AN EMPIRICAL RE-EXAMINATION OF THE FISHER HYPOTHESIS: PANEL COINTEGRATION TESTS

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ABSTRACT

There is no unanimity in the literature on the Fisher hypothesis. This study will revisit this academic quandary with a powerful econometric test proposed by Pedroni (2004). The strength of this test is that the test statistic is able to accommodate short run dynamics, deterministic trends and different slope coefficients.

The study will use monthly interest rate and inflation data for the G5 countries. The study starts with stationarity characteristics of the data and then applies the Pedroni panel cointegration tests. This will shed some light on the Fisher hypothesis and the mixed evidence that exists in the literature. **JEL Classification:** F410

INTRODUCTION

The Fisher hypothesis is one of the most controversial topics in financial economics, with serious ramifications for policy analysis. Fisher basically states that there should be a one-to-one correspondence between the nominal interest rate and the rate of inflation, resulting in stable (if not fixed) real interest rates. It implies that there is effectively no correlation between expected inflation and ex ante real interest rates. If this theory holds (as claimed), then in the long run the real interest rate would remain unchanged under monetary policy shocks.

This study will extend Dutt and Ghosh (2007) studying the Fisher effect for G5 countries in which they found mixed evidence in favor of the hypothesis. There is no unanimity among the researchers and by extension policy makers since the empirical literature is all over the place. Therefore this study will revisit this academic quandary with a powerful econometric technique proposed by Pedroni (2004), where he introduces pooling of economic data which allows for one to vary the degree of heterogeneity among the panel members. It examines both the between dimension and within dimension residuals. The strength of this test is that the resultant "test statistic" is able to accommodate short run dynamics, deterministic trends and also different slope coefficients. This test statistic is "standard normal' and free of nuisance parameters.

This test has been used for studies of Purchasing Power Parity (hereafter PPP) and seems particularly suitable for an analysis of the Fisher effect. One property of cointegration tests is that the span of the data (and not the number of observations) is important in increasing the power of the tests (Pedroni 2004). Increasing the span of the data may not be possible in some cases due to the lack of availability of data, and in others may introduce structural changes like regime changes which would call into questions the validity of the results. Therefore, the study will use the Pedroni (2001, 2004) methodology to test for PPP. This procedure allows us to increase the power of the tests even when we don't have access to a larger span of data.

The next section presents a brief literature review. The third section describes the model that is estimated in this paper and the fourth section is a description of the data set. The fifth section is a description of the Pedroni panel cointegration procedure and the sixth section is a description of our empirical results. The final section contains some concluding remarks.

LITERATURE REVIEW

Fisher (1930) hypothesized that:

$$i_t = r_t + \pi_t^e \quad (1)$$

where i_t is the nominal interest rate and it is composed of two entities, namely the expected rate of inflation (π_t^e) and the real interest rate (r_t.) Based on this, it postulates a one-to-one correspondence between the nominal interest rate and the expected inflation rate, assuming the constancy of real interest rates over time. This theory has been extensively examined in the economics literature.

The genesis was with Fisher (1930), where he tested the relationship between nominal interest rates and inflation for the UK and USA over decades and found "no apparent correlation." But, when past inflation was substituted as a proxy measure for expected inflation, the "correlation coefficient" jumped from the 30's into the 90's. Thus price changes do affect interest rates.

This study starts with a brief survey of the different Fisher studies done over time. Fama (1975) examined US treasury bills for the period 1953-71 and found evidence that nominal interest rates did incorporate inflation rates, supporting the Fisher hypothesis. But following studies by Nelson and Schwert (1977), Carlson (1977), Joines (1977) and Tanzi (1980) did not find any evidence of Fama's "joint hypothesis." Then Mishkin (1992) found evidence supporting Fisher (high correlation between interest rates and inflation) but it changes over time. He reported that the hypothesis held over specific time intervals, but failed over others. Based on this observation he made the distinction between the short and long run fisher effect and leaned towards supporting the interest/ inflation nexus over the long run.

This long run correlation was supported by Crowder and Hoffman (1996) who report a near one-to-one correspondence between nominal interest and inflation for the USA over the period 1952-92. It is also supported by Fahmy and Kandil (2003) for the USA over the decade of the 80'S and 90'S, using cointegration techniques. Tillman (2004) also supports the Fisher hypothesis for post-war data. USA data has been generally favorable to the Fisher hypothesis, but Canadian data has not. Dutt and Ghosh (1995) use cointegration techniques and separate the entire exchange rate period into fixed and floating rate regimes, but do not find evidence supporting Fisher for Canada in neither the fixed nor the floating exchange rate regimes. But contrary to this, Crowder (1997) finds evidence supporting Fisher for Canada.

Mishkin and Simon (1995) find long run evidence supporting Fisher (but not so in the short run) for Australia. Again contrary to this, Hawtrey (1997) and Olekalns (1996) find supporting evidence for Australia. Then there is Evans (1998) who finds no evidence supporting Fisher for the UK. But Muscatelli and Spinelli (2000) find that the long run Fisher relationship holds for Italy over the long run (1948-90.) Esteve, Bajo-Rubio and Diaz-Roldan (2004) find partial evidence supporting the Fisher hypothesis for Spain.

The Atkins and Serletis (2003) study uses the autoregressive distributed lag (ARDL) model to examine Fisher for Norway, Sweden, Italy, Canada, UK and the USA, but finds little supporting evidence. Then again Atkins and Coe (2002) using the same methodology as Atkins and Serletis (2003), does not find any evidence of even a long run Fisher relationship for Canada and the USA. Interestingly enough, when they extend their study to examine for a "tax adjusted" Fisher correlation, they do not find any evidence of that either. Again Atkins and Sun (2003) find a long run (but not a short run) Fisher relationship for USA and Canada. Recent studies like Kaliva (2008) and Westerlund (2008) find significant evidence supporting the Fisher hypothesis.

The Model

According to the Fisher identity, we can write

$$R_{kt} = E_t r_{kt} + E_t \pi_{kt} \qquad (2)$$

where R_{kt} = k-period nominal interest rate at time t
r_{kt} = k-period real interest rate at time t
π_{kt} = inflation rate from time t to time t+k

The expected inflation cannot be observed. Assuming rational expectations, we will get

$$\pi_{kt} = E_t \pi_{kt} + e_{kt}$$

We can rewrite eq. 2 as

$$R_{kt} = E_t r_{kt} + \pi_k - e_{kt} \qquad (3)$$

$$R_{kt} - \pi_k = E_t r_{kt} - e_{kt} \qquad (4)$$

Expected value of e_{kt} should be zero. Therefore if R_{kt} and π_{kt} are both I(1), and R_{kt}-π_{kt} is stationary, then this would imply that the nominal interest rate and the inflation rate are cointegrated with a cointegrating vector of (1, -1). This would be an indication of a 'full Fisher effect". Even if the cointegrating vector is (1, -β) this would be evidence of a "partial Fisher effect." Absence of cointegration would mean that nominal interest rate and the inflation rate do not move together over time, and therefore there is no long run relation between them according to Lee et. al. (1998).

DATA DESCRIPTION

This study estimates and tests the Fisher equation for the G-5 countries, United States, France, Germany, Japan, and the United Kingdom. All data were obtained from the OECD National Accounts database. All data is monthly. Data is available for the different countries for different time periods, and therefore we have used different groups of the G5 countries to implement our analysis. The different groups are

G2 - Germany, United States: June 1964 – June 2013

G3 - France, Germany, United States: January 1970 – June 2013

G4 - France, Germany, United States, United Kingdom: January 1978 – June 2013

G5 - France, Germany, Japan, United States, United Kingdom: April 2002 –June 2013

PEDRONI'S PANEL COINTEGRATION TESTS

Cointegration techniques are commonplace in the economics literature, when studying long run relationships between non-stationary variables. One point of concern has been the power of traditional cointegration tests. The problem with these tests is that they inherently suffer from low power and confidence. Increasing the time span of the variable series increases its credibility, but in reality it is a difficult proposition. The time span availability of the variables is not dependent on the researcher's discretion. On the other hand if one blindly increases the data time span, the test strength will possibly increase but one could very well have introduced major policy shifts and structural economic changes. An example of this would be using pre-war and post-war data together, just to increase the time span.

Another possibility is to increase the data frequency keeping time span the same. An example would be to use daily instead of weekly data or weekly data in place of monthly data. This increases the number of observations, but that does not necessarily increase the strength of the results.

It has also been pointed out that the power of these tests depends more on the span of the data rather than the number of observations (Perron 1989, 1991). For example, if we consider a time span of 1969 to 2011, moving from annual to quarterly to monthly data will not appreciably increase the power, but increasing the span to 1960 - 2011 will increase the power of the tests. If increasing the time span of the data is not a practical solution (additional data may not be available, or it may introduce structural changes in the model) one alternative is to consider additional cross-sectional data instead of a longer time period, thus resulting in panel data.

When considering panel data, it is important not to sacrifice differences between cross sections. One remedy to solve this dilemma has been proposed by Pedroni (2001 and 2004) where he introduces similar cross-sectional data over the available time period. This pooling of similar data will help in the above stated situation. One example would be where he pooled data from economically similar countries to study PPP (Pedroni, 2004.) The problem here is that simple pooling of time series data would involve "in model" heterogeneity. Here he has constructed "panel cointegration" test statistic (Pedroni, 2004) which allows for one to vary the degree of heterogeneity among the panel members.

Moreover Pedroni (2001) has done residual based tests for the null of "no cointegration" for heterogeneous data. In Pedroni (2004) he extends the same test to include heterogeneous dynamics and slope coefficients. It examines both the between dimension and within dimension residuals. The strength of this test is that the resultant "test statistic" is able to accommodate short run dynamics, deterministic trends and also different slope coefficients. This test statistic is "standard normal' and free of nuisance parameters.

Pedroni (2004) proposes the following way of testing for cointegration in a panel data setup. He proposes the following regression

$$y_{it} = \alpha_i + \delta_i t + \beta X_{it} + e_{it} \qquad (5)$$

where y_{it} = relevant variable where i= 1, 2….N observations and t= 1, 2….T time periods.

X_{it} = m-dimensional column vector for each member i

t= time period under consideration

and β_i == m-dimensional row vector for each member i

The variables y_{it} and X_{it} are assumed to be I(1) for each member I of the panel, and under the null hypothesis of "no cointegration" e_{it} will also be I(1). The parameters α_i and δ_i allow for differences between cross sections. The slope coefficient may also be different between cross sections. Pedroni (2004) proposes a set of residual based test statistics for the null of "no cointegration" which do not assume that the slope coefficient is the same in all cross sections.

First we test for the order of integration(non-stationarity) of the raw data series y_{it} and x_{it}. They are integrated of order one i.e., I(1.) The null is of no cointegration with an I(1) error structure. Here α_i, δ_i and β_i are allowed to be heterogeneous.

The null is:

H_o : Panel series are not cointegrated, versus the alternative

H_A : Panel series are cointegrated.

Here when we are pooling different data series, the slope coefficient β_i will not be of a common slope across different data series. The strength of these pooled tests is that the slope coefficients are not constrained to be the same, but rather allowed to be heterogeneous (i.e., allowed to vary across individual data series.) The tests distributional properties are that the standard central limit theorem (CLT) is assumed to hold for each individual series, as the time span grows. The advantage is that the error structure includes all auto regressive moving average (ARMA) processes. The matrix structure is (m+1) x (m+1) in size where the off diagonal entities Ω_{2li} capture the feedback between the regressors and the dependent variable, based on the invariance principle. Also cross sectional independence or process i.i.d. (independent and identically distributed) is assumed. This allows for the application of the standard CLT even in the presence of heterogeneous errors. Here Ω_i >0 ensures that there is no cointegration between y_{it}. The invariance and cross sectional independence help construct the asymptotic properties of the test statistic. It allows the test statistic to converge asymptotically to the actual values.

$$T^{-2} \sum_{t=1}^{T} z_{it-1} z'_{it-1} \Rightarrow L'_i \int_0^1 Zi(r)\, Z_i(r)'\, d_r\, L_i \qquad (6)$$

$$T^{-1} \sum_{t=1}^{T} z_{it-1}\, \xi'_{it} \Rightarrow L'_i \int_0^1 Z_i(r)\, d\, Z_i(r)'\, dr\, L_i + \Gamma_i \qquad (7)$$

These convergence results hold under standard assumptions. The assumption of sectional independence allows for "averaging" over the cross sectional sums of the panel statistic. Moreover it also reduces the effect of "nuisance parameters" due to serial correlation in the data as T→∞. This makes the computation a lot simpler. It also has another distinct advantage. Applying the limit T→∞ results in higher order terms being eliminated prior to "averaging," leaving only the first order terms of the time series.

Pedroni considers two class of statistics. The first pools the residuals of the regression "within panel dimensions" and the second pools the residuals "between panel dimensions." Similarly in equation (8) and (9)

$$Z_{\hat{v}_{NT}} \equiv \hat{L}_{11}^{2} \left(\sum_{i=1}^{N} A_{22i} \right)^{-1} \tag{8}$$

$$Z_{t_{NT}} \equiv \left(\tilde{\sigma}_{NT}^{2} \sum_{i=1}^{N} A_{22i} \right)^{-1/2} \sum_{i=1}^{N} \left(A_{21i} - T\hat{\lambda}_i \right) \tag{9}$$

and stand for "panel variance ratio statistic" and "panel t statistic" respectively. Equations (10) and (11) below pool the data "between panel dimension" to compute the group mean of the time series.

$$\tilde{Z}_{\hat{\rho}_{NT-1}} \equiv \sum_{i=1}^{N} A_{22i}^{-1} \left(A_{21i} - T\hat{\lambda}_i \right) \tag{10}$$

$$\tilde{Z}_{t_{NT}} \equiv \sum_{i=1}^{N} \left(\hat{\sigma}_i^{2} A_{22i} \right)^{-1/2} \left(A_{21i} - T\hat{\lambda}_i \right) \tag{11}$$

Pedroni (2004) then demonstrates the asymptotic distribution of the residual based tests for the null of "no cointegration" in heterogeneous panels. His results are fairly general and assumes "only finite second moments." These results apply to all cases and for any number of regressors, when we measure the slope coefficients separately for each panel data series. He also conducts Monte Carlo simulations to study the small sample properties of the 'statistic' for different panel dimensions. He demonstrates excellent convergence of the "t" statistic (as "T" increases beyond 150 observations) keeping N fixed. Then he keeps "T" fixed and varies "N." As the index becomes larger and larger the convergence properties becomes more stable. He also studies the strength and stability of his test statistic against various 'alternative hypotheses."

Now regarding the data generating process, it is

$y_{it} = x_{it} + e_{it}$ where

$e_{it} = øe_{it-1} + \eta_{it}$ and $\Delta x_{it} \sim N(0,1)$
$\eta_{it} \sim N(0,1)$, $ø = \{0.9, 0.95, \text{and so on}\ldots\}$

The alternative hypothesis here is that the residuals e_{it} is stationary. Pedroni uses the autoregressive (AR) process, rather than a moving average (MA) error correction process. The tests are powerful enough to show that using monthly data with more than 20 years of observations, it is quite easily possible to distinguish the cases from the null of "no cointegration" when the data is pooled. Moreover the Monte Carlo simulations show that:

Case 1: For small panels, the group-rho statistic rejects the null of "no cointegration."
Case 2: For large dimensional panels, the panel –v statistic has the best power. The other statistics lie in between the two extremes of case 1 and case 2.

EMPIRICAL RESULTS

The inflation rates and interest rates for each panel are tested for the presence of unit roots using panel unit root test.

At the 5 percent level, the G2 and G3 mostly have unit roots (for the G3 one statistic is against the presence of a unit root). For the G4 group the inflation series have an unit root whereas the interest series does not. For the G5 group the inflation series does not have an unit root whereas the interest rate series does.

We then proceed to apply the Pedroni (2004) tests, which are a test of the null hypothesis that all the individuals in the panel are not cointegrated against the alternate hypothesis that a significant portion of the individuals are cointegrated. We also go on to estimate the Pedroni (2001) Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) tests which test whether the coefficient of the cointegrating equation is equal to one.

The results given in table 2 are for the Pedroni (2004) tests and there is some evidence in favor of cointegration between inflation rates and interest rates for the G-2 group of countries. The standard model results in an acceptance of the null hypothesis (H_0: all countries in the panel are not cointegrated) whereas the time demeaned model shows evidence in favor of the alternate hypothesis of cointegration (hypothesis (H_1: a substantial portion of the countries in the panel are cointegrated). This is (at best) weak evidence in favor of the weak form of the PPP hypothesis in the full data set.

The results in table 3 are for the Pedroni (2001) test which is supposed to be carried out on a data set which is cointegrated and the null hypothesis is that the coefficient in the cointegrating equation is equal to one, which would be evidence in favor of the strong form of the Fisher hypothesis. Since we have weak evidence in favor of cointegration the results from strong form test are suspect. The null hypothesis of the existence of the strong form of the Fisher hypothesis is rejected in all four cases for the panel tests, indicating that strong form of the Fisher hypothesis does not exist for the panel or for individual countries.

Tables 4-9 give the results of the Pedroni (2001, 2004) tests for the groups G3 (France, Germany, United States), G4 (France, Germany, United States, United Kingdom) and G5 (France, Germany, Japan, United States, United Kingdom). For the G3 countries the results are given in tables 4 and 5. The Panel Statistics in table 4 indicate rejection of the null in favor of the alternate hypothesis that a substantial portion of the countries are cointegrated as 6 of the eight statistics are significant. The Pedroni (2001) test results given in table 5 for the G3 countries indicates the rejection of the null hypothesis that the coefficient in the Fisher equation is equal to 1. Therefore there is some evidence for the weak form of the Fisher hypothesis for the G3 countries but no evidence in favor of the strong form of the Fisher hypothesis. For the G4 group of countries the results are given in tables 6 and 7. The Pedroni (2004) test results given in table 6 indicate that for the G4 countries 5 out of 8 statistics provide evidence in favor of rejecting the null hypothesis of no cointegration in favor of the alternate hypothesis of cointegration. The Pedroni (2001) statistics results given in table 7 indicate the rejection of the null hypothesis of the coefficient in the Fisher equation is equal to 1. Therefore the results provide evidence against both weak and strong form of the Fisher hypothesis for the G4 countries. For the G5 group the Pedroni (2004) statistics results given in table 8 indicate that the standard model is cointegrated whereas the time-demeaned model is not cointegrated. The Pedroni (2001) results for the G5 countries given in table 9 indicate a rejection of the null hypothesis that the coefficient of the Fisher equation is equal to 1. Therefore the evidence is mixed in favor of the weak form of the Fisher hypothesis but against the strong form.

There is some evidence in favor of the weak form of the Fisher hypothesis for the different groups of countries as shown in tables 2, 4, 6, and 8. The results presented in tables 3, 5, 7, and 9 however show that there is no evidence in favor of the strong form of the Fisher hypothesis.

CONCLUSION

We have looked at the evidence in favor of the Fisher effect for different groups of countries among the G-5 countries using panel data tests. These tests provide us with the opportunity for improving the power of cointegration tests when we don't have access to a greater span of data. This is an important issue since the data for some countries is limited and carrying out panel data tests allow us to obtain robust results even with limited data. The evidence in favor of cointegration is weak at best. This implies that the evidence in favor of the partial Fisher effect is weak at best. There is no evidence in favor of the full Fisher effect for any of the groups or countries. The lack of evidence in favor of the strong Fisher effect indicates that while inflation and interest rates may move together for some countries, there is no one-to-one correspondence. On the other hand, weak evidence in favor of the partial Fisher effect indicates that there is some evidence that some degree of policy coordination has taken place over time, which is not surprising as these are some of the largest economies in the world. However, the weak evidence in favor of cointegration of the inflation rates and interest rates itself indicates that the countries do not have inflation rate targets. The European central bank (ECB) does have an inflation target, but it makes decisions for only Germany and France, and that too since 1999. Prior to that time the German central bank probably did pay more attention to inflation than other European Central Banks. In the United States too the primary concern of the Federal Reserve has been growth and stable prices, and not primarily stable prices. This would explain the lack of a Fisher effect.

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TABLE 1: LEVIN AND LIN AND IPS PANEL UNIT ROOT TESTS

	Levin – Lin ADF statistic	IPS ADF statistic
G2		
Inflation	-1.38	-1.82
Interest rate	0.77	0.76
G3		
Inflation	-0.58	-1.02
Interest rate	1.58	1.99*
G4		
Inflation	-1.17	-1.69
Interest rate	2.02*	2.60*
G5		
Inflation	-4.30*	-4.66*
Interest rate	0.02	0.40

Note: All statistics in the above table are distributed as N(0,1) under the null hypothesis of an unit root. Therefore, we can conclude that all series in the data set have an unit root (there is only one significant value).

G2 – Germany, United States – June 1964 – June 2013
G3 – France, Germany, United States – January 1970 – June 2013
G4 – France, Germany, United States, United Kingdom – January 1978 – June 2013
G5 – France, Germany, Japan, United States, United Kingdom – April 2002 – June 2013.

TABLE 2: PEDRONI (2004) TESTS FOR PANEL COINTEGRATION: GERMANY, UNITED STATES – JUNE 1964 – JUNE 2013

	v-stat	Rho-stat	t-stat	ADF-stat
Panel Statistics				
Standard	0.8698	-1.9269	-0.6666	1.3921
Time demeaned	3.7894*	-4.2430*	-2.4984*	-1.8270

NOTE: All reported values are distributed as N (0, 1) under the null hypothesis. An asterisk indicated rejection of the null hypothesis at the 10% level or higher.

TABLE 3: PEDRONI (2001) TESTS FOR PANEL COINTEGRATION: GERMANY, UNITED STATES – JUNE 1964 – JUNE 2013

Country	FMOLS	t-stat	DOLS	t-stat
Germany	0.08	-58.74**	0.22	-29.11**
United States	0.10	-49.04**	0.17	-30.15**
Panel results				
Without Time Dummies				
Between	0.09	-69.89**	0.19	-41.91**
With Time Dummies				
Between	0.03	-140.44**	0.11	-61.85**

TABLE 4: PEDRONI (2004) TESTS FOR PANEL COINTEGRATION: FRANCE, GERMANY, UNITED STATES – JANUARY 1970 – JUNE 2013

	v-stat	Rho-stat	t-stat	ADF-stat
Panel Statistics				
Standard	0.6873	-3.9694*	-1.7949*	1.4159
Time demeaned	4.1062*	-5.2421*	-3.1087*	-2.4759*

NOTE: All reported values are distributed as N (0, 1) under the null hypothesis. An asterisk indicated rejection of the null hypothesis at the 10% level or higher.

TABLE 5: PEDRONI (2001) TESTS FOR PANEL COINTEGRATION: FRANCE, GERMANY, UNITED STATES – JANUARY 1970 – JUNE 2013

Country	FMOLS	t-stat	DOLS	t-stat
France	0.11	-61.28**	0.13	-53.62**
Germany	0.09	-52.45**	0.22	-27.34**
United States	0.11	-43.96**	0.18	-28.03**
Panel results				
Without Time Dummies				
Between	0.11	-83.59**	0.18	-62.93**
With Time Dummies				
Between	0.03	-190.02**	0.07	-105.89**

TABLE 6: PEDRONI (2004) TESTS FOR PANEL COINTEGRATION: FRANCE, GERMANY, UNITED STATES, UNITED KINGDOM – JANUARY 1978 – JUNE 2013

	v-stat	Rho-stat	t-stat	ADF-stat
Panel Statistics				
Standard	-0.1648	-0.7851	0.2043	2.5581*
Time demeaned	3.7994*	3.8049*	2.5610*	-1.7871*

NOTE: All reported values are distributed as N (0, 1) under the null hypothesis. An asterisk indicated rejection of the null hypothesis at the 10% level or higher.

TABLE 7: PEDRONI (2001) TESTS FOR PANEL COINTEGRATION: FRANCE, GERMANY, UNITED STATES, UNITED KINGDOM – JANUARY 1978 – JUNE 2013

Country	FMOLS	t-stat	DOLS	t-stat
France	0.12	-46.69**	0.14	-39.19**
Germany	0.08	-42.98**	0.25	-18.65**
United States	0.09	-46.87**	0.15	-29.35**
United Kingdom	0.07	-52.21**	0.12	-29.43**
Panel results				
Without Time Dummies				
Between	0.09	-86.57**	0.17	-58.31**
With Time Dummies				
Between	0.02	-228.73**	0.04	-106.35**

TABLE 8: PEDRONI (2004) TESTS FOR PANEL COINTEGRATION: FRANCE, GERMANY, JAPAN, UNITED STATES, UNITED KINGDOM – APRIL 2002 – JUNE 2013

	v-stat	Rho-stat	t-stat	ADF-stat
Panel Statistics				
Standard	-1.3460	2.0620*	3.0140*	2.3197*
Time demeaned	-1.2303	1.4391	1.5109	1.4027

NOTE: All reported values are distributed as N (0, 1) under the null hypothesis. An asterisk indicated rejection of the null hypothesis at the 10% level or higher.

TABLE 9: PEDRONI (2001) TESTS FOR PANEL COINTEGRATION: FRANCE, GERMANY, JAPAN, UNITED STATES, UNITED KINGDOM – APRIL 2002 – JUNE 2013

Country	FMOLS	t-stat	DOLS	t-stat
France	0.02	-22.05**	0.19	-5.27**
Germany	0.01	-24.61**	0.18	-4.73**
Japan	0.00	-20.71**	0.06	-5.30**
United States	0.02	-29.07**	0.14	-8.23**
United Kingdom	-0.04	-19.46**	-0.33	-7.08**
Panel results				
Without Time Dummies				
Between	0.00	-47.59**	0.05	-13.69**
With Time Dummies				
Between	-0.01	-81.91**	-0.09	-23.58**