The Role of Foreign Trade in Economic Growth and Individual Heterogeneity Problem in Panel Data: The Case of African Countries

CHRISTIAN L., NGUENA

University of Yaounde 2

3 February 2012

"The Role of Foreign Trade in Economic Growth and Individual Heterogeneity Problem in Panel Data: The Case of African Countries"

Christian Lambert NGUENA*
CEREG, Cameroon

ABSTRACT

Purpose: In this work we proposed to analyze the problem of individual heterogeneity in panel data and implement resolution to verify the role of foreign trade on economic growth in Sub-Saharan Africa. The purpose was to verify improvement in terms of specification and estimation of economic growth model, linked to the consideration or not of individual heterogeneity.
Design/methodology/approach: To achieve this we have used two models, one taking into account the individual heterogeneity and the other not, to estimate and compare their result.
Findings: From this comparison, it appears that taking into account individual heterogeneity improves the quality of the model.
Practical implications: This implies that the same economic policy may lead to different results in different countries. Thus, it is desirable that economic policy decision for several countries must consider their individual characteristics before implementation.
However, the study reveals a positive impact of foreign trade on Sub-Saharan Africa countries economic growth.
Originality/value: This paper provides warning signs to African continental integration by highlighting countries heterogeneity and policy coordination issue.

Key words: individual heterogeneity, panel data, foreign trade, economic growth.
Jel classification: C12, E01, O47

Introduction

At the time when everyone is happy or regrets to have entered the era of trade globalization, it is clear that all continents or even all countries did not enter at the same speed. Particularly Africa remains the least commercially integrated continent with low economic growth level. This situation of African economy appears to be in contradiction with theoretical predictions on the role of foreign trade on economic growth.

In theoretical terms, the relationship between trade and economic growth has been the subject of analyses for mercantilists and classicists. Mercantilists point out that in a context of international trade expansion, economic growth is ensured by the excess of exports over imports. Classicism on the other hand is dominated by the theory of comparative advantage of David Ricardo.

Empirically, the relationship between economic growth and foreign trade is perceived differently. Some studies conclude that trade is an engine of growth, others see it as a brake. What is it for African countries? Is there a case of individual heterogeneity?

* ✉: clanguena@yahoo.fr.. This paper has been improved by valuable comments issued from discussion at various international conferences and from anonymous readers. The author thanks all of them and especially the scientific committee of African Econometric Society (AES) for reviewing this paper and recommends it for a presentation last year. Special thank to Ms. Estelle Carine Magne for reviewing this paper. However the author is fully responsible of any mistake in the text.

I. *LITERATURE REVIEW ON FOREIGN TRADE AND ECONOMIC GROWTH*

I.1. Theoretical literature Review on growth and foreign trade

Economic growth is among the topics traditionally discussed in the context of macroeconomics. Two schools of thought have focused on economic growth by linking to external trade: this is the current mercantilist thought and the classical school of thought.

I.1.1. Current mercantilist thinking

Mercantilism is defined as a body of doctrine advocating state intervention to develop national wealth. This development is provided by the excess of exports over imports in a context marked by the expansion of international trade.

I.1.2. Classical school

The relationship between economic growth and foreign trade was also conventionally analyzed by Adam Smith and David Ricardo. In 1776, Adam Smith in "the Wealth of Nations" formalizes the first economic theory overall favorable to economic exchange. In his trade foundations questioning the reason for trade and the interest for nations to trade, Smith develops the absolute advantage theory. According to this theory, any country has interest in participating in the exchange if she produces a good or service at lower cost than its competitors. In his reasoning model, if each nation has this kind of advantage in the production of at least one asset she is interested in participating in the exchange.
More recent theories of the connection between trade and growth suggest different (growth) effects of trade, from none to positive as well as negative effects.

I.2. Literature review on economic growth and foreign trade

In reality, the relationship between trade and economic growth is perceived differently. Some consider the trade as the engine of growth while others see it as a brake.

I.2.1.Foreign trade as an economic growth engine

Empirically, there appears to be good evidence that international trade affects economic growth positively by facilitating capital accumulation, industrial structure upgrading, technological progress and institutional advancement. Specifically, increased imports of capital and intermediate products, which are not available in the domestic market, may result in the rise in productivity of manufacturing (Lee, 1995). More active participation in the international market by promoting exports leads to more intense competition and improvement in terms of productivity (Wagner, 2007). Grossman and Helpman (1991) argue that openness can increase domestic imports of goods and services that include new technologies. Therefore through learning by doing and technology transfer, the country has a technological advancement and its production becomes more efficient and increases

productivity. It is expected that more open economies are growing at a faster rate than more protectionist.

After analyses of theoretical work of Grossman and Helpman (1991b), Romer (1991), Lucas (1988) and those of empirical Balassa (1985), Barro (1991), Redding (1997) conclude that although the theoretical literature cannot decide on the positive or negative effect of international trade on economic growth, empirical studies point out that International trade is a source of growth and reduce income disparity between countries.

In the same way, we can point out that the most important effects on economic growth come from exports. For them, exports are a key channel for normal growth in developing countries. They are a real support to the relatively lower aggregate demand in these economies and the main source of foreign exchange. Several other studies on the determinants of growth in Southern Africa shows that investment and openness to international trade provide earnings growth while population growth and public consumption have a negative effect on economic growth. These results are reinforces the situation of Chinese economy: from 1949 to 1978, the communist regime had largely insulated the Chinese economy of international trade. In 1978, the Communist Party opened the Chinese economy to private enterprise and foreign trade. Since then, China has experienced growth rates of nearly 10% on average.

In general, the previous sections show that many authors have studied the relationship between trade and growth thus foreign economic growth has proven that this relationship is positive and significant. However, this idea does not make the unanimity.

I.2.2.Foreign trade as a brake on economic growth

Many scientists discuss the positive relationship between trade and economic growth. In the logic of learning by doing growth, some authors show that the initial situation of a country determines the nature of their specialization. Some others argue that opening a small economy led to its poor specialization. Indeed opening a small economy may instead contribute to the push into poor development especially when its specialization is in a low growth sector. Sub-Saharan Africa is in this situation since its exports are based on primarily commodities. This is consistent with Grossman and Helpman (1992) theses about a country that protects its economy can stimulate growth if the government encourages domestic investment which improves their comparative advantage principle.

Ndokoula (2004), in his work on economic growth determinants in Central African Republic, found that openness has a negative impact on economic growth. International trade can also be seen as exploitation of developing countries. International trade enables businesses and consumers in developed countries to exploit workers in third world by maintaining low wages. His assertion is based on the fact that the income gap between workers in large companies and those subsidiaries in the countries development are so enormous that it is difficult to justify.

In a world where large industries with economies of scale dominate, the classical explanation of trade and its positive impact on welfare does not hold. The cost advantage e.g. a first mover gains because of increasing economies of scale can prevent possible other producers from entering the market even though they would have an (comparative) advantage. In this scenario, a small country that opens up to trade and has not yet acquired the necessary scale effects is not capable to compete with the first mover.
Another line of argumentation points to possible disadvantages of an increased specialization particularly for developing countries. If these countries e.g. specialize in sectors with less productivity growth or lower income elasticity of demand (e.g. agricultural sector), their income growth will always lag behind that of developed countries and the income disparity between rich and poor countries will grow. Redding (1999) calls this the "specialization trap".

I.2.3.The intermediary point of view

Between those who view foreign trade as an engine of economic growth and those who see it as detrimental to economic growth, there is a nuanced argument. The nature and extent of foreign trade on economic growth depends largely on the conditions under which such trade takes place. For example, one of the channels through which is the relationship between trade and economic growth is investment. A country that liberalizes its trade attracts investment flows abroad. However, this may result in lower domestic investment due to greater international competition and so the net effect remains ambiguous.
We can summarize the theoretical work of authors such as Grossman and Helpman (1991 e), Rivera-Batiz and Helpman (1991b) and drew some following conclusions:
- In the case of partial integration between identical and developed countries, technology exchange without business relationship leads to overlaps between manufactured products;
- When there is a technology and goods exchange, there is a growth rate permanently higher. When the two countries are of different sizes, the smallest is less innovative under free trade than autarky. The effect of openness on economic growth is more important when there is economic policy coordination between countries;
- For optimal economic growth, trade liberalization has no impact on economic growth when there are still some imperfections in the market or in institutions. It must be accompanied by other policies such as improving the quality of institutions, political and economic stability, promotion of investment in a broad sense...etc.
- For profit on foreign trade, it requires that the country is endowed with a skilled workforce capable of assimilating, after discernment, foreign technology.

II. *EMPIRICAL ANALYSES INDIVIDUAL HETEROGENEITY*

The first part was devoted to presenting the characteristics of the African economy and make literature review on trade and economic growth; His conclusion do not allow us to comment on the relationship that exists between trade and economic growth in Sub-Saharan Africa sub region. The purpose of this second part is to empirically test this relationship. This will allow us to test our research hypotheses. Thus, to verify the first hypothesis concerning the effect of taking into account the heterogeneity on the specification and model estimation, we will estimate common-effect statistical model and statistical models with specific effects. The comparison of the results of these estimates will allow us to refute or confirm our hypothesis. A dynamic model is also estimated by the approach of Arellano and Bond to check the influence of trade on economic growth. The results of these estimates will be interpreted and the conclusion will be clear.

II.1.Data and methodology

An empirical study on temporal series of developing countries taken individually is not relevant given the limited length of the series. Indeed, greater the number of observations is reduced, less the significance tests is good. Reason why we have chose to form a panel that included the countries of Sub-Saharan Africa. The sample consists of 24 countries of Sub-Saharan Africa. The study covers the period from 1987 to 2011. Economic growth has been apprehended by the change in real GDP per capita. For a better capture of the effects of trade on economic growth, we took two main areas, exports and imports as % of GDP. As additional explanatory variables, we retained the variables considered as determinants of economic growth in other studies, public investment as % of GDP, private investment as % of GDP, foreign direct investment as % of GDP, the rate of population growth, total consumption as % of GDP, life expectancy, the credit granted to private as % of GDP, the dependency ratio and the change in the GDP deflator. Before being used in the estimates, the data are transformed in logarithm as follows:

Y, the dependant variables which is real GDP per capita;

X1 to X11 respectively which are explanatory variables: Imports as % of GDP; Exports as % of GDP; Rate of population growth; Total consumption as % of GDP; Public investment as % of GDP; Private investment as % of GDP; Foreign direct investment as % of GDP; Life expectancy of the population; Credit to the private sector as % of GDP; Dependency ratio and GDP deflator.

The choice of the period and the sample was guided primarily by data availability.

To test the first research hypothesis, we estimate in turn the statistical models with specific effects. The comparison of results from these estimates will allow us to refute or confirm our hypotheses. To consider a possible influence due to oil production in some countries, a dummy variable X12 that takes the value "1" for oil producing countries and "0" for the rest of the country will be introduced.

The various previous works on economic growth and foreign trade, left a feeling of dissatisfaction related to the indicators used to measure the opening and econometric

methods which did not take into account biases due to individual heterogeneity. We seek to overcome these problems.

To analyze econometrically the impact of trade on economic growth in countries of Sub-Saharan Africa, we will use a dynamic model. A standard econometric technique such as OLS or GLS does not provide efficient estimates of a dynamic model because of the presence of the dependent variable as explanatory variable. The estimation of such model is using GMM-system approach also known as Arellano and Bond 2.
The advantage of this method is that it allows control of country specific effects and potential endogeneity of explanatory variables. For example, if it is assumed that foreign trade influences economic growth, it can also cause the expansion of foreign trade. Thus, to address these problems, Arellano and Bond combine the equation in first difference with that in level. In the equation in first differences, lagged variables in levels are used as instruments and in the level equation it is the lagged variables first differences that are used as instruments.

II.2. Presentation and results interpretation

II.2.1. Statistic models

II.2.1.1. Common effects model estimation

Reg Y X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11, robust noconstant

Linear regresión

Number of obs	=	407	
F(11, 396)	=	7812.21	
Prob F	=	0.0000	
R-equared	=	0.9930	
Root MSE	=	.50232	

Y	Coef.	Robust Std. Err.	t	$\lvert p \succ t \rvert$	[95% conf.	Interval]
X1	-.0259734	.0870112	-0.30	0.765	-.197035	.1450882
X2	.2738462	.0624549	4.38	0.000	.1510617	.3966307
X3	-.0122034	.0144015	-0.85	0.397	-.0405163	.0161095
X4	-1.239112	.1763153	-7.03	0.000	-1.585743	-.8924809
X5	.0072085	.0515945	0.14	0.889	-.0942249	.1086419
X6	.1934799	.0382354	5.06	0.000	.1183102	.2686496
X7	5.84e-06	.0002065	0.03	0.977	-.0004002	.0004119
X8	2.619896	.2108585	12.42	0.000	2.205354	3.034438
X9	3.37e-06	3.68^{e}-07	9.15	0.000	2.65^{e}-06	4.09^{e}-06
X10	-1.952483	.3571838	-5.47	0.000	-2.654696	-1.250269
X11	.004494	.0074908	0.60	0.549	-0102328	.0192207

The R2 indicates that the variability of the explanatory variables explain more than 99 % of the variability of the dependent variable, this implies that the model is globally

significant. Based on statistics and probability student, we see that the variables X2, X4, X6, X8 and X10 are significant at 1 %, variable X9 is significant at 10%. Among the variables of interest X1 and X2, only X2 has a positive coefficient significant at 1 %. Thus, under the assumption of no fixed effects, foreign trade positively influence economic growth through exports. An increase in exports of 1 franc would increase about 0.27 francs of GDP. The change in exports has an immediate effect on the gross value added. This supports the view of John Stuart Mill, who states that a country benefits from its foreign trade more than its exports prevail on its imports. Indeed the most important effects of trade on economic growth come from exports. Imports affect growth through the use of imported equipment or the assimilation of foreign technology. This requires a certain period. Thus, the significance of imports is not warranted at this time. To validate this model and therefore its results, further tests are required:

- Errors normality test

This test helps us to verify if the errors follow a central normal distribution, a necessary condition for making sure that the interpretation of previous results is correct. The results of this test are:

Skewness Kurtosis tests for Normality

			joint	
Variable	pr(Skewness)	pr(Kurtosis)	adj chi(2)	prob>chi2
residu	0.373	0.463	1.34	0.5120

The probability of this test is 0.517, the calculated value of chi2 (2) is lower than 5.991 in the table read. This situation leads us to reject the null hypothesis of normality of errors.

- Ramsey Reset Test

This test checks the omission of relevant explanatory variables or model misspecification. For our model, the results are as follows:

Ramset Reset test using powers of the fitted values of Y
H0: model has no omitted variables
F (3,393)= 37,19
Prob>F= 0.0000

The probability of this test is 0.0000, we can not reject the null hypothesis of good specification.

- Heteroskedasticity test

The test checks for homoscedasticity hypothesis that the residue has a constant variance.

Breuch-Pagan / Cook-Weisberg test for heteroskedasticity
H0: Constant variance

Variables: fitted values of Y
Chi2 (1) = 26,82
Prob>chi2 = 0,0000

As shown in the result of Breuches-Pagan test, the probability of the test does not allow us to reject the null hypothesis of constant variance.
The above results should be interpreted with great reservations.

II.2.1.2. Fixed effects model estimation

Xtreg Y X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11, fe

Fixed-efects (within) regresión		Number	= 407
Group variable(i) : pays		Number of groups	= 24
R-sq: within	= 0.2795	Obs per group: min	= 16
Between	= 0.0688	avg	= 17.0
Overall	= 0.0169	max	= 17
		F(11,372)	= 13.12
Corr(u-i, xb) = -0.2265		prob>F	=0.0000

Y	Coef	std.Err.	t	p>t	[95% conf.	Interval]
X1	-.2046896	.0286211	-7.15	0.000	-.2609691	-.1484101
X2	.1359109	.0242325	5.61	0.000	.088261	.1835608
X3	.0030461	.0024956	1.22	0.223	-.0018611	.0079533
X4	.2293669	.0751424	3.05	0.002	.0816098	.377124
X5	.1016276	.0145501	6.98	0.000	.0730169	.1302383
X6	.0233096	.0135264	1.72	0.086	-0032881	.0499074
X7	.0001004	.0000424	2.37	0.018	.0000171	.0001837
X8	-.5180587	.0927989	-5.58	0.000	-.7005349	-.3355824
X9	-6.51^{e}-08	4.06^{e}-07	-016	0.873	-8.64^{e}-07	7.33^{e}-07
X10	-.418466	.11919	-3.51	0.001	-.6528367	-.1840954
X11	.0026682	.0016364	1.63	0.104	-.0005496	.005886
Cons	6.879926	.4835223	14.23	0.000	5.929146	7.830705

sigma-u	.85145855	
sigma-e	.09860855	
rho	.98676524	(fraction of variance due to u-i)

F test that all u-i=0: F(23,372) = 419.47 prob F = 0.0000

For the fixed effects model, the most relevant R2 is within R2 which gives the idea of the share of intra-individual variability of the dependent variable explained by the independent variables. The R2 between however, gives an idea of the contribution of fixed effects in explaining the model. Thus, in view of our results, the intra-individual variability of economic growth is explained up to 28% by the explanatory variables. The

contribution of fixed effects in explaining the dependent variable in this model is about 7%. The fixed effects model presented two Fisher statistics:
-The top of the table tests the joint significance of explanatory variables. It is 13.03 and its probability is less than 5%. The model is globally significant.
-The bottom of the table tests the joint significance of individual effects. Its value is 419.94 and its probability is less than 5%. Thus, we conclude that the individual effects are significant and that the common effects model is not appropriate.
This is a partial confirmation of the first hypothesis that heterogeneity has an influence on the specification and estimation of the model.

Rho value indicates the proportion of residual variance attributable to individual effects. This share rises over 98%. In other words, over 98% of the disturbances are due to individual heterogeneity. Corr. (U_i, Xb) = -0.2222, it tells us about the possibility of correlation between individual effects and explanatory variables. At this stage we cannot rule on the relevance of fixed effects model compared to random effects, hence the need to analyze it.

On an individual level, based on the probability of student statistics, we find that the coefficients X1, X8 and X10 are negatively significant at 1%. The coefficients of the variables X2, X5 and the constant are positively significant that the 1% level. The coefficient of the variable X4 is positively significant at 5% and for the coefficients of X7 and X11, they are positively significant at 10%. Thus, on the basis of these results, we can assume that our variables of interest, i.e. imports and exports affect economic growth in Sub-Saharan Africa. An increase in imports of 1 F resulting in less of GDP by about 0.2 F, while the increase of exports F involve an increase in GDP of about 0.14 F. imports affecting a negative influence and exports an positive influence, the magnitude and direction of the effect of trade on economic growth will result from the confrontation between the two effects. Given the commercial situation of Sub-Saharan Africa countries, it is likely that the overall effect of trade on economic growth is negative.

II.2.1.3. Model with random effect estimation

xtreg Y X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11, re robust

Random-effects GLS regression	Number of obs	=	407
Group variable (i): pays	Number of groups	=	24
R-sq within = 0.2743	Obs per group: min	=	16
Between = 0.0315	Avg	=	17.0
Overall = 0.0300	Max	=	17
Random effects u-i gaussian	Wall chi2(11)	=	155.10
Corr (u-i, x) =0 (assumed)	Prob chi2	=	0.0000

Y	Coef	Std.Err	Z	PZ	95% conf.	Interval

X1	-.19848808	.0328592	-6.04	0.000	-.2628836	-.1340781
X2	.1586799	.029038	5.46	0.000	.1017665	.2155934
X3	.0028253	.0024864	1.14	0.256	-.002048	.0076986
X4	.1841501	.1076619	1.71	0.087	-.0268633	.3951634
X5	.1014591	.0185312	5.48	0.000	.0651386	.1377797
X6	.0245933	.0176468	1.39	0.163	-.0099938	.0591804
X7	.0000969	.0000532	1.82	0.068	-7.27e-06	.0002012
X8	-.414226	.1224554	-3.38	0.001	-6542341	-.1742178
X9	-4.23e-08	7.34e-08	-0.58	0.564	-1.86e-07	1.02e-07
X10	-.5086193	.1192242	-4.27	0.000	-.7422943	-.2749442
X11	.0025087	.0018976	1.32	0.186	-.0012105	.0062279
Cons	6.581956	6292916	10.46	0.000	5.348567	7.815345

Sigma-u .42394408
Sigma-e .09860855
Rho .94867494 (fraction of variance due to u-i)

As shown by Chi2 statistics (Wald chi2 (12) = 4950.53) and his probability (Prob chi2 = 0.0000), the model is globally better. The most relevant R2 is the R2 between which measures the proportion of the interindividual variability of the dependent variable by the explanatory variable. It has a low value (3%). Within R2 however, gives an idea of the contribution of country random effects on the explanation of the model. Its value is more than 27%.

On an individual level, as for the fixed effects model, the coefficients of X1, X8 and X10 variable are negatively significant at 1%. The coefficients of the variables X2, X5 and the constant are positively significant at 1% and those variables X4 and X7 are positively significant at 10%. The coefficients of our variables of interest are significant at 1%. An increase in imports of 1 franc would reduce GDP about 0.20 francs, while an increase in exports of the same magnitude would increase the GDP of about 0.16 francs. Considering the results of two models (fixed effects and random effects), one is tempted to conclude that the two specifications are identical (Reminding that the fundamental assumption of the random effects model is corr. (Ui, X) = 0). It is therefore necessary to choose between these two models which is appropriate for our case. The Breuch Pagan Lagrangian multiplier test can helps us make that choice.

Lagrangian multiplier test of Pagan and Breuch

Breuch and Pagan Lagrangien multiplier test for random effects;
Ypays, t =Xb+upays+epays, t
Estimated results :
Var sd = sqrt(var)

Y	.6795615	.8243552
e	.0097236	.0986085
u	.1797286	.4239441

Test : var(u) = 0

Chi2(1) = 1728.49
Prob chi2 = 0.0000

The Breuches and Pagan test can check the significance of random effects.
The results of this test show that the calculated value of chi2 (1) is far greater than its critical value read from the tables which is 3.841 at 5% threshold or 6.635 at 1% threshold. This leads us to reject the null hypothesis of no random effects. In other words, the appropriate model is the random effects.
We can conclude that in the specification of Sub-Saharan Africa economic growth as a function of imports, exports, investment, consumption, credit to the private, life expectancy and inflation, there are pertinent individual characteristics (individual heterogeneity) that are not relevant correlated with the explanatory variables.

II.2.1.4.Comparaison between common effects model and random effects model

By comparing the results of two models, we find that they are too globally significant. However, there are differences in variables coefficients. For the common effects model, the variables X6 and X9 coefficients are significant at 1% level when they are not for the random effects model. Meanwhile, the X1, X5 and X7 coefficients are significant for the random effects model when they are not for common effects model. The variable X4 coefficient which is negatively significant for common effects model become positive for random effects model, while the variable X8 coefficient which was positively significant for the common effects model becomes significantly negative effects model random. For those variables whose significance has not changed, the magnitude varied. It is the case of X2, X10 variables and the constant.

Regarding our variables of interest, the effect of imports is significant only when one takes into account individual heterogeneity. As for exports, although they are positively significant for both models, the magnitude of their significance decreases when we take into account individual heterogeneity. These differences are in addition to the fact that taking into account the heterogeneity of individual states from the latter in the disturbance. Thus, our first hypothesis is confirmed. As for the second hypothesis, it refers to the dynamic model and its verification is the subject of the next section.

II.2.2. Dynamic models

As mentioned previously, dynamic models are characterized by the presence of one or more lagged endogenous variables among the explanatory variables. Such models are better suited to study the phenomenon of economic growth. To verify the role of foreign trade on economic growth in Sub-Saharan Africa countries, we adopted a dynamic panel approach. The same approach was also used by Fotso Ndefo (2003) to analyze the impact of Foreign Direct Investment on economic growth.

II.2.2.1. Estimation of dynamic model by Arellano and Bond approach

Xtabond Y X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11, lags(1) artests(2)

Arellano-Bond dynamic panel-data estimation	Number of obs	=	358
Group variable (i): countries	Number of groups	=	24
	Wald chi2(12)	=	304.54
Time variable (t): year	Obs per group: min	=	13
	Avg	=	14.91667
	Max	=	15

One-step results

D.Y	Coef	Std.Err.	Z	Pz	95% conf.	Interval
Y						
LD.	.6938086	.0526667	13.17	0.000	.5905838	.7970335
X1						
D1.	-.307819	.0217065	-1.42	0.156	-0733259	.0117621
X2						
D1.	-.0116726	.0237785	-0.49	0.624	-.0582776	.0349324
X3						
D1.	.0023368	.0012603	1.85	0.064	-.0001334	.004807
X4						
D1.	-.2008485	.0533102	-3.77	0.000	-.3053346	-.0963624
X5						
D1.	.0027539	.0103013	0.27	0.789	-.0174364	.229441
X6						
D1.	-.0054989	.0104273	-0.53	0.598	-.0259361	.0149383
X7						
D1.	.0000102	.0000266	0.38	0.701	-.0000419	.0000624
X8						
D1.	-.0387151	.0802581	-0.48	0.630	-.1960181	.118588
X9						
D1.	3.13e-08	2.12e-07	0.15	0.883	-3.84e-07	4.46e-07
X10						
D1.	.0179876	.1095815	0.16	0.870	-.1967881	.2327634
X11						
D1.	.0001997	.0008679	0.23	0.818	-.0015013	.0019007
cons	.0024745	.0007952	3.11	0.002	.0009158	.00400331

The estimation results of our growth model by the approach of Arellano and Bond 2 show that our variables of interest did not influence economic growth. Only the coefficients of the variables X3 and X4 are respectively significant at 10% and 1%. Meanwhile, consumption has a negative impact on economic growth. Validation of these results requires that the instruments are valid and there is no order two residues autocorrelation.

Test of instruments validity and autocorrelation of residuals

Sargan test of over-identifying restrictions:
Chi2 (119) = 121.25 Prob>chi2 = 0.4253

Arellano-Bond test that average auto covariance in residuals of order 1 is 0:
H0: no autocorrelation z = -5.98 pr>z =0.0000
Arellano-Bond test that auto covariance in residuals of order 2 is 0
H0: no auto correlation z = -1.18 pr>z = 0.2382

The Sargan test often used to verify instruments validity is based on the null hypothesis that the instruments are valid. The probability of chi2 is equal to 0.4253 for our case; we cannot reject the null hypothesis. Similarly, the test of Arellano and Bond (p = 0.2382) shows that there is no autocorrelation of order two for residues.

Under the assumption that explanatory variables affect the growth with a lack time, the growth equation is written:

$y_{i,t} - y_{i,t-1} = (\alpha - 1)y_{i,t-1} + x_{i,t} - 1\beta + u_i + \varepsilon_{i,t}$ And the equation to be estimated becomes:

$y_{i,t} = \alpha y_{i,t-1} + x_{i,t} - 1\beta + u_i + \varepsilon_{i,t}$

The previous estimate results, (see annexe), of this relationship by the approach of Arellano and Bond (1991) shows that the coefficients of X2, X3 and X7 variables are significant. But the significance of the coefficients can be attributed to residuals autocorrelation. These results should be interpreted with care since we saw in the first part that this approach has limits. Thus, the Arellano and Bond 2 approach using GMM in system becomes essential.

II.2.2.2. Arellano and Bond approach

The approach of Arellano and Bond shows that only the population growth is likely to significantly influence economic growth (see annexe below). However, the assumption of no residuals autocorrelation is rejected, which makes less credible results. Under the assumption that the explanatory variables act late, we have the following relationship:

$y_{i,t} = \alpha y_{i,t} - 1 + x_{i,t} - 1\beta + u_i + \varepsilon_{i,t}$

The application of Arellano and Bond approach gives the following result:

Dynamic panel-data estimation, con-step system GMM

Group variable: countries	Number of obs	=	383
Time variable: year	Number of groups	=	24
Number of instruments = 38	Obs per group: min	=	15
Wald chi2(11) = 28287.55	Avg	=	15.96
Prob>chi2	Max	=	16

Y	Coef	Robust Std. Err.	Z	Pz	95% con.	Interval

Y						
L1.	.9801827	.042622	23.00	0.000	.8966453	1.06372
X1						
L1.	.0567664	.0260795	2.18	0.030	.0056516	.1078812
X2						
L1.	-.002653	.0158449	-0.17	0.867	-0337084	.0284023
X3						
L1.	-.0016833	.0006809	-2.47	0.013	-.0030178	-.0003488
X4						
L1.	-.0194573	.0742798	-0.26	0.793	-.1650431	.1261284
X5						
L1.	.0034278	.0083816	0.41	0.683	-.0129998	.0198555
X6						
L1.	.0168614	.0138816	1.21	0.224	-.010346	.0440688
X7						
L1.	9.51e-06	.0000195	0.49	0.625	-.0000287	.0000477
X8						
L1.	.0122757	.1273756	0.10	0.923	-.2373759	.2619273
X9						
L1.	-6.86e-09	1.69e-08	-0.41	0.684	-3.99e-08	2.62e-08
X10						
L1.	-.1120089	.1136347	-0.99	0.324	-.3347289	.1107111
X11						
L1.	-.0012901	.001088	-1.19	0.236	-.0034226	.0008424
cons	-.0842784	.3326494	-0.25	0.800	-7362592	.5677023

For explanatory variables Xit-1, the lagged values of one and two periods were then used as instruments while for the variable Yit-1 lagged values of three and four periods are used as instruments. To avoid bias of over-instrumentation often observed in small samples, the collapse option was used and to correct heteroscedasticity of t-Statistics, the robust option was used.

The above results show that the model is globally significant. At individual level, X1 and X3 coefficients are significant at 5%. Indeed, a change in imports delayed by one period positively influences economic growth while the variation of population growth delayed by one period negatively influences economic growth. Foreign trade had a positive impact on economic growth in Sub-Saharan Africa via imports. An increase in imports delayed by one period of 1 franc leads to increased economic growth of 0.057 francs. This can be explained in that a part of imports is made by investment goods.
These results allow us to confirm the second hypothesis, taking into account individual heterogeneity influences the relationship between trade and economic growth.

Tests of instruments validity and autocorrelation of residuals

Sargan test of overid. Restrictions: chi2(25) = 25.92 prob chi2 = 0.412
Hansen test of overid. Restrictions: chi2(25) = 9.44 prob chi2 = 0.998

Arellano-Bond test for AR(1) in first differences : z = -2.63 pr z =0.009
Arellano-Bond test for AR(2) in first differences: z = -0.74 pr z = 0.458

The order two autocorrelation test results (p = 0.458), the Sargan (0.412) and Hansen (0.998) of instruments validity cannot reject the null hypotheses. In other words, the residuals are not auto correlated and instruments are adequate. Accordingly, previous results are validated.

The estimation of the dynamic model by xtabond2 command gives the α value of initial per capital real GDP coefficient. We must therefore calculate the coefficient of this variable in the growth model (α-1) and his student statistics. These two values are obtained using the command Lincom.

Lincom L.Y-1
(1) L.Y = 1

Y	Coef.	Std. Err.	z	pz	95% conf.	Interval
(1)	-.0198173	.042622	-0.46	0.642	-.1033547	.0637202

The real GDP per capital lagged one period coefficient (Yit-1) is equal to -0.0198 and is significant at 10%. The data that we used to test our hypotheses relate to Sub-Saharan Africa economies. Some of these countries are oil producers. It is therefore necessary to verify whether the act of producing the oil did not influence the link between trade and economic growth in Sub-Saharan Africa.

For this, we introduced X12 variable takes the value one (1) for oil-producing country, and zero (0) for the rest, and we turn once again economic growth model using the approach of Arellano and Bond. The results remain similar and the correlation coefficient of X12 variable is not significant. This implies that oil production has no significant influence on economic growth in Sub-Saharan Africa.

Conclusion

This last part was intended to empirically test our research hypotheses using Sub-Saharan Africa economies countries data. Remembering that our research hypotheses were:
Taking into account the individual heterogeneity improves specialization and estimation model; and taking into account Sub-Saharan African countries specificities influence the effect of trade on economic growth.

Under the assumption of the statistical relationship between foreign trade and economic growth, we estimated two models namely:
The common effects model (this model ignores the existence of individual heterogeneity) and the random effects model that takes into account individual heterogeneity.

By comparing the results from these two models, we find that there are differences in the overall significance of the model. This observation is a confirmation of the first hypothesis. Thus, taking into account individual heterogeneity improves model quality and explanatory variables coefficients.

To check the possible influence of trade on economic growth in Sub-Saharan Africa, we estimated a dynamic model of economic growth with the approach of Arellano and Bond. The results show that the correlation coefficients of imports and population growth are significant at 5%. Foreign trade has a positive impact on economic growth through imports. This statement is in the same direction as the second hypothesis: taking into account individual heterogeneity influences relationship between trade and economic growth. Thus, our research hypotheses are confirmed.
Regarding the second hypothesis, a dynamic model of economic growth was estimated using the approach of Arellano and Bond 2. The results showed that in Sub-Saharan Africa, when taking individual heterogeneity into account, foreign trade has a positive influence on economic trade through imports. These results confirm our hypothesis.

In general and to summarize, this work showed that there are differences between the results from the growth model which does not take into account individual heterogeneity and those who considered it.
This implies that the same economic policy may lead to different results in different countries. Thus, it is desirable that to take a decision for several economies of the same region, we must consider their individual characteristics.

Bibliography reference

1. Abdeljabbar, A. et Hanchance, S. (2003), « *Ouverture, capital humain et croissance économique : fondements théorique et identification des liens à l'aide des données de panel* » ; Journal of economic literature.
2. Amadou, A. (2006), *« Libéralisation commerciale et croissance économique dans les pays de l'UEMOA* » Université de Lomé.
3. Arellano, M. and S. Bond. (1991). "*Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations*". The Review of Economic Studies, 58. pp. 277 – 297.
4. Balassa (1985), "*export, policy choices and economic growth in developing countries after the 1973 oil shock*"; journal of development economics, Vol. 18.

5. Elhanan Helpman, (1992). "*Innovation, Imitation, and Intellectual Property Rights*" NBER Working Papers 4081, National Bureau of Economic Research, Inc.
6. Fotso Ndefo, N. (2003), "*Impact des investissements Directs Etrangers sur la Croissance : Quelques résultats sur les pays Africains du sud du Sahara* » ; Journal of economic litterature.
7. Grossman, Gene M & Helpman, Elhanan, (1991). "*Quality Ladders in the Theory of Growth*", Review of Economic Studies, Wiley Blackwell, vol. 58(1), pages 43-61, January.
8. Krugman, Paul & Taylor, Lance, (1978). "*Contractionary effects of devaluation*" Journal of International Economics, Elsevier, vol. 8(3), pages 445-456, August.
9. Krugman, (1987). "*Trigger Strategies and Price Dynamics in Equity and Foreign Exchange Markets*", NBER Working Papers, 2459, National Bureau of Economic Research, Inc.
10. Lee J.W. (1995), "*Capital goods import and long-run growth*", Development Economics, 48(1), 91-110.
11. Lucas, Robert E., Jr. (1988). "*On the mechanics of economic development*". Journal of Monetary Economics 22 (July): 3 –42. Lucas, Robert E., Jr. 1996.
12. Ndokoula, Robert (2004), « *Les déterminants de la croissance économique en République Centraficaine* » MPRA W P;
13. Redding, S., (1997). "*Dynamic Comparative Advantage and the Welfare Effects of Trade*" Economics Papers 140, Economics Group, Nuffield College, University of Oxford.
14. Redding, Stephen (1999). "*Dynamic comparative advantage and the welfare effects of trade*", Oxford Economic Papers, vol.51, pp. 15-39.
15. Rivera-Batiz, Luis A. & Romer, Paul M., (1991). "*International trade with endogenous technological change*" European Economic Review, Elsevier, vol. 35(4).
16. Robert J. Barro, (1991). "*Government Spending in a Simple Model of Endogenous Growth*" NBER Working Papers 2588, National Bureau of Economic Research.
17. Wagner J. (2007), "*Exports and productivity: A survey of the evidence from firm level data*", The World Economy, 30(1), 60-82.

ANNEXES

- **List of country concerned by our study:**

-Benin	- Comores	- Guinea	- Mauritania
-Burkina Faso	- Congo	- Kenya	- Mozambique
-Burundi	- Ivory Coast	- Lesotho	- Niger
-Cameroon	- Ethiopia	- Madagascar	- Rwanda
-Cap Verde	- Gabon	- Malawi	- Senegal
-Chad	- Gambia	- Mali	- Swaziland

- **Arellano and Bond (1991) Approach (Explanatory variable are lagged) :**

Xtabond Y L. Y L.x1 L.x2 L.x3 L. x4 L.x5 L.x6 L.x7 L.x8 L.x9 L.x10 L.x11, lags(1) artests(2)

Note : L.Y dropped due to collinearity

Arellano-Bond dynamic panel-data estimation Number of obs = 358
Group variable (i): pays Number of groups = 24
Wald chi2(12) =254.04
Time variable (t): Année Obs per group: min =13
avg =14.91667
max =15

One-step results

D.Y	Coef.	Std. Err	z	p>/z/	[95% conf.	Interval]
Y						
LD.	.4081094	.0347743	11.74	0.000	.3399531	.4762657
LD.	(dropped)					
X1						
LD.	-.000654	.0225575	-0.03	0.977	-.0448659	.0435578
X2						
LD.	.0636686	.0223046	2.85	0.004	.0199523	.1073849
X3						
LD.	-.002862	.0012199	-2.35	0.019	-.0052529	-.0004711
X4						
LD.	-.0194029	.0510557	-0.38	0.704	-.1194703	.0806645
X5						
LD.	.0124008	.0099311	1.25	0.212	-.0070638	.0318655
X6						
LD.	-.0073034	.0097035	-0.75	0.452	-.0263218	.0117151
X7						
LD.	.0000909	.0000273	3.34	0.001	.0000375	.0001443
X8						
LD.	-.0184908	.0775665	-0.24	0.812	-.1705183	.1335368
X9						
LD.	9.39e-08	2.12e-07	0.44	0.657	-3.21e-07	5.09e-07
X10						
LD.	.1123487	.1127217	1.00	0.319	-.1085817	.3332791
X11						
LD.	.0015207	.0008673	1.75	0.080	-.0001792	.0032206
Cons	.0023342	.0007801	2.99	0.003	.0008053	.0038631

Sargan test of over-identifying restrictions:
chi2(119) =176.35 prob chi2 =0.0005
Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
H0: no autocorrelation z = -6.15 pr> z =0.0000

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
H0: no autocorrelation z = -1.76 pr >z =0.0777

- **Arellano and Bond2 Approach (Explanatory variable are lagged) :**

Xtabond2 Y L. Y x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11, iv(Année) robust gmm(x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11, lag(1 2) collapse) gmm(L.Y, lag(3 4) collapse)

Dynamic panel-data estimation, one-step system GMM

Group variable:		Number of obs	= 383
Time variable: Année		Number of groups	= 24
Number of instruments = 38		Obs per group: min	= 15
Wald chi2(11) = 15158.91		avg	= 15.96
Prob> chi2 = 0.000		max	= 16

Y	Coef.	Robust Std. Err.	Z	p>/z/	[95% conf.	Interval]
Y						
L1.	1.002154	.0311298	32.19	0.000	.9411404	1.063167
X1	.0282834	.0457872	0.62	0.537	-.0614578	.1180245
X2	.0213187	.0341303	0.62	0.532	-.0455755	.088213
X3	.0077895	.0010916	7.14	0.000	.00565	.009929
X4	-.0799919	.0854944	-0.94	0.349	-.2475579	.087574
X5	.020661	.020649	1.00	0.317	-.0198103	.0611324
X6	.0030326	.022836	0.13	0.894	-.0417251	.0477903
X7	8.46e-07	.0000398	0.02	0.983	-0000772	.0000789
X8	.0349445	.0789804	0.44	0.658	-.1198544	.1897433
X9	6.10e-08	3.90e-08	1.56	0.118	-1.55e-08	1.38e-07
X10	-.1077146	.182793	-0.59	0.556	-.4659822	.250553
X11	-.0012983	.0017845	-0.73	0.467	-.0047958	.0021992
Cons	-.0261653	.3903621	-0.07	0.947	-791261	.7389303

Arellano-Bond test for AR(1) in first differences: z = -2.75 pr> z =0.006
Arellano-Bond test for AR(2) in first differences: z = -0.55 pr> z =0.584

Sargan test of overid. Restrictions: chi2(25) = 84.13 prob> chi2 =0.000
Hansen test of overid. Restrictions: chi2(25) = 10.90 prob >chi2 = 0.993
. Lincom L.Y-1

(1) L.Y = 1

Y	coef	std.Err	z	p>z	[95% conf.	Interval]
(1)	.0021536	.0311298	0.07	0.945	-.0588596	.0631669

- **Arellano and Bond2 Approach (Introduction of X12 variable for taking into account petrol production) :**

Xtabond Y L. Y L.x1 L.x2 L.x3 L. x4 L. x5 L. x6 L. x7 L. x8 L. x9 L. x10 L. x11 L. x12, iv(Année)
Robust gmm(L.x1 L.x2 L. x3 L.x4 L.x5 L.x6 L. x7 L.x8 L.x9 L.x10 L.x11 L.x12 L, lag(1 2) collapse)
Gmm(L.Y,lag(3 4) collapse)

Dynamic panel-data estimation, one-step system GMM

Group variable: pays					Number of obs	= 383
Time variable: Année					Number of groups	= 24
Number of instruments = 40					Obs per group: min	= 15
Wald chi2(12) = 33294.30					avg	= 15.96
Prob> chi2 = 0.000					max	= 16

Y	Coef.	Robust Std. Err.	Z	p>z	[95% conf.	Interval]
Y						
L1.	.9804948	.0477361	20.54	0.000	.8869338	1.074056
X1						
L1.	.0548961	.024748	2.22	0.027	.006391	.1034013
X2						
L1.	-.0005361	.0207304	-0.03	0.979	-.0411669	.0400947
X3						
L1.	-001597	.0007453	-2.14	0.032	-.0030578	.0001362
X4						
L1.	.0085279	.0625659	0.14	0.892	-1140989	.1311548
X5						
L1.	.0053858	.0105296	0.51	0.609	-.0152518	.0260233
X6						
L1.	.0145505	.0134449	1.08	0.279	-.0118011	.0409021
X7						
L1.	9.60e-06	.0000227	0.42	0.673	-.000035	.0000542
X8						
L1.	.0180696	.1302178	0.14	0.890	-.2371526	.2732918
X9						
L1.	-9.21e-09	2.45e-08	-0.38	0.708	-5.73e-08	3.89e-08
X10						
L1.	-.1434543	.1400916	-1.02	0.306	-.4180288	.1311202
X11						
L1.	-0013614	.0010577	-1.29	0.198	-.0034344	.0007116

X12						
L1.	.0134075	.0400395	0.33	0.738	-.0650684	.0918835
Cons	-.2397922	.3303872	-0.73	0.468	-.8873391	.4077548

Arellano-Bond test for AR(1) in first differences: z = -2.64 pr >z = 0.008
Arellano-Bond test for AR(2) in first differences: z = -0.77 pr >z = 0.444

Sargan test of overid. Restrictions: chi(26) = 26.60 prob>chi2 = 0.431

.Lincom L.Y-1
(1) L.Y = 1

Y	coef	std. Err.	z	p>/z/	[95% conf. Interval]	
(1)	-.0195052	.0477361	-0.41	0.683	-.1130662	.0740557