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An Empirical Analysis of Non-Life Insurance Consumption Stationarity*

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This paper explores whether the stationarity hypothesis of non-life insurance consumptions is supported during the period 1979–2005 for 31 countries. The stationarity of insurance consumption has important implications for modelling and forecasting insurance activities. On a global scale, this paper first implements the recent panel seemingly unrelated regressions augmented Dickey–Fuller unit root test, which allows us to account for possible cross-country effects and to identify how many and which countries of the panel contain a unit root. The main conclusion is that whether non-life insurance consumptions are stationary or not will be affected by different regions and their levels of development. Overall, our empirical results illustrate that non-life insurance consumptions in these countries are a mixture of stationary (integrated of order zero) and non-stationary (integrated of order one) processes. Higher risk aversion, lower income level and lower level of insurance market development may lead to non-stationarity. Finally, for the estimated half-lives of Africa, the degrees of mean reversion are greater than those for Europe and America.
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Introduction

The last two decades have seen accelerated growth in insurance markets, and thus insurance market activity is becoming more and more important as the service sector of the world economy has grown substantially since World War II. In 1989, the service sector accounted for approximately 60 per cent of the world's gross domestic product (GDP).[1] The global insurance industry, which makes up a significant portion of the service sector, has grown at a rate of over 10 per cent annually since 1950. It is often argued that the development of the financial sector may have a significant impact on

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[1] UNCTAD (1990).

economic activities. Thus, there is a growing body of literature on the relationship between financial sector development and economic growth.[2]

Insurance, like other financial services, has grown in quantitative importance as an integral part of the general development of the financial sector, with more recently the emphasis increasingly being shifted to insurance business. Outreville[3] argues that the development of an insurance market is significantly related to a country's level of financial development. Holsboer[4] makes the argument that insurance, which is a determinant of economic growth, has earned a prominent role in society. Trichet[5] demonstrates that the insurance sector, acting as a conduit to transfer risk, contributes to economic growth. It is possible that insurance consumption could be a proxy for the development of insurance markets (or activities).[6] Consequently, recent hot issues examine the interrelationship that potentially exists between growth in the insurance industry and macroeconomics, and deduce whether insurance consumptions are stationary.

Few studies at best have used unit root tests to investigate the stationarity characteristics of insurance consumptions. Previous studies lack a diagnostic analysis of the order of integration for the variables entering the long-run relationship as implied by insurance consumption and macroeconomics, which could lead to spurious regression bias.[7] Our motivation for the present research is rooted in whether non-life insurance consumptions are stationary. Stationarity implies that probability laws controlling a process are stable over time. However, series that are non-stationary in levels have a unit root, and shocks change the long-run level of the series permanently.

If insurance consumptions are trend stationary (mean-reverting), then a series should return to its trend path over time, and it should be possible to forecast future movements in insurance activities based on past behaviour. From a consumption point of view, this ensures that one can forecast future movements in insurance activities based on historical behaviour. By contrast, if insurance consumptions are a non-stationary process, then shocks to insurance consumptions are likely permanent. Thus, the random walk (non-stationary) property also implies that the volatility of insurance consumption can grow without bound in the long run, providing information for insurance consumption decisions and strategies.

From an empirical perspective, the order of integration of the variables has critical implications for the appropriate modelling of data. The permanent versus transitory

[2] For example, King and Levine (1993), Arestis and Demetriades (1997) and Shen and Lee (2006).
[3] Outreville (1990, 1996).
[4] Holsboer (1999).
[5] Trichet (2005).
[6] Assuming that the inhabitants of a nation are homogeneous relative to those of other countries, the per capita of non-life insurance premiums (that is, insurance density) represents a country's insurance consumption (Browne *et al.*, 2000).
[7] Granger and Newbold (1974) and Phillips (1986), among others, suggest that a traditional estimation of systems involving non-stationary variables leads to spurious results, because the test statistics no longer follow standard distributions. As a result, if the variables entering the system are non-stationary—I(1)—and non-cointegrated, then the best modelling strategy to circumvent the problems of spurious results is a vector auto-regression in first differences. However, if the variables are I(1) and cointegrated, then a vector error-correction model is suitable for modelling the system.

nature of shocks is related for theoretical models that aim at being consistent with the actual data generating process of the series.[8] Moreover, proper characterisations of the unit root properties of insurance consumptions are essential in econometric modelling. For instance, in testing for causality between insurance activities and macroeconomics, a precondition is that both variables need to be integrated of order one (characterised by a random walk). For policy-makers and finance professionals, Diebold and Kilian[9] also propose that pre-testing for unit roots before applying forecasts yields superior forecasting performance, as opposed to the alternatives of working always with differenced series or working always with level series.

Earlier studies assumed that the data follows stationary processes and used statistical methods were appropriate for that assumption. It is important to check the stationarity of a series before proceeding to an analysis, because some useful properties in stationary series may exist only after taking differences (such as growth rate of insurance consumption) into account; these differences, such as insurance consumption, do not exist in the level series. This research not only updates previous studies, but also extends them by conducting the panel "seemingly unrelated regressions augmented Dickey–Fuller" (Panel SURADF hereafter) test developed by Breuer.[10] According to our knowledge, this is the first fully fledged panel data unit root analysis of non-life insurance consumption encompassing this enlarged set of 31 selected countries globally during the period 1979–2005.

Instead of a time-series data approach,[11,12] this research employs unit root tests for a panel of 31 countries. Because the panel data approach provides more powerful tests and estimates, it allows us to increase the information available coming from the cross-sections. Different from previous papers, we not only investigate one economy or a cross-section of countries as the study's core, but also specialise in the former subject, which is divided into different regional countries or levels of income by the panel data approach. The purpose of this paper is to provide new insights into non-life insurance consumption series proxied by insurance density (per capita of non-life insurance premiums). One thing worth noting is that using panel data creates another problem in which different countries as a whole are treated as an entity and not as a separate unit.[13] As a result, we cannot identify the difference in the stationarity hypothesis of insurance consumption among countries. To partially resolve the homogenous problem in using panel data, we classify the panel data into different sub-panels.

Non-life insurance basically consists of insurance policies that protect the insured against losses and damages other than those covered by life insurance, such as motor, property, pecuniary loss, and marine, aviation, and transport.[14] Different types of insurance, which affect economic activity in different ways, offer diverse kinds of

[8] Aksoy and Leon-Ledesma (2008).
[9] Diebold and Kilian (2000).
[10] Breuer *et al.* (2001).
[11] Ward and Zurbruegg (2000).
[12] Harrington and Yu (2003).
[13] See Lee and Lee (2009).
[14] Braun and Koeniger (2007) also argue that durables, such as cars or houses, which are a substantial component in the balance sheets of households can be insured in the market.

risk management to protect households and corporations. This research focuses on non-life insurance industries, because they facilitate economic transactions through risk transfer and indemnification, and also promote financial intermediation. For example, assets-based (property) insurance protects the value of collateral underpinning the loans, reducing a bank's credit risk exposures and promoting higher levels of lending.[15] In addition, the largest policy-holders of non-life insurance are enterprises, and when they experience large losses, their productivity declines, which may depress economic growth. In this situation, indemnification of non-life insurance for unexpectedly large losses can help corporations to rapidly restructure their productivity.

Table 1 provides a summary of the non-life insurance business of all 31 countries in terms of premium volume, market share, insurance density and insurance penetration for 2005. Premium volume represents non-life insurance premiums written in the reporting country and is a main indicator of the importance of the insurance industry in that country's economy. The share of a country is the ratio of that country's premiums to all 31 countries. Insurance density is calculated by dividing direct gross insurance premiums by the population and represents average insurance spending per capita in a given country. Insurance penetration is the ratio of direct gross premiums to GDP and shows the relative importance of the insurance business in the domestic economy.[16] As can be seen in Table 1, the United States is first in 2005 in premium volume with a 52.77 per cent share, followed by the United Kingdom (8.49 per cent) and Japan (8.48 per cent). The top ten countries with a premium volume of 50 per cent belong to Europe. In insurance penetration, these statistics in 2005 indicate that the insurance business has become increasingly important in financial markets.

The specific aims and contributions of this paper are fivefold. First, our approach is a significant departure from previous studies, as we apply the newly developed Panel SURADF test, which allows us to account for possible cross-country effects and to identify how many and which countries of the panel contain a unit root. After employing this new panel unit root test, we compare the results with those from conventional unit root tests. Therefore, it is the aim of this paper to advance Ward and Zurbruegg's[11] study by examining the relationships between economic growth and growth in the insurance industry for nine economic co-operation and development (OECD) countries.

Second, with respect to the stationarity issue of insurance consumption, it must be kept in mind that all of these studies—in testing for a unit root and in testing the stationarity hypothesis—are joint tests of a unit root for all countries of the panel and they are incapable of determining the mix of I(0) and I(1) series in a panel setting. Not surprisingly, they cannot identify how many and which series in the panel are stationary processes, resulting in mixed empirical findings.

Third, the use of Monte Carlo simulations to derive the empirical distribution of the tests allows us to correct for finite-sample bias.

Fourth, no studies have yet to consider the stationarity of insurance consumption for global data on a group of different regions and income levels. It is argued that the

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[15] Zou and Adams (2006).
[16] See Browne *et al.* (2000).

Table 1 Non-life insurance business of the 31 countries in 2005

Country	*Premiums (U.S.$ millions)*	*Share (%)*	*Rank*	*Insurance density*	*Insurance penetration*
Algeria	542	0.05	28	16.50	0.53
Australia	24,300	2.05	8	1195.34	3.29
Austria	10,064	0.85	11	1222.35	3.30
Belgium	15,367	1.30	10	1466.51	4.14
Canada	44,267	3.73	6	1370.54	3.91
Colombia	1986	0.17	25	43.55	1.49
Denmark	7487	0.63	15	1382.39	2.89
Egypt	461	0.04	30	6.23	0.51
France	68,162	5.75	4	1119.74	3.19
India	4848	0.41	19	4.43	0.60
Indonesia	968	0.08	27	4.39	0.34
Ireland	9801	0.83	12	2356.52	4.89
Italy	47,453	4.00	5	809.68	2.68
Japan	100,523	8.48	3	786.72	2.21
Kenya	348	0.03	31	10.16	1.82
Malaysia	2432	0.21	24	95.95	1.78
Mexico	7524	0.63	14	72.99	0.98
Morocco	1111	0.09	26	36.83	1.88
New Zealand	4788	0.40	20	1168.12	4.36
Norway	6723	0.57	17	1454.16	2.23
Philippines	558	0.05	29	6.72	0.57
Portugal	5244	0.44	18	497.09	2.83
South Africa	7256	0.61	16	154.75	3.00
South Korea	24,085	2.03	9	498.71	3.04
Spain	34,757	2.93	7	800.89	3.09
Sweden	8844	0.75	13	980.05	2.47
Thailand	2860	0.24	23	44.53	1.62
Turkey	4787	0.40	21	66.43	1.32
United Kingdom	100,629	8.49	2	1670.84	4.51
United States	625,838	52.77	1	2111.39	5.05
Venezuela	3254	0.27	22	122.44	2.25
Total	1,185,955	100	—	747.82[a]	2.48[a]

[a]These figures represent weighted averages.
Note: Premium volume represents total non-life insurance premiums written in the reporting country. The share of a country is the ratio of that country's premiums to all members. Insurance density is calculated by dividing direct gross premiums by the population. Insurance penetration is the ratio of direct gross premiums to GDP.

level of insurance consumption can be influenced by income levels and regional specific characteristics.[17–21] Ward and Zurbruegg[18] present evidence that insurance

[17] Enz (2000).
[18] Ward and Zurbruegg (2000).
[19] Esho *et al.* (2004).
[20] Hussels *et al.* (2005).
[21] It should also be noted that Ward (2002) examines the costs of distributing insurance, which is worth discussing as it tackles an under-researched area of the distribution and insurance literature, indicating that regional specific characteristics need critical consideration.

consumptions in OECD countries are less sensitive to changes in income than in the Asian sample. Esho *et al.*[19] also show that insurance consumption is positively correlated with income level. In this regard, this paper is an examination in understanding how it affects the stationarity of insurance consumption.

Fifth and finally, to provide a complete analysis of short-run adjustments and the mean reversion process of insurance consumption, we proceed by measuring the half-lives and the corresponding confidence intervals when stationarity is confirmed. The half-life provides a summary measure of how long it takes for insurance consumption, after facing a unit of shock, to dissipate by one half.

The remainder of the paper is structured as follows. The next section clarifies the reason why it is useful to know that insurance consumptions are stationary. The subsequent section provides the methodology and discusses the advantage of the Panel SURADF unit root test. The penultimate section presents the data and empirical results. The conclusions for empirical research as well as the policy implications are discussed in the final section.

Why does the stationarity of insurance consumption matter?

The stationary characteristic of insurance consumption should be seriously considered when conducting economic or financial policies. First, the unit root is transferred to other macroeconomic variables when insurance consumptions are non-stationary. Hence, failure to reject the null hypothesis implies a non-stationary series, in which shocks in insurance consumption have permanent effects. This is consistent with path dependency or hysteresis in insurance consumption. Second, a rejection of the null supports the alternative hypothesis of a stationary series in which shocks in a country's insurance consumption have temporary effects. If insurance consumptions are non-stationary and characterised by hysteresis or path dependency, then shocks have permanent effects on insurance consumed. Third, whether key macroeconomic variables are stationary or not has important implications for alternative economic theories, which suggest different conclusions on the desirability and efficiency of government intervention through the use of stabilisation policies. If shocks to insurance consumption are permanent, then an insurance policy has long-lasting effects. When insurance consumption temporarily deviates from the trend path, the government's administrative policy should not be to adopt unnecessary targets. Finally, insurance consumption shows stationarity, making it possible for the series to forecast future movements in insurance consumption established on past behaviour. If insurance consumptions are non-stationary, then past behaviour has no value in forecasting future activities of the insurance market, and one needs to look at other variables explaining insurance consumption in order to generate forecasts of future insurance demand.

Among the few studies to date employing unit root tests to examine the stationarity characteristics for insurance consumption, Cummins and Outreville[22] implement unit

[22] Cummins and Outreville (1987).

root tests with panel data to investigate the stationary processes of insurance consumption. Niehaus and Terry[23] test written premiums, losses paid and surpluses from 1946 to 1988 and find that the hypothesis of a unit root is not rejected, which is not inconsistent with stationarity. Haley[24] investigates the stationarity of underwriting margins from 1930 to 1989 and from 1949 to 1992, and the unit root hypothesis is not rejected.[25] Ward and Zurbruegg[11] employ the Phillips and Perron[26] unit root test and demonstrate that the insurance premiums written are non-stationary for nine selected OECD countries from 1961 to 1996.

Understanding the process of insurance consumption can be vital in order to distinguish among theories that most accurately describe observed behaviour. Insurance services are capable of generating a significant productive impact within an economy. To facilitate newly developed econometric techniques, the purpose of most research studies has been to investigate whether macroeconomic variables take precedence over insurance consumption if insurance consumption can boost those variables. In other words, insurance consumption always has aligned relationships with an economic system and is vitally correlated with the economic system.

Browne *et al.*[16] explain a substantial proportion of the variation in property-liability insurance consumption across countries belonging to OECD. Ward and Zurbruegg[11] examine the dynamic relationships between economic growth and insurance industry growth. The statistical and econometric methodology used in the research on this subject has been very diverse, yet the only procedure is unanimous, in testing whether insurance consumptions are stationary or not. Harrington and Yu[12] try to apply a battery of unit root tests to investigate whether underwriting margins are stationary under different assumptions concerning deterministic components in the data-generating process.

As can be seen in Niehaus and Terry,[23] market imperfections play a critical role in the reason why insurance consumption can be an I(1) process. From the aspect of rational expectations, the fundamental premium setting by insurers is the present value of expected future losses, in which expectations are formed employing all relevant information in a perfect market. Insurance consumptions are therefore the best predictor of future losses in the sense that premiums aggregate all related information. However, Venezian[27] provides an alternative hypothesis whereby insurance premiums are backward-looking. Premiums may be biased predictors of future losses under his aspect, because unexpected past losses influence premiums even if these unexpected losses offer little information about future loss payments. Thus, unexpected past loss data contributes to explain current premiums even after controlling for expected future loss payments. Winter[28] presents the same arguments in which premiums are not the best predictors of future losses—that is, insurance consumption depends on both

[23] Niehaus and Terry (1993).
[24] Haley (1993, 1995)
[25] Others can be found in Leng (2006).
[26] Phillips and Perron (1988).
[27] Venezian (1985).
[28] Winter (1994).

expected future loss payments and the past value of surplus. Consequently, current insurance consumption should be explained by future losses and past information.

There is an ongoing liberalisation of capital markets for foreign investors. Many countries have opened up their stock markets to foreign investors with minimal restrictions. Thus, their capital markets are accessible to more and more foreign investors, who are now allowed to manage derivative financial products instead of other commodities. The structure of cost has also changed. Insurance covers uncertain insured events in the future and provides promises of indemnification in the case of any loss. This uncertain promise of future indemnification includes three aspects: whether it will happen or not, when it will happen and the scale of loss. Therefore, the uncertainty of these three aspects causes the structure of operational cost to be uncertain.

The value of the premium varies with the value of insured property and fare. The value of the fare in turn is based on past statistical experience to estimate a possible future outcome. Consequently, the prediction uncertainty of the actuary science constitutes the second source of operational cost, while investment activities are influenced by future economic and social factors or environmental change, thus increasing the third source of operational cost.[29] We may also consider the effect of macroeconomic shocks on insurance consumption. As can been seen in Guo *et al.*,[30] since insurance premium rates are usually based on projected investment income and expected losses subject to business cycles, it seems reasonable to expect macroeconomic variables to have significant effects on insurance consumption over time.

A common feature of the panel unit root tests in practice is that they maintain the null hypothesis of a unit root in all panel members. Thus, their rejection indicates that at least one panel member is stationary, with no information about the number of series or which ones are stationary. Unlike extant panel unit root tests that deliver conclusions only about the panel as a whole, our Panel SURADF test provides information about the number and identity of the panel countries that reject or do not reject the null hypothesis of a unit root. When a series is non-stationary, testing for the presence of cointegration among the variables can be conducted, whereas others may employ the traditional regression model.

Ward and Zurbruegg[11] argue that the importance of insurance markets to an economy may derive from the rate of the structural change of insurance provision rather than its level of activity. In this regard, it is meaningful to discuss whether shocks to the paths of insurance consumption are permanent or temporary. Although the business model works whether insurance consumptions are stationarity or not, one should note the significance of stationarity characteristics for insurance consumptions. However, even when insurance consumptions are an I(1) process, penetration does not grow indefinitely without a dramatic change in insurers' business model. One hundred per cent penetration implies that the entire GDP will be channelled through the insurance industry and that most of the policies will produce losses. Such a business

[29] According to the Directorate General of Budget, Accounting, and Statistics.
[30] Guo *et al.* (2009).

model is costly, inefficient and marginalises the idea of risk transfer, which is at the heart of insurance.[31]

Methodology

At the beginning of our analyses we check for unit roots, because: (i) Stock and Watson[32] argue that the causality tests are very sensitive to the stationarity of the series; and (ii) Nelson and Plosser[33] state the fact that many macroeconomic series are non-stationary. Breuer *et al.*[10] claim that the common problem of the conventional panel tests mentioned above is that they maintain the null of the unit root in all panel members. Therefore, their rejection indicates that at least one panel member is stationary, with no information about the number of series or which ones are stationary.[34]

In expanding upon this issue, Breuer *et al.*[10, 35] develop a panel unit root test that involves the estimation of the augmented Dickey–Fuller (ADF) regression in a seemingly unrelated regressions (SUR) framework and then test for the individual unit root within the panel members. This procedure has several advantages. First, these multivariate tests use the information content in the variance–covariance matrix, such that the unrealistic assumption of cross-section independence made in the panel tests can be avoided. Second, conventional univariate unit root tests not only fail to consider information across regions, but are also restricted regarding the problem of a small sample, thereby leading to less efficient estimations.[36] For this reason, we implement multivariate ADF-type unit root tests that have better power properties than their univariate counterparts. Exploiting the information from the error covariance and allowing for an autoregressive process will produce more efficient estimators than the single-equation methods.

A third advantage is that the estimation tests also allow for an important degree of heterogeneity in the lag structure across the panel members, in that the lag order of the augmented test can vary among the individuals and the autoregressive parameter can also differ for every cross-section. A fourth advantage is that the Panel SURADF unit root test allows us to identify how many and which members of the panel contain a unit root.[29] Sarno and Taylor[37] point out that the conventional types of panel unit root tests are biased towards being stationary, if only one serie is strongly stationary.

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[31] The authors thank an anonymous referee's kind suggestions.
[32] Stock and Watson (1989).
[33] Nelson and Plosser (1982).
[34] Mark (2001) argues that one potential pitfall with the panel test is that the rejection of the non-stationarity hypothesis does not mean that all series are stationary. It is possible that out of N time-series, only one is stationary and $(N-1)$ have a unit-root process.
[35] Breuer *et al.* (2002).
[36] See Chiu (2002).
[37] Sarno and Taylor (1998).

The unit root test of the Panel SURADF for N countries and T time periods is based on the system of ADF equations, which can be represented as

$$\begin{aligned}
\Delta X_{1,t} &= \alpha_1 + \beta_1 X_{1,t-1} + \gamma t + \sum_{j=1}^{k1} \varphi_{1,j} \Delta X_{1,t-j} + \varepsilon_{1,t}, \quad t = 1, 2, ..., T \\
\Delta X_{2,t} &= \alpha_2 + \beta_2 X_{2,t-1} + \gamma t + \sum_{j=1}^{k2} \varphi_{2,j} \Delta X_{2,t-j} + \varepsilon_{2,t}, \quad t = 1, 2, ..., T \\
&\vdots \qquad\qquad\qquad \vdots \\
\Delta X_{N,t} &= \alpha_N + \beta_N X_{N,t-1} + \gamma t + \sum_{j=1}^{kN} \varphi_{N,j} \Delta X_{N,t-j} + \varepsilon_{N,t}, \quad t = 1, 2, ..., T
\end{aligned} \tag{1}$$

where X denotes insurance consumption (proxied by insurance density), and $\varepsilon_{i,t}$ ($i = 1, 2, \ldots, N$) is an error term. Coefficient α_i is the heterogeneous constant term, $\beta_i = \rho_i - 1$, and ρ_i is the autoregressive coefficient for the i^{th} cross-sectional member of the series, while t denotes the deterministic time trend.

Equation (1) tests the null hypothesis of a unit root against the trend stationarity. The model allows for heterogeneous fixed effects, heterogeneous trend effects and heterogeneous lags for each cross-sectional unit in the panel. The flexibility to test for a unit root within each cross-sectional unit is especially beneficial for applied work in which mixed stationary and non-stationary series are likely. This system is estimated by the SUR procedure, and we test the N null (H_o^i) and alternative hypotheses (H_A^i) individually as

$$\begin{aligned}
&H_0^1 : \beta_1 = 0;\ H_A^1 : \beta_1 < 0 \\
&H_0^2 : \beta_2 = 0;\ H_A^2 : \beta_2 < 0 \\
&\vdots \qquad\qquad \vdots \\
&H_0^N : \beta_N = 0;\ H_A^N : \beta_N < 0.
\end{aligned} \tag{2}$$

The test statistics are computed from the SUR estimated system while the critical values are generated by Monte Carlo simulations. The estimated 1, 5 and 10 per cent critical values are obtained from the simulations and 10,000 replications by using the lag and covariance structure from the panel of insurance consumption. As Breuer *et al.*[10] show that the imposition of an identical lag structure across panel members could bias the test statistics, we select the lag structures for each equation based on the method of Perron.[38] The major difference lies in the formulation of the null hypothesis between the Panel SURADF and other panel unit tests, such as the multivariate augmented Dickey–Fuller test of Sarno and Taylor,[37] and the Levin *et al.* (LLC)[39] and

[38] The lag parameters are selected based on the recursive t-statistic as suggested by Perron (1989). The maximum lag length for the general to specific methodology is set at 8.
[39] Levin *et al.* (2002).

Im *et al.* (IPS)[40] tests. While the other tests are joint tests of a unit root for all panel members, the Panel SURADF tests investigate a separate unit root null hypothesis for each individual panel member and therefore identify precisely how many and exactly which ones among the series in the panel are stationary processes.

Breuer *et al.*[10] remind us that outcomes differing from the univariate ADF test may arise for several reasons. First, a non-zero covariance matrix introduces more information into the estimation and results in lower standard errors. Second, the coefficient of the lag term moves either closer to or farther away from zero. Third, the critical values for the Panel SURADF change. They are higher in absolute value than the single-equation Dickey–Fuller[41] test. In all cases, the power of the SURADF exceeds the ADF test.[35]

Breuer *et al.*[35] document the power of the SURADF test in various environments regardless of whether the series are I(0) or not I(0). The advantage of the Panel SURADF is that it analyses the variables without imposing uniformity across the panel under either the null or alternative hypotheses in accordance with the SURs. More importantly, this testing procedure enables us to handle heterogeneous serial correlation across panel observations, especially when residual cross-correlations are high. Although the Panel SURADF test is needed to simulate critical values specific to each empirical environment, such simulations generally increase the power of the test for hypotheses such as those in the other panel tests.

Even more importantly, the unit root tests are uninformative as to the speed of mean reversion. Alternatively, the "half-life" of deviation—which is defined as the number of periods required for a unit shock to dissipate by one-half—measures the degree of mean reversion and the speed of adjustment back towards the long-run equilibrium. To motivate this measure, suppose that the deviations of the insurance consumption series $X_{i,t}$ from its long-run value $X_{i,0}$ follow an AR(1) process:

$$X_{i,t} - X_{i,0} = \alpha(X_{i,t-1} - X_{i,0}) + \varepsilon_{i,t}, \tag{3}$$

where ε is a white noise. The half-life deviation h is defined as the horizon at which the percentage deviation from the long-run equilibrium is one-half—that is

$$\alpha^h = \frac{1}{2} \Rightarrow h = \frac{\ln(1/2)}{\ln(\alpha)}. \tag{4}$$

A conventional 95 per cent confidence interval associated with the above half-life statistic based on normal distributions is then defined as

$$\hat{h} \pm 1.96\,\hat{\sigma}_{\hat{\alpha}}\left(\frac{\ln(0.5)}{\hat{\alpha}}[\ln(\hat{\alpha})]^{-2}\right). \tag{5}$$

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[40] Im *et al.* (2003).
[41] Dickey and Fuller (1979).

Table 2 List of selected region countries from *World Development Indicators*

Europe			
Austria	Belgium	Denmark	France
Ireland	Italy	Norway	Portugal
Spain	Sweden	United Kingdom	
Asia and Pacific			
Australia	India	Indonesia	Japan
South Korea	Malaysia	New Zealand	Philippines
Thailand	Turkey		
America and the Caribbean			
Canada	Colombia	Mexico	United States
Venezuela			
Middle East and Africa			
Algeria	Egypt	Kenya	Morocco
South Africa			

Here, $\hat{\sigma}_{\hat{\alpha}}$ is an estimate of the standard deviation of α.[42] Since h cannot be negative, we impose a lower bound of zero.

Data and empirical results

As can be seen in Table 2, our study uses annual time series for 31 countries in four regions. Annual data for insurance consumption, which is proxied by insurance density defined as per capita of non-life insurance premiums, is taken from the Swiss Reinsurance Company, and all variables are taken into a log term. We use the time period 1979–2005, because of the availability of empirical data.

We start by testing for the presence of a unit root in insurance consumption using the ADF,[41] DF-GLS,[43] PP,[26] KPSS[44] and NP[45] unit root tests. Next, and very important to note, is that in conducting the unit root tests the selections of the optimal lag length and the optimal bandwidth have the greatest effects on the results. The estimation method in this research utilises not only the modified Akaike information criterion—as put forth by Ng and Perron[45]—in the ADF, DF-GLS and the NP tests for the selection of the optimal lag length, but also the kernel-based criteria—as put forth by Newey and West[46]—in the PP and the KPSS tests for the selection of the bandwidth. Table A1 (see Appendix A) reports the results of these univariate unit root tests with intercept and trend. There are different results for different methods, as well as for different regions (or income levels).

[42] See Rossi (2005) for more details.
[43] Elliott *et al*. (1996.
[44] Kwiatkowski *et al*. (1992).
[45] Ng and Perron (2001).
[46] Newey and West (1994).

Table 3 Panel SURADF tests and critical values (11 European countries)

Country panel label	*Panel SURADF statistics*	*Critical values*		
		0.01	*0.05*	*0.1*
Austria	−6.097**	−6.121	−5.494	−5.082
Belgium	−3.082	−5.719	−5.008	−4.649
Denmark	−4.920	−6.309	−5.659	−5.312
France	−4.855	−6.258	−5.582	−5.215
Ireland	−3.200	−5.800	−5.105	−4.712
Italy	−2.913	−4.894	−4.213	−3.840
Norway	−3.547	−5.676	−4.986	−4.599
Portugal	−2.021	−5.760	−5.086	−4.695
Spain	−3.943	−6.126	−5.430	−5.047
Sweden	−5.073***	−5.055	−4.411	−4.038
United Kingdom	−2.870	−5.211	−4.536	−4.159

Notes: ** and *** indicate respective significance at the 5 per cent and 1 per cent levels. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al*., 2001).

As shown in Table A1, the ADF (1979) unit root tests reject the unit root null for approximately 10 per cent of the countries at the 10 per cent level or better, the DF-GLS (1996) tests only reject null hypotheses for 7 per cent of the countries at the 1 per cent level, the PP (1988) tests only reject the unit root null for 7 per cent of the countries at the 5 per cent level or better, and the NP (2001) tests (MZ_{α}^{GLS}) do not reject the unit root null for all countries. In addition, the KPSS (1992) tests reject the null hypotheses of stationarity for 20 per cent of the countries at the 10 per cent level or better.[47] The results of different tests are mixed and conflicting. A possible reason for the failure of these univariate tests is in having low power due to the short time span of the data.

There are good reasons to believe that considerable heterogeneity exists in these countries under investigation, and thus the traditional panel unit roots applied may present misleading inferences. Tables 3–6 provide the Panel SURADF tests and the critical values for different regions. As the SURADF test has non-standard distributions, the critical values need to be obtained via simulations. In the data generation phase of the simulation, the intercepts and the coefficients on the lagged values for each series were set equal to zero. The estimated 1, 5 and 10 per cent critical values are obtained from Monte Carlo simulations based on 27 observations for each series and 10,000 replications by using the lag and covariance structure from the panel of insurance consumption. Since the SUR estimation takes into account error correlation, which will be different for different data series, the critical values for the SURADF are different for each series.

[47] The null hypothesis of the KPSS test examines for I(0), while the null of the remaining four tests examines for I(1).

Table 4 Panel SURADF tests and critical values (ten Asian and Pacific countries)

Country panel label	*Panel SURADF statistics*	*Critical values*		
		0.01	*0.05*	*0.1*
Australia	−1.917	−3.779	−3.204	−2.883
India	−1.879	−3.798	−3.230	−2.923
Indonesia	−0.892	−3.873	−3.308	−2.985
Japan	−2.902	−4.137	−3.503	−3.188
South Korea	−2.690	−4.450	−3.825	−3.486
Malaysia	−0.504	−4.590	−3.983	−3.659
New Zealand	0.216	−4.036	−3.445	−3.125
Philippines	−1.727	−4.008	−3.418	−3.089
Thailand	−1.742	−4.906	−4.261	−3.925
Turkey	−0.342	−3.805	−3.244	−2.951

Notes: Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al.*, 2001).

Table 5 Panel SURADF tests and critical values (five American and Caribbean countries)

Country panel label	*Panel SURADF statistics*	*Critical values*		
		0.01	*0.05*	*0.1*
Canada	−5.033***	−3.491	−2.902	−2.603
Colombia	−2.800*	−3.588	−3.001	−2.670
Mexico	−5.719***	−3.612	−3.029	−2.735
United States	−1.370	−3.473	−2.911	−2.624
Venezuela	−0.569	−3.430	−2.893	−2.585

Notes: * and *** indicate respective significance at the 10 per cent and 1 per cent levels. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al.*, 2001).

Table 6 Panel SURADF tests and critical values (five Middle East and African countries)

Country panel label	*Panel SURADF statistics*	*Critical values*		
		0.01	*0.05*	*0.1*
Algeria	−1.983	−3.564	−2.994	−2.684
Egypt	−1.324	−3.487	−2.947	−2.678
Kenya	−2.204	−3.500	−2.893	−2.621
Morocco	−3.029*	−3.704	−3.159	−2.868
South Africa	−1.586	−3.701	−3.158	−2.865

Notes: * indicates significance at the 10 per cent level. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al.*, 2001).

We report results for four regional panels (Europe, Asia and the Pacific, America and the Caribbean, and Middle East and Africa). Our main finding is that we are able to reject the null hypothesis of panel non-stationary at the 5 per cent level or better, as seen in Table 3, for Europe except for Austria and Sweden; at the 10 per cent level or

Table 7 Summary of Tables 3–6

Region	*Number of countries*	*Number of stationary countries (10% level)*	*Country name*
Europe	11	2	Austria, Sweden
Asia and Pacific	10	0	—
America and the Caribbean	5	3	Canada, Colombia, Mexico
Middle East and Africa	5	1	Morocco
Total	31	6	—

better, as seen in Table 5, for America and the Caribbean except for Canada, Colombia and Mexico; and as also can be seen in Table 6, we are able to reject the null hypothesis of non-stationary at the 10 per cent level for Morocco. Note, however, that the null hypothesis of non-stationarity cannot be rejected for all Asia and the Pacific countries in Table 6. Table 7 offers a more detailed understanding of those relationships. Our results match the findings of Ward and Zurbruegg[11] except for Austria and Canada.

We find that different reasons of stationarity exist between regions. Table 7 presents the numbers of countries that are stationary. The empirical results provide three views that could explain why insurance consumptions are stationary or not. First, countries with a median level of insurance market development may see it as easier to have stationary characteristics. As shown in Tables 3, 5 and 6, the ratios of those countries that are stationary are approximately their average. They include Austria and Sweden in Europe, Canada, Colombia and Mexico in America and the Caribbean, and Morocco in Middle East and Africa. Second, a higher insurance penetration ratio is not necessary for stationarity, such as Japan and South Korea in Asia and Pacific. Third, the less risk aversion there is, the higher the possibility will be for stationarity. Browne *et al.*[16] present that risk aversion as negatively related to premium density. Canada, Colombia and Mexico in America and the Caribbean, as well as Morocco in the Middle East and Africa show higher premium density, and thus insurance consumption has a stationarity process.

In order to check the robustness of our results, it is worthwhile providing some insights on the likely reasons for our findings. This study implements an alternative version categorised by different income levels. Tables B1–B2 in Appendix B provide the results of Panel SURADF tests and critical values between two different income levels, including high- and low-income levels. They are classified according to World Bank estimates of 2004 GNI per capita. Remarkably, in the two cases our results are robustly supported by taking income level into account, and they are consistent with the findings from Browne *et al.*[16] Our own findings suggest that whether insurance consumptions are stationary or not will be affected by different regions or income levels during the period 1979–2005.

Another version considers the structural changes for the Panel SURADF unit root method. It is widely agreed in empirical studies that macroeconomic series are typically affected by the effects of exogenous shocks and regime changes. Researchers have been mindful of the need to allow for structural breaks when testing for a unit root.[48] In order to obtain robust test results, this study goes further to perform the Zivot and Andrews (ZA hereafter)[49] unit root test with a panel SUR framework.

There are two important differences in our testing approach. First, ZA (1992) extend the ADF approach by endogenising the break point determination. Second, the method of SURADF has the capability to consider a structural break by applying ZA estimations, which is called the panel SURZA test. Tables C1–C4 in Appendix C provide the estimated breakpoint for each country, the Panel SURZA tests and the critical values for different regions. The results are almost the same as prior results of the Panel SURADF test. Therefore, after considering the influence of a structure break, we conclude that our important findings—of whether insurance consumption being stationary or not will be affected by regions—do not change.

The break dates are worth a more detailed discussion. The fact that a number of critical insurance or economic events occurred in the past can be overlooked. The earliest period of breaks is mostly found around the bankruptcy crisis of American insurance companies from 1982 to 1985, which impacted heavily on the global insurance market. Countries that suffered from this include Australia, Colombia, Philippines, Portugal, South Africa, Turkey, the United States and Venezuela. Similar arguments are also reported in Leng *et al.*[50] and Meier.[51] The structural break occurs later, mainly in the three-year period of 1997–1999, when the Asian Financial Crisis took place. This prompted the following countries to experience breaks: Austria, Denmark, France, Indonesia, Japan, Malaysia, Norway, South Korea, Spain and Thailand. Some other related events, such as the economic crisis of African countries in the late 1980s and early 1990s and Iraq's 1990 invasion of Kuwait, and the subsequent end to the decade of declining oil prices, also caused structural breaks.

In the above analysis, the stationarity of insurance consumption can be verified by performing unit root tests to determine whether they contain a unit root. However, the unit root test alone may not be sufficient to justify the adjustment dynamics of a long-run equilibrium for insurance consumption. They are uninformative as to the degree of mean reversion. It is likely that although the unit root hypothesis is rejected, deviations are still persistent. What we are interested in is the insurance consumption of the speed of convergence to the long-run equilibrium. One measure of the degree of mean reversion that has attracted a lot of attention in the literature is the half-life. Recently, the point estimates of the half-lives alone provide an incomplete description of the speed of convergence towards the long-run equilibrium. To this end, the corresponding confidence intervals are computed to provide better indications of uncertainty around the estimates of half-lives.

As can be seen in Table 8, which represents the half-lives and their confidence intervals, the half-lives of income-based groups (Panel B) approximately range from 0.25 to 8.22 years. The half-lives are between 0.25 and 8.22 years among high-income level countries, dropping from a much higher time of 2.39–5.54 years among the

[48] Lee and Chang (2008).
[49] Zivot and Andrews (1992).
[50] Leng *et al* (2002).
[51] Meier (2006).

Table 8 Estimated half-Lives and confidence intervals (CI)

Country	*β*	*Half-life*	*CI at 95%*
Panel A. Regions			
Europe			
Austria	−0.1295	5.00	[0, 11.50]
Sweden	−0.2372	2.56	[0, 5.52]
America and the Caribbean			
Canada	−0.9353	0.25	[0, 0.83]
Colombia	−0.2513	2.39	[0, 5.56]
Mexico	−0.1176	5.54	[1.84, 9.24]
Middle East and Africa			
Morocco	−0.2543	2.36	[0.38, 4.35]
Panel B. Income level			
High income countries			
Australia	−0.2520	2.39	[0, 5.95]
Austria	−0.1295	5.00	[0, 11.50]
Canada	−0.9353	0.25	[0, 0.83]
Japan	−0.0809	8.22	[0, 18.44]
Sweden	−0.2372	2.56	[0, 5.52]
Low income countries			
Colombia	−0.2513	2.39	[0, 5.56]
Mexico	−0.1176	5.54	[1.84, 9.24]

Note: The method of estimation of confidence intervals (CI) for half-lives is proposed by Rossi (2005); see Rossi (2005) for more details.

low-income level countries. For high-income level countries, the adjustment speeds to long-run equilibrium are much slower than those of low-income level countries. In addition, from the region view (Panel A) the half-lives are 0.25–5.54 years between Europe and America, falling from 2.36 years for Africa. This implies that for Africa, the degrees of mean reversion are greater than those for Europe and America.

Conclusions

This paper employs data from 31 countries in four regions (Europe, Asia and the Pacific, America and the Caribbean, and Middle East and Africa) from 1979 to 2005 to examine the stationarity properties of non-life insurance consumption by applying the newest developed Panel SURADF test of Breuer *et al.*[10] Our results report new findings for the current literature. The main conclusion is that whether insurance consumptions are stationary or not will be affected by regions. The results also reveal that conventional panel unit root tests can result in misleading inferences, which are biased towards stationarity even if only one series in the panel is strongly stationary. Similar results are obtained when we divide the sample into income groups (high- and low-income levels) following the classification criterion of the World Bank.

By inspecting the results as a whole, we find that non-life insurance consumption in the 31 countries is a mixture of I(0) and I(1) processes, and there is weak evidence to support the convergence of insurance consumption. However, the null of non-stationarity is rejected in some selected countries. These results reveal that conventional panel unit root tests can lead to misleading inferences in which they are biased towards stationarity, even if only one series in the panel is strongly stationary.

Some policy implications emerge from our results. First, we are able to reject the null hypothesis of a unit root in some countries, which might have to do with a government's financial policy. The findings imply that, without considering the influence of a new system, insurance consumption will not be inherited if there is a shock to insurance consumption in respect of the Panel SURADF unit root test. The findings of stationarity also suggest that exogenous shocks (like financial crises or critical economic events) do not have any permanent effect on insurance consumptions. These factors are transitory and will have short-run effects on insurance markets.

Second, insurance consumptions being non-stationary in most countries means that future insurance activities cannot be predicted based on past insurance premiums. This, in turn, suggests that institutional and regulatory mechanisms will not be as important, compared with the situation in which insurance premium movements could be exploited to make profits using technical analysis.

Third, for forecasting purposes, the fact that non-life insurance premiums exhibit a random walk for most countries means that it is not possible to forecast future movements in premiums based on past behaviour, at least for the timeframe considered in this study.

Finally, our results suggest that different reasons, such as higher risk aversion, lower income level and lower level of insurance market development, may lead to non-stationarity.

For the persistence measures, the estimated half-lives and their confidence intervals, the income level-based half-lives approximately range from 0.25 to 8.22 years. For high-income level countries, the adjustment speeds to the long-run equilibrium are much slower than those for low-income level countries. In addition, for Africa the degrees of mean reversion are greater than those for Europe and America. Finally, it is worth highlighting the fact that our study has opened up some directions for future research on insurance consumption. Future studies can employ Panel SURADF tests on other financial or macroeconomic variables, such as urbanisation and demographic conditions.

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Appendix A

The results of univariate unit root tests

See Table A1.

Table A1 Univariate unit root tests results of 31 countries

Country	*ADF*	*DF-GLS*	*PP*	*KPSS*	*NP* (MZ_{α}^{GLS})
Algeria	−1.103 (1)	−1.543 (1)	−1.051 (3)	0.116 (3)	−13.091
Australia	−1.454 (0)	−1.741 (0)	−1.454 (0)	0.104 (2)	−5.736
Austria	−3.100 (0)	−2.444 (0)	−3.211 (2)	0.098 (3)	−4.998
Belgium	−2.669 (0)	−2.183 (0)	−2.750 (1)	0.066 (2)	−4.378
Canada	−4.891 (0)***	−5.098 (0)***	−4.891 (1)***	0.073 (2)	−12.983
Colombia	−4.196 (0)**	−4.364 (0)***	−4.196 (0)**	0.119 (1)*	−12.667
Denmark	−2.195 (0)	−2.009 (0)	−2.515 (2)	0.071 (2)	−4.760
Egypt	−1.483 (0)	−1.480 (0)	−1.928 (2)	0.091 (3)	−3.524
France	−2.600 (0)	−2.210 (0)	−2.696 (1)	0.069 (2)	−4.812
India	−0.565 (0)	−1.059 (0)	−0.487 (1)	0.129 (3)*	−3.487
Indonesia	−2.101 (0)	−2.257 (0)	−2.101 (0)	0.150 (3)**	−7.391
Ireland	−2.529 (0)	−2.174 (0)	−2.628 (1)	0.079 (2)	−4.731
Italy	−2.808 (0)	−2.261 (1)	−2.800 (1)	0.079 (3)	−8.644
Japan	−0.859 (0)	−0.973 (0)	−1.075 (1)	0.183 (3)**	−1.823
Kenya	−1.666 (0)	−1.833 (0)	−1.666 (0)	0.119 (2)	−5.682
Malaysia	−1.579 (0)	−1.648 (0)	−1.894 (1)	0.088 (3)	−4.606
Mexico	−1.906 (1)	−1.824 (1)	−0.955 (2)	0.182 (3)**	−5.474
Morocco	−3.262 (0)*	−2.046 (0)	−3.060 (2)	0.117 (3)	−2.183
New Zealand	−2.173 (0)	−1.982 (0)	−2.247 (1)	0.106 (3)	−4.636
Norway	−2.111 (0)	−1.992 (0)	−2.360 (2)	0.063 (2)	−4.888
Philippines	−2.037 (0)	−1.854 (0)	−2.037 (0)	0.097 (3)	−4.176
Portugal	−2.199 (0)	−1.779 (0)	−2.253 (1)	0.108 (3)	−2.972
South Africa	−1.587 (0)	−1.757 (0)	−1.587 (0)	0.081 (2)	−4.996
South Korea	−1.618 (2)	−1.785 (2)	−1.544 (2)	0.153 (3)**	−6.736
Spain	−2.004 (0)	−1.734 (0)	−2.308 (2)	0.073 (3)	−3.343
Sweden	−1.970 (0)	−1.765 (0)	−2.354 (2)	0.064 (2)	−3.507
Thailand	−1.220 (0)	−2.426 (1)	−1.668 (2)	0.118 (3)	−12.693
Turkey	−1.218 (0)	−1.575 (0)	−1.648 (2)	0.096 (3)	−5.237
United Kingdom	−2.534 (0)	−2.272 (0)	−2.620 (1)	0.062 (2)	−5.639
United States	−1.779 (0)	−1.739 (0)	−2.302 (2)	0.080 (3)	−4.373
Venezuela	−2.448 (0)	−2.348 (0)	−2.448 (0)	0.104 (3)	−7.045

Notes: *, ** and *** indicate significance at the 10 per cent, 5 per cent and 1 per cent levels, respectively. DF-GLS and MZ_{α}^{GLS} are unit root tests proposed by Elliott *et al.* (1996) and Ng and Perron (2001), respectively. The numbers in parentheses are the lag order in the ADF and DF-GLS tests. The lag parameters are selected on the basis of modified Akaike information criterion (MAIC). The truncation lags are for the Newey–West correction of the PP and MZ_{α}^{GLS} tests in parentheses. The null hypothesis of the KPSS test examines for I(0), while the null of the remaining four tests examines for I(1).

Appendix B

Results for the alternative classification method

See Tables B1 and B2.

Table B1 Panel SURADF tests and critical values (17 high-income countries)

Country panel label	*Panel SURADF statistics*	*Critical values*		
		0.01	*0.05*	*0.1*
Australia	−4.893**	−5.533	−4.795	−4.413
Austria	−6.510**	−6.863	−6.063	−5.628
Belgium	−2.922	−6.218	−5.483	−5.094
Canada	−17.227***	−5.638	−4.954	−4.594
Denmark	−4.682	−6.848	−6.123	−5.729
France	−4.921	−6.731	−6.030	−5.610
Ireland	−1.987	−6.687	−6.018	−5.611
Italy	−2.328	−5.019	−4.351	−3.959
Japan	−4.288*	−5.035	−4.383	−4.024
South Korea	−3.150	−4.595	−3.939	−3.617
New Zealand	−3.942	−5.964	−5.245	−4.847
Norway	−2.916	−6.117	−5.318	−4.918
Portugal	−3.668	−5.908	−5.142	−4.723
Spain	−3.405	−6.699	−5.950	−5.525
Sweden	−6.590***	−6.102	−5.361	−4.963
United Kingdom	−1.275	−5.754	−4.998	−4.560
United States	−2.322	−5.277	−4.563	−4.204

Notes: Classified according to World Bank estimates of 2004 GNI per capita. *, ** and *** indicate significance at the 10 per cent, 5 per cent and 1 per cent levels, respectively. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al*., 2001).

Table B2 Panel SURADF tests and critical values (14 low-income countries)

Country panel label	*Panel SURADF statistics*	*Critical values*		
		0.01	*0.05*	*0.1*
Algeria	−2.435	−4.515	−3.887	−3.555
Colombia	−3.841**	−3.982	−3.376	−3.048
Egypt	−1.788	−4.030	−3.415	−3.092
India	−1.910	−4.381	−3.747	−3.403
Indonesia	−1.728	−4.516	−3.831	−3.468
Kenya	−1.633	−4.140	−3.511	−3.186
Malaysia	−0.718	−4.626	−4.047	−3.689
Mexico	−8.559***	−4.718	−4.089	−3.726
Morocco	−3.662	−4.780	−4.139	−3.798
Philippines	−3.388	−4.425	−3.741	−3.395
South Africa	−2.081	−4.460	−3.873	−3.522
Thailand	−2.382	−4.869	−4.222	−3.884
Turkey	−0.157	−4.524	−3.959	−3.601
Venezuela	−1.487	−4.159	−3.539	−3.226

Notes: Classified according to World Bank estimates of 2004 GNI per capita. ** and *** indicate significance at the 5 per cent and 1 per cent levels, respectively. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al*., 2001).

Appendix C

Results for consideration of a structural break

See Tables C1–C4.

Table C1 Panel SURZA tests and critical values (11 European countries)

Country	*TB*	*Panel SURZA statistics*	*Critical values*		
			0.01	*0.05*	*0.1*
Austria	1997	−6.022***	−5.828	−5.216	−4.850
Belgium	1994	−3.122	−5.481	−4.816	−4.455
Denmark	1997	−4.949	−6.029	−5.382	−5.010
France	1997	−4.788	−5.939	−5.323	−4.969
Ireland	2001	−3.499	−5.616	−4.973	−4.614
Italy	1987	−3.099	−4.776	−4.094	−3.739
Norway	1997	−3.437	−5.434	−4.801	−4.446
Portugal	1983	−1.964	−5.805	−5.136	−4.747
Spain	1997	−3.891	−5.845	−5.172	−4.801
Sweden	1993	−4.073*	−4.914	−4.213	−3.881
United Kingdom	2001	−3.205	−5.015	−4.379	−4.013

Notes: SURADF has the capability to consider a structural break by applying ZA (1992) estimations, which is called the Panel SURZA test. * and *** indicate respective significance at the 10 per cent and 1 per cent levels. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al.*, 2001). TB indicates the estimated structural break.

Table C2 SURZA Tests and Critical Values (ten Asia and Pacific countries)

Country	*TB*	*Panel SURZA statistics*	*Critical values*		
			0.01	*0.05*	*0.1*
Australia	1985	−1.812	−3.797	−3.262	−2.967
India	1991	−2.000	−3.833	−3.242	−2.935
Indonesia	1998	−0.983	−3.963	−3.395	−3.091
Japan	1997	−3.119	−4.049	−3.476	−3.155
South Korea	1997	−3.526	−4.541	−3.924	−3.617
Malaysia	1998	−0.312	−4.705	−4.113	−3.741
New Zealand	1992	0.281	−4.018	−3.425	−3.109
Philippines	1983	−1.934	−4.177	−3.541	−3.212
Thailand	1997	−1.984	−4.927	−4.294	−3.945
Turkey	1984	−0.439	−3.769	−3.262	−2.968

Notes: SURADF has the capability to consider a structural break by applying ZA (1992) estimations, which is called the Panel SURZA test. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al.*, 2001). TB indicates the estimated structural break.

Table C3 SURZA tests and critical values (five American and Caribbean countries)

Country	*TB*	*Panel SURZA statistics*	*Critical values*		
			0.01	*0.05*	*0.1*
Canada	1992	−5.066***	−3.473	−2.914	−2.591
Colombia	1983	−2.772*	−3.540	−2.981	−2.665
Mexico	1990	−5.851***	−3.615	−3.019	−2.713
United States	1985	−1.366	−3.458	−2.885	−2.584
Venezuela	1984	−0.639	−3.404	−2.841	−2.561

Notes: SURADF has the capability to consider a structural break by applying ZA (1992) estimations, which is called the Panel SURZA test. * and *** indicate respective significance at the 10 per cent and 1 per cent levels. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al.*, 2001). TB indicates the estimated structural break.

Table C4 SURZA tests and critical values (five Middle East and African countries)

Country	*TB*	*Panel SURZA statistics*	*Critical values*		
			0.01	*0.05*	*0.1*
Algeria	1988	−1.960	−3.603	−2.972	−2.689
Egypt	1989	−1.369	−3.557	−2.991	−2.668
Kenya	1991	−1.815	−3.540	−2.959	−2.649
Morocco	1988	−2.232	−3.713	−3.156	−2.856
South Africa	1984	−1.107	−3.830	−3.204	−2.909

Notes: SURADF has the capability to consider a structural break by applying ZA (1992) estimations, which is called the Panel SURZA test. Critical values are calculated using the Monte Carlo simulation with 10,000 draws, tailored to the present sample size (for details of this simulation, see Breuer *et al.*, 2001).