Working Papers 2018 14

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JUNE 2018
The analyses, opinions and fi ndings of these papers represent the views of the authors, they are not necessarily those of the Banco de Portugal or the Eurosystem

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Lisbon, 2018 • www.bportugal.pt

Working Papers | Lisbon 2018 • Banco de Portugal Av. Almirante Reis, 71 | 1150-012 Lisboa • www.bportugal.pt •
Edition Economics and Research Department • ISBN (online) 978-989-678-590-1 • ISSN (online) 2182-0422

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June 2018

Abstract
This paper tests for structural changes in the duration of bull regimes of adjusted market capitalization stock indexes comprehending 18 developed and emerging economies, using a novel approach introduced by Nicolau (2016); and investigates whether the structural changes detected in the bull markets' duration are connected to the business cycle. Interestingly, the results show that structural changes in the duration of bull market regimes seem to anticipate periods of economic recession. The results provide statistically significant evidence that decreases in bull markets duration do not occur independently from economic crises, as 13 out of the 18 markets considered in our sample verify such decreases at least 12 months prior to the occurrence of an economic crisis. Additionally, these structural changes seem to affect smaller companies first, and then the larger ones. The association between decreases in the bull market regimes' duration and economic crises is possibly a consequence of the financial markets' leading behavior over the economy, with these structural changes serving as proxies for decreasing confidence in the financial markets, which naturally affects economic stability.

JEL: C12, C22

Keywords: Structural breaks, duration, bull markets.

Acknowledgements: João Nicolau was partially supported by the Project CEMAPRE - UID/MULTI/00491/2013 financed by FCT/MCTES and Paulo M. M. Rodrigues through UID/ECO/00124/2013 and Social Sciences DataLab, Project 22209, POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209). The opinions expressed in the paper are those of the authors and do not necessarily coincide with those of Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the authors.

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1. Introduction

Bull and bear market regimes have been characterized as long periods of price rises and price declines, respectively (Chauvet and Potter, 2000 and Sperandeo, 1990). The identification of these regimes is of importance for policy makers and for investors, given that their impact on asset pricing is an important source of time variation in risk premia (see, for example, Gordon and St-Amour, 2000; Ang et al., 2006). This has led, over the years, to the development of parametric and non-parametric methodologies for the identification of bull and bear markets (see e.g. Kole and van Dijk, 2017). A first-class of approaches proposed in the literature considered data-based identification methodologies, which are mainly concerned with converting the notion of rising and declining stock prices into quantitative criteria to enable the construction of identification algorithms; see, for instance, Fabozzi and Francis (1977) and Kim and Zumwalt (1979). Note that these approaches rely on returns sharing some common underlying characteristics throughout the entire sample (such as, e.g., common mean or common standard deviation), and identify bull and bear markets as extremes within this set of returns. A second-class of approaches, which is less restrictive, considers the identification of bull and bear regimes as periods during which prices are not too far from local peaks and troughs of the current market. Hence, bull and bear markets are detected relative to characteristics of the current market and not the entire sample. This approach has been used by, among others, Pagan and Sossounov (2003), Lunde and Timmermann (2004) and Candelon, Piplack and Straetmans (2008). Kole and van Dijk (2017) provide an extensive comparison of different approaches and an in depth discussion of their merits.

Regime duration dependence has been an active topic of research, both in the business cycle (Chauvet and Potter, 2009) as well as in the financial markets (Pagan and Sossounov, 2000) literature. For the purpose of the present paper we will focus on duration dependence in bull markets only and employ the Lunde and Timmermann [LT] (2004) algorithm for the identification of these markets. Our first contribution lies in the detection of possible structural changes in duration dependence. This is an important point to which to date little attention has been given in the literature. Its importance is directly linked to applications of bull and bear regimes as key components of stock markets. To test for structural changes in duration dependence we consider the test recently proposed by Nicolau (2016). In the next section we will briefly introduce this procedure, along with two simple alternative tests derived from the former.

A further important point which has received considerable attention in the literature is the link between macroeconomics and finance, especially after the financial crisis of 2008 which had worldwide impact. Building on the works of, e.g., Estrella and Mishkin (1998), Avouyi-Dovi and Matheron (2005), Claessens et al. (2012) and Nyberg (2013), a second contribution of this paper is to explore the possible relationship between structural changes in the duration of bull markets and business cycles. Understanding stock market regimes and economic cycles and how they are connected to investment performance can help determine the best timing strategies and portfolio structures. Empirical evidence suggests that, typically stocks fall prior to recessions. However, while stocks as a whole have leading behavior relative to the economy, specific sectors and firms may have different relative performance throughout the economic cycle. Depending on the business activities of a given sector or industry, there is generally a particular phase of the business cycle that is more favorable to some activities/firms/sectors than others (see e.g. Fort et al., 2013).

Finally, the third contribution of this paper looks to shed light on this topic by considering small, mid and large cap stocks in our analysis. This is of importance since periods of market upheaval and economic recession are characterized by investor flight to perceived quality and liquidity in response to uncertainty and fear. Many investors reduce their overall exposure to equities during times of crisis. Others reduce or sell off their exposure to the small cap segment of the market. Market cap is one measure of potential liquidity for stocks, and some investors sell off their small cap holdings during these volatile periods, reinvesting the proceeds in what they believe to be safer and more liquid assets. Moreover, smaller companies may be better positioned to move quickly as the economic environment improves. This suggests that small companies' bull market cycles may have leading behavior when compared to medium and large companies' bull market regimes.

The underlying motivation of this work relies on a central premise of finance theory, namely that financial markets are "forward looking." Since news and information about future states of the economy are continuously processed by market participants, expectations about upcoming economic conditions as well as risk preferences and tolerances are also subject to continuous revision. Such revisions may give rise to inducements to trade, which causes relative stock prices and stock market indexes to fluctuate. Given that trading levels are directly related to liquidity, one may expect that aggregate liquidity should also convey information about future macroeconomic conditions. For example, the "flight to quality" phenomenon, which reflects the "forward looking" nature of equity markets, usually occurs prior to difficult economic times when investors shift their equity allocation to completely move away from the stock market or invest into safer securities to construct portfolios that are more defensive and more focused on wealth preservation. During a "flight to quality" episode, an unusual amount of asset trading occurs in a short period of time which leads to important price changes and enhanced stock volatility, which in turn causes aggregate liquidity to worsen (illiquidity increases). In a recent study, Næs et al. (2011) suggest that stock market liquidity acts as a strong leading indicator of economic growth.

Our most novel finding is that structural changes associated with decreases in the duration of bull market regimes seem to anticipate periods of economic recession. Hence, the present study aims to contribute to the understanding of the link between finance and macroeconomics, by exploring the possible relations between structural changes in the duration of bull markets and the business cycle, a research field never considered to date. The paper is organized as follows. Section 2 introduces the duration dependence measure and structural change tests considered; Section 3 presents the structural breaks tests results and analyses the link between duration dependence in bull cycles and economic recessions; and Section 4 concludes.

2. Breaks in duration dependence

2.1. Bull markets duration

A crucial step for the detection of possible structural changes in the duration of bull markets, consists in the identification of the bull regimes. There are several (parametric and nonparametric) approaches in the literature which allow for the identification of bull and bear markets. However, Kole and van Dijk (2017) show that non-parametric rule-based methods are generally preferable for (in-sample) identification of the state of the market, as they are more transparent and robust to misspecification than alternative methods. Thus, in this paper, the algorithm proposed by Lunde and Timmermann (2004) is preferred, given that it does not restrict cycle duration, and avoids interval censoring issues. This algorithm defines bullish cycles as the movements of a time series between two local maximums without significant drops in between, or as the movements between a local minimum and a local maximum.

In specific, the algorithm considers a change from a bull (bear) to a bear (bull) market if the price drops (increases) by more than a pre-specified percentage. There are two main implementation issues related to the LT-algorithm: first, the choice of filters, and second, the short-term fluctuations and filtering. If there is a drift in the stock price series from which one derives the bull/bear markets, one has to adjust the filter so as to account for this feature. In particular, if the series exhibits an upward trend, an asymmetric filter is required so that in order to go from a bear market to a bull market, the stock price would have to increase more than it would have to decrease to go the other way (see Lunde and Timmermann, 2004, for details).

Once the bull markets are identified based on the LT-algorithm, their duration dependence can be computed. For that purpose, consider the indicator variable S_t, which takes a value of one if the stock market is in a bull state at time t, and zero otherwise (bear state). Assuming, as in Nicolau (2016), that $\{S_t\}$ is a stationary first order Markov chain process, the duration of the bull market is determined as,

$$\theta := \frac{1}{1 - p_{11}} \tag{1}$$

where p_{11} is the transition probability, i.e., $p_{11} := P(S_t = 1 | S_{t-1} = 1)$; see, e.g., Taylor and Karlin (1998). The duration of the cycle is estimated by replacing p_{11} with its respective maximum likelihood estimate, *viz.*,

$$\widehat{p}_{11} := \frac{n_{11}}{n_1} \tag{2}$$

where n_1 is the number of times $S_t = 1$ in a given sequence and n_{11} is the number of times that $S_t = 1$ given that $S_{t-1} = 1$ (see, for example, Basawa and Rao, 1980).

2.2. The structural change tests

Since one of the goals of this paper is to determine whether bull market durations are constant over time, the recent procedure introduced by Nicolau (2016) is applied. In specific, considering θ_t the duration of a bull cycle at time t as defined in (1) and focusing on observations $t := \lfloor rT \rfloor$ for $r \in [r_0, r_1]$, a pre-specified compact subset of (0,1) where $\lfloor x \rfloor$ is the integer part of x and T is the sample size, our target is to test $H_0 : \theta_{\lfloor rT \rfloor} = \theta$, $\forall r \in [r_0, r_1]$ (i.e. parameter constancy) against the alternative $H_1 : \theta_{\lfloor rT \rfloor} \neq \theta$ for some $r \in [r_0, r_1]$.

The following structural break tests are considered,

$$\mathcal{D}_1 \quad : \quad = \underset{r \in [r_0, r_1]}{Max} Q_T^2(\lfloor rT \rfloor); \tag{3}$$

$$\mathcal{D}_2 \quad : \quad = \frac{1}{T} \sum_{j=w+1}^{T-1} Q_T^2(j); \tag{4}$$

$$\mathcal{D}_3 \quad : \quad = \frac{1}{T} \sum_{j=w+1}^{T-1} |Q_T(j)| \tag{5}$$

where

$$Q_T(\lfloor rT \rfloor) := \left(\frac{\lfloor rT \rfloor - w}{T - w} \frac{\lfloor rT \rfloor}{\widehat{\sigma}^2} \right)^{1/2} (\widehat{\theta}_{\lfloor rT \rfloor} - \widehat{\theta}_T). \tag{6}$$

The constant w in (6) is a shifting value such that $w < \lfloor r_0 T \rfloor$ and $\widehat{\sigma}^2$ is the maximum likelihood estimate of $AVar(\widehat{\theta}_T)$,

$$AVar(\widehat{\theta}_T) := \lim_{T \to \infty} Var\left(\sqrt{T}(\widehat{\theta}_T - \theta) \right) = \frac{p_{11}}{(1 - p_{11})^3 \pi_1}$$

with $\pi_1 := P(S_t = 1)$. The test in (3) was introduced in this context by Nicolau (2016) and is based on Andrews (1993), and the tests in (4) and (5) are inspired in Andrews and Ploberger (1994).

Moreover, from the continuous mapping theorem it follows as $T \to \infty$ that,

$$\mathcal{D}_1 \xrightarrow{d} \underset{r \in R}{Sup} B(r)^2; \tag{7}$$

$$\mathcal{D}_2 \xrightarrow{d} \int_0^1 B(r)^2 dr; \tag{8}$$

$$\mathcal{D}_3 \xrightarrow{d} \int_0^1 |B(r)| \, dr \tag{9}$$

where $B(r) := W(r) - rW(1)$, and $W(r)$ is a standard Wiener process. For detailed proofs of these results see, e.g., Nicolau (2016).

Critical values at the 10%, 5% and 1% significant levels for the tests in (3), (4) and (5), are respectively, 1.46, 1.78, 2.54, for $\mathcal{D}_1$, 0.34, 0.45, 0.75, for $\mathcal{D}_2$, and 0.49, 0.58, 0.76 for $\mathcal{D}_3$.

Monte Carlo simulations carried out by the authors (available upon request) show that all tests present empirical rejection frequencies under the null which are close to the nominal size considered in the simulations (5%) and are consistent. However, for smaller sample sizes, the alternative tests in (4) and (5) have smaller size distortions but also less statistical power than (3). In this sense, tests (4) and (5) will be applied as a complement to (3).

3. Empirical Analysis

3.1. Data

The database used in our analysis comprises adjusted market capitalization stock indexes for 18 developed and emerging markets, constructed by Morgan Stanley Capital International (MSCI) and downloaded from DataStream. In specific, the markets considered are the US (US), the UK (UK), Canada (CAN), Belgium (BE), Denmark (DEN), Germany (GER), Finland (FIN), France (FR), Ireland (IR), Italy (IT), the Netherlands (NET), Norway (NOR), Spain (SP), Sweden (SWE), Switzerland (SWI), Australia (AU), South Africa (SAF) and South Korea (KOR).

The classification of markets as emerging or developed follows three essential criteria: economic development, market accessibility and size/liquidity. The adjusted market capitalization stock indexes are derived from the equity universe, precisely as the investable market index. This index is then divided by the size of the companies with respect to their full market capitalization, resulting in large, mid and small cap indexes. Subsequently, for each market under analysis, the structural change tests previously described are applied to the corresponding bull market durations identified from the large, medium and small cap indexes constructed by MSCI[1].

The sample sizes of the daily price indexes considered vary between 6212 and 6734 observations, due to restrictions on their availability in DataStream, with the longest samples starting 25 May 1992 and the shortest 31 May 1994. The last observed period included is 21 March 2018 for all series.

3.2. Structural break test results

The estimated breakpoint dates given by the structural change tests $\mathcal{D}_1$, $\mathcal{D}_2$, and $\mathcal{D}_3$, introduced in (3), (4) and (5), are consistent. This property is supported by the results in Bai (2000) since bull and bear markets are

1. See: www.msci.com/eqb/methodology/meth_docs/MSCI_June2017_GIMIMethodology.pdf.

typically governed by a stationary first order Markov chain process, which has a first order vector autoregressive representation holding the same asymptotic properties.

To obtain robust results in our empirical analysis against possible size distortions, we identify a structural change if the null $H_0 : \theta_{\lfloor rT \rfloor} = \theta, \forall r \in [r_0, r_1]$ is rejected by the $\mathcal{D}_1$, $\mathcal{D}_2$ or $\mathcal{D}_3$ tests in (3) - (5) at a 5% significance level. For illustration purposes, in Figure 1 we present the application of the tests to the UK market.

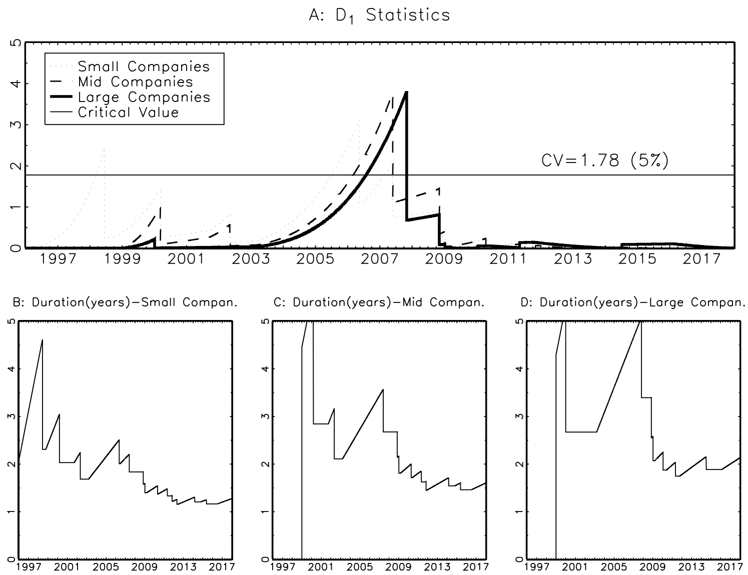

FIGURE 1: Illustration of application of the $\mathcal{D}_1$ test to the UK bull market

Panels B, C and D in Figure 1 depict the bull market durations (in years) in small, mid and large company markets. Panel A presents the results of the $\mathcal{D}_1$ statistics for the three markets. It is interesting to observe that: a) structural changes in the duration of the bull markets due to a decrease of duration occur before the crisis of 2008; and b) the sequence of breaks typically starts in small companies, followed by breaks in mid and large companies. The UK market illustrates what we have generally observed for other markets as well. As will be discussed in the following sections, structural changes due to a decrease in the duration of bull cycles tend to anticipate recession periods; and these decreases typically occur first for indexes associated with smaller companies. Table 1 and Figure 2 summarize the results obtained.

Table 1 - Structural changes in the duration of the bull market associated with large, mid and small companies

Markets	**Number DDBC**	**Number eco. crisis**	**Breakpoint Small Cap**	**Breakpoint Mid Cap**	**Breakpoint Large Cap**	**Pattern**
US	1	2	7/17/2000	-	-	[Small]
UK	3	1	5/10/2006	5/23/2007	10/31/2007	[Small>Mid>Large]
CAN	3	1	5/9/2006	5/9/2006	11/6/2007	[Small/Mid>Large]
BE	1	3	7/17/2007	-	-	[Small]
DEN	2	5	7/17/1998	-	4/14/1998	[Large>Small]
GER	1	2	-	5/9/2006	-	[Mid]
FIN	2	2	6/8/1998	-	1/3/2000	[Small>Large]
FR	2	3	-	5/10/2006	7/16/2007	[Mid>Large]
IR	3	5	1/21/1999	1/5/2001	5/7/2007	[Small>Mid]& [Large]
IT	2	2	-	4/25/2007	5/15/2007	[Mid/Large]
NET	1	3	-	5/17/2002	-	[Mid]
NOR	2	3	5/20/2002	9/2/2005	-	[Small>Mid]
SP	3	1	10/1/1997	5/10/2006	11/8/2007	[Small] & [Mid>Large]
SWE	3	1	5/11/2006	3/3/2000	3/6/2000	[Mid/Large] & [Small]
SWI	2	2	01-02-2001 & 11-05-2006	-	-	[Small] & [Small]
AU	3	3	5/11/2006	7/24/2007	7/24/2007	[Small>Mid/Large]
SAF	1	2	-	5/7/2007	-	[Mid]
KOR	3	3	2/20/1997	6/17/1997	6/17/1997	[Small>Mid/Large]
Total	38	44	13	13	11	

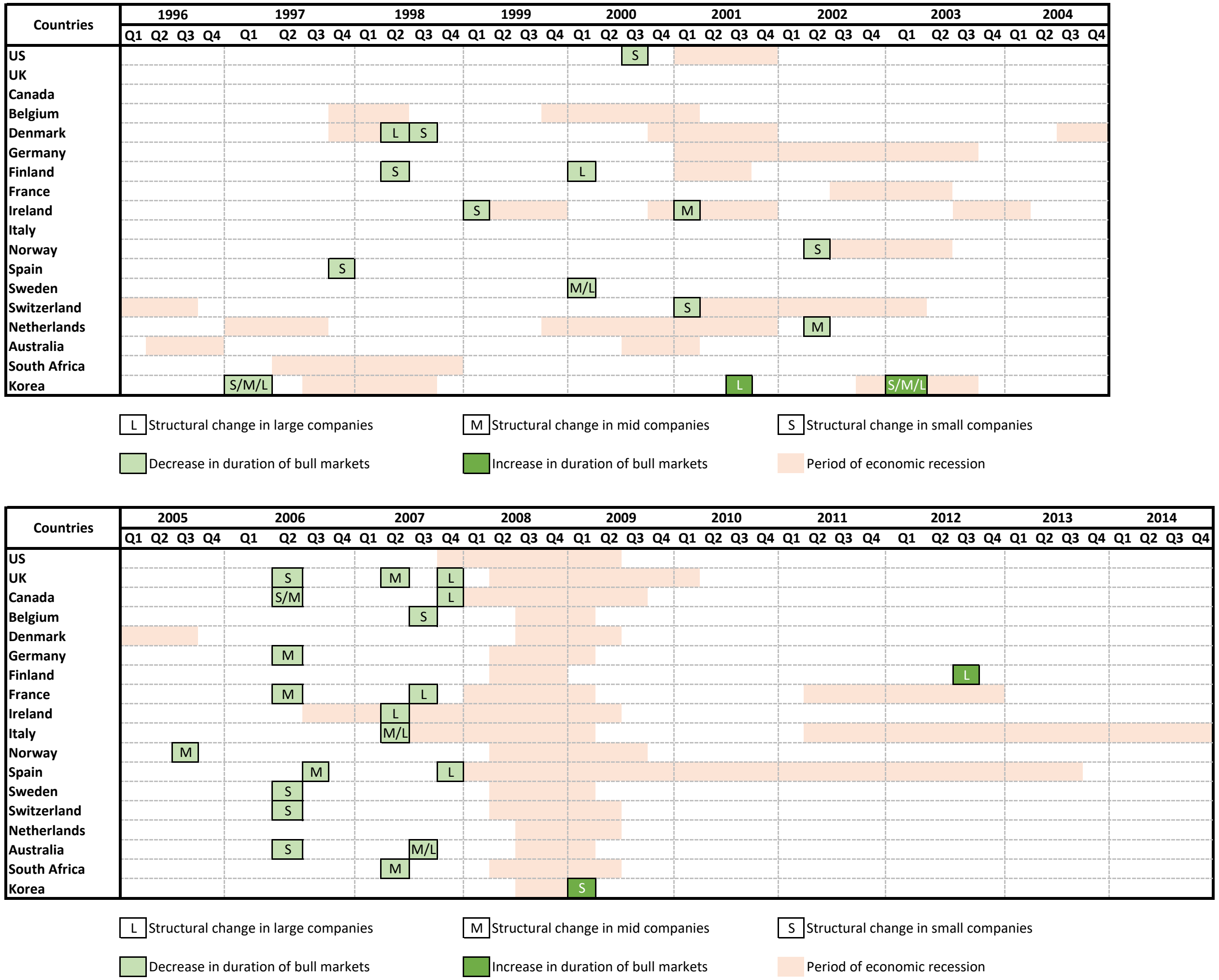

FIGURE 2: Structural changes in bull markets

The application of the $\mathcal{D}_1, \mathcal{D}_2$ and $\mathcal{D}_3$ tests in (3), (4) and (5), respectively, reveal evidence of several structural changes in the bull markets' duration between 1996 and 2014[2]. Upon a closer inspection (see Figure 2), it becomes clear that the breaks follow some interesting patterns. Specifically, it is noticeable that decreases in the duration of bull markets (henceforth DDBC) seem to occur right before periods of economic recession[3]. To understand this relation, consider the financial paradigm found right before the crisis of 2008, a period marked by increasing benchmark interest rates[4], growing real estate bubbles and the subprime mortgage crises that significantly contributed to the decline of confidence in financial markets, backing up the popular conception that "bull markets do not die of old age, they die of fright". Additionally, Jansen and Nahuis (2003) and Fisher and Statman (2003), among others, have documented significant relations between consumer confidence and the stock market. Moreover, Chen (2011) shows that the lack of consumer confidence is associated with a higher probability of regime switching from a bull to a bear state in financial markets.

To explain the pattern observed between smaller and larger companies, notice that Kim and Burnie (2002) show that smaller companies are more vulnerable to adverse changes in economic conditions given their lower productivity and higher financial leverage. Additionally, Ehrmann (2010) points out that a monetary policy tightening, which leads to restricted access to credit by companies, is more likely to affect the smaller ones given the higher amount of collateral they have to pledge and their difficulties to access other forms of external finance, compared to larger companies.

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2. Structural changes in the duration of bull markets nor economic crises were not detected after 2014 for the markets included in the sample.

3. For an extensive chronology of peaks and troughs of business cycles presented by the Economic Cycle Research Institute (ECRI) see https://www.businesscycle.com/ecri-business-cycles/international-business-cycle-dates-chronologies and Fushing et al. (2010).

4. See https://tradingeconomics.com/country-list/interest-rate for a detailed record of benchmark interest rates in the world economies.

Noticing that a monetary policy tightening actually happened during the years anticipating the crisis of 2008, with a progressive worldwide increase in interest rates during the period before the crisis, it seems that the structural changes detected are therefore a combination of the vulnerability of smaller companies and the conditions verified over the pre-crisis period.

3.3. DDBC and economic recessions

The next goal is to formally analyze whether DDBC anticipate periods of economic recession. To this end we define the indicator variable,

$$I_i(m) := max\left\{I_i^{small},\ I_i^{medium},\ I_i^{large}\right\}$$

where

$$I_i^{\kappa} := \begin{cases} 1 \quad if \quad A_{i\kappa}(m) \\ 0 \qquad otherwise \end{cases},\quad \text{for } \kappa = small,\ medium \text{ or } large \text{ and } i = 1, ..., 18$$

with $A_{i\kappa}(m)$ the event where, for the i^{th} market, a DDBC in companies of size κ occurs m months or less before a peak in the business cycle.

Under the null hypothesis, that DDBC do not anticipate business cycle recessions, $\{I_i(m)\}$ is a sequence of i.i.d. random variables with *Bernoulli* distribution of parameter $p := P\left[I_i(m) = 1\right]$, which corresponds to the probability of at least one DDBC occurring in a given market m months or less prior to an economic crisis, with both events independent of each other. The statistic that allows us to test if the structural changes detected anticipate periods of economic recession is given by,

$$T(m) := \sum_{i=1}^{n} I_i(m) \sim Binomial(n, p) \tag{10}$$

where n is the number of markets in the sample. Hence, $T(m)$ is the sum of markets which have at least one DDBC m months or less before a crisis. Clearly, the greater $T(m)$, the greater the likelihood that DDBC can anticipate economic recessions. To calculate p under the null hypothesis, we consider the following estimator:

$$\widehat{p} := \sum_{x=1}^{k}\sum_{y=1}^{\infty} P\left[X = x \cap Y = y\right]\left[1 - \left(\frac{T - \frac{250}{12}ym}{T}\right)^{x}\right] \tag{11}$$

where X is a random variable relative to the total number of DDBC associated with the small, mid and large cap indexes of a given market and Y is a random variable relative to the number of economic crises experienced in the sample period. Notice that $\left[1 - \left(\frac{T - \frac{250}{12}ym}{T}\right)^{x}\right]$ represents the probability that at least one of the x DDBC found in the stock indexes of a given market anticipates by m or less months one of its y economic crises.

The probability $P\left[X = x \cap Y = y\right]$ is estimated using the markets included in the sample, as,

$$\widehat{P}\left[X = x \cap Y = y\right] = \frac{\text{N}^{o}\text{ of Markets verifying x DDBC and y crisis}}{n}$$

where n is the total number of markets in the sample verifying statistical evidence of DDBC and economic crisis.

To contrast the structural change test results and the economic crises' dates, one needs to have information on both. The former were computed directly through the application of the test statistics discussed in section 2, while the latter are obtained by considering the dates provided by ECRI9 when available or from Fushing et al (2010) otherwise.

Table 2 presents the results concerning the application of the test procedure in (10) considering two values for p, one estimated as in (11) and the other an overestimate of this probability, $p = 0.5$, more favorable to the null hypothesis of no connection between DDBC and economic crises. Considering all the scenarios specified, there is strong statistical evidence that DDBC effectively anticipate periods of economic recession.

Table 2 - Binomial test results on dependence between DDBC and economic crises

m	**p**	**n**	**T(m)**	**P-Value**
12	0.1920	18	13	0.0000
24	0.3473	18	16	0.0000
12	0.5000	18	13	0.0481
24	0.5000	18	16	0.0007

Note: m corresponds to the number of months prior to an economic crisis, p is the probability, and n corresponds to the total number of markets.

The estimated probabilities associated to the event in which DDBC occur m months or less before an economic crisis, with both events independent are 0.19 and 0.35 for $m = 12$ and $m = 24$, respectively. One concludes that for the 18 markets considered which show statistical evidence of at least one DDBC and one economic crisis, 13 have at least one DDBC preceding an economic recession over the previous 12 months. This number increases to 16 if the number of months considered is 24.

These results point to strong statistical evidence that DDBC indeed anticipate economic crisis in those countries. It seems that most markets considered have at least one DDBC preceding an economic crisis. The p-values obtained are significantly small even when using an overestimate of the probability, $p = 0.5$, with the rejection of H_0 (*that DDBC do not anticipate economic crisis in the business cycle*), observed for all the scenarios considered, at a 1% significance level, except for $m = 12$ and $p = 0.5$ where the rejection is at a 5 % significance level.

Table 3 - Binomial test results on the dependence between DDBC in small, mid and large markets and economic crises

m	**p**	**n**	$T_{small}(m)$	**P-Value**
12	0.1033	13	6	0.0011
24	0.2056	13	9	0.0002
12	0.5000	13	6	0.7095
24	0.5000	13	9	0.1334

m	**p**	**n**	$T_{mid}(m)$	**P-Value**
12	0.1082	13	5	0.0009
24	0.2164	13	9	0.0003
12	0.5000	13	5	0.8666
24	0.5000	13	9	0.1334

m	**p**	**n**	$T_{large}(m)$	**P-Value**
12	0.0974	11	8	0.0000
24	0.1948	11	9	0.0000
12	0.5000	11	8	0.1133
24	0.5000	11	9	0.0327

Note: Regarding the markets considered in the analysis of the small, mid and large cap indexes see Table 1.

In order to analyse the contribution of each size index to the result previously presented, we conduct the same binomial test segregating between company size; see Table 3. With respect to the estimated probabilities associated to the event in which DDBC occur m months or less before an economic crisis in small, mid and large companies, with both events independent, these are 0.10, 0.11 and 0.10, respectively, for $m = 12$, and 0.21, 0.22 and 0.19, respectively, for $m = 24$. The number of markets verifying DDBC associated with small and mid companies is the same for both sizes (13 markets); see Table 1. Hence, for the 13 markets corresponding to the small and mid companies the statistical evidence of at least one DDBC preceding an economic recession over the previous 12 months is observed for 6 and 5 markets, respectively. This number increases to 9 for both company types if the number of months considered is increased to 24. For large companies the number of markets with evidence of DDBC is smaller, only 11, but the number of companies that show statistical evidence of having at least one DDBC preceding an economic recession over the previous 12 and 24 months (8 and 9, respectively), is proportionally larger than for the small and medium companies. This happened because DDBC for large companies tend to occur after mid and small DDBC and closer to the date of economic crises. Interestingly, when an overestimate of the probability is considered, $p = 0.5$, the null hypothesis is only rejected for large companies when at least one DDBC preceding an economic recession over the previous 24 months is considered.

4. Conclusions

The application of structural change tests to bull markets duration in a database comprising large, mid and small cap indexes constructed by MSCI led to the detection of several breakpoints, with our finding being the detection of a relationship between decreases in the duration of bull cycles (DDBC) and economic crises. For 13 of the 18 markets, DDBC anticipate at least one economic recession within 12 months. This figure increases to 16 if the larger period of 24 months is considered. Statistically, there is significant evidence that these structural changes do not occur independently from economic recessions, in fact DDBC effectively seem to anticipate such macroeconomic events.

The decreasing confidence in the financial markets that usually precedes economic recessions manifests itself in the length of bull markets. Hence, monitoring financial markets with respect to bull market durations may contribute to the identification and prevention of periods of economic recession. Markets should closely monitor decreases in bull markets duration and research on this subject ought to evolve to provide methodologies to predict and better understand these structural changes.

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