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On The Relationship Between The Tax Burden And Income Convergence: Some Further Results

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Abstract

Using OECD data (1965-1994) for 22 selected countries; we test for tax burden and *per capita* GDP convergence based on a time series approach. We further examine the issue of a possible relationship existing between *per capita* GDP and tax burden convergence. Generally, the evidence from this paper does not show any close relationship between tax burden and *per capita* GDP convergence.

Keywords
Tax burden, *per capita* GDP, convergence, unit roots, cointegration

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1. INTRODUCTION

The idea of cross-country or regional convergence has been widely examined in the economics literature. The focus has, however, been on convergence in *per capita* income measured in line with the principles of the neoclassical growth model. Here, so-called "beta convergence" occurs when there is a negative relationship between the average growth rate of a given variable and the logarithm of its initial level. On the other hand, so-called "sigma convergence" occurs when the standard deviation of the logarithm of the given variable decreases over time. See Barro and Sala-i-Martin (1992), Esteve *et al*. (2000), Dobson and Ramlogan (2002), for example.

The Time series approach to identifying convergence is, however, becoming increasingly popular. Since its introduction by Bernard and Durlauf (1995) several authors have adopted this method of identifying convergence. For example see Greasley and Oxley, (1997), St. Aubyn (1999), Esteve *et al*. (2000), among others. Here, the technique simply involves testing for the presence of unit roots in the difference between the two series being examined for convergence. Provided that the two series converge, the difference between them should be stationary.

Greasley and Oxley (1997) applied the Augmented Dickey Fuller (ADF) and Perron (1989) tests to the differences between annual *per capita* GDP of several pairs of OECD countries and found bivariate convergence for Sweden-Denmark, France-Italy, Belgium-Netherlands, and Australia-UK. St. Aubyn (1999) examined sixteen industrialized countries from 1890 to 1989 for convergence in GDP *per capita* using the ADF and the Kalman filter techniques and found convergence for five countries (Australia, Belgium, France, Netherlands, and Switzerland) with respect to the US. Esteve *et al*. (2000) looked at convergence in fiscal pressure across EU countries over the period 1967 to 1994 using both the traditional cross-section and time series methods. Scully (1991) examined the issue of a possible relationship existing between convergence in fiscal regimes (represented by the level and pattern of revenues and expenditures) and *per capita* income. He showed that under the assumptions of the Tiebout model, spatial convergence in income distribution and level of *per capita* income would imply spatial convergence in fiscal regimes, thus diminishing opportunities for Tiebout-type moves. Scully found evidence for this in the various states of the US where states with relatively low initial levels of taxation have had relatively higher growth rates of taxation and states with low initial real *per capita* income have had higher growth rates of real *per capita* income. In particular, Scully observed that the 48 contiguous states of the US and the District of Columbia converged in real *per capita* income between 1929 and 1986 and between 1957 and 1986. These states also exhibit convergence in income distribution over the period 1960 to 1980, and fiscal convergence over the period 1929 to 1986. His explanation of this linkage in convergence is that the tendency of labor and capital to migrate to where their respective marginal product is higher ensures that convergence in *per capita* income is correlated with convergence in income distribution. He used the beta convergence measure in all cases. It would be interesting to see how this finding extends to the international level (a cross-country study) especially for the European Union (EU), which has already experienced significant integration over recent years and allows free movement of people within its borders; an important requirement for the Tiebout model to hold.

In this paper, we examine the convergence process in the tax burden and output *per capita* among 22 selected OECD countries, based only on time series analysis. The time series approach has, however, been found to be generally more inclined to accept the null hypothesis of no convergence as compared to the cross-sectional method (St. Aubyn, 1999). This is mainly due to the low power associated with unit root tests and the possibility of discontinuities existing in the differenced series. Three different unit root tests have been performed on the level and lagged difference series of all countries. The third test (Perron's test) has been very useful in helping to model the significant level and trend changes that are associated with many of the series.

The import of this paper is that it compares convergence in GDP *per capita* and tax-burden over virtually the same time period, thus further exploring the issue of a possible relationship between convergence in fiscal regimes (tax-burden) and *per capita* GDP.

2. TIME SERIES STOCHASTIC CONVERGENCE AND COMMON TREND

We adopt the definition of Bernard and Durlauf (1995, p.99) who consider convergence in an explicitly time series setting based upon differences between countries' GDP *per capita.* In particular they define stochastic convergence in output as follows:

> If $y_{i,t}$ is log real *per capita* output for country i at time t, and I_t is the information set at time t, then countries p=1,2,…, n converge if the long-term forecasts of outputs for all countries are equal at a fixed time t:

$$\underset{k\to\infty}{Limit}\, E(y_{1,t+k} - y_{p,t+k} \mid I_t) = 0;\ \forall p \neq 1,$$

when p=2, for example, this definition of convergence requires that the two countries' outputs be cointegrated, with a cointegrating vector [1, -1]. So, in practice convergence would be rejected if the series (y_i-y_j) contains a unit root. In the multivariate case, convergence requires that there must be (p-1) cointegrating vectors of the form [1, -1] or one common long-term trend. Accordingly, we can test for convergence by constructing a time-series based on the (p-1) deviations, $Dy_{i,t}$=($y_{1,t}$-$y_{i,t}$) and apply Johansen's (1991) multivariate cointegration analysis.

If the output series do not converge, they may still have common trends, and there may be a small number of stochastic trends affecting output that differ across countries (Bernard and Durlauf, 1995, pp.99-100). Countries p=1,2,…,n contain a single common trend if the long-term forecasts of output are simply proportional at a fixed time t:

$$\underset{k\to\infty}{Limit}\, E(y_{1,t+k} - a'_p y^*_{,t+k} \mid I_t) = 0;\ \forall p \neq 1,$$

where $y^*_t = (y_{2,t}, y_{3,t},....., y_{p,t})$. If p=2, for example, countries i and j have a common trend if y_i and y_j are cointegrated with a cointegrating vector [1,-α], and this is readily tested using the Engle and Granger (1987) procedure. In the multivariate case, Johansen's maximum likelihood analysis can again be used in conjunction with the original output data for all of the countries to determine the number of cointegration vectors (common trends).

3. DATA AND ECONOMETRIC METHODOLOGY

3.1 Data

The tax burden data used is in the form of total tax revenue as a percentage of GDP over the period 1965-1994, and is taken from OECD for 22 selected countries. The real GDP *per capita* data covers the period 1965-1992 and is taken from the Penn World Tables 5.6 Database Files for the same countries.

3.2 Unit Root Tests

We carry out the Augmented Dickey-Fuller (ADF), Kwiatkowski, *et al*. (KPSS) and Perron (1989) tests to test for unit roots in the levels and lagged differences of all the original series. It is well known that special care must be taken if it is suspected that a structural change has occurred in the series since this biases the ADF statistic towards a non-rejection of unit root. Since most of our series exhibit structural breaks, the Perron (1989) approach is very useful here.

Perron (1989) considered three different models under the null hypothesis: one that permits an exogenous change in the level of the series (a "crash"), one that permits an exogenous change in the rate of growth, and one that allows both changes to take place simultaneously. These hypotheses are parameterized as follows:

Null hypotheses:

Model (A) $y_t = a_0 + y_{t-1} + m_1 D_p + e_t$

Model (B) $y_t = a_0 + y_{t-1} + m_1 D_L + e_t$

Model (C) $y_t = a_0 + y_{t-1} + m_1 D_p + m_2 D_L + e_t$,

where D_p represents a pulse dummy variable such that D_p=1 if t= τ+1and zero otherwise, and D_L represents a level dummy variable such that D_L=1 if t>τ and zero otherwise.

The corresponding alternative hypotheses are:

Model (A) $y_t = a_0 + a_2 t + m_2 D_L + e_t$

Model (B) $y_t = a_0 + a_2 t + m_3 D_T + e_t$

Model (C) $y_t = a_0 + a_2 t + m_2 D_L + m_3 D_T + e_t$,

where D_T=t-τ for t>τ and zero otherwise. Therefore, following Perron's ADF testing strategy, the regression equations we use to test for a unit root are:

$$\Delta y_t = a_0 + a_1 y_{t-1} + a_2 t + m_1 D_p + m_2 D_L + \sum_{i=1}^{k} b_i \Delta y_{t-i} + e_t$$

$$\Delta y_t = a_0 + a_1 y_{t-1} + a_2 t + m_2 D_L + m_3 D_T + \sum_{i=1}^{k} b_i \Delta y_{t-i} + e_t$$

$$\Delta y_t = a_0 + a_1 y_{t-1} + a_2 t + m_1 D_p + m_2 D_L + m_3 D_T + \sum_{i=1}^{k} b_i \Delta y_{t-i} + e_t$$

We test the null hypothesis that a_1=0 against the alternative that a_1<0. The choice of breakpoints and the appropriate model are based on observation of the data. To determine k, we have undertaken a sequence of hypothesis tests starting with k=10. Simulated critical values are obtained from Perron (1989) and Perron and Vogelsang (1993).

3.3 Cointegration Tests

We use the Johansen (1991) cointegration test to examine the data for possible cointegration features. In line with this test, we express a p-dimensional (p×1) vector autoregressive model with Gaussian errors in a first-differenced error correction form as:

$\Delta_1 y_t = \pi\, y_{t-1} + \sum_{j=1}^{p-1} \Gamma_j\, \Delta_1\, y_{t-j} + \varepsilon_t$ where $\pi = -(I_m - \sum_{j=1}^{p} \boldsymbol{p}_i)$ and $\Gamma_j = -\sum_{i=j+1}^{p} \boldsymbol{p}_i$ for j=1,2,....,p-1

The π matrix conveys information about the long-run relationship between y_t variables, and the rank of π is the number of linearly independent and stationary linear combinations of variables studied. Thus, testing for cointegration involves testing for the rank of π matrix r by examining whether the eigenvalues of π are significantly different from zero. Johansen (1991) proposed two test statistics for testing the number of cointegration vectors (or the rank of π) in the VAR model. These are the trace test and the maximum eigenvalue test (λ-max). The likelihood ratio statistic for the trace test is:

$$-2\ln Q = -T \sum_{i=r+1}^{p} \ln(1 - \hat{l}_i),$$

where $\hat{l}_{r+1}, \ldots, \hat{l}_p$ are the estimated p-r smallest eigenvalues. The null hypothesis to be tested is that there are at most r cointegrating vectors. That is, the number of cointegrating vectors is less than or equal to r, where r is 0,1, or 2..., and so forth. In each case, the null hypothesis is tested against the general alternative of m-cointegrating vectors for the m-variable case.

Alternatively, the λ-max statistic is:

$$-2\ln Q = -T\ln(1 - \hat{l}_{r+1}),$$

In this test, the null hypothesis of r cointegrating vectors is tested against the alternative of r+1 cointegrating vectors. Thus, the null hypothesis r=0 is tested against the alternative that r=1, r=1 against the alternative r=2, and so forth.

4. RESULTS OF STOCHASTIC CONVERGENCE TESTS

4.1 Pair-wise Convergence

In Table 1 (in the Appendix) we show the results of testing for unit roots in each of the tax-burden (TB) series, allowing for the possibilities of I(2), I(1) and I(0) processes. We have used both the ADF test, in which the null hypothesis is non-stationarity, and the KPSS test for which the null hypothesis is stationarity. A 10% significance level is used to compensate for the low powers of these tests, although the results are not very sensitive to this choice.

The results show that all of the tax burden series are I(1) except for Portugal, Sweden, Switzerland and Turkey, which are I(0). These four countries are thus left out of further tests of convergence since by definition two converging series must have the same level of integration. We measure convergence with respect to the US and with respect to Canada, because they are the biggest economies and we expect them to be the converging points for the other economies.

We next test for bivariate convergence in the tax burden with respect to the US by taking the difference between the series for each country and the US, and testing the resulting series for a unit root. The results are shown in Table 2 (in the Appendix). The results indicate that there is bivariate tax burden convergence between the US and three other countries (Austria, Norway and Turkey).

Table 3 (in the Appendix) also shows details of results of tests of convergence with respect to Canada. Here, we obtain bivariate tax burden convergence between Canada and Austria, and between Canada and Ireland.

We perform equivalent tests on the *per capita* GDP series. The results appear in Tables 4-6 (in the Appendix). Two of the series (Portugal and Spain) exhibit I(2) process. Five others (New Zealand, Finland, Germany, Norway and Sweden) are I(0), while the remaining series are I(1). Leaving out the I(0) and including the first difference of the I(2) series, we examine the remaining series for convergence with respect to the US and Canada. The results in Table 5 indicate that eleven countries (Canada, Australia, Japan, Austria, Denmark, Ireland, Italy, Portugal, Spain, Turkey and UK) have *per capita* GDP convergence with the US. Under convergence with respect to Canada (Table 6), we obtain *per capita* GDP convergence for the US, Japan, Austria, Ireland, Luxemburg, Spain and UK.

4.2 Group Convergence

The results of applying Johansen's (1991) cointegration test (trace and λ-max) to examine stochastic convergence among various groupings of our series appear in Tables 7 and 8. Each of the series being examined exhibits a trend, so following the suggestion of Franses (2001) we include a drift and trend in the cointegrating equation, and a drift but no trend in the VAR models when applying Johansen's procedure. This corresponds to "case 4" in the Eviews (1998) econometrics package. Since the cointegration results are sensitive to the number of lags included in the regression, we use unrestricted VAR models to carefully select the optimal lag based on the AIC selection criterion. In each group, the country in the parentheses is the country with respect to which differences of the other countries have been taken.

We examine two main groups: the group of seven most developed countries (G7) and the EU for convergence. We split each group into sub-groups and test for group convergence in each sub-group before examining the main group for convergence.

Table 7 Group Convergence Test Results for Tax-burden (G7)

	NUMBER OF COINTEGRATING VECTORS				
	Trace (5%)	λ-max(5%)	Trace (1%)	λ-max(1%)	Lags
G7[1] $(US)_1$	3	3	3	3	5
G7[2] $(US)_2$	3	3	2	2	5
G7 (US)	6	6	5	5	2
G7[3] $(CAN)_1$	3	3	3	3	5
G7[4] $(CAN)_2$	3	3	3	3	5
G7 (CAN)	6	6	5	5	2

[1] G7 $(US)_1$ includes Canada, Germany and France.

[2] G7 $(US)_2$ includes Italy, Japan and UK.

[3] G7 $(CAN)_1$ includes US, Germany and France.

[4] G7 $(CAN)_2$ includes Italy, Japan and UK.

From Table 7, the results under both G7$(US)_1$ and G7$(US)_2$ suggest convergence at the 5% level of significance. Putting the two groups together under G7(US), the G7 group as a whole also suggests stochastic convergence. The results for G7$(CAN)_1$, G7$(CAN)_2$ and G7(CAN) also suggest convergence at both the 1% and 5% level of significance. We therefore conclude at the 5% level of significance that the G7 countries exhibit tax burden convergence with respect to the US and Canada since, for an m-variable case, having "m" cointegrating vectors indicates that all the "m" series are stationary.

Table 8 Group Convergence Test Results for Tax-burden (EU)

	NUMBER OF COINTEGRATING VECTORS				
	Trace (5%)	λ-max(5%)	Trace (1%)	λ-max(1%)	Lags
EU_1(UK)[1]	3	3	3	3	5
EU_2(UK)[2]	2	2	2	2	5
EU_3(UK)[3]	3	3	2	1	5
EU(UK)	2	1	1	1	0

[1] EU_1 includes Australia, Belgium and Denmark.

[2] EU_2 includes France, Ireland and Italy.

[3] EU_3 includes Luxemburg, Netherlands, Spain.

We perform the convergence tests for the EU countries in three sub-groups before examining all EU member countries for convergence under EU(UK). In each case the difference was taken with respect to the UK, with each group made up of three countries. In Table 8 only $EU(UK)_1$ and $EU(UK)_3$ indicate convergence at the 5% level of significance. What is clear is that there is no convergence among all the EU countries, but there exists a significant number of common trends among these countries. This result is consistent with the findings of Sosvilla-Rivero *et al*. (1998) who obtained tax burden convergence for 14 out of the 15 member EU countries using the traditional beta and sigma convergence approaches. In particular, they obtained convergence for these countries over the period 1967-1974 and observed divergence over the period 1984-1995, suggesting that there has been at least some fiscal integration within the EU.

Turning to group convergence in *per capita* GDP, because the *per capita* GDP of Germany is I(0), the G7 countries have been reduced to G6. Again, we split the G6 countries into two groups.

Table 9 Group Convergence Test Results on Per Capita GDP (G6)

	NO. OF COINTEGRATING VECTORS				
	Trace (5%)	λ-max(5%)	Trace (1%)	λ-max(1%)	Lags
G6[1] $(US)_1$	0	0	0	0	3
G6[2] $(US)_2$	0	0	0	0	2
G6 (US)	4	3	3	3	2
G6[3] $(CAN)_1$	0	0	0	0	3
G6[4] $(CAN)_2$	0	0	0	0	4
G6 (CAN)	4	3	3	3	2

[1] G6 $(US)_1$ includes Canada and France.

[2] G6 $(US)_2$ includes Italy, Japan and UK.

[3] G6 $(CAN)_1$ includes US and France.

[4] G6 $(CAN)_2$ includes Italy, Japan and UK.

The results in Table 9 show that there is no evidence of group convergence in the $G6(US)_1$, $G6(US)_2$ and the G6(US) groups. The results with respect to Canada also fail to suggest convergence in the $G6(CAN)_1$, $G6(CAN)_2$ and the G6(CAN) groups.

It is clear from a comparison of the results in Tables 7 and 9 that there is no correspondence between the tax burden convergence and *per capita* GDP convergence for the G7 countries.[1]

Table 10 Group Convergence Test Results on Per Capita GDP (EU)

	NUMBER OF COINTEGRATING VECTORS				
	Trace (5%)	λ-max(5%)	Trace (1%)	λ-max(1%)	Lags
EU_1 (UK)[1]	2	2	1	1	4
EU_2 (UK)[2]	1	1	1	1	4
EU_3 (UK)[3]	3	3	3	3	4
EU (UK)	3	2	3	2	0

[1] EU_1 includes Australia, Belgium and Denmark.

[2] EU_2 includes France, Ireland and Italy.

[3] EU_3 includes Luxemburg, Netherlands, Spain.

From Table 10 it is clear that none of the three sub-groups exhibits convergence, and neither does the entire EU group. Again, a comparison of the results in Tables 8 and 10 fails to show any relationship between tax burden convergence and *per capita* GDP convergence for the EU countries.

4.3 Some Other Results

Based on the findings of Greasley and Oxley (1997), who obtained bivariate convergence in GDP *per capita* for France-Italy; Belgium-Netherlands; Australia-UK; and Sweden-Denmark over the period 1900-1987, we also examine these pairs of countries for convergence in tax burden and GDP *per capita.* Again based on our unit root tests, we reduce these four pairs of countries to three. While we observe no bivariate convergence in tax burden for these pairs of countries in Table 11, we do observe stochastic convergence in *per capita* GDP for all of them, with the latter results being very consistent with findings of Greasley and Oxley.

Tabel 11 Pairwise Convergence - Tax Burden

	ADF	KPSS	PERRON	UNIT ROOT
Belgium - Netherlands	-2.100	0.210*	-	YES
Australia- UK	-1.94	0.447*	-3.425	YES
France - Italy	-1.353	0.178*	-3.262	YES

* Denotes significance at 10% level.

Table 12 Pairwise Convergence – Per Capita GDP

	ADF	KPSS	PERRON	UNIT ROOT
Belgium - Netherlands	-5.110*	0.087	-	NO
Australia- UK	-2.786	0.167*	-4.564*	NO
France - Italy	-2.182	0.144*	-4.781*	NO

* Denotes significance at 10% level.

5. CONCLUSIONS

Generally, the evidence from this paper does not show any close relationship between tax burden convergence and *per capita* GDP convergence. Under tax burden pair-wise convergence with respect to the US, we observe convergence for Austria, Norway, and Turkey; while under *per capita* GDP pair-wise convergence with respect to US, we observe convergence for Canada, Australia, Japan, Austria, Denmark, Ireland, Italy, Portugal, Spain, Turkey and UK. Examining convergence with respect to Canada, we find pair-wise convergence in the tax burden for the Austria and Ireland; while we find pair-wise convergence in *per capita* GDP for US, Japan, Austria, Ireland, Luxemburg, Spain and UK. Thus, all countries that exhibit tax burden convergence also show convergence in *per capita* GDP with respect to both the US and Canada. However, there are also several other countries such as Canada, Australia, Japan, Denmark, Ireland, Italy, Portugal, Spain and UK that do not have convergence in tax burden with respect to the US but exhibit *per capita* GDP convergence with respect to the US while US, Japan, Luxemburg, Spain and UK also show convergence in *per capita* GDP with respect to Canada but no tax burden convergence with respect to Canada. The results under the pairwise convergence test are therefore not conclusive.

On the other hand, our group convergence tests conclusively show that there is no close relationship between tax burden convergence and *per capita* GDP convergence, even though we find strong evidence indicating tax burden convergence for the G7 countries. The group convergence tests performed on both the G7 and EU fail to show any correspondence between tax burden and *per capita* GDP convergence.

Further pairwise tests conducted based on findings of Greasley and Oxley reveal convergence in *per capita* GDP for France-Italy, Belgium-Netherlands and Australia-UK, which is consistent with the findings of Greasley and Oxley. However, corresponding pairwise convergence tests performed on the tax burden series fail to show convergence.

Several reasons could account for the absence of evidence supporting Scully's findings. Firstly, the assumptions under which Scully made his proposition (the Tiebout model assumptions) are fairly restrictive. For instance, even though there is free movement of people between the EU countries in particular (thus satisfying a major assumption of Tiebout model) there is obviously a cost (assumed to be zero in the Tiebout model) associated with such movement. We therefore expect this close relationship between tax burden and *per capita* GDP convergence to take a relatively long period of time to be achieved.

Second, as noted by Bernard and Durlauf (1995), time series convergence testing techniques are less reliable (compared to the 'beta' and 'sigma' convergence testing techniques) in identifying stochastic convergence of countries that start at different initial conditions and are converging to, but are not yet at steady-state tax burden/*per capita* GDP distribution. This is because the data could have been generated by some process other than the invariant process that is assumed in time series tests. Consequently, unit root tests may erroneously accept a no-convergence null.

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APPENDIX

TABLE 1 SUMMARY OF UNIT ROOT TESTS ON TAX-BURDEN SERIES

COUNTRY[1]	ADF	LAGS	KPSS	B.W.[2]	PERRON	L[3]	UNIT ROOT
CAN: TB	-3.052	0	0.087	2	-3.338	0.3	YES
:DTB	-4.909*	0	-	-	-	-	NO
USA: TB	-3.709*	0	0.104	2	-2.956	0.2	YES
:DTB	-6.456*	0	-	-	-	-	NO
OZ : TB	-1.457	0	0.171*	3	-	-	YES
:DTB	-5.397*	0	-	-	-	-	NO
JAP: TB	-0.432	0	0.115	2	0.426	0.3	YES
:DTB	-4.023*	0	-	-	-	-	NO
NZ : TB	-2.719	0	0.119	3	-	-	YES
:DTB	-6.486*	0	-	-	-	-	NO
AUS: TB	-2.399	0	0.149*	4	-3.393	0.4	YES
:DTB	-6.638*	0	-	-	-	-	NO
BEL: TB	-1.145	0	0.176*	4	-2.543	0.7	YES
:DTB	-4.181*	0	-	-	-	-	NO
DEN: TB	-2.609	0	0.117	3	-3.086	0.8	YES
:DTB	-4.093*	0	-	-	-	-	NO
FIN: TB	-2.685	0	0.083	2	-3.330	0.4	YES
: DTB	-4.998*	0	-	-	-	-	NO
FRA: TB	-0.858	0	0.114	4	-1.734	0.6	YES
: DTB	-3.939*	0	-	-	-	-	NO
GER: TB	-2.001	0	0.163*	4	-	-	YES
: DTB	-6.262*	0	-	-	-	-	NO
IRE: TB	-2.711	0	0.124*	3	-	-	YES
: DTB	-5.436*	0	-	-	-	-	NO
ITA: TB	-2.033	0	0.159*	4	-	-	YES
: DTB	-4.796*	0	-	-	-	-	NO
LUX: TB	-0.987	0	0.162*	4	-3.060	0.6	YES
: DTB	-4.368*	0	-	-	-	-	NO
NET: TB	-1.415	3	0.184*	4	-	-	YES
: DTB	-4.039*	2	-	-	-	-	NO
NOR: TB	-0.885	7	0.186*	4	-3.485	0.7	YES

: DTB	-4.415*	6	-	-	-	-	NO
POR: TB	-3.894*	0	0.106	6	-	-	NO
: DTB	-4.971*	4	-	-	-	-	NO
SPA: TB	-2.581	3	0.135*	4	-	-	YES
: DTB	-8.816*	0	-	-	-	-	NO
SWE: TB	-2.019	1	0.161*	3	-3.600*	0.9	NO
: DTB	3.459*	0	-	-	-	-	NO
SWI: TB	-2.314	2	0.165*	4	-3.963*	0.5	NO
: DTB	2.610*	3	-	-	-	-	NO
TUR: TB	-3.045	1	0.103	2	-4.814*	0.6	NO
: DTB	-5.435*	2	-	-	-	-	NO
UK: TB	-2.238	0	0.115	2	-1.645	0.2	YES
: DTB	-4.451*	0	-	-	-	-	NO

* Denotes significance at the 10% level.

[1] We define the country abbreviations as follows: CAN: Canada , USA: United States, OZ: Australia, JAP: Japan, NZ: New Zealand, AUS: Austria, BEL: Belgium, DEN: Denmark, FIN: Finland, FRA: France, GER: Germany, IRE: Ireland, ITA: Italy, LUX: Luxemburg, NET: Netherlands, NOR: Norway, POR: Portugal, SPA: Spain, SWE: Sweden, SWI: Switzerland, TUR: Turkey, UK: United Kingdom.

[2] B.W. represents the bandwidth parameter.

[3] L represents the lambda in the Perron's test (*i.e.* time of break relative to the total sample size)

TABLE 2 TAX BURDEN CONVERGENCE WITH RESPECT TO USA

COUNTRY	ADF	KPSS	PERRON	L	UNIT ROOT
CAN	-2.717	0.076	-2.875	0.4	YES
OZ	-1.712	0.126*	-1.438	0.4	YES
JAP	-1.298	0.109	0.766	0.9	YES
NZ	-2.605	0.102	-3.004	0.8	YES
AUS	-2.526	0.138*	-3.515*	0.4	**NO**
BEL	-0.979	0.162*	-1.669	0.2	YES
DEN	-2.632	0.110	-3.311	0.2	YES
FIN	-3.139	0.071	-2.916	0.3	YES
FRA	-1.409	0.105	-2.306	0.3	YES
GER	-1.877	0.142*	-1.961	0.2	YES
IRE	-2.666	0.109	-2.254	0.4	YES
ITA	-2.455	0.156*	-	-	YES
LUX	-1.026	0.155*	-2.692	0.6	YES
NET	-0.630	0.179*	-2.744	0.1	YES
NOR	-0.942	0.182*	-3.756*	0.7	**NO**
SPA	-2.833	0.136*	-	-	YES
TUR	-3.307*	0.082	-4.253*	0.7	**NO**
UK	-2.418	0.107	-2.821	0.5	YES

* Denotes significance at 10% level.

TABLE 3 TAX BURDEN CONVERGENCES WITH RESPECT TO CANADA

COUNTRY	ADF	KPSS	PERRON	L	UNIT ROOT
USA	-2.717	0.076	-2.875	0.4	YES
OZ	-1.887	0.119	-0.569	0.8	YES
JAP	-1939	0.112	-3.106	0.8	YES
NZ	-2.434	0.098	-3.383	0.8	YES
AUS	-2.214	0.117	-3.715*	0.4	**NO**
BEL	-1.161	0.150*	-1.658	0.2	YES
DEN	-2.779	0.129*	-1.685	0.3	YES
FIN	-3.033	0.098	-2.784	0.4	YES
FRA	-1.797	0.101	-0.801	0.5	YES
GER	-2.080	0.132*	-2.742	0.5	YES
IRE	-2.524*	0.122*	-4.267*	0.8	**NO**
ITA	-2.625	0.152*	-3.141	0.3	YES
LUX	-1.112	0.149*	-1.240	0.1	YES
NET	-2.005	0.162*	-2.589	0.1	YES
NOR	-0.994	0.179*	-3.326	0.7	YES
SPA	-3.189	0.131*	-3.390	0.3	YES
TUR	-2.858	-0.086	-3.082	0.3	YES
UK	-1.488	0.112	-2.311	0.8	YES

* Denotes significance at 10% level.

TABLE 4 SUMMARY OF UNIT ROOT TESTS ON PER CAPITA GDP SERIES

COUNTRY	ADF	NL	KPSS	B.W	PERRON	L	UNIT ROOT
CAN: GDP	-2.347	1	0.186*	0	-	-	YES
:D GDP	-3.789*	0	-	-	-	-	NO
USA: GDP	-3.878*	1	0.069	4	-2.632	0.4	YES
:D GDP	-4.238*	0	-	-	-	-	NO
OZ : GDP	-2.541	0	0.100	1	-2.524	0.6	YES
:D GDP	-4.992*	0	-	-	-	-	NO
JAP: GDP	-2.030	0	0.105	2	-2.210	0.4	YES
:D GDP	-3.528*	0	-	-	-	-	NO

NZ : GDP	-1.967	0	0.085	3	-3.678*	0.5	NO
:D GDP	-3.225*	3	-	-	-	-	NO
AUS: GDP	-1.806	0	0.092	5	-3.191	0.6	YES
:D GDP	-4.168*	1	-	-	-	-	NO
BEL: GDP	-1.713	0	0.111	4	0.097	0.6	YES
:D GDP	-4.932*	0	-	-	-	-	NO
DEN: GDP	-2.200	0	0.083	3	-2.105	0.6	YES
:D GDP	-4.344*	0	-	-	-	-	NO
FIN: GDP	-4.294*	1	0.086	4	-	-	NO
: D GDP	-4.316*	1	-	-	-	-	NO
FRA: GDP	-1.908	0	0.139*	4	-	-	YES
: D GDP	-3.997*	0	-	-	-	-	NO
GER: GDP	-3.213*	1	0.089	2	-3.523*	0.6	NO
: D GDP	-3.739*	0	-	-	-	-	NO
IRE: GDP	-3.188	5	0.091	3	-3.070	0.7	YES
: D GDP	-3.388*	0	-	-	-	-	NO
ITA: GDP	-2.987	0	0.142*	0	-	-	YES
: D GDP	-4.907*	0	-	-	-	-	NO
LUX: GDP	-1.592	0	0.132*	3	-	-	YES
: D GDP	-3.206*	2	-	-	-	-	NO
NET: GDP	-2.741	1	0.122*	4	-	-	YES
: D GDP	-3.221*	0	-	-	-	-	NO
NOR: GDP	-3.304*	1	0.010	2	-	-	NO
: D GDP	-3.835*	2	-	-	-	-	NO
POR: GDP	-0.147	0	0.010	3	-2.551	0.4	YES
: D GDP	3.326	8	0.161*	-	-	-	YES
SPA: GDP	-2.839	2	0.091	4	-1.663	0.7	YES
: D GDP	-2.252	0	0.122*	-2.009	-	-	YES
SWE: GDP	-3.783*	6	0.083	1	-	-	NO
: D GDP	-3.373*	1	-	-	-	-	NO
SWI: GDP	-3.030	1	0.076	3	-1.893	0.4	YES
: D GDP	-3.074	4	0.088	-	-4.754*	0.4	NO
TUR: GDP	-1.833	0	0.088	4	-2.857	0.6	YES
: D GDP	-4.513*	0	-	-	-	-	NO
UK: GDP	-2.962	1	0.114	3	-2.554	0.6	YES
: D GDP	-3.316*	1	-	-	-	-	NO

* Denotes significance at 10% level.

TABLE 5 PER CAPITA GDP CONVERGENCE WITH RESPECT TO USA

COUNTRY	ADF	KPSS	PERRON	L	UNIT ROOT
CAN	-1.727	0.173*	-3.847*	0.9	**NO**
OZ	-5.171*	0.088	-	-	**NO**
JAP	-1.821	0103	-4.226*	0.8	**NO**
AUS	-2.743	0.121*	-4.665*	0.6	**NO**
BEL	-2.746	0.120*	-	-	YES
DEN	-3.359*	0.061	-	-	**NO**
FRA	-2.752	0.144*	-2.479	0.6	YES
IRE	-3.729*	0.068	-	-	**NO**
ITA	-2.838	0.072	-6.552*	0.6	**NO**
LUX	-1.976	0.143*	0.751	0.5	YES
NET	-2.914	0.140*	-3.091	0.4	YES
POR	-3.160*	0.055	-	-	**NO**
SPA	-3.924*	0.048	-	-	**NO**
SWI	-2.355	0.063	-2.182	0.5	YES
TUR	-4.520*	0.136*	-4.104*	0.4	**NO**
UK	-3.297*	0.172*	-4.348*	0.6	**NO**

* Denotes significance at 10% level.

TABLE 6 PER CAPITA GDP CONVERGENCE WITH RESPECT TO CANADA

COUNTRY	ADF	KPSS	PERRON	L	UNIT ROOT
USA	-1.727	0.173*	-3.847*	0.5	**NO**
OZ	-1.181	0.102	-1.178	0.7	YES
JAP	-0.331	0.122*	-4.364*	0.8	**NO**
AUS	-4.599*	0.120	-	-	**NO**
BEL	-1.713	0.111	-2.719	0.9	YES
DEN	-1.900	0.152*	5.041	0.6	YES
FRA	-3.137	0.083	-3.420	0.6	YES
IRE	-2.769	0.131*	-4.782*	0.9	**NO**
ITA	-1.045	0.105	-2.860	0.9	YES
LUX	-0.417	0.161*	-4.729*	0.9	**NO**
POR	-1.173	0.154*	0.539	0.6	YES
SPA	-2.036	0.118	-4.192*	0.6	**NO**
NET	-2.097	0.105	-2.846	0.9	YES
NOR	-2.558	0.110	-3.373	0.3	YES
SWI	-1.323	0.106	-1.215	0.6	YES
TUR	-2.678	0.096	-2.329	0.6	YES
UK	-0.872	0.172*	-6.282*	0.6	**NO**

* Denotes significance at 10% level.

FOOTNOTES

1. The G_6 $(US)_1$ and G_6 $(CAN)_1$ groups should be compared to G_7 $(US)_1$ and G_7 $(CAN)_1$ with caution since Germany has been dropped from G_6 $(US)_1$ and G_6 $(CAN)_1$ groups. Same caution holds when comparing the G_6 (US) and G_6 (CAN) groups to their G7 counterparts.