Inflation and Stock Returns in 18 OECD Countries: Some Robust Panel Integration and Cointegration Tests

Hassan M. Shirvani
University of St. Thomas-Houston

Sidika Gulfem Bayram
University of St. Thomas-Houston

Natalya (Natasha) Delcoure
TX A&M University-Kingsville

Applying Im, Pesaran and Shin (2003) and Pesaran (2007) approach, we examine the presence of unit roots in inflation rates and stock returns of 18 OECD countries. Under the assumption of cross sectional dependence, results support unit roots in our sample. Application of Johansen (1991) test fails to detect cointegration in some cases. Larsson, Lyhagen and Löthgren (2001) panel test provides strong evidence of cointegration for all the countries in the sample. We fail to support the presence of a uniformly positive relationship between inflation and stock returns, thus casting some doubt over equities as effective long run inflation hedges.

Keywords: Fisher effect, OECD countries, panel cointegration

INTRODUCTION

A constant feature of most recent empirical work in time series econometrics involves testing for unit roots in the underlying economic and financial variables. According to Campbell and Perron (1991), unit roots have important implications for both theoretical and empirical research. In particular, they indicate irreversible short run departures of the variables from their long run equilibrium values, a finding at odds with many theories of economic and financial behavior, in which such departures are supposedly self-correcting. Consequently, when unit roots found, attempts have been made to either justify them by newer theoretical models, or reject them by using more powerful empirical tests. Examples of the first include the real business cycle model (Kydland and Prescott, 1982) and the efficient markets hypothesis (Fama, 1991) to justify the presence of unit roots in outputs and stock prices, respectively. At the same time, more powerful unit root tests have been applied, using the nonlinear autoregression (Balke and Fomby, 1997; Enders and Granger, 1998; Kapetanios, Shin, and Snell, 2002), and panel data approaches (Levin and Lin, 1993; Maddala and Wu, 1999; Im, Pesaran, and Shin, 2003; Pesaran, 2007).

Among the above unit root tests, the panel data approach has received considerable attention due to the fact that the standard augmented Dickey-Fuller (1979; henceforth ADF) test for individual time series has a low power in differentiating between stationary, though persistent, from nonstationary processes. As shown by Levin and Lin (1993) and Quah (1994), using panels can enhance the power of the ADF test. This is particularly true for panels with numerous members and longer sample durations. Unlike the earlier work in this area, more recent panel unit root tests allow for both heterogeneity and cross section dependence of the panel members, thus making it possible to test more realistic alternative hypotheses (Im, Pesaran and Shin, 2003; Moon and Perron, 2004; Pesaran, 2007).

In light of the preceding, this paper attempts to illustrate the use of the panel data unit root tests by analyzing the time series behavior of both inflation rates and stock returns in 18 OECD countries over the 1985-2013 period. Given the importance of both inflation and stock returns to the performance of the economy, there already exists a voluminous literature on their time series behavior, with mixed results. Concerning inflation, while Nelson and Schwert (1977), Baillie (1989), Ball and Cecchetti (1990), Johansen (1992), Evans and Lewis (1995), Edwards (1998), Crowder and Wohar (1999), and Ng and Perron (2001) have found evidence of unit roots, Culver and Papell (1997), Lee and Wu (2001), and Basher and Westerlund (2008) have failed to do so. Likewise, and concerning nominal stock returns, while Fama (1970), Kim, et al. (1991), McQueen (1992), Richardson (1993), Chaudhuri and Wu (2003), and Narayan and Smyth (2005) find evidence of unit roots in many countries, Fama and French (1988), Lo and MacKinlay (1988) and Poterba and Summers (1988) find evidence against the presence of unit roots. Most of these earlier studies, however, either fail to draw on the more powerful panel unit root tests mentioned above or do so only under very limited assumptions or time periods.

This paper advances the empirical evidence by testing for unit roots in inflation and stock returns of a panel of 18 OECD countries over the 1985-2013 period. Thus, in addition to using the panel testing methodology, our study covers a larger number of OECD countries and for a longer and more updated time period than many earlier studies. In addition, we explicitly test and find cross sectional dependence among the panel members, a finding that necessitates the use of the more powerful Pesaran (2007) unit root test.

Since the results to be later presented in the paper do indicate the presence of unit roots in both inflation rates and stock returns of our sample OECD countries, a related issue arises as to whether there is a long run positive relationship between inflation and stock return, that is, whether equities are effective long run inflation hedges. Not surprisingly, the evidence for this so-called Fisher effect has also been mixed (Bodie, 1976; Fama, 1981; Gultekin, 1983; Boudoukh and Richardson, 1993; Choudhry, 2001, Cifter, 2015). This paper makes an attempt to shed additional light on this issue by testing for the presence of cointegration between inflation and stock returns of our sample countries, using both the standard Johansen (1991) and the more robust Larsson, Lyhagen and Löthgren (2001) panel cointegration tests.

The rest of the paper is organized as follows. Section II discusses the econometric methodology employed. Section III presents the empirical results. Section IV concludes.

METHODOLOGY

As stated earlier, the main objective of this paper is to test the null hypothesis of unit roots in inflation rates and stock returns of a sample of OECD countries, using the more powerful panel unit root test. We can, of course, increase the power of the ADF test by using longer spans of the individual series, but this may complicate the test by possible regime shifts and other structural breaks in the data. Instead, by allowing for both cross sectional and time variations, panel tests can potentially enhance the power of the ADF test (Levin and Lin, 1993). More specifically, Levin and Lin (LL, henceforth) start from the standard ADF test for each of the N members of a panel over T periods, as follows:

$$\Delta y_{i,t} = \alpha_i + \rho\, y_{i,t-1} + \sum_{j=1}^{j=p_i} \beta_{i,j} \Delta y_{i,t-j} + \varepsilon_{i,t} \quad (1)$$

where i = 1,….,N, t = 1,….,T, and $\varepsilon_{i,t} \approx idd\ (0, \sigma_i^2)$. In this test, the null and alternative hypotheses are, respectively, defined as:

$$H_0 : \rho = 0, \tag{2}$$

$$H_1 : \rho < 0. \tag{3}$$

Drawing on the unrealistic assumption of a uniform speed of adjustment for all panel members, LL show that their pooled estimate of ρ follows a standard normal distribution. To address this limitation, Im, Pesaran and Shin (IPS, henceforth) estimate instead the following ADF regression:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \sum_{j=1}^{j=p_i} \beta_{i,j} \Delta y_{i,t-j} + \varepsilon_{i,t}\ , \tag{4}$$

where the null and alternative hypotheses are now defined as:

$$H_0 : \rho_i = 0, \qquad \text{for all } i = 1,\dots,N \tag{5}$$

$$H_1 : \rho_i < 0. \qquad \text{for some } i = 1,..,N \tag{6}$$

Based on the above ADF regressions, IPS propose their $\bar{t}$ test statistic as the average of the corresponding individual ADF t-statisitcs (t_i), as shown below:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_i \tag{7}$$

Assuming cross sectional independence, and using the Lindberg-Levy central limit theorem, IPS show that their $\bar{t}$ statistic has an asymptotically normal distribution. In addition, using Monte Carlo simulations, IPS compute the mean (μ) and variance (var) of their average ADF t-statistic for different values of N, T and ADF lag (p_i). Consequently, the standardized IPS $\bar{t}$ statistic, denoted by $\bar{z}$, can be written as:

$$\bar{z} = \frac{\sqrt{N}\,(\bar{t} - \mu)}{\sqrt{var}} \tag{8}$$

As pointed out by O'Connell (1998), however, the presence of cross sectional dependence can seriously distort the size of the above IPS test. To address this issue, attempts have been made to use a host of factor and error components models (Choi, 2001; Phillips and Sul, 2003; and Pesaran, 2007). In particular, Pesaran (2007) offers a modified IPS test, in which the standard ADF test is further augmented by the lagged values of the level and first differences of the cross sectional averages:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + c_i \bar{y}_{i,t-1} + \sum_{j=1}^{j=p_i} \beta_{i,j} \Delta y_{i,t-j} + \sum_{j=0}^{j=p_i} d_{i,j} \Delta \bar{y}_{i,t-j} + \nu_{i,t}\ , \tag{9}$$

where $\overline{y}_t = \frac{1}{N}\sum_{i=1}^{N} y_{it}$. Following IPS, Pesaran uses the average of the CADF (cross sectionally augmented ADF) t-statistics, as defined below:

$$\overline{tt} = \frac{1}{N}\sum_{i=1}^{N} t_i \tag{10}$$

Under cross sectional dependence, the $\overline{tt}$ statistic no longer has an asymptotic normal distribution. Therefore, using simulations, Pesaran offers the critical values of the standardize d version ($\overline{zz}$, hereafter) of this statistic for various sample and panel sizes.

Given the preceding, and before the application of the above panel unit root tests, it is important to test for cross sectional dependence. This is done by using the diagnostic techniques developed by Breusch and Pagan (1980) and Pesaran (2004). Specifically, the Breusch-Pagan Lagrange Multiplier (LM) test is based on the following test statistic:

$$\text{LM} = \text{T}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} \rho^2_{ij}, \tag{11}$$

where ρ_{ij} is the Pearson correlation coefficient between the estimated residuals from the ADF regressions of the panel members i and j. Under the null of no cross sectional dependence, the LM statistic has a chi-squared distribution with N(N-1)/2 degrees of freedom. Similarly, the Pesaran cross sectional dependence (CD) test is based on the following test statistic:

$$\text{CD} = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} \rho_{ij}\right), \tag{12}$$

where ρ_{ij} is defined as before. Under the null of no cross sectional dependence, the Pesaran CD statistic has asymptotically a standard normal distribution.

Our discussion so far has centered on the methodological issues surrounding the use of more robust panel unit root tests. Of related interest is the use of equally more robust panel cointegration tests in establishing the presence of long run relationships among variables characterized by unit roots. Perhaps the most popular non-panel cointegration test in a multivariable context is that of Johansen (1991). The Johansen test follows the assumption that the data with unit roots can be described by a VAR in levels of order q as follows:

$$y_t = \prod{}_1 y_{t-1} + \prod{}_2 y_{t-2} + \cdots + \prod{}_q y_{t-q} + \mu_t, \tag{13}$$

where y_t is a vector of n difference-stationary variables and μ_t is a vector of Gaussian white noise disturbances. The above VAR can be restated in the first differences of the variables as follows:

$$\Delta y_t = \prod y_{t-1} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \cdots + \Gamma_{q-1}\Delta y_{t-q+1} + \mu_t \tag{14}$$

Elements of y_t are cointegrated if they have linear combinations that are stationary. According to Johansen (1991), if there are r such cointegrating relations, the rank of Π equals $r < n$ and Π can be factored as the product of two n x r matrices $(\Pi = -\beta\alpha')$, where α represents the matrix of r cointegrating vectors and β represents the matrix of adjustment coefficients. Under the cointegration assumption, equation 14 can be expressed in the following error correction model (ECM) form:

$$\Delta y_t = -\beta Z_{t-1} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \cdots + \Gamma_{q-1} \Delta y_{t-q+1} + \mu_t \quad (15)$$

where $Z_t \equiv \alpha' y_t$ represents the error correction terms. Johansen then introduces a likelihood ratio-based trace statistic to test for the number of cointegrating vectors r. Larsson, Lyhagen and Löthgren (2001) have extended the Johansen test by offering a standardized average trace statistic ($\overline{zzz}$) for the panel members, which, under the null hypothesis of r cointegrating vectors, follows an asymptotic normal distribution. More specifically, we have:

$$\overline{zzz} = \frac{\sqrt{N}\,(\overline{Trace} - \mu)}{\sqrt{var}} \quad (16)$$

where $\overline{\text{Trace}}$ = average trace for all panel members, and μ *and* var are the mean and variance of $\overline{\text{Trace}}$ as tabulated by Larsson et al. (2001).

EMPIRICAL RESULTS

In this section, we present the empirical results of testing for the presence of unit roots in inflation rates and stock returns of 18 OECD countries, using the methodology discussed in the preceding section and drawing on our earlier work. The data, which are taken from the Estima OECD files, are quarterly, expressed in nominal terms, and cover the 1985:1-2013:3 period (only sample period for which complete data were available for the largest number of OECD countries). Since the countries in the sample are all OECD members, they are among the largest and most advanced industrial countries in the world. As such, they share many important economic and financial structural characteristics. In addition, they display significant economic and financial interactions, given the growing integration of their capital markets in recent decades. These facts are of considerable importance in performing robust panel unit root tests.

As a first step, this section therefore conducts the standard ADF tests for our variables against the alternative hypotheses that they are stationary around a constant. (Given that no clear trend was visible in the underlying data, no time trend was included in the ADF tests). In addition, the appropriate lag lengths for our ADF tests were selected by using the Akaike information criterion (Akaike, 1973). The ADF test results with a lag of seven quarters are given in Table 1. As it is seen from the table, the null of a unit root can be rejected for both inflation rates and stock returns of most of the sample countries, indicating the presence of mean reversion for most of our variables. If true, these findings render inflation rates and stock returns largely predictable in the long run.

Having established the lack of random walk behavior in our data based on the ADF test, we now proceed to test for unit roots within a panel framework. This approach should lend additional power to our ADF tests. We begin by the IPS test, ignoring for the time being the possible cross sectional dependence of the panel. To this end, we estimate the individual ADF equations and their corresponding $\bar{z}$ statistic, which, as seen before, has an asymptotic normal distribution. Based on the corresponding $\bar{z}$ values for our panel, -7.68 for the rate of inflation and -12.04 for the stock return, which are both highly significant at the 5 percent level. It is thus clear that the IPS test strongly rejects the null hypothesis of unit roots for our panel, consistent with our earlier ADF results. That is, once again we cannot reject mean reversion in our underlying variables. However, as discussed earlier, the IPS test can result in spurious findings in the presence of cross sectional dependence. Thus, we need to test for cross sectional dependence among our sample countries.

TABLE 1
ADF UNIT ROOT TEST RESULTS

Country	Inflation Rate	Stock Return	Country	Inflation Rate	Stock Return
Austria	-3.96*	-4.26*	Japan	-1.74	-3.97*
Belgium	-3.78*	-4.20*	Netherlands	-3.38*	-3.43*
Canada	-2.03	-4.59*	Norway	-3.50*	-3.88*
Denmark	-3.88*	-4.61*	N. Zealand	-3.08*	-3.95*
France	-1.82	-3.95*	Spain	-4.07*	-3.60*
Germany	-1.15	-3.84*	Sweden	-3.68*	-3.55*
Greece	-3.08*	-3.15*	Turkey	-0.41	-2.83
Ireland	-7.63*	-3.58*	UK	-1.68	-3.85*
Italy	-1.12	-3.89*	US	-4.04*	-4.16*

* Indicates significant at the 5 percent level.

The cross sectional dependence of panels can be tested based on the LM and CD diagnostic tests mentioned earlier in the paper. As a first step in that direction, we need to estimate the pairwise correlations for all the ADF residuals obtained for the individual panel members. Based on these correlations, we can then calculate the corresponding diagnostic test statistics. The Breusch-Pagan LM statistic, which has a chi-squared distribution with 153 degrees of freedom for our sample, has a value of 1,164.37 for the inflation rate and a value of 6,125.47 for the stock return, both highly significant at the 5 percent level. Similarly, the Pesaran CD test statistic, which has a standard normal distribution, has a value of 22.72 for the inflation rate and a value of 70.54 for the stock return, again both highly significant at the 5 percent level. Thus, both our diagnostic tests are consistent with cross sectional dependence for our panel. Under these conditions, we need to apply the Pesaran-modified IPS test, as discussed earlier.

To apply the more robust Pesaran test, we first estimate the cross sectionally augmented ADF (CADF) equation 9 for all inflation rates and stock returns in our sample. The results are reported in Table 2. Based on the critical value of -3.25 provided by Pesaran for individual CADF equations, the null hypothesis of a unit root cannot be rejected for almost any of the sample countries at the 5 percent level. To increase the power of the test, we need to apply the panel version of CADF, as discussed earlier. To this end, the cross The estimated $\overline{zz}$ statistic has a value of -1.09 for the inflation rate and 0.61 for the stock return, both larger than the 5 percent critical value of -2.20. This means that the unit root hypothesis cannot be rejected for either inflation rates or stock returns. Clearly, these results are at odds with those found earlier for our standard IPS test, where the issue of the presence of cross sectional dependence across our panel members was ignored. Based on these more robust test results, we can raise questions about the long run predictability of both inflation and stock market performance, at least in the context of our OECD countries.

TABLE 2
CADF UNIT ROOT TEST RESULTS

Country	Inflation Rate	Stock Return	Country	Inflation Rate	Stock Return
Austria	-0.59	-2.05	Japan	-3.62	-2.56
Belgium	-0.58	-1.60	Netherlands	0.04	-1.92
Canada	-1.54	-0.60	Norway	-0.57	-1.71
Denmark	-0.33	-1.10	N. Zealand	-2.42	-1.66
France	0.14	-1.66	Spain	-0.61	-1.33
Germany	-3.02	-1.57	Sweden	-1.25	-1.59
Greece	-2.61	-3.30*	Turkey	-2.87	-1.46
Ireland	-1.19	-1.36	UK	-1.49	-1.64
Italy	-2.86	-1.29	US	0.37	-1.19

* Indicates significant at the 5 percent level.

Given the presence of unit roots in our inflation rates and stock returns, we also proceed to test for the existence of cointegration between these variables. More specifically, we are interested to see whether there exists a positive long run relationship between inflation and stock returns, a la Fisher. Since the pace of economic growth, as measured, say, by changes in industrial production, can impact both inflation and stock market performance, we include this variable in our cointegration equations to control for the possible negative effect of growth on inflation and, therefore, indirectly on stock returns. (Our tests imply that the overwhelming majority of our outputs are also characterized by unit roots). Once again, we shall make use of both the standard and panel cointegration tests, as discussed earlier in the paper. Table 3 presents the country-by-country and panel test results for three different hypotheses regarding the number of cointegrating vectors (r = 0, r = 1, and r = 2). Starting from the Johansen trace test results for the individual countries, the table shows the presence of no cointegrating vector for six countries (Austria, Belgium, Canada, Spain, Sweden and Turkey), one cointegrating vector for ten countries (Denmark, France, Germany, Greece, Ireland, Italy, Japan, Norway, UK, and US), and two cointegrating vectors for two countries (Netherlands and New Zealand). However, the use of the more robust panel cointegration test indicates the presence of only one cointegrating vector for all the sample countries. More specifically, as the table shows, the average trace values are respectively 38.11, 16.15, and 5.10 for r = 0, 1, and 2. Standardizing these average trace values by their simulated means and variances given by Larsson et al. (2001), we obtain the $\overline{zzz}$ values of, respectively, 6.54, 1.01 and -1.29, where only the first value exceeds 1.645, the 5% critical value for a normal distribution. Thus, there is one and only cointegrating vector for each country in the sample.

TABLE 3
STANDARD AND PANEL COINTEGRATION TEST REULTS

	r = 0	r = 1	r = 2		r = 0	r = 1	r = 2
Country	**Trace**	**Trace**	**Trace**	**Country**	**Trace**	**Trace**	**Trace**
Austria	32.45	16.65	6.64	Japan	39.09*	12.27	3.10
Belgium	30.41	16.46	6.50	Netherlands	44.24*	21.00*	8.59
Canada	29.32	15.13	7.10	Norway	39.63*	17.58	6.21
Denmark	35.52*	16.88	6.28	N. Zealand	43.68*	20.69*	8.25
France	39.14*	13.97	5.32	Spain	30.02	15.67	2.61
Germany	41.66*	17.79	2.78	Sweden	33.12	20.15	8.32
Greece	38.70*	11.58	5.12	Turkey	25.74	8.66	0.33
Ireland	56.38*	15.53	0.65	UK	39.87*	15.59	4.69
Italy	48.57*	18.64	4.48	US	38.48*	16.62	4.97
$\overline{Trace}$	38.11	16.15	5.10	$\overline{zzz}$	6.54*	1.01	-1.29

* Indicates significant at the 5 percent level.

In addition, the estimated cointegrating equations indicate a negative relationship between stock return and inflation for half of the countries in the sample, with the other half being characterized by a positive relationship (See Table 4). In other words, we find no consistent empirical support for the Fisher effect in our data. Interestingly, even when we include the nominal interest rate as a proxy for expected inflation in our cointegrating equations, we still largely obtain the same results, namely, that equities fail to provide a consistent long run hedge against inflation.

TABLE 4
COINTEGRATION EQUATIONS (DEPENDENT VARIABLE=STOCK RETURNS)

Country	Constant	Inflation	Industrial Production	Country	Constant	Inflation	Industrial Production
Austria	-0.448	31.109	26.220	Japan	-0.001	1.792	-0.047
Belgium	0.068	-8.741	-1.409	Netherlands	-0.009	-13.955	23.276
Canada	0.019	-1.204	0.364	Norway	-0.133	30.605	-1.554
Denmark	0.000	1.624	2.120	N. Zealand	0.149	-35.138	0.586
France	0.016	-4.372	56.685	Spain	0.016	-0.231	2.601
Germany	-0.488	36.032	72.769	Sweden	-0.014	0.927	5.052
Greece	-0.001	2.428	3.844	Turkey	-0.043	1.431	1.624
Ireland	0.105	1.371	-4.899	UK	0.008	-0.378	6.320
Italy	0.021	-3.020	4.056	US	0.032	-2.104	1.302

CONCLUSION

This paper has examined the presence of unit roots in inflation rates and nominal stock returns of a sample of 18 OECD countries over the 1985-2013 period, using the heterogeneous panel unit root tests developed by Im, Pesaran and Shin (2003) and Pesaran (2007). Under the assumption of cross sectional independence across the panel, we find no evidence of unit roots, thus failing to reject mean reversion for our variables for all the countries in the sample. However, under the assumption of cross sectional dependence, an assumption borne out by our diagnostic test results, we find support for the presence of unit roots in these variables. Thus, the use of more robust panel unit root tests seems to raise questions about the long run predictability of both the inflation rate and the stock return, at least in the context of our OECD countries. If valid, these findings also lend support to those who assert that both the commodity and security markets are informationally efficient.

Additionally, our paper has also tested for the presence of a long run positive relationship between stock returns and inflation rates, the so-called Fisher effect. According to this effect, nominal stock returns tend to adjust for changes in the rate of inflation to ensure the independence of real stock returns from inflationary expectations. While the standard Johansen (1991) test largely fails to detect any cointegration, even after allowing for economic growth, the more robust Larsson, Lyhagen and Löthgren (2001) panel cointegration test provides strong evidence of long run cointegration for all the countries in our sample. However, the signs of the estimated cointegration coefficients fail to detect any consistent Fisher effect for our OECD countries. Indeed, for half of the countries in the sample, the relationship between stock returns and inflation rates are negative, even in the presence of an output variable, thus providing support for the mixed findings in the literature, as alluded to earlier in the paper.

REFERENCES

Akaike, H. (1973). Information Theory and an Extension of the Maximum Likelihood Principle. *Second International Symposium on Information Theory: Akademiai Kiado*, pp. 267-281

Balke, N.S., & Fomby, T.B. (1997). Threshold Autoregression. *International Economic Review*, 38, 627-645.

Ball, L., & Cecchetti, S.G. (1990). Infaltion and Unertainty at Long and Short Horizons, Brookings Papers on Economic Activity. *The Brookings Institution*, 21(1), 215-254.

Baillie, R.T. (1989). Econometric Tests of Rationality and Market Efficiency. *Econometric Reviews*, 8, 151-186.

Basher, S. A., & Westerlund, J. (2008). Is There Really a Unit Root in the Inflation Rate? More Evidence from Panel Data Models. *Applied Economics Letters*, 15, 161-164.

Bodie, Z. (1976). Common Stocks as a Hedge Against Inflation. *Journal of Finance*, 31, 459-470.

Boudoukh J., & Richardson, M. (1993). Stock Returns and Inflation: A Long-Horizon Perspective. *American Economic Review*, 83, 1346-1355.

Breusch, T.S., & Pagan, A. (1980). Lagrange Multiplier Test and Its Applications to Model Specification in Econometrics. *Review of Economic Studies*, 47, 139-153.

Campbell, J., & Perron, P. (1991, February). *Pitfalls and Opportunities: What Macroeconomists Should Know about Unit Roots*. National Bureau of Economic Research, Macroeconomics Conference, Cambridge, Mass.

Chaudhuri, K., & Wu Y. (2003). Random Walk versus Breaking Trend in Stock Prices: Evidence from Emerging Markets. *Journal of Banking and Finance*, 27, 575-592.

Choi, I. (2001). Unit Root Tests for Panel Data. *Journal of International Money and Banking*, 20, 249-272.

Choudhry, T. (2001). Inflation and Rates of Return on Stocks: Evidence from High Inflation Countries. *Journal of International Financial Markets, Institutions and Money*, 11, 75-96.

Cifter, A. (2015). Stock Returns, Inflation, and Real Activity in Developing Countries: A Market Switvhing Approach. *Pandeconomicus*, 62, 55-76.

Crowder, W., & Wohar, M. (1999). Are Tax Effects Important in the Long Run Fisher Relationship. Evidence from the Municipal Bond Market. *Journal of Finance*, 54, 307-317.

Culver, S. E., & Papell, D.H. (1997). Is There a Unit Root in the Inflation Rate? Evidence from Sequential Break and Panel Data Model. *Journal of Applied Econometrics*, 12, 435-444.

Dickey, D. A., & Fuller, W.A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, 74, 427-431.

Edwards, S. (1998). Two Crises: Inflationary Inertia and Credibility. *Economic Journal*, 108, 680-702.

Enders, W., & Granger, C.W. (1998). Unit Root Tests and Asymmetric Adjustment with an Example Using the Term Structure of Interest Rates. *Journal of Business and Economic Statistics*, 16, 304-311.
Evans, M.D., & Lewis, K.K. (1995). Do Expected Shifts in Inflation Affect Estimates of the Long Run Fisher Relation? *Journal of Finance*, 50, 225-253.
Fama, E. (1981). Inflation, Stock Returns, Real Activity, and Money. *American Economic Review*, 71, 545-565.
Fama, E.F., & French, K. (1988). Permanent and Temporary Components of Stock Prices. *Journal of Political Economy*, 96, 246-273.
Fama, E. (1991). Efficient Markets II. *Journal of Finance*, 46, 1575-1617.
Gultekin, N.B. (1983). Stock Market Returns and Inflation: Evidence from Other Countries. *Journal of Finance*, 38, 49-65.
Im, K., Pesaran, H., & Shin, K. (2003). Testing for Unit Roots in Heterogenous Panels. *Journal of Econometrics*, 115, 53-74.
Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, 59(6), 1551–1580.
Kapetanios, G., Shin, Y., & Snell, S. (2002), Testing for a Unit Root in the Nonlinear STAR Framework. *Journal of Econometrics*, 112(2), 359-379.
Kim, M.J., Nelson, C.R., & Startz, R. (1991), Mean Reversion of Stock Prices: A Reappraisal of the Empirical Evidence. *Review of Economic Studies*, 58, 515-528.
Kydland F.E., & Prescott, E.C. (1982). Time to Build and Aggregate Fluctuations. *Econometrica*, 50, 1345-1370.
Larsson, R., Lyhagen, J., & Löthgren, M. (2001). Likelihood-based cointegration tests in heterogeneous panels. *The Econometrics Journal*, 4, 109-142.
Lee, H., & Wu, J. (2001). Mean Reversion of Inflation Rates: Evidence from 13 OECD Countries. *Journal of Macroeconomics*, 23, 447-487.
Levin, A., & Lin, F. (1993). *Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties*. Unpublished Manuscript, University of California, San Diego.
Maddala, G.S., & Wu, S. (1999). A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and Statistics*, 61, 631-652.
McQueen, G. (1992). Long Horizon Mean Reverting Stock Prices Revisited. *Journal of Financial and Quantitative Analysis*, 27, 1-18.
Moon, H. R., & Perron, B. (2004). Testing for a Unit Root in Panels with Dynamic Factors. *Journal of Econometrics*, 122, 81-126.
Narayan, P., & Smyth, R. (2005), Are OECD stock Prices Characterized by a Random Walk? Evidence from Sequestioal Trend Break and Panel Data Models. *Applied Financial Economics*, 15, 547-556.
Nelson, C.R., & Schwert, G.W. (1977). Short-Term Interest Rates as Predictors of Inflation: On Testing the Hypothesis that the Real Rate of Interest is Constant. *American Economic Review*, 67, 478-486.
Ng, S., & Perron, P. (2001). Lag Length Selection and the Construction of Unit root Tests with Good Size and Power. *Econometrica*, 69, 1519-1554.
O'Connell, P. G. J (1998). The Overvaluation of Purchasing Power Parity. *Journal of International Economics*, 44(1), 1-19.
Pesaran, H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. Cambridge *Working Papers in Economics*, No 435.
Pesaran, H. (2007). A Simple Panel Unit Root Test in the Presence of Cross Section Dependence. *Journal of Applied Econometrics*, 22, 265–312.
Phillips, P., & Sul, D. (2003). Dynamic Panel Estimation and Homogeneity Testing under Cross Section Dependence. *Econometric Journal*, 6, 217-259.
Quah, D. (1994). Exploiting Cross Section Variation for Unit Root Inference in Dynamic Data. *Economic Letters*, 44, 9–19.