Profit rates in the developed capitalist economies: a time series investigation.

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Abstract

This paper examines whether there is empirical evidence to support the hypothesis of secular decline in the economy-wide profit rates as predicted by classical economic theories. We specifically consider profit rates in the OECD economies based on the national accounts data contained in the Extended Penn World Table database. In our analysis we use linear trend, Augmented Dickey-Fuller (ADF) tests, and also allow for structural breaks and instabilities in the series. Results suggest that profit rates in OECD economies exhibited a wide variety of patterns, including stochastic and deterministic trends, random walk, reversals, as well as stability. Secular decline (fluctuation around falling deterministic trend) hypothesis is supported for Canada, Portugal and the USA, while secular rise is witnessed for Greece and Norway.

Keywords: Profit rate, autoregressive model, structural breaks, trend

JEL Classification: B5, C22, P17

1. Introduction

Theoretical research on the dynamics of profit rates in capitalist economies has been particularly prolific in the classical and heterodox economic theory with their focus on the inherent instability and cyclical nature of capitalism. Various other economists (Keynes, Schumpeter) have also examined profit rates problem, but in a broader context, looking at the overall ability of capitalism to sustain profit rates opportunities and respectively to expand. Neoclassical economics was also concerned with the level of profit rates, focusing more narrowly on the health of the corporate sector and considering profit rates as fundamentals of financial markets performance.

In a related vein, empirical research attempted to establish regularities (tendencies, cycles etc.) in the actual profit rates' series and thereby provide factual basis for theories.

The recent revived interest in the subject has been due to declining growth rates in the developed economies, increased volatility and turbulence in the global economy and structural torsions. Availability of economic data on profit rates (at national and sectoral level) has also been stimulating applied research of the topic.

This paper revisits the hypothesis of the secular decline in profit rates (tendency of profit rates to decline in the long-run) that has been recurrent in classical economics and attempts to validate empirically whether profit rates in the developed economies have been declining in recent decades. *Inter alia* it addresses a number of issues that were not adequately dealt with in previous studies. Firstly, the analysis of profit rates has to rely on a theoretically sound indicator and acknowledge the differences that exist between the definition of the profit rate in classical economics and contemporary definitions of the profit rate which form the base for profit rates indicators in the modern national accounts. Likewise we have to define the scope of profit rate indicator (economy-wide rate versus rate in manufacturing sector or in particular industry), as well as variables from which profit rate indicator is derived (in particular definition of capital stock). Secondly, the majority of the studies examined profit rates in a single economy (usually as variable in the study of country's capital accumulation, macroeconomic analysis or the study of country's structural problems) or in a small set of economies. This shortcoming stemmed from the lack of available economic data that could allow comparative analysis. Thirdly, the empirical treatment of profit rates data relied mostly on visual inspection of profit rate series or on simple regression techniques (e.g. estimation of the linear trend) without proper consideration of unit root properties of the series, the possibility of trend reversals and breaks in the data. This paper attempts to address these issues by adopting profit rates' indicator based on the national accounts, by comparing a large set of the economies, and by using advanced econometric techniques.

2. Literature review

The early consideration of profit rates dates back to A. Smith and D. Ricardo: the former postulated the decrease in the level of profit due to competition, while the latter argued that competition would reduce the profit differences on investments rather than general rate of profit. The latter would only fall in wages rise, e.g. due to diminishing returns in agriculture and rise in food prices in agriculture-based economy (Tsoulfidis and Paitaridis, 2012; Ricardo, 1951, p. 120; Mizuta, 2015).
Later, the possibility of insufficient profit generation in capitalism was an area of concern for J. M. Keynes and J. A. Schumpeter, the former attributing it to financial sector failures, the latter to possible degeneration of entrepreneurial function in corporate capitalist system (Keynes, 1936/1991, Ch. 24; Argitis, 2003, p. 13; Schumpeter, 1942/1976, Part II).

Profit generation problems come hand in hand with other factors that condition crises and instabilities in capitalist economies (Edvinsson, 2010, p. 43). Sweezy (1942) and Ramirez (2007) for instance point to under-consumption and deficient aggregate demand as explanation of crises, instability and stagnation, as well as to production disproportionality and anarchic nature of capitalism. Likewise Minsky (1986), Onaran et al. (2012) and Stockhammer (2012) see the origins of instabilities and crises in debt-led instead of investment-led growth in capitalism.

Overall the complex interplay between finance and financial profits, effective demand, structural torsions between braches of the economy, debt, and non-financial profits have long been a matter of investigation in heterodox economics - classical, Keynesian, Schumpeterian and Minskian (Argitis, 2003).

In Marxist literature, the secular decline hypothesis was explained as follows. Capitalist competition allows innovating capitalists to reap super-normal profits that subsequently dwindle when innovations swarm through the economy. The need to maintain profits forces capitalists to introduce labour saving technologies and to ensure sufficient pool of reserve labour (and thereby low real wages). Together with ongoing capital accumulation, this creates the disparity between growth in capital accumulation and growth in surplus value (the latter growing slower), leading to falling rate of profit (Marx, 1867/1967, p. 612). Rate of profit in this formulation is determined by wages and profits in numerator of the ratio, and capital stock in denominator. Thus, profit rate falls due to wage and profit factors - declining rate of exploitation, rising real wages and fall in profit share (Tutan, Campbell, 2005); as well as factors on capital stock side - change in the value composition of capital and falling capital productivity (Duménil, Lévy, 2001; Wolff, 2003; Mohun, 2009).

It should be noted that while it has been common in heterodox economics to talk about secular decline and "law of the tendency of the rate of profit to fall", the precise form of decline (deterministic decline, cyclical fluctuation around falling trend, or no falling trend at all) has been debatable. For instance, the works of Marx suggest that this tendency is not inevitable and that various countervailing factors (and restorative crises of various sorts) may slow down, reverse, or halt the decline in the rate of profit, meaning thereby in-built resilience in capitalist economies (Marx, 1867/1967, Vol. III, Ch. 14). Possible countervailing factors could include stagnant real wages and availability of cheap labour-power (Zachariah, 2009), export of capital and foreign investment (Brewer, 1990), foreign trade to expand markets (Grossman, 1992, pp. 142-201), diversion of productive investment into financial sector (Guillén, 2007, p. 458). In a related vein, as put by Reuten (2004, p. 170), certain economists, including N. Kaldor (1957, pp. 597-8, 613), did not consider secular deterioration hypothesis plausible at all, hypothesizing instead stationarity of profit rates (Kaldor for instance attributed constant profit rates to constant savings propensities and hence wage and profit shares, and similar growth rates between output and capital per capita, and hence constant capital-output ratio). This is one of the well-known Kaldor's "balanced growth" facts.

On empirical front, the studies of profit rates looked at two distinct issues. Firstly, equalization tendencies in the rate of profit both across (Glyn, 2007), and within economies (Kambahampati, 1995; Tescari, Vaona, 2014) and convergence to steady-state (Pyo, Nam, 1999) have been considered, either through time-series analysis, or by probabilistic analysis of the distribution, equalisation and divergence of the rates of profits (Farjoun, Machover, 1983; Cottrell, Cockshott, 2006).

Secondly, a number of studies looked at trends and cycles in the rates of profit (economy-wide rates, rates for manufacturing and corporate sector), both in individual developed and developing economies. The studies included, among others, Weisskopf (1979) and Mohun (2006) for USA; Mohun (2002) for Australia; Reati (1986) and Poletayev (1992) for Germany; Hayashi and Prescott (2001) for Japan; Román (1997) for Spain; Erixon (1987) for Sweden. Comparative studies included Sylvain (2001), Li et al (2007), Daly and Broatbent (2009). Results of the empirical analysis are rather conflicting: while some studies attest to long-run fall in profit rates (Hayashi, Prescott, 2001), others provide evidence of periods when profit rates recover and rise (Mohun, 2006), stabilise (Izquierdo, 2007), or experience cycles (Basu, Manolakos, 2010). This can partially be attributed (in addition to issues of measurement and profit rates' indicators) to the fact that most empirical studies with the exception of Basu and Manolakos (2010) tended to rely on visual inspection of the data or the use of early generation econometric methods (simple linear trends).

This paper does not engage in a theoretical debate on the causes and effects of the fall in the rate of profit. Instead it attempts to describe statistically and econometrically profit rate patterns and dynamics. To this purpose it looks which of the theoretical lines in literature (long-run tendency to decline, versus more diverse behaviour of profit rates) looks more plausible and documents which events could have contributed to this. Specifically, we attempt to differentiate in profit rates' series between deterministic trend, deterministic trend with breaks, stochastic trend around non-zero mean, pure random walk or reversion to historical mean.

3. Methodology

This paper considers the profit rate in the whole economy, instead of examining profit rate in manufacturing (which was believed to be the core of national economy), given profound changes in economic structure (specifically the decline in manufacturing and the rise of tertiary sector) that has been taking place in developed economies over the last few decades.

The paper uses data that includes government sector in both output and capital stock and therefore do not exclusively look at corporate sector, and also do not provide separate estimates for profit-type incomes and incomes from self-employment. With regard to residential sector, the data contained dwellings as part of capital stock. An argument can be raised against this, as residential sector represents substantial part of total capital stock, while generating much smaller part of total value added produced (Tutan, Campbell, 2005, p. 15). On the other hand, Edvinsson (2005) argues that inclusion of residential capital in the total capital stock may be warranted, as "renting out residential buildings is an important source of profit in contemporary society, and the rents paid are important components of the expenses of wage workers" (p. 192).

The empirical analysis makes use of profit rates data contained in Extended Penn World Table Version 4.0 (EPWT), constructed by D. Foley and A. Marquetti (2012). EPWT itself is based to large extend on Penn World Table 7.0/PWT 7.0 (Heston, Summers, Aten, 2011). The critical feature of the EPWT is availability of capital stock series for a large sample of developed economies over 40-50 year period, allowing time series econometric analysis.

The rate of profit variable was constructed as:

$$\pi = \frac{(Y - Nw - D)}{K} \tag{1}$$

,where *Y* is the chain index of real GDP in 2005 purchasing power parity (PPP), *K* is net fixed standardised capital stock in 2005 PPP, *D* is estimated depreciation from *K*, *w* is average real wage in 2005 PPP, while *N* is the number of employed workers.

Variable *Y* was constructed as product of population and real GDP per capita in 2005 PPP in PWT 7.0. Variable *N* was obtained by dividing variable *Y* by the real GDP per worker in PWT 7.0. Variable *K* was computed using perpetual inventory method (PIM) from investment series based on the real investment share of GDP presented in the PWT 7.0. Variable *D* was calculated from capital stock values as:

$$D_t = K_{t-1} + I_t - K_t \tag{2}$$

Marquetti (2012) acknowledges shortcomings of variables' construction in PWT. They include common and high rates of depreciation across economies in the database (the problem that is inevitable when the task is to ensure comparability of capital stock estimates); inclusion of gross residential capital formation and change in inventories; short reporting period for investment variable, as well as *ad hoc* assumptions about asset life across gross capital formation categories.

Based on EPWT, profit rates' series were constructed for the following economies (periods) – Australia, Austria, Belgium, Canada, Ireland, Italy, Luxembourg, Netherlands, New Zealand, Spain, UK, USA (1964-2008); Denmark, Finland, France, Sweden (1964-2009); Japan, Norway, Switzerland (1964-2007); Greece (1965-2008); Portugal (1965-2009).

Several data observations were missing for the Netherlands (1965-8) and Norway (1964-7). Newton interpolation polynomial was used to obtain continuous series for these economies. Germany, being third largest developed economy was not included in the sample: EPWT contained real wage data only for West Germany starting from 1982, making sample too short and not including variables pertaining to former East Germany.

As a first step, we estimated a linear trend model based on the following semi-logarithmic equation:

$$\ln \pi = \alpha + \beta t + \mu_t \tag{3}$$

,where $\ln \pi$ is the natural logarithm of the profit rate series, t is the year of observation, and μ_t is the random disturbance term. Coefficient β stands for trend coefficient, i.e. the average annual rate of change in the profit rate over the respective period. To correct possible autocorrelation, AR terms were included in the equation.

As mentioned by Nelson and Kang (1984), the OLS estimators in the simple trend model tend to be inconsistent if variable in question is nonstationary. In this case the estimates of the trend are biased and spurious trends are present. In addition the frequent problems that are encountered in estimation of the linear trend are the rejection of normality and the presence of heteroscedasticity. This notwithstanding, following Canjels and Watson (1997), the use of linear trend model may deem appropriate and correct inference may be obtained, provided efficient estimators, such as Prais-Winsten are used.

This paper therefore uses conventional linear trend model with AR terms and estimators obtained using Prais-Winsten procedure. It also considers autoregressive model of Augmented Dickey-Fuller (ADF) type that addresses above-mentioned problems and encompasses both trend- and difference-stationarity, i.e.

$\ln\pi = \alpha + \beta t + \mu_t$ and (4)

$\Delta\ln = \beta + \mu_t$. (5)

Thereby, no prior testing of the series for presence of unit root is required. The autoregressive model with a time trend has the following form:

$$\ln\pi = \alpha + \beta t + \delta\ln\pi_{t-1} + \mu_t, \quad (6)$$

,where t is time variable and μ_t is random disturbance term. The model has been applied in a number of contexts to examine univariate dynamics of the series (Athukorala, 2000; Erten, 2011 among others).

Equation (6) may be re-parametrized in a differences form to read:

$$\Delta(\ln\pi) = \alpha + \beta t + \gamma\ln\pi_{t-1} + \mu_t, \quad (7)$$

,where $\gamma = \delta - 1$.

To correct for possible presence of autocorrelation additional lag of dependent variable (in first difference) is added. If autocorrelation is not eliminated with 1 lag, additional lags are introduced until problem is solved. The testing equation is therefore:

$$\Delta(\ln\pi) = \alpha + \beta t + \gamma\ln\pi_{t-1} + \psi\Delta(\ln\pi_{t-1}) + \theta\Delta(\ln\pi_{t-m}) + \mu_t \quad (8)$$

The estimation results of this autoregressive equation can be interpreted in the following fashion.

If $\beta \neq 0, \gamma < 0$, the non-zero deterministic trend is present and series revert to this trend after short-run disturbance.

If $\beta = 0, \gamma < 0$, there is no deterministic trend, but series revert to historical mean.

If $\beta = 0, \gamma = 0$, series exhibit random walk with zero mean (i.e. past behaviour of profit rate series gives no indication of the future dynamics, meaning that in the future profit rate may be higher, smaller or equal to the current value).

If $\beta \neq 0, \gamma = 0$, there is random walk with drift (i.e. stochastic trend). In this case, if $\beta > 0$, it is likely that future level of profit rate will be greater than current, while if $\beta < 0$, it is likely that profit rates will decline in the future.

In the former two cases, an ideal error-correction model is obtained, with statistically significant and negative γ coefficient, belonging to $-1 < \gamma < 0$ (Engle, Granger, 1987).

In this regard, only first two cases can be considered as a reliable guide to future dynamics of profit rates. Also, the hypothesis of secular decline in profit rates will be supported when $\beta < 0, \gamma = 0$ and $\beta < 0, \gamma < 0$. The possibility of secular increase is also acknowledged (in this case $\beta > 0$).

The long run trend rate from autoregressive estimation above is defined as:

$$b = -\beta\gamma^{-1} = -\frac{\beta}{\gamma} \tag{9}$$

If $\gamma = -1$, then equation (3) defined above is obtained.

Regarding interpretation of regression results, it was ensured that coefficient γ on a lagged depended variable is statistically significant and that $-1 < \gamma < 0$ holds. Following Pesaran et al (2001), the t-statistics of coefficient was compared to usual t-value critical bounds, as well as to Dickey and Fuller (1979) unit root t-statistics (in cases when dependent variable is not stationary in levels and distribution of t-statistics is non-standard). It was also ensured that coefficients on respective dummy variables were significant too. First order lagged dependent variable $\Delta(\ln \pi_{t-1})$ was included to correct autocorrelation, irrespective of term's significance. Additional lagged terms $\Delta(\ln \pi_{t-m})$ were included if autocorrelation persisted (Said, Dickey, 1984). Post-estimation of the model, usual diagnostic tests for autocorrelation, normality, heteroscedasticity, and ARCH effect were performed.

Autoregressive ADF-type model was first estimated without dummy variables provided that all diagnostic tests had been passed. If non-normality of residuals or heteroscedasticity were present, the dummy variables were introduced and the model was re-estimated. Dummy variables were based on the year when break or instability in series were likely to occur. Three types of information to determine dummy variables were obtained: residuals from the ADF model, recursive residuals and N-step forecasts (Brown et al, 1975). In addition, Quandt-Andrews test (Andrews, 1993) was performed. As a robustness check, the identified breaks and instabilities were compared to breaks identified by Bai-Perron (2003) procedure. Regarding type of the dummy variable (impulse or shift), the above information about the dummy variables was compared to the series' graphical data.

In case of inconsistency of results between linear trend model and ADF model (with or without dummy), or between results of these models and the graphical data, additional and more powerful unit root tests were performed to differentiate between trend stationarity with breaks and unit root behaviour, as well as between trend stationarity with breaks and unit root with breaks behaviour. The former type are Zivot-Andrews/ZA (1992) test and Lumsdaine-Papell/LP (1997) test; the latter type are Lee-Strazicich/LS tests (2003, 2004). ZA and LP tests (with one and two breaks respectively) were performed in three variants: allowing for shift in the level of series, growth rate of series, or both. LS tests (with one or two breaks) were performed based on "break" model allowing for structural breaks in both the intercept and the slope under the alternative hypothesis.

The linear trend model was then re-estimated, including the dummy variables corresponding to the breaks identified by ZA, LP and LS tests. It was acknowledged that these tests are not tests for break timing *per se*, that dummy variables were thereby likely to be insignificant and that normality and heteroscedasticity problems were likely to re-appear.

The overall conclusion was made when concordance between the results of the three types of models (linear trend with dummies based on residuals, autoregressive model with and without dummies, and linear trend with dummies from ZA, LP and LS tests) was ensured.

4. Empirical results

Before formally testing secular decline hypothesis, the profit rate patterns are presented (Figure 1). The visual observation suggests that over the study period (1964 to late 2000s) the profit rates were likely to exhibit downward trends in Austria, Canada, Japan, Portugal, Spain, Switzerland and USA. Upward trends were likely in Luxembourg and Norway. In other economies either no distinct trend was present, or trend reversals and random walk behaviour were likely.

[FIGURE 1]

The visual inspection also suggests two distinct patterns for profit rates in most economies – decline until mid or late 1970s, followed by partial or complete reversal. Early decline was likely present in all economies, except Luxembourg and perhaps Norway. Complete recovery was witnessed in Australia, Greece, Italy, Ireland, New Zealand, Netherlands, Sweden and the UK, while partial recovery or stabilisation was likely in Austria, Belgium, France and Spain. Such countries as Luxembourg, Norway witnessed not only complete recovery, but also reversal of the trend.

These visual observations however should be interpreted with caution, as spurious regressions and in particular spurious trends and cyclicality are possible (Granger, Newbold, 1974; Nelson, Kang, 1981).

As to explanation of the phenomenon, Kliman (2012) argues that initial downward trend was inevitable, due to initially very high profit rates in the early post-WWII period: this was a result of precedent decline in the value of physical capital and financial assets during turbulent 1930-40s. Hence, decline in 1960-70s was predetermined, and the low profit rates in 1970s were not seen as unprecedented, but more as historically normal. Explaining recovery since 1980s, such authors as Duménil, Levy (2004) and Glyn (2006) point to the profound pro-business political and economic restructuring that have been occurring, as well as to rising rentier class and “unproductive” sectors, such as finance and military-industrial complex.

Table 1 presents the results of a linear trend model estimated on the logarithm of the profit rates' series. Modelling used ARMA conditional least squares (CLS) method based on Gauss-Newton/Marquardt algorithm, with up to three AR terms included to correct for serial correlation. In the case of Austria and Japan, CLS method delivered the results that seemed to contradict the data (specifically, CLS resulted in the positive sign of the trend) and hence ARMA generalized least squares (GLS) was additionally performed. To ensure normality of the data, shift or impulse dummy variables were incorporated into trend regression. The choice of dummies was dictated by the presence of large positive/negative residuals in the trend regression with no dummies, as well as by visual observation of the series. In the case of Denmark, several specifications of the trend regression with or without dummies resulted in heteroscedasticity problem; to address it, the sample was curtailed to 1964-2007. Likewise, heteroscedasticity (at 5% significance level) was present in the case of Italy and the UK even after inclusion of dummy variables; the problem was addressed by obtaining Huber-White heteroscedasticity-robust standard errors.

[TABLE 1]

Positive trend was observed in 11 cases (Belgium, Finland, Greece, Ireland, Italy, Luxembourg, Netherlands, New Zealand, Norway, Sweden and the UK). Statistically significant positive trend coefficients were however present for Greece (at 10% significance level), and Netherlands and Norway (at 5% level). Negative trend was observed in 10 cases (Australia, Austria, Canada, Denmark, France, Japan, Portugal, Spain, Switzerland, and the USA). Statistically significant negative trend coefficient was present for Canada, Portugal, Switzerland and the USA (at 5% significance level). With regard to Austria and Japan, trend coefficients were insignificant irrespective of the estimation method. The estimates suggest that profit rates rose by 2.3%, 1.4% and 2.8% per annum over study period in Greece, Netherlands and Norway respectively. Profit rates declined by 0.8%, 2.2%, 1.4% and 0.7% per annum over study period in Canada, Portugal, Switzerland and the USA.

Table 2 contains the suggested dates of structural breaks in the series obtained from the four alternative tests. Negative or positive sign in parentheses represented fall (rise) in series. We note that Bai-Perron procedure that is more systematic and robust than the four other tests confirms the timing of breaks and instabilities in the series. Bai-Perron method of sequential testing of I+1 versus I breaks pointed to the same breaks as Quandt-Andrews test, and also suggested additional break in 1990 for Netherlands, in 1999 for Austria and in 1974 for Portugal. Compared to residuals, recursive residuals and N-step forecasts, Bai-Perron procedure pointed to at least one similar break in all economies, except Austria, Canada, Denmark, France, Norway and Portugal. In these latter economies however the location of the break was quite close to the actual one.

[TABLE 2]

The four tests combined indicate up to three possible instabilities for most of the economies. These instabilities are clustered in three periods – mid-1970s, early 1980s and late 2000s, with most of the residuals in these periods being negative. The negative residuals in mid-1970s can be attributed to the first oil shock, the collapse of the Bretton-Woods system, stagflation and world-wide recession. Negative residuals in 2009-10 reflect Global Financial Crisis, while instabilities in early 1980s reflect recession of early 1980s, the rejection of Keynesian economic policies, and certain financial crises (Latin American debt crisis, and savings and loans crisis in the US). The number of breaks associated with the Great Recession of the late 2000s was much smaller. Importantly, the breaks occurring in the 1970s were in most cases due to the fall in the profit rates; in general adverse economic events and developments resulted in negative residuals and fall in series.

In addition, country-specific factors were prominent. In Australia, the 1982-3 dummy variable corresponds to the start of economic deregulation, trade liberalisation and movement towards flexible exchange rate system undertaken by Fraser and Hawke governments. In Belgium, the 1991 dummy variable corresponds to the economic recession of the early 1990s (the worst since the end of WWII), as well as other structural problems (slow productivity growth, structural unemployment and other symptoms of Eurosclerosis). In Finland, 1990 dummy reflects the breakup of COMECON and Soviet Union, and the demise of the foreign trade of Finland with its Eastern European partners. The dummy variables for the USA (1980, 1982 and 1983-4) relate to the start of the Reagan presidency and the onset of Reaganomics economic policies, as well as to the deep recession of early 1980s. In Norway, the 2000 dummy variable reflect the period of low oil prices that affected Norwegian petroleum sector. The impulse dummies in Greece (1974, 1988, 1991), Spain (1975, 1984) and Portugal (1975) can be attributed to political transition to democracy that took place in mid-1970s (demise of regimes of Franco, Salazar and "regime of the colonels"), as well as accession to European Community (the case of Spain in mid-1980s) and its broad implications. In Italy 1979 dummy reflects deep political crisis during 1979 general elections.

The dummy variables to be used in autoregressive ADF model are presented in Table 3, with dummy variables respectively set at 1 or 0 to correct structural changes. We note that if structural shifts were modelled, the dummy variables were set greater or smaller than one after specific date.

[TABLE 3]

Tables 4 and 5 present the estimates from autoregressive ADF model, the former table - with no structural breaks, while the latter – with breaks (in impulse or structural shift form). In all cases, it was ensured that coefficient of the lagged variable $\ln\pi_{t-1}$ has negative sign. To address possible serial correlation, additional lag terms of $\Delta\ln\pi_{t-1}$ were included (irrespective of its significance). It was also ensured that included dummy variables are statistically significant.

[TABLE 4]

In autoregressive ADF model without dummy variables (Table 4), the trend was statistically significant in the case of Canada, Norway and the USA, with profit rate series falling by 0.79% and 0.67% per annum respectively in Canada and the USA during 1964-2008 period. In Norway, profit rates were rising by 2.78% per annum over 1964-2007 period. For other countries in question, trend rate was not estimated due to insignificance of trend coefficient. Using Dickey-Fuller critical values, the coefficient of $\ln\pi_{t-1}$ term was likewise significant only for the USA, while using conventional t-statistics critical values it was also significant for Canada and Norway.

It was therefore concluded that in these economies profit rates followed non-zero deterministic trend model with series reverting to trend after short disturbance ($\beta \neq 0$, $\gamma < 0$). With regard to other economies, coefficient of $\ln\pi_{t-1}$ was significant at 5% t-statistics critical value in France and Spain, suggesting that series in these economies reverted to historical mean ($\beta = 0$, $\gamma < 0$). In Ireland, series followed random walk with zero mean ($\beta = 0$, $\gamma = 0$).

The ADF model results fall in line with estimates of linear trend in Table 1, both in terms of significance and sign of trend. Both models suggest that profit rates in Canada and the USA deteriorated around negative deterministic trend and in Norway around positive deterministic trend. In the case of France, Ireland and Spain, ADF model confirmed the results of the linear trend model that pointed to the absence of deterministic trend and suggested either mean reversion or random walk as alternatives.

[TABLE 5]

ADF model with dummy variables (Table 5) showed that trend was statistically significant in Denmark, Greece, Portugal, Switzerland and the UK, with profit rates deteriorating by 2.33%, 2.92%, 0.83% and 1.46% per annum in Denmark, Portugal, Switzerland and the UK over the examined periods. In Greece, profit rates were increasing by 2.13% per annum over 1965-2008 period. The coefficient of $\ln\pi_{t-1}$ term was significant in Finland, New Zealand and Switzerland (using Dickey-Fuller critical values), and in Austria, Belgium, Greece, Japan, Luxembourg and Portugal (using t-statistics 5% critical value). It is thus concluded that profit rates in Greece, Portugal and Switzerland followed non-zero deterministic trend with likely reversion to trend after disturbance ($\beta \neq 0$, $\gamma < 0$). Deterministic trend was positive in Greece and negative in other two economies. Series in Austria, Belgium, Finland, Japan, Luxembourg and New Zealand were likely to revert to historical mean (β =

0, $\gamma < 0$). Profit rates in Australia, Italy, Netherlands and Sweden were following random walk with zero mean ($\beta = 0$, $\gamma = 0$), while series in Denmark and the UK were likely to follow stochastic trend (random walk with drift), as $\beta \neq 0$ but $\gamma = 0$. In both Denmark and the UK, $\beta < 0$ suggesting that profit rates were likely to decline in the future relative to the current level.

The comparison of autoregressive ADF model with linear trend model (Table 1) demonstrates similarity of results for most of the economies: Australia and Sweden (negative, but insignificant trend with series exhibiting random walk); Austria and Japan (negative but insignificant trend with series reverting to historical mean); Belgium, Finland, Italy, Luxembourg and New Zealand (positive, but insignificant trend with series reverting to historical mean or, in the case of Italy, following random walk with zero mean); Denmark and the UK (positive or negative insignificant trend with series following stochastic trend); Greece (positive and significant trend in both models); and Portugal and Switzerland (negative and significant trend in both models). For the Netherlands, results are contradictory. While linear trend model suggests statistically significant positive deterministic trend, autoregressive ADF model pointed to random walk behaviour with zero mean. The presence of certain results' inconsistencies as well as the low power of ADF test necessitated the use of unit root tests with structural breaks. Results are presented in Tables 6 and 7.

The tests were run on the log of profit rate series, allowing for a maximum of 8 lag terms. According to ZA test (models with trend, intercept, and more general model with both trend and intercept), trend stationarity hypothesis is accepted only for Canada (model with intercept), while in all other cases series were likely to contain unit root. According to LP test (with same types of models as in ZA test), trend stationary is accepted for Italy and Portugal (trend plus intercept), Spain (trend plus intercept as well as trend models), and the USA (model with intercept).

[TABLE 6]

Based on LS tests (1 or 2 breaks in series), trend stationarity with break was expected for a larger number of series, excluding France, Italy, Luxembourg, Netherlands, New Zealand, Sweden, Switzerland and the UK.

[TABLE 7]

In cases when trend stationarity was expected, the linear trend model was re-estimated with breaks suggested by ZA, LP and LS tests (in either impulse or shift form). It is born in mind that these tests are not the tests for the presence of structural break, that the inclusion of these break dates does not necessarily allow for normality (or absence of heteroscedasticity), and that break dates may not correspond to actual economic events or developments. Results of the modified linear trend model are presented in Tables 8 and 9.

Trend model with breaks from ZA and LP tests (Table 8) demonstrates that coefficient of trend was not significant in the case of Italy and Spain, thereby confirming earlier result of the absence of deterministic trend in these countries' profit rates. In contrast, trend coefficient was significant for Canada, Portugal and the USA.

[TABLE 8]

With regard to trend model with breaks from LS tests (Table 9), trend coefficients were significant for Canada, Portugal and the USA (negative trend), as well as for Greece and Norway (positive trend). This again is in concordance with the results of ADF and linear trend models.

[TABLE 9]

Conclusion

The paper attempted to contribute to empirical debate on the direction of economy-wide profit rates in the developed economies. It employed comparable national accounts data spanning the period of 5 decades. It employed a battery of econometric tests and techniques: linear trend model with autoregressive terms and dummy variables; tests for the presence of structural breaks; Augmented Dickey-Fuller (ADF) model of a general form with and without dummy variables; Zivot-Andrews (ZA), Lumsdaine-Papell (LP) and Lee-Strazicich (LS) unit root tests with structural breaks; as well as linear trend model with dummy variables based on breaks from these tests.

The results demonstrated substantial consistency across tests conducted, as well as consistency between tests and visual observation of the data. Specifically, conventional linear trend model suggested negative deterministic trend for Canada, Portugal, Switzerland and the USA, and positive deterministic trend for Greece, Netherlands and Norway. Two versions of autoregressive ADF model also demonstrated deterministic trends for these economies with the exception of Netherlands. Linear trend models based on ZA, LP and LS fully confirmed autoregressive ADF model results (with Switzerland being the exception). Other economies had non-deterministic changes in their rates of profit.

Overall, secular decline in profit rates took place in Canada, the USA and Portugal, arguably giving support to Marx's hypothesis of the tendency of the profit rate to fall along deterministic trend. For the US it confirms earlier results by Basu and Manolakos (2010). Some support of the hypothesis could have been provided for profit rates in Netherlands, but only if linear trend model is considered in isolation from other tests. Likewise, there is support of secular decline hypothesis for Switzerland, but only if results of ZA, LP and LS tests are disregarded. Secular rise in profit rates has been witnessed in Greece and Norway, and this result is in sharp contrast to the classical hypothesis. In the former case this could be attributed to rapid transformation of the economy in 1960-80s from a relatively low base; in the latter case increase in economy-wide profit could have been boosted by the growth of oil sector. In Portugal, profit rates seemed to follow a specific pattern of secular decline interrupted by crises, with rates after each crisis been lower than before it (i.e. stepwise decline).

With regard to Denmark and the UK, profit rates in these economies appear to have experienced random walk with drift, pointing to stochastic trends and long waves, thereby giving some support to hypothesis of cyclical movements in profit rates. This has to be confirmed formally by isolating cyclical component in the series. In addition, for Denmark, the stochastic trend result was obtained on series that were trimmed due to heteroscedasticity; the result contradicts visual inspection of the data, as well as LS test. Autoregressive model also points to significant and negative trend coefficient. If full series were considered, it arguably could show negative deterministic trend and thus confirm secular decline hypothesis.

For the group of economies where profit rates followed random walk with zero mean (Australia, Ireland, Italy and Sweden), the hypothesis of Kaldor-like stability/stationarity was not tested (this could have been achieved by performing ADF test with no trend). It is however possible to estimate innovation variance of the random walk component (Cochrane, 1988, p. 895) and thereby select those series with the smallest random walk component. Overall, based on tests performed we argue that profit rates in these economies give no support to either secular decline or decline with cyclical component hypotheses.

Those economies that experienced reversion of profit rates to historical means (Austria, Belgium, Finland, France, Japan, Luxembourg, New Zealand and Spain) are likely to demonstrate the case of restorative crises, where previous decline in profit rates was reversed, partially or substantially. This case neither supports nor contradicts secular decline hypothesis; more definitive conclusions would require longer series to investigate. Similar observation may be made regarding countervailing factors that are presumed to operate in medium and long-run (Shaikh, 1992).

Overall, the behavior of profit rates was rather diverse, and thus it is unlikely that "universal profit rates' laws" hold or only one hypothesis is correct.

The future research of profit rates dynamics may be pursued in the following directions. Firstly, the future analysis will have to address the wide diversity of profit rate patterns across the economies (including the economies that are supposed to demonstrate similar profit rate dynamics) as well similarities of profit rates' patterns across the economies with different political-economic and social settings. The paper pointed to some of the facts that require explanation – similar profit rates' dynamics in the closely integrated economies of Canada and the USA, but rather different dynamics in closely related economies in Europe (e.g. Belgium and Luxembourg); different profit rates directions in formerly developing economies of Portugal and Greece; similarities in profit rates' patterns in Greece and Norway. The type of analysis that would be needed would require looking at national forms of capitalism and unique constellation of factors in each economy in question. Alternatively, the analysis of a single factor (economic integration, or one of the countervailing factors, such as financialization, trade liberalization) on the rates of profit in a range of economies may be undertaken. These types of investigation would therefore allow unpacking the operation of countervailing tendencies and explain how restorative crises work through the economic system.

Secondly, while the focus of this paper has been on developed economies, an alternative research avenue could be the study of profit rates in transition and developing economies (or few remaining centrally planned economies), with a different set of factors likely to be salient and different patterns discovered. Also, the dynamics of profit rates would clearly be diverse if sectoral or industrial profit rates were considered. In this connection it would be instructive to examine profit rates in the context of structural change or sectoral re-allocation of capital. Finally, future research may be carried in "microeconomic" fashion, in line with above mentioned works by Farjoun and Machover (1983), i.e. by examining profit rates across firms, narrow industries, and by considering distributions of profit rates.

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Figure 1 - Profit rates in OECD economies

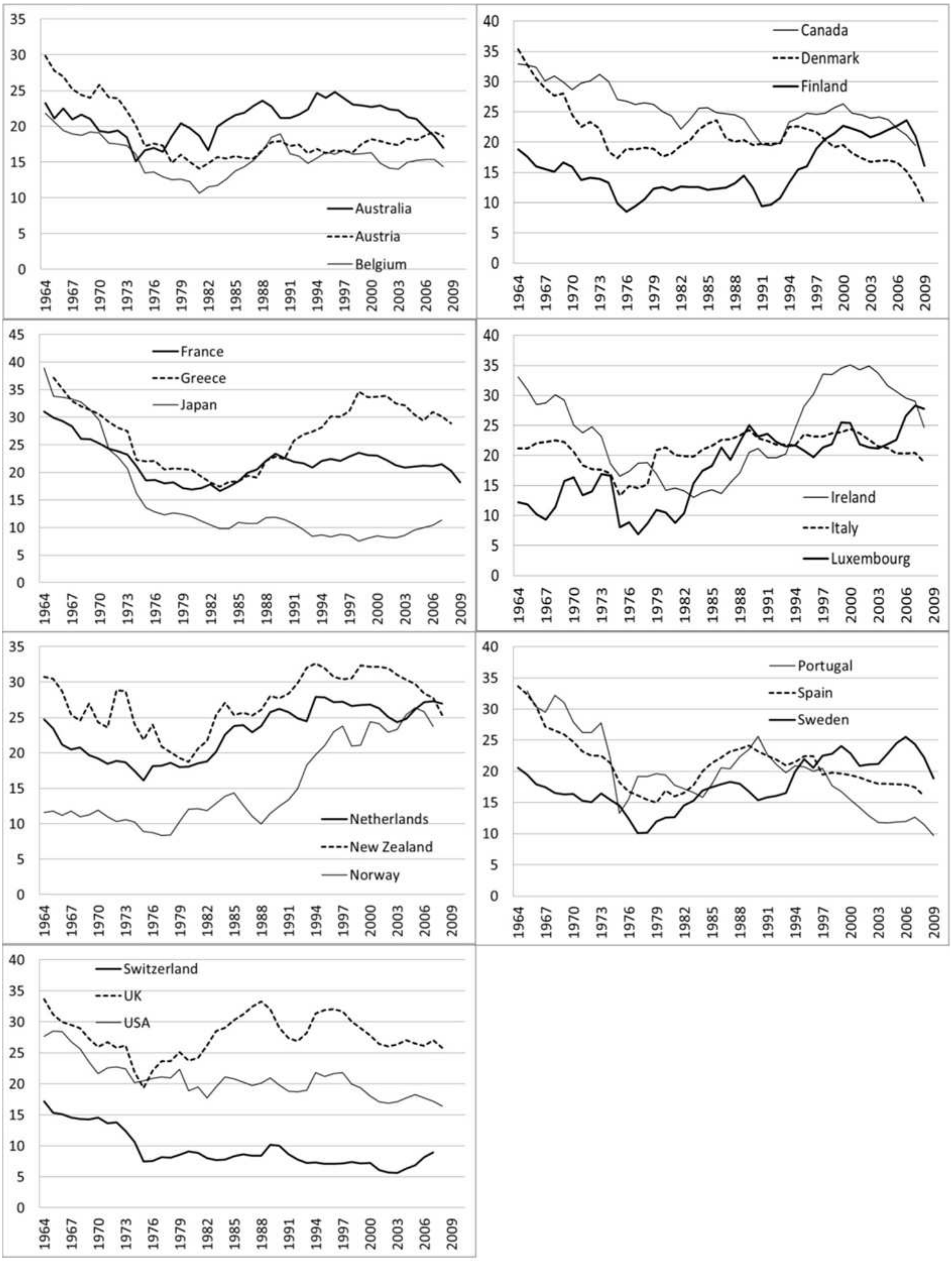

Table 1 – Linear trend regressions with AR terms

Country	Trend	Model	R^2 adj	Normality	Serial correlation	Heteroskedasticity	ARCH	Dummy variable	Dummy variable	Dummy variable date
Australia	-0.0001 (0.986)	AR(1)	0.81	0.837 (0.658)	0.231	0.137	0.356	-0.150 (0.000)	-0.149 (0.000)	D(1974=1, 1982=1)
Austria	-0.0071 (0.299)	AR(1)**	0.92	1.951 (0.377)	0.433	0.198	0.234	0.144 (0.013)		D(1 before 1978)
Belgium	0.0002 (0.969)	AR(2)	0.86	3.832 (0.147)	0.946	0.603	0.874	-0.106 (0.004)		D(1981=1)
Canada	**-0.0079** (0.003)	AR(2)	0.87	0.168 (0.919)	0.781	0.291	0.843			
Denmark*	-0.0034 (0.419)	AR(1)	0.90	0.485 (0.785)	0.199	0.870	0.776	0.157 (0.012)		D(1 before 1974)
Finland	0.0094 (0.197)	AR(2)	0.91	1.033 (0.597)	0.123	0.628	0.867	-0.114 (0.017)	-0.156 (0.009)	D(1975-76=1, 1991=1)
France	-0.0001 (0.988)	AR(2)	0.90	2.423 (0.298)	0.409	0.247	0.367			
Greece	**0.0225** (0.071)	AR(1)	0.94	2.714 (0.257)	0.323	0.188	0.604	-0.099 (0.013)		D(1974=1)
Ireland	0.0142 (0.310)	AR(2)	0.94	0.729 (0.694)	0.217	0.077	0.319			
Italy	0.0028 (0.619)	AR(2)	0.9	0.269 (0.874)	0.216	0.0304 (Huber-White)	0.580	-0.179 (0.000)	-0.176 (0.012)	D(1975=1, 1979-80=0)
Japan	-0.0262 (0.127)	AR(2)**	0.98	0.270 (0.873)	0.466	0.471	0.940	0.142 (0.026)		D(1 before 1971)
Luxembourg	0.0267 (0.223)	AR(3)	0.90	0.091 (0.956)	0.424	0.050	0.636	-0.824 (0.000)		D(1 after 1975)
Netherlands	**0.0139** (0.000)	AR(1)	0.93	3.946 (0.139)	0.184	0.549	0.471			

Table 1 – Cont.

Country	Trend	Model	R^2 adj	Normality	Serial correlation	Heteroskedasticity	ARCH	Dummy variable	Dummy variable	Dummy variable date
New Zealand	0.0077 (0.130)	AR(1)	0.80	0.515 (0.773)	0.359	0.110	0.034	-0.106 (0.052)		D(1972=0)
Norway	**0.0278** (0.000)	AR(2)	0.95	1.188 (0.552)	0.104	0.791	0.265			
Portugal	**-0.0221** (0.007)	AR(2)	0.91	0.056 (0.972)	0.551	0.070	0.207	-0.277 (0.000)		D(1975=1)
Spain	-0.0028 (0.654)	AR(2)	0.90	3.299 (0.192)	0.453	0.151	0.289			
Sweden	0.0090 (0.133)	AR(2)	0.91	0.011 (0.994)	0.910	0.536	0.741	0.123 (0.089)		D(1 after 1978)
Switzerland	**-0.0142** (0.036)	AR(2)	0.92	0.625 (0.732)	0.678	0.779	0.386	-0.137 (0.004)		D(1975=1)
UK	0.0012 (0.707)	AR(2)	0.86	2.372 (0.305)	0.952	0.003 (Huber-White)	0.674	-0.149 (0.000)		D(1974-75=1)
USA	**-0.0074** (0.003)	AR(1)	0.83	2.323 (0.313)	0.689	0.717	0.614			

Note: * Estimates performed on curtailed sample (1964-2007) using Prais-Winsten procedure. Statistically significant trend coefficients are highlighted in bold. Values in parentheses include p-values. For normality test, Jarque-Bera values and respective p-values (in parentheses) are presented. Autocorrelation and heteroscedasticity tests are Breusch-Godfrey Serial Correlation LM Test, and White test respectively. (White) stands for Huber-White heteroscedasticity-consistent standard errors that were obtained for correct interpretation coefficients in the presence of heteroscedasticity.

Table 2 – Tests of breaks and instabilities in profit rates' series

Country	Recursive residuals	N-step forecasts	Residuals	Quandt-Andrews
Australia	1974(-) 1978-9(+)	1974(-)	1974(-) 1982(-) 1983(+)	1984
Austria			1971(+) 1975(-) 1978(-)	1974
Belgium	1975(-) 1991(-)	1975(-)	1975(-) 1981(-) 1991(-)	1974
Canada	1982(-) 1994(+)		1982(-) 1983(+) 1994(+)	1976
Denmark*	1977-8(+)	1977-8(+)	1974(-) 1977-8(+) 1994(+)	1971
Finland	1974-5(-) 1997(+)	1975(-) 1997(+)	1975(-) 1990-1(-)	1997
France	1975(-) 1982(+)	2009(-)	1974-5(-) 1983(-)	1973
Greece	1974(-) 1988(+)	1974(-)	1974(-) 1988(+) 1991(+)	1993
Ireland	1974(-) 1987(+)	1974(-) 1987(+)	1974(-) 1980(-) 1994(+)	1995
Italy	1975(-) 1979(+)	1975(-)	1975(-) 1979(+)	1979
Japan	1972(+) 1985(+)		1971(-) 1974(-) 1985(+)	1974
Luxembourg	1975(-) 1977(-)	1975(-)	1969(+) 1975(-) 1977(-)	1984
Netherlands	1976(+) 1994(+)		1974-5(-) 1976(+) 1994(+)	1984
New Zealand	1972(+) 1983(+)	1972(+) 1983(+)	1969(+) 1972(+) 1974(-)	1989
Norway	1975(-) 1979(+)		1975(-) 1979(+) 1986(-)	1993
Portugal	1974-5(-)		1974-5(-)	2000
Spain	1980(+) 1997(-)	1980(+)	1980(+) 1981(-) 1997(-)	1971
Sweden	1973(+) 1976-7(-) 1982(+)		1973(+) 1976-7(-) 1982(+)	1994
Switzerland	1976(+) 1989(+)	1975(-1)	1975(-) 1989(+) 2001(-)	1975
UK	1974(-) 1978-9(+)		1972-5(-) 1976(+)	1983
USA	1971(+) 1980(-) 1994(+)		1980(-) 1982(-) 1994(+)	1970

Note: * Estimates performed on curtailed sample (1964-2007).

Table 3 – Dummy variables in autoregressive ADF model

Country	Dummy variables	Country	Dummy variables
Australia	1974=1 1983=0	Luxembourg	1975=1 1977=1 1981=1
Austria	1975=1 1978=1	Netherlands	1975=1 1994=0
Belgium	1975=1 1991=1	New Zealand	1972=0 1983=0
Canada	1982=1	Norway	1975=1
Denmark*	1974=1	Portugal	1975=1
Finland	1975=1 1990-1=1 1997=1	Spain	1997=1
France	1975=1	Sweden	1976-7=1
Greece	1974=1 1988=0 1991=0	Switzerland	1975=1
Ireland	1974=1	UK	1972-5=1
Italy	1975=1 1979=0	USA	1980=1
Japan	No dummies		

Note: * Estimates performed on curtailed sample (1964-2007).

Table 4 – Results of autoregressive ADF estimation with no dummy variables

Country	Constant	t	$ln\pi_{t-1}$	$\Delta ln\pi_{t-1}$	$\Delta ln\pi_{t-2}$	R^2_{adj}	Serial correlation	Heteroscedasticity	ARCH	Normality	Trend (%)
Canada	0.767	-0.0018	-0.227	0.417		0.18	0.781	0.291	0.843	0.168	-0.79
	(0.011)	(0.042)	***(-2.718)***	(0.008)						(0.919)	
France	0.278	0.0000	-0.093	0.355		0.15	0.409	0.247	0.367	2.423	X
	(0.065)	(0.988)	***(-1.998)***	(0.026)						(0.298)	
Ireland	0.183	0.0013	-0.070	0.518	-0.207	0.20	0.343	0.241	0.268	0.299	X
	(0.163)	(0.271)	(-1.607)	(0.003)	(0.217)					(0.861)	
Norway	0.370	0.0049	-0.178	0.410		0.21	0.104	0.791	0.265	1.189	2.78
	(0.012)	(0.014)	***(-2.692)***	(0.008)						(0.552)	
Spain	0.326	-0.0003	-0.109	0.364		0.18	0.453	0.151	0.289	3.299	X
	(0.045)	(0.675)	***(-2.203)***	(0.017)						(0.192)	
USA	1.390	-0.0030	-0.441	0.123	0.234	0.21	0.950	0.934	0.496	4.000	-0.67
	(0.001)	(0.013)	**(-3.742)**	(0.415)	(0.123)					(0.136)	

Note: Estimates for Denmark were obtained on a curtailed sample. Values in parentheses include p-values and t-ratios (indicated in bold for $ln\pi_{t-1}$ term). For normality test, Jarque-Bera values and respective p-values (in parentheses) are presented. Autocorrelation and heteroscedasticity tests are Breusch-Godfrey Serial Correlation LM Test, and White test respectively.

Table 5 – Results of autoregressive ADF estimation with dummy variables

Country	Constant	t	$\ln\pi_{t-1}$	$\Delta\ln\pi_{t-1}$	Dummy1	Dummy2	Dummy timing	R^2_{adj}	Serial correlation	Heteroscedasticity	ARCH	Normality	Trend (%)
Australia	0.319	-0.0005	-0.103	0.079	-0.213	0.170	D (1974=1)	0.36	0.357	0.188	0.857	0.127	X
	(0.225)	(0.552)	(-1.177)	(0.557)	(0.001)	(0.006)	D (1983=1)					(0.938)	
Austria	0.267	0.0005	-0.098	-0.153	-0.149	-0.149	D (1975=1)	0.41	0.342	0.837	0.696	0.651	X
	(0.059)	(0.450)	***(-2.219)***	(0.246)	(0.002)	(0.002)	D (1978=1)					(0.722)	
Belgium	0.253	6.1E-05	-0.093	0.220	-0.160	-0.144	D (1975=1)	0.32	0.908	0.693	0.445	4.007	X
	(0.110)	(0.931)	(-1.696)	(0.106)	(0.006)	(0.013)	D (1991=1)					(0.135)	
Denmark*	0.295	-0.0019	-0.083	0.191	-0.065		D (0 from 1975)	0.17	0.102	0.422	0.232	1.521	-2.33
	(0.273)	(0.069)	(-0.959)	(0.222)	(0.101)							(0.467)	
Finland	0.466	0.0018	-0.184	0.465	-0.285	-0.239	D(1975=1)	0.61	0.955	0.027	0.298	2.520	X
	(0.000)	(0.132)	**(-4.739)**	(0.001)	(0.000)	(0.000)	D(1990-1=1)			(Huber-White)		(0.284)	
Greece	0.502	0.0040	-0.188	0.077	0.096		D (0 from 1974)	0.15	0.157	0.108	0.617	0.469	2.13
	(0.011)	(0.011)	***(-2.837)***	(0.622)	(0.051)							(0.791)	
Italy	0.578	0.0001	-0.097	0.032	-0.261	-0.290	D (1975=1)	0.66	0.116	0.176	0.869	0.531	X
	(0.001)	(0.824)	(-1.650)	(0.744)	(0.000)	(0.000)	D (1979=0)					(0.767)	
Japan	0.403	-0.0004	-0.171	0.408	0.129		D (0 from 1974)	0.35	0.743	0.733	0.465	1.169	X
	(0.114)	(0.849)	***(-2.030)***	(0.013)	(0.056)							(0.557)	
Luxembourg	0.616	0.0029	-0.222	0.192	-0.697	-0.675	D (1975=1)	0.67	0.588	0.022	0.821	0.099	X
	(0.003)	(0.195)	***(-2.710)***	(0.031)	(0.000)	(0.000)	D (1977=1)			(Huber-White)		(0.951)	
Netherlands	0.215	-0.0002	-0.084	0.105	0.071		D (1 from 1976)	0.24	0.826	0.772	0.675	1.985	X
	(0.334)	(0.881)	(-1.106)	(0.473)	(0.010)							(0.371)	
New Zealand	0.849	0.0019	-0.166	0.163	-0.226	-0.132	D (1972=0)	0.33	0.883	0.100	0.395	0.746	1.12
	(0.001)	(0.046)	***(-2.165)***	(0.229)	(0.001)	(0.046)	D (1983=0)					(0.689)	
Portugal	0.637	-0.0052	-0.177	0.195	-0.371		D (1974-5=1)	0.53	0.774	0.130	0.132	2.228	-2.92
	(0.008)	(0.002)	***(-2.645)***	(0.094)	(0.000)							(0.329)	
Sweden	0.172	-0.0016	-0.072	0.345	0.097		D (1 from 1978)	0.30	0.816	0.264	0.512	0.948	X
	(0.445)	(0.487)	(-0.856)	(0.029)	(0.069)							(0.622)	
Switzerland	1.053	-0.0039	-0.462	0.545	0.176		D (0 from 1975)	0.32	0.481	0.575	0.704	4.697	-0.83
	(0.001)	(0.067)	**(-3.607)**	(0.001)	(0.010)							(0.095)	
UK	0.386	-0.0018	-0.125	0.175	0.088		D (1 from 1976)	0.30	0.102	0.178	0.628	5.195	-1.46
	(0.106)	(0.069)	(-1.779)	(0.235)	(0.005)							(0.074)	

Note: Estimates for Denmark were obtained on a curtailed sample. Values in parentheses include p-values and t-ratios (indicated in bold for $\ln\pi_{t-1}$ term). For normality test, Jarque-Bera values and respective p-values (in parentheses) are presented. Autocorrelation and heteroscedasticity tests are Breusch-Godfrey Serial Correlation LM Test, and White test respectively.

Table 6 – Results of Zivot-Andrews and Lumsdaine-Papell unit root tests with structural breaks

	A. Zivot-Andrews test						B. Lumsdaine-Papell test					
Country	Trend + Intercept		Trend		Intercept		Trend + Intercept		Trend		Intercept	
Australia	-2.874	0	-2.921	0	-3.428	0	-4.596	0	-4.504	0	-4.056	0
Austria	-4.746	0	-4.427	0	-4.418	0	-5.498	0	-5.704	0	-4.700	0
Belgium	-3.590	1	-2.737	1	-3.193	1	-5.410	1	-5.909	1	-4.893	1
Canada	-3.684	1	-2.984	1	**-4.855**	1	-5.729	5	-5.113	5	-4.957	5
Denmark*	-2.892	1	-2.731	1	-3.417	1	-5.500	3	-4.885	3	-4.176	3
Finland	-3.796	1	-3.599	1	-4.100	1	-5.499	1	-4.112	1	-5.580	1
France	-2.340	1	-2.280	1	-3.364	1	-4.202	1	-4.107	1	-4.363	1
Greece	-2.497	3	-3.236	3	-3.607	3	-5.034	3	-5.661	3	-3.518	3
Ireland	-2.513	5	-2.489	5	-4.075	5	-4.893	5	-4.52	5	-5.332	5
Italy	-4.711	0	-2.187	0	-3.097	0	**-6.805**	0	-4.47	0	-4.974	0
Japan	-2.918	1	-2.914	1	-2.169	1	-5.267	1	-4.881	1	-3.500	1
Luxembourg	-4.077	0	-2.676	0	-3.804	0	-5.610	6	-5.696	6	-3.734	6
Netherlands	-3.807	8	-3.602	8	-4.407	8	-5.614	8	-4.883	8	-5.508	8
New Zealand	-2.821	1	-2.765	1	-3.233	1	-6.128	1	-4.67	1	-4.374	1
Norway	-2.398	7	-2.781	7	-2.984	7	-3.626	7	-3.306	7	-4.006	7
Portugal	-3.020	2	-2.281	2	-3.357	2	**-6.758**	1	-5.534	1	-4.657	1
Spain	-3.048	4	-3.051	4	-3.861	4	**-9.203**	4	**-6.432**	4	-4.963	4
Sweden	-3.945	1	-3.560	1	-3.946	1	-5.443	1	-4.379	1	-4.637	1
Switzerland	-4.107	1	-3.901	1	-4.114	1	-5.395	1	-4.198	1	-4.330	1
UK	-3.804	1	-2.943	1	-4.050	1	-4.435	5	-4.858	5	-3.998	5
USA	-4.672	2	-3.864	2	-4.385	2	-5.953	2	-5.481	2	**-6.036**	2

Note: * Estimates performed on curtailed sample (1964-2007). Identified break dates are – 1994 for Canada, 1978 and 2001 for Italy, 1973 and 1993 for Portugal, 1980, 1989 and 1990 for Spain, and 1983 and 1993 for the USA. Values in bold indicate trend stationarity with break(s).

Table 7 – Results of Lee-Strazicich unit root tests with structural breaks

Country	Lee-Strazicich (2004)		Lee-Strazicich (2003)		Country	Lee-Strazicich (2004)		Lee-Strazicich (2003)	
Australia	-2.679	8	**-5.641**	8	Luxembourg	-4.116	6	-5.524	1
Austria	**-5.762**	7	**-6.322**	7	Netherlands	-4.017	8	-4.871	6
Belgium	-3.729	6	**-6.565**	5	New Zealand	-3.641	4	-5.323	1
Canada	-4.104	5	**-5.772**	5	Norway	-4.296	6	**-6.009**	6
Denmark*	-2.986	6	**-6.149**	8	Portugal	**-4.683**	1	**-7.395**	6
Finland	**-4.641**	1	-5.306	1	Spain	-2.835	4	**-5.775**	1
France	-3.389	6	-4.310	1	Sweden	-4.072	3	-4.969	1
Greece	-3.504	8	**-7.163**	5	Switzerland	-3.554	1	-5.305	4
Ireland	-3.760	5	**-6.303**	1	UK	-2.965	5	-5.133	6
Italy	-3.960	3	-5.304	7	USA	-3.653	2	**-7.277**	6
Japan	-3.357	3	**-6.117**	5					

Note: * Estimates performed on curtailed sample (1964-2007). Values in bold indicate trend stationarity with break(s).

Table 8 – Linear trend regressions with ZA and LP dummy variables

Country	Constant	Trend	Dummy variable	Dummy 1	Dummy 2	Model	R^2_{adj}	Normality	Serial correlation	Heteroscedasticity	ARCH
Canada	3.397	-0.0081	D (1994=1)	0.065		AR(2), ZA	0.89	0.461	0.998	0.560	0.244
	0.000	0.003		0.016				0.794			
Canada	3.385	-0.0071	D (1 from 1994)	-0.027		AR(2), ZA	0.87	0.247	0.851	0.615	0.944
	0.000	0.029		0.605				0.884			
Italy	2.796	-0.0029	D (1 from 1978)	0.324	0.047	AR(1), LP	0.85	138.184	0.566	0.821	0.671
	0.000	0.618	D (0 from 2002)	0.000	0.440			0.000			
Italy	2.909	-0.0046	D (1 from 1978)	0.291	-0.179	AR(2), LP	0.93	0.666	0.711	0.639	0.266
	0.000	0.298	D (1975=1)	0.000	0.000			0.717			
Portugal	3.413	-0.0221	D (1975=1)	-0.277		AR(2), LP	0.91	0.056	0.551	0.070	0.207
	0.000	0.007		0.000				0.972			
Portugal	3.532	-0.0256	D (1975=1)	-0.335	-0.082	AR(1), LP	0.91	0.016	0.171	0.099	0.003
	0.000	0.029	D (0 after 1993)	0.000	0.408			0.992			
Spain	3.003	0.0002	D (1 from 1980)	-0.116	0.030	AR(2), LP	0.91	4.685	0.157	0.083	0.615
	0.000	0.975	D (0 after 1989)	0.023	0.530			0.096			
Spain	3.052	-0.0010	D (1 from 1980)	-0.115	-0.003	AR(2), LP	0.91	4.054	0.165	0.056	0.641
	0.000	0.889	D (0 from 1990)	0.026	0.943			0.132			
USA	3.278	-0.0178	D (1 after 1983)	0.142	0.168	AR(1), LP	0.87	0.732	0.336	0.081	0.226
	0.000	0.000	D (1 after 1993)	0.003	0.000			0.693			

Table 9 – Linear trend regressions with LS dummy variables

Country	Constant	Trend	Dummy variable	Dummy 1	Dummy 2	Model	R2adj	Normality	Serial correlation	Heteroscedasticity
Australia	2.934	0.0020	D (1 in 1981)	0.028	-0.029	AR(1), LS 2003	0.67	4.446	0.714	0.474
	0.000	0.711	D (1 in 1993)	0.597	0.581			0.108		
Austria	2.459	0.0099	D (1 in 1986)	-0.006	0.042	AR(1), LS 2003	0.91	3.071	0.901	0.156
	0.000	0.457	D (1 in 1992)	0.866	0.279			0.215		
Austria	2.481	0.0094	D (1 after 1986)	-0.007		AR(1), LS 2004	0.91	2.962	0.843	0.083
	0.000	0.461		0.866				0.227		
Belgium	2.541	0.0039	D (1 in 1979)	0.018	-0.011	AR(1), LS 2003	0.84	5.064	0.193	0.728
	0.000	0.610	D (1 in 1987)	0.707	0.814			0.079		
Canada	3.397	-0.0080	D (1 in 1986)	-0.015	0.036	AR(2), LS 2003	0.87	0.198	0.752	0.481
	0.000	0.003	D (1 in 2000)	0.611	0.219			0.906		
Denmark*	3.075	-0.0055	D (1 in 1982)	0.014	0.025	AR(1), LS 2003	0.88	3.286	0.104	0.896
	0.000	0.269	D (1 in 1997)	0.764	0.589			0.193		
Finland	2.329	0.0106	D (0 in 1996)	0.076		AR(2), LS 2004	0.89	13.488	0.172	0.688
	0.000	0.139		0.156				0.001		
Greece	2.389	0.0247	D (1 after 1982)	-0.041	0.046	AR(1), LS 2003	0.93	10.692	0.671	0.162
	0.000	0.063	D (0 after 1998)	0.504	0.458			0.005		
Ireland	2.684	0.0113	D (1 after 1983)	0.078	-0.029	AR(2), LS 2003	0.94	0.561	0.247	0.098
	0.000	0.439	D (1 in 1998)	0.320	0.537			0.755		
Japan	3.472	-0.0290	D (1 in 1983)	-0.011	0.017	AR(2), LS 2003	0.98	0.645	0.787	0.181
	0.000	0.153	D (1 in 1996)	0.785	0.662			0.725		
Norway	2.015	0.0279	D (1 in 1982)	-0.042	-0.049	AR(2), LS 2003	0.95	0.581	0.166	0.302
	0.000	0.000	D (1 in 1998)	0.384	0.318			0.748		
Portugal	3.552	-0.0270	D (1 after 1983)	0.075	-0.150	AR(1), LS 2003	0.86	150.679	0.106	0.975
	0.000	0.002	D (0 after 1989)	0.537	0.268			0.000		
Portugal	3.433	-0.0202	D (0 in 1986)	-0.070		AR(2), LS 2004	0.86	76.358	0.137	0.238
	0.000	0.005		0.352				0.000		
Spain	3.035	-0.0083	D (1 in 1986)	0.168	-0.010	AR(2), LS 2003	0.93	7.683	0.691	0.191
	0.000	0.163	D (1 after 1979)	0.000	0.698			0.021		
USA	3.154	-0.0075	D (1 in 1978)	-0.037	0.019	AR(1), LS 2003	0.82	3.096	0.568	0.947
	0.000	0.005	D (0 in 1995)	0.401	0.677			0.212		