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RESEARCH ARTICLE

Business cycles, financial cycles and capital structure

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Abstract We perform peridogram based cycle analysis of firm capital structure and find evidence that firms' leverage is both persistent and cyclical. The cyclicality of leverage is supported by the trade-off, pecking order and market timing capital structure theories (Korajczyk and Levy in J Financ Econ 68:75–109, 2003; Bhamra et al. in Rev Financ Stud 23:645–703, 2010). Although market timing theory research supports persistence, previous literature dictates that the trade-off and pecking order theories may predict either persistent or mean reverting leverage. Our tests reject mean reversion in favor of persistent and cyclical leverage. We corroborate pecking order theory literature that predicts leverage is persistent. In these models, when firms' investment spending is below earnings, leverage decreases. In addition, we examine whether firms change their capital structure as a result of business and financial cycles. Since financial cycles last longer than business cycles, financial cycles should have a long term effect on leverage. Our findings confirm the persistent leverage business cycle models that suggest firms change their capital structure due to financial and credit cycles (Jermann and Quadrini in Am Econ Rev 102:238–271, 2012; Azariadis et al. in Rev Econ Stud 83:1364–1405, 2016). We conclude that leverage is persistent due to the cyclicality of the financing decision.

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1 Introduction

The most common theories in the literature today of how a firm sets its capital structure include the trade-off (*TO*) theory, the pecking order (*PO*) theory and the market timing (*MT*) theory. In the static trade-off theory of Modigliani and Miller (1958), the tax benefits of debt are weighed against bankruptcy costs; if the benefits outweigh the costs, then the firm will have higher leverage. This theory suggests that firms change their capital structure to meet its target, and is thus mean reverting (Taggart 1977; Jalilvand and Harris 1984; Auerbach 1985). However, the widely used standard trade-off model of dynamic capital structure (e.g. Fischer et al. 1989; Goldstein et al. 2001; Hackbarth et al. 2006; Strebulaev 2007) suggests that as firms' observed capital structure changes, they return to their target sparingly due to adjustment costs. Studies show that even small adjustment costs can lead to large changes in leverage (Fischer et al. 1989; Welch 2004; Leary and Roberts 2005). Thus, this model implies that capital structure is persistent. Research has also shown that the trade-off theory applies to capital structure changes made as a result of the business cycle. During a contraction, the market value of equity decreases as investors expect a decrease in future dividends; the agency problem also increases as managers receive less wealth and shareholders receive more (Levy and Hennessy 2007). This results in higher firm leverage and implies that capital structure is countercyclical. On the other hand, firms may reduce leverage during economic downturns to improve their financial flexibility. This would signify that capital structure is procyclical (Bhamra et al. 2010). Several other studies find that during financial booms the benefits of debt outweigh the costs and result in procyclical patterns (e.g. Jensen and Meckling 1976; Gertler and Hubbard 1993; Zwiebel 1996). These patterns of capital structure are not a result of either asset substitution (Jensen 1986), risk shifting (Vanden 2016) or debt overhang (Myers 1977) because bankruptcy is unlikely.

Pecking order theory (Myers and Majluf 1984) posits that because of asymmetric information costs, external financing is expensive and firms will prefer to use internal funds before issuing debt or equity. As noted by Korajczyk and Levy (2003), pecking order theory implies that leverage is countercyclical; as internally generated funds increase during a boom leverage decreases, and as internally generated funds decrease during a contraction leverage increases. Previous literature has also found that firms that make capital structure decisions based on pecking order theory will exhibit mean reverting debt ratios as firms increase leverage in years that internal funds are low and decrease leverage when internal funds are high (Shyam-Sunder and Myers 1999; Myers 2001). However, given the prior research on earnings persistence (e.g. Fama and French 1995; Frankel and Litov 2009), leverage should also be persistent. The static pecking order model suggests that leverage decreases as retained earnings increase when investment spending is below the firm's earnings (Strebulaev 2007). Moreover, the dynamic pecking order model of capital structure proposes that firms have to consider both investment spending and external financing costs. As both current and future earnings increase, the firm will be able to have a lower debt ratio.

The market timing theory of Baker and Wurgler (2002) suggests that there is no optimal capital structure and that a firm's capital structure is a result of all previous market timing attempts. Firms will attempt to time the market and issue equity when their market values are high and repurchase equity when their market values are low. This implies that leverage is countercyclical; during a contraction, firms will not issue equity and issue debt instead. Further evidence that leverage is countercyclical is found by Huang and Ritter (2009). They find that firms issue equity when the risk premium is lower during an expansion and firms issue debt when the risk premium is higher during a contraction. A positive relationship between business cycles and equity issues has also been found by several studies (e.g. Choe et al. 1993; Bayless and Chaplinsky 1996; Baker and Wurgler 2002). Because firm capital structure in the market timing model is a result of prior issuance decisions, it is persistent (Huang and Ritter 2009). A study by Lemmon et al. (2008) find that capital structure is so persistent that firm leverage a year before an IPO predicts the firm's leverage in 20 years.

Firms may change their capital structure as a result of cycles (whether they are business or financial). Claessens et al. (2012) suggest that financial cycles tend to be permanent most of the time; thus, we expect leverage to be persistent. Leverage persistence may also occur as a result of business cycles (Bierens 2001; Al-Zoubi 2017). The National Bureau of Economic Research (NBER) defines a business cycle as the rise and fall of economic growth over a period of time. A financial cycle is identified as the increase and decrease of credit availability, residential home prices, and stock prices over a period of time. Several studies have examined the connection between business and financial cycles. Cochrane (2005) suggests that business and financial cycles are connected due to wealth and substitution effects in a frictionless financial system, and are exacerbated by financial accelerator mechanisms. Claessens et al. (2012) find evidence that business and financial cycles are linked; they discover that the duration of recessions depend on the strength and intensity of financial cycles. They also discover that recoveries are more robust with an increase in credit availability and home prices, recessions are worsened by home price decreases, and that upturns and downturns of financial cycles have a tendency to last longer than recoveries and recessions of business cycles. Previous literature has shown that financial cycles occur less frequently than business cycles (Borio et al. 2016; Borio 2014; Drehmann et al. 2012). However, Dovern and Van Roye (2014) show that the risk of a financial crisis in an economy increases with an increase in the economy's openness and that financial crises in the U.S. have lagged but persistent effects on the business cycle. As a result, unlike foreign financial crises, U.S. financial crises may have persistent effects on leverage. Even older studies have argued that business cycles are accompanied by financial cycles (Juglar 1862; Schumpeter 1950). Juglar (1862) finds that a sudden crash in stock markets after an expansion results in a deep recession that lasts for up to 7–11 years; thus, equity meltdowns should have a permanent effect. Consequently, firms that make capital structure decisions based on pecking order theory should have persistent leverage. A study by Azariadis et al. (2016) finds that collateralized debt is acyclical, while unsecured debt is procyclical. Their model shows that inefficient capital allocation is a result of self-imposed borrowing constraints on unsecured debt. These self-imposed constraints result in a self-fulfilling prediction of the credit environment in the future, which leads to persistent business cycle dynamics. Moreover, Jermann and Quadrini (2012) conclude that persistent technological shocks result in cyclical leverage.

There is no consensus about the cyclicality of leverage in corporate finance literature. External financing forms are interchangeable; as a result, one component could be countercyclical, while the total amount is procyclical. Jermann and Quadrini (2012) find that equity financing is countercyclical when the constraint on debt is relaxed during an expansion. On the other hand, Levy and Hennessy (2007) relax the constraint on equity during an expansion and find that equity financing is procyclical. Covas and Den Haan (2011) find that both debt and equity are procyclical; another study by Covas and Den Haan (2012) finds that equity is even more procyclical for small firms. In fact, during economic booms, external financing increases faster than investment. This increase serves as a cushion during economic downturns. Karabarbounis et al. (2014) examine firm capital structure with respect to business cycles. They discover that firms issue more debt during expansions, and that the cyclicality of equity is dependent on the definition of equity. Using Jermann and Quadrini's (2012) definition of equity (the sale of stock net of equity repurchases) in their model, they find that equity is countercyclical. On the other hand, when they use Covas and Den Haan's (2011) definition of equity (the change in the book value of equity) in their model, they find that equity is procyclical.[1]

We first use periodogram based cycle analysis and examine the cycle durations of leverage. Our results imply that firms tend to change their capital structure in response to business cycles as suggested by the trade-off, pecking order and market timing theories. We conclude that leverage is cyclical and persistent. Our findings are in sharp contrast to the mean reversion prediction of the trade-off theory that firms try to meet their target, the pecking order theory that possible overpricing results from temporary financial cycles, and the mechanical mean reversion principle. We reject mean reversion in in favor of cyclical and persistent leverage.

The paper is presented as follows: Sect. 2 describes the data and methodology used, Sect. 3 discusses the empirical results, Sect. 4 discusses the robustness of our results, and Sect. 5 concludes.

2 Data and methodology

2.1 Data

Our sample consists of all companies listed on NYSE, AMEX, and NASDAQ. Firms must have data for total assets and total liabilities in the Compustat Quarterly file from Q1:1975 to Q2:2016.[2]

[1] Barucci and Viva (2013) develop a model of capital structure in which perpetual contingent capital (e.g., convertible bonds) are countercyclical. In bad times, perpetual contingent capital is used to reduce expected bankruptcy costs.

[2] The number of firms changes throughout the sample period as companies join or leave the exchanges or do not report data for all of the required variables (TA, TL, and TE) for a given quarter or more.

Following previous capital structure literature, we exclude all financial companies (SIC Code 6000–6999). The leverage ratio (LR) is calculated as aggregate total liabilities (TL) divided by aggregate total assets (TA):

$$LR = \frac{TL}{TA},$$

where $TL = \sum_i TL_i$ and $TA = \sum_i TA_i$.

We calculate changes in the leverage ratio (ΔLR) for the overall market as the seasonally differenced quarterly leverage ratio to remove the possibility of any unit root. ΔLR is computed as the difference between LR in quarter t and LR in the same quarter from a year ago:

$$\Delta LR = LR_t - LR_{t-4}.$$

We use the Graham et al. (2015) data set to determine the robustness of our results. This data set contains two measures of leverage, which includes the annual leverage ratio (ALR), defined as total debt to total assets, and the market value of leverage ratio (MLR), defined as total debt to the sum of book debt and the market value of equity. All firms in the CRSP database with information in either Compustat or Moody's Industrial Manuals from 1920 to 2010 are included in the data set. Regulated industries, i.e. financial firms, utilities and railroads, are omitted from the sample. To remove any possibility of real unit root, we calculate changes in those two ratios as:

$$\Delta ALR = ALR_t - ALR_{t-1},$$

and

$$\Delta MLR = MLR_t - MLR_{t-1}.$$

We present descriptive statistics for the time series of aggregate variables that are used in this study in Table 1. We can see that TA, TL, and TE variables have much higher standard deviations relative to their means, which indicates increased volatility. We can also see that all variables, are positively skewed; this suggests that their distributions exhibit slightly long right-hand tails as a result of a few observations with high values. We note that the leverage ratios, LR, ALR, and MLR, have negative kurtosis which implies thinner tails than Gaussian.

We plot the aggregate leverage ratio (LR) over the sample period Q1:1975 to Q2:2016 in Fig. 1. We can see that our sample period has six business cycles and five financial crises. The troughs of business cycles in this study occurred in 1975, 1980, 1981, 1991, 2001, and 2009; financial crises included in the sample period were Black Monday (1987), Black Wednesday (1992–1993),[3] the Mexican Economic Cri-

[3] Black Wednesday refers to September 16, 1992 when the British government was forced to withdraw the pound sterling from the European Exchange Rate Mechanism (ERM) after it was unable to keep the pound above its agreed lower limit.

Table 1 Descriptive statistics

Variables	Mean	Median	Max	Min	SD	Skewness	Kurtosis
TA	9,454,092	4,484,333	120,774,537	217,235	1,200,389	4	19.78
TL	6,012,267	2,652,554	95,693,331	98,496	831,683	5	31
LR	0.60	0.61	0.86	0.32	0.10	0.16	−0.42
ΔLR	0.00	0.00	0.34	−0.36	0.13	0.05	0.35
ALR	0.26	0.22	0.47	0.11	0.01	0.16	−1.59
MLR	0.20	0.18	0.367	0.08	0.01	0.38	−1.23
ΔALR	0.00	0.00	0.03	−0.04	0.02	0.02	−0.03
ΔMLR	0.00	−0.00	0.15	−0.11	0.04	0.86	3.17

This table reports summary statistics of the time series aggregates of variables used in this study. Statistics are calculated for all companies listed on the NYSE, AMEX, and NASDAQ with data available for total assets (TA), total liabilities (TL), and total owners' equity (TE) variables on Compustat's Quarterly file from Q1:1975 to Q2:2016. Following previous capital structure literature, we exclude all financial companies (SIC Code 6000–6999). The leverage variable (LR) is calculated as the total liabilities (TL) divided by total assets (TA). Change in leverage (ΔLR) for the overall market is calculated as the seasonally differenced quarterly leverage ratio (LR) to remove the possibility of unit root. More specifically, ΔLR is calculated as the difference between LR in quarter t and LR in the same quarter from 1 year ago and is computed as $\Delta LR = LR_t - LR_{t-4}$. The Graham et al. (2015) data set contains the annual leverage ratio (ALR), defined as total debt to total assets, and the market value of leverage ratio (MLR), defined as total debt to the sum of book debt and the market value of equity. All firms in the CRSP database with information in either Compustat or Moody's Industrial Manuals from 1920 to 2010 are included in the data set. Regulated industries, i.e. financial firms, utilities and railroads, are omitted from the sample. The changes in the annual leverage ratio and the changes in the market value of leverage ratio are calculated as ($\Delta ALR = ALR_t - ALR_{t-1}$) and ($\Delta MLR = MLR_t - MLR_{t-1}$), respectively TA and TL are in millions

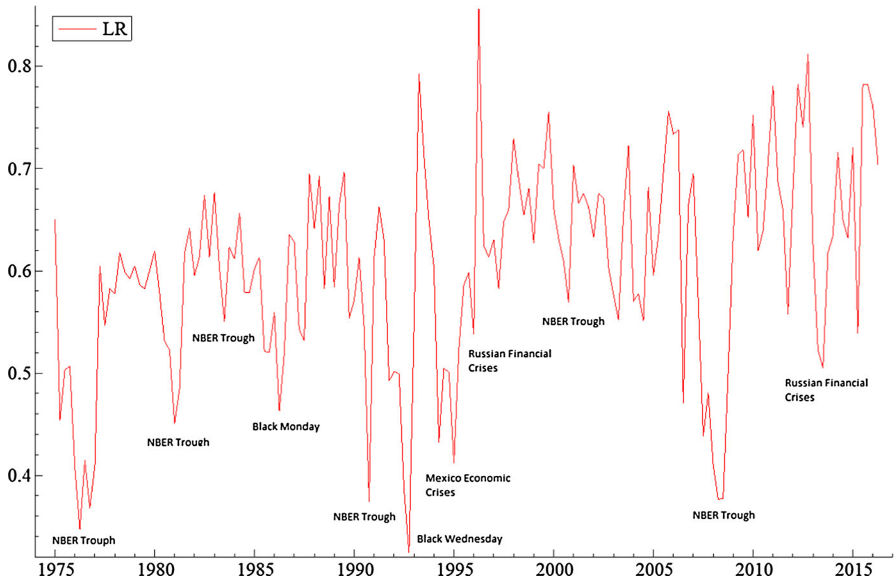

Fig. 1 Aggregate leverage ratio plot. This figure shows the aggregate leverage ratio (LR) plotted over the sample period Q1:1975 to Q2:2016. LR is computed as the total liabilities (TL) divided by total assets (TA). As shown in Fig. 1, the period covered in our study has six NBER business cycles (1975, 1980, 1981, 1991, 2001, and 2009) and five financial crises (1987 Black Monday, 1992–1993 Black Wednesday, 1994–1995 Mexico Economic Crisis, 1998 Russian Financial Crisis, and 2014 Russian Financial Crisis)

sis (1994–1995),[4] and the Russian Financial Crises (1998 and 2014).[5] Further, we observe that LR exhibits strong cyclicality; LR decreases with each contraction in the U.S. economy throughout the sample period. The large swing in the leverage ratio can be attributed to the 1994 collapse of the global bond market due to a confluence of forces driven by rising short-term interest rates. One year after the Black Wednesday, particularly in early February of 1994, the Federal Reserve began nudging short-term interest rates higher in a gradual basis as the U.S. economy had recovered from 1993 recession (Fortune Magazine, February, 2013). Given the high leverage of the bond market, the climbing short-horizon interest rates caused the prices of long-term bonds to collapse and this triggered a sell off of long-term bonds. By September of 1994, the U.S. bond market had shed off more than $600 million of its value. Similarly, the global bond market declined by about $1.5 trillion.

The lowest levels of LR correspond to troughs in NBER business cycles. We plot the aggregate leverage ratio (ALR) and the market value of leverage ratio (MLR) over the sample period 1920–2010 in Figs. 2 and 3. Similar to Graham et al. (2015),

[4] The Mexican economic crisis was sparked by the Mexican government's sudden devaluation of the peso against the U.S. dollar in December 1994.

[5] The Russian financial crisis began on August 17, 1998 when the Russian government and the Central Bank devalued the Russian ruble and defaulted on its debt. The Russian financial crisis of 2014 refers to the collapse of the Russian ruble that began in the second half of 2014; the Ruble declined in value by nearly 50% from June 2014 to December 2014.

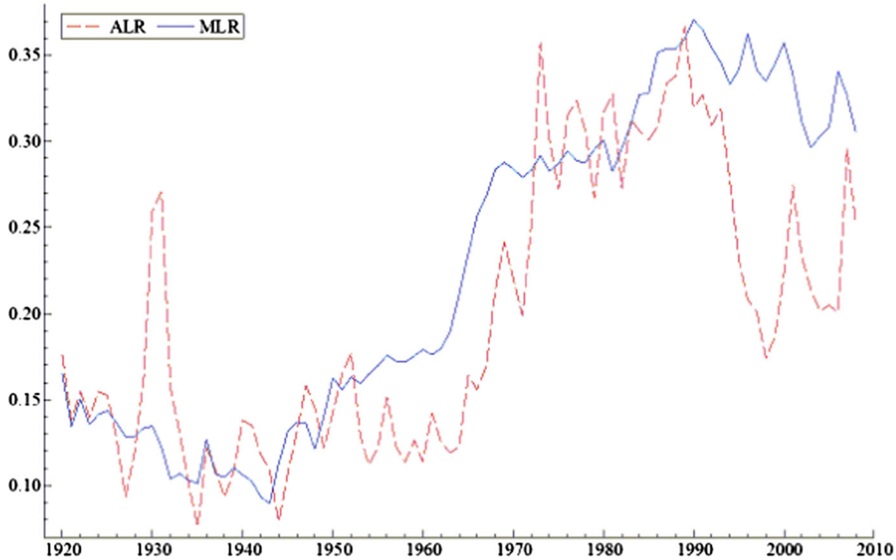

Fig. 2 Annual leverage ratio (ALR) and market value of leverage ratio (MLR) plot. This figure shows the annual leverage ratio (ALR), defined as total debt to total assets, and the market value of leverage ratio (MLR), defined as total debt to the sum of book debt and the market value of equity from the Graham et al. (2015) data set. All firms in the CRSP database with information in either Compustat or Moody's Industrial Manuals from 1920 to 2010 are included in the data set. Regulated industries, i.e. financial firms, utilities and railroads, are omitted from the sample

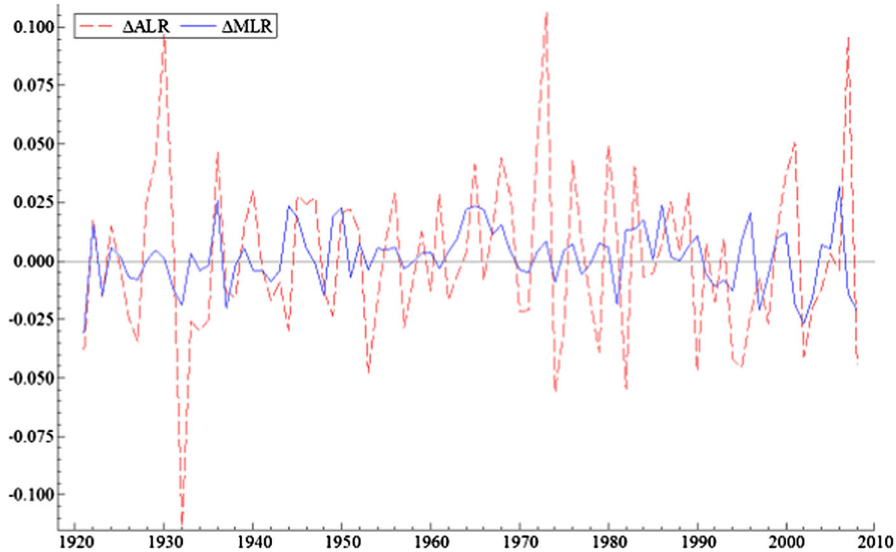

Fig. 3 Changes in the annual leverage ratio and changes in the market value of leverage ratio plot. This figure shows changes in the annual leverage ratio ($\Delta ALR = ALR_t - ALR_{t-1}$) and the changes in the market value of leverage ratio ($\Delta MLR = MLR_t - MLR_{t-1}$) from the Graham et al. (2015) data set. All firms in the CRSP database with information in either Compustat or Moody's Industrial Manuals from 1920 to 2010 are included in the data set. Regulated industries, i.e. financial firms, utilities and railroads, are omitted from the sample

Table 2 NBER business cycle durations in quarters

Peak	Trough	Duration trough to trough (in quarters)	Duration peak to peak (in quarters)
November 1973 (Q4)	March 1975 (Q1)	29	29
January 1980 (Q1)	July 1980 (Q3)	13	12
July 1981 (Q3)	November 1982 (Q4)	16	18
July 1990 (Q3)	March 1991(Q1)	7	5
March 2001 (Q1)	November 2001 (Q4)	25	27
December 2007 (Q4)	June 2009 (Q2)	32	32

This table shows NBER business cycle length in quarters from trough to trough and peak to peak. There are six business cycles during the period covered in our study from Q1:1975 to Q2:2016. The duration for each business cycle from trough to trough and peak to peak is given

we observe higher amounts of leverage in the middle of the century. One noticeable finding is that the book value of leverage is more volatile than the market value of leverage. In bad times, when companies deleverage and debt financing is low (Covas and Den Haan 2011), the market value of equity is so low that is mitigating the effect of deleveraging. However, the book value leverage decreases as it does in the data.

The term business cycle refers to the rise and fall of economic growth over an extended period of time. The duration of a business cycle can be calculated as one trough to another or one peak to another. Each business cycle has four stages: expansion, peak, contraction, and trough. A peak refers to the highest point or top of the business cycle, while a trough is the lowest level or bottom of the business cycle. We find that there are six business cycles during our sample period of Q1:1975 to Q2:2016. In Table 2, we report the quarter and year that each peak and trough occurs, as well as the NBER business cycle duration in quarters from trough to trough and peak to peak. We observe that the durations of troughs and peaks are similar. For example, the first business cycle from both trough to trough and peak to peak lasted 29 quarters. Similarly, the last business cycle from both trough to trough and peak to peak lasted 32 quarters.

2.2 Methodology

Our statistical tests allow us to determine if there is a complex unit root, as opposed to a real unit root or mean reversion. Persistent leverage with a real unit root should be impossible; if leverage has a real unit root with positive drift, it would converge to infinity. Moreover, a driftless unit root would result in negative leverage, which is also unrealistic (see, Al-Zoubi 2008, for further discussion). Thus, the complex unit root statistical analysis we use is superior to the real unit root analysis used in previous studies (i.e., Francis and Leachman 1994; Gil-Alana 2007; Harvey 1985; Caporale et al. 2013). The standardized periodogram enables us to test for duration stabilization and cyclicality in leverage without having to set cycles, a priori. We develop the null hypothesis before looking at the data generated because periodogram frequencies may not correspond to NBER cycles. This is similar to pretesting and results in lower size biases (see, Bierens 2001).

To construct a specification test, we follow Bierens (2001) by defining the standardized continuous periodogram of leverage as:

$$\rho(\xi) = \frac{2}{n\sigma_y^2}\left(\left(\sum_{t=1}^{n} y_t \cos(\varepsilon_t)\right)^2 + \left(\sum_{t=1}^{n} y_t \sin(\varepsilon_t)\right)^2\right), \tag{1}$$

where $t = 1, \ldots, n$, ε_t are $iid(0, 1)$ random shocks, σ_y^2 is the sample variance and ξ is a random function in $(0, \pi)$ given as $2\pi/k$, $k = 2, \ldots, n$, where k is the possible cycle period.

Following Bierens (2001) and Díaz-Emparanza (2004), we consider that leverage displays multiple peaks in cycle frequencies, and test the null hypothesis that the leverage ratio, LR_t, and changes in leverage, ΔLR_t, are complex unit root processes of the form:

$$(\Delta)\,LR_t = \sum_{j=0}^{k}(\Delta)\,LR_{j,t} = \prod_{j=1}^{k}\left(1-2\cos\left(\phi_{k+1+j}\right)L+L^2\right)(\Delta)\,LR_t = \mu_j+\eta_j(L)\varepsilon_{j,t},$$

where, $\phi_j \in (0, 2\pi) - \{\pi\}$, $\eta_j(L)$ is a finite order-lag polynomial with all its roots outside the complex unit circle, and the $\left(\varepsilon_{1,t}, \ldots, \varepsilon_{k,t}\right)$'s are $i.i.d.\,(0, 1)$, with $E\left(\left|\varepsilon_{j,t}\right|^{2+\gamma}\right) < 0$ for some $\gamma > 0$. As suggested by Díaz-Emparanza (2004), we also include the possibility that $\left(\phi_j\right) \in (0, 2\pi) - \{\pi\}$ to determine if the cycle is caused by the root $\cos\left(\phi_j\right) + \sin\left(\phi_j\right)$ and its alias.[6] The resulting cycle has periods of $2\pi/\phi_j$ and periods of $2\pi/\left(2\pi - \phi_j\right)$ for its alias.[7]

We next use the nonparametric technique of Bierens (2001) to test for the existence of possible cycles in leverage. The distribution of our test statistic of (1) takes the form:

$$\max_{j=1,\ldots K}\left\{\frac{\rho\left(\phi_j\right)}{n} \geq B_k\right\}, \tag{2}$$

where

$$B(k) = \left(\sum_{m=1}^{k}\frac{\int_0^1 w_{1,m}(x)^2\,dx + \int_0^1 w_{2,m}(x)^2\,dx}{\left(\int_0^1 w_{1,m}(x)\,dx\right)^2 + \left(\int_0^1 w_{2,m}(x)\,dx\right)^2}\right)^{-1},$$

and $\left(w_{1,m}, w_{2,m}\right)$ are two independent Brownian motions.

[6] Note that the alias of a cycle is the equivalent cycle of the root $\exp\left(j\phi_j\right)$ if $\left(\phi_j\right) \in (0, \pi)$ and $\exp\left(-j\phi_j\right)$ if $\left(\phi_j\right) \in (\pi, 2\pi)$.

[7] Díaz-Emparanza (2004) find that if the data generating process is discrete, then both cycles have the same cyclical behavior; however, it is difficult to discriminate these cycles from their alias.

We assume that leverage is a complex unit root, $\rho(\xi)/n$, has a spike at $\xi = \phi$, and the distribution function maximum converges to a random variable that has a lower bound of $B(k)$. Alternatively, stationary leverage, $\rho(\xi)$, has an upper bound of:

$$\rho(\xi) = \frac{\left|\eta e^{1\varepsilon}\right|^2}{\sigma_y^2}\left(w_1, \varepsilon(1)^2, w_2, \varepsilon(1)^2\right),$$

with a X^2 distribution scaled by the factor $\frac{|\eta e^{1\varepsilon}|^2}{\sigma_y^2}$.

Further, we test the null hypothesis of whether leverage is mean reverting against the alternative of cyclicality by changing the variance σ_ξ^2 and the lag polynomial by their OLS counterparts, σ_ε^2 and $\hat{\theta}_p$. The test statistic is

$$\hat{A}_{k.p} = \hat{\sigma}^{-2}\sum_{j=1}^{k}\left|\hat{\theta}_p\left(\exp\left(i\phi_j\right)\right)\right|^2\rho\left(\phi_j\right). \quad (3)$$

with a χ^2_{2k} distribution under the null hypothesis of mean reversion. If any of the values of ϕ_j relate to complex-conjugate unit roots, then the test statistic in (3) approaches infinity.

3 Empirical results

3.1 Cycle durations

Following the methodology of Bierens (2001), we first look at the periodograms for both leverage and changes in leverage. From these periodograms (Fig. 4), we can find the frequencies $\phi_{0,1}, \ldots, \phi_{0,k}$ that correspond to the highest peaks (k). The results are shown in Table 3. The highest and most significant peak for leverage occurs at a cycle duration of 114 quarters. Additional significant peaks occur with cycles of 68, 49, 38, 23 and 18 quarter durations. The highest and most significant peaks for changes in leverage correspond with 112, 65, 46, and 35 quarter durations. We also find significant peaks occur at 29 and 18 quarter durations, which is consistent with our results for leverage.[8] All cycles identified cannot be rejected at either the 5 or 10% level; two of these cycles match NBER business cycle durations. More specifically, the cycles with durations of 23 and 18 quarters for LR and 29 and 18 quarters for ΔLR correspond to NBER business cycles which began in November 2001 of 27 quarters, March 1975 of 29 quarters, and November 1982 of 18 quarters. As shown in Table 3, these cycles cannot be rejected at the 5% level. However, the long cycles captured by our tests with durations of 49, 68, and 114 quarters, which cannot be rejected at the 10% level, do not correspond to NBER business cycles. The 49 quarters cycle is a Juglar (1862) type cycle, which can last for up to 11 years. The 68 quarters cycle is a Kuznets swing cycle;

[8] We use the Easyreg International free software at http://personal.psu.edu/hxb11/EASYREG.HTM to conduct our empirical analysis.

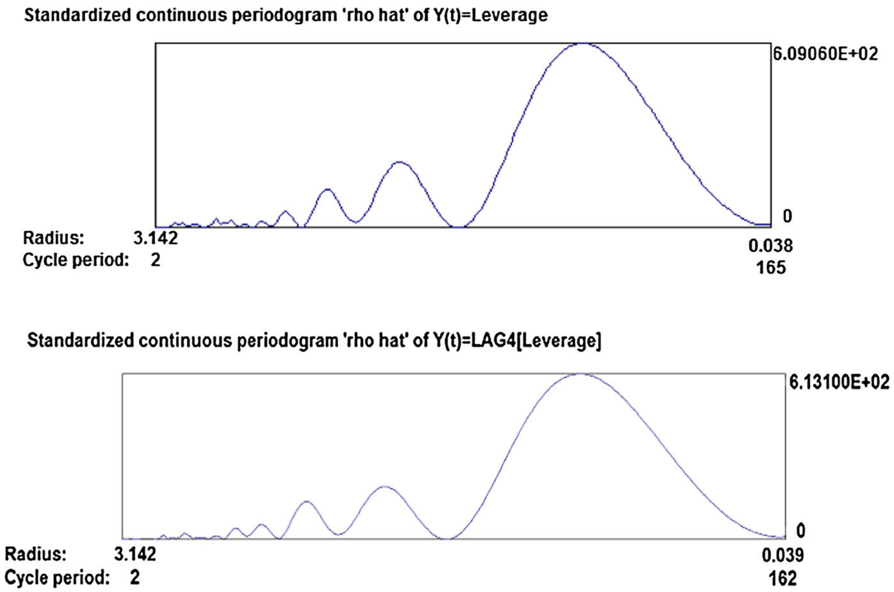

Fig. 4 Standardized periodogram of leverage ratio (*LR*) and changes in leverage (ΔLR)

Kuznets (1930) argues that an economic wave with a length of 60 to 100 quarters is a result of changes in demographics and infrastructure investments. The 114 quarters cycle is a technological wave; first introduced by Kondratieff (1935), technological waves usually have a length of 40–60 years. However, the modern timing version of this wave by Šmihula (2009) suggests that the information and telecommunications revolution from 1985 to 2015 is a Kondratieff type wave with a shorter length of 120 quarters.

3.2 Persistent-cyclical TO, PO, and MT theories null versus persistent-noncyclical leverage

Previous capital structure literature on the trade-off, pecking order and market timing models have found evidence that leverage is persistent and cyclical. The dynamic trade-off capital structure model suggests that leverage is persistent because firms will return to their target sparingly due to high adjustment costs (Fischer et al. 1989; Welch 2004; Leary and Roberts 2005). The trade-off model also predicts that leverage is cyclical either because of the benefits of debt (e.g. Korajczyk and Levy 2003) or the need for financial flexibility (Bhamra et al. 2010).

The pecking order model suggests that leverage is cyclical; as earnings increase leverage decreases, and as earnings decrease leverage increases (Korajczyk and Levy 2003). However, given the prior research on earnings persistence (e.g. Fama and French 1995; Frankel and Litov 2009), leverage could also be persistent. Strebulaev (2007) finds that retained earnings increase when capital spending is below the firm's earnings, leverage decreases; as a result, they conclude that leverage is persistent.

Table 3 Results of the $B(k)$ test for leverage ratio and changes in leverage ratio (Q1:1975 to Q2:2016)

J	$\phi_{0,1}$	Cycle	$\hat{\rho}(\phi_{0,j})/n$
LR			
1	0.0533	114	3.4147**
2	0.0924	68	1.2063**
3	0.1282	49	0.7646**
4	0.1654	38	0.2922**
5	0.2732	23	0.1525*
6	0.3491	18	0.1741*
ΔLR			
1	0.0561	112	3.4405**
2	0.0966	65	1.0960**
3	0.1365	46	0.7929**
4	0.1795	35	0.3028**
5	0.2166	29	0.2363*
6	0.3696	18	0.1470*

Test statistic = max $\hat{\rho}(\phi_{0,j})/n$ and p values for LR and ΔLR are (3.4147, 1), and (3.4405, 1), respectively
** Significant at 10% level
* Significant at 5% level
Joint test: 10 and 5% Critical regions = (0.0331, 0.0199)
Individual tests: 10 and 5% Critical regions = (0.1403, 0.2411)

Leverage based on the market timing theory is also persistent and cyclical. Firms following this model attempt to time the market and issue equity during a boom and issue debt during a contraction (Huang and Ritter 2009). Thus, the firm's current capital structure is a result of previous financing decisions and is persistent.

We test these theories under the null and hypothesize that the leverage and changes in leverage have six persistent cycles against the alternative of a single unit root. As shown in Table 3, the alternative hypothesis that leverage is persistent but noncyclical is rejected in favor of six cycles for both leverage and changes in leverage at even the 10% significant level. Therefore, our results suggest that firms tend to change their capital structure in response to business cycles as suggested by the trade-off, pecking order, and market timing theories. This is consistent with previous literature (e.g. Korajczyk and Levy 2003), that find evidence of cyclical leverage. We also find that financing decisions are persistent as predicted by Jermann and Quadrini (2012) and the dynamic trade-off model with financial flexibility (Bhamra et al. 2010), as well as the pecking order model through earnings persistence (Strebulaev 2007).

We note that capital structure irrelevance theory predicts persistent but noncyclical leverage (Modigliani and Miller 1958). This model implies that the leverage ratio should be persistent and look like a unit root. However, our findings are consistent with Villamil (2008, 2010) which suggest that capital structure is relevant because of market frictions and differing agent expectations. We reject the irrelevance proposition and conclude that leverage is both persistent and cyclical.

3.3 Mean reverting TO and PO null versus persistent and cyclical leverage

One possible prediction of trade-off and pecking order theories is that leverage is mean reverting. In early models with no transaction costs, the trade-off theory

Table 4 Results of the $\hat{A}_{k.p}$ test for leverage ratio and changes in leverage ratio (Q1:1975 to Q2:2016)

p	LR		ΔLR	
	$\hat{A}_{k.p}$	p value	$\hat{A}_{k.p}$	p value
1	301.67	0.0000	34.21	0.0006
2	290.36	0.0000	38.62	0.0001
3	249.54	0.0000	50.54	0.0000
4	247.96	0.0000	96.56	0.0000
5	255.43	0.0000	76.30	0.0000
6	236.66	0.0000	65.61	0.0000
7	209.49	0.0000	78.85	0.0000
8	290.16	0.0000	142.12	0.0000
12	293.36	0.0000	190.18	0.0000
18	345.19	0.0000	289.47	0.0000
24	335.78	0.0000	370.33	0.0000
36	322.13	0.0000	794.28	0.0000
48	193.99	0.0000	1381.05	0.0000

10% Critical region = (18.55) and 5% Critical region = (21.03)

implies that firms change their capital structure more frequently to meet its target (Taggart 1977; Jalilvand and Harris 1984; Auerbach 1985). Previous literature on pecking order theory suggests that leverage is mean reverting because firms increase leverage when earnings are high and decrease leverage when earnings are low (Shyam-Sunder and Myers 1999; Myers 2001). Firms may have several years of leverage increases, followed by several years of leverage decreases, which results in slow mean reversion. Pecking order theory may also predict that leverage is mean reverting as a result of mispricing during temporary financial crises. After a financial crisis, equity values decrease and leverage may sharply increase. However, permanent financial cycles associated with business cycles should result in persistent leverage.

The mechanical mean reversion model of capital structure (e.g. Chen and Zhao 2007) predicts that firms with high (low) leverage tend to exhibit a lower (higher) leverage ratio even if they engage in leverage enhancing (reducing) activities. There is no consensus in previous literature of whether firms' leverage is cyclical and persistent as implied by the trade-off theory (Jensen and Meckling 1976; Fischer et al. 1989; Gertler and Hubbard 1993; Zwiebel 1996; Welch 2004; Leary and Roberts 2005; Levy and Hennessy 2007; Bhamra et al. 2010), the pecking order theory (Korajczyk and Levy 2003; Strebulaev 2007) and the market timing theory (Baker and Wurgler 2002; Lemmon et al. 2008; Huang and Ritter 2009), or if firms' leverage is mean reverting as predicted by the trade-off theory (Taggart 1977; Jalilvand and Harris 1984; Auerbach 1985) and pecking order theory (Shyam-Sunder and Myers 1999; Myers 2001). Consequently, we test whether firm leverage is mechanically mean reverting or cyclical and persistent. The results of this test are shown in Table 4. We control for the model's sensitivity to possible misspecified autoregressive lag polynomials and experiment with an extensive range of lags up to 48 quarters. We find that the stationary $AR(p)$ null hypothesis is rejected for all lags at a 1% signif-

Table 5 Results of the $B(k)$ test for annual and market leverage ratios and changes in annual and market leverage ratios (1920–2010)

J	$\phi_{0,j}$	Cycle	$\hat{\rho}(\phi_{0,j})/n$
ALR			
1	0.0911	69	0.7676**
2	0.1698	37	0.1774*
3	0.2417	26	0.0716
4	0.3142	20	0.0371
5	0.3610	17	0.0503
6	0.4488	7	0.0346
Δ*ALR*			
1	0.0722	87	0.1189
2	0.1698	37	0.0146
3	0.3307	19	0.0638
4	0.6283	10	0.0479
5	0.7854	8	0.0353
6	1.2566	5	0.0788
MLR			
1	0.0997	63	0.8717**
2	0.1795	35	0.0561
3	0.2513	25	0.1387
4	0.3307	19	0.1225
5	0.4188	15	0.0792
6	0.8976	7	0.0391
Δ*MLR*			
1	0.1309	48	0.02738
2	0.23271	27	0.01402
3	0.31416	20	0.03793
4	0.41888	15	0.02515
5	1.5708	7	0.07322
6	0.8976	4	0.05899

Test statistic = $\max\hat{\rho}(\phi_{0,j})/n$ and p values for ALR, ΔALR, *MLR*, and Δ*MLR* are (0.7676, 1), (0.1189, 0.9774), (0.8717, 1), and (0.07322, 0.4067), respectively

** Significant at 10% level

* Significant at 5% level

Joint Test: 10 and 5% Critical regions = (0.0331, 0.0199)

Individual Tests: 10 and 5% Critical regions = (0.1403, 0.2411)

icance level for both leverage and changes in leverage. Most notably, the change in leverage is supposed to be stationary even if the leverage ratio is slowly mean reverting. We find that changes in leverage are persistent and cyclical. Thus, our results imply that the mean reversion predictions of trade-off and pecking order theories and mechanical mean reversion are rejected in favor of cyclical and persistent capital structure.

4 Robustness checks and market leverage extension

We use the annual leverage (ALR) and market value (MLR) ratios of Graham et al. (2015) to determine the robustness of our results. To eliminate a possible real unit root, we calculate the change of the ratio as the annual difference. We perform the

Table 6 Results of the $\hat{A}_{k.p}$ test for annual and market leverage ratios and changes in annual and market leverage ratios (1920–2010)

p	*ALR*		Δ*ALR*	
	$\hat{A}_{k.p}$	p value	$\hat{A}_{k.p}$	p value
1	103.38	0.0000	32.35	0.0012
2	166.28	0.0000	23.59	0.0231
3	171.72	0.0000	30.49	0.0024
4	174.92	0.0000	23.18	0.0262
5	177.49	0.0000	21.79	0.0399
6	175.22	0.0000	18.66	0.0970
7	174.45	0.0000	17.44	0.1339
8	170.5	0.0000	19.08	0.0867
12	167.61	0.0000	19.26	0.0824
18	172.19	0.0000	19.87	0.0697
24	163.72	0.0000	12.87	0.3785
36	157.1	0.0000	13.56	0.3201
48	159.37	0.0000	19.31	0.0792
p	*MLR*		Δ*MLR*	
	$\hat{A}_{k.p}$	p value	$\hat{A}_{k.p}$	p value
1	112.32	0.0000	20.36	0.0607
2	36.46	0.0003	23.39	0.0246
3	36.55	0.0003	35.29	0.0004
4	36.61	0.0003	45.63	0.0000
5	36.53	0.0003	44.07	0.0000
6	35.47	0.0004	46.90	0.0000
7	34.48	0.0006	40.05	0.0001
8	36.90	0.0002	51.56	0.0000
12	36.26	0.0003	61.21	0.0000
18	43.98	0.0000	40.05	0.0001
24	37.81	0.0002	40.06	0.0001
36	34.89	0.0005	53.91	0.0000
48	34.48	0.0006	48.35	0.0000

10% Critical region = (18.55) and 5% Critical region = (21.03)

$B(k)$ test to examine the persistent and cyclical null hypothesis against persistent and noncyclical leverage. Next, we conduct the $\hat{A}_{k.p}$ test to examine the null hypothesis of mean reversion against persistent and cyclical leverage. The annual data of Graham et al. (2015) is long enough to include possible long waves in capital structure. The results of the tests and cycle periods in years are reported in Tables 5 and 6.

The results of the $B(k)$ test are given in Table 5. As shown, the joint test suggests that the complex unit root hypothesis cannot be rejected. We note that the cycle durations for ALR and MLR have very close characteristics. More specifically, the last four cycles of ALR (26, 20, 17 and 7 years) and MLR (25, 19, 15, and 7 years) match the cycle periods found in the quarterly data. However, these cycles are rejected to have only one pair of complex unit roots. We notice that the most significant peaks occur at cycle durations of 69 (276-Q) and 63 years (252-Q), which are typical Kondratieff long waves; these cycles cannot be rejected at the 10% level. These results are consistent with our earlier results; the hypothesis that leverage is persistent and noncyclical is rejected. Although the joint hypothesis that changes in leverage, ΔALR and ΔMLR, has six complex unit roots cannot be rejected, each cycle is rejected individually at the 5% significance level in favor of a single unit root. However, due to first order differencing, these differenced variables cannot be unit root without a higher order characteristic. We next conduct the $\hat{A}_{k.p}$ test to determine if each of these differenced series is mean reverting against complex unit roots.

The results of the $\hat{A}_{k.p}$ test are shown in Table 6. Again, we reject mean reversion in favor of cyclical and persistent leverage for ALR, MLR, and ΔMLR across all lag lengths. However, the last eight autoregressive lag polynomials of the ΔALR show mean reversion and the first six lags show a complex unit root. We conclude that capital structure is cyclical and persistent, and is consistent with the persistent versions of the trade-off, pecking order and market timing theories. The persistence of capital structure is due to the cyclical financing decision; this supports the study by Jermann and Quadrini (2012) that finds cyclical leverage following persistent technological shocks. Our results are robust regardless of whether we use the book value or market value of equity and whether we use quarterly or annual data in our analysis.

5 Conclusion

The purpose of this paper is to determine whether capital structure is persistent, mean reverting, and/or cyclical. Our first hypothesis where leverage and changes in leverage are persistent and noncyclical is rejected in favor of persistent and cyclical null. This is in contrast to the Modigliani and Miller (1958) theory that capital structure is irrelevant and should be persistent and non-cyclical. Our results are consistent with trade-off theory literature that capital structure is cyclical either due to the benefits of debt or a firm's need for financial flexibility. We support the business cycle models of capital structure which find persistent and cyclical leverage. Moreover, our findings substantiate previous pecking order theory literature that suggests capital structure is persistent due to earnings persistence, and cyclical because leverage decreases as earnings increase during booms, and leverage increases as earnings decrease during recessions. Further, our results are consistent with preceding studies that examine market timing theory. These studies suggest that a firm's capital structure is persistent because it is a result of all prior issue decisions and is cyclical because firms will issue equity during expansions and issue debt during contractions. To test the robustness of our findings, we examine the mean reversion null against persistent and cyclical leverage. We reject the mean reversion theories in previous trade-off and pecking order literature and conclude that capital structure is persistent and cyclical. Firms do not change their capital structure to meet its target debt ratio or due to earnings changes. They consider both investment spending and external financing costs when making capital structure decisions.

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