Saving, investment and capital mobility in African countries

John Thornton
Olumuyiwa S Adedeji

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Saving, Investment and Capital Mobility in African Countries

Olumuyiwa S. Adedeji and John Thornton*
Fiscal Affairs Department, International Monetary Fund, Washington DC, USA

Recently developed panel co-integration techniques are applied to data for six African countries to test the Feldstein–Horioka approach to measuring capital mobility. The results suggest three conclusions: savings and investment in panel data are non-stationary series and they are co-integrated; capital was relatively mobile in the African countries during 1970–2000, with estimated savings–retention ratios of 0.73 (FMOLS), 0.45 (DOLS), 0.51 (DOLS with heterogeneity) and 0.39 (DOLS with cross-sectional dependence effects); and there was a marked drop in the savings–retention ratio from 1970–85 to 1986–2000. The results could be interpreted as indicating that capital mobility in African countries has increased, reflecting the implementation of market-orientated reforms, including the privatisation and rationalisation of the public sector, and the partial liberalisation of their exchange rate regimes and financial systems.

JEL classification: F31, F32, F36

1. Introduction
The reasons invoked for the relatively poor economic performance of most African countries usually include their limited financial market linkages with the global economy, which magnifies the negative impact of macroeconomic volatility on economic growth.
and reduces the gains from the diffusion of knowledge (e.g., Sachs and Warner 1997; Collier and Gunning 1999a, b). In this paper, we examine the issue of capital mobility in African economies by looking at the correlation of investment and savings ratios as suggested by Feldstein and Horioka (1980). They estimated the following cross-section regression to check the relation between savings and investment:

\[
\left( \frac{I}{Y} \right)_i = \alpha + \beta \left( \frac{S}{Y} \right)_i + \mu_i, \tag{1}
\]

where \(I\) is the national investment, (public and private) by country \(i\), \(S\) the national saving, \(Y\) the national income and \(\mu\) the error term. Feldstein and Horioka argue that \(\beta\) serves as an indicator of the degree of international capital mobility in that saving and investment would be perfectly correlated in a closed economy but should be unrelated in an open economy since saving could seek out the highest global returns. Thus, if \(\beta\) is large and near to one in this model, capital is immobile; in contrast, if \(\beta\) is near to zero, then capital is highly mobile. Feldstein and Horioka (1980) concluded that the high correlation they found among saving and investment rates in Organisation for Economic Co-operation and Development (OECD) countries was evidence of low capital mobility, contradicting the theory embedded in many open economy macromodels and much other empirical evidence that capital was mobile across industrial countries. Their results sparked a huge literature on trying to reconcile them with the overwhelming evidence of high capital mobility (at least in industrial countries). One strand of this literature focuses on current account explanations and suggests that public or private decision-makers respond to balance of payments equilibria in such a way as to restore equilibrium, which induces an association between saving and investment even under high capital mobility. An influential study in this regard is that of Coakley et al. (1996), who relate savings and investment behaviour to the current account via a market-determined risk.

Alternative approaches to assessing the degree of capital mobility, such as covered or uncovered interest parity, are discussed in Obstfeld (1993).

A comprehensive recent survey of the Feldstein-Horioka literature is Coakley et al. (1998), who point out that although the savings–investment association is generally accepted, there remains considerable debate about whether it is informative about capital mobility.

\[2\]

\[3\]
premium that responds to the balance of payments, thereby ensuring long-run solvency and making the current account share of Gross Domestic Product (GDP) a stationary process. Since saving and investment rates are integrated processes, a stationary current account implies that they co-integrate with a unit coefficient. Coakley et al. (1996) argue that it is the long-run solvency constraint that is capturing in the Feldstein–Horioka equation.

The Coakley et al. (1996) study was important in shifting the analytical focus of the literature on the Feldstein–Horioka framework to testing the statistical properties of saving and investment rates and of current account balances. However, many of these studies focus on country-by-country analyses of the integration and co-integration properties of the savings and investment series and do not take advantage of information across countries and are of low power in small samples. This is particularly the case with studies examining the degree of capital mobility in African countries where long spans of data typically are unavailable (e.g., Ghosh and Ostry, 1995; Adedeji, 2001a, b). In contrast, some of the recent empirical literature using the Feldstein–Horioka approach (e.g., Ho, 2002; Kim et al., 2005) has made use of the new developments in panel co-integration techniques that have higher power than the conventional time series tests. A major advantage of these techniques is that it allows one to pool the long-run information contained in the panel while permitting the short-run dynamics and heterogeneity among different panel members. We apply these techniques to a panel of six African countries for which suitable savings and investment data are available. Specifically, we test for the co-integration of saving and investment ratios for the period 1970–2000 and examine whether the co-integration coefficients (savings–retention ratios) have changed over time. Our results show that for the pool of these countries both savings and investment are non-stationary

4 The studies by Adedeji (2001a, b) and Ghosh and Ostry (1995) are based on the intertemporal approach to the current account, treating it as a buffer for smoothing consumption in the face of shocks affecting output, investment and government expenditures. Previous attempts at current account analysis in African countries, such as Jebuni et al. (1994) and Komolafe (1996), have tended to focus on the major determinants of current account balance and are founded in the more traditional approaches to the current account: the elasticity, monetary and absorption approaches.

5 The countries in the study are Cameroon, Gabon, Ghana, Nigeria, South Africa, and Zimbabwe.
co-integrated series, that the saving-retention ratio is relatively low and that it is substantially lower in the second half of the sample period than in the first. The results could be interpreted as indicating that capital has been relatively mobile and that its mobility has increased over time in the African countries.

2. Data, Methodology and Results

We use annual data for total domestic savings and investment in relation to GDP from the Penn World Table (version 6.1). The data are summarised in Table 1, which shows marked differences between savings and investment ratios within and across countries. The first step is to analyse the time series properties of the series in order to determine the persistence of the pooled savings and investment rates.

Several panel unit root tests currently exist. The power of these tests is substantially greater than the tests for time series in that the failure to reject a unit root test occurs much less frequently. We use the panel unit root test proposed by Levin et al. (2002) (LLC), which allows for heterogeneity of the intercepts across members of the panel, and by Im et al. (2003) (IPS), which allows for heterogeneity in intercepts as well as in the slope coefficients; both of these tests are constructed by averaging individual augmented Dickey–Fuller (ADF) (Dickey and Fuller, 1979) t-statistics across cross-section units.

The LLC test is of the null hypothesis that each individual time series in the panel is integrated against the alternative hypothesis that all individual time series are stationary. The test is based on the following pooled ADF equation:

\[
\Delta y_{it} = X_{it}'\alpha + \delta y_{it-1} + \sum_{L=1}^{p_i} \beta_{ij}\Delta y_{it-L} + \varepsilon_{it},
\]

where a common \( \delta = \rho - 1 \) is assumed, \( X_{it} \) represents the exogenous variables in the models, including any fixed effects or individual trends, and \( p_i \) is the required country-specific degree of lag augmentation to make the residuals white noise that is determined by the conventional step-down procedure. The null hypothesis \( H_0 \) is \( \delta = 0 \) under the assumption that \( \delta_i = \delta \) for all \( i \) is tested against the alternative hypothesis, \( H_1 \) that \( \delta < \delta_i \) for all \( i \). The test is based on a
technique that removes autocorrelation as well as deterministic components.

The panel specification for the IPS test takes the form:

\[
\Delta y_{it} = X'_{it} \alpha + \delta y_{it-1} + \sum_{L=1}^{p} \beta_{ij} \Delta y_{it-L} + \varepsilon_{it}. \tag{3}
\]

All variables are as defined in equation (2); however, in this case \( X_{it} \) also includes the time dummies used to account for cross-sectional correlation that could result from common shocks affecting all countries in the panel in the period. The null hypothesis is \( H_0 \) is \( \delta_i = 0 \) for all \( i \) (i.e., all series have a unit root) and is tested against

<table>
<thead>
<tr>
<th></th>
<th>Investment</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970–2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cameroon</td>
<td>8.4</td>
<td>8.5</td>
</tr>
<tr>
<td>Gabon</td>
<td>13.0</td>
<td>23.8</td>
</tr>
<tr>
<td>Ghana</td>
<td>6.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Nigeria</td>
<td>9.3</td>
<td>11.3</td>
</tr>
<tr>
<td>South Africa</td>
<td>12.9</td>
<td>16.0</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>20.0</td>
<td>18.9</td>
</tr>
</tbody>
</table>

|                |            |        |
| 1970–85        |            |        |
| Cameroon       | 10.1       | 8.1    |
| Gabon          | 16.7       | 29.1   |
| Ghana          | 7.6        | 7.2    |
| Nigeria        | 9.3        | 9.3    |
| South Africa   | 17.5       | 19.8   |
| Zimbabwe       | 26.1       | 25.1   |

|                |            |        |
| 1986–2000      |            |        |
| Cameroon       | 6.6        | 8.6    |
| Gabon          | 9.1        | 18.1   |
| Ghana          | 7.6        | 7.2    |
| Nigeria        | 6.1        | -5.1   |
| South Africa   | 8.0        | 11.9   |
| Zimbabwe       | 13.5       | 12.3   |

Source: Penn World Tables (Version 6.1).
the alternative $H_1$ that $\delta_i < 0$ for $i = 1, 2, \ldots, N_1$ and $\delta_i = 0$, for $i = N_1 + 1, N_1 + 2 \ldots N$. On the assumption that the $N$ cross-section units are independently distributed, the t-statistic can be computed as an average of the individual ADF t-statistics such that:

$$\frac{\sum_{i=1}^{N} t_{iTi}(p_i)}{N},$$

where $t_{iTi}(p_i)$ is the t-statistic for testing $\delta_i = 0$ in each individual ADF regression. In a further step, the above t-bar statistic is standardised so that it converges to a standard normal distribution as $N$ increases. A key strength of the IPS test is that $\delta_i$ is allowed to differ across countries and only a fraction of panel members is required to be stationary under the alternative hypothesis.

The results of the LLC and IPC test are reported in Table 2. It shows that the null of the unit roots for the panel data for the savings and investment series cannot be rejected. Therefore, we can implement a test for panel co-integration between savings and investment.

The next step is to test whether savings and investment are co-integrated. The available techniques for panel co-integration tests are in essence an application of the Engle and Granger (1987) co-integration analysis. As in the analysis of single time series, these approaches test the residuals from the estimation for stationarity. Kao (1999) and Pedroni (1995) provide different statistics for this purpose, both of which assume homogenous slope coefficients across countries.

**Table 2: Panel Unit Root Test for Saving and Investment Ratios, 1970–2000**

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>$P$-values</td>
</tr>
<tr>
<td>Savings ratio</td>
<td>0.161</td>
<td>0.564</td>
</tr>
<tr>
<td>Investment ratio</td>
<td>−0.639</td>
<td>0.2615</td>
</tr>
</tbody>
</table>

*Note: The null hypothesis in both tests is that all individual series are non-stationary.*
Kao (1999) tests the residuals \( \hat{e}_{it} \) of the OLS panel estimation by applying DF- and ADF-type tests:

\[
\hat{e}_{it} = \hat{e}_{it} \rho_{it-1} + u_{it} \tag{5}
\]

and

\[
\hat{e}_{it} = \hat{e}_{it} \rho_{it-1} + \sum_{j=1}^{P} \phi_j \Delta \hat{e}_{it-j} + u_{it}. \tag{6}
\]

The null hypothesis of no co-integration, \( H_0 \) is \( \rho = 1 \), is tested against the alternative hypothesis of stationary residuals, \( H_1: \rho < 1 \). The OLS estimate of \( \rho \) can be written as:

\[
\hat{\rho} = \frac{\sum_{i=1}^{N} \sum_{t=2}^{T} \hat{e}_{it} \hat{e}_{it-1}}{\sum_{i=1}^{N} \sum_{t=2}^{T} \hat{e}_{it}^2}. \tag{7}
\]

Kao presents five DF and ADF types of co-integration tests in the panel data, the asymptotic distributions of which converge to a standard normal distribution \( N(0, 1) \). The test statistics are DF-roh*, DF-t* and ADF, which are for co-integration with the endogenous regressors, and DF-roh and DF-t which are based on assuming strict endogeneity of the regressors.

Pedroni (1995) suggests a Phillips–Perron-type panel co-integration test, which implies less strict assumptions with respect to the distribution of the error terms than do the DF and ADF tests described above. He provides two test statistics, PC_1 and PC_2, which converge to a standard normal distribution. First, under the null hypothesis of no co-integration, the panel autoregressive coefficient estimator \( \hat{\rho}_{N,T} \) can be constructed as follows:

\[
\hat{\rho}_{N,T-1} = \frac{\sum_{i=1}^{N} \sum_{t=2}^{T} (\hat{e}_{it-1} \Delta \hat{e}_{it} - \hat{\lambda}_i)}{\left( \sum_{i=1}^{N} \sum_{t=2}^{T} \hat{e}_{it-1}^2 \right)} \tag{8}
\]

where \( \hat{\lambda}_i \) acts as a scalar equivalent to the correlation matrix, \( \Gamma \), and corrects for any correlation effect. Pedroni provides the limiting distribution of two test statistics:

\[
PC_1 = \frac{T \sqrt{N} (\hat{\rho}_{N,T-1})}{\sqrt{2}} \Rightarrow N(0, 1) \tag{9}
\]
and

\[
PC_2 = \frac{\sqrt{NT(T-1)}}{\sqrt{2}}(\hat{\rho}_{N,T-1}) \Rightarrow N(0, 1)
\]

Table 3 shows the outcomes of the co-integration tests between savings and investment rates. The results indicate that the null hypothesis of no co-integration between saving and investment ratios can be rejected at conventional significance levels in all cases.

Finally, we use the fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) methodologies developed by Kao and Chiang (2001) to estimate the long-run co-integrating vector between saving and investment. These estimators are designed for non-stationary panels and correct the standard pooled OLS for serial correlation and endogeneity of regressors that are normally present in long-run economic relationships. To illustrate these techniques briefly, suppose we have the co-integrated regression for a panel of \( i = 1, \ldots, n \),

\[
\begin{array}{cccc}
\text{Kao (1999)}^a & \text{Pedroni (1995)}^b \\
\hline
\text{DF-rho} & \text{DF-t} & \text{DF-rho}^* & \text{DF-t}^* & \text{ADF} & \text{PC}_1 & \text{PC}_2 \\
(0.0000) & (0.0006) & (0.0000) & (0.0005) & (0.0003) & (0.0000) & (0.0000) \\
\end{array}
\]

\textit{Note:} P-values are in paranthesis.

\( ^a \)The DF test statistics are analogous to the parametric Dickey–Fuller test for non-stationary time series. The DF-rho and DF-t statistic assume strict exogeneity of the regressors with respect to errors and no autocorrelation. DF-rho* and DF-t* statistics are based on endogenous regressors. These tests depend on consistent estimates of the long-run variance–covariance matrix to correct for nuisance parameters once the limiting distribution has been found. The ADF test is analogous to the ADF test for non-stationary time series.

\( ^b \)PC1 and PC2 are the non-parametric Phillips–Perron tests.
2, \ldots, N \text{ countries from time } t = 1, 2, \ldots, T, \text{ then:}
\begin{equation}
y_{it} = \alpha_i + x'_{it} \beta + \mu_{it},
\end{equation}

where $y_{it}$ are $1 \times 1$, $\beta$ is an $M \times 1$ vector of the slope parameters, $\alpha_i$ are the intercepts, and $\mu_{it}$ are the stationary disturbances. It is assumed that $x_{it}$ are $M \times 1$ integrated processes of order 1 for all $i$, where $x_{it} = x_{it-1} + \varepsilon_{it}$. Under these specifications, $y_{it}$ is co-integrated with $x_{it}$ in equation (11).

Kao and Chiang (1998) derive limiting distributions for the FMOLS and DOLS estimators in co-integrated regressions and demonstrate that they are asymptotically normal. The FMOLS estimator is constructed by making corrections for endogeneity and serial correlation to the OLS estimator and is written as:
\begin{equation}
\hat{\beta}_{FM} = \left[ \sum_{i=1}^{N} \sum_{t=1}^{T} (x_{it} - \bar{x}_i) \right]^{-1} \left[ \sum_{i=1}^{N} \sum_{t=1}^{T} (x_{it} - \bar{x}_i) y_{it}^+ - T \hat{\Delta}_{\varepsilon\mu}^+ \right],
\end{equation}

where $\hat{\Delta}_{\varepsilon\mu}$ is the serial correlation correction term and $y_{it}^+$ is the endogeneity correction.

The panel DOLS estimator corrects for endogeneity and serial correlation by including leads and lags of the differenced $I(1)$ regressors in the regression and is written as:
\begin{equation}
y_{it} = \alpha_i + x'_{it} \beta + \sum_{j=-q_1}^{q_2} c_{ij} \Delta x_{it+j} + \nu_{it},
\end{equation}

Kao and Chiang (1998) show that for panels of the size used in this study (six countries over 30 years) the DOLS estimator outperforms both OLS and FMOLS in parameter estimation and inference testing.

The estimates of the savings–retention ratio by period are reported in Table 4. For the entire period (1970–2000), the FMOLS estimate of the FH coefficient is 0.73, whereas the DOLS estimate is 0.45, with both coefficients statistically significant. The estimates for sub-periods indicate a marked decline in the savings–retention ratio over time: from 0.81 to 0.52 in the case of the FMOLS estimate and from 0.58 to 0.14 in the case of the DOLS estimate, with all coefficients statistically significant.

As a final step, we focus on the superior DOLS estimator and allow for heterogeneity, as captured by country-specific fixed
effects, and a limited degree of cross-sectional dependence through year effects. These results are reported in Table 5. In both cases, the savings–retention ratios are again relatively low (0.51 and 0.39, respectively), and they are sharply lower in the second sub-sample period than in the first.

The finding of a generally low retention ratio, and of a marked difference in the size of the retention ratio according to the estimation method, is in line with the results from recent studies of developing economies that have used similar techniques. For example, Ho (2002) reports a savings–retention coefficients of 0.84 (FMOLS) and 0.47 (DOLS) for a data panel of 20 OECD countries.

Table 4: Panel Co-integration Vector

<table>
<thead>
<tr>
<th></th>
<th>FMOLS</th>
<th>DOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saving–retention ratio</td>
<td>t-ratio</td>
</tr>
<tr>
<td>1970–2000</td>
<td>0.7337</td>
<td>12.0904</td>
</tr>
<tr>
<td>1970–85</td>
<td>0.8067</td>
<td>8.6136</td>
</tr>
<tr>
<td>1986–2000</td>
<td>0.5232</td>
<td>11.8038</td>
</tr>
</tbody>
</table>

Table 5: Panel Co-integration Vector

<table>
<thead>
<tr>
<th></th>
<th>Savings-retention ratio</th>
<th>t-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heterogeneity (country-fixed effects)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970–2000</td>
<td>0.5149</td>
<td>7.6363</td>
</tr>
<tr>
<td>1970–85</td>
<td>0.5817</td>
<td>4.9687</td>
</tr>
<tr>
<td>1986–2000</td>
<td>0.2787</td>
<td>5.0298</td>
</tr>
<tr>
<td>Cross-sectional dependence (year effects)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970–2000</td>
<td>0.3946</td>
<td>6.4597</td>
</tr>
<tr>
<td>1970–85</td>
<td>0.5593</td>
<td>5.3651</td>
</tr>
<tr>
<td>1970–2000</td>
<td>0.1400</td>
<td>2.4935</td>
</tr>
</tbody>
</table>

Note: DOLS with Heterogeneity and Cross-Sectional Dependence.
countries, and Kim et al. (2005) report 0.58 (FMOLS) and 0.76 (DOLS) from a data panel of 11 Asian countries during 1960–79, falling to 0.39 (FMOLS) and 0.42 (DOLS) in 1980–98. Lower retention ratios for developing than developed economies are also found in the early empirical literature on the issue, with Dooley et al. (1987) and Mamingi (1994) arguing that this mainly reflected country size factors, in that these are small open economies that cannot influence the world interest rate (hence their savings–investment correlation is not biased upwards) and in which fiscal policy used for demand management purposes does not crowd out private sector investment.\(^6\)

In the context of the Feldstein–Horioka framework, we interpret our results as indicating that capital has been relatively mobile in the African countries and that its mobility has increased over time. This would be consistent with the structural reform process in many of these countries over the sample period: during the first half of the period, most of the African countries considered pursued a policy of strict trade controls in conjunction with marked restrictions on capital flows, but in the second half of the period, they initiated outward-orientated economic reforms culminating in the privatisation and the rationalisation of their public sectors and the partial liberalisation of their exchange rate regimes and financial systems.

3. Conclusions

This paper examined international capital mobility in six African countries using the Feldstein–Horioka approach and applying recently developed panel co-integration techniques. The results suggest three conclusions. First, savings and investment in panel data for these countries are non-stationary series and they are co-integrated. Second, capital was relatively mobile in the African countries in the sample during 1970–2000, with estimated savings–retention ratios of 0.73 (FMOLS), 0.45 (DOLS), 0.51 (DOLS with heterogeneity) and 0.39 (DOLS with cross-sectional dependence effects), which are not out of line with findings from panel studies for non-African countries. Finally, there was a marked drop in the savings–retention ratios between 1970–85

\(^6\) In their survey of the empirical literature, Coakley et al. (1998) summarise the cross-section coefficients for developing countries as being around 0.62.
and 1986–2000, which could be interpreted as indicating increased capital mobility, reflecting the impact of outward-orientated economic reforms over the period.

References


