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Testing for the existence of a bubble in the stock market

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Abstract

Are specific developments in stock prices in line with fundamentals or do they reflect a rising bubble? And if the latter result applies, how is it possible to detect a bubble in real time? The answer to this question is of utmost relevance for a number of areas, not least for either financial market participants or for central banks aiming at pursuing a policy of "leaning against the wind". In this study, we make use of a sample of 17 OECD industrialised countries and the euro area over the sample period 1969 Q1 – 2008 Q3 and carry out univariate and multivariate panel tests to find evidence of bubbles in the stock market of those countries over the past four decades.

Non-technical summary

Can stock price bubbles be detected? And can they be detected in real time? The answers to these questions are of utmost relevance for a number of areas, not least for the issue of whether central banks can pursue a policy of "leaning against the wind". This paper contributes to the literature on this topic by trying to detect asset prices misalignments (bubbles) by focusing on the evidence stemming from a sample of 17 OECD industrialised countries and the euro area over the sample period 1969 Q1 – 2008 Q3.

Concentrating in particular on the stock market, univariate panel tests and cointegration analysis are carried out and lead to the conclusion that the no-bubble hypothesis can be rejected in each country on the basis of the univariate tests but not on the basis of the multivariate tests. Insofar, our results do not provide a clear-cut answer and require some further analysis.

Content

1 Introduction

Economists often use the expression "bubble" to describe an asset price that is not in line with the level justified by economic fundamentals. As a matter of fact, several dramatic rises in stock prices seem to have occurred throughout history in various countries and periods and have accordingly been described as bubbles. This study applies some empirical tests attempting to identify these bubbles in the stock market in a number of industrialized countries.

There exist a large number of papers trying to detect "rational" bubbles. For instance, equity prices contain a rational bubble if investors are paying more for the stock than the value they know would be justified on the basis of the value of the discounted dividend payments. This happens because investors expect to be able to sell the stocks at a higher price in the future. The pricing of the stock is still rational, and there are no arbitrage opportunities. The model is derived from a utility maximization problem (Gurkaynak 2008).

Testing for bubbles is essentially testing the validity of the traditional stock market valuation model. Most approaches follow the approach of Diba and Grossman (1987, 1988), who propose the use of unit root and cointegration tests for stock prices and observable fundamentals. If the stock prices are not behaving in a more explosive way than dividends do, then rational bubbles do not exist. In the absence of bubbles, dividends determine the stationarity property of the stock prices. If dividends and stock prices are integrated (of order one) series and if rational bubbles do not exist, then stock prices and dividends are cointegrated (Cerqueti and Costantini 2006).

Most results are based on individual country analysis and cross-country studies are very rare. One exception is represented by the work of Herrera and Perry (2003) who investigate the existence of stock price bubbles in Latin America in the period 1980-2001 relying on the model of Campbell, Lo and MacKinlay (1997). Cerqueti and Costantini (2006) follow a similar approach and analyse the existence of rational bubbles for an international panel of nine countries over the sample period 1991-2006.

Our paper makes a contribution to the existing literature in several respects. Firstly, the time and cross-section dimensions are extended to at most the period of four decades (from 1970 to 2008) and to 18 countries. Secondly, a time series approach and a panel approach are applied. The use of panel data is generally considered as a mean to generating more powerful tests and it improves the power of univariate procedures.

This paper is structured as follows. Section 0 starts by reviewing some theoretical issues related to stock market valuation and bubbles identification. Section 0 proceeds by discussing the data underlying the empirical part while Section 0 reports the results of the empirical analysis. In particular, the latter focuses on tests for the evidence of bubbles in some OECD countries in a univariate and multivariate context. Section **Fehler! Verweisquelle konnte**

nicht gefunden werden. draws some conclusions.

2 Literature Review

2.1 Stock prices and their determinants: some general considerations

For the stock market to fulfil its economic functions sufficiently well, equity prices must not deviate systematically from their "fundamental" value. This value usually depends on the future stream of income that firms are expected to generate. If equity prices fully reflect all the available information that is relevant for valuing stocks, they are said to meet the efficiency condition (Campbell et. al. 1997). If the latter condition is not met, stock prices might convey the wrong signals to market participants about the true profitability and risks of certain companies or even of the stock market as a whole, thus leading to an inefficient allocation of capital in the economy.

In order to determine such a fundamental value, an approach to value stocks would have to be derived and possible sources of market inefficiencies would need to be developed. On a general basis, financial assets are valued according to the discounted present value of the future cash flow that investors expect to derive from holding the asset. The discount rates applied to future cash flows are the expected rates of return that investors demand for holding the asset in their portfolios. Applied to the theory of the valuation of shares, the discounted cash flow method corresponds to the dividend discount model (Balke and Wohar 2001 as well as Campbell et. al. 1997).

If stock prices are efficient, they will equal the discounted present value of (rationally) expected future dividends. In this context, the discount rates can be broken down into a measure of "opportunity costs" (which are the returns expected on investing in assets other than stocks), and a corresponding equity-specific risk premium, which is in essence related to the degree of riskiness of an asset as perceived by investors. As stocks are widely seen to be riskier than, for example, government bonds or bank deposits, investors demand a correspondingly higher expected rate of return for holding stocks. In fact, the results in the empirical literature generally support the view of a positive equity (risk) premium, the latter being for instance approximated by the long-term average of the margins between the observed returns on stocks and the one on either long-term bonds or short-term bank deposits (Bailey et. al. 1999).

The main conclusion drawn from the dividend discount model is that stock prices are by their very nature forward-looking. If it is further assumed that current stock prices embody all relevant information available to the investor, it follows that changes in stock prices are mainly driven by "news", i.e. by incoming information that leads market participants to revise their expectations about stock fundamentals.

As regards the identification of possible sources of stock market "inefficiency", the fact that stock price fundamentals are not directly observable implies that any assessment of whether stocks are efficiently priced requires a judgement as to whether investors' expectations about future dividends, interest rates and stock market risks are justifiable and correctly reflected in stock prices. In general, such an assessment can be based on both empirical and theoretical arguments.

From a theoretical perspective, the hypothesis of market efficiency rests on the assumption that investors have an incentive to make use of all available information when deciding at which price to sell or buy stocks. Even if investors do not all use the available information in a rational way, it can be assumed that an effective arbitrage mechanism is at work and ensures that rational investors push securities prices sufficiently close to their fundamental values (see Campbell et. al.).

This arbitrage mechanism would generally work in a way that rational investors would sell (or sell short) an "overpriced" security in one market and simultaneously buy the same asset or a security with the same pay-off structure as a hedge in another market where it is correctly priced or "underpriced". As a consequence, the prices on the two different markets can be expected to balance out quickly at the fundamentally justified level. In the real world, however, arbitrage activities might not be as powerful as just described, due for instance to the fact that perfect substitutes for stocks are usually not available and that arbitrageurs might be confronted with borrowing constraints and short-term investment horizons.

However, limited arbitrage *per se* is by no means sufficient to create market inefficiencies. It has to be compounded by some form of irrational behaviour on the part of at least some investors (investor sentiment). Theories of "investor sentiment" – based on evidence from experimental studies and psychological theories about belief formation – try to explain the motives behind investors behaving in a way that drives prices away from fundamentals. Most of them can be subsumed under "overreaction" and "positive feedback trading". Overreaction refers to the situation where, after a series of positive earnings news, investors become overly optimistic about future earnings announcements and dividend expectations, thus driving stock prices up to excessively high levels. Positive feedback investors instead buy stocks after prices rise with the expectation that observed price increases will continue, with the result that stock prices may in fact increase further on account of higher demand, thus giving rise to further expectations of future price rises (ECB 2002).

These theories lead to another distinction regarding the source of a possible bubble. On the one hand, a bubble could emerge from overreacting investors ("intrinsic bubbles") (Froot and Obstfeld 1991), while on the other hand, bubbles could result from positive feedback trading, whereby self-fulfilling expectations must be seen as the main driving force behind a bubble that feeds itself once triggered by some extraneous event ("extrinsic bubbles") (ECB 2003). Taken together, imperfections in real-world capital markets, combined with the potential threat of irrationality on the part of some investors, imply that the efficiency of stock prices remains an empirical question. However, the empirical evidence with regard to the efficiency of stock prices remains at best ambiguous, varying according to the selected theoretical framework and the applied empirical methodology. As the fundamental value of stocks is not directly observable, it is impossible to decide with certainty whether stocks are efficiently priced at a specific point in time or not. A commonly used tool to assess the level of stock prices is to put stock valuation ratios, such as the dividend yield and price-earnings ratio, in a historical context. This is based on the idea that these valuation ratios should, over time, eventually revert to some long-run equilibrium level. Statistically, historical comparisons can be carried out in two ways. A simple method consists of comparing current valuation ratios with historical averages. Alternatively, a long-run equilibrium relationship between stock market valuation ratios and, for example, real interest rates and potential output growth (as a rough measure of long-term dividend growth) can be estimated, allowing the long-run equilibrium to vary over time. For both methods a stock market over- or undervaluation might be indicated when current valuation ratios are considerably out of line with the estimated long-run equilibrium level.

It should be kept in mind that, however, neither of the two approaches can provide a sufficient proof of a stock market bubble.[1] Hence, historical comparisons cannot solve the problem of diagnosing bubbles with an adequate degree of certainty. They can only provide some weak indications of periodic market excesses pushing valuation ratios far beyond thresholds set by historical patterns.

2.2 Theoretical and model-based considerations on detecting stock price bubbles

Attempts to identify an asset price bubble in real time have a long-standing tradition in economics and econometrics. While recent studies have mostly focused on the (purely) statistical criterion of the deviation of an asset price indicator exceeding a certain threshold when compared to an underlying development (such as, for instance, a one-sided trend or filter), it has become

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1 For example, extraordinarily high price-earnings ratios may be justified by correct expectations of extraordinary growth of corporate earnings over an extended future period of time. In this case, the initially high price-earnings ratio would be expected to decline towards its long-run average over time, driven mainly by the materialisation of earnings expectations, and not because they would reflect sharp drops in stock prices caused by the bursting of a bubble.

evident that some several possibilities of defining an asset prices bubble and its burst remain which differ according either to the indicator used (such as, for instance, stock price index, house price index or a composite indicator of the two) or to the threshold beyond which an asset price development can be defined as being "excessive". However, the definition and/or detection of asset price bubbles have in the literature also been discussed on the basis of more theoretical grounds. For instance, in his paper, Filardo (2004) defines an asset price bubble a situation in which "*an asset price tends to grow persistently out of line with fundamentals, often in a frothy way, and tends to end unexpectedly with a sharp correction*". He also mentions that an asset price could be related to situations of persistent undervaluations and overvaluations. Therefore, in his view the analysis should focus on a bubble's size, and in particular an asset price bubble should be huge enough to affect macroeconomic variables which are relevant for monetary policy decisions. This definition is in line with Kindleberger (1978), who stated that "*a bubble is an upward price movement over an extended range that then implodes*". Shiller (2005) gives a more precise definition, according to which "*a speculative bubble* [is] *a situation in which news of price increases spur investor enthusiasm, which spreads by psychological contagion from person to person, in the process amplifying stories that might justify the price increases and bringing in a larger and larger class of investors, who, despite doubts about the real value of an investment, are drawn to its partly through envy of others successes and partly through a gambler's excitement*". This definition has a strong psychological basis which is relevant for Shiller to explain speculative bubbles. Simon (2003) instead states that "*a bubble is an asset market event where prices rise, potentially with justification, rise further on the back of speculation, and then fall dramatically for no clear reason when the speculation collapses*".

With respect to the "intrinsic bubbles" the integration/cointegration test strategy relies on the property that the bubble and the fundamentals diverge at an explosive rate. Froot and Obstfeld (1991) suggest a model for the stock prices, fundamental prices and bubble process, which is represented by the following:

(1) $$P_t = \left(\frac{1}{1+r}\right) E_t(D_t + P_{t+1})$$

(2) $$P_t^{PV} = \sum_{j=1}^{\infty} \left(\frac{1}{1+r}\right)^j E_t(D_{t+j})$$

(3) $$B_t = \left(\frac{1}{1+r}\right) E_t(B_{t+1}).$$

To tie the bubble to fundamentals, dividends should be explicitly modelled. Froot and Obstfeld suggest that (log) dividends follow a random walk with drift:

(4) $d_t = \nu + d_{t-1} + \xi_t$,

where $\xi_t = N(0, \sigma^2)$. They show that the bubble process is of the form:

(5) $B(D_t) = cD_t^{\lambda}$

where λ is the positive root of $\lambda^2\sigma^2/2 + \lambda\nu - \ln(1+r) = 0$ and c is an arbitrary positive constant. This bubble process depends on the level of dividends and does not take off on its own. If such a bubble is present, stock prices will be more sensitive to dividends innovations than is justified by the linear pricing equation. The fundamental price is equal to:

(6) $P_t^{PV} = \kappa D_t$,

where $\kappa = \dfrac{e^{(\nu+\sigma^2/2-\ln(1+r))}}{(1+r)-e^{(\nu+\sigma^2/2)}}$, r is the return on stocks over the whole sample period and period and ν, σ are the trend growth rate of (log) dividends and the standard deviation of the residuals of an AR(1) process describing the dividends (eq.4). Since the error term for d_t is normal, D_t is log-normal and its mean includes its variance. Under the null hypothesis of no intrinsic bubble, prices are a linear function of dividends and the price dividend ratio is a constant. If the intrinsic bubble exists, it implies a nonlinear relation between stock prices and dividends. In this case, the price/dividend ratio is:

(7) $\dfrac{P_t}{D_t} = \kappa + cD_t^{\lambda-1} + \iota_t$,

where ι_t is a well-behaved AR(1) error term. The bubble test strategy is conducted by running regressions of price/dividend ratios on a constant and dividends. Not finding any significant coefficient except for the constant in these regressions will indicate lack of bubbles, while finding a nonlinear relationship between prices and dividends will be interpreted as signalling the presence of an intrinsic bubble. Similar work along these lines has also been carried out by Lamont (1998), Balke and Wohan (2002) and Bohl and Siklos (2004).

Other studies have argued that the price-dividend ratio exhibits fractional integration such that while it is characterised by long memory, the series is ultimately mean-reverting (Caporale and Gil-Alana 2004; Cuñado et al. 2005; Koustas and Serletis 2005). It is worth noting, however, that the majority of these studies have focused on the US stock market.

Studies that have focused on more than just one country include, for instance, Brooks and Katsaris (2003) who focus in the UK, Kanas (2005) who seems to find non-linear dynamics in the price-dividend relationship for Germany, Japan, the UK and the US and Kapetanios et al. (2006) who focus on the behaviour between prices an dividends for eleven major industrial countries.

Along the same lines, Herrera and Perry (2003) apply the Self-Exciting Threshold Autoregression (SETAR) mechanism of Potter (1995) to determine the number of bubbles in some countries. They determine the bubble component as the difference between the observed price and P^{PV}. Furthermore, they use the price dividend ratio equation with a linear time trend:

$$(8) \quad \frac{P_t}{D_t} = c_1 + c_2 D_t^{\lambda_1 - 1} + c_3 D_t^{\lambda_2 - 1} + c_4 X + \iota_t,$$

where *X* is a linear term on dividends or a linear time trend. The parameters λ_1, λ_2 are the positive and negative roots of the dynamic system $\lambda^2 \sigma^2 / 2 + \lambda \nu - \ln(1 + r) = 0$. They also present an approach to estimate the number of crashes. They construct an auxiliary variable, defined as the ratio of the stock market price to the maximum value of the series up to that time, to show its evolution and determine crash periods. This variable takes values between zero and unity. When the stock price index falls below a certain value (such as, for instance, 35%) relative to the historical maximum, this situation is determined as a crash. Another possible definition of a crash is the one used by Mishkin and White (2003) who define a crash as a fall in the price of a security or an index below a certain threshold (for example, 20%) per day, per week, per month or in a year. In addition, the interest rate spread of highly rated assets and of asset having a speculative grade are considered to characterise the crash periods.

3 The data set

The present study analyses the properties of stock prices (represented by the share prices indices) on an individual basis and in conjunction with the price/earnings ratio and the dividend yields. The main sources of the series are the BIS, DataStream, Euro area wide model (AWM), the European Central Bank (both official and internal databases), Eurostat, Global Financial Data, IMF International Financial Statistics, the respective National Central Banks for each country, OECD Main Economic Indicators and Economic Outlook and Reuters. A detailed description of the series used in the analysis is contained in a more recent work analysing the role of money and credit for asset price misalignments.[2]

The dataset used for the analysis consists of quarterly data collected for 17 main industrial economies (plus the euro area as a whole) and spans over more than three decades, starting in 1969 Q1 and ending in 2008 Q3.[3] The countries considered in the sample set are the following: Australia (AU), Canada (CA), Denmark (DK), the euro area (EA), France (FR), Germany (DE), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), New Zealand

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2 See Gerdesmeier, Reimers and Roffia (2009); in particular Annex 3.

3 For a few variables in some counties the starting point may be slightly later (see the same Annex 3 of the paper mentioned above for more detail on the starting date for each series for each country).

(NZ), Norway (NO), Portugal (PT), Spain (ES), Sweden (SE), Switzerland (CH), the United Kingdom (UK) and the United States (US). In the following section we focus on testing for the evidence of a bubble in these countries on the basis of univariate and multivariate analyses.

4 Testing for the evidence of bubbles

4.1 Univariate panel tests

There are several methods to detect asset price bubbles.[4] In this subsection we concentrate on integration (univariate) and cointegration (multivariate) based tests, following the test strategy of Herrera and Perry (2003). In the empirical tests, a bubble (*B*) is defined as the difference between the fundamentals determined price (P^{PV}) and the observed price (*P*). In the case of stocks, the fundamentals price can be expressed as the sum of discounted expected future cash flows to the holder of the asset.

(9) $P_t = P_t^{PV} + B_t$.

If $B_t > 0$, it can be expected to grow at the real rate of interest *r*:

(10) $B_{t+1} = B_t(1+r) + b_{t+1},$

where b_{t+1} is the innovation in the bubble at time $t+1$. Testing for a bubble implies the rejection of the existence of a stable (non-explosive) relationship among stock prices, dividends and returns (see Campbell, Lo and MacKinlay, 1997; Sarno and Taylor, 1999). The equation that establishes the basis for these tests relies on what suggested by Campbell, Lo and MacKinlay (1997)[5]:

$$(11) \qquad (d_t - p_t) = -\frac{k}{1-\rho} + E_t \sum_{j=0}^{\infty} \rho^j (-\Delta d_{t+1+j} + r_{t+1+j}),$$

where d_t represents the log of the dividends, p_t is the log of stock prices, $(d_t - p_t)$ is the average of the log dividend-price ratio, r_t represents the returns, $\rho = 1/(1+\exp(d-p))$ and $k = -\log(\rho) - (1-\rho)\log(1/(\rho-1))$. Eq.(11) states that, if prices increase, either dividends increase or expected future returns decrease in order to maintain the dividend-price ratio stationary. A natural way to test the existence of a bubble is to see whether stock prices are stationary when they are differenced the number of times which is required to make dividends stationary (Gurkaynak 2005). Furthermore, the unit root properties are also tested in the log dividend/price ratio and in the real return series (Herrera and Perry 2003). If dividends follow an I (1) process, their difference is stationary and the return series must be of the same order of integration as the dividend/price ratio. If the series have a unit root, the no-bubble hypothesis is rejected. On this basis, the cointegrating relationship between the log

4 Gurkaynak (2005) provides a survey of econometric tests of asset price bubbles.

5 See Campbell, Lo and MacKinlay (1997), p. 264.

dividend-price ratio and returns is tested. If a stable relationship among the two variables is rejected, then the no-bubble hypothesis also is rejected. Hence, if no cointegrating relationship exists, a bubble occurs.

As regards the unit root tests, we apply the panel unit root tests[6] such as the LLC (Chu et al. 2002), IPS (Im et al. 2003), Breitung (2000) and Hadri (1999) tests. All tests allow for individual specific components like deterministic and dynamic effects, while the long-run behaviour of the variables can also differ across the panel members. The LLC, Breitung and Hadri tests employ the assumption that the persistence parameters are common across cross-sections, whereas the other tests allow that the parameters to vary freely across cross-sections. The LLC and IPS tests are based on the ADF procedure: the null hypothesis of a unit root is tested against the alternative of a stationary process for all (LLC) or at least for one cross section (IPS). The LLC and Breitung tests differ in the way they correct for autocorrelations and deterministic components of the series. The LLC test procedure removes together autocorrelation and deterministic components using an auxiliary OLS regression. By contrast, Breitung's method removes only the autoregressive portion from the series in a first step. Then, in a second step the filtered series are transformed and detrended. The persistence parameter is estimated from a pooled proxy equation, where the test statistic is asymptotically normal distributed. The test hypotheses are instead interchanged in the Hadri test, which adapts the KPSS method to panel data. Provided that the degree of cross-section correlation is not substantial, the test statistics are asymptotically distributed as a standard normal with a left- (IPS) or right- (Hadri) hand-side rejection area. As regards the other tests, the Maddala-Wu-ADF-Fisher and Maddala-Wu-PP-test assume that the cross section members are independent. By contrast, the Hartung-ADF-Fisher test allows for a constant correlation among the cross section members. This correlation may be different from zero (Demetrescu et al. 2006). Such a test is characterized as a panel unit root test of the second generation and it does not need a balanced sample structure.[7]

Fehler! Verweisquelle konnte nicht gefunden werden. below reports the results of all these panel unit root tests just described. As regards the log of the real stock prices, the null hypothesis of a unit root is not rejected on the

6 For a review of these tests see, for example, Banerjee (1999) and Hurlin and Mignon (2004).

7 All these unit root tests are defined in the literature as panel unit root tests of the first generation. Unit root tests of the second generation assume the data set to be balanced, which is not the case under analysis (for instance, a stock price index for the euro area is only available since 1973). An exception is represented by the approach of Demetrescu, Hassler and Tarcolea (2006), which applies the Hartung principle for panel unit root tests, whereas it uses the Hartung-ADF-Fisher-test for the ADF-Fisher test.

basis of the LLC, Breitung, IPS and three Fisher-type tests. Besides, the Hadri test-statistic (which tests the null hypothesis of stationarity) turns out to be significant, thus also denoting the non-stationarity of the series. Considering the (log) dividend yields, the evidence is more mixed. This is, for instance, reflected in the fact that the alternative hypothesis of the IPS test is such that at least one series is stationary and the null is rejected for this test, whereas as regards the LLC (which has the alternative of all series being stationary) the p-value of the test is close to the 5% level. Considering the Hartung and Breitung tests, the p-values are above 5%. Moreover, it seems that, while on an aggregate level, most of the tests suggest that null hypothesis of a unit root can be rejected, results at country level point into the opposite direction, thus implying that the overall results are driven by peculiar developments in some countries. Overall, the existence of a unit root in the log of the dividend yields points towards the existence of an intrinsic bubble. Finally, real returns turn out to be stationary on the basis of all unit root tests. These results, therefore, present evidence that the no-bubble hypothesis can be rejected because the return series seem not to have the same order of integration as the dividend-price ratio.

Table 1: Unit root tests

Variable	***Log of real stock prices***	***Log of dividend yields***	***Real returns***
Im-Pesaran-Shin (IPS)	1.391 *(0.918)*	-3.664 *(0.00)*	-32.214 *(0.00)*
Hadri	26.209 *(0.00)*	20.901 *(0.00)*	0.239 *(0.406)*
Lev in-Lin-Chu (LLC)	0.574 *(0.717)*	-1.693 *(0.045)*	-23.35 *(0.00)*
Maddala-Wu-ADF-Fisher (MW-ADF)	22.023 *(0.944)*	67.786 *(0.001)*	836.483 *(0.00)*
Maddala-Wu-PP-Fisher (MW-PP)	18.479 *(0.986)*	54.603 *(0.014)*	837.037 *(0.00)*
Hartung-ADF-Fisher (H-ADF)	0.6091 *(0.729)*	-1.612 *(0.053)*	-25.254 *(0.00)*
Breitung	-0.176 *(0.430)*	0.518 *(0.698)*	-13.704 *(0.00)*
Decision	*Non-stationary*	*Stationary/Non-Stationary**	*Stationary*

* The final decision depends on whether one considers countries separately or on an aggregate level.

The LLC, Breitung and Hadri tests employ the assumption that the persistence parameters are common across cross-sections, whereas the other tests allow that the parameters to vary freely across cross-sections. The LLC and IPS tests as well as the MW-ADF and MW-PP tests are based on the ADF procedure: the null hypothesis of a unit root is tested against the alternative of a stationary process. The test hypotheses are interchanged in the Hadri test, which adapts the KPSS method to panel data.

The figures in brackets denote the probability of not rejecting the null hypothesis.

4.2 Bivariate cointegration tests

As a second step, we run the bivariate cointegration test between the log of the dividend yields and the real returns. The results are shown in the table below. In order to test the cointegration hypothesis, the Johansen procedure is applied to bivariate models of the log of the dividend yields and the real returns series. The preferred lag order of the unrestricted VARs is selected on the basis of the Hannan-Quinn information criterion information criteria and is shown in column 2 of **Fehler! Verweisquelle konnte nicht gefunden werden.**. Moreover, the table includes the results of the trace test and the max eigenvalue test of the null hypothesis of no cointegration between the variables.

As it seems generally natural to rule out the presence of a deterministic trend in equilibrium long-run returns to investment in the bond and stock markets, all cointegration tests are based on case no. 2, namely the intercept is restricted to the cointegrating space.

Looking at column (5) it turns out that the null hypothesis of no cointegrating vectors is rejected for all countries. Taken together, these results provide clear evidence against the existence of at least a bubble. It is noticeable, however, that the results stemming from the unit root tests and the cointegration tests point to different directions, thus requiring further investigation on the basis of other techniques.

Table 2: Bivariate cointegration tests of the log of the dividend yields and the real returns

Country (1)	**Lag order of VAR** (2)	**Trace H0 r=0** (3)	**MAX eigenvalue r=0** (4)	**No. of cointegration vectors** (5)	
Australia*	3	15.11	15.11	*Tr. Stat.* *Max Eig.*	2 2
Canada	4	23.33	21.07	*Tr. Stat.* *Max Eig.*	1 1
Denmark	2	69.34	64.00	*Tr. Stat.* *Max Eig.*	1 1
Euro area	2	61.09	57.99	*Tr. Stat.* *Max Eig.*	1 1
France	2	114.49	110.68	*Tr. Stat.* *Max Eig.*	1 1
Germany	2	70.84	67.16	*Tr. Stat.* *Max Eig.*	1 1
Ireland	2	57.38	51.9	*Tr. Stat.* *Max Eig.*	1 1
Italy*	3	10.1	10.1	*Tr. Stat.* *Max Eig.*	2 2
Japan	2	92.15	87.26	*Tr. Stat.* *Max Eig.*	1 1
The Netherlands	2	96.23	93.72	*Tr. Stat.* *Max Eig.*	1 1
New Zealand	3	33.51	25.46	*Tr. Stat.* *Max Eig.*	1 1
Norway	2	72.07	64.61	*Tr. Stat.* *Max Eig.*	1 1
Portugal	2	42.9	37.1	*Tr. Stat.* *Max Eig.*	1 1
Spain	2	45.92	42.21	*Tr. Stat.* *Max Eig.*	1 1
Sweden	2	82.2	76.43	*Tr. Stat.* *Max Eig.*	1 1
Switzerland	2	84.47	80.84	*Tr. Stat.* *Max Eig.*	1 1
United Kingdom	2	72.8	68.48	*Tr. Stat.* *Max Eig.*	1 1
United States	2	40.82	38.92	*Tr. Stat.* *Max Eig.*	1 1

* For both countries, the trace and the max eigenvalue procedures test for the existence of exactly one cointegrating vector.

5 Conclusion

Large swings in asset prices, interest rates and economic activity in a variety of countries over the past several years have brought new attention to the behavior of asset markets. Generally speaking, it is a well established fact that distinguishing the nature of the sources of asset price movements – and, therefore, if the eventual bursting of such bubbles is likely to be destabilising for the financial system and the real economy – in real time is an extremely difficult task, as estimates of the equilibrium value of asset prices are usually surrounded by a high degree of uncertainty.

This paper contributes to the related literature by investigating some approaches to analyze whether developments in stock prices are in line with fundamentals or they reflect a rising bubble. The answer to this question is of utmost relevance for a number of areas, not least for either financial market participants or for central banks aiming at pursuing a policy of "leaning against the wind". In this study, we make use of a sample of 17 OECD industrialised countries and the euro area over the period 1969 Q1 – 2008 Q3 and carry out univariate and multivariate panel tests to find evidence of bubbles in the stock market over the past four decades. Univariate tests clearly reject the non-bubble hypothesis pointing towards the fact that there have been for some countries and sometimes over protracted periods from the path implied by the fundamentals, the results based on the cointegration tests provide clear evidence against the existence of a bubble. It is noticeable, therefore, that the results stemming from the unit root tests and the cointegration tests point to different directions, thus requiring further investigation on the basis of other techniques and methodologies.

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