contribute in the Investment Saving debate by showing short run and long run relationships using Gregory-Hansen Cointegration test and ECM-ARDL model.

3. METHODOLOGY

The main trust of the study is to investigate the saving-investment relationship in the presence of structural breaks. In this sense, we employ the one break Gregory-Hansen (1996) cointegration test to obtain a reliable inference on how the correlation between savings and investment changes with the observed break dates. The cointegrating relationship is estimated using ADRL and the Gregory and Hansen (1996) residual test for cointegration with regime shifts. The study employs the long-run generic model by Feldstein and Horioka [1] with this form:

\[ I_t = \beta_0 + \beta_1 S_t + \epsilon_t \] (1)

Where, \( I_t \) is the ratio of gross capital formation to GDP at time t, \( S_t \) is the ratio of gross savings to GDP at time t. \( \beta_1 \) is the constant, while \( \beta_1 \) is the regression coefficient for savings and investment (saving retention coefficient or Feldstein Horioka coefficient) and it ranges between 0 and 1.

The higher estimate for \( \beta_1 \) would suggest that most savings remain in the economy and are mobilised into investment while the lower estimate for \( \beta_1 \) would suggest that either capital mobility, the economy is poor in mobilising its national saving or both scenarios are true. The residuals \( \epsilon_t \) are assumed to be white noise and spherically distributed.

The estimated model is specified as follows:

\[ (I/Y)_t = \alpha + \beta (S/Y)_t + \gamma (O/Y)_t + \epsilon_t \] (2)

Where \( (I/Y)_t \) is investment as a share of GDP at time t, \( (S/Y)_t \) is saving as a share of GDP at time t, and \( (O/Y)_t \) is a measure of openness of the country represented as a share of trade (exports and imports) in GDP at time t.

The I-S function can be written as a conditional ARDL which will include the optimal lag-length of the data generating process (Narayan, 2005). To examine this long-term relationship the following ARDL model is estimated:

\[ \Delta (I/Y)_t = \beta_0 + \beta_1 (I/Y)_{t-1} + \beta_2 (S/Y)_{t-1} + \beta_3 (O/Y)_t + \sum_{i=1}^{p} y_i \Delta (I/Y)_{t-i} + \sum_{i=0}^{q} \phi_i \Delta (S/Y)_{t-i} + \mu_t \] (3)

3.1 Gregory- Hansen Co-integration Testing

In the model if the variables are integrated of different orders, bound test is used. With break in
any of the series, bound test will yield inconsistent results. Due to the presence of a break point, the bounds co-integration test gives inconsistent results, hence we used the Gregory- Hansen (G-H) co-integration testing for a break point at unknown date. The G-H co-integration test involves testing the null hypothesis of no co-integration at break point against an alternative of co-integration at a break point in an unknown date using the ADF, $Z_t$, and $Z_0$ statistics.

We reject the null hypothesis if the absolute value of the Z-statistic is higher than 5% critical value otherwise do not reject the null hypothesis. If the null hypothesis is rejected, it implies that the linear combination of the variables exhibits stable properties in the long run, but with structural break.

4. EMPIRICAL RESULTS

The data for this paper is obtained from the World Bank’s World Development Indicators (WDI) for the period 1969 to 2016. The Gregory and Hansen test for co-integration and ECM-ARDL are used in analyzing the short-run and long-run relationship between investment and saving.

4.1 Gregory-Hansen Test for Co-integration

We applied three models by Gregory and Hansen test for cointegration with level shift, trend and regime shift. The maximum lag was two. We also used the bound testing for cointegration and it yields inconsistent results hence we used the Gregory and Hansen (1996) test designed for cointegration test when controlling for structural breaks in our model. When we applied time series graph for the investment ratios ($I/Y$), we could noticed that break point is 15 and the date of the break is 1983. This is true because in the Gambia in 1983 there was a series of coup and investment will be lower and that in turn will have negative impact on the growth of the Gambia. In the first model, the break is the level or constant and the lag method is Bayesian criteria and with asymptotic critical values being 1%, 5% and 10% respectively. The result indicated that the absolute value of ADF, $Z_t$, $Z_0$ are all less than 5% critical values, therefore we failed to reject the null hypothesis that the break point was 1983. This result may be true because the break point fluctuate overtime. When the other explanatory variables are dropped in the model, the break date changes to 2005. Test statistic ADF and $Z_t$ are less than 5% critical value and hence we fail to reject the null. The Gambia experienced huge foreign and domestic debt as a percentage of GDP in 2005. Foreign debt was 138 percent of GDP in 2005.

4.2 ARDL Results

A dummy variable is generated for the break point, which is 1983. This break dummy is interacted with the $(I/Y)$ and $(S/Y)$ . The ARDL model is estimated with break dummies (see Table 2).

The results generated show that the coefficient of the adjustment term is negative but highly significant at 1%. The long run coefficient for saving (saving retention coefficient) is negative and significant but openness is positive and not significant. The break dummy is negative and highly significant. This shows that the break is important in modeling the relationship between investment and saving in The Gambia. The interaction term of investment and the break dummy is positive and highly significant at 5%, but the interaction term for saving and the break dummy is positive and not significant.

In the short run, the coefficient of saving to output is positive ($\beta = 0.5493598$) and significant at 1% and trade is also positive and significant at 5%. The Adjusted R-square is 78.05% indicated that the model is good.

ECM-ARDL model is also estimated without Break Dummies. The results are shown in Table 3.

The results generated showed that the coefficient for adjustment term is negative and highly significant at 1%. The long run coefficient for saving (saving retention coefficient) and openness are positive and not significant. This shows the importance of having structural breaks in the model. In the short run, the saving to output coefficient is positive ($\beta = 0.6025012$) and significant at 1% and trade is also positive and significant at 1%. The Adjusted R-square is 66.59% indicated that the model is good.

Table 1. Gregory-Hansen test for co-integration with level, trend and regimes shifts

<table>
<thead>
<tr>
<th>Level Shift</th>
<th>ADF</th>
<th>Z_t</th>
<th>Z_α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural break date</td>
<td>1983</td>
<td>1983</td>
<td>1983</td>
</tr>
<tr>
<td>Test Statistic</td>
<td>-4.27</td>
<td>-4.31</td>
<td>-27.50</td>
</tr>
</tbody>
</table>

Critical Values

1% | -5.77 | -5.77 | -63.64 |
5% | -5.28 | -5.28 | -53.58 |
10% | -5.02 | -5.02 | -48.65 |

Trend ADF | Z_t | Z_α |
| Structural break date | 1982 | 1982 | 1982 |
| Test Statistic | -5.28 | -5.34 | -36.18 |

Critical Values

1% | -6.05 | -6.05 | -70.27 |
5% | -5.57 | -5.57 | -59.76 |
10% | -5.33 | -5.33 | -54.94 |

Regime Shifts ADF | Z_t | Z_α |
| Structural break date | 1983 | 1983 | 1983 |
| Test Statistic | -4.96 | -5.02 | -33.58 |

Critical Values

1% | -6.51 | -6.51 | -80.15 |
5% | -6.00 | -6.00 | -68.94 |
10% | -5.75 | -5.75 | -63.42 |

Table 2. The estimated saving retention coefficient with break dummies

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Run Adjustment</td>
<td>-.3327076</td>
<td>-3.77</td>
</tr>
<tr>
<td>S/Y</td>
<td>-2.213166</td>
<td>-2.00</td>
</tr>
<tr>
<td>Openness</td>
<td>.0004342</td>
<td>0.48</td>
</tr>
<tr>
<td>D_1983</td>
<td>-.2318987</td>
<td>-3.03</td>
</tr>
<tr>
<td>D_1983 *(I/Y)</td>
<td>1.270662</td>
<td>3.32</td>
</tr>
<tr>
<td>D_1983 *(S/Y)</td>
<td>1.769754</td>
<td>1.52</td>
</tr>
<tr>
<td>Short Run S/Y</td>
<td>.5493598</td>
<td>4.19</td>
</tr>
<tr>
<td>Openness</td>
<td>.0010989</td>
<td>2.62</td>
</tr>
<tr>
<td>Constant</td>
<td>.0607577</td>
<td>2.36</td>
</tr>
</tbody>
</table>

Number of observations = 47
R-squared = 0.8186
Adj R-squared = 0.7805
Log likelihood = 104.12727
Root MSE = 0.0294

Table 3. The estimated saving retention coefficient without break dummies

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Run Adjustment</td>
<td>-.2188929</td>
<td>-2.32</td>
</tr>
<tr>
<td>S/Y</td>
<td>.0534191</td>
<td>0.06</td>
</tr>
<tr>
<td>Openness</td>
<td>.0011047</td>
<td>0.81</td>
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<tr>
<td>Short Run S/Y</td>
<td>.6025012</td>
<td>3.94</td>
</tr>
<tr>
<td>Openness</td>
<td>.001601</td>
<td>3.29</td>
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<tr>
<td>Constant</td>
<td>.0143425</td>
<td>0.69</td>
</tr>
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5. CONCLUSION

The paper provided an explanation of the saving and investment puzzle in The Gambia in the presence of structural break. Gregory and Hansen test for cointegration and the ECM-ADRL model are used in modeling the short-run and long-run relationship between investment and saving.

The time series graph for the investment ratios (I/Y) revealed a break date in 1983 which is verified by the Gregory-Hansen Test for Cointegration with level, trend and regimes shifts. The break date changes to 2005 when the other explanatory variables are dropped in the model.

The ARDL model is estimated with break dummies showed the long run coefficient for saving (saving retention coefficient) is negative and significant, the break dummy is negative and highly significant. The interaction term of investment and the break dummy is positive and highly significant. In the short run, coefficient of saving to output ratio and the coefficient of openness are positive and significant.

The estimation without Break Dummies showed the long run coefficient for saving (saving retention coefficient) and openness are positive and not significant. This shows the importance of having structural breaks in the model. In the short run, the coefficient of saving to output coefficient and openness are positive and significant.

The high saving-investment correlation in the short run of $\beta = .5493598$ and $\beta = .6025012$ respectively suggests that the Gambian economy is in conformity with the FH hypothesis in the short run but not in the long run.

In conclusion, given the importance of the investment-savings relationship, the results from the paper should stimulate interest for researchers interested in the FH puzzle in The Gambia to factor inter alia the budget deficit and current account deficit.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

### REFERENCES


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