The Impact of Remittances and Foreign Aid on Savings/Investment in Sub-Saharan Africa

Liu Lishan[*]

In this stage, I will list the detailed information of the analysis results of each model by following the authors' empirical process.

Definition of variables

gdppc: GDP per capita, 2000 $ constant

remit: Migrant remittances, % GDP

inv: Investment/Gross fixed capital formation (% of GDP)

gs: Gross savings, % GDP

depint: Deposit interest rate

lendint: Lending interest rate

open: Openness as a ratio of imports and exports on GDP, %

inflat: Inflation rate measured by the change in Consumer Price Index

aid: Foreign aid (Official Development Assistance), % of GDP

Savings model

$$gs_{it} = \beta_0 + \beta_1 gdppc_{it} + \beta_2 remit_{it} + \beta_3 aid_{it} + \beta_4 depint_{it} + \beta_5 inflat_{it} + \alpha_i + \epsilon_{it}$$

```
# F-test
sm<-read.csv("E:/dataproject/replication-project/data/sm.csv",
             fileEncoding="UTF-8-BOM",check.names=FALSE,
             header=TRUE,as.is=TRUE,sep=",",na.strings = "")
sm<-pdata.frame(sm,index=c("country","year"))
```

```
## at least one couple (id-time) has NA in at least one index dimensionin resulting p
##  to find out which, use e.g.table(index(your_pdataframe), useNA = "ifany")
```

```
head(sm)
```

```
##               country year        gs    gdppc    remit      aid depint inflat
## Benin-1980   Benin 1980  4.172431 305.3488 5.479605 6.278590 6.1875  9.596
## Benin-1981   Benin 1981 -3.251559 326.8632 4.802502 6.292210 6.2500  0.795
## Benin-1982   Benin 1982 13.221546 325.1686 2.914546 6.286586 7.7500  4.059
## Benin-1983   Benin 1983  8.192516 302.5671 4.002875 7.753699 7.5000 -6.067
```

[*]Graduate School of Economics

```
## Benin-1984   Benin 1984  7.516613 317.6625 4.001959 7.138005 7.2500 10.265
## Benin-1985   Benin 1985  2.634223 332.3023 3.852703 8.980477 7.2500  1.151
```

```
smfe<-plm(gs~gdppc+remit+aid+depint+inflat,data=sm,model = "within")
smpool<-plm(gs~gdppc+remit+aid+depint+inflat,data=sm,model="pooling")
pFtest(smfe,smpool)
```

```
##
##  F test for individual effects
##
## data:  gs ~ gdppc + remit + aid + depint + inflat
## F = 24.534, df1 = 35, df2 = 596, p-value < 2.2e-16
## alternative hypothesis: significant effects
```

The F-test shows the null hypothesis of individual homogeneity is rejected at the 1 per cent level and that individual specificities are presented.

```
# Hausman test
smre<-plm(gs~gdppc+remit+aid+depint+inflat,data=sm,model="random",
          random.method="swar")
phtest(smfe,smre)
```

```
##
##  Hausman Test
##
## data:  gs ~ gdppc + remit + aid + depint + inflat
## chisq = 12.321, df = 5, p-value = 0.03065
## alternative hypothesis: one model is inconsistent
```

At this step, I check fixed effect or random effect by performing the Hausman test. The results show the fixed effects model is good at the 5 per cent level.

As the authors state, "The introduction of country-specific effects in the model will allow considering a possible presence of heterogeneity of data and unobservable country specificities and characteristics correlated with the regressors". So I estimate the relations with the OLS (country fixed effects) method as they do.

```
# OLS (country fixed effects)
smfe1<-plm(gs~gdppc+remit+aid+depint+inflat,data=sm,model="within",
           effect = "individual")
summary(smfe1)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = gs ~ gdppc + remit + aid + depint + inflat, data = sm,
##     effect = "individual", model = "within")
##
## Unbalanced Panel: n = 36, T = 5-25, N = 637
##
## Residuals:
##       Min.    1st Qu.     Median    3rd Qu.       Max.
```

```
## -51.534154  -3.534288  -0.054161   3.618080  38.535205
##
## Coefficients:
##          Estimate Std. Error t-value  Pr(>|t|)
## gdppc   0.0037202  0.0013739  2.7078 0.0069671 **
## remit   0.1960507  0.0691279  2.8361 0.0047225 **
## aid     0.1771930  0.0497174  3.5640 0.0003945 ***
## depint -0.0702551  0.0642865 -1.0928 0.2749037
## inflat  0.0465853  0.0227133  2.0510 0.0407027 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    36698
## Residual Sum of Squares: 34615
## R-Squared:      0.056779
## Adj. R-Squared: -0.0065243
## F-statistic: 7.17548 on 5 and 596 DF, p-value: 1.5565e-06
```

```
bptest(smfe1)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  smfe1
## BP = 21.884, df = 5, p-value = 0.0005508
```

```
# Using White’s method correction solves the problem of heteroscedasticity.
coeftest(smfe1,vcov=vcovHC(smfe1,method='white1',type='HC0'))
```

```
##
## t test of coefficients:
##
##          Estimate Std. Error t value  Pr(>|t|)
## gdppc   0.0037202  0.0012983  2.8654 0.0043120 **
## remit   0.1960507  0.1826034  1.0736 0.2834177
## aid     0.1771930  0.0466402  3.7991 0.0001601 ***
## depint -0.0702551  0.0537980 -1.3059 0.1920883
## inflat  0.0465853  0.0224140  2.0784 0.0380999 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
smse1<-coeftest(smfe1,vcov=vcovHC(smfe1,method='white1',type='HC0'))
```

As authors state, “the former literature underlines the possibility that some explanatory variables, such as GDP per capita, may be endogenous to both savings and investment. In this situation, our estimated coefficients with OLS method may be biased…we control for the potential problem of simultaneity bias by using ‘internal instruments’, where the potentially endogenous variables on the right-hand side are replaced with their own lagged values. In the econometric theory, a two-period lag is sufficient to get good instrument (exogenous). We then re-estimate our models and apply this solution with the instrumental variables method (2SLS)".

```
# 2SLS instrumental variables method
sm$lgdppc1 = plm::lag(sm$gdppc)
sm$lgdppc2 = plm::lag(sm$lgdppc1)
head(sm)
```

```
##              country year        gs    gdppc    remit      aid depint inflat
## Benin-1980   Benin 1980  4.172431 305.3488 5.479605 6.278590 6.1875  9.596
## Benin-1981   Benin 1981 -3.251559 326.8632 4.802502 6.292210 6.2500  0.795
## Benin-1982   Benin 1982 13.221546 325.1686 2.914546 6.286586 7.7500  4.059
## Benin-1983   Benin 1983  8.192516 302.5671 4.002875 7.753699 7.5000 -6.067
## Benin-1984   Benin 1984  7.516613 317.6625 4.001959 7.138005 7.2500 10.265
## Benin-1985   Benin 1985  2.634223 332.3023 3.852703 8.980477 7.2500  1.151
##               lgdppc1  lgdppc2
## Benin-1980       NA       NA
## Benin-1981 305.3488       NA
## Benin-1982 326.8632 305.3488
## Benin-1983 325.1686 326.8632
## Benin-1984 302.5671 325.1686
## Benin-1985 317.6625 302.5671
```

```
smfe2<-plm(gs~gdppc+remit+aid+depint+inflat|
             remit+aid+depint+inflat+lgdppc1+lgdppc2,
           data=sm,model="within",effect="individual")
summary(smfe2)
```

```
## Oneway (individual) effect Within Model
## Instrumental variable estimation
##
## Call:
## plm(formula = gs ~ gdppc + remit + aid + depint + inflat | remit +
##     aid + depint + inflat + lgdppc1 + lgdppc2, data = sm, effect = "individual",
##     model = "within")
##
## Unbalanced Panel: n = 36, T = 4-23, N = 599
##
## Residuals:
##       Min.    1st Qu.     Median    3rd Qu.       Max.
## -50.637289  -3.518696   0.020703   3.575353  39.393847
##
## Coefficients:
##          Estimate Std. Error z-value Pr(>|z|)
## gdppc   0.0015822  0.0015412  1.0266 0.304625
## remit   0.2181295  0.0683569  3.1910 0.001418 **
## aid     0.1590070  0.0498616  3.1890 0.001428 **
## depint -0.0697578  0.0646062 -1.0797 0.280258
## inflat  0.0558810  0.0235088  2.3770 0.017453 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Total Sum of Squares:    33151
## Residual Sum of Squares: 31168
## R-Squared:      0.059832
## Adj. R-Squared: -0.0075637
## Chisq: 34.3422 on 5 DF, p-value: 2.0352e-06
```

```
bptest(smfe2)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  smfe2
## BP = 22.271, df = 7, p-value = 0.002281
```

```
# Using White's method correction solves the problem of heteroscedasticity.
coeftest(smfe2,vcov.=vcovHC(smfe2,method='white1',type='HC0'))
```

```
##
## t test of coefficients:
##
##          Estimate Std. Error t value Pr(>|t|)
## gdppc   0.0015822  0.0013858  1.1417 0.254076
## remit   0.2181295  0.1856581  1.1749 0.240536
## aid     0.1590070  0.0492084  3.2313 0.001305 **
## depint -0.0697578  0.0527178 -1.3232 0.186300
## inflat  0.0558810  0.0234552  2.3825 0.017532 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
smse2<-coeftest(smfe2,vcov.=vcovHC(smfe2,method='white1',type='HC0'))
```

Investment model

$$inv_{it} = \beta_0 + \beta_1 gdppc_{it} + \beta_2 remit_{it} + \beta_3 aid_{it} + \beta_4 lendint_{it} + \beta_5 gs_{it} + \beta_6 open_{it} + \alpha_i + \epsilon_{it}$$

As remittances and savings may also be correlated, use the residual series collected from the estimation of savings-remittances equation as a proxy of savings variable. Corresponding to the country index, create a new data of investment model.

```
# F-test
im_resid<-read.csv("E:/dataproject/replication-project/data/im_resid.csv",
                   fileEncoding="UTF-8-BOM",check.names=FALSE,header=TRUE,
                   as.is=TRUE,sep=",",na.strings = "")
im_resid<-pdata.frame(im_resid,index=c("country","year"))
head(im_resid)
```

```
##             country year      inv    gdppc    remit      aid lendint     open
## Benin-1980    Benin 1980       NA 305.3488 5.479605 6.278590    14.5 53.13862
## Benin-1981    Benin 1981       NA 326.8632 4.802502 6.292210    14.5 59.88937
```

```
## Benin-1982   Benin 1982 27.052328 325.1686 2.914546 6.286586    16.0 57.85734
## Benin-1983   Benin 1983 16.626738 302.5671 4.002875 7.753699    14.5 45.34201
## Benin-1984   Benin 1984 12.475506 317.6625 4.001959 7.138005    14.5 50.51130
## Benin-1985   Benin 1985  8.748403 332.3023 3.852703 8.980477    14.5 60.30122
##                      gs
## Benin-1980  -5.5846821
## Benin-1981 -12.5439893
## Benin-1982   4.2598805
## Benin-1983  -0.7042386
## Benin-1984  -2.1054174
## Benin-1985  -6.9149034
```

```
imfe<-plm(inv~gdppc+remit+aid+lendint+open+gs,data=im_resid,model="within")
impool<-plm(inv~gdppc+remit+aid+lendint+open+gs,data=im_resid,model="pooling")
pFtest(imfe,impool)
```

```
##
##  F test for individual effects
##
## data:  inv ~ gdppc + remit + aid + lendint + open + gs
## F = 14.203, df1 = 30, df2 = 417, p-value < 2.2e-16
## alternative hypothesis: significant effects
```

The F-test shows the null hypothesis of individual homogeneity is rejected at the 1 per cent level and that individual specificities are presented.

```
# Hausman test
imre<-plm(inv~gdppc+remit+aid+lendint+open+gs,data=im_resid,model="random",
          random.method="swar")
phtest(imfe,imre)
```

```
##
##  Hausman Test
##
## data:  inv ~ gdppc + remit + aid + lendint + open + gs
## chisq = 158.7, df = 6, p-value < 2.2e-16
## alternative hypothesis: one model is inconsistent
```

At this step, I check fixed effect or random effect by performing the Hausman test. The results show the fixed effects model is good at the 1 per cent level.

As previously mentioned, I estimate the relations with the OLS (country fixed effects) method at first.

```
# OLS (country fixed effects)
imfe1<-plm(inv~gdppc+remit+aid+lendint+open+gs,data=im_resid,model="within",
           effect = "individual")
summary(imfe1)
```

```
## Oneway (individual) effect Within Model
##
## Call:
```

```
## plm(formula = inv ~ gdppc + remit + aid + lendint + open + gs,
##     data = im_resid, effect = "individual", model = "within")
##
## Unbalanced Panel: n = 31, T = 5-25, N = 454
##
## Residuals:
##      Min.   1st Qu.    Median   3rd Qu.      Max.
## -26.15695  -2.06762  -0.29376   1.75762  21.64397
##
## Coefficients:
##            Estimate  Std. Error t-value  Pr(>|t|)
## gdppc    0.00122075  0.00091508  1.3340  0.182920
## remit   -0.32605235  0.04931002 -6.6123 1.161e-10 ***
## aid      0.23570980  0.05385412  4.3768 1.524e-05 ***
## lendint -0.04694220  0.05647510 -0.8312  0.406335
## open     0.05890552  0.01885941  3.1234  0.001912 **
## gs       0.25212288  0.03326932  7.5782 2.288e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    13481
## Residual Sum of Squares: 10422
## R-Squared:      0.2269
## Adj. R-Squared: 0.16016
## F-statistic: 20.3981 on 6 and 417 DF, p-value: < 2.22e-16
```

```r
bptest(imfe1)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  imfe1
## BP = 113.87, df = 6, p-value < 2.2e-16
```

```r
# Using White's method correction solves the problem of heteroscedasticity.
coeftest(imfe1,vcov.=vcovHC(imfe1,method='white1',type='HC0'))
```

```
##
## t test of coefficients:
##
##            Estimate  Std. Error t value  Pr(>|t|)
## gdppc    0.00122075  0.00099164  1.2310 0.2190029
## remit   -0.32605235  0.07591910 -4.2947 2.178e-05 ***
## aid      0.23570980  0.06535300  3.6067 0.0003477 ***
## lendint -0.04694220  0.05597092 -0.8387 0.4021243
## open     0.05890552  0.02793351  2.1088 0.0355597 *
## gs       0.25212288  0.05248157  4.8040 2.173e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
imse1<-coeftest(imfe1,vcov.=vcovHC(imfe1,method='white1',type='HC0'))
```

Re-estimate using the 2SLS, a two-period lag of GDP per capita as instrument (exogenous).

```r
# 2SLS instrumental variables method
im_resid$lgdppc1 = plm::lag(im_resid$gdppc)
im_resid$lgdppc2 = plm::lag(im_resid$lgdppc1)
head(im_resid)
```

```
##             country year       inv    gdppc    remit       aid lendint     open
## Benin-1980   Benin 1980        NA 305.3488 5.479605 6.278590    14.5 53.13862
## Benin-1981   Benin 1981        NA 326.8632 4.802502 6.292210    14.5 59.88937
## Benin-1982   Benin 1982 27.052328 325.1686 2.914546 6.286586    16.0 57.85734
## Benin-1983   Benin 1983 16.626738 302.5671 4.002875 7.753699    14.5 45.34201
## Benin-1984   Benin 1984 12.475506 317.6625 4.001959 7.138005    14.5 50.51130
## Benin-1985   Benin 1985  8.748403 332.3023 3.852703 8.980477    14.5 60.30122
##                      gs  lgdppc1  lgdppc2
## Benin-1980  -5.5846821       NA       NA
## Benin-1981 -12.5439893 305.3488       NA
## Benin-1982   4.2598805 326.8632 305.3488
## Benin-1983  -0.7042386 325.1686 326.8632
## Benin-1984  -2.1054174 302.5671 325.1686
## Benin-1985  -6.9149034 317.6625 302.5671
```

```r
imfe2<-plm(inv~gdppc+remit+aid+lendint+open+gs|
             remit+aid+lendint+open+gs+lgdppc1+lgdppc2,
           data=im_resid,model="within", effect="individual")
summary(imfe2)
```

```
## Oneway (individual) effect Within Model
## Instrumental variable estimation
##
## Call:
## plm(formula = inv ~ gdppc + remit + aid + lendint + open + gs |
##     remit + aid + lendint + open + gs + lgdppc1 + lgdppc2, data = im_resid,
##     effect = "individual", model = "within")
##
## Unbalanced Panel: n = 31, T = 4-23, N = 426
##
## Residuals:
##      Min.   1st Qu.    Median   3rd Qu.      Max.
## -27.01093  -2.13724  -0.21946   1.82288  21.12126
##
## Coefficients:
##           Estimate Std. Error z-value  Pr(>|z|)
## gdppc    0.0025477  0.0010228  2.4910   0.01274 *
## remit   -0.3609917  0.0487538 -7.4044 1.318e-13 ***
## aid      0.2790976  0.0542204  5.1475 2.640e-07 ***
## lendint -0.0342687  0.0566458 -0.6050   0.54520
```

```
## open     0.0338704  0.0190764  1.7755   0.07581 .
## gs       0.2688865  0.0334411  8.0406 8.941e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    12373
## Residual Sum of Squares: 9233.9
## R-Squared:      0.25372
## Adj. R-Squared: 0.18466
## Chisq: 132.872 on 6 DF, p-value: < 2.22e-16
```

```r
bptest(imfe2)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  imfe2
## BP = 120.44, df = 8, p-value < 2.2e-16
```

```r
# Using White's method correction solves the problem of heteroscedasticity.
coeftest(imfe2,vcov.=vcovHC(imfe2,method='white1',type='HC0'))
```

```
##
## t test of coefficients:
##
##           Estimate Std. Error t value  Pr(>|t|)
## gdppc    0.0025477  0.0012737  2.0003   0.04616 *
## remit   -0.3609917  0.0723379 -4.9904 9.108e-07 ***
## aid      0.2790976  0.0683428  4.0838 5.381e-05 ***
## lendint -0.0342687  0.0575604 -0.5954   0.55195
## open     0.0338704  0.0270297  1.2531   0.21093
## gs       0.2688865  0.0503695  5.3383 1.598e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
imse2<-coeftest(imfe2,vcov.=vcovHC(imfe2,method='white1',type='HC0'))
```

Comparison

Table 1 and 2 are at the end of the file.

Differences

In authors' results, GDP per capita and remittances both positively and significantly influences savings and investment. In my results, GDP per capita only positively influences investment and remittances negatively and significantly influences investment.

In authors' results, the coefficient of deposit interest is positive and significant at the 5 per cent level. In my results, the coefficient is negative and not significant.

In authors' results, inflation is detrimental to savings. In my results, inflation positively influence savings.

In authors' results, economic openness encourages investment. In my results, openness does not have that influence.

Similarities

Foreign aid positively and significantly influences savings and investment.

High lending interest rates inhibit investment.

Savings is also a determinant of investment; its coefficient is positive and significant at the 1 per cent level regardless to the estimation method used.

Both of our robustness test using 2SLS method (column 2) does not significantly change the results.

Difficulties

The process of learning how to do linear panel regression and use plm and stargazer (showing robust standard erros) package cost much time. I refer to many sources from the Internet, especially from CRAN.

Table 1: Regression Results for Savings model

	Dependent variable:	
	gs	
	(1)	(2)
gdppc	0.004***	0.002
	(0.001)	(0.001)
remit	0.196	0.218
	(0.183)	(0.186)
aid	0.177***	0.159***
	(0.047)	(0.049)
depint	−0.070	−0.070
	(0.054)	(0.053)
inflat	0.047**	0.056**
	(0.022)	(0.023)
Observations	637	599
R^2	0.057	0.060
Adjusted R^2	−0.007	−0.008
F Statistic	7.175*** (df = 5; 596)	34.342***
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 2: Regression Results for Investment Model

	Dependent variable:	
	inv	
	(1)	(2)
gdppc	0.001	0.003^{**}
	(0.001)	(0.001)
remit	-0.326^{***}	-0.361^{***}
	(0.076)	(0.072)
aid	0.236^{***}	0.279^{***}
	(0.065)	(0.068)
lendint	-0.047	-0.034
	(0.056)	(0.058)
open	0.059^{**}	0.034
	(0.028)	(0.027)
gs	0.252^{***}	0.269^{***}
	(0.052)	(0.050)
Observations	454	426
R^2	0.227	0.254
Adjusted R^2	0.160	0.185
F Statistic	20.398^{***} (df = 6; 417)	132.872^{***}
Note:	*p<0.1; **p<0.05; ***p<0.01	