A Panel Unit Root Test Approach to PPP Exchange Rates with Non-linear Deterministic Trends

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ABSTRACT

This paper investigates the purchasing power parity (PPP) hypothesis using panel data. Under PPP the real exchange rate is stationary around a constant mean. Recent panel data unit root tests are employed to test the PPP proposition where, under the conventional null hypothesis of a unit root, the real exchange rate is not stationary and PPP does not hold. In this case, as the time period $t + n$ approaches infinity, its variance relative to period t will also approach infinity. The usual alternative in unit root tests is stationarity around a constant mean or a linear trend. The paper brings innovation into the PPP and panel unit root testing literature by allowing for possible non-linear deterministic trends in the alternative hypothesis (as advanced by Cushman (2004)). If the null hypothesis is rejected in favour of the alternative of a non-linear trend, PPP still does not hold, but does at least revert back to a meaningful, stable long-run equilibrium. Given this non-linear trend, the variance of the real exchange rate as $t + n$ approaches infinity, conditional on that trend, remains finite.

Overall, evidence for stationarity in exchange rates is found in four out of six panels under consideration, including both support for stationary processes with no trend or a linear trend as well as for processes following a non-linear deterministic trend, in particular at time orders 5 and 6. The rejections are, in fact, most consistent at the nonlinear orders. Given nonlinear trends, PPP as usually defined does not hold, despite the rejection of unit roots. It is also found that stronger evidence for stable long-run equilibria in real exchange rates appears when the German Deutschmark is chosen as a base currency instead of the US Dollar. Finally, it appears that a very recent panel unit root test that takes account of cross-sectional dependencies delivers more consistent and sensible results.

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1 INTRODUCTION

This paper investigates the purchasing power parity (PPP) hypothesis using panel data. Under PPP the real exchange rate is stationary around a constant mean. Recent panel data unit root tests are employed to test the PPP proposition where, under the conventional null hypothesis of a unit root, the real exchange rate is not stationary and PPP does not hold. In this case, as the time period $t + n$ approaches infinity, its variance relative to period t will also approach infinity. The usual alternative in unit root tests is stationarity around a constant mean or a linear trend. The paper brings innovation into the PPP and panel unit root testing literature by allowing for possible non-linear deterministic trends in the alternative hypothesis (as advanced by Cushman (2004)). If the null hypothesis is rejected in favour of the alternative of a non-linear trend, PPP still does not hold, but does at least revert back to a meaningful, stable long-run equilibrium. Given this non-linear trend, the variance of the real exchange rate as $t + n$ approaches infinity, conditional on that trend, remains finite.

The panel data unit root testing approach, which has been developed approximately over the past twenty years, is chosen since it offers much greater power in hypothesis testing by increasing the number of observations and otherwise possesses several major advantages over conventional single time-series or cross-sectional data sets (a detailed description of which is given in the paper, following mainly Hsiao (2003)).

The research therefore adds to the literature of international monetary theory, in which PPP testing has been an ongoing and much debated field, as well as the econometric literature in that existing panel unit root tests have to be modified to account for the non-linearities and in that more recent panel unit root tests are being used so as to eliminate mistakes that were made previously.

This leaves several areas for possible future research, such as comparing the non-linear hypothesis with other qualified PPP theories (e.g. anomalous periods, constant means with just one shock in the time series), or the use of unit root tests for non-stationary panel.

2 THEORETICAL FOUNDATIONS AND LITERATURE

2.1 The Theoretical Concept of Purchasing Power Parity and Key Literature

If the value of a country's currency rises above the level warranted by its economic conditions, the exporting industries of the country will become less competitive in international markets and a trade deficit will be likely to follow. It is important, therefore, for policy makers to have forecasting ability about the equilibrium value of the exchange rate if an effective exchange rate management is desired. In fact, discussion of "overvalued" or "undervalued" currency assumes that there exists a stable equilibrium exchange rate to which the value of a currency can be referenced. This equilibrium value of an exchange rate is determined by the changes in the relative national price levels.

The law of one price (LOOP) states that in competitive markets free of transportation costs and barriers to trade, identical (perfectly homogenous) tradable commodities sold in different countries must sell for the same commodity price when their respective prices are expressed in terms of the same currency.

$$P_i = \frac{EP_i^*}{v} \qquad \text{or } E = v\left(\frac{P_i}{P_i^*}\right) \tag{2.1}$$

where $P_i\left(P_i^*\right)$ is the domestic (foreign) price of traded good i and E is the home currency price of foreign currency (the nominal exchange rate). v is equal to one if the LOOP holds.

Concurrently, purchasing power parity (PPP) is a proposition about the relationship of average prices (derived from a basket of goods) at home and abroad.[1] It can also be used to calculate an alternative exchange rate between the currencies of two countries, known as the real exchange rate.

To further exemplify this proposition, consider the average prices of two goods, good 1 (traded) and good 2 (non-traded), in a two good world and their ratio in the following example:

$$P = aP_1 + (1-a)P_2 \text{ and } P^* = a^* P_1^* + \left(1-a^*\right)P_2^* \qquad \text{respectively} \tag{2.2}$$

where the asterisk * on weight *a* denotes foreign country values. Then

$$\frac{P}{P^*} = \frac{aP_1 + (1-a)P_2}{a^* P_1^* + \left(1-a^*\right)P_2^*}. \tag{2.3}$$

Let $RP = \frac{P_2}{P_1}$ and $RP^* = \frac{P_2^*}{P_1^*}$ be the relative prices of non-tradables. Then

$$\frac{P}{P^*} = \frac{P_1\left[a + (1-a)RP\right]}{P_1^*\left[a^* + \left(1-a^*\right)RP^*\right]} \tag{2.4}$$

is the ratio of average prices. Then

$$\frac{P_1}{P_1^*} = \frac{E}{v} \text{ from (2.1)} \tag{2.5}$$

Then, substituting and inverting, the real exchange rate can be defined as:

$$Q = \frac{EP^*}{P} = v\frac{\left[a^* + \left(1-a^*\right)RP^*\right]}{\left[a + (1-a)RP\right]} \tag{2.6}$$

with substitution.

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[1] Derivation adopted from Professor David O. Cushman, ECON 356 lecture notes

The distinction has now to be made between absolute PPP and relative PPP. Absolute PPP occurs when the average price at home equals the average price abroad when expressed in the same currency. This requires that $Q = 1$, which is unlikely because it is likely that the consumption weights or relative prices will differ between the two countries. Relative PPP occurs when Q_t is constant, but not necessarily 1.0. This is more likely to hold than absolute PPP because it only requires that relative prices and consumption weights remain constant, or move together over time between the two countries. To illustrate further, let us take the logs of Equation (2.6):

$$q \equiv \ln\left(\frac{EP_i^*}{P_i}\right) \equiv e + p_i^* - p_i \,. \tag{2.7}$$

where lower case letters represent logs. Relative PPP requires q_t constant, but not equal to any specific value.

It is the expression in (2.7) in levels which is of major importance during the analytical part of the paper, since it is the variable q which is tested in the univariate procedure of unit root testing. All the unit root tests assume that this long-run PPP relationship exists in terms of log levels.

The concept of testing the PPP relationship for a unit root is that, if a unit root exists in the data, the real exchange rate would not revert back to a long-run mean value and relative PPP would not hold in the long run. Relative PPP will also fail to hold if the real exchange rate has a deterministic trend, but in that case the period $t + n$ future real exchange rate, conditional on this trend, does not have an infinite conditional variance as n approaches infinity as it does in the unit root case.

More specifically, during the process of univariate unit root testing the variable (in this case q) is tested on its own lagged values. Mathematically, this can be expressed by:

$$q_t = D + \alpha q_{t-1} + \varepsilon_t \tag{2.8}$$

or

$$\Delta q_t = D + (\alpha - 1) q_{t-1} + \varepsilon_t \tag{2.9}$$

where ε_t is a mean zero covariance stationary process and D specifies possible deterministic factors such as a constant or trends.

If it is found that the variable and its previous time-series value are related only through ε_t, the series is said to have a unit root (as it lies on the unit circle), i.e. it follows a random walk and no meaningful relationship can be found over time. In the above case this would mean testing for $H_0 : \alpha = 1$ with the alternative hypothesis of $H_1 : -1 < \alpha < 1$.

The ability of the usual unit root test to reject a false null hypothesis depends on what trends are specified in the test. For example, the Dickey-Fuller test without a linear trend will have no power against a deterministic linear-trend process as the sample size increases. Dickey and Fuller (1981) provide tables of different test statistics for precisely these different combinations of hypotheses about the simple random walk model and those models including intercepts and deterministic trends.

Moreover, the point of the present thesis is to consider the possibility of a deterministic non-linear trend process and to therefore include such trends in the unit root tests. The standard testing approach has been to accept the presence of PPP if the unit root is rejected. But if this rejection is in favour of deterministic non-linear trends (or linear trends), then relative PPP does not hold, although the real exchange rate does have a stable long-run equilibrium, unlike under a unit root process.

We should note the classic reasons for fluctuation in real exchange rates. From Equation (2.6) above, q_t varies from violation in LOOP (fluctuations in v) and from fluctuations in relative prices (captured in the variables RP and RP^*). Fluctuations in v could occur if traded goods are imperfect substitutes, e.g., a rise in income in one country could lead a rise in demand for goods of the other country, raising v and the real exchange rate, Q. Changes in RP and RP^* capture the Balassa-Samuelson effect (Balassa (1964) and Samuelson (1964); see also Bhagwati (1984) and Kravis and Lipsey (1983)). If productivity gains against foreign countries are concentrated in the tradable sector, the domestic relative price of non-tradables will increase, and as the relative average price rises the real exchange rate appreciates. Other factors playing a role in this outcome are trade barriers and real border effects, transaction costs and varying responsiveness to productivity innovations for different jobs.

In acknowledging the inevitability of these factors and the amount of empirical research finding no support for the PPP hypothesis (as discussed below), recent research has had a motivation to produce theories which loosen up the original strong assumptions of PPP and incorporate non-linearities into the testing procedures. These implications are discussed in more detail in the next Section.

A thorough analysis giving an overview of all the different facets of research done on PPP is the recent paper by Taylor and Taylor (2004). The authors first give a review of the underlying principles of PPP and the inherent theoretical problems it brings with it as well as a historical account of the research conducted over the decades. But they also focus on the more recent theoretical developments and expansions of the theory and how those have been empirically tested so far, as well as an outline of potential areas which have not been fully exploited as of yet. Their analysis includes a description of the power problem faced by empirical testing procedures, and an account of how this could be overcome amongst others by the use of panel data. Another focus in the latter half of the paper explains one of those theoretical expansions indicated, namely that of accounting for non-linearities in the mean reversion path taken by exchange rates due to e.g. transaction costs.

This is also the area of research the two authors focus on in other studies and which is explained in a little more detail below. Their paper thus re-emphasises the importance and timeliness of the work at hand, since my work is in fact a combination of some of the remedies suggested by Taylor and Taylor in order to arrive at better empirical outcomes.

One of the most well known publications summarising the PPP field of study before the arrival of the Taylor and Taylor (2004) article is that by Rogoff (1996). In his paper he lists all different econometric types of studies as well as grouping them into categories of PPP supportive and PPP rejecting articles. For a selection of supportive PPP studies, one can, e.g. consult Glen (1992), who, in addition to giving a detailed review of existing studies, manages to reject a random walk for monthly data in the post-Bretton Woods era and for the twentieth century as a whole using long-horizon autocorrelations and variance ratio statistics to test for long-term mean reversion in real exchange rates. Another important work is that by Abuaf and Jorion (1990), who were among the first to use Dickey-Fuller type tests, and who find strong evidence for mean reversion in a period from 1900-1972.
Taylor, Peel and Sarno (2001) and Taylor (2003) find strong arguments for non-linearly mean reverting processes. Sarno and Taylor (2002) also give this conclusion in a paper which is aimed mainly at giving a broad overview of PPP developments.

Opposed to these studies stand especially earlier studies which strongly support the null of a random walk and therefore non-stationarity and a breakdown of PPP. One of the most important papers among these is by Adler and Lehmann (1983), who build on earlier work by Roll (1979) and also extensively analyse the empirical validity of long-run PPP. They conduct tests with both monthly and annual data for a multitude of countries and find these follow ‘martingale’ models rather than being serially correlated autoregressive processes.

Rogoff (1996) also points out that one of the strongest factors for rejection is the long time-span of convergence and therefore the low power of tests. He quotes Frankel's estimates of a rate of convergence after a shock of 14 percent per year, implying a half-life for PPP deviations of 4.6 years. This would then lead to the conclusion that a long period should preferably be tested and again, this could be a reason why some of the above mentioned studies with long time-spans had positive results.

Hakkio (1984) was one of the first to reconsider the notion of PPP under a new angle, after it had suffered from a substantial amount of rejecting research in the 70s. He did so by using simultaneous estimations of data for the years 1973-82 for several countries and found strong evidence for PPP. This approach led the way for panel data studies which would then later start to focus on the use of unit root testing to shed light on the PPP question.

Other seminal papers in this field are those by Frankel and Rose (1996), who use data on 150 countries and 45 annual post WWII observations and find strong overall evidence for mean reversion with a half-life of around four years. Papell (1997), making use of data from 20 countries with 21 quarterly data points, finds stronger support against the unit root null in larger rather than smaller panels, monthly rather than quarterly data, and when the German mark, rather than the United States dollar is used as the base currency. He also finds that taking account of serial correlation weakens the evidence for PPP. Oh (1996) uses 150 countries over a time span of 41 years (1950-90) in his panel to find positive PPP results especially for G6 and OECD countries using Augmented Dickey-Fuller type tests.

Finally, Wu (1996) tests exchange rates between 19 OECD countries, both in monthly (1974-93) and annual (1974-92, with 16 countries) time spans and, again, finds overwhelming support for PPP.

2.2 The Concept of Non-Linear Deterministic Trends in PPP

Over the years, economists have tried to come up with theoretical explanations for the often observed failure of PPP when empirically tested. This included allowing for slight modifications of the core PPP theory, as outlined above, which would allow for modest deviations of the exchange rate from its long-run mean, in order to more truly model reality. Under relative PPP, the exchange rate q has a constant mean. Another possibility would be the occurrence of a linear upward (or downward) trend rather than a constant mean, which would violate PPP theory, however, in what Dornbusch and Vogelsang (1991) phrase 'qualified PPP' this trend might be very slight over a long period and might be economically negligible. Qualified PPP also includes the notions of a period with a single shock or an anomalous period respectively occurring during the observed time-series with an otherwise constant mean, or one permanent but not large shock to the mean.

Finally, recent research has tried to incorporate the idea of non-linearities in the adjustment to the long-run mean into the estimation process, thus coming ever closer to real economic behaviour. Non-linearities theoretically arise due to international transactions costs between spatially separated markets and, as more recently developed, due to transactions costs in international arbitrage. The first of these approaches focuses on non-linearities in the mean-reversion process, pioneered predominantly by Taylor, Peel and Sarno (2001). This approach is briefly outlined below, for completeness sake.

Cushman (2004) focuses on potential non-linearities in the series' trend itself, which is the approach that is adopted in this paper and is extended, as explained above, by working in a panel data framework. For example, a non-linear trend could be underlying a real exchange rate series because of the above described Balassa-Samuelson effect in Equation (2.6). In addition to the classical explanations for deviations from PPP, Cushman

(2004) points out the Krugman and Obstfeld proposition that fluctuations can occur if home and foreign tradables are imperfect substitutes. As before, this concept is linked to productivity and income differences. Here, a rise in productivity would lead to a rise in home income which in turn would increase relative demand for foreign tradables and would lead to an exchange rate appreciation. Also, exchange rate targeting by central banks could further explain real exchange rate fluctuations in the form of non-linear trends, since e.g. the target could evolve round a non-linear trend.

The so brought about fluctuations would have to be random (with no long-term effects) or offsetting each other in order for PPP to hold and for the real exchange rate to remain constant. Then, to the attempts at incorporating these fluctuations into models with linear deterministic trends would be to consider non-linear deterministic trends.

The statistical background of this approach lies in the work advanced by Ouliaris, Park and Phillips (1989) and Bierens (1997). Ouliaris et al (1989) extend the Dickey and Fuller and Phillips and Perron tests to allow for a deterministic polynomial time trend in the maintained hypothesis. In the same spirit Bierens (1997) also modifies ADF tests but makes use of Chebishev polynomials rather than regular polynomials in order to approximate non-linear time-trends and proceeds to apply these tests to the series for the US GNP deflator, the consumer price index and the interest rate. He states that his results indicate that these series are non-linear trend stationary.

Cushman adopts the same approach as Bierens and includes higher orthogonal polynomial time orders for the potential deterministic trends. He uses two distinct sets of unit root tests. Firstly the J test as developed by Park and Choi (1988) and a test derived by adding the additional time terms to the (more powerful) Elliott, Rothenberg and Stock (1996) variation (as compared to Ouliaris et al) are used. Secondly, the set of tests proposed by Bierens are used to distinguish between linear and non-linear trends if the unit root null is rejected. He finds support for his proposition in 4 out of 13 analysed exchange rates and mean stationarity for the other four, but suggests that non-linear trends should be present even in those, because of the cross-exchange rate constraints.

The approach of introducing orthogonal Chebishev polynomial time orders as conducted by Cushman and Bierens is however a rather advanced one, especially when basing the unit root testing procedure on panel data, and the analysis in this work therefore limits itself to simple higher order trend terms, which can be introduced into panel unit root tests as outlined below.

As touched upon above, the concept of non-linear mean reversion should be explained here as a side note. In this approach, non-linearities are assumed to occur during the period in which an exchange rate returns to its equilibrium value, after a short-term shock has occurred. The main proponents of this theory are Taylor, Peel and Sarno, who, in their (2001) study use data on four major real bilateral dollar exchange rates from 1973-96.

According to them, real exchange rates behave more like unit root processes the closer they are to long-run equilibrium and, conversely, become more mean reverting the further they are from equilibrium. Moreover, while small shocks to the real exchange rate around equilibrium will be highly persistent, larger shocks mean revert much faster than the "glacial rates" previously reported for linear models (e.g. Rogoff (1996)).

Granger and Teräsvirta (1993) argue that, if the real exchange rate is measured using price indices made up of goods prices each with a different size of international arbitrage costs, one would expect adjustment of the overall real exchange rate to be smooth rather than discontinuous.

In two different papers, Sarno and Taylor (2002) and Taylor (2003) give a helpful overview of developments in PPP theory and testing over the last 20 years and explain two more potential sources of non-linearities, in addition to those discussed above, research on which has so far been scarce. These are from interactions of heterogeneous agents in the foreign exchange market at the micro-structural level and secondly, from the effects of official intervention in the foreign exchange market (exchange rate targeting by central banks).

2.3 Introduction to Panel Data Analysis

2.3.1 Advantages of Panel Data

A panel data set is one that follows a given sample of individuals over time, and thus provides multiple observations on each individual in the sample. Individuals can be understood to be, e.g. single persons, companies, or, as in the case of this paper, bilateral exchange rates.[2]

Panel data sets for economic research possess several major advantages over conventional cross-sectional or times-series data sets. Panel data usually give the researcher a large number of data points, increasing the degrees of freedom and hence improving the power of hypothesis tests and efficiency of econometric estimates.

Panel data involve two dimensions: a cross-sectional dimension, N, and a time-series dimension, T. Although one might expect that the computation of panel data estimators would be more complicated than the analysis of cross-section data alone (where T = 1) or time series data alone (where N = 1), panel data can actually provide a number of advantages in the estimation process, e.g. the possibility of generating more accurate predictions for individual outcomes than time-series data can predict alone, achieved for instance by pooling the data.

One of the issues when analysing PPP in a panel data framework, unconventional to standard panel data analysis, is that one has to deal with a

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[2] See Hsiao (2003) for an excellent introduction to and overview of panel data analysis

large time dimension, T, (monthly or annual observations) and only a medium sized cross-sectional dimension, N, (countries). This is further discussed below. One of the stronger assumptions frequently postulated in unit root testing within panel data analysis is that the test statistics converge to a normal distribution as $N \to \infty$ and $T \to \infty$, and as $N/T \to k$. This assumption becomes inhibiting when smaller sample sets are being considered and has been under refinement in a big part of recent literature.

2.3.2 Issues Involved in Utilising Panel Data

Of course, there also are a few precautions that have to be kept in mind when making use of panel data. Possibly the most important and at the same time one of the hardest issues to deal with is that of cross-sectional dependence. Most panel studies assume that apart from the possible presence of individual invariant but period-varying time-specific effects, the effects of omitted variables are independently distributed across cross-sectional units.[3] However, in reality the actions of economic agents or economic shocks that affect some agents (e.g. countries) but not others, as well as natural factors such as distances between agents, can lead to interdependence among themselves. Since in most cases it is difficult to establish estimates of such factors (e.g. distance measures), econometricians have often relied on strong parametric assumptions to model cross-sectional dependence. The problem of cross-sectional dependence is being tackled in the new test approach by Pesaran (2005) and is explored in this paper.

Another frequent issue is the one of heterogeneity bias. In general, different individuals may be subject to the influences of different factors. However, when important factors peculiar to a given individual are left out, the typical assumption that economic variable y is generated by a parametric probability distribution function $P(y \mid \theta)$, where θ is an m-dimensional real

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[3] Hsiao, p.309

vector, identical for all individuals at all times, may not be a realistic one. Ignoring the individual or time-specific effects that exist among cross-sectional or time-series units but are not captured by the included explanatory variables can lead to parameter heterogeneity bias in the model estimation. [4]

Another problem frequently encountered in panel data analysis is that of selectivity bias. This occurs if the cross-sectional sample is not randomly drawn from the population. [5] This however is only a problem if the included exchange rates are being used to predict the behaviour of all exchange rates in some larger population of exchange rates and can therefore be disregarded in the analysis at hand.

These differences in behaviour across individuals as well as over time can then be accounted for in the way of different model specifications. For instance, a single-Equation model with observations of y depending on a vector of characteristics x can be written in the following form:

$$y_{it} = \alpha_{it}^{*} + \sum_{k=1}^{K} \beta_{kit} x_{kit} + u_{it} \qquad i = 1, \ldots, N\,,\ t = 1, \ldots, T \qquad (2.10)$$

which would be the most unrestricted specification where all coefficients vary over time and individuals. Of course, no such model could ever be estimated in reality. Alternatives to this specification could be models in which only the intercept is allowed to vary over time and/or individuals and the slope coefficients are kept constant. Suppose also the alternative of merely allowing coefficients to vary across individuals. This could be estimated but there would be no gain from pooling (estimating the panel). So, one generally restricts some of the coefficients to be equal across individuals, the coefficients thought least likely to introduce the "heterogeneity" bias described above.

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[4] See Hsiao, p.8

[5] Hsiao, p.10

A final note should be made on the meaning of fixed- and random-effects models. Fixed-effects models are those of the form as stated above, to which dummy variable-like vectors are introduced to allow for the effects of those omitted variables that are specific to individual cross-sectional units but stay constant over time, and the effects that are specific to each time period but are the same for all cross-sectional units. Random-effects models treat those variables as random variables. It is standard practice in the regression analysis to assume that the large number of factors that affect the value of the dependent variable, but that have not been explicitly included as independent variables, can be appropriately summarized by a random disturbance.

2.4 Key Developments in Panel Unit Root Testing and its Application to PPP

The most frequently applied unit root testing procedure, in univariate as well as in panel data analysis, is that by Dickey and Fuller (1979, 1981). A basic form of the augmented Dickey Fuller test in a panel setting and in the context of PPP would be:

$$\Delta q_{it} = \mu_i + \delta_i t + \left(\rho_i - 1\right) q_{i,t-1} + \sum_{l=1}^{p_i} \phi_{il} \Delta q_{i,t-l} + \varepsilon_{it} \quad i = 1,...,N \,,\ t = 1,...,T \tag{2.11}$$

where q_{it} is the real exchange rate as derived above, Δ denotes the first-difference operator, $1-L$, with L being the lag operator that shifts the observation by one period, $Ly_{it} = y_{i,t-1}$.

μ_i is the constant (note how in this example the constant is only allowed to vary over individuals, as is taken to be the case in most of the literature), t is a deterministic time trend, which is of major importance later on in this paper, and there are a number of lagged terms, p_i of them.

ε_{it} is assumed to be independently distributed across i and t: $\varepsilon_{it} \sim i.i.d\left(0,\sigma^2\right)$[6]. The term ε_{it} would in this case represent the random disturbance of the random-effect approach outlined in the previous Section.
If, under $H_0 : \rho_i = 1$, then q_{it} contains a unit root. If, under $H_1 : \rho_i < 1$, then q_{it} is stationary around the mean or trend.

There are, however, a number of inadequacies within earlier research. A brief overview of the development of panel unit root tests can show how these have been mended over time.

Breitung and Meyer (1994) have derived the asymptotic normality of the Dickey-Fuller test statistic for panel data with an arbitrarily large cross-section dimension and a small fixed time series dimension. Their approach allows for time-specific effects and higher-order serial correlation, as long as the pattern of serial correlation is identical across individuals, but cannot be extended to panel with heterogeneous errors. Quah (1994) is one of the first to recognise the pitfalls encountered by research when the time dimension of the data is of similar size or even larger than the cross-section dimension, an issue outlined above.

A seminal paper in the panel unit root testing field is that of Levin and Lin (1993), which has since been revised and published together with Shu in 2002. The authors develop a 3-step unit root test for pooled cross-section time series data, rather than testing for a unit root in each individual time series, thus gaining more power.

In terms of the model outlined in Equation (2.11), their null hypothesis would be specified as

$$H_0 : \rho_1 = \rho_2 = ... = \rho_N = 1$$

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[6] This is a strong assumption, which can be expected to be violated and has been subject to much debate in the literature. This issue will be discussed below in the discussion of new panel unit root test procedures.

with the alternative hypothesis

$$H_1 : -1 < \rho_1 = \rho_2 = ... = \rho_N = \rho < 1$$

They point out that their test is particularly useful for data sets of moderate size.

The aforementioned problem of heterogeneity bias could however play a significant role in Levin and Lin's approach since all the ρ values of the H_1 are assumed equal. One crucial problem that has not been accommodated in either of the two articles is that of cross-sectional dependence.[7] Other influential literature which suffers from the same assumption detriment is, e.g. that by Choi (2001), Maddala and Wu (1999).

The problem of cross-sectional dependence has been explored in particular by O'Connell (1998), whose critique weakens a lot of the earlier results from panel unit root tests on PPP. He explores several arguments why cross-country dependence has to be taken into account, and suggests that a GLS estimator can be used, since it is invariant to the numeraire price index and controls for interdependence in the data. It should be noted that O'Connell accounts for serial correlation in both of his tests by allowing his error terms to be generated by a VAR(p) process. He mentions that the invariance property of the FGLS is preserved because the serial correlation of each real exchange rate series is assumed to be the same, which is, as he argues a reasonable assumption. If the serial correlation properties are allowed to be heterogeneous across countries, then the invariance property breaks down. He also gives power arguments for advantage of GLS. According to O'Connell, when assuming independence across real exchange rates, it is possible to find evidence in favour of PPP in a variety of real exchange rate panels. However, this evidence is extremely fragile: once cross-sectional dependence is controlled for, no such evidence can be

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[7] The assumption described for Equation (2.11)

found.[8] As Bai and Ng (2004, see below) point out, O'Connell's approach is theoretically valid only when N is fixed. O'Connell also finds that the method of using time dummies as in Frankel and Rose (1996, s.a.) is advantageous for testing for PPP.

Im, Pesaran and Shin (2003, IPS hereafter) suggest cross-sectionally demeaning the data to solve the problem of dependence. As Pesaran (2005) points out, this could not work in a general setting where pair-wise cross-section covariances of the error terms differ across the individual series. Pesaran therefore develops a newer test building on the IPS foundation.

The very latest set of publications is now starting to take into account those deficiencies in earlier research as outlined above. It is in these that a foundation for the present research can be found. Some of these articles include Bai and Ng (2004), Harvey and Bates (2002), Moon and Perron (2004), Pesaran (2005) and Phillips and Sul (2002).

Pesaran (2005) argues that, although the test proposed by Harvey and Bates is valid for general specifications of error cross-correlations, it is limited by requiring the parameters to be the same across all the series. Their procedure also seems to work only when N is small and T relatively large.

Bai and Ng (2004), Moon and Perron (2004), and Phillips and Sul (2002) avoid the restrictive nature of the cross-section de-meaning procedure (as first introduced by IPS (2003)) by allowing the common factors to have differential effects on different cross-section units. In the context of a residual one-factor model Phillips and Sul (2002) show that in the presence of cross-section dependence the standard panel unit root tests are no longer asymptotically similar, and propose an orthogonalisation procedure which in effect asymptotically eliminates the common factors before preceding to the application of standard panel unit root tests.

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[8] O'Connell, p.13

Independently, similar orthogonalisation procedures are used by Bai and Ng (2004) and Moon and Perron (2004) in a more general set up. Moon and Perron's (2004) work, however, is based on non-stationary panel data.

The paper at hand therefore employs the tests as developed by IPS (2003) and the further developed test based on IPS by Pesaran (2005), the CIPS. More detail is now given on those two test procedures.

2.4.1 Im Pesaran and Shin's (2003) IPS Test

As already mentioned above, IPS base their panel unit root test, which has by now already become somewhat of a standard in panel unit root testing procedures, on the mean of individual unit root statistics. Of particular importance to this paper is a standardised t-bar statistic IPS develop in their test which is essentially based on the Augmented Dickey-Fuller statistics averaged across the groups.

Below follows a brief outline of the theoretical background as taken from IPS (2003), Sections two and four specifically. Starting with the simple dynamic linear heterogeneous panel data model:

$$y_{it} = (1-\phi_i)\mu_i + \phi_i y_{i,t-1} + \varepsilon_{it} \quad i = 1,...,N; t = 1,....,T \tag{2.12}$$

where initial values, y_{i0}, are given. The null hypothesis of unit roots is then $\phi_i = 1$ for all i. This can also be expressed as

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \varepsilon_{it} \tag{2.13}$$

where $\alpha_i = (1-\phi_i)\mu_i$, $\beta_i = -(1-\phi_i)$ and $\Delta y_{it} = y_{it} - y_{i,t-1}$.

The null hypothesis of unit roots then becomes

$$H_0 : \beta_i = 0 \quad \text{for all } i \tag{2.14}$$

against the alternatives

$$H_1 : \beta_i < 0 , \quad i = 1, 2, ..., N_1 , \;\; \beta_i = 0 , \; i = N_1 + 1, N_1 + 2, ..., N \tag{2.15}$$

As IPS point out, this formulation of the alternative hypothesis allows for β_i to differ across groups. It also allows for some (but not all) of the individual series to have unit roots under the alternative hypothesis.[9]

The summarised explanation of the test statistic continues with the more general case of heterogeneous panel with serially correlated errors, ε_{it} , as is outlined in IPS's paper, section four.

Starting out with the data generating process for y_{it} this is generated by a finite-order $AR\left(p_i + 1\right)$ process:

$$y_{it} = \mu_i \phi_i \left(1\right) + \sum_{j=1}^{p_i+1} \phi_{ij} y_{i,t-j} + \varepsilon_{it} \;\; , \quad i = 1, ..., N, \, t = 1, ..., T, \tag{2.16}$$

which can be expressed equivalently as the $ADF\left(p_i\right)$ regression:

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,i-t} + \sum_{j=1}^{p_i} \rho_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \;\; , \quad i = 1, ..., N, \, t = 1, ..., T, \tag{2.17}$$

where $\phi_i \left(1\right) = 1 - \sum_{j=1}^{p_i+1} \phi_{ij}$, $\alpha_i = \mu_i \phi_i \left(1\right)$, $\beta_i = -\phi_i \left(1\right)$, and $\rho_{ij} = -\sum_{h=j+1}^{p_i+1} \phi_{ih}$

They then proceed by writing the ADF regressions for each i in matrix notations:

$$\Delta \mathbf{y}_i = \beta_i \mathbf{y}_{i,-1} + \mathbf{Q}_i \gamma_i + \varepsilon_i \tag{2.18}$$

where $\mathbf{Q}_i = \left(\tau_T , \Delta \mathbf{y}_{i,-1} , \Delta \mathbf{y}_{i,-2} , ..., \Delta \mathbf{y}_{i,-p_i}\right)$ and $\gamma_i = \left(\alpha_i , \rho_{i1} , \rho_{i2} , ..., \rho_{ip_i}\right)'$

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[9] IPS (2003), p.55

Following some assumptions, a t-bar statistic is formed as a simple average of the individual Dickey-Fuller *t* statistics for testing $\beta_i = 0$ in (2.17):

$$t - bar_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}\left(p_i, \boldsymbol{\rho}_i\right) \tag{2.19}$$

where $t_{iT}\left(p_i, \boldsymbol{\rho}_i\right)$ is given by

$$t_{iT}\left(p_i, \boldsymbol{\rho}_i\right) = \frac{\sqrt{T - p_i 2}\left(\mathbf{y'}_{i,-1}\mathbf{M}_{Q_i}\Delta\mathbf{y}_i\right)}{\left(\mathbf{y'}_{i,-1}\mathbf{M}_{Q_i}\mathbf{y}_{i,-1}\right)^{1/2}\left(\mathbf{y'}_i\mathbf{M}_{X_i}\Delta\mathbf{y}_i\right)^{1/2}} \tag{2.20}$$

$\boldsymbol{\rho}_i = \left(\rho_{i1}, \rho_{i2}, ..., \rho_{ip_i}\right)'$, $\mathbf{M}_{Q_i} = \mathbf{I}_T - \mathbf{Q}_i\left(\mathbf{Q}_i'\mathbf{Q}_i\right)^{-1}\mathbf{Q}_i'$, $\mathbf{M}_{X_i} = \mathbf{I}_T - \mathbf{X}_i\left(\mathbf{X}_i'\mathbf{X}_i\right)^{-1}\mathbf{X}_i'$, and $\mathbf{X}_i = \left(\mathbf{y}_{i,-1}, \mathbf{Q}_i\right)$

NT here indicates that this is the t-bar statistic for the general case where the errors in (2.16) may be serially correlated, possibly with different serial correlation patterns across groups, but with T and N sufficiently large.

IPS then proceed to derive a number of individual standardised t-bar statistics of which the one that is of relevance to this paper is that expressed in Equation (4.10) in their paper. In this case the standardisation of the t-bar statistic is carried out using the means and variances of $t_{iT}\left(p_i, \mathbf{0}_i\right)$ evaluated under $\beta_i = 0$. This is the most general statistic in which the lag length is allowed to vary as well.

The so-derived standardised t-bar statistic is:

$$W_{tbar}\left(\mathbf{p}, \boldsymbol{\rho}\right) = \frac{\sqrt{N}\left\{t - bar_{NT} - \frac{1}{N}\sum_{i=1}^{N} E\left[t_{iT}\left(p_i, \mathbf{0}\right) \middle| \beta_i = 0\right]\right\}}{\sqrt{\frac{1}{N}\sum_{i=1}^{N} Var\left[t_{iT}\left(p_i, \mathbf{0}\right) \middle| \beta_i = 0\right]}} \Rightarrow^{T,N} N\left(0,1\right) \tag{2.21}$$

Following this definition, IPS present the relevant values of the means and variances of $t_{iT}\left(p_i,\mathbf{0}_i\right)$ in the ADF(*p*) for the two cases of no trend and trend order one (linear trend) in their Table 3, in each case, mean and variance values are given for lag orders zero to eight. This provides the option for expansion for non-linear time trends as outlined below. As is indicated in the Equation, this statistic approaches the normal distribution for large values of N, T, as proven by IPS (2003).

2.4.2 Pesaran's (2005) Test

Pesaran's (2005) approach to dealing with the problem of cross-section dependence is augmenting the standard DF (or ADF) regressions with the cross-section averages of lagged levels and first-differences of the individual series. Similarly to the initial IPS test, standard panel unit root tests can then be based on the simple averages of the individual cross-sectionally augmented ADF statistics (denoted by him as CADF).

The derivation of the test statistic presented here follows Section 5 in Pesaran's (2005) paper for the case of serially correlated individual-specific errors in addition to the cross dependency.

Starting with a similar dynamic linear heterogeneous panel data model as in Equation (2.12):

$$y_{it}=\left(1-\phi_i\right)\mu_i+\phi_i y_{i,t-1}+u_{it}\quad i=1,...,N;t=1,....,T \tag{2.22}$$

where the initial value, y_{i0}, is given. Here, the null hypothesis would be $H_0:\phi_i=1$.

This time the error term, u_{it}, has the one-factor structure including a common effect and an idiosyncratic component. Pesaran presents three ways to introduce serial correlation into the model in Section 5.1 of his paper, firstly, the case where only the idiosyncratic components are serially correlated, secondly the case where the serial correlation is found in the common effects and finally a two step model in which the residual serial correlation is introduced first and then allowing for the cross-section dependence by assuming a one-factor model for the residuals. He confines his analysis to stationary first-order autoregressive processes. As Pesaran also points out, all three methods yield the same ADF regressions, but with different error specifications and parameter heterogeneity.

It is the third method that is then further developed and is briefly outlined here. Therefore, the residual serial correlation would be modelled as follows:

$$u_{it} = \rho_i u_{i,t-1} + \eta_{it}, \left|\rho_i\right| < 1, \text{ for } i = 1,2,...,N \tag{2.23}$$

The cross-section dependence would be expressed in the one-factor model for the residuals

$$\eta_{it} = \gamma_i f_t + \varepsilon_{it} \tag{2.24}$$

in which f_t is the unobserved common effect, and ε_{it} is the individual-specific (idiosyncratic) error.

These can be written as:

$$\Delta y_{it} = -\mu_i \beta_i \left(1-\rho_i\right) + \beta_i \left(1-\rho_i\right) y_{i,t-1} + \rho_i \left(1+\beta_i\right) \Delta y_{i,t-1} + \gamma_i f_t + \varepsilon_{it} \tag{2.25}$$

which is Equation (4.49) in Pesaran's paper and where $\beta_i = -\left(1-\phi_i\right)$ and $\Delta y_{it} = y_{it} - y_{i,t-1}$.

The unit root hypothesis of interest from Equation (2.22), $\phi_i = 1$, can now be expressed as

$$H_0 : \beta_i = 0 \text{ for all } i, \tag{2.26}$$

Against the possibly heterogeneous alternatives,

$$H_1 : \beta_i < 0, \quad i = 1, 2, ..., N_1, \ \beta_i = 0, \ i = N_1 + 1, N_1 + 2, ..., N. \tag{2.27}$$

Under the unit root hypothesis we have

$$\Delta y_{it} = \rho \Delta y_{i,t-1} + \gamma_i f_t + \varepsilon_{it}$$

and

$$f_t = \bar{\gamma}^{-1} \left(\Delta \bar{y}_t - \rho \Delta \bar{y}_{t-1} \right) - \bar{\gamma}^{-1} \bar{\varepsilon}_t$$

For this, it is assumed that $\bar{\gamma} = \frac{1}{N} \sum_{j=1}^{N} \gamma_j$ and that $\bar{\gamma} \neq 0$ for a fixed N and as $N \to \infty$. Pesaran points out that, for a sufficiently large N under this assumption the common effects can be approximated by linear combinations of $\Delta \bar{y}_t$ and $\Delta \bar{y}_{t-1}$.

In addition the DF regressions must be augmented for residual serial correlation and the lagged levels of the cross-section means of the processes, namely $\Delta y_{i,t-1}$ and $\bar{y}_{t-1}$.

In turn, Pesaran suggests running the following CADF regressions which are augmented to asymptotically filter out the effects of both the cross-section and the time dependence patterns in the residuals[10]:

$$\Delta \mathbf{y}_i = b_i \mathbf{y}_{i,t-1} + \bar{\mathbf{W}}_i c_i + \mathbf{e}_{it} \tag{2.28}$$

where $\bar{\mathbf{W}}_i = \left(\Delta \mathbf{y}_{i,-1}, \Delta \bar{\mathbf{y}}, \Delta \bar{\mathbf{y}}_{-1}, \boldsymbol{\tau}_T, \bar{\mathbf{y}}_{-1} \right)$ $T \times 5$; $\boldsymbol{\tau} = (1, 1, ..., 1)'$, $\Delta \bar{\mathbf{y}} = \left(\Delta \bar{y}_1, \Delta \bar{y}_2, ..., \Delta \bar{y}_T \right)'$, $\bar{\mathbf{y}}_{-1} = \left(\bar{y}_0, \bar{y}_1, ..., \bar{y}_{T-1} \right)'$

The individual CADF statistics are given by the t-ratio $t_i(N, T)$:

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[10] Pesaran (2005), Section 5.2

$$t_i(N,T) = \frac{\Delta \mathbf{y}'_i \bar{\mathbf{M}}_w \mathbf{y}_{i,-1}}{\hat{\sigma}_i \left(\mathbf{y}'_{i,-1} \bar{\mathbf{M}}_w \mathbf{y}_{i,-1}\right)^{1/2}} \tag{2.29}$$

$$\hat{\sigma}_i^2 = \frac{\Delta \mathbf{y}'_i \mathbf{M}_{i,w} \Delta \mathbf{y}_i}{T-4} \tag{2.30}$$

where

$$\Delta \mathbf{y}_i = \left(\Delta y_{i1}, \Delta y_{i2}, ..., \Delta y_{iT}\right)' \ , \ \mathbf{y}_{i,-1} = \left(y_{i0}, y_{i1}, ..., y_{iT-1}\right)'$$

$$\bar{\mathbf{M}}_i = \mathbf{I}_T - \bar{\mathbf{W}}_i(\bar{\mathbf{W}}_i' \bar{\mathbf{W}}_i)^{-1} \bar{\mathbf{W}}_i' \ , \mathbf{M}_{i,w} = \mathbf{I}_T - \mathbf{G}_i \left(\mathbf{G}_i' \mathbf{G}_i\right)^{-1} \mathbf{G}_i'$$

and $\mathbf{G}_i = \left(\mathbf{y}_{i,-1}, \bar{\mathbf{W}}_i\right)$

The detailed derivation of the statistic with all the underlying algebra can be followed in Pesaran's (2005) paper.

For an approach that can be extended to higher order processes, e.g. an AR(p) error specification, the relevant individual CADF statistics is given by the OLS t-ratio of b_i in the following p^{th} order cross-section/time-series augmented regression:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \bar{y}_{y-j} + \sum_{j=1}^{p} \delta_{ij} \Delta y_{i,t-j} + e_{it} \qquad (2.31)^{11}$$

This is the testing procedure which can also be extended to models containing linear and non-linear trends. Using the cross-section/time-series augmented regression, (2.31), the statistic $t_i^*(N,T)$ can be computed:

$$t_i^*(N,T) = CADF_{if}^* + o_p\left(1\right)$$

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[11] Pesaran (2005), Equation (5.60)

where $CADF_{if}^{*}$ is the cross-sectionally augmented Dickey-Fuller distribution and $t_i^*(N,T)$ its respective statistic. This is explained in Pesaran (2005) Theorem 3.2 and is:

$$CADF_{if}^{*} = \frac{\int_0^1 W_i(r)\,dW_i(r) - \boldsymbol{\psi}_{if}'\boldsymbol{\Lambda}_f^{-1}\boldsymbol{\kappa}_{if}}{\left(\int_0^1 W_i^2(r)\,dr - \boldsymbol{\kappa}_{ir}'\boldsymbol{\Lambda}_f^{-1}\boldsymbol{\kappa}_{if}\right)^{1/2}} \tag{2.32}$$

where

$$\boldsymbol{\Lambda}_f = \begin{pmatrix} 1 & \int_0^1 W_f(r)\,dr \\ \int_0^1 W_f(r)\,dr & \int_0^1 W_f^2(r)\,dr \end{pmatrix}$$

and

$$\boldsymbol{\psi}_{if} = \begin{pmatrix} W_i(1) \\ \int_0^1 W_f(r)\,dW_i(r) \end{pmatrix}, \boldsymbol{\kappa}_{if} = \begin{pmatrix} \int_0^1 W_i(r)\,dr \\ \int_0^1 W_f(r)W_i(r)\,dr \end{pmatrix}$$

with $W_i(r)$ and $W_f(r)$ being independent standard Brownian motions.[12]

The $CIPS^*(N,T)$ statistic given by

$CIPS^*(N,T) = \frac{1}{N}\sum_{i=1}^{N} t_i^*(N,T)$ then approximates

$$CIPS^* \sim^{(N,T)_j} \frac{1}{N}\sum_{i=1}^{N} CADF_{if}^{*}$$

The similarity to the previously outlined IPS test is obvious.

An interesting feature of Pesaran's test is in the way the common factors are treated. In his specifications the common factor term is introduced

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[12] Pesaran (2005), p.8, Theorem 3.2

to model cross-section dependence of the stationary components. It is therefore sensible not to allow f_t to have a unit root.

This contrasts, e.g., with other recently developed tests such as the Bai and Ng (2004), which allows for the possibility of a unit root in the common factors, but the unit properties of those common factors and the idiosyncratic component of the individual series are unrelated. As a result they are able to carry out separate unit root tests in the common and the idiosyncratic components.

3 METHODOLOGY

In order to conduct the panel unit root tests explained above it is therefore necessary to first outline how non-linear trend terms can be introduced.

3.1 Introducing Non-Linear Trend Terms into IPS

Introducing a non-linear trend term into the ADF regression as derived from Equation (2.17) above gives:

$$\Delta q_{it} = \sum_{k=0}^{l_i} \theta_{ki} t^k + \beta_i q_{i,i-t} + \sum_{j=1}^{p_i} \rho_{ij} \Delta q_{i,t-j} + \varepsilon_{it} \ . \qquad (3.1)$$

In the estimation process, the maximum value of *k*, the time order, was set equal to the same value for each individual *i*. Note that in this case IPS' dependent term, y_{it}, has been changed to q_{it} to keep in line with the formulation of the real exchange rate outlined in Chapter 2. This does not alter the statistical process, however

As with the original IPS model outlined above, the null hypothesis would still test for

$$H_0 : \beta_i = 0 \, , \; i = 1, 2, ..., N \qquad (3.2)$$

against the alternatives

$$H_1 : \beta_i < 0 \, , \; i = 1, 2, ..., N_1 \, , \beta_i = 0 \, , \; i = N_1 + 1, N_1 + 2, ..., N \ . \qquad (3.3)$$

The first term in Equation (3.1) allows for drift of time order $(l-1)$ under H_0 and a deterministic trend of time order l under the alternative hypothesis.

Although the basic IPS test with the original t-bar statistic with means or linear trends is available pre-programmed in some econometric software, the version with higher order time trends is not available as of yet and therefore had to be programmed with an econometric package.[13]

The beauty with this test statistic is that it intrinsically standardises the t-bar statistic within it using the mean and variance, so that it approaches a standard normal distribution with large T and N, as in Equation (2.21). See Im et al. (2003).

To therefore introduce non-linear trend terms into the model it is only necessary to calculate the relevant means and variances. The respective means and variances have thus been estimated accordingly using Monte Carlo simulations with 50,000 repetitions for trend orders two to ten and for lag values zero to eight in each trend order by Professor Cushman. The resulting values are recorded in Table 9.7, Appendix B below. Table 9.7 is therefore an extension for non-linear trend orders of the original IPS (2003) Table 3, p.66 in the IPS (2003) paper.

This little convenience also leads to the fact that the critical values for the overall IPS statistic will still approximate standard normal distribution critical values. I further verified this fact in a Monte Carlo Simulation of 100 observations for trend orders up to ten in this study. Tables for test statistics under the normal distribution can be found in every econometric textbook and the relevant statistics have been reproduced in Table 9.18 part 3 in Appendix C below.

The overall IPS statistic that is obtained from the computation above does not, however, indicate which individuals are responsible for any rejection of the null. It is therefore worthwhile to also record and study the individual ADF *t*-statistics that are calculated in the process of the IPS. This can give some evidence as to which series are most likely to be stationary around the trend.

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[13] Professor Cushman coded it in TSP v4.5

Since these individual statistics are ADF statistics, the critical values for the regression including no trend and a linear trend ($k = 0,1$) respectively can be easily obtained from standard tables. The remaining ADF critical values for trend orders $k = 2,3,...,10$ under the Dickey-Fuller distribution have been estimated by Professor Cushman using Monte Carlo Simulations of 50,000 repetitions and are presented in Table 9.18, Appendix C below. These critical values obviously are for 1 individual only and are independent of the panel size N.

3.2 Introducing Non-Linear Trend Terms into CIPS

Introducing a trend term in a similar fashion into Equation (2.31) for the CIPS:

$$\Delta q_{it} = \sum_{k=0}^{l_i} \theta_{ki} t^k + b_i q_{i,t-1} + c_i \overline{q}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \overline{q}_{y-j} + \sum_{j=1}^{p} \delta_{ij} \Delta q_{i,t-j} + e_{it} \qquad (3.4)$$

where, again, $k = 0,1,2,...,l_i$.

Again, the null hypothesis would be

$$H_0 : b_i = 0 \qquad (3.5)$$

against the alternatives

$$H_1 : b_i < 0\,,\ i = 1,2,...,N_1\,, b_i = 0\,,\ i = N_1 + 1, N_1 + 2,..., N \qquad (3.6)$$

The underlying test statistic, i.e. the $CIPS*(N,T)$ statistic, as explained above, consists of the cross-section average of the t-statistic on $q_{i,-1}$. This had to be programmed similarly to the IPS statistic using econometric software. Since in this case the t* statistics are directly influenced by any trend terms, and are asymptotically correlated due to their dependence on the common factor (standard central limit theorems do not apply), critical values had to be obtained via Monte Carlo Simulations for a number of sizes of N in the panel and for trends of order $k = 0,1,2,...10$ for each N using Professor Cushman's TSP code. All critical values for the CIPS test are presented in Table 9.19, Appendix D below.

4 DATA AND RESOURCES

The data series needed for the research are the standard data used to test for PPP, i.e., exchange rates between a selection of countries and their price indices.

All data are quarterly and are obtained from the IMF IFS international financial statistics data service (updated October 2004). Quarterly data were chosen primarily to avoid the aggregation problems involved with annual data and to avoid having to estimate detailed dynamics with monthly data. Two sets of exchange rates are tested, which are the U.S. and German exchange rates with each other and a number of other OECD countries listed below. All tests are conducted on two different base rates not only for additional empirical output which can be analysed, but also due to the findings of Papell and Theodoridis (2001). The authors conduct panel unit root tests on the theory of PPP with twenty-one different base currencies and find that the conditions necessary for numeraire irrelevancy are not supported by their data. Further, they find that evidence of PPP is stronger for European than for non-European base currencies. They give the obvious explanations of distance between the countries and volatility of the exchange rates as the most important determinants of their results.

The countries under consideration in my panel are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Mexico, Netherlands, N. Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK and the United States. The standard CPI indices (ZF series, 1995M6=100) are used for price indices for all countries. The time period under consideration for all series is 1974Q1 to 1998Q4 so as to lie between the collapse of the Bretton Woods System in March of 1973 and the amalgamation of most European currencies into the Euro in January of 1999. This leaves 100 time series observations whereas the cross-sectional composition varies with individual test runs.

5 RESULTS AND ANALYSIS

The panel unit root tests are run in three different sets of panels: Firstly, the whole set of 23 exchange rates was tested as one panel. Next, the combination of 17 exchange rates as initially used by Smith et al. (2004) and again by Pesaran (2005), who corrects for a computational error in Smith et al.'s (2004) PPP analysis. No particular reason for the choice of countries in this set is given but it was chosen here as a further control mechanism in order to compare results with those of Pesaran (2005). The countries in this set are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland and the UK. The time span is kept at T=100, following Pesaran's (2005) first panel rather than the panel with T=45 employed by Smith et al. (2004).

The third panel is constructed out of the G7 member countries Canada, France, Germany, Italy, Japan, UK. This panel is chosen to see if any findings in the larger panels hold in a panel of the economically largest countries. In Equation (2.6) trends in relative prices will affect Q differently on the level of trade between the two countries, which would be reflected in a and a^*. Thus, Q may have different trends for different country pairs, leading to different results in different panels.

Some potential problems that one should be aware of are the fact that all panels include some of the same q_t series and there is therefore multiple testing on the same data. The same problem can arise to an important extent from the use of many different time orders. Also, the asymptotic critical values for the CIPS test were derived under the circumstance of no lags. This may lead to size distortion in finite samples since there are bound to be lag orders found in the real data. The greatest weight is therefore given to rejections at the 0.01 level. No extensive simulations to address the problem are conducted as, e.g., Cushman (2004) does.

The procedure to choose lag orders is based on the sequential test-down procedure of Ng and Perron (1995). In both the IPS and the CIPS tests, each individual univariate series has its own DF equation. Each is subjected to the test-down procedure as follows. Starting with the longest lag-order equation, the coefficient(s) of the longest lag order (*p*) are tested for statistical significance (one coefficient for IPS in Equation (3.1) and two for CIPS in Equation (3.4)). If significant, the procedure stops and this lag order is specified for the given individual real exchange rate. If not significant, that lag is dropped and the equation re-estimated and the new longest lag checked for significance. The procedure continues until the longest remaining lag order is significant. If none are, lag order 0 is chosen.[14] In contrast to this, Pesaran (2005) sets all his lag orders to the same value in all equations, and simply reports results for lag orders one through four.

The key overall statistics for the two tests and all panels are presented at this point followed by an interpretation and analysis in Section 5.1. The complete set of results including all individual statistics can be found in Appendix A.

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[14] Ng and Perron (1995), p.272

Starting with Table 5.1 for the overall statistics of the panel of 23 US-based exchange rates:

Table 5.1 Overall Statistics - Panel of 23 US-based exchange rates

Trend\Test	IPS	CIPS
0	-3.65002***	-2.25003**
1	-1.81301**	-2.89926***
2	-0.20308	-3.43179***
3	-0.20805	-3.45793**
4	2.50776***	-4.01090***
5	-2.50097***	-4.17983***
6	-0.53526	-4.11829
7	-0.42091	-3.99449
8	2.29891**	-4.46578
9	-1.62352*	-4.49136
10	-3.92420***	-5.22235**

Notes:

a. Trend refers to the time order of the trend included in the regression
b. Asterisks denote a significant rejection of the H_0 at the 1% (***), 5% (**) and 10% (*) level respectively (critical values given in Appendices C and D).

The same notation applies to all Tables below.

The differences in terms of overall rejections between the two tests can clearly be observed from Table 5.1. Whereas the CIPS test finds strong evidence to reject the H_0 at trend orders 2 and three, there is no rejection at any significance level for those time orders with the IPS test. The IPS test on the other hand rejects the H_0 at an even higher significance level at trend order 10 and also finds evidence against a unit root process at trend order 8.

In terms of individual results, it can be seen from Table 9.1 in Appendix A that for the IPS test, Mexico and New Zealand in particular show highly significant rejections throughout the trend orders, not just at one specific order. Twenty out of twenty-three exchange rates show no strong significance at any trend order. For the CIPS test, evidence of stationarity at the lower orders is found especially for France, Iceland, Mexico and New Zealand, whereas Finland and Iceland are showing strong significance at order 6, Greece at 7, Japan, Switzerland and Denmark at 8, Switzerland at 9 and Belgium, Switzerland

and the UK at 10, leaving more evidence for the hypothesis of a stationary process at one particular higher order trend.

Next is Table 5.2 showing the overall statistics for the panel of 23 German-based exchange rates:

Table 5.2 Overall Statistics - Panel of 23 German-based exchange rates

Trend\Test	IPS	CIPS
0	-4.62887***	-2.15461*
1	-4.26722***	-2.68707*
2	-6.49301***	-3.10331**
3	-5.26821***	-3.33605
4	-5.02627***	-3.72249*
5	-3.91157***	-4.24568***
6	-3.22337***	-4.50234***
7	-0.92254	-4.64000**
8	-5.59005***	-4.57426
9	-3.52165***	-4.71806
10	-4.93848***	-4.93202

Judging from the overall tests statistics alone, there appears to be very strong evidence for stationary processes amongst the panel series, especially when referring to the IPS test. With the exception of trend order 7, all trend orders show very strong rejections of the H_0 at the 1% level. The CIPS overall statistics are not as inclined towards the stationarity hypothesis as those of the IPS, yet there are still rejections of the H_0 at 7 out of 11 trend orders.

When referring to the individual statistics presented in Table 9.2 it appears that the IPS overall statistic is not simply ‘triggered’ to reject the H_0 by single individual statistics, as can be observed elsewhere, but it in fact shows an abnormal amount of rejections of the H_0 by individual statistics which the CIPS does not reject. This might point to the importance of accounting for contemporaneous correlation in-between the cross-section terms in the panel. Also, the IPS test finds surprisingly many individually significant series at the higher orders, e.g. nine significant exchange rates at order 8 and ten individually significant exchange rates at order 10. The CIPS on the other hand shows only weak to no significance at most orders for which the IPS shows a very high significance, with the exceptional overlapping verdict for trend order six.

Table 4.3 presents the overall statistics for the panel of 17 US-based exchange rates

Table 5.3 Overall Statistics - Panel of 17 US-based exchange rates

Trend\Test	IPS	CIPS
0	-3.12240***	-1.86890
1	-1.73580**	-2.66349*
2	0.02098	-3.35388***
3	-0.04110	-3.33919
4	2.33253***	-3.86956**
5	-1.93258**	-3.79340*
6	0.29018	-3.79657
7	0.53596	-3.62088
8	2.84551***	-3.77843
9	-0.79530	-3.90465
10	-3.18989***	-5.25680**

The overall test statistics in this case show a reasonable level of congruence. With the exception of trend orders 0, 2 and 8, the two tests' verdicts overlap to the extent that even the level of significance is identical in most cases. From Tables 5.1 and 5.3 a slight pattern seems to emerge in that the H_0 is more likely to be rejected at linear and lower non-linear trend orders and again at trend order 10, whereas the midrange of trend orders under consideration shows less evidence for stationarity.

When looking at individual results in Table 9.3, it is not as apparent in this case which underlying individual series cause the IPS to overall reject the H_0 at order eight and ten, since here, none of the individual statistics show significance. For the CIPS test, a different kind of complexity can be observed. At order eight, three individual series show strong evidence for a stationary process, yet this leads to no overall rejection of the H_0 at any significance level. Thus, the three individual rejections may reflect type I errors.

Table 5.4 contains the overall statistics for the panel of 17 German-based exchange rates

Table 5.4 Overall Statistics - Panel of 17 German-based exchange rates

Trend\Test	IPS	CIPS
0	-3.72495***	-2.4523***
1	-3.40303***	-3.30222***
2	-5.11258***	-3.24988**
3	-4.03049***	-3.38465
4	-3.38465***	-3.41533
5	-3.74432***	-4.18724**
6	-2.66857***	-4.5619***
7	-1.78969**	-4.62483**
8	-4.7751***	-4.74613*
9	-2.62689***	-4.75226
10	-4.01048***	-4.89894

When judging by the results of the IPS test, this panel is another example for strong evidence of stationary processes at seemingly all trend orders. The CIPS test’s overall results show similar, if not as strong indications of stationarity especially at the lower trend orders and again in the range of order 5 to 8.

From the individual results in Table 9.4, for the CIPS test, the same tendency to fail to reject the H_0 can be identified as above, even if one or, in some cases, more exchange rate within the respective trend order show strong or very strong significance of a stationary process.

The overall statistics for the Panel of G7 countries under US-based exchange rates are presented in Table 5.5:

Table 5.5 Overall Statistics - Panel of G7 countries under US-based exchange rates

Trend\Test	IPS	CIPS
0	-1.21042	-1.66698
1	-1.11159	-2.40549
2	0.24110	-3.05610
3	-0.78314	-3.46169
4	0.84594	-4.22525
5	-0.33158	-3.91504
6	0.58781	-3.67350
7	0.96876	-3.51912
8	1.28246	-4.89808
9	0.73253	-4.18064
10	-1.60330*	-5.15172

Almost completely concurrent results for both tests are found. This might on the one hand be attributed to a low test power with only six exchange rates being tested in the panel, on the other hand it could indicate that the G7 member countries' exchange rate do in fact follow a unit root process .

The final table showing overall test statistics is Table 5.6 for the panel of G7 countries under German-based exchange rates:

Table 5.6 Overall Statistics - Panel of G7 countries under German-based exchange rates

Trend\Test	IPS	CIPS
0	-2.55244***	-2.52751*
1	-1.88158**	-3.40563***
2	-3.58938***	-3.34739*
3	-2.51116***	-3.44566*
4	-2.16945**	-3.25204
5	-1.76962**	-3.30892
6	-0.31374	-3.39822
7	0.94780	-3.69167
8	-2.89466***	-4.40096
9	-0.32941	-3.89499
10	-0.18373	-4.43466

Once again, contradictory overall test verdicts are observed between the two tests since there is no agreement over significant rejections of the H_0 at any trend order, with only trend order 1 having a reasonable overlapping result. The same precaution must be given to this panel as to the previous panel based on US exchange rates since we have the same low power problem as before.

Individually, consistently strong rejections for both tests of the H_0 for France at lower trend orders can be observed in Table 9.6, which might be the cause for the overall rejections at those levels.

5.1 Interpreting the Results

As could be expected, the overall results for the panel test statistics vary greatly with the differing compositions of the panels at hand for both currency bases and, possibly most important, between the two tests.

Overall it can be observed that more rejections of the H_0 at the 1 percent level take place for both tests when panels are based on the German Deutschmark. Outstanding in this case are the results for the IPS test for the full German-based panel of 23 countries (minus Germany) and the German-based panel of 17 countries, in which *all* trend orders returned rejections, i.e. an indication that at least one of the underlying series was stationary at any trend order (in the German-based panel of 17 countries all but trend order 7 showed significance at the 1 percent level, order 7 was significant at the 5 percent level). This could initially be interpreted as a strong indication of the validity of non-linear deterministic trends in exchange rates. The CIPS test showed no such extreme results in any of the panels under consideration.

Contrasting to this, there are only four cases in total in which the IPS test shows a rejection at the 5 percent level of significance across all panels tested, whereas the CIPS shows approximately as many overall rejections at the 5 percent level as at the 1 percent level of significance. Since it is rather unusual for any statistical test to have most of its significant results lie in the 1 percent region of significance, this outcome might point towards a “hypersensitivity” of the IPS test in its rejections. Arguably, this sensitivity might be caused by the influence of cross-section dependencies between the individual series which is accounted for in the CIPS test but not picked up by the IPS.

Interlinking with the observation discussed in the previous paragraph is another one, that of ‘freak’ individual observations causing the IPS to overall reject the H_0, where the CIPS would not, or at least not at a high level of significance. An example for this would be trend order 10 for the panel of all 23 US-based exchange rates, Table 5.1. Here, only two individual test statistics, those of Iceland and Mexico, show a significant rejection at only the 10 percent level. Yet, the IPS overall statistic rejects the H_0 at the 1 percent level. In direct contrast to this, for the same trend order, the IPS would also reject the H_0, but only at the 5 percent level and this outcome is based on 6 individually significant statistics rather than just the two. Generally, there are a lot less of these 'freak' observations in the results produced by the CIPS test.

To further compare and contrast the overall predictions of the two panel unit root tests and to make further predictions about the hypothesis of non-linear deterministic trends, the following two representations might be of aid. First, Table 5.7 lists those trend orders for all the panels under consideration at which both, the IPS and the CIPS tests rejected the H_0 at the 1 percent level (i.e. both are marked with a '***' in the result Tables above). Next, Table 5.8 lists those trend orders for all panels at which one of the two tests, either the IPS or the CIPS shows a rejection at the 1 percent level ('***') and the other shows a rejection at least at the 5 percent level ('**') of significance. In effect, Table 5.8 is therefore a less stringent version of Table 5.7 and includes those results from Table 5.7. These results indicate overlapping verdicts for both tests and at the same time give an indication of which trend orders show most prevalence of stationary processes.

Table 5.7 - Trend order at which both IPS & CIPS show '***'

Panel	Trend order at which both IPS & CIPS show '***'
23 US-based	4,5
23 German-based	5,6
17 US-based	
17 German-based	0,1,6
G7 US-based	
G7 German-based	

Table 5.8 - Trend order at which one of IPS or CIPS shows ‘***’ and the other at least shows ‘**’

Panel	Trend order at which one of IPS or CIPS shows ‘***’ and the other at least shows ‘**’
23 US-based	0,1,4,5,10
23 German-based	2,5,6
17 US-based	4,10
17 German-based	0,1,2,5,6
G7 US-based	
G7 German-based	1

What is most evident from these summarising tables is that there is but one coinciding strong rejection in the third panel of exchange rates, comprising the G7 member countries. This observation is further discussed below.

It is difficult to make a precise judgement as to which trend order is specifically likely to produce evidence for stationary processes. Trend orders 5 and 6 show most evidence for stationarity when looking at the overall statistics above. By contrast, when looking at the individual statistics, orders zero, one and two show most cases where several individual statistics reject the H_0, even if this does not lead to most frequent overall rejections at those orders, as indicated in the Tables above. What is underlined is the proposition about the importance of the underlying panel composition and the base-currency used in the exchange rates.

An obvious discrepancy between the results of the two tests emerges at higher trend orders. Whereas there are largely overlapping outcomes in both tests at lower trend orders, with both tests at least leading to the same overall conclusion (either reject or fail to reject the H_0) almost all of the time, this is not the case at higher trend orders. An example of this observation would be the panel of 17 German-based exchange rates, Table 5.4. Here, the overall verdict differs starkly from order 8 to 10, with the IPS rejecting the H_0 each time at the 1 percent level and the CIPS only marginally rejecting

H_0 at order 8 and failing to reject it at orders 9 and 10. These differing verdicts seem to be caused by completely contrasting individual results, once again with the IPS seeming to detect more individually stationary processes than the CIPS.

The increased likelihood of an overall H_0 rejection by the IPS at higher trend orders casts further doubt on the reliability of this test. A deterministic trend following a polynomial order of 10 could be seen to be too complex to be plausible for the real economic forces that presumably cause deviations from PPP. The pattern of overall statistic results observed from the CIPS test, in which rejections slowly ‘ebb down’ with increasing trend orders seems to be more realistic than the pattern displayed by the IPS test, where there generally is a lack of rejections in the mid range of trend orders and then, all of a sudden, rejections at the 1 percent significance level are observed again at order 10. As a counter argument, a non-linear function that looks simple to the eye may nevertheless require a high polynomial time order. For example, suppose the non-linear function is very similar to a step function with one step (i.e., one mean for, say, the first half of the sample, and a second mean for the second half). In order to approximate this using a time polynomial one would require a rather higher order, if the jump were significant.

The third set of panels, made up of exchange rates between the G7 countries and the US and Germany respectively, showed the weakest overall results. In the case of US-based exchange rates, there were no rejections of the H_0 at any significance levels or at any trend order for neither test. Overall rejections in the case of the German based panel can clearly be seen to be caused by the high significance levels of France (and to an extent Japan) at most of the lower trend orders. These results could lead to the conclusion that in these sets of panels the cross-sectional dimension, N, was too low (6 for US-based and 5 for the case of German-based exchange rates) and thus depriving the tests of too much power to be significant.

When looking at all test results with their individual underlying statistics, an interesting pattern seems to evolve regardless of which test is being used. That is, a few individual countries display evidence for a stationary process (i.e. there are strong and very strong rejections of the imposed H_0) not only at a certain trend order consistently through the different panel samples, but instead at any polynomial trend order throughout the panel, not just one. The most extreme case of this phenomenon can be seen for Switzerland throughout the different panels and for both the US and the German base rates. Other countries where this effect can be observed frequently are France, Iceland, Mexico and New Zealand for the US-based panels and France and New Zealand for the German-based panels. This could be explained if, for example, for a specific series the time order is really 2, a rejection with a test specified for order 10 will still occur if the test is powerful enough. If the time order is really 10, but well approximated by time order 2, then the time order test could be well enough specified to reject.

Overall then, there appears some evidence to support the notion that the CIPS test improves on the results obtained by the IPS. This is shown through more consistent results between panels and more ‘sensible’ overall verdicts based on the underlying individual statistics. The greater sensibility of the results achieved by the CIPS test point towards the importance of addressing the issue of cross-sectional dependence within panel data as explained above and Pesaran’s test might be a great step in the right direction. It might be a useful idea to analyse which trend orders are more likely to produce rejections of the H_0 when focussing solely on the CIPS results. In the same vain as the analysis presented in Table 5.7, where, at the 1% level, stationary processes where predicted mainly at higher trend orders 5 and 6, Table 5.9 presents results for the CIPS test only and, again, all rejections of the H_0 at the 1% level are shown for the individual panels.

Table 5.9 - Trend order at which CIPS shows ‘***’	
Panel	Trend order at which CIPS shows ‘***’
23 US-based	1,2,4,5
23 German-based	5,6
17 US-based	2
17 German-based	0,1,6
G7 US-based	
G7 German-based	1

Although varied, the results presented in Table 5.9 are similar to those of Table 5.7 and show that there is evidence of stationary processes in higher trend orders, again, especially at orders 5 and 6. Importantly though, the CIPS rejections seem to be triggered by more individually strong rejections of the unit root hypothesis, rather than no individual rejections at all as is the case in some of the IPS test results. Furthermore, in terms of the search for support of non-linear deterministic trends, the panels including exchange rates based on the German Mark suggest more stationary processes than those based on the US Dollar.

It should be noted, however, that the CIPS may not be the best testing procedure. There are a number of possibly contradictory results, such as the case analysed in the note to result Section 5.3. Here, in the case for the panel of 17 US-based exchange rates, the CIPS test fails to reject the H_0 even though three individual series showed strong evidence for a stationary process. However, it is possible to get a few individual rejections by chance in a large panel even if none of the individual nulls are actually false.

If one were to take the last summarising table, Table 5.9 as an indication for the validity of PPP, there is no strong support that the basic hypothesis holds (there is only one rejection in favour of mean stationarity), but it can be seen that the null of a unit root has been rejected in favour of a non-linear trend process in the long-run real exchange rate at a number of higher trend orders.

6 POSSIBLE EXTENSIONS

There are a number of obvious extensions that lend themselves to be considered in future research in this area. There is always the option of using other sets of exchange rates in different combination of panels, other base currencies and other time periods. Further, a range of different tests could be adapted in a similar manner to that presented above to account for the non-linear deterministic trends, e.g. GLS based tests as proposed by Papell (1997). It might be interesting to test other combinations of smaller panels and compare those to the results presented for the G7 countries in order to arrive at more precise conclusions about the power properties of the tests in panels with few versus many individual real exchange rates.

An immediate feature within the framework of this paper’s work which has not been considered is that of accounting for other lag orders in the CIPS test, which could be achieved through bootstrapping. Additionally, an in-depth structural break analysis as begun by Pesaran (2005) could be conducted.

A more challenging future undertaking would be to combine the two concepts of non-linear deterministic trends and non-linear mean reversion into a testing procedure, but this is well beyond the scope of this paper.

7 CONCLUSION

Two main innovative concepts are applied to PPP testing in this paper. First, non-linear deterministic trends of different orders are specified. Second, the testing employs modern panel unit root tests with more statistical power and less susceptibility towards cross-sectional dependency than other individual and panel approaches.

A key issue takes the form of a comparison of results achieved by two panel unit root tests, the Im, Pesaran and Shin (2003) IPS test and its further enhanced version, CIPS, by Pesaran (2005). The latter test accounts for the issue of cross-sectional dependence within panels. Section 5.7 finds that the more recent CIPS test by Pesaran seems to generate more consistent results than the IPS test, as there are, e.g., no cases where an overall rejection of the null hypothesis is found without any underlying significant individual statistics. The greater consistency and sensibility of the results generated by the CIPS test point toward the importance of accounting for cross-sectional dependence within panels.

Regarding the central theme of the paper, both tests reject the null of unit roots throughout the panels under consideration at various trend orders, often in favour of non-linear deterministic trend processes in the real exchange rate. Most strong rejections of the null are seen in the two larger panel sets at trend orders between zero and six with a high number of significant overall rejections at orders five and six and significant individual rejections at orders zero and one in particular. The rather weak results obtained for the third set of panels consisting of the G7 countries could indicate that the underlying exchange rates in these panels have a unit root process, but could also be attributed to the low power one has to deal with in panels of cross-section sizes N=5 or N=6. Additionally, a larger number of strong rejections (at the 1 percent level) of the null hypothesis occur for those panels taking the German Deutschmark as a base currency rather than the US dollar.

The number of overall rejections at trend orders other than zero and one does suggest that there is a case for non-linear deterministic trends. If true, the standard form of PPP, which requires a constant equilibrium real exchange rate, breaks down for the rates with such trends, despite the rejection of the unit root. However, some (if not all) of the underlying real exchange rates in the respective panels do at least have a finite variance conditional on the higher order trend. Thus, a meaningful long-run equilibrium can be said to exist, contrary to the unit root model. There is thus evidence for the proposition that more advanced and powerful testing techniques will generate more consistent results, arguably in favour of a long-run equilibrium of some form in real exchange rates.

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9 APPENDICES

Appendix A: Complete Panel Results

Table 9.1 Pt.1 - Panel of 23 US-based exchange rates

Trend	0		1		2	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-3.65002***	-2.25003**	-1.81301**	-2.89926***	-0.20308	-3.43179***
indiv. Stats						
Australia	-1.64526	-1.38028	-2.63977	-3.84148**	-2.59689	-3.64048
Austria	-2.20400	-1.83837	-2.43193	-2.94760	-2.57595	-3.24746
Belgium	-2.30926	-1.83038	-2.27631	-2.01523	-2.57664	-3.15734
Canada	-0.55238	-0.43220	-1.91082	-2.00985	-1.38250	-2.57782
Denmark	-2.21668	-2.37908	-2.31665	-2.70561	-2.46115	-3.00780
Finland	-2.63655*	-2.51864	-2.61939	-2.57723	-2.60502	-3.05699
France	-2.21667	-3.82514**	-2.20486	-4.16542**	-2.41836	-4.26164**
Germany	-2.32548	-2.09376	-2.34622	-2.07296	-2.62856	-3.10184
Greece	-1.81790	-1.59864	-2.05638	-2.01059	-2.80480	-1.74022
Iceland	-2.73350*	-3.37839**	-2.77782	-3.81486**	-2.95140	-4.33041**
Ireland	-2.36491	-1.65391	-2.70482	-1.21687	-2.68441	-3.77387
Italy	-2.41624	-2.41651	-2.62987	-2.68415	-2.59683	-3.06383
Japan	-1.71030	-1.83862	-2.86051	-4.02428**	-2.92727	-4.14178**
Mexico	-3.11059**	-4.00751***	-3.14341	-4.47375***	-3.44129	-4.26827**
Netherlands	-2.08247	-2.80929	-2.06247	-3.13973	-2.68016	-3.68395
N. Zealand	-3.38565**	-3.58020**	-3.45873*	-3.80697**	-3.52697	-3.77343
Norway	-2.47217	-2.66360	-2.45034	-3.38037	-2.42624	-4.04393*
Portugal	-1.62464	-1.47436	-2.01228	-2.67419	-2.01148	-2.72143
Spain	-1.89571	-2.33180	-1.94233	-1.80252	-1.92796	-4.41176**
Sweden	-2.14547	-1.53526	-2.22205	-4.18075**	-2.63767	-4.25086**
Switzerland	-2.28668	-3.03947*	-2.71870	-4.06522**	-2.82555	-4.02766*
Turkey	-1.42805	-1.84565	-1.34018	-1.68665	-2.41002	-3.04152
UK	-2.41241	-1.27960	-3.05648	-1.38673	-3.06506	-1.60682

Table 9.1 Pt.2 - Panel of 23 US-based exchange rates

Trend	3		4		5	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-0.20805	-3.45793**	2.50776***	-4.01090***	-2.50097***	-4.17983***
indiv. Stats						
Australia	-2.77896	-3.66280	-3.26223	-3.63639	-3.43588	-3.57232
Austria	-2.89406	-2.58531	-2.75616	-3.11112	-3.82982	-3.04480
Belgium	-2.77203	-1.32147	-2.54990	-3.37586	-3.67237	-3.26175
Canada	-4.16095*	-4.88382**	-3.88540	-5.09623**	-3.56143	-2.85846
Denmark	-2.71273	-2.84580	-2.43459	-3.74232	-4.39403	-3.94907
Finland	-2.99218	-2.94877	-2.53654	-5.09286**	-4.15580	-4.85915*
France	-2.72760	-3.94491	-2.43031	-3.92540	-2.97831	-4.59021
Germany	-2.89395	-2.32669	-2.91807	-5.07703**	-3.91707	-4.58889
Greece	-2.91404	-2.62429	-3.62400	-3.01785	-4.35292	-5.29283**
Iceland	-3.75199	-4.31327*	-2.95584	-4.48899*	-3.81923	-5.41881**
Ireland	-2.94500	-2.83563	-2.84107	-1.83043	-4.69306*	-4.40647
Italy	-2.87538	-2.79284	-2.60858	-5.23357**	-3.65086	-5.06412*
Japan	-3.49802	-4.12403	-2.92570	-4.34837	-3.64779	-4.12145
Mexico	-3.55284	-4.28834*	-3.95036	-4.24397	-3.88837	-4.10473
Netherlands	-2.43082	-3.79483	-2.42517	-4.76375*	-4.47184	-4.55058
N. Zealand	-4.09542*	-3.69221	-4.31300*	-2.77735	-4.63221*	-2.95773
Norway	-3.11154	-4.15183	-2.65876	-5.33828**	-3.73633	-3.58418
Portugal	-2.79685	-3.37929	-2.43355	-3.02519	-4.34071	-2.98416
Spain	-2.23390	-4.27142*	-1.83177	-4.51360*	-4.51950	-4.57429
Sweden	-2.27193	-4.58150**	-2.46150	-4.42610	-4.03112	-4.49599
Switzerland	-3.00545	-4.28413*	-3.18663	-5.06676**	-3.81557	-5.00149*
Turkey	-2.38182	-2.97812	-1.97953	-2.10740	-3.35049	-3.94744
UK	-3.04336	-2.90119	-3.28091	-4.01184	-4.24563	-4.90720

Table 9.1 Pt.3 - Panel of 23 US-based exchange rates

Trend	6		7		8	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-0.53526	-4.11829	-0.42091	-3.99449	2.29891**	-4.46578
indiv. Stats						
Australia	-3.30872	-3.56825	-3.65378	-2.41815	-2.34469	-0.56394
Austria	-3.61319	-2.73143	-3.10668	-3.36572	-3.49431	-4.94493
Belgium	-3.55278	-2.27120	-3.46543	-2.27514	-4.54262	-3.61056
Canada	-4.22543	-1.91568	-3.37954	-2.69123	-4.41574	-2.86529
Denmark	-4.12700	-3.69831	-3.52625	-3.65919	-3.41651	-6.03921**
Finland	-4.09040	-5.52220**	-5.06327	-5.43191*	-3.53330	-4.46672
France	-3.03859	-3.54272	-4.05608	-2.66783	-3.31165	-2.90380
Germany	-4.43806	-4.47986	-3.18350	-4.45107	-4.55564	-4.78649
Greece	-4.27468	-4.42915	-4.93861	-6.13499**	-4.28301	-4.70522
Iceland	-3.50245	-5.35679**	-4.46911	-5.52894*	-4.44818	-5.47700
Ireland	-4.07869	-4.14046	-4.14289	-2.37255	-3.57412	-2.72550
Italy	-3.60245	-4.88729	-5.21314*	-4.76237	-4.52461	-4.38131
Japan	-3.60326	-3.72088	-2.12440	-2.98008	-3.94583	-5.94390**
Mexico	-5.82671***	-5.28631*	-5.26851*	-5.15217	-5.59880**	-5.07550
Netherlands	-4.30303	-4.24320	-3.80870	-4.37537	-3.53406	-4.80086
N. Zealand	-4.32799	-4.20228	-3.38069	-3.74453	-2.36141	-2.73486
Norway	-3.35367	-3.95288	-4.04241	-4.10789	-3.19117	-5.25804
Portugal	-4.26352	-3.18975	-4.26805	-3.94408	-3.87079	-4.90903
Spain	-4.11686	-5.09218*	-5.08321	-3.93264	-4.65194	-3.96379
Sweden	-3.63046	-4.62036	-5.55858**	-4.48767	-4.91281	-5.88077**
Switzerland	-3.78496	-4.52322	-3.87541	-4.69084	-4.53990	-6.03220**
Turkey	-3.86563	-4.41346	-4.47971	-4.55956	-4.44925	-5.05459
UK	-2.84399	-4.93285	-4.68339	-4.13937	-2.93023	-5.58948*

Table 9.1 Pt.4 - Panel of 23 US-based exchange rates

Trend	9		10	
Test	IPS	CIPS	IPS	CIPS
overall stat	-1.62352*	-4.49136	-3.92420***	-5.22235**
indiv. Stats				
Australia	-2.77644	-2.13304	-5.04086	-4.38242
Austria	-4.64889	-4.74112	-5.04727	-4.82204
Belgium	-4.59051	-3.05501	-5.06572	-6.82328**
Canada	-2.35918	-1.33385	-5.57856	-5.62705
Denmark	-4.80839	-5.87099*	-5.08031	-6.01746*
Finland	-5.60027	-5.05163	-5.67828	-6.13537*
France	-4.13841	-2.94384	-4.61057	-5.79316
Germany	-4.75594	-4.44925	-5.19345	-4.82436
Greece	-5.22476	-4.62003	-5.21354	-6.15282*
Iceland	-5.27140	-5.58387	-5.91474*	-5.57415
Ireland	-4.84183	-4.81153	-5.05706	-4.74264
Italy	-4.87049	-3.52252	-5.17797	-3.58929
Japan	-5.35264	-5.72621	-5.43599	-5.74940
Mexico	-5.43880	-4.42171	-5.85941*	-4.40413
Netherlands	-4.69532	-4.81600	-5.34512	-4.80180
N. Zealand	-5.28244	-4.25172	-5.28982	-4.91424
Norway	-4.77176	-5.27587	-4.74769	-3.98641
Portugal	-4.86774	-4.66608	-5.26804	-4.97897
Spain	-5.46525	-3.74244	-5.38952	-3.66899
Sweden	-5.61781	-5.40076	-5.62277	-5.60902
Switzerland	-5.35086	-6.23247**	-5.31210	-6.68974**
Turkey	-5.04392	-5.13975	-4.86661	-4.43664
UK	-4.13020	-5.51153	-4.59870	-6.39075**

Table 9.2 Pt.1 - Panel of 23 German-based exchange rates

Trend	0		1		2	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-4.62887***	-2.15461*	-4.26722***	-2.68707*	-6.49301***	-3.10331**
indiv. Stats						
Australia	-1.84371	-1.67177	-3.33910*	-3.25082	-3.52216	-3.34710
Austria	-1.74065	-2.17662	-1.07436	-1.24886	-2.98506	-2.76760
Belgium	-2.23696	-2.17766	-3.12909	-3.17737	-3.27970	-3.97732*
Canada	-1.92319	-2.11230	-2.29538	-3.26839	-3.67324*	-3.25059
Denmark	-2.26587	-2.04561	-2.55759	-2.53161	-2.82226	-2.51290
Finland	-2.89924	-2.61184	-2.93993	-2.65909	-4.18575**	-3.43103
France	-3.90458***	-4.21267***	-4.12054***	-4.62377***	-4.89040***	-4.47330**
Greece	-2.48858	-1.41765	-2.93151	-2.30927	-2.96102	-2.55128
Iceland	-2.62928*	-3.43097**	-2.74118	-3.79527**	-4.27580**	-3.32661
Ireland	-1.59885	-0.96401	-1.18138	-0.44654	-4.00760**	-2.80811
Italy	-2.36497	-2.25332	-2.24433	-2.61334	-3.53973	-2.88251
Japan	-2.03350	-1.83396	-3.08261	-3.66465*	-4.73258***	-3.77355
Mexico	-4.51728***	-2.93807*	-4.85505***	-2.88986	-4.82594***	-3.67457
Netherlands	-1.63172	-1.46808	-2.31078	-2.49952	-1.85617	-2.32767
N. Zealand	-2.98886**	-3.48934**	-2.95629	-3.60280*	-3.51860	-3.53550
Norway	-2.28008	-2.41123	-2.49654	-2.31774	-3.40697	-3.35106
Portugal	-1.97672	-0.88496	-4.08067***	-2.15647	-4.30136**	-2.23622
Spain	-2.51479	-2.43558	-2.27595	-2.48257	-3.04547	-2.57295
Sweden	-1.64169	-1.28931	-3.47625***	-2.64869	-4.17202**	-2.59952
Switzerland	-2.45340	-2.29267	-4.42803***	-3.99238**	-5.18289***	-5.02499***
Turkey	-1.85056	-1.92376	-2.19977	-1.32339	-2.91521	-2.26029
UK	-2.32946	-1.36014	-2.31747	-1.61324	-2.34132	-1.58815

Table 9.2 Pt.2 - Panel of 23 German-based exchange rates

Trend	3		4		5	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-5.26821***	-3.33605	-5.02627***	-3.72249*	-3.91157***	-4.24568***
indiv. Stats						
Australia	-3.51815	-3.12724	-3.58115	-3.05247	-4.51639	-4.76549*
Austria	-2.89457	-2.70730	-4.61601**	-4.05029	-3.66850	-4.35358
Belgium	-3.22101	-3.69774	-3.04997	-2.72723	-4.59196	-4.85156*
Canada	-3.49968	-3.32034	-3.54260	-2.87645	-4.16238	-4.70377
Denmark	-2.70722	-2.41040	-3.04008	-1.94356	-3.25353	-2.92974
Finland	-4.13397*	-3.54989	-5.41998**	-4.46761*	-5.34047***	-4.73624
France	-4.89324***	-4.51752**	-4.84169	-4.54599*	-4.81465	-4.52383
Greece	-3.15614	-2.74839	-2.97896	-3.38229	-3.16926	-4.08437
Iceland	-4.18350*	-3.31115	-5.36498**	-3.85319	-5.25347**	-5.09343**
Ireland	-4.40735**	-2.99778	-3.92624	-2.34863	-3.80633	-3.99323
Italy	-3.05187	-2.60446	-3.84272	-4.20825	-4.07249	-4.38479
Japan	-4.75933**	-3.74729	-4.84111	-3.87161	-4.81066*	-3.81043
Mexico	-4.80996**	-3.77115	-4.74901	-4.94732**	-3.89896	-5.35211**
Netherlands	-3.84489	-3.81523	-4.36257	-4.56170*	-4.20680	-4.36419
N. Zealand	-3.55950	-3.42102	-3.13354	-3.65400	-3.33503	-4.06910
Norway	-3.41291	-3.48467	-4.36709	-5.12723**	-4.18493	-4.28546
Portugal	-4.77334**	-3.51228	-4.77581	-4.42354	-4.77548*	-3.52049
Spain	-3.05979	-2.72353	-3.37692	-2.38876	-4.07024	-2.59081
Sweden	-4.52864**	-3.75571	-4.52319	-3.25513	-4.62510*	-3.89411
Switzerland	-5.59324***	-5.46728***	-5.69724**	-5.20777**	-5.79358***	-5.61710**
Turkey	-3.04486	-1.88486	-2.93040	-4.15289	-3.06018	-4.61443
UK	-2.92350	-2.81790	-3.06307	-2.84877	-3.08745	-2.86667

Table 9.2 Pt.3 - Panel of 23 German-based exchange rates

Trend	6		7		8	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-3.22337***	-4.50234***	-0.92254	-4.64000**	-5.59005***	-4.57426
indiv. Stats						
Australia	-4.63663	-4.24180	-4.04552	-3.98781	-4.65716	-3.73802
Austria	-5.28246**	-4.92502	-5.44237*	-4.95321	-5.26824	-5.74983*
Belgium	-4.47584	-4.81324	-4.99447	-4.28752	-5.04020	-4.36441
Canada	-4.15496	-4.72841	-2.50786	-4.10875	-4.22346	-3.44436
Denmark	-2.69260	-2.81764	-5.18097*	-5.31038*	-4.34933	-2.89334
Finland	-5.29671**	-4.66185	-5.28438*	-4.01269	-5.56179*	-4.50100
France	-5.33978**	-4.89346	-6.08300***	-5.33531*	-4.97949	-4.68147
Greece	-3.40180	-5.06860*	-3.16407	-4.92914	-5.36411	-5.25414
Iceland	-5.67689**	-4.94143	-5.25186*	-4.93489	-6.70826***	-4.80972
Ireland	-3.20166	-3.22228	-2.10676	-5.38930*	-4.90952	-2.69534
Italy	-3.44536	-4.56508	-2.15179	-3.51413	-3.95374	-3.91135
Japan	-2.90872	-3.98804	-5.33303*	-4.17255	-6.80776***	-5.52536*
Mexico	-5.44542**	-5.42756**	-4.45056	-5.36344*	-5.26413	-5.38573
Netherlands	-5.43818**	-5.09465*	-5.40328*	-4.85488	-5.58644*	-5.15024
N. Zealand	-3.08795	-4.24721	-3.67627	-4.29730	-3.84951	-3.82052
Norway	-4.21332	-3.76543	-3.11837	-3.72887	-5.76168**	-4.93513
Portugal	-5.38705**	-3.71413	-4.51027	-4.32599	-6.08289**	-5.28638
Spain	-3.96668	-4.23039	-4.45876	-5.03942	-5.29361	-4.78361
Sweden	-4.64507	-4.32033	-4.38505	-5.23203	-6.02322**	-5.09834
Switzerland	-5.98109***	-5.93742**	-5.95822**	-6.11114**	-5.85675**	-5.12864
Turkey	-3.40334	-4.65710	-2.63426	-4.47384	-3.22085	-4.54231
UK	-3.71495	-4.79048	-2.65221	-3.71742	-6.76124***	-4.93451

Table 9.2 Pt.4 - Panel of 23 German-based exchange rates

Trend	9		10	
Test	IPS	CIPS	IPS	CIPS
overall stat	-3.52165***	-4.71806	-4.93848***	-4.93202
indiv. Stats				
Australia	-4.07033	-3.36160	-6.32711**	-4.25228
Austria	-6.71950***	-6.49910**	-6.68560**	-6.19967*
Belgium	-4.95055	-4.08498	-5.43711	-5.48997
Canada	-3.62766	-4.00304	-5.08472	-4.53931
Denmark	-4.41399	-5.87673*	-4.00131	-4.48775
Finland	-5.31063	-4.66017	-5.93594*	-5.74701
France	-4.47137	-3.61729	-3.94642	-6.55845**
Greece	-4.75667	-4.46529	-6.92481***	-5.98821*
Iceland	-6.62541**	-4.78685	-6.52948**	-4.66484
Ireland	-4.59596	-4.50554	-4.42090	-2.50270
Italy	-3.50171	-2.89099	-2.59671	-2.58218
Japan	-4.65794	-5.60350	-4.59576	-5.63411
Mexico	-6.06130**	-4.85177	-5.96365*	-5.10428
Netherlands	-6.03962**	-5.44266	-5.66483	-4.48057
N. Zealand	-4.34119	-4.55869	-5.38385	-3.98293
Norway	-5.34752	-5.17718	-6.95531***	-4.41147
Portugal	-6.04815**	-5.12863	-6.06575*	-5.58577
Spain	-5.20347	-4.74552	-4.95423	-4.10654
Sweden	-5.17483	-5.06032	-5.11010	-5.26550
Switzerland	-5.93915*	-4.65552	-6.50513**	-5.37889
Turkey	-3.96516	-5.29835	-3.33033	-5.05848
UK	-6.71807***	-4.52370	-6.69096**	-6.48342**

Table 9.3 Pt.1 - Panel of 17 US-based exchange rates

Trend	0		1		2	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-3.12240***	-1.86890	-1.73580**	-2.66349*	0.02098	-3.35388***
indiv. Stats						
Australia	-1.64526	-1.28881	-2.63977	-3.81820**	-2.59689	-3.60050
Austria	-2.20400	-1.28729	-2.43193	-2.18030	-2.57595	-3.11282
Belgium	-2.30926	-1.71139	-2.27631	-1.61924	-2.57664	-3.16035
Canada	-0.55238	-0.48242	-1.91082	-1.40379	-1.38250	-2.52037
Denmark	-2.21668	-0.90866	-2.31665	-0.99793	-2.46115	-3.82625*
Finland	-2.63655*	-2.59522*	-2.61939	-2.69628	-2.60502	-3.21782
France	-2.21667	-3.09309*	-2.20486	-3.46438*	-2.41836	-4.26889**
Germany	-2.32548	-2.00945	-2.34622	-1.85345	-2.62856	-3.12062
Italy	-2.41624	-2.31426*	-2.62987	-2.61352	-2.59683	-2.91286
Japan	-1.71030	-1.72430	-2.86051	-3.53638*	-2.92727	-3.52343
Netherlands	-2.08247	-1.81040	-2.06247	-1.99497	-2.68016	-3.52752
N. Zealand	-3.38565**	-3.55716**	-3.45873*	-3.90913**	-3.52697	-3.87868*
Norway	-2.47217	-1.93365	-2.45034	-3.34518	-2.42624	-3.64456
Spain	-1.89571	-1.93092	-1.94233	-1.96328	-1.92796	-2.50067
Sweden	-2.14547	-1.80627	-2.22205	-4.27161**	-2.63767	-4.23990**
Switzerland	-2.28668	-1.74989	-2.71870	-3.93295**	-2.82555	-3.97891*
UK	-2.41241	-1.56809	-3.05648	-1.67870	-3.06506	-1.98184

Table 9.3 Pt.2 - Panel of 17 US-based exchange rates

Trend	3		4		5	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-0.04110	-3.33919	2.33253***	-3.86956**	-1.93258**	-3.79340*
indiv. Stats						
Australia	-2.77896	-3.62766	-3.26223	-3.59504	-3.43588	-3.56539
Austria	-2.89406	-2.46393	-2.75616	-3.32065	-3.82982	-3.16512
Belgium	-2.77203	-1.69523	-2.54990	-2.91349	-3.67237	-3.07601
Canada	-4.16095*	-4.88119**	-3.88540	-5.09524**	-3.56143	-2.41763
Denmark	-2.71273	-2.94649	-2.43459	-2.88811	-4.39403	-3.20790
Finland	-2.99218	-3.72081	-2.53654	-5.54318***	-4.15580	-5.21986**
France	-2.72760	-4.35734*	-2.43031	-4.38636	-2.97831	-4.87203*
Germany	-2.89395	-2.46082	-2.91807	-3.59534	-3.91707	-4.77773*
Italy	-2.87538	-2.56635	-2.60858	-4.53566*	-3.65086	-4.35982
Japan	-3.49802**	-4.15073	-2.92570	-4.40685	-3.64779	-4.11135
Netherlands	-2.43082	-2.66578	-2.42517	-3.58840	-4.47184	-3.44573
N. Zealand	-4.09542*	-3.81784	-4.31300*	-2.00075	-4.63221*	-3.00805
Norway	-3.11154	-3.80742	-2.65876	-4.43805	-3.73633	-2.62066
Spain	-2.23390	-2.36013	-1.83177	-2.19250	-4.51950	-2.44685
Sweden	-2.27193	-4.51370**	-2.46150	-4.54318*	-4.03112	-4.27747
Switzerland	-3.00545	-3.82996	-3.18663	-5.49507***	-3.81557	-5.81818***
UK	-3.04336	-2.90079	-3.28091	-3.24462	-4.24563	-4.09802

Table 9.3 Pt.3 - Panel of 17 US-based exchange rates

Trend	6		7		8	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	0.29018**	-3.79657	0.53596	-3.62088	2.84551***	-3.77843
indiv. Stats						
Australia	-3.30872	-3.53152	-3.65378	-2.39602	-2.34469	-0.73405
Austria	-3.61319	-3.48458	-3.10668	-3.77936	-3.49431	-3.05978
Belgium	-3.55278	-2.80373	-3.46543	-2.74844	-4.54262	-2.62838
Canada	-4.22543	-1.63200	-3.37954	-2.28249	-4.41574	-2.54766
Denmark	-4.12700	-2.88780	-3.52625	-2.77055	-3.41651	-4.34048
Finland	-4.09040	-5.51556**	-5.06327	-5.42279*	-3.53330	-4.97013
France	-3.03859	-4.07365	-4.05608	-2.54067	-3.31165	-3.82237
Germany	-4.43806	-4.58528	-3.18350	-4.59483	-4.55564	-3.24669
Italy	-3.60245	-4.42020	-5.21314*	-4.34384	-4.52461	-3.10716
Japan	-3.60326	-3.78188	-2.12440	-3.16125	-3.94583	-5.88679**
Netherlands	-4.30303	-3.03815	-3.80870	-4.85154	-3.53406	-2.83136
N. Zealand	-4.32799	-3.63103	-3.38069	-4.02798	-2.36141	-2.90794
Norway	-3.35367	-3.15983	-4.04241	-3.73630	-3.19117	-3.74117
Spain	-4.11686	-3.47042	-5.08321	-3.62061	-4.65194	-3.77562
Sweden	-3.63046	-4.87330	-5.55858**	-4.26081	-4.91281	-5.90897**
Switzerland	-3.78496	-4.85854	-3.87541	-4.72058	-4.53990	-5.85530**
UK	-2.84399	-4.79424	-4.68339	-2.29698	-2.93023	-4.86938

Table 9.3 Pt.4 - Panel of 17 US-based exchange rates

Trend	9		10	
Test	IPS	CIPS	IPS	CIPS
overall stat	-0.79530	-3.90465	-3.18989***	-5.25680**
indiv. Stats				
Australia	-2.77644	-1.07269	-5.04086	-4.47360
Austria	-4.64889	-3.47035	-5.04727	-5.00512
Belgium	-4.59051	-2.86400	-5.06572	-5.47939
Canada	-2.35918	-1.16060	-5.57856	-4.29349
Denmark	-4.80839	-4.33252	-5.08031	-7.20349***
Finland	-5.60027	-5.17739	-5.67828	-6.06299*
France	-4.13841	-3.54617	-4.61057	-5.69303
Germany	-4.75594	-3.76627	-5.19345	-4.97502
Italy	-4.87049	-5.37313	-5.17797	-5.19552
Japan	-5.35264	-3.55342	-5.43599	-3.50587
Netherlands	-4.69532	-3.58198	-5.34512	-4.79067
N. Zealand	-5.28244	-3.60236	-5.28982	-4.68790
Norway	-4.77176	-3.92837	-4.74769	-5.42608
Spain	-5.46525	-3.62793	-5.38952	-3.37590
Sweden	-5.61781	-5.74082*	-5.62277	-6.02156*
Switzerland	-5.35086	-6.86748***	-5.31210	-7.07541***
UK	-4.13020	-4.71355	-4.59870	-6.10060*

Table 9.4 Pt.1 - Panel of 17 German-based exchange rates

Trend	0		1		2	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-3.72495***	-2.4523***	-3.40303***	-3.30222***	-5.11258***	-3.24988**
indiv. Stats						
Australia	-1.84371	-1.82987	-3.3391*	-2.7423	-3.52216	-2.95975
Austria	-1.74065	-2.22687	-1.07436	-1.65156	-2.98506	-2.74418
Belgium	-2.23696	-2.50675	-3.12909	-3.75142**	-3.2797	-3.71515
Canada	-1.92319	-2.19616	-2.29538	-2.75057	-3.67324*	-2.94403
Denmark	-2.26587	-2.05693	-2.55759	-2.54735	-2.82226	-2.52078
Finland	-2.89924*	-3.15092*	-2.93993	-3.65981*	-4.18575**	-3.52766
France	-3.90458***	-4.38036***	-4.12054***	-4.9982***	-4.8904***	-4.37845**
Italy	-2.36497	-3.18207*	-2.24433	-4.78867***	-3.53973	-3.44149
Japan	-2.0335	-1.75104	-3.08261	-3.93149**	-4.73258***	-3.24675
Netherlands	-1.63172	-1.90329	-2.31078	-2.71817	-1.85617	-2.60468
N. Zealand	-2.98886**	-3.47407**	-2.95629	-4.05396**	-3.5186	-3.67749
Norway	-2.28008	-2.30354	-2.49654	-4.8384***	-3.40697	-4.99827***
Spain	-2.51479	-2.50545	-2.27595	-2.60777	-3.04547	-2.49929
Sweden	-1.64169	-1.31845	-3.47625***	-2.10201	-4.17202**	-2.36143
Switzerland	-2.4534	-3.26193**	-4.42803***	-4.22971**	-5.18289***	-4.89502***
UK	-2.32946	-1.18912	-2.31747	-1.46418	-2.34132	-1.48365

Table 9.4 Pt.2 - Panel of 17 German-based exchange rates

Trend	3		4		5	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-4.03049***	-3.38465	-4.24525***	-3.41533	-3.74432***	-4.18724**
indiv. Stats						
Australia	-3.51815	-2.55338	-3.58115	-2.64062	-4.51639	-5.28029**
Austria	-2.89457	-2.82466	-4.61601**	-3.47079	-3.6685	-4.23045
Belgium	-3.22101	-3.44458	-3.04997	-2.58057	-4.59196	-4.76173
Canada	-3.49968	-2.93394	-3.5426	-2.65437	-4.16238	-4.28371
Denmark	-2.70722	-2.41935	-3.04008	-1.24812	-3.25353	-3.7359
Finland	-4.13397*	-3.82699	-5.41998***	-3.7327	-5.34047**	-4.48699
France	-4.89324***	-4.46786*	-4.84169**	-4.42487	-4.81465	-4.3567
Italy	-3.05187	-3.21497	-3.84272	-4.18179	-4.07249	-4.9116*
Japan	-4.75933**	-3.12438	-4.84111**	-3.40902	-4.81066	-3.42824
Netherlands	-3.84489	-3.84163	-4.36257*	-4.27452	-4.2068	-4.17381
N. Zealand	-3.5595	-3.30645	-3.13354	-3.5388	-3.33503	-4.26836
Norway	-3.41291	-4.96833**	-4.36709*	-4.94762**	-4.18493	-4.69235
Spain	-3.05979	-2.59589	-3.37692	-2.51033	-4.07024	-2.50146
Sweden	-4.52864**	-2.68695	-4.52319*	-3.10822	-4.6251	-3.97043
Switzerland	-5.59324***	-5.34727***	-5.69724***	-5.35284**	-5.79358*	-5.42747**
UK	-2.9235	-2.59771	-3.06307	-2.57017	-3.08745	-2.48636

Table 9.4 Pt.3 - Panel of 17 German-based exchange rates

Trend	6		7		8	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-2.66857***	-4.5619***	-1.78969**	-4.62483**	-4.7751***	-4.74613*
indiv. Stats						
Australia	-4.63663	-4.96714	-4.04552	-4.90588	-4.65716	-4.96343
Austria	-5.28246**	-5.11155*	-5.44237*	-5.04378	-5.26824	-5.54535*
Belgium	-4.47584	-4.69449	-4.99447	-4.87786	-5.0402	-4.82273
Canada	-4.15496	-4.06878	-2.50786	-3.56741	-4.22346	-3.25079
Denmark	-2.6926	-2.6312	-5.18097*	-5.49758*	-4.34933	-4.89559
Finland	-5.29671**	-4.40335	-5.28438*	-4.09396	-5.56179*	-4.06756
France	-5.33978**	-4.9425	-6.083**	-5.36414*	-4.97949	-4.7488
Italy	-3.44536	-4.67271	-2.15179	-3.40266	-3.95374	-3.627
Japan	-2.90872	-3.18087	-5.33303*	-3.88104	-6.80776***	-5.57676*
Netherlands	-5.43818**	-5.03311	-5.40328*	-4.71899	-5.58644*	-4.72098
N. Zealand	-3.08795	-4.42284	-3.67627	-4.45191	-3.84951	-4.34576
Norway	-4.21332	-5.57384**	-3.11837	-4.93824	-5.76168**	-5.38647
Spain	-3.96668	-4.47095	-4.45876	-5.12016	-5.29361	-4.75704
Sweden	-4.64507	-4.57126	-4.38505	-4.88109	-6.02322**	-4.70398
Switzerland	-5.98109***	-5.90622**	-5.95822**	-6.00498**	-5.85675**	-5.24549
UK	-3.71495	-4.33967	-2.65221	-3.24763	-6.76124***	-5.28037

Table 9.4 Pt.4 - Panel of 17 German-based exchange rates

Trend	9		10	
Test	IPS	CIPS	IPS	CIPS
overall stat	-2.62689***	-4.75226	-4.01048***	-4.89894
indiv. Stats				
Australia	-4.07033	-4.20818	-6.32711**	-4.24076
Austria	-6.7195***	-6.37984**	-6.6856**	-6.29701*
Belgium	-4.95055	-4.52237	-5.43711	-5.38574
Canada	-3.62766	-3.72573	-5.08472	-4.31663
Denmark	-4.41399	-5.63543	-4.00131	-4.71529
Finland	-5.31063	-4.94593	-5.93594*	-4.6995
France	-4.47137	-3.62974	-3.94642	-5.29871
Italy	-3.50171	-2.60449	-2.59671	-2.68984
Japan	-4.65794	-5.34999	-4.59576	-5.46655
Netherlands	-6.03962**	-5.35251	-5.66483	-4.29605
N. Zealand	-4.34119	-5.00693	-5.38385	-4.09675
Norway	-5.34752	-5.20459	-6.95531***	-5.21252
Spain	-5.20347	-4.66081	-4.95423	-4.39024
Sweden	-5.17483	-4.58297	-5.1101	-5.03495
Switzerland	-5.93915*	-5.11676	-6.50513**	-5.67978
UK	-6.71807***	-5.10985	-6.69096**	-6.56278**

Table 9.5 Pt.1 - Panel of G7 countries under US-based exchange rates

Trend	0		1		2	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-1.21042	-1.66698	-1.11159	-2.40549	0.24110	-3.05610
indiv. Stats						
Canada	-0.55238	-0.53221	-1.91082	-2.15924	-1.38250	-2.44370
France	-2.21667	-1.59919	-2.20486	-2.75486	-2.41836	-4.37985**
Germany	-2.32548	-1.2887	-2.34622	-1.00969	-2.62856	-2.89917
Italy	-2.41624	-2.80161	-2.62987	-2.85390	-2.59683	-3.01328
Japan	-1.71030	-1.88903	-2.86051	-3.79463**	-2.92727	-3.77532
UK	-2.41241	-1.89114	-3.05648	-1.86063	-3.06506	-1.82527

Table 9.5 Pt.2 - Panel of G7 countries under US-based exchange rates

Trend	3		4		5	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-0.78314	-3.46169	0.84594	-4.22525	-0.33158	-3.91504
indiv. Stats						
Canada	-4.16095*	-5.06042	-3.88540	-5.20065	-3.56143	-2.84318
France	-2.72760	-4.42775*	-2.43031	-4.68920*	-2.97831	-5.32274**
Germany	-2.89395	-1.20983	-2.91807	-3.26336	-3.91707	-2.99148
Italy	-2.87538	-2.93578	-2.60858	-4.49535*	-3.65086	-4.31406
Japan	-3.49802	-3.62630	-2.92570	-3.67330	-3.64779	-3.64540
UK	-3.04336	-3.51005	-3.28091	-4.02966	-4.24563	-4.37339

Table 9.5 Pt.3 - Panel of G7 countries under US-based exchange rates

Trend	6		7		8	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	0.58781	-3.67350	0.96876	-3.51912	1.28246*	-4.89808
indiv. Stats						
Canada	-4.22543	-1.70483	-3.37954	-2.72464	-4.41574	-2.78515
France	-3.03859	-4.93736	-4.05608	-4.39336	-3.31165	-4.03086
Germany	-4.43806	-4.71449	-3.18350	-2.85069	-4.55564	-5.65692*
Italy	-3.60245	-4.34058	-5.21314*	-4.38740	-4.52461	-5.18533
Japan	-3.60326	-2.42755	-2.12440	-3.09093	-3.94583	-5.85153*
UK	-2.84399	-3.91618	-4.68339	-3.66769	-2.93023	-5.87869**

Table 9.5 Pt.4 - Panel of G7 countries under US-based exchange rates

Trend	9		10	
Test	IPS	CIPS	IPS	CIPS
overall stat	0.73253	-4.18064	-1.60330*	-5.15172
indiv. Stats				
Canada	-2.35918	-0.89725	-5.57856	-5.93096
France	-4.13841	-4.15905	-4.61057	-4.77373
Germany	-4.75594	-5.72914	-5.19345	-5.67218
Italy	-4.87049	-4.97898	-5.17797	-4.68066
Japan	-5.35264	-3.52087	-5.43599	-3.54639
UK	-4.13020	-5.79853*	-4.59870	-6.30641*

Table 9.6 Pt.1 - Panel of G7 countries under German-based exchange rates

Trend	0		1		2	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-2.55244***	-2.52751*	-1.88158**	-3.40563***	-3.58938***	-3.34739*
indiv. Stats						
Canada	-1.92319	-1.47101	-2.29538	-3.06970	-3.67324*	-3.44097
France	-3.90458***	-4.10524***	-4.12054***	-5.05299***	-4.89040***	-4.44901**
Italy	-2.36497	-3.00969*	-2.24433	-2.99213	-3.53973	-2.98499
Japan	-2.03350	-2.38885	-3.08261	-4.26651**	-4.73258***	-3.37754
UK	-2.32946	-1.66278	-2.31747	-1.64681	-2.34132	-2.48446

Table 9.6 Pt.2 - Panel of G7 countries under German-based exchange rates

Trend	3		4		5	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-2.51116***	-3.44566*	-2.16945**	-3.25204	-1.76962*	-3.30892
indiv. Stats						
Canada	-3.49968	-3.50817	-3.54260	-3.66339	-4.16238	-3.89222
France	-4.89324***	-4.45089*	-4.84169**	-4.38937	-4.81465	-4.40003
Italy	-3.05187	-2.92434	-3.84272	-2.69900	-4.07249	-3.30463
Japan	-4.75933**	-3.36276	-4.84111**	-2.97625	-4.81066	-2.82569
UK	-2.92350	-2.98212	-3.06307	-2.53218	-3.08745	-2.12201

Table 9.6 Pt.3 - Panel of G7 countries under German-based exchange rates

Trend	6		7		8	
Test	IPS	CIPS	IPS	CIPS	IPS	CIPS
overall stat	-0.31374	-3.39822	0.94780	-3.69167	-2.89466***	-4.40096
indiv. Stats						
Canada	-4.15496	-4.42759	-2.50786	-4.43703	-4.22346	-4.08587
France	-5.33978**	-4.79907	-6.08300***	-5.30032*	-4.97949	-4.29374
Italy	-3.44536	-3.18048	-2.15179	-2.86593	-3.95374	-3.83288
Japan	-2.90872	-2.08241	-5.33303*	-2.68028	-6.80776***	-5.05803
UK	-3.71495	-2.50154	-2.65221	-3.17478	-6.76124***	-4.73427

Table 9.6 Pt.4 - Panel of G7 countries under German-based exchange rates

Trend	9		10	
Test	IPS	CIPS	IPS	CIPS
overall stat	-0.32941	-3.89499	-0.18373	-4.43466
indiv. Stats				
Canada	-3.62766	-4.13884	-5.08472	-5.77742
France	-4.47137	-4.21785	-3.94642	-4.82765
Italy	-3.50171	-2.68737	-2.59671	-2.19737
Japan	-4.65794	-3.89641	-4.59576	-3.57250
UK	-6.71807***	-4.53450	-6.69096**	-5.79835

Appendix B: Means and Vars for the IPS Test

Table 9.7 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 0

trend 0										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5	-1.558	2.648								
10	-1.504	1.069	-1.488	1.255	-1.319	1.421	-1.306	1.759	-1.171	2.080
15	-1.514	0.923	-1.503	1.011	-1.387	1.078	-1.366	1.181	-1.260	1.279
20	-1.522	0.851	-1.516	0.915	-1.428	0.969	-1.413	1.037	-1.329	1.097
25	-1.520	0.809	-1.514	0.861	-1.443	0.905	-1.433	0.952	-1.363	1.005
30	-1.526	0.789	-1.519	0.831	-1.460	0.865	-1.453	0.907	-1.394	0.946
40	-1.523	0.770	-1.520	0.803	-1.476	0.830	-1.471	0.858	-1.428	0.886
50	-1.527	0.760	-1.524	0.781	-1.493	0.798	-1.489	0.819	-1.454	0.842
60	-1.519	0.749	-1.519	0.770	-1.490	0.789	-1.486	0.802	-1.458	0.819
70	-1.524	0.736	-1.522	0.753	-1.498	0.766	-1.495	0.782	-1.470	0.801
100	-1.532	0.735	-1.530	0.745	-1.514	0.754	-1.512	0.761	-1.495	0.771

Table 9.7 Pt.2

trend 0								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15	-1.239	1.420						
20	-1.313	1.171	-1.238	1.237				
25	-1.351	1.055	-1.289	1.114	-1.273	1.164	-1.212	1.217
30	-1.384	0.980	-1.331	1.023	-1.319	1.062	-1.266	1.105
40	-1.421	0.912	-1.380	0.942	-1.371	0.968	-1.329	0.996
50	-1.451	0.863	-1.418	0.886	-1.411	0.910	-1.377	0.929
60	-1.454	0.839	-1.427	0.858	-1.423	0.875	-1.393	0.896
70	-1.467	0.814	-1.444	0.834	-1.441	0.851	-1.415	0.871
100	-1.494	0.781	-1.476	0.795	-1.474	0.906	-1.456	0.818

Table 9.8 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 1

trend 1										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5	-2.463	13.859								
10	-2.166	1.132	-2.173	1.453	-1.914	1.627	-1.922	2.482	-1.750	3.947
15	-2.167	0.869	-2.169	0.975	-1.999	1.036	-1.977	1.214	-1.823	1.332
20	-2.168	0.763	-2.172	0.845	-2.047	0.882	-2.032	0.983	-1.911	1.052
25	-2.167	0.713	-2.172	0.769	-2.074	0.796	-2.065	0.861	-1.968	0.913
30	-2.172	0.690	-2.173	0.734	-2.095	0.756	-2.091	0.808	-2.009	0.845
40	-2.173	0.655	-2.177	0.687	-2.120	0.702	-2.117	0.735	-2.057	0.759
50	-2.176	0.633	-2.180	0.654	-2.137	0.661	-2.137	0.688	-2.091	0.705
60	-2.174	0.621	-2.178	0.641	-2.143	0.653	-2.142	0.674	-2.103	0.685
70	-2.174	0.610	-2.176	0.627	-2.146	0.634	-2.146	0.650	-2.114	0.662
100	-2.177	0.597	-2.179	0.605	-2.158	0.613	-2.158	0.625	-2.135	0.629

Table 9.8 Pt.2

trend 1								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15	-1.804	1.590						
20	-1.888	1.165	-1.778	1.243				
25	-1.955	0.991	-1.868	1.055	-1.851	1.145	-1.761	1.208
30	-1.998	0.899	-1.923	0.945	-1.912	1.009	-1.835	1.063
40	-2.051	0.792	-1.995	0.828	-1.986	0.872	-1.925	0.902
50	-2.087	0.730	-2.042	0.753	-2.036	0.786	-1.987	0.808
60	-2.101	0.705	-2.065	0.725	-2.063	0.747	-2.024	0.766
70	-2.111	0.673	-2.081	0.689	-2.079	0.713	-2.046	0.728
100	-2.135	0.638	-2.113	0.650	-2.112	0.661	-2.088	0.670

Table 9.9 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 2

trend 2										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10	-2.627	1.394	-2.658	2.047						
15	-2.623	0.952	-2.631	1.106	-2.414	1.156	-2.390	1.422	-2.191	1.591
20	-2.627	0.804	-2.637	0.885	-2.486	0.917	-2.470	1.056	-2.316	1.135
25	-2.617	0.724	-2.625	0.783	-2.511	0.821	-2.500	0.909	-2.376	0.964
30	-2.629	0.681	-2.635	0.725	-2.544	0.741	-2.537	0.810	-2.438	0.852
40	-2.624	0.642	-2.628	0.663	-2.563	0.675	-2.559	0.715	-2.490	0.742
50	-2.635	0.615	-2.636	0.628	-2.585	0.641	-2.583	0.668	-2.528	0.684
60	-2.626	0.598	-2.629	0.608	-2.588	0.614	-2.585	0.633	-2.541	0.647
70	-2.631	0.585	-2.632	0.597	-2.596	0.605	-2.596	0.621	-2.558	0.628
100	-2.628	0.563	-2.631	0.571	-2.607	0.575	-2.607	0.586	-2.582	0.593

Table 9.9 Pt.2

trend 2								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15	-2.177	1.973	-2.005	2.200				
20	-2.298	1.315	-2.157	1.413	-2.134	1.600	-2.006	1.716
25	-2.363	1.083	-2.245	1.143	-2.222	1.265	-2.115	1.340
30	-2.427	0.930	-2.327	0.979	-2.306	1.063	-2.212	1.135
40	-2.485	0.789	-2.415	0.828	-2.401	0.879	-2.329	0.918
50	-2.526	0.718	-2.471	0.741	-2.464	0.780	-2.408	0.810
60	-2.540	0.671	-2.497	0.693	-2.492	0.717	-2.446	0.739
70	-2.556	0.648	-2.519	0.665	-2.516	0.687	-2.477	0.706
100	-2.583	0.607	-2.558	0.617	-2.556	0.629	-2.530	0.638

Table 9.10 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 3

trend 3										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10	-3.014	1.877	-3.082	3.190						
15	-3.004	1.076	-3.018	1.279	-2.745	1.355	-2.722	1.769	-2.480	1.974
20	-3.002	0.869	-3.020	0.969	-2.837	1.024	-2.817	1.194	-2.630	1.269
25	-2.998	0.767	-3.015	0.836	-2.881	0.866	-2.869	0.968	-2.721	1.040
30	-3.005	0.714	-3.018	0.760	-2.913	0.768	-2.907	0.850	-2.791	0.893
40	-3.001	0.655	-3.008	0.681	-2.935	0.692	-2.930	0.736	-2.848	0.763
50	-3.007	0.615	-3.011	0.632	-2.954	0.647	-2.950	0.679	-2.888	0.694
60	-3.000	0.599	-3.005	0.612	-2.959	0.617	-2.958	0.640	-2.907	0.654
70	-3.006	0.585	-3.009	0.596	-2.969	0.601	-2.969	0.621	-2.926	0.627
100	-3.002	0.559	-3.007	0.566	-2.980	0.570	-2.982	0.580	-2.954	0.583

Table 9.10 Pt.2

trend 3								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15	-2.483	2.665						
20	-2.613	1.508	-2.450	1.610	-2.425	1.863	-2.279	2.026
25	-2.707	1.190	-2.567	1.254	-2.536	1.395	-2.408	1.492
30	-2.781	0.991	-2.666	1.046	-2.642	1.147	-2.532	1.218
40	-2.844	0.825	-2.761	0.870	-2.745	0.933	-2.659	0.986
50	-2.886	0.733	-2.822	0.763	-2.814	0.809	-2.748	0.840
60	-2.906	0.680	-2.856	0.701	-2.850	0.732	-2.796	0.754
70	-2.925	0.647	-2.883	0.667	-2.879	0.692	-2.834	0.707
100	-2.955	0.596	-2.926	0.606	-2.925	0.620	-2.895	0.627

Table 9.11 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 4

trend 4										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10										
15	-3.338	1.253	-3.362	1.566	-3.031	1.641	-3.010	2.267	-2.725	2.548
20	-3.334	0.964	-3.358	1.090	-3.139	1.144	-3.109	1.357	-2.884	1.474
25	-3.328	0.823	-3.349	0.904	-3.195	0.934	-3.181	1.054	-3.005	1.117
30	-3.330	0.757	-3.346	0.811	-3.222	0.814	-3.213	0.908	-3.074	0.952
40	-3.332	0.673	-3.344	0.699	-3.261	0.708	-3.255	0.761	-3.159	0.788
50	-3.338	0.635	-3.346	0.651	-3.284	0.661	-3.281	0.687	-3.209	0.704
60	-3.334	0.610	-3.342	0.629	-3.291	0.634	-3.290	0.655	-3.232	0.664
70	-3.335	0.590	-3.340	0.598	-3.296	0.600	-3.298	0.618	-3.249	0.627
100	-3.329	0.558	-3.335	0.565	-3.308	0.566	-3.310	0.573	-3.280	0.574

Table 9.11 Pt.2

trend 4								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15								
20	-2.862	1.791	-2.675	1.930	-2.655	2.302	-2.492	2.541
25	-2.987	1.303	-2.831	1.385	-2.802	1.571	-2.660	1.666
30	-3.060	1.073	-2.928	1.147	-2.903	1.275	-2.782	1.356
40	-3.152	0.864	-3.055	0.912	-3.036	0.992	-2.937	1.042
50	-3.207	0.747	-3.134	0.787	-3.124	0.847	-3.049	0.887
60	-3.229	0.695	-3.171	0.718	-3.163	0.756	-3.101	0.788
70	-3.247	0.646	-3.198	0.669	-3.194	0.700	-3.141	0.723
100	-3.283	0.587	-3.251	0.600	-3.251	0.617	-3.217	0.625

Table 9.12 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 5

trend 5										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10										
15	-3.634	1.463	-3.666	1.929	-3.267	2.083	-3.272	3.213		
20	-3.631	1.073	-3.662	1.236	-3.401	1.283	-3.373	1.593	-3.118	1.722
25	-3.625	0.896	-3.652	0.987	-3.474	1.010	-3.457	1.166	-3.255	1.249
30	-3.627	0.812	-3.650	0.862	-3.513	0.864	-3.505	0.973	-3.347	1.023
40	-3.628	0.705	-3.643	0.733	-3.551	0.733	-3.547	0.797	-3.441	0.831
50	-3.636	0.653	-3.646	0.672	-3.577	0.680	-3.573	0.711	-3.492	0.733
60	-3.634	0.628	-3.645	0.645	-3.590	0.650	-3.591	0.669	-3.527	0.681
70	-3.635	0.605	-3.643	0.612	-3.597	0.614	-3.599	0.632	-3.547	0.639
100	-3.626	0.570	-3.635	0.577	-3.605	0.578	-3.609	0.585	-3.577	0.587

Table 9.12 Pt.2

trend 5								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15								
20	-3.107	2.103	-2.903	2.282	-2.896	2.830	-2.711	3.316
25	-3.237	1.495	-3.058	1.591	-3.033	1.827	-2.873	1.905
30	-3.329	1.175	-3.178	1.257	-3.151	1.423	-3.012	1.515
40	-3.433	0.908	-3.324	0.963	-3.306	1.059	-3.197	1.108
50	-3.489	0.782	-3.406	0.820	-3.393	0.885	-3.309	0.922
60	-3.525	0.713	-3.460	0.742	-3.452	0.788	-3.382	0.817
70	-3.546	0.661	-3.493	0.684	-3.488	0.722	-3.429	0.743
100	-3.580	0.602	-3.545	0.613	-3.544	0.630	-3.507	0.634

Table 9.13 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 6

trend 6										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10										
15	-3.922	1.841	-3.968	2.538	-3.498	2.777				
20	-3.906	1.205	-3.949	1.418	-3.647	1.447	-3.620	1.864	-3.326	2.015
25	-3.898	0.980	-3.932	1.089	-3.730	1.112	-3.712	1.307	-3.482	1.406
30	-3.901	0.854	-3.925	0.919	-3.768	0.928	-3.754	1.064	-3.572	1.132
40	-3.901	0.743	-3.918	0.772	-3.816	0.775	-3.810	0.839	-3.691	0.876
50	-3.907	0.675	-3.921	0.695	-3.845	0.700	-3.842	0.734	-3.754	0.761
60	-3.908	0.643	-3.921	0.659	-3.862	0.660	-3.864	0.690	-3.795	0.697
70	-3.905	0.617	-3.916	0.627	-3.867	0.627	-3.871	0.644	-3.814	0.653
100	-3.898	0.576	-3.907	0.582	-3.875	0.585	-3.879	0.595	-3.843	0.599

Table 9.13 Pt.2

trend 6								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15								
20	-3.314	2.581	-3.084	2.802	-3.092	3.691		
25	-3.462	1.703	-3.264	1.816	-3.235	2.072	-3.054	2.229
30	-3.552	1.316	-3.387	1.403	-3.365	1.602	-3.218	1.677
40	-3.680	0.966	-3.561	1.027	-3.540	1.140	-3.417	1.197
50	-3.750	0.820	-3.657	0.857	-3.643	0.927	-3.549	0.964
60	-3.792	0.731	-3.721	0.757	-3.711	0.806	-3.635	0.838
70	-3.813	0.679	-3.755	0.697	-3.750	0.736	-3.685	0.765
100	-3.847	0.613	-3.810	0.627	-3.808	0.640	-3.768	0.652

Table 9.14 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 7

trend 7										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10										
15	-4.187	2.307	-4.255	3.577						
20	-4.166	1.370	-4.214	1.649	-3.862	1.714	-3.830	2.237	-3.501	2.401
25	-4.161	1.074	-4.199	1.216	-3.967	1.228	-3.946	1.459	-3.688	1.590
30	-4.158	0.929	-4.187	1.005	-4.012	1.008	-3.995	1.159	-3.791	1.230
40	-4.158	0.781	-4.179	0.816	-4.067	0.816	-4.059	0.893	-3.926	0.938
50	-4.158	0.700	-4.174	0.716	-4.093	0.718	-4.091	0.760	-3.994	0.791
60	-4.158	0.666	-4.174	0.679	-4.111	0.680	-4.112	0.706	-4.037	0.717
70	-4.160	0.632	-4.174	0.642	-4.121	0.639	-4.126	0.661	-4.065	0.669
100	-4.154	0.587	-4.165	0.591	-4.131	0.588	-4.136	0.599	-4.099	0.603

Table 9.14 Pt.2

trend 7								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15								
20	-3.499	3.161	-3.253	3.592				
25	-3.664	1.902	-3.450	1.999	-3.430	2.365	-3.239	2.546
30	-3.767	1.439	-3.583	1.544	-3.559	1.773	-3.398	1.878
40	-3.910	1.033	-3.777	1.107	-3.751	1.237	-3.619	1.302
50	-3.989	0.860	-3.886	0.899	-3.871	0.991	-3.768	1.047
60	-4.034	0.758	-3.957	0.782	-3.947	0.837	-3.863	0.876
70	-4.064	0.703	-4.002	0.728	-3.996	0.772	-3.925	0.793
100	-4.103	0.618	-4.062	0.632	-4.060	0.648	-4.016	0.655

Table 9.15 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 8

trend 8										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10										
15	-4.404	2.922								
20	-4.413	1.581	-4.463	1.907	-4.055	1.990	-4.034	2.797	-3.684	3.006
25	-4.398	1.178	-4.436	1.330	-4.174	1.359	-4.151	1.667	-3.865	1.808
30	-4.402	1.006	-4.435	1.084	-4.240	1.089	-4.220	1.276	-3.992	1.361
40	-4.399	0.823	-4.424	0.860	-4.305	0.864	-4.295	0.953	-4.149	1.008
50	-4.398	0.730	-4.418	0.751	-4.331	0.745	-4.328	0.799	-4.222	0.835
60	-4.398	0.684	-4.416	0.699	-4.348	0.703	-4.349	0.731	-4.267	0.750
70	-4.400	0.652	-4.415	0.669	-4.358	0.661	-4.362	0.679	-4.295	0.691
100	-4.393	0.595	-4.404	0.597	-4.368	0.594	-4.373	0.608	-4.332	0.608

Table 9.15 Pt.2

trend 8								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15								
20	-3.724	4.057						
25	-3.840	2.189	-3.614	2.335	-3.616	2.734	-3.432	2.944
30	-3.963	1.606	-3.759	1.724	-3.738	1.995	-3.570	2.127
40	-4.129	1.122	-3.984	1.191	-3.958	1.328	-3.816	1.389
50	-4.214	0.911	-4.103	0.954	-4.085	1.052	-3.972	1.100
60	-4.263	0.790	-4.179	0.829	-4.166	0.894	-4.074	0.934
70	-4.293	0.726	-4.225	0.749	-4.218	0.797	-4.141	0.823
100	-4.336	0.625	-4.293	0.641	-4.291	0.660	-4.243	0.670

Table 9.16 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 9

trend 9										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10										
15										
20	-4.483	1.711	-4.532	2.120	-4.087	2.169	-4.072	3.079	-3.694	3.165
25	-4.426	1.202	-4.449	1.355	-4.170	1.366	-4.135	1.650	-3.840	1.721
30	-4.626	1.089	-4.664	1.187	-4.451	1.188	-4.436	1.393	-4.195	1.489
40	-4.627	0.869	-4.654	0.916	-4.522	0.910	-4.510	1.013	-4.348	1.071
50	-4.625	0.761	-4.649	0.790	-4.553	0.788	-4.552	0.847	-4.436	0.877
60	-4.623	0.709	-4.642	0.722	-4.569	0.720	-4.570	0.753	-4.481	0.772
70	-4.627	0.673	-4.644	0.688	-4.585	0.679	-4.590	0.692	-4.519	0.702
100	-4.618	0.606	-4.632	0.611	-4.595	0.606	-4.603	0.621	-4.561	0.621

Table 9.16 Pt.2

trend 9								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15								
20								
25	-3.787	2.001	-3.563	2.038	-3.569	2.360	-3.382	2.526
30	-4.171	1.752	-3.964	1.834	-3.949	2.068	-3.761	2.183
40	-4.329	1.206	-4.170	1.290	-4.142	1.452	-3.990	1.530
50	-4.427	0.957	-4.306	1.004	-4.286	1.103	-4.167	1.154
60	-4.475	0.826	-4.385	0.861	-4.371	0.927	-4.272	0.977
70	-4.516	0.737	-4.442	0.771	-4.434	0.827	-4.350	0.852
100	-4.567	0.640	-4.521	0.653	-4.520	0.676	-4.469	0.683

Table 9.17 Pt.1 - Mean and variance of T(p,0) in ADF(p) regression; trend 10

trend 10										
obs	mean0	var0	mean1	var1	mean2	var2	mean3	var3	mean4	var4
5										
10										
15										
20	-4.357	1.755	-4.383	2.228	-3.876	2.246	-3.788	3.090		
25	-4.273	1.126	-4.291	1.275	-4.015	1.288	-3.961	1.555	-3.643	1.595
30	-4.615	1.072	-4.659	1.183	-4.438	1.172	-4.410	1.377	-4.145	1.444
40	-4.840	0.906	-4.866	0.961	-4.719	0.959	-4.706	1.067	-4.538	1.115
50	-4.833	0.789	-4.850	0.817	-4.740	0.804	-4.735	0.863	-4.619	0.891
60	-4.834	0.736	-4.852	0.749	-4.772	0.748	-4.778	0.782	-4.681	0.806
70	-4.840	0.688	-4.860	0.703	-4.796	0.692	-4.801	0.710	-4.725	0.732
100	-4.834	0.621	-4.849	0.624	-4.809	0.614	-4.603	0.621	-4.561	0.621

Table 9.17 Pt.2

trend 10								
obs	mean5	var5	mean6	var6	mean7	var7	mean8	var8
5								
10								
15								
20								
25	-3.552	1.847	-3.297	1.895	-3.258	2.197	-3.040	2.278
30	-4.101	1.692	-3.880	1.774	-3.850	2.003	-3.641	2.068
40	-4.518	1.286	-4.349	1.355	-4.320	1.519	-4.157	1.600
50	-4.606	0.984	-4.471	1.037	-4.443	1.133	-4.316	1.170
60	-4.667	0.857	-4.561	0.896	-4.542	0.990	-4.444	1.031
70	-4.721	0.774	-4.641	0.798	-4.633	0.851	-4.544	0.888
100	-4.567	0.640	-4.521	0.653	-4.520	0.676	-4.469	0.683

Appendix C: Critical Values for the IPS Test

Table 9.18 Pt.1 - Critical Values IPS

Individual Stats (based on one individual, identical across all numind)
(ADF stats, sample size=100)

sign. Level \ trend	0	1	2	3	4	5	6
0.99	-3.52834	-4.05122	-4.48935	-4.89147	-5.21472	-5.51679	-5.78978
0.95	-2.90140	-3.46322	-3.89092	-4.26338	-4.61428	-4.90783	-5.19608
0.90	-2.58964	-3.15819	-3.58889	-3.95112	-4.29859	-4.59832	-4.88344

Table 9.18 Pt.2

sign. Level \ trend	7	8	9	10
0.99	-6.04302	-6.33402	-6.57727	-6.83661
0.95	-5.45626	-5.71832	-5.94120	-6.17432
0.90	-5.14689	-5.39245	-5.62642	-5.85320

Table 9.18 Pt.3 - Overall IPS Stats
(identical across all numind and trends)
(normal distr., sample size=100)

sign. Level	
0.99	-2.326
0.95	-1.644
0.90	-1.281

Appendix D: Critical Values for the CIPS Test

Table 9.19 Pt.1 - Critical Values CIPS

numind	trend	0			1		
		0.99	0.95	0.90	0.99	0.95	0.90
5	Ind Stats	-3.86615	-3.24557	-2.92651	-4.37623	-3.72545	-3.41686
	CIPS Stats	-2.85224	-2.54521	-2.37797	-3.34712	-3.05002	-2.89290
6	Ind Stats	-3.88604	-3.26370	-2.94328	-4.36627	-3.73510	-3.42589
	CIPS Stats	-2.75474	-2.48188	-2.33176	-3.23993	-2.98379	-2.84191
7	Ind Stats	-3.88104	-3.24103	-2.91157	-4.39494	-3.74605	-3.41664
	CIPS Stats	-2.67815	-2.42318	-2.28386	-3.17293	-2.93092	-2.80101
8	Ind Stats	-3.88064	-3.25113	-2.92891	-4.36885	-3.73377	-3.41706
	CIPS Stats	-2.63309	-2.39113	-2.25844	-3.12269	-2.88990	-2.77142
9	Ind Stats	-3.90088	-3.25623	-2.92165	-4.35294	-3.72331	-3.41432
	CIPS Stats	-2.58818	-2.35918	-2.23494	-3.07361	-2.86043	-2.74860
10	Ind Stats	-3.87897	-3.25587	-2.93189	-4.33941	-3.73573	-3.41846
	CIPS Stats	-2.54779	-2.32872	-2.21190	-3.03075	-2.82889	-2.72525
15	Ind Stats	-3.88863	-3.26207	-2.93358	-4.33655	-3.73389	-3.41719
	CIPS Stats	-2.42462	-2.24813	-2.15207	-2.91548	-2.75087	-2.66123
16	Ind Stats	-3.90811	-3.26028	-2.92899	-4.34131	-3.73712	-3.42207
	CIPS Stats	-2.41194	-2.23737	-2.14149	-2.90264	-2.74177	-2.65553
17	Ind Stats	-3.89826	-3.25213	-2.92426	-4.33801	-3.72513	-3.40071
	CIPS Stats	-2.39380	-2.22593	-2.13377	-2.88443	-2.73058	-2.64844
20	Ind Stats	-3.91305	-3.27003	-2.93739	-4.36803	-3.75053	-3.42448
	CIPS Stats	-2.36039	-2.20234	-2.11618	-2.84826	-2.70393	-2.62851
22	Ind Stats	-3.87275	-3.23029	-2.91262	-4.35383	-3.73485	-3.41570
	CIPS Stats	-2.33914	-2.18974	-2.10485	-2.83017	-2.69110	-2.61469
23	Ind Stats	-3.86553	-3.23774	-2.92061	-4.34638	-3.73392	-3.42845
	CIPS Stats	-2.33269	-2.18544	-2.10160	-2.81738	-2.68493	-2.61143
25	Ind Stats	-3.88696	-3.24406	-2.93464	-4.33144	-3.73517	-3.41788
	CIPS Stats	-2.31519	-2.17435	-2.09302	-2.80476	-2.67289	-2.60031
30	Ind Stats	-3.92259	-3.26139	-2.93357	-4.34203	-3.74159	-3.42190
	CIPS Stats	-2.28960	-2.15614	-2.08042	-2.77646	-2.65363	-2.58506

Table 9.19 Pt.2

numind	trend	2			3		
		0.99	0.95	0.90	0.99	0.95	0.90
5	Ind Stats	-4.71606	-4.12516	-3.80997	-5.08915	-4.47887	-4.16506
	CIPS Stats	-3.74151	-3.45073	-3.29946	-4.08432	-3.80102	-3.64840
6	Ind Stats	-4.74149	-4.13616	-3.82110	-5.12038	-4.47699	-4.16909
	CIPS Stats	-3.62842	-3.38444	-3.25101	-3.97863	-3.72980	-3.59672
7	Ind Stats	-4.77492	-4.14721	-3.82387	-5.09304	-4.48184	-4.17039
	CIPS Stats	-3.56805	-3.33595	-3.21063	-3.91975	-3.68210	-3.55722
8	Ind Stats	-4.73678	-4.14242	-3.82236	-5.10014	-4.48108	-4.16001
	CIPS Stats	-3.51038	-3.29326	-3.17892	-3.86080	-3.63985	-3.52811
9	Ind Stats	-4.75961	-4.12791	-3.81746	-5.10303	-4.49184	-4.16446
	CIPS Stats	-3.46849	-3.26593	-3.15614	-3.81113	-3.61263	-3.50096
10	Ind Stats	-4.72174	-4.12946	-3.82416	-5.10602	-4.46775	-4.17043
	CIPS Stats	-3.42883	-3.23522	-3.13474	-3.77184	-3.58165	-3.47752
15	Ind Stats	-4.74423	-4.12826	-3.81430	-5.09543	-4.48192	-4.15602
	CIPS Stats	-3.31184	-3.15543	-3.07088	-3.65780	-3.50229	-3.41816
16	Ind Stats	-4.73501	-4.13861	-3.81895	-5.10091	-4.48283	-4.16590
	CIPS Stats	-3.29356	-3.14384	-3.06061	-3.63978	-3.48972	-3.40953
17	Ind Stats	-4.72488	-4.11314	-3.80626	-5.11019	-4.47870	-4.15382
	CIPS Stats	-3.28245	-3.13076	-3.05025	-3.62237	-3.47508	-3.39874
20	Ind Stats	-4.75304	-4.13824	-3.82565	-5.11659	-4.48706	-4.17114
	CIPS Stats	-3.24276	-3.10681	-3.03269	-3.58568	-3.45198	-3.37943
22	Ind Stats	-4.74394	-4.13248	-3.81550	-5.10318	-4.46872	-4.15583
	CIPS Stats	-3.22480	-3.09202	-3.02106	-3.57161	-3.43827	-3.36771
23	Ind Stats	-4.72306	-4.12602	-3.81142	-5.10562	-4.47097	-4.15573
	CIPS Stats	-3.21519	-3.08500	-3.01713	-3.55922	-3.42904	-3.36149
25	Ind Stats	-4.74183	-4.12772	-3.81638	-5.06117	-4.46718	-4.15750
	CIPS Stats	-3.19790	-3.07399	-3.00682	-3.54736	-3.41970	-3.35308
30	Ind Stats	-4.74747	-4.12933	-3.81620	-5.09289	-4.48050	-4.15412
	CIPS Stats	-3.17258	-3.05198	-2.98980	-3.51694	-3.39760	-3.33712

Table 9.19 Pt.3

numind	trend	4			5		
		0.99	0.95	0.90	0.99	0.95	0.90
5	Ind Stats	-5.40468	-4.78331	-4.47220	-5.68623	-5.08900	-4.76289
	CIPS Stats	-4.38973	-4.10313	-3.95784	-4.67755	-4.38977	-4.23861
6	Ind Stats	-5.44147	-4.79180	-4.47652	-5.70637	-5.07060	-4.75677
	CIPS Stats	-4.29413	-4.03769	-3.90592	-4.58126	-4.32855	-4.19054
7	Ind Stats	-5.40494	-4.79740	-4.47492	-5.71922	-5.07849	-4.76454
	CIPS Stats	-4.22310	-3.98522	-3.86505	-4.50971	-4.27655	-4.15039
8	Ind Stats	-5.40554	-4.78898	-4.48161	-5.70393	-5.07293	-4.75975
	CIPS Stats	-4.16825	-3.94928	-3.83624	-4.45713	-4.23567	-4.12191
9	Ind Stats	-5.43090	-4.78681	-4.47241	-5.72094	-5.07668	-4.75511
	CIPS Stats	-4.12614	-3.92162	-3.81307	-4.41002	-4.20324	-4.09449
10	Ind Stats	-5.42277	-4.78812	-4.47183	-5.72225	-5.08311	-4.76573
	CIPS Stats	-4.08457	-3.89320	-3.79129	-4.37208	-4.17799	-4.07240
15	Ind Stats	-5.42680	-4.79413	-4.48083	-5.72892	-5.09514	-4.76487
	CIPS Stats	-3.97162	-3.80989	-3.72756	-4.25556	-4.09208	-4.01044
16	Ind Stats	-5.41947	-4.79632	-4.47890	-5.70504	-5.09030	-4.77148
	CIPS Stats	-3.94542	-3.79629	-3.71585	-4.23423	-4.08161	-3.99916
17	Ind Stats	-5.40556	-4.79964	-4.48102	-5.68738	-5.08148	-4.76304
	CIPS Stats	-3.93061	-3.78470	-3.70870	-4.22023	-4.07026	-3.99093
20	Ind Stats	-5.44315	-4.80292	-4.48485	-5.70381	-5.09510	-4.76934
	CIPS Stats	-3.89830	-3.75906	-3.68808	-4.18352	-4.04379	-3.97135
22	Ind Stats	-5.39836	-4.78175	-4.46565	-5.69854	-5.06477	-4.75318
	CIPS Stats	-3.87871	-3.74851	-3.67796	-4.16205	-4.03235	-3.96038
23	Ind Stats	-5.40909	-4.79480	-4.47589	-5.71826	-5.08619	-4.76930
	CIPS Stats	-3.86738	-3.73836	-3.67214	-4.14891	-4.02135	-3.95561
25	Ind Stats	-5.41828	-4.78357	-4.47470	-5.70453	-5.08043	-4.75402
	CIPS Stats	-3.85342	-3.72788	-3.66393	-4.12977	-4.00993	-3.94437
30	Ind Stats	-5.37825	-4.78413	-4.47065	-5.70989	-5.07604	-4.76227
	CIPS Stats	-3.81793	-3.70412	-3.64495	-4.10362	-3.98880	-3.92698

Table 9.19 Pt.4

numind	trend	6			7		
		0.99	0.95	0.90	0.99	0.95	0.90
5	Ind Stats	-5.99665	-5.35530	-5.03137	-6.24154	-5.60304	-5.28579
	CIPS Stats	-4.95210	-4.65954	-4.50585	-5.21107	-4.90577	-4.75381
6	Ind Stats	-6.01844	-5.36300	-5.02691	-6.25473	-5.60183	-5.27914
	CIPS Stats	-4.84384	-4.59280	-4.45546	-5.09657	-4.84105	-4.70301
7	Ind Stats	-5.98856	-5.35714	-5.02868	-6.24928	-5.61728	-5.28867
	CIPS Stats	-4.77707	-4.54318	-4.41742	-5.01613	-4.78821	-4.66574
8	Ind Stats	-5.97972	-5.33709	-5.02252	-6.22044	-5.59894	-5.27403
	CIPS Stats	-4.71814	-4.50155	-4.38195	-4.97035	-4.74755	-4.63166
9	Ind Stats	-6.00141	-5.35561	-5.02943	-6.26595	-5.60670	-5.28064
	CIPS Stats	-4.67857	-4.47354	-4.35828	-4.92506	-4.71708	-4.60640
10	Ind Stats	-5.98224	-5.35282	-5.03508	-6.23250	-5.59478	-5.27076
	CIPS Stats	-4.63368	-4.44243	-4.34126	-4.87951	-4.68779	-4.58489
15	Ind Stats	-6.00419	-5.37330	-5.03727	-6.26003	-5.62291	-5.29342
	CIPS Stats	-4.51399	-4.35535	-4.27224	-4.75198	-4.60194	-4.51758
16	Ind Stats	-5.98240	-5.36456	-5.03328	-6.24541	-5.60663	-5.28760
	CIPS Stats	-4.50057	-4.34695	-4.26505	-4.74373	-4.59203	-4.51056
17	Ind Stats	-5.98672	-5.34320	-5.02586	-6.22891	-5.59114	-5.26996
	CIPS Stats	-4.47990	-4.33324	-4.25626	-4.72945	-4.57868	-4.50062
20	Ind Stats	-6.01055	-5.35680	-5.03805	-6.25786	-5.61402	-5.28561
	CIPS Stats	-4.44291	-4.30764	-4.23432	-4.68727	-4.55057	-4.47866
22	Ind Stats	-6.01379	-5.34891	-5.02361	-6.26262	-5.59512	-5.27606
	CIPS Stats	-4.42705	-4.29200	-4.22433	-4.66647	-4.53871	-4.46815
23	Ind Stats	-5.98317	-5.34958	-5.02265	-6.24954	-5.60629	-5.27958
	CIPS Stats	-4.41261	-4.28686	-4.21833	-4.65703	-4.53454	-4.46570
25	Ind Stats	-5.99480	-5.34400	-5.01871	-6.25017	-5.60502	-5.27400
	CIPS Stats	-4.39979	-4.27356	-4.20982	-4.64032	-4.51725	-4.45475
30	Ind Stats	-5.99560	-5.34834	-5.02876	-6.24206	-5.61070	-5.28030
	CIPS Stats	-4.36496	-4.25265	-4.19155	-4.60817	-4.49558	-4.43568

Table 9.19 Pt.5

numind	trend	8			9		
		0.99	0.95	0.90	0.99	0.95	0.90
5	Ind Stats	-6.50225	-5.84742	-5.52035	-6.75000	-6.08776	-5.75376
	CIPS Stats	-5.44253	-5.13925	-4.98699	-5.67745	-5.36821	-5.20744
6	Ind Stats	-6.49818	-5.85407	-5.52016	-6.72257	-6.06436	-5.74472
	CIPS Stats	-5.33146	-5.07389	-4.93546	-5.56244	-5.29883	-5.15584
7	Ind Stats	-6.50992	-5.85313	-5.52562	-6.76349	-6.07478	-5.74742
	CIPS Stats	-5.25780	-5.02001	-4.89552	-5.48747	-5.24536	-5.12041
8	Ind Stats	-6.50724	-5.84090	-5.51324	-6.74515	-6.07884	-5.74414
	CIPS Stats	-5.19925	-4.98189	-4.86428	-5.43609	-5.20815	-5.08588
9	Ind Stats	-6.50432	-5.85038	-5.53132	-6.75637	-6.09770	-5.75368
	CIPS Stats	-5.15746	-4.95221	-4.84147	-5.38585	-5.17527	-5.06376
10	Ind Stats	-6.48138	-5.83463	-5.51402	-6.72780	-6.07193	-5.73780
	CIPS Stats	-5.11588	-4.91825	-4.81536	-5.34743	-5.14443	-5.04038
15	Ind Stats	-6.50873	-5.85859	-5.52642	-6.74790	-6.09678	-5.75886
	CIPS Stats	-4.98942	-4.83144	-4.75004	-5.21912	-5.05733	-4.97319
16	Ind Stats	-6.49368	-5.84601	-5.52609	-6.74864	-6.07881	-5.74979
	CIPS Stats	-4.98109	-4.82318	-4.74376	-5.19943	-5.04509	-4.96324
17	Ind Stats	-6.48686	-5.83928	-5.51102	-6.73063	-6.07026	-5.73713
	CIPS Stats	-4.96033	-4.80965	-4.73315	-5.18443	-5.03256	-4.95393
20	Ind Stats	-6.48563	-5.85483	-5.51488	-6.73090	-6.08078	-5.74921
	CIPS Stats	-4.91935	-4.78146	-4.71167	-5.14897	-5.00441	-4.93396
22	Ind Stats	-6.50097	-5.84783	-5.51713	-6.75125	-6.08516	-5.75398
	CIPS Stats	-4.90186	-4.76895	-4.70079	-5.12767	-4.99102	-4.92058
23	Ind Stats	-6.51252	-5.83940	-5.51614	-6.73938	-6.07559	-5.74254
	CIPS Stats	-4.89076	-4.76323	-4.69664	-5.11299	-4.98606	-4.91543
25	Ind Stats	-6.47849	-5.85033	-5.51436	-6.72828	-6.07446	-5.74498
	CIPS Stats	-4.87063	-4.74865	-4.68394	-5.09643	-4.97090	-4.90598
30	Ind Stats	-6.48116	-5.85099	-5.51978	-6.73273	-6.07680	-5.74742
	CIPS Stats	-4.83818	-4.72535	-4.66624	-5.06116	-4.94860	-4.88880

Table 9.19 Pt.6

numind	trend	10		
		0.99	0.95	0.90
5	Ind Stats	-6.98182	-6.30239	-5.97106
	CIPS Stats	-5.88132	-5.58256	-5.42264
6	Ind Stats	-6.93439	-6.29798	-5.96133
	CIPS Stats	-5.77209	-5.51328	-5.37160
7	Ind Stats	-6.97293	-6.30793	-5.96355
	CIPS Stats	-5.69987	-5.46044	-5.33185
8	Ind Stats	-6.94998	-6.29820	-5.96086
	CIPS Stats	-5.64602	-5.41420	-5.29751
9	Ind Stats	-6.96598	-6.32035	-5.97595
	CIPS Stats	-5.59533	-5.38583	-5.27573
10	Ind Stats	-6.95600	-6.29274	-5.95805
	CIPS Stats	-5.55520	-5.35645	-5.25222
15	Ind Stats	-6.96671	-6.30576	-5.97012
	CIPS Stats	-5.42894	-5.26782	-5.18346
16	Ind Stats	-6.98552	-6.30599	-5.95873
	CIPS Stats	-5.40253	-5.25413	-5.17374
17	Ind Stats	-6.95314	-6.28023	-5.95533
	CIPS Stats	-5.39678	-5.24271	-5.16390
20	Ind Stats	-6.96538	-6.30931	-5.96024
	CIPS Stats	-5.35198	-5.21423	-5.14163
22	Ind Stats	-6.94246	-6.30372	-5.96105
	CIPS Stats	-5.33384	-5.19898	-5.13215
23	Ind Stats	-6.98486	-6.30800	-5.95885
	CIPS Stats	-5.31814	-5.19549	-5.12655
25	Ind Stats	-6.95294	-6.29689	-5.95850
	CIPS Stats	-5.30288	-5.18204	-5.11780
30	Ind Stats	-6.95624	-6.29230	-5.96362
	CIPS Stats	-5.27399	-5.15622	-5.09799