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Revisiting the sustainability of current account deficit: SPSM using the panel KSS Test with a Fourier Function

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Abstract

This study applies the Sequential Panel Selection Method (SPSM) to test the mean reversion properties in the current account balance as percentages of GDP for the ten OECD countries (Australia, Canada, Finland, Germany, Korea, Mexico, Norway, Switzerland, United Kingdom and United States) over the span of 1981Q1– 2010Q4. SPSM classifies the whole panel into a group of stationary countries and a group of non-stationary countries. In doing so, we can clearly identify how many and which series in the panel are stationary processes. Our empirical results indicate that the mean reversion holds true for most of the OECD countries, with the exception of Germany, the United Kingdom and the United States. Our results have important economic implications for the ten OECD countries.

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1. Introduction

The economic implications of current account deficit have long been the focus of research and policy. For an open economy linked to a world market, one important aspect of inter-temporal fiscal plans is the time path of the current accounts, which measures changes in national net indebtedness. Non-stationary or unit root series suffer permanent effects from random shocks and thus the series follow a random walk. Persistent current account deficits might increase domestic interest rates to attract foreign capital, imply increasing interest payments, which imposes government default crisis or an excess burden on future generations. Conversely, in the absence of unit root (stationarity or mean reversion), the country's current account fluctuates around a constant long-run mean and implies the sustainability of the external debt. In this case, the government has no incentive make drastic policy changes and default on its international debts in the near future.

Empirical evidence on the stationarity of current account deficits is abundant but inconclusive thus far. According to Trehan and Walsh (1991), Hakkio and Rush (1991) and Husted (1992), most researchers who study the current-account sustainability use conventional unit root and cointegration tests to investigate the mean-reverting behavior of the current account (Otto, 1992; Ghosh, 1995; Wu et al., 1996; Fountas and Wu, 1999; Apergis et al., 2000; Bergin and Sheffrin, 2000; Liu and Tanner, 2001; Arize, 2002; Baharumshah et al., 2003; Dulger and Ozdemir, 2005; Onel and Utkulu, 2006; Ogus and Sohrabji, 2008; Ismail and Baharumshah, 2008). Motivated by the statistical power of the advances in panel unit root and panel cointegration tests (Levin and Lin, 1993; Maddala and Wu, 1999; Breitung, 2000), an increasing number of authors have applied these new tools to test whether or not the current account imbalance is sustainable in the long run, for example, to name a few, Wu (2000), Wu et al. (2001), Lau and Baharumshah (2005), Lau et al. (2006), Kalyoncu (2006), Holmes (2006) and Chu et al. (2007), to name a few. Chen (2011) examines whether or not the current account deficits for the OECD countries can be characterized by a unit root process with regime switching.

As for the empirical methods for unit root tests, it has been reported that conventional unit root tests — the Augmented Dickey and Fuller (1981, ADF), the Phillips and Perron (1988, PP), and the Kwiatkowski et al. (1992, KPSS) tests, not only fail to consider information across regions, but also have lower power when compared with near-unit-root but stationary alternatives. In this regards, first generation panel-based unit root tests—Levin-Lin-Chu (Levin et al., 2002), the Im-Pesaran-Shin (Im et al., 2003), and the MW (Maddala and Wu, 1999) tests are developed. A serious drawback of the first generation panel-based unit root tests is that they do not take (possible) cross-sectional dependencies into account in the panel-based unit root test procedure. Hence, four second generation panel-based unit root tests of Bai and Ng (2004), Choi (2002), Moon and Perron (2004), and

Pesaran (2007) are proposed. However, they are not informative in terms of the number of series that are stationary processes when the null hypothesis is rejected.

To classify a whole panel into a group of stationary series and a group of non-stationary series, this paper adopts the Sequential Panel Selection Method (hereafter, SPSM), proposed by Chortareas and Kapetanios (2009). This method uses a sequence of panel unit root tests to distinguish between stationary and non-stationary series. For a large panel such as the data in this study, remarked by Chortareas and Kapetanios (2009), if more than one series are actually non-stationary then the use of panel methods to investigate the unit root properties of the set of series may indeed be more efficient and powerful compared to univariate methods. This method first implements a panel unit root test to all time series in the panel and if the null is not rejected we accept the non-stationarity hypothesis and the procedure stops. If the null is rejected then we remove from the set of series the one with the minimum individual DF *t*-test and redo the panel unit root test on the remaining set of series. The procedure is continued until either the test does not reject the null hypothesis or all the series are removed from the set. The end result is a separation of the set of variables into a set of stationary variables and a set of non-stationary variables.

In each trial of SPSM, we develop tests for unit roots that account jointly for structural breaks and non-linear adjustment. Structural breaks are modeled by means of a Fourier function that allows for infrequent smooth temporary mean changes. Perron (1989) argued that if there is a structural break, the power to reject a unit root decreases when the stationary alternative is true and the structural break is ignored. Both Becker et al. (2004, 2006) and Enders and Lee (2004) develop tests which model any structural break of an unknown form as a smooth process via means of Flexible Fourier transforms. Several authors, including Gallant (1981), Becker et al. (2004) and Enders and Lee (2004), and Pascalau (2010), show that a Fourier approximation can often capture the behavior of an unknown function even if the function itself is not periodic. Nonlinear adjustment is modeled by means of an ESTAR model for the 'band of inaction' where time series data may revert to their mean only when they are sufficiently far away from it but behave as non-stationary processes when they are close to their mean. Ucar and Omay (2009) proposed a nonlinear panel unit root test by combining the nonlinear framework in Kapetanios et al. (2003, KSS) with the panel unit root testing procedure of Im et al. (2003), which has been prove to be useful in testing the mean reversion of time series.

The main contribution of this paper is to clearly distinguish stationarity of current account deficit among ten OECD countries, while literatures just validate overall evidence for current account sustainability by conventional panel unit root tests. To the best of our knowledge, this study is the first to date, to utilize the SPSM with KSS unit root test and Fourier function on the stationarity of current account among OECD countries. Overall, our empirical study provides evidence that the mean reversion in current account holds in seven out of the ten countries. The nonstationarity of current accounts among OECD countries still exists for the concern of economic policy.

The remainder of this empirical study is organized as follows. Section 2 presents the data used. Section 3 introduces the theoretical model of current account. Section 4 describes the methodology, the empirical findings and policy implications. Finally, Section 5 presents some concluding remarks.

2. Data

This empirical study employs the current account balance as percentages of GDP. Depending on the availability of data, we focus on ten OECD countries, that is, Australia, Canada, Finland, Germany, Korea, Mexico, Norway, Switzerland, United Kingdom and United States) over the span of 1981Q1– 2010Q4, with 120 quarterly observations for each country. All the data are taken from the OECD database.

3. Theoretical Model

Following Ghosh (1995) and Wu (2000), this study considers a small open economy in which the world interest rate is fixed at r with a quadratic utility function. Under these conditions, the optimal current account can be represented as

$$\mathrm{CA}_t = -\sum_{k=0}^{\infty} \frac{1}{(1+r)} E_t \Delta Y_{t+k} \tag{1}$$

Where $Y_t = Q_t - I_t - G_t$ is the net output or national cash flow; Q_t denotes the country's GDP; I_t is the level of investment; G_t is the level of government expenditure; and CA_t is the current account balance. Eq. (1) states that the current account (CA_t) is determined by future expectations with regard to changes in net output. If Y_t is $I(1)$, the first difference ΔY_t is stationary, which means that CA_t on the left-hand side of Eq. (1) is stationary. Based on these assumptions, current accounts follow a mean-reverting process. Using these results, Wu (2000) and Lau and Baharumshah (2005) have demonstrated that the stationarity of the current account is important for any empirical investigation of the relationship.

4. Methodology and Empirical results

4.1. Methodology

In line with Kapetanios et al. (2003), the KSS test is based on detecting the presence of non-stationarity against a nonlinear but globally stationary exponential smooth transition autoregressive (ESTAR) process. The model is given by

$$\Delta X_t = \gamma X_{t-1}\{1-\exp(-\theta X_{t-1}^2)\} + \nu_t . \tag{2}$$

Meanwhile, X_t is the data series of interest, v_t is an i.i.d. error with zero mean and constant variance, and $\theta \geq 0$ is the transition parameter of the ESTAR model and governs the speed of transition. Under the null hypothesis X_t follows a linear unit root process, but X_t follows a nonlinear stationary ESTAR process under the alternative. One shortcoming of this framework is that the parameter γ is not identified under the null hypothesis. Kapetanios et al. (2003) have used a first-order Taylor series approximation for $\{1-\exp(-\theta X_{t-1}^2)\}$ under the null hypothesis $\theta = 0$ and have then approximated equation (1) by using the following auxiliary regression:

$$\Delta X_t = \xi + \delta X_{t-1}^3 + \sum_{i=1}^{k} \theta_i \Delta X_{t-i} + v_t \qquad t = 1,2,....,T . \tag{3}$$

In this framework the null hypothesis and alternative hypotheses are expressed as $\delta = 0$ (non-stationarity) against $\delta < 0$ (non-linear ESTAR stationarity). The system of the KSS equations with a Fourier function by Becker et al. (2004, 2006) and Enders and Lee (2004) that we estimate here is:

$$\Delta X_{i,t} = \xi_i + \delta_i X^3{}_{i,t-1} + \sum_{j=1}^{k1} \theta_{i,j} \Delta X_{i,t-j} + a_{i,1} \sin\left(\frac{2\pi kt}{T}\right) + b_{i,1} \cos\left(\frac{2\pi kt}{T}\right) + \varepsilon_{i,t} \tag{4}$$

Meanwhile, T is sample size, t is time trend with $t = 1,2,....,T$ and k represents the frequency selected for the approximation, and $[a_{i,1}, b_{i,1}]'$ measures the amplitude and displacement of the frequency component. The rational for selecting $[\sin(2\pi kt/T), \cos(2\pi kt/T)]$ is based on the fact that a Fourier expression is capable of approximating absolutely integrable functions to any desired degree of accuracy. Ludlow and Enders (2000) shows that a single frequency is enough to approximate structural breaks. Thus, we set $k_1 = 1$ in equation (3). As there is no a priori knowledge concerning the shape of the breaks in the data, a grid-search is first performed to find the best frequency.

The SPSM proposed by Chortareas and Kapetanios (2009) are based on the following steps:

(1) The Panel KSS test with/without a Fourier function is first conducted to all series in the panel. If the unit-root null cannot be rejected, the procedure is stopped, and all the series in the panel are nonstationary. If the null is rejected, go to Step 2.

(2) Remove the series with the minimum KSS statistic since it is identified as being stationary.

(3) Return to Step 1 for the remaining series, or stop the procedure if all the series are removed from the panel.

Final result is a separation of the whole panel into a set of mean-reverting series and a set of non-stationary series.

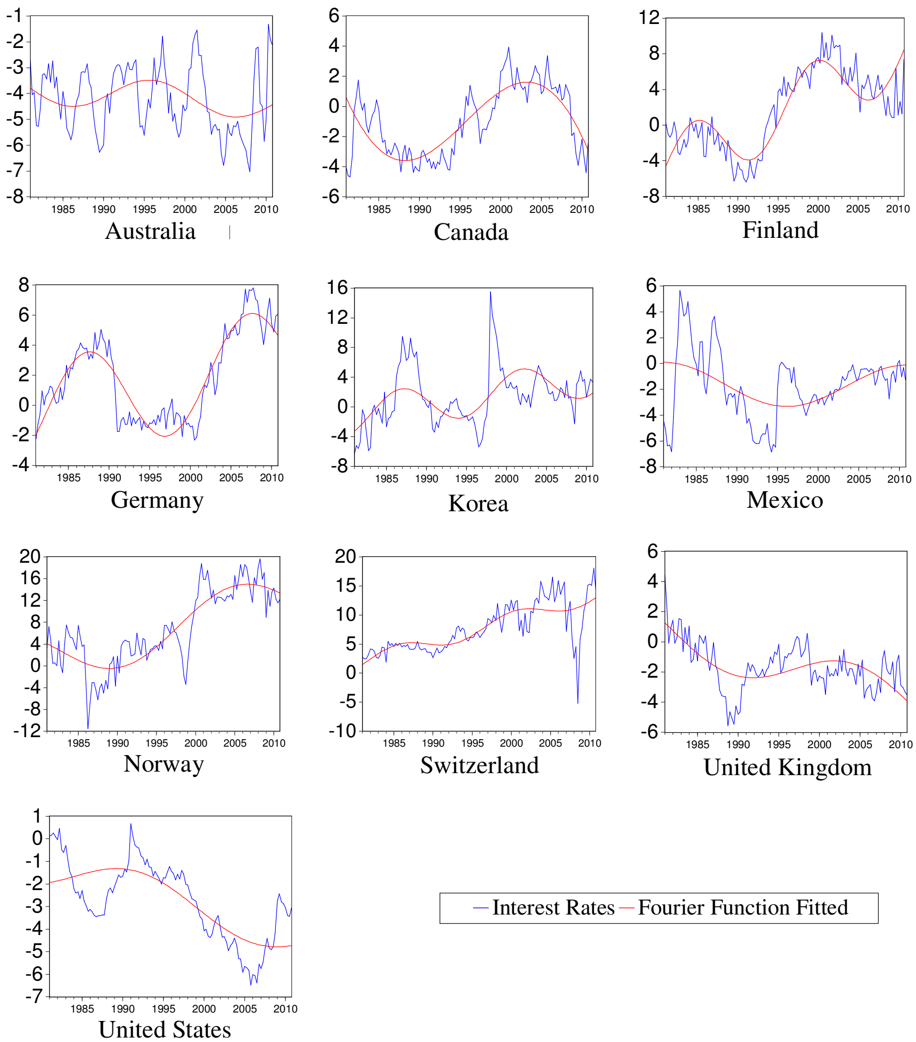

Figure 1 Time Series Plots of Interest Rates for the Current Account as Percentage of GDP and Fitted Nonlinearities (1981Q1– 2010Q4)

4.2. Empirical Results

Figure 1 displays the time paths of the current account balance as percentages of GDP for each OECD country. We can clearly observe structural shifts in the trend of the data. Accordingly, it appears sensible to allow for structural breaks in testing for a unit root (and/or stationarity). The estimated time paths are also shown in the Figure 1. A further examination of the figures indicates that the all Fourier approximations seem reasonable and support the notion of long swings in the current account balance as percentages of GDP.

Tables 1 and 2 report the results for the first generation and second generation panel unit root tests. In Table 1, three first generation panel-based unit root tests all yield the same results, indicating that the current account balance are non-stationary in the ten OECD countries. Conversely, Table 2 shows that based on the second generation panel-based unit root tests, the stationarity does hold among these ten countries.

Table 1. **First Generation Panel Unit Root Tests**

Levin, Lin and Chu (2002)	t_{ρ}^{*}	$\hat{\rho}$	t_{ρ}^{*B}	t_{ρ}^{*C}	
	4.128	-0.071***	2.872	2.903	
	(1.000)	(0.000)	(0.998)	(0.998)	
Im, Pesaran and Shin (2003)	t_bar_{NT}	$W_{t,bar}$	$Z_{t,bar}$	$t\_bar_{NT}^{DF}$	$Z_{t,bar}^{DF}$
	-2.167	-2.402***	-2.341***	-2.716	-4.369***
		(0.008)	(0.010)		(0.000)
Maddala and Wu (1999)	P_{MW}	Z_{MW}			
	35.989**	2.528***			
	(0.015)	(0.006)			

Notes: *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. The numbers in parentheses denote the p-value.

Table 2. **Second Generation Panel Unit Root Tests**

Bai and Ng (2004)	$\hat{r}$	$Z_{\hat{e}}^{c}$	$P_{\hat{e}}^{c}$	MQ_{c}	MQ_{f}
	4	2.571***	36.262**	2	3
		(0.005)	(0.014)		
Moon and Perron (2004)	t_{a}^{*}	t_{b}^{*}	$\hat{\rho}_{pool}^{*}$	t_{a}^{*B}	t_{b}^{*B}
	-18.761***	-5.563***	0.892	-18.970***	-5.608***
	(0.000)	(0.000)		(0.000)	(0.000)
Choi (2002)	P_{m}	Z	L^{*}		
	10.605***	-6.083***	-7.334***		
	(0.000)	(0.000)	(0.000)		
Pesaran (2007)	P^{*}	$CIPS$	$CIPS^{*}$		
	4	-2.864***	-2.864***		
		(0.010)	(0.010)		

Notes: *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. The numbers in parentheses denote the p-value.

To identify how many and which series in the panel are stationary processes, we proceed to the SPSM procedure mixed with the Panel KSS test. As a benchmark, we firstly report the results of the Panel KSS test without a Fourier function. Table 3 shows that, the null hypothesis of unit root was rejected when the Panel KSS test was first applied to the whole panel, producing a value of -2.1972 with a very small *p*-value 0.0018. After implementing the SPSM procedure, we found Australia is stationary with the minimum KSS value of -3.4986 among the panel. Then, Australia was removed from the panel and the Panel KSS test was implemented again to the remaining set of series. After that, we found that the

Panel KSS test still rejected the unit root null with a value of -2.0526 (p-value of 0.0084), and Canada was found to be stationary with the minimum KSS value of -3.028 among the panel this time. Then, Canada was removed from the panel and the Panel KSS test was implemented again to the remaining set of series. The procedure was continued until the Panel KSS test failed to reject the unit root null hypothesis at the 10% significance level. To check the robustness of our test, we continued the procedure until the last sequence. Apparently, the SPSM procedure using the Panel KSS test (without a Fourier function) provided stationary evidence in the current account balances for four out of the ten OECD countries (Australia, Canada, Korea and Norway).

Table 3. Panel KSS Unit Root Test

Sequence	**OU statistic**	**Min. KSS statistic**	**Series**
1	-2.1972(0.0018)***	-3.4986	Australia
2	-2.0526(0.0084)***	-3.028	Canada
3	-1.9307(0.0378)**	-2.7999	Korea
4	-1.8065(0.0792)*	-2.0717	Norway
5	-1.7623(0.1682)	-1.9662	Mexico
6	-1.7215(0.251)	-1.9565	Finland
7	-1.6627(0.2426)	-1.9248	Switzerland
8	-1.5754(0.341)	-1.6502	Germany
9	-1.538(0.1976)	-1.5791	United States
10	-1.4969(0.5472)	-1.4969	United Kingdom

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. The significance level is 5%. The maximum lag is set to be 8. The bootstrap replications are 5000. The numbers in parentheses denote the p-value. OU statistic is the invariant average KSS $t_{i,NL}$ statistic (Ucar and Omay, 2009).

We go for the Panel KSS test with a Fourier function. First, a grid-search is performed to find the best frequency, as there is no a priori knowledge concerning the shape of the breaks in the data. Table 4 reports the results of Panel KSS test with a Fourier function. Particularly, we estimate equation (4) for each Fourier frequency integer k = 1 to 5, following the recommendations of Enders and Lee (2004, 2009) that a small frequency k can capture a wide variety of breaks. From the fourth column at the Table 4, the residual sum of squares (RSSs) indicates the optimal frequency integer k. Similarly, the procedure was again continued until the Panel KSS test failed to reject the unit root null hypothesis at the 10% significance level, and finally we found that the unit root hypothesis are rejected for all the ten OECD countries, with exception of Germany, the United Kingdom and the United States. Our empirical findings suggest that allowing for nonlinearities and structural breaks results in more rejection of the unit root null hypothesis.

Table 4. Panel KSS Unit Root Test with Fourier Function

Sequence	**OU statistic**	**Min. KSS**	**Fourier Frequency (k)**	**Series**
1	-3.3017(0)***	-3.5194	3	Australia
2	-3.2463(0)***	-2.9285	2	Switzerland
3	-3.2433(0)***	-2.9192	1	Canada
4	-2.8777(0.0028)***	-2.8729	1	Norway
5	-2.6914(0.0286)**	-2.7776	2	Korea
6	-2.5641(0.0846)*	-2.2564	2	Finland
7	-2.5709(0.0922)*	-2.0227	1	Mexico
8	-1.9292(0.6404)	-1.9865	3	Germany
9	-1.5309(0.7146)	-1.4901	1	United Kingdom
10	-1.9809(0.4468)	-1.1481	2	United States

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. The numbers in parentheses denote the p-value. The numbers in parentheses denote the p-value. OU statistic is the invariant average KSS $t_{i,NL}$ statistic (Ucar and Omay, 2009).

The major implication that emerges from this study is that stationarity of current account balance is country-specific and occurs along with structural breaks presented by the Fourier function. When current account balance levels deviate persistently from their average level due to some long-lived events, the mean to which they revert presents a temporary break which can lead to acceptance of the unit root null. Furthermore, while literatures based on panel unit root tests supports the evidence of mean reversion in the current account balances, the economist should be mindful of the current account deficits in the three countries, including Germany, the United Kingdom and the United States, uncovered by this empirical study. The volatility of current account balances among these three countries are empirically permanent and worthy of concern for economic stability. What, however, are the most effective policies to address the nonstationarity in current account balances? To answer this, the underlying reasons for the nonstationarity must be identified but that is beyond the scope of this paper; it will be investigated in a future study.

5. Conclusions

This study applies the Sequential Panel Selection Method (SPSM) to test the mean reversion properties in the current account balance as percentages of GDP for the ten OECD countries (Australia, Canada, Finland, Germany, Korea, Mexico, Norway, Switzerland, United

Kingdom and United States) over the span of 1981Q1– 2010Q4. Empirical results from the SPSM using the Panel KSS test with a Fourier function indicate that the mean reversion holds true for all the ten OECD countries, with the exception of Germany, the United Kingdom and the United States. Our results have important economic implications for the ten OECD countries under study.

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