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An empirical application of the EVA® framework to business cycles

Nicolás Cachanosky [a,*], Peter Lewin [b]

[a] Department of Economics, Metropolitan State University of Denver, Campus Box 77, P.O. Box 173362, Denver, CO 80217, United States
[b] Naveen Jindal School of Business, University of Texas at Dallas, 800W Campbell Road, Richardson, TX 8508, United States

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ABSTRACT

Following financial concepts like duration and economic value added (EVA®) we estimate the impact of interest rate movements on firms that are more and less *roundabout*. We find that firms that are more roundabout, that is, work with expected cash-flows with higher *duration*, are more sensitive to interest rate movements. To the extent that monetary policy is able to move the discount rate used by investors, monetary policy changes the relative present value of any investment project and therefore affects resource allocation. We show evidence that this effect is present in the U.S. in the years prior to the subprime crisis.

1. Introduction

In this paper we apply the EVA® framework and financial concepts like duration to business cycles, in particular to the 2008 subprime mortgage crisis. The application of financial tools used to analyze firm's performance and value bond cash-flows has rarely been applied to macroeconomics. On the contrary, the traditional way to understand macroeconomic cycles relies heavily on aggregates such as output, unemployment, investment, and price level indicators. In this paper we offer a financial application of macroeconomic disaggregation.

It is well known that the traditional macroeconomic model-setting composed exclusively of aggregates is inadequate for a complete understanding the 2008 crisis. Because of this inadequacy several scholars have turned to the Mises-Hayek, or Austrian, Business Cycle theory (ABCT), to help explain it (Borio & Disyatat, 2011; Calvo, 2013; Diamond & Rajan, 2012; Hume & Sentance, 2009; Lal, 2010; Leijonhufvud, 2009; Ohanian, 2010).[1] Most of this literature, however, falls short when pointing to empirical evidence that is distinctive to the ABCT. Specifically, it is not easy to provide evidence to show that during a period of easy monetary policy marginal investment occurs in projects that are *too roundabout*, meaning that they are too capital-intensive and have too long an investment period to be sustainable at the equilibrium or Wicksellian natural rate of interest. We call this effect produced by monetary policy on the length of investment[2] or degree of roundaboutness the ABCT-effect. The ABC can be summarized as a business-cycle that occurs owing to Wicksell-effect distortions when interest rates are pushed outside their equilibrium levels.

The challenges to an empirical study of the ABCT are well known. Macroeconomic data is simply not available in a way that allows one to easily assess the empirical significance of the ABCT thesis.[3] Nonetheless, some studies point to the presence of the ABCT-effect in the U.S. as well as internationally in the years prior to the 2008 crisis (Cachanosky, 2014b, 2015b; Hoffmann, 2010; Young, 2012). None of these studies, however, rely on a financial approach to this problem. Following Cachanosky and Lewin (2014, 2016) we use the EVA® framework to study the presence of the ABCT-effect in the 2008 crisis.

* Corresponding author.
E-mail addresses: ncachano@msudenver.edu (N. Cachanosky), plewin@utdallas.edu (P. Lewin).

[1] Hoffmann (2010) is an exception. See also Caballero (2010). For a review of the renewed interest in the ABCT see Cachanosky and Salter (2016).

[2] A convenient and consistent measure of this is provided by the concept of duration (D) found in the financial literature and discussed below.

[3] Some examples of empirical work in this area are Keeler (2001); Lester and Wolff (2013); Luther and Cohen (2014); Mulligan (2005, 2006, 2013), and Young (2005). As far as we can tell, this is the first empirical work using EVA® to assess this particular theory.

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In the next section we present the financial framework and its relation to business cycles. In section three we discuss the points in favor of and against the ABCT interpretation of the subprime crisis. In sections four and five we present stylized facts and an econometric model to assess the presence of ABCT-effects respectively. Section six concludes. The appendix provides a table of the abbreviation used in this paper.

2. The EVA® framework and business cycles

The market value (price) of an investment project is the present-value of its discounted cash-flow. Formula 1 shows the free-cash-flow (FCF) calculation in discrete time.

$$V = \sum_{t=0}^{\infty} \frac{FCF_t}{(1 + WACC)^t} \tag{1}$$

where V is the market value of the expected cash-flow, t is the time period, *FCF* is the expected free cash-flow,[4] and *WACC* is the weighted average opportunity cost of capital. If the project is financed exclusively with a loan from the bank, then the *WACC* equals the interest rate charged by the bank. But in the presence of multiple investors the opportunity-cost of capital is the weighted average of all the investors' opportunity-costs. For simplicity it is assumed that the *WACC* is the same for each period of the project. This simplification, instead of assuming different discount rates per period, does not affect the implications of the paper. It can be shown that formula 1 is mathematically equivalent to formula 2 (Koller, Goedhart, & Wessels, 1990, pp. 697–699).

$$V = K_0 + \sum_{t=1}^{\infty} \frac{(ROIC_t - WACC) \cdot K_{t-1}}{(1 + WACC)^t} = K_0 + \sum_{t=1}^{\infty} \frac{\text{EVA}_t}{(1 + WACC)^t} \tag{2}$$

where *ROIC* is the rate of return over invested capital and K is the financial capital invested by the firm. EVA® stands for *economic value added*, the excess of the rate of return over the opportunity cost of capital times the amount of capital invested. EVA®, then, is another term for economic profits. Given that K_0 represents the initial value of capital, $V - K_0 = MVA$ where *MVA* stands for market value added (to the capital already owned). *MVA* is the expected value added for the investors and is the present-value of future expected economic profits.

$$MVA = \sum_{t=1}^{\infty} \frac{(ROIC_t - WACC) \cdot K_{t-1}}{(1 + WACC)^t} = \sum_{t=1}^{\infty} \frac{\text{EVA}_t}{(1 + WACC)^t} \tag{3}$$

This is the EVA® framework we use in this paper. In corporate finance this is mostly used in preference to *FCF* for two reasons. First, it allows one to track economic profits (EVA) for each period. This is not possible in the traditional *FCF* representation because the cash-flow is not represented in terms of economic profits *per* period. Second, because $FCF = NOPAT - NI$, it is possible that a positive EVA value in any given period is paired with a negative FCF in the same period inviting confusion about the performance of the project in any given period. Succinctly, EVA is a cleaner estimate of firm performance when looking at particular periods and not only at the present-value.[5]

It is well known that associated with a series of cash-flows and a present-value for any multi-period project there is a measure of the average time for which one must wait to earn a dollar from the investment in the project known as Macaulay duration (D) or its closely related measure, modified duration (*MD*.) Duration is a value-weighted measure of average time "involved" in the project and as such provides a unique opportunity to operationalize the concepts of "long-term" *versus* "short-term" investments as articulated in the ABCT.[6] Formula 3 can be combined with D to provide for three essential investment properties key to the ABCT. (1) It is forward looking, (2) it captures discount rate sensitivity, and (3) resource allocation in different period of time (K). Characteristic number three is not present in the *FCF* formulation and *MVA* allows us to track the allocation of resources across time and firms.

Different cash-flows have different values of D, and therefore the value of some investment projects are more sensitive to movements in the discount rates than others. It can also be shown that the present-value of cash-flows with higher values of K are more sensitive to movements in the discount rate (Cachanosky and Lewin (2014, p. 659). In other words, present-values of longer cash-flows and higher values of financial capital are paired with higher interest rate sensitivity. And D is what drives the ABCT-effect.

If different projects have different expected cash-flows, and therefore different values of D, it follows that movements in the discount rate will affect the relative present-values of said projects in favor of projects with higher D (more roundabout). The natural or Wicksellian interest rate is the one that results in projects with an optimal D (not too short, not too long).[7] Note that it is possible to have an interest rate different from its natural level and have full employment of resources but assigned to projects with the *wrong* value of D. This is a *time* inconsistency problem, not an unemployment problem.

Starting from equilibrium, assume two types of project, high-D (HD) and low-D (LD). Then resources are allocated in an optimal aggregate D ($\hat{D}^*$). Therefore, if there is a monetary policy successful in moving downward the discount rate used in the market the estimated (expected) present-values of *HD* projects rise more than those of *LD* projects.[8] This change in relative prices signals that resources should be reallocated from *LD* projects o *HD* projects thus increasing $\hat{D}$ beyond $\hat{D}^*$.

$$\hat{D} = D_{HD} \cdot w_{HD} + D_{LD} \cdot w_{LD} \tag{4}$$

where $\omega_j = \frac{MVA_j}{MVA}$, $j = \{HD, LD\}$. If the discount rate is below its natural level, then the price change signals the reallocation of resources such that $\hat{D} > \hat{D}^*$ as the weight of resources allocated to *HD* projects rises and the weight of resources allocated to *LD* projects falls, and similarly for the *MVA* of each type of project.[9]

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[4] $FCF = NOPAT - NI$; where *NOPAT* stands for net operating profits after taxes and *NI* stands for net investment.

[5] EVA®, a trademark of Stern Value Management, is used in corporate finance as a way to estimate economic profits and calculate management compensation, it became popular in the 1990s. EVA® in itself it a re-arrengement of the well-known FCF estimation. To name a few, some companies that apply EVA® are General Electric, Coca-Cola, Microsoft, Merck, IBM, Procter & Gamble, Inter, AT&T, Wal-Mart Stores, Boeing, Time Warner, and Apple (Fernandez, 2002; Tortella & Brusco, 2003).

Certainly there are other uses of the EVA® framework, like the estimation of value drivers to track which components of the cash-flow add more value to the firm. See Ehrbar, 1998; Koller et al. (1990); Stern, Shiely, and Ross (2003); Stewart (1991), and Young and O'Byrne (2000).

[6] As originally conceived, the ABCT attempted to make use of Böhm-Bawerk's (1884) average period of production (*APP*). It turns out that Böhm-Bawerk's formula is an inadequate measure insofar as it puports to be a purely physical measure of time and yet time itself has to be valued – interest is inevitably involved. Hicks (1939) independently came up with a construct that measures time in value-weighted terms which he called the "average-period" (*AP*) and which is identical to Macaulay duration (D). See Lewin and Cachanosky (2014) and Osborne (2005, 2014).

[7] On the Wicksell or natural rate of interest see Anderson (2005); Garrison (2012), and Williams (2003).

[8] It could be argued that central banks have little impact on market interest rates. This, of course, begs the question of why central banks target a market interest rate. It is different to say, however, that in the long-run central banks cannot control real interest rates than to say that their effect is null in the short-run. The problem is that the short-run might be long enough. As an example, there are two empirical ways to show that central banks do have the power to move interest rates away from their equilibrium values. One is Taylor (2009), who shows how the Federal Funds rate deviated the Federal Funds rate from the Taylor rule target between 2002 and 2006. Another way is to compare the Federal Funds rate with estimations of the natural or Wicksellian interest rate, from which the Federal Funds rate also deviates as shown in Fig. 1 below (Laubach & Williams, 2003; Selgin et al., 2015).

[9] The rational expectations objection to this effect fails on the ground that real, tangible wealth effects are produced favoring *HD* projects, and also that expectaions are not single-valued and systematic errors will be made, see the discussion in Cachanosky (2015a).

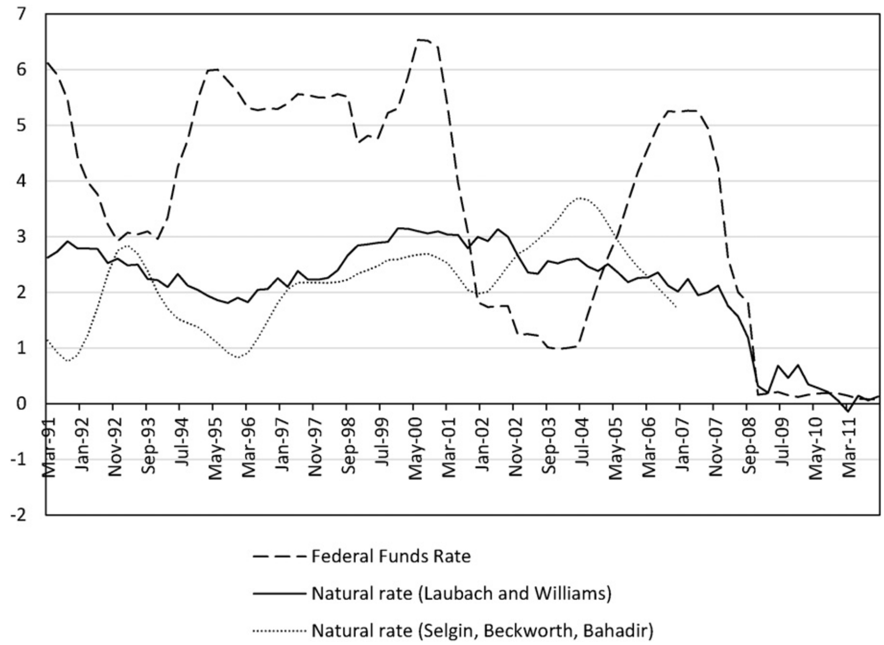

Fig. 1. Federal Funds rate and natural rate estimations.

Intuitively what is happening can be summarized as follows. A fall in the discount rate makes some projects with negative present-values look not only profitable, but more-so than other projects that already had positive values at the natural rate of interest. Marginal investment occurs in the project with the expected higher return. If the fall in the discount rate is policy induced, then the opposite effect occurs when the monetary authority reverses its policy and increases interest rates. Some projects now not only look less profitable than alternative projects, but may have negative *MVA*s showing that they are, in fact, unsustainable. The policy-induced boom in *HD* projects eventually becomes a bust. This is, in financial terms, the Wicksell (ABCT) effect, that has been used as an explanation of the subprime crisis.[10] It is the presence of this effect what we study in this paper. Before looking at the data, we have something to say about the ABCT-effect as an explanation of the subprime crisis.

3. The ABCT-effect as explanation of the subprime crisis

As we mention in the introduction, a number of scholars have turned to the ABCT to explain the 2008 subprime mortgage crisis. Others have offered ABCT-consistent arguments (without an explicit endorsement) to explain the subprime crisis as well (McKinnon, 2010; Meltzer, 2009; Schwartz, 2009; Taylor, 2009). At first sight, the events that led to the subprime crisis fit into the stylized facts of the ABCT. At the turn of the century the Federal Reserve decided to reduce the federal fund rates to historically low levels. The result was a bubble that eventually burst triggering a recession. The crisis provoked interest in NGDP Targeting as a monetary policy rule, which is a special case of Hayek's (1931) own position to avoid credit induced business cycles.[11] While nothing in that *contradicts* the ABCT, nothing *specifically* supports the ABCT-effect.[12]

As discussed in the previous section, all else equal, a policy that is successful in reducing the discount rate will increase the relative present-values of *HD* investment projects relative to the present-values of *LD* investment projects. However, the loose monetary policy that took place after 2001 did not occur under *all else equal* conditions. Specific regulation in place channeled the excess of credit into the housing market, hence a bubble in the housing market (Allison, 2012, Chapter 7; White, 2008).[13] Fig. 1 shows the federal funds rate and natural rate estimations by Laubach and Williams (2003) and Selgin, Beckworth, and Bahadir (2015). Both estimations show that the federal funds rate was below the natural rate estimations. (See Fig. 2.)

The reason we talk about the subprime crisis and the housing bubble is because these are the events that triggered a renewed interest in the ABCT. Our paper, however, explores whether ABCT effects can be captured in the rest of the economy. In short, we want to offer a financial microeconomic look at economic activities other than the housing market to expand the empirical research done so far on this business cycle theory.

4. Stylized facts

We use e *EVA Online* database from the *EVADimensions* to study to what extent monetary policy is correlated with resource allocation. The *EVA Online* database provides yearly estimations of the *EVA*, *MVA*, *K*, and *WACC* for firms that are present in stock exchanges around the world. The series goes from 1997 to 2014. Using the firms present in the Dow Jones Index in 2001 we build two groups: (1) *HD* (high duration) and (2) *LD* (low duration). The *HD* group consists of the 10 largest firms in terms of financial capital. It can be shown that firms with a larger *K* have a larger duration *ceteris paribus* (Cachanosky & Lewin, 2014). The *LD* group consists of the 10 smaller firms in terms of financial capital. Capital is defined as the value of "the corresponding investment in the firm's net business assets, including rented assets – covering working capital, net PP&E [plant, property, and equipment], investments in intangibles, investments at equity and cost, goodwill

[10] For a more detailed discussion of this effects in financial terms see Cachanosky and Lewin (2016), Cachanosky (2015a) and Lewin and Cachanosky (2016).

[11] See Cachanosky (2014a); McCallum (2011); Salter (2013) and Sumner (2012, 2013).

[12] For a comparison between the ABCT and other business cycle theories see Sechrest (1997) and Shah (1997).

[13] It might be thought that building houses is not a high roundabout process. Young (2015), for instance, argues that the ABCT theory needs to be updated to account for risk in the financial market to capture the characteristics of the subprime crisis. This is not true. Insofar as houses and other durable structures embody services that are received over a long period of time, they are indeed long-term investments. The distinction between production and consumption in this case is an irrelevant national income accounting convention. The purchase of a house is a long-term, capital-intensive investment in order to receive of a flow of housing services.

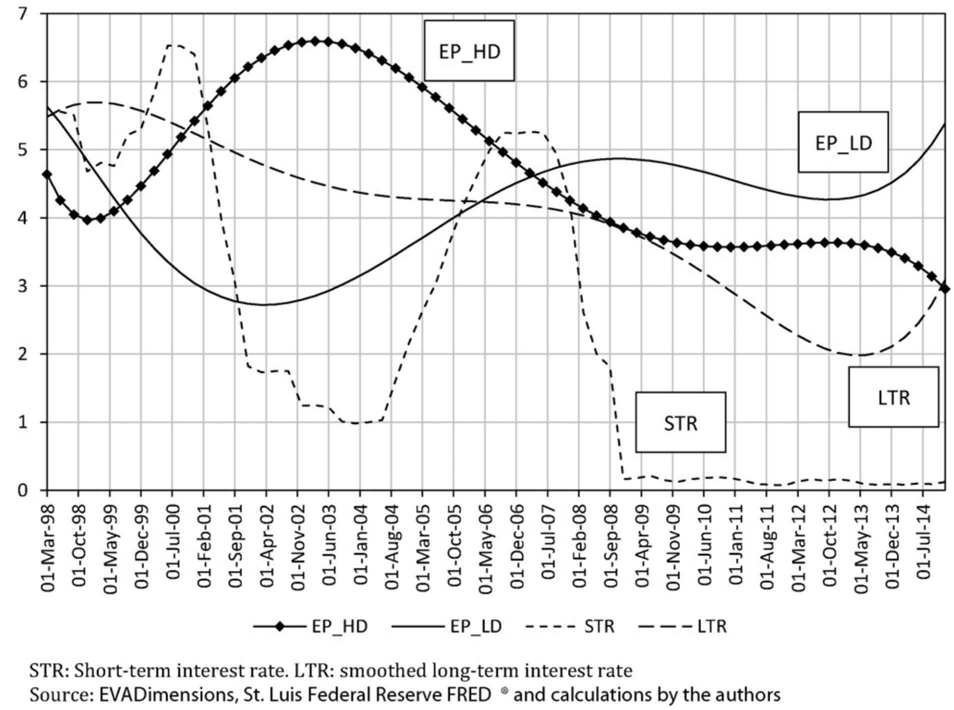

Fig. 2. Economic profit rate, short-term and long-term interest rate. STR: Short-term interest rate. LTR: smoothed long-term interest rate. Source: *EVADimensions, St. Luis Federal Reserve FRED ® and calculations by the authors.*

and miscellaneous assets – but net of excess cash, so that the measures correspond."

We apply two filters to the firms chosen for each group. First, firms that have gone bankrupt or merged with another for which no data is available are left out of the sample. Second, two firms, General Motors (HD) and Microsoft (LD), are also left out of the sample. The reason is that these two firms have an outlier behavior and each firm is also the largest one in each group. By leaving these two firms out we avoid affecting the behavior of each group by the particular own conditions of these firms. The two groups include the firms shown in Table 1.

We would like to comment on the fact that two similar firms, IBM and Hewlett-Packard, are in different groups. Can two firms that build computers be on different groups? In principle it is possible, since the size, in terms of *K*, also affects the duration of the firms. But it is also the case that IBM has changed its business moving away from computer manufacturing and focusing on IT solutions like outsourcing, integrated technology, integration services, enterprise applications and analytics, processing platforms, processing bid data, data analytics, business servers, and data storage among others. In 2005 and 2014 IBM sold its personal computer and ×86 server businesses to Lenovo. These two firms do not provide anymore the same kind of goods and services to their customers.

We expect two things. First, that the *perceived* profits of the *HD* group would be more sensitive to those of the *LD* group. Secondly, that the *HD* group will expand faster than the *LD* group when interest rates fall. If this is the case, then ratio K_{HD}/K_{LD} should increase.

From the *EVA Online* database we aggregate the variables *K* and *EVA* for each group with $f = 1 \ldots 10$ firm for each year *t*, $K_{HD,t} = \sum_{f=1}^{10} K_{f,t}$ (similarly for the other group.) With these two aggregates we can estimate the economic profit rate (EP) for each group. Given that $EVA_t = (ROIC_t - WACC_t) \cdot K_{t-1}$ we define the economic profit rate as the spread between the *ROIC* and the WACC: $EP_t = \frac{EVA_t}{K_{t-1}}$.[14] The *EP* variable captures the first effect mentioned above. The percent change in *K* captures the second effect discussed above. Note that *EP* shows the profit *rate*, not the absolute value of profits.

There are two caveats to mention. In first place investment is expected to depend on long-term interest rates (LTR) while the Federal Reserve targets a short-term interest rate (STR) such as the federal funds rate. Therefore, we use both, the *STR* and the smoothed *LTR* series to see if there is any difference in their correlations. Secondly, the subprime crisis can be considered a change in market conditions. Especially because of interest being paid on reserves by the Federal Reserve we expect monetary policy to have less of an effect on firms after this policy was put in place. Succinctly, after the subprime crisis the increase in reserves was not being channeled to the market. This regime change can be seen in the different correlation values, some of which change sign, between the periods 1998:Q1–2007:Q4 and 2008:Q1–2014:Q4 shown in Tables 2 and 3. (See Table 1.)

Note that for the period 1998:Q1–2007:Q4 the ratio of *K* has a higher correlation with *LTR* than with *STR*. Note also the negative correlation between interest rates and EP_{HD}, though the correlation is higher with *STR* than with *LTR*. Finally, *STR* is more correlated with EP_{HD} than *LTR* suggesting the possibility that monetary policy that affects short-term

Table 1
HD and LD groups' components.

HD group		LD group	
Firm	Ticker	Firm	Ticker
Exxon Mobile	XOM	Hewlett-Packard	HPQ
Citigroup	C	The Boeing Company	BA
Wal-Mart Stores Inc.	WMT	The Home Depot, Inc.	HD
AT&T	T	Alcoa Inc.	AA
International Business Machines Corp.	IBM	The Coca-Cola Company	KO
JPMorgan Chase & Co.	JPM	United Technologies Corporation	UTX
General Electric	GE	American Express	AXP
The Walt Disney Company	DIS	E. I. du Pont de Nemours and Company	DD
International Paper Co.	IP	Eastman Kodak	KODK
Intel Corporation	INTC	Caterpillar Inc.	CAT

[14] $EP_{HD,t} = \frac{EVA_{HD,t}}{K_{HD,t-1}}$ and the analogous for the *LD* group.

Table 2
Correlation matrix, 1998:Q1–2007:Q4.

Time	K_{HD}/K_{LD}	EP_{HD}	EP_{LD}	*STR*	*LTR*	
1	0.9820	0.2409	0.0193	−0.2409	−0.9572	*Time*
	1	0.0676	0.1420	−0.0846	−0.8876	K_{HD}/K_{LD}
		1	−0.8257	−0.8362	−0.4791	EP_{HD}
			1	0.5800	0.1322	EP_{LD}
				1	0.4711	*STR*
					1	*LTR*

Table 3
Correlation matrix, 2008:Q1–2014:Q4.

Time	K_{HD}/K_{LD}	EP_{HD}	EP_{LD}	*STR*	*LTR*	
1	−0.4053	−0.8014	−0.0414	−0.5650	−0.8370	*Time*
	1	−0.0931	0.9164	0.3047	0.8328	K_{HD}/K_{LD}
		1	−0.3500	0.6640	0.4569	EP_{HD}
			1	0.2198	0.5809	EP_{LD}
				1	0.5820	*STR*
					1	*LTR*

interest rates does have a potential impact, even if indirect, on perceived profit by the firms. We also like to point out to the fact that EP_{LD} has a positive correlation with both interest rates. This does not mean that profits in absolute values decrease when interest rates do so. EVA_{LD} for instance, is negatively correlated with *LTR*. What this means is that the rate of profits is decreasing. This is because K_{LD} grew faster than EVA_{LD}; for the 1998–2007 period K_{LD} and EVA_{LD} grew 83.9% and 62.6% respectively.

The correlation results also suggest that *K* is going to be unevenly affected by movements in interest rates. Fig. 3 shows the quarterly percent change in K_{HD} and K_{LD}. Until the subprime crisis their behavior depicts an opposite behavior to each other. The growth in K_{LD} decreases and even becomes negative after the crisis. The growth rate of *K* in the HD (LD) increase (decrease) with STR and LTR between 2000 and 2004 and revert their behavior when LTR starts to flatten and STR increases.

This initial result suggests the presence of some ABCT-effects. These results are also consistent with the findings of Young (2012) for the U.S. economy for the same period. In the next section we turn to an econometric model.

5. Econometric model

To get a better measure of the correlation between the relative size of *HD* and *LD* firms we run an ARMAX(1,0) model were we regress the differentiated K_{HD}/K_{LD} ratio on *STR* and *LTR* interest rates plus a selection of controls. The reason we differentiate the K_{HD}/K_{LD} series is to avoid stationarity of the series. Before discussing the results, a few explanations are needed.

First, as mentioned in the previous section, we consider the subprime crisis a potential change of monetary policy regime. Therefore, we add a dummy with value one since 2008 and interaction terms of the dummy with time and interest rates variables. This allows us to capture a potential difference in intercept and marginal effects before and after 2008.

Second, because *STR* and *LTR* interest rates are correlated, we do not run them together in the same model to avoid coefficient interpretation problems due to multicollinearity between these two variables. Similarly, note that *LTR* and the time period variable have a correlation coefficient of −0.9572. This means that part of the effect of the *LTR* on the capital ratios of the *HD* and *LD* group might be captured in the time coefficient instead of showing up in the LTR coefficient. For this reason, we run two models (5 and 6) with *LTR* but no time trend.

Third, the *EVA Online* dataset is on a yearly basis. We produce quarterly data through a six-degree polynomial interpolation. Admittedly this does not add information on the *EVA Online* series, but it allows us to use quarterly data on the other variables used in the model.[15] (It implicit uses the assumption of proportionality to estimate extra data points, and, the strength of the model will depend on the strength of that assumption).

Finally, we use a smoothed *LTR* series. We expect the trend of the *LTR* to be more correlated than short-run oscillations due to temporary movement of demand or supply. The *STR* series is smooth enough and we use it as it is.

Our base model is the following:

$$\Delta\left(\frac{K_{HD}}{K_{LD}}\right)_t = c + \beta_1 t + \beta_2 (t \cdot D_t) + \beta_3 \Delta\left(\frac{K_{HD}}{K_{LD}}\right)_{t-1} + \beta_4 i_t + \beta_5 (i_t \cdot D_t) + \beta_6 U_t + \beta_7 \cdot D_t + \varepsilon_t \tag{5}$$

where *c* is the constant term, *i* is the interest rate (*STR* or *LTR*), *t* denotes the time period, *D* is the dummy variable, and *U* is the unemployment rate. In terms of robustness we run different versions of the same base model. The basic iteration consists of using either *STR* or *LTR* and their lagged values. We do not run contemporaneous and lagged values of the interest rate because these series are serially correlated. Because of the high correlation between *LTR* and the time variable, we also run a model with *LTR* and no time variable.[16] The results are show in Table 4.

Note first, that in terms of the sign of the interest rates coefficient before the subprime crisis, five out of six of them show the expected sign and are statistical significant save for model 4 (see below about economic significance).

Second, the dummy variable signals a regime change in 2008 by (1) having a statistical significant effect on the intercept (especially models 1 to 4) but also (2) by affecting the slope – marginal effect – of *STR* and *LTR* on the capital ratio of the *HD* and *LD* groups captured in the various of the interaction terms.

Third, it should be noted that while the AR(1) coefficients are less than 1 in absolute values, they show a long-memory in the $\Delta(K_{HD}/K_{LD})$ series. While certainly investments in large firms like the ones observed in our sample are difficult to reverse, the impact of these coefficients should be kept in mind the economic significance calculations discussed below.

Admittedly the economic significance of the coefficient is hard to interpret because the regressed variable is the difference of the ratio of two variables. To have an estimation of the economic significance we perform a simple simulation in the following way. We assume a deviation of 0.10 on the interest rates for the period 2002:Q1 to 2005:Q5. This will show the accumulated deviation of the predicted values from the observed values or this time period. We take this to be the period when the Federal Reserve had a *loose* monetary policy. While the particular start and end of this window can be discussed, we find this period to be aligned with Taylor (2009) and Fig. 1 reproduced above. We use the 6 models to calculate the percent deviation between the estimate hypothetical values of $\widehat{\frac{K_{HD}}{K_{LD}}}$ and the observed value of this series (Table 5). It should be considered that, besides long-memory in the AR(1) coefficients, we are performing a linear estimation of the effect of the interest rate (*STR* or *LTR*) on K_{HD}/L_{HD}, but this effect is likely not linear. The results shown in Table 5 have high values that should be read more as a pattern effect than as a point prediction.

With the exception of model 4, all predictions show results with similar magnitudes; in relative terms, *HD* firms over-expand with respect to *LD* firms. At this point we want to mention two negative

[15] Also for this reason we don't adjust for quarterly seasonality in the regression.

[16] The addition of other controls like change in real GDP and exchange rates with the Euro and the Chinese Yuan are left out beacause their presence in the model fails to improve the information criteria values. Namely, the cost in terms of degrees of freedom is larger than the control they bring to the model.

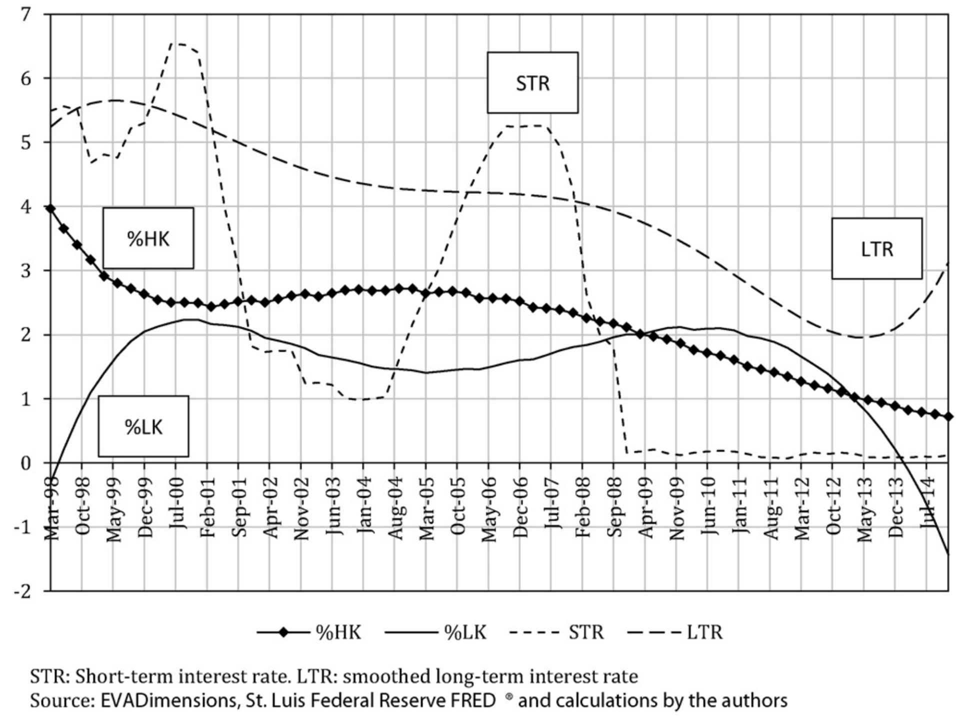

Fig. 3. Percent change in financial capital, short-term and long-term interest rates. STR: Short-term interest rate. LTR: smoothed long-term interest rate. Source: *EVADimensions, St. Luis Federal Reserve FRED ® and calculations by the authors.*

outcomes of this effect. First, to the extent that K rises because of more factors of production are allocated, then the HD group is *over* investing at the expense of *under* investment taking place in other markets. Because investment irreversibility the reallocation of these resources will be costly when the rise in the discount rate shows that the expected economic profit is not there. Second, to the extent that K rises because

Table 4
Econometric models, 1998:Q1, 2014:Q4.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
C	0.0214***	0.0306***	0.1597***	−0.0132	0.0453***	0.0435***
	(0.0044)	(0.0048)	(0.0056)	(0.0201)	(0.0088)	(0.0075)
AR(1)	0.8918***	0.8748***	0.8315***	0.9101***	0.9622***	0.9406***
	(0.0186)	(0.0192)	(0.0058)	(0.0277)	(0.0313)	(0.0300)
t	0.0002***	0.0002***	−0.0010***	0.0004 **		
	(4.27e−5)	(4.34e−5)	(4.38e−5)	(0.0002)		
D	−0.0358***	−0.0203***	−0.2733***	−0.0436***	−0.0109	−0.0077*
	(0.0078)	(0.0067)	(0.0060)	(0.0096)	(0.0080)	(0.0046)
t·D	0.0005***	0.0003***	0.0028***	0.0007***		
	(0.0001)	(0.0001)	(5.88e−5)	(0.0002)		
STR	−0.0027***					
	(0.0003)					
STR·D	0.0007					
	(0.0016)					
STR(t-1)		−0.0030***				
		(0.0004)				
STR(t-1)·D		−0.0020				
		(0.0013)				
LTR			−0.0264***		−0.0079***	
			(0.0009)		(0.0015)	
LTR·D			0.0380***		0.0017	
			(0.0010)		(0.0020)	
LTR(t-1)				0.0021		−0.0074***
				(0.0031)		(0.0011)
LTR(t-1)·D				0.0004		0.0007
				(0.0013)		(0.0013)
U	−0.0359***	−0.0203***	−0.2733***	−0.0436***	−0.0110***	−0.0017***
	(0.0078)	(0.0067)	(0.0060)	(0.0096)	(0.0007)	(0.0007)
Schwartz criterion	−567.2117	−565.8240	−737.5069	−514.3692	−499.0892	−504.7618
Akaike criterion	−584.8492	−583.4615	−755.1445	−532.0068	−512.3174	−517.9900
Hannah-Quinn	−577.8700	−576.4823	−748.1653	−525.0275	−507.0830	−512.7556

* Indicates significance at the 1 percent level.
** Indicates significance at the 5 percent level.
*** Indicates significance at the 10 percent level.

Table 5
Economic significance when *STR* and *LTR* fall 0.1%, 2002:Q1–2005:Q4.

	Model 1%($\frac{K_{HD}}{K_{LD}}$)	Model 2%($\frac{K_{HD}}{K_{LD}}$)	Model 3%($\frac{K_{HD}}{K_{LD}}$)	Model 4%($\frac{K_{HD}}{K_{LD}}$)	Model 5%($\frac{K_{HD}}{K_{LD}}$)	Model 6%($\frac{K_{HD}}{K_{LD}}$)
2002:Q1	3.1%	0.0%	3.1%	0.0%	2.9%	0.0%
2002:Q2	6.0%	3.0%	6.1%	−3.2%	5.7%	2.9%
2002:Q3	9.0%	5.9%	9.1%	−6.4%	8.5%	5.7%
2002:Q4	11.9%	8.8%	12.0%	−9.6%	11.3%	8.5%
2003:Q1	14.7%	11.7%	15.0%	−12.6%	14.1%	11.3%
2003:Q2	17.5%	14.5%	17.8%	−15.6%	16.7%	14.0%
2003:Q3	20.2%	17.2%	20.5%	−18.6%	19.3%	16.6%
2003:Q4	22.9%	19.9%	23.1%	−21.4%	21.9%	19.2%
2004:Q1	25.5%	22.5%	25.7%	−24.1%	24.4%	21.7%
2004:Q2	28.0%	25.1%	28.2%	−26.8%	26.9%	24.2%
2004:Q3	30.5%	27.7%	30.7%	−29.4%	29.3%	26.6%
2004:Q4	32.8%	30.1%	33.0%	−31.8%	31.7%	29.0%
2005:Q1	35.2%	32.5%	35.3%	−34.2%	34.0%	31.4%
2005:Q2	37.4%	34.8%	37.6%	−36.5%	36.3%	33.7%
2005:Q3	39.6%	37.0%	39.7%	−38.8%	38.5%	36.0%
2005:Q4	41.7%	39.2%	41.9%	−40.9%	40.8%	38.2%
2006:Q1	0.0%	41.4%	0.0%	−43.0%	0.0%	40.5%

the capital goods already in possession rise in *value*, the firm might experience solvency problems when the discount rate rises. Either way the relative rise in *K* is capturing the ABCT-effect.

6. Conclusions

It has been claimed that to properly understand the 2008 crisis the ABCT theory is needed. In this paper we provide an empirical approach that supports the intuition that the ABCT-effect was, at least to some extent, present in the events that lead to the 2008 crisis. Housing is not only a long cash-flow service that went through a bubble as predicted by this theory, similar effects can be observed when we group a sample of large firms into more and less roundabout or, what is the same, with more and less duration.

To do this we apply financial calculation and data to macroeconomic effects. We think this is interesting approach in need of further research. Just to mention a few research pats, our sample is limited in terms of number of firms, a better suited model could offer a better estimation of the impact interest rates have on the relative size of the firms. We focus on the relative size of firms, measured in *K*, other studies can observe at the effects on the *WACC*, *ROIC*, or *EP*. Firms could be grouped in economic sectors, rather than ranked by size, to mention a few. But as far as we know, this is the first study of its kind in the area of business-cycles.

Appendix A

Abbreviation

ABCT	Austrian Business Cycle Theory
AP	Average Period
APP	Average Period of Production
D	Duration
EVA®	Economic Value Added
FCF	Free-Cash-Flow
MD	Modified Duration
MVA	Market Value Added
NI	Net Investment
NOPAT	Net Operating Profits After Taxes
ROIC	Return Over Invested Capital
WACC	Weighted Average Cost of Capital

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