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Abstract

This paper investigates the sustainability of trade balances in the Sub-Saharan African regions, using both the panel unit root (IPS) test proposed by Im *et al*. (2003) and the cross-sectionally augmented version of the IPS (CIPS test) suggested by Pesaran (2007), where the former test is based on the assumption of cross-section independence and the latter allows for it. On the one hand, the empirical results based on the IPS test indicate that the balance of trade in Sub-Saharan African regions is sustainable. On the other hand, the empirical results of the CIPS test reveal that it is not. Since cross-section dependence was recognized using the CD test developed by Pesaran (2004), the empirical results based on the IPS test could be spurious.

Keywords: sustainability, trade balances, Sub-Saharan Africa, CIPS test

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I. Introduction

The balance between exports and imports, i.e. the trade balance, is an important indicator of macroeconomic performance. While a temporary trade imbalance (trade deficits or surplus) is not necessarily a bad situation, large and persistent inequalities of this type can lead to serious problems, such as an increase in domestic interest rates to attract foreign capital and the collapse of exchange rates. To stabilize the trade balance, it is important for policy makers to determine whether trade deficits (or surpluses) are only a momentary phenomenon and whether the trade balance is sustainable.

Husted (1992) offers the first crucial empirical study of trade balance sustainability. He proposes a theoretical model that explains the existence of a long-run equilibrium relationship between exports and imports. This model implies—under the hypothesis that intertemporal budget constraints are valid in an open economy—that exports and imports have a long-run relationship and that the trade balance is sustainable. In other words, given the premise, it is expected that the two series have a cointegrating relationship. Husted, employing the US quarterly data from 1967 to 1987, probes the association of exports and imports and concludes that the two series were cointegrated and, hence, that US trade deficits were a short-run phenomenon.

Since this seminal work, many researchers have shown an interest in the econometric analysis of the long-run relationship between exports and imports and have investigated trade balance sustainability for various countries. Focusing on the studies of the last decade, Arize (2002) investigates the long-run dynamics of exports and imports in 50 developed and developing countries, using the quarterly data from 1973: 2 to 1998: 1, and finds that they were cointegrated in 35 of 50 countries. Baharumshah *et al*. (2003), referring to the annual data of four ASEAN countries (Indonesia, Malaysia, the Philippines and Thailand) from 1961 to 1999, argues that no long-run relationship between exports and imports existed for these nations, except for Malaysia, in the period prior to the Asian financial crisis (1961–1997). Irandoust and Ericsson (2004) examine a cointegrating relationship between exports and imports for six countries—Germany, Sweden, the USA, France, Italy and the UK—and conclude that these were cointegrated in the first three countries; consequently, their trade imbalances were short-run phenomena. Most recently, Konya (2009) investigates this issue, using the quarterly data of the Czech Republic from 1993: 1 to 2006: 1, Slovenia from 1992: 2 to 2006: 1 and Hungary from 1990: 1 to 2006: 1. His study concludes that the shares of exports and imports in GDP were cointegrated in the first two nations, but no such stationary linear combination appeared in the levels of exports and imports of the three.

These earlier studies have applied individual unit root and cointegration tests to each country's time series data. However, it is well known that these tests lack power with small samples. Wu (2000) and Hamori (2009) investigate the long-run relationship between exports and imports by panel unit root and cointegration methodology, which enhances the power of the statistical analysis. Wu relies on the quarterly data of 10 OECD countries (Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, the UK and the USA) from 1977: 1 to 1997: 4, and finds that the trade balance was sustainable. Hamori uses the annual data of G7 countries from 1960 to 2005 and arrives at the opposite conclusion.

Despite the large number of studies on the sustainability of trade balance, little attention has been given to the Sub-Saharan African region. Among the few scholars who have discussed it, Narayan and Narayan (2005) employ the data from the 1960s (or 1970) to 2000 of 22 developing countries, 19 of which are located south of the Sahara desert in Africa. They find that exports and imports were conintegrated for only 6 of the latter group. Their empirical results imply that the trade balance is not sustainable in a large number of Sub-Saharan African countries and, hence, that appropriate policies are required to prevent their trade imbalances from increasing. However, since their analysis is based on individual unit root and cointegration tests, the question of its veractiy remains unanswered.[1]

Furthermore, a problem arises from the fact that the above studies assume that time series data are cross-sectionally independent among countries. This assumption is rather restrictive. Pesaran (2007) argues that panel unit root tests can lead to spurious conclusions if they fail to take account of significant degrees of the cross-section dependence. He proposes a new panel unit root test that allows for such dependence and shows that its presence can make a difference in the results obtained with conventional panel unit root measures and his new one.

This paper empirically analyzes the sustainability of the trade balance using panel data. The contribution of this paper is twofold. First, it is based on data of the Sub-Saharan African region, which has received little attention. Second,

[1] Arize (2002) also used the data of 7 Sub-Saharan African countries, and found that for 5 of them, exports and imports were cointegrated.

in conducting our analysis, we rely on both the conventional panel unit root and cointegration tests and the recently developed tests of Pesaran (2007). Section II of our paper describes the model and data, while Section III reports the empirical results. We find that the latter significantly depends on the techniques used in the analysis.

II. Model and Data

Based on Husted (1992) and other previous studies, let us consider a proxy of the trade balance such as

$$TB_{it} = LEX_{it} - LIM_{it}\,, \tag{1}$$

where i and t denote a country and time, and LEX_{it} and LIM_{it} are the natural logarithm of real exports and real imports, respectively. If LEX_{it} and LIM_{it} are cointegrated with a cointegrating vector of (1,–1), then the trade balance is sustainable.

This paper uses the unbalanced panel data of 37 countries in the Sub-Saharan African region from 1980 to 2006 (see Data appendix). The export of goods and services and the import of goods and services (both measured in constant 2000 US dollars) are used for the empirical analysis. The source of these data is the Word Development Indicator published by World Bank.

As a preliminary analysis, we carried out the panel unit root test (IPS test) developed by Im *et al.* (2003) for the logarithm of exports and imports. As is clear from Tables 1 and 2, the null hypothesis of a unit root is not rejected for the levels of exports and imports, while the null hypothesis of a unit root is rejected for their first difference.[2]

III. Empirical Results

Empirical results with cross-section independence

If exports and imports have cointegrating vectors of the form (1,–1), the trade balance will be stationary. Thus, we perform panel cointegration tests on exports and imports by carrying out panel unit root tests on the yield spreads.

Table 3 shows the empirical results of the IPS tests for 37 countries from 1980 to 2006. As deterministic term specifications, we use two cases: (i) fixed effect and (ii) fixed effect and individual time trend. These are given as follows:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + \sum_{j=1}^{p} c_{ij} \Delta y_{i,t-j} + u_{it}, \quad i=1,2,\ldots,N;\ t=1,2,\ldots,T, \tag{2}$$

and

$$\Delta y_{it} = a_{0i} + a_{1i} t + b_i y_{i,t-1} + \sum_{j=1}^{p} c_{ij} \Delta y_{i,t-j} + u_{it}, \quad i=1,2,\ldots,N;\ t=1,2,\ldots,T \tag{3}$$

where t is the time trend, u_{it} is the error term of *i*-th cross section at time *t* and Δ is the difference operator, i.e. $\Delta y_{it} = y_{it} - y_{i,t-1}$. Equations (2) and (3) give the standard ADF(p) regression with a constant term and with a constant term and

[2] All calculations were implemented with R version 2.9.2 (R Development Core Team, 2009), *Ox* version 4.1 (Doornik, 2006), and Eviews 6.

time trend, respectively, where p is the lag length of the augmented term in ADF regression.

The null hypothesis is that trade balances have unit roots (there is no cointegrating relationship between exports and imports). The alternative hypothesis is that trade balances do not have unit roots (there is a cointegrating relationship between exports and imports). We choose the lag length for the auxiliary regression as $p = 0$ and $p = 1$.

With fixed effects, the test statistic is –1.879 for $p = 0$ and –2.854 for $p = 1$. With fixed effects and individual time trends, the test statistic is –2.587 for $p = 0$ and –3.153 for $p = 1$. In summary, the null hypothesis of no cointegration is rejected in all cases at the 5% significance level. This finding means that trade balances are stationary variables without a unit root and, thus, that exports and imports have cointegrating relationships with a cointegrating vector of the form (1,–1). Our empirical results, therefore, do support the idea that trade balances in the Sub-Saharan African area are sustainable.

Empirical results with cross-section dependence

Panel unit root tests can lead to spurious results if they fail to take account of significant degrees of error cross-section dependence. The problem can be quite serious when such dependence is high. As a result, it becomes important to check the degree of residual cross-section dependence.

We estimate individual ADF(p) regressions without cross-section augmentations for $p=0$ and $p=1$, and then compute pair-wise cross-section correlation coefficients of the residuals from these regressions ($\hat{\rho}_{ij}$). Table 4 gives the cross-section dependence (*CD*) test statistic for unbalanced panels proposed by Pesaran (2004). These are defined as follows:

$$CD = \sqrt{\frac{2}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\sqrt{T_{ij}}\,\hat{\rho}_{ij}\right), \tag{4}$$

$$\hat{\rho}_{ij} = \frac{\sum_{t\in T_i\cap T_j}(e_{it}-\bar{e}_i)(e_{jt}-\bar{e}_j)}{\left[\sum_{t\in T_i\cap T_j}(e_{it}-\bar{e}_i)^2\right]^{1/2}\left[\sum_{t\in T_i\cap T_j}(e_{jt}-\bar{e}_j)^2\right]^{1/2}},$$

$$\bar{e}_i = \frac{\sum_{t\in T_i\cap T_j} e_{it}}{\#(T_i\cap T_j)},$$

where $T_{ij} = \#(T_i \cap T_j)$, T_i is the set of dates over which time series data is available for the *i*-th cross section and $\#(T_i \cap T_j)$ is the number of the elements that are included in the common set $T_i \cap T_j$.

As the table shows, the *CD* statistics for $p=0$ are 3.619 (Case I) and 3.175 (Case II), which are strongly significant at 1%. In the case of $p=1$, the *CD* of Case II is significant at 10%. Three *CD* statistics out of four indicate the presence of cross-section dependence; therefore, panel unit root tests that allow for cross-section dependence are preferable for our analysis.

Pesaran (2007) augments the standard ADF regressions with the cross-section averages of lagged levels and first differences as follows:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \overline{y}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \overline{y}_{t-j} + \sum_{j=1}^{p} \delta_{ij} \Delta y_{i,t-j} + u_{it}, \quad (5)$$

and

$$\Delta y_{it} = a_{0i} + a_{1i} t + b_i y_{i,t-1} + c_i \overline{y}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \overline{y}_{t-j} + \sum_{j=1}^{p} \delta_{ij} \Delta y_{i,t-j} + u_{it}, \quad (6)$$

where $\overline{y}_t = N^{-1} \sum_{j=1}^{N} y_{jt}$. Equations (4.11) and (4.12) give the cross-sectionally augmented DF regression (CADF) with a fixed effect and with a fixed effect and individual time trend, respectively. Thus, the cross-sectionally augmented version of the IPS (CIPS) test statistic takes the following form:

$$CIPS(N,T) = \frac{1}{N} \sum_{i=1}^{N} t_i(N,T), \quad (7)$$

where $t_i(N,T)$ is the cross-sectionally augmented ADF statistic for the *i*-th cross-section given by the *t*-ratio of the coefficient of $y_{i,t-1}$ in the CADF regression.

Table 5 presents the results of the CIPS test that allows for cross-section dependence. Here, the CIPS test statistic is –2.243 for $p = 0$ and –2.104 for $p = 1$, when each CADF regression includes a fixed effect, and –2.310 for $p = 0$ and –2.312 for $p = 1$, when each CADF regression includes a fixed effect and individual time trend. The null hypothesis of a unit root is not rejected at the 5% significance for three out of four cases. Thus, the empirical results indicate that the trade balances in the Sub-Saharan African region are not sustainable, and thus, the findings based on the IPS test may be spurious.

IV. Summary and Conclusion

The trade balance is a key indicator of macroeconomic performance. Since large and persistent trade deficits may lead to various problems, such as the increase of domestic interest rates and the collapse of exchange rates, it is important to observe carefully whether the dynamics of the trade balance is sustainable. If not, appropriate policies must be implemented to prevent the deterioration of the terms of trade.

This paper investigates the sustainability of the trade balance in the Sub-Saharan African regions, using both the IPS test proposed by Im *et al*. (2003) and CIPS test proposed by Pesaran (2007), where the former test is based on the assumption of cross-section independence and the latter allows for it. We first perform the IPS test, which results in the rejection of the null hypothesis of no cointegration in all cases at the 5% significance level. This finding indicates that the trade balance in the Sub-Saharan African regions is sustainable. We next calculate *CD* statistics as proposed by Pesaran (2004) to check the presence of cross-section dependence in error terms of the individual ADF(p) regressions (without cross-section augmentation). This permits the recognition of cross-section dependence; thus, the CIPS test is preferable for our analysis. Unlike the IPS assessment, this test does not reject the null hypothesis of no cointegration in three out of four cases at the 5% significance level. Therefore, it seems rational to conclude that the trade balance in the Sub-Saharan African regions is not sustainable and that the results based on the IPS test may be spurious.

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Data appendix

Country	Sample Period	Country	Sample Period
Benin	1980–2005	Malawi	1980–2006
Botswana	1980–2006	Mali	1980–2006
Burkina Faso	1980–2006	Mauritania	1980–2005
Cameroon	1980–2006	Mauritius	1980–2006
Cape Verde	1986–2006	Mozambique	1980–2006
Chad	1980-2006	Namibia	1980–2006
Comoros	1980–2006	Nigeria	1980–2005
Congo, Dem. Rep.	1980–2006	Rwanda	1980–2006
Cote d'Ivoire	1980–2006	Senegal	1980–2006
Eritrea	1992–2006	Seychelles	1985–2006
Ethiopia	1981–2006	South Africa	1980–2006
Gabon	1980–2006	Sudan	1980–2006
Gambia	1980–2006	Swaziland	1980–2006
Ghana	1980–2006	Tanzania	1990–2006

Guinea	1986–2006	Togo	1980–2005
Guinea-Bissau	1980–2006	Uganda	1982–2006
Kenya	1980–2006	Zambia	1980–2006
Lesotho	1980–2006	Zimbabwe	1980–2005
Madagascar	1980–2006		

Table 1. Panel unit root tests: export

Case I: Intercept only		
	$p = 0$	$p = 1$
IPS (Level)	5.033	4.023
IPS (1st difference)	–19.649	–13.436

Case II: Intercept and Time Trend		
	$p = 0$	$p = 1$
IPS (Level)	–1.368	–2.021
IPS (1st difference)	–17.090	–11.156

Notes: *IPS* denotes the statistics of the panel unit root test, proposed by Im *et al.* (2003), and is asymptotically distributed as the standard Normal distribution. p is the order of augmentation.

Table 2. Panel unit root tests: import

Case I: Intercept only		
	$p = 0$	$p = 1$
IPS (Level)	4.554	3.952
IPS (1st difference)	–21.001	–12.606

Case II: Intercept and Time Trend		
	$p = 0$	$p = 1$
IPS (Level)	–0.067	–1.964
IPS (1st difference)	–20.016	–10.487

Notes: *IPS* denotes the statistics of the panel unit root test, proposed by Im *et al.* (2003), and is asymptotically distributed as the standard Normal distribution. p is the order of augmentation.

Table 3. Panel cointegration tests: trade balance

Case I: Intercept only		
	$p = 0$	$p = 1$
IPS	–1.879	–2.854

Case II: Intercept and Time Trend		
	$p = 0$	$p = 1$
IPS	–2.587	–3.153

Notes: *IPS* denotes the statistics of Im *et al.* (2003) test, and is asymptotically distributed as the standard Normal distribution. p is the order of augmentation.

Table 4. Cross-section correlation of the errors of the individual ADF(p) regressions

Case I: Intercept only		
	$p = 0$	$p = 1$
CD	3.619	1.927

Case II: Intercept and Time Trend		
	$p = 0$	$p = 1$
CD	3.175	1.192

Notes: *CD* denotes the test statistics of cross-section dependence, proposed by Pesaran (2004), and it is asymptotically distributed as the standard Normal distribution. p is the order of augmentation.

Table 5. Panel cointegration tests with cross-section dependence: trade balance

Case I: Intercept only		
	$p = 0$	$p = 1$
CIPS	–2.243	–2.104
Case II: Intercept and Time Trend		
	$p = 0$	$p = 1$
CIPS	–2.310	–2.312
Critical Values of CIPS Distribution		
Significant Level	1%	5%
Critical Values (Case I)	–2.268	–2.133
Critical Values (Case II)	–2.776	–2.640

Notes: *CIPS* denotes the statistics of the cross-sectionally augmented *IPS* test (Pesaran, 2007). Following Pesaran (2007), the critical values of *CIPS* distributions were calculated by Monte Carlo Simulation, under $N = 37$ and

$T = 27$. p is the order of augmentation.