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Article

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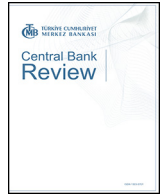
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How do fund rates affect the U.S. firms? A threshold estimation

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ABSTRACT

Purpose: The financing of growth of the firm is quite sensitive to fluctuations in Fund rates. This requires a treatment of Fund rates being subject to structural shifts. This paper examines the impact of threshold Federal Fund Rate (FFR), being a proxy for Federal Reserve policy, on different dimensions of growth of the US firm. The goal is to examine the extent to which shifts in FFR cause changes in firms' growth using three main proxies: assets, sales revenue and number of employees.

Design/methodology/approach: This paper follows "Threshold Fixed Effect" model as a new methodological treatment that offers a structural change in the sources of funds for financing growth of the firms. The authors propose that "Threshold Fixed effect regression" and "Threshold First Difference Generalized Method of Moments" provide robust results of the impact of FFR shifts on growth of the firms.

Findings: The main findings are as follows. First, the impact of FFR is substantially significant on growth of the firms listed in S&P500 when FFR declines below the threshold point 1.35 percent. That is, a slight move in the FFR adversely affects growth of firms four times higher relative to the situation when FFR is greater than 1.35 percent. Second, as far as actual Fund rates are fluctuating around zero percent, the results show that each one percent increase in the FFR is associated with a decrease in the firm size by 0.5 percent.

Originality/value: This paper offers **three** significant contributions to the literature. First, this paper offers a novel treatment of the effect of Fund rates on the financing of growth of the firm. As far as the authors' knowledge is concerned, this paper might be the first attempt to use "Threshold fixed effect" model to estimate the effects of threshold FFR on growth of the firm. Second, the results of threshold FFR offer robust evidence that theories of firm capital structure are contingent on structural changes in threshold interest rates. Third, this paper provides an empirical guideline to central banks regarding the determination of Fund rates that help firms to grow.

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1. Introduction

The literature concerned with the economics of the firm suggests that the epistemology of growth of the firm is centered around the efficiency of the use of capital whether borrowed (debt) or owned (equity) or both. As far as borrowed capital is concerned, the rate of interest is treated at all time as a benchmark for the use of borrowed capital. The same is true in case of equity capital. The latter cannot be considered as an efficient investment unless the internal rate of return is greater than an average interest rate in the

economy. The epistemology of growth and the efficiency of the firm have resulted in various proxies for growth. That is, growth in sales, profit, and number of employees (Delmar et al., 2003). Financing growth of the firm is widely examined in the firms' capital structure theories that include trade-off, pecking order and cash flow theories. The common factor in these theories is that firms use debt financing conditionally. Firms are highly sensitive to structural changes in interest rates. That is, market timing of interest rates determines the right time to borrow.

This paper contributes to the related literature in two ways. First, as far as firm capital structure is concerned, this study provides a threshold interest rate that helps firms to determine the right time to borrow. The expected outcome is to resolve the uncertainty of expected interest rate. Second, this paper provides an empirical guideline to central banks regarding the determination of interest rate that helps firms grow, thus materializes the role of

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central banks in economic growth at large.

The authors propose a model that assumes a structural shift in the funding of firms through external debt. The structure shift treatment corresponds to monetary policy adjustments that reduced the cost of external credits following the 2008–2009 financial crises. Specifically, the authors examine whether the monetary policy, being measured by FFR, does linearly and symmetrically affect growth of the firm. In this respect, this paper differs from prior studies in terms of utilizing the Threshold Fixed Effect and Threshold Difference Generalized Method of Moments to precisely depict the structural change in the impact of FFR on the growth of firms.

It is quite plausible to assume various drivers of growth of the firm. The cost of financing is quite detrimental driver as far as it is always treated as external factor being determined by monetary policy. Therefore, as firms grow, there must be a supportive monetary policy. Firms listed in S&P500 offer significant insights. The authors estimated that the market capitalization of S&P500 firms reached around \$23 Trillion in 2017 that is roughly 30% of the world's entire GDP which is estimated at \$77 Trillion. In addition, the authors note that those firms follow a dynamic process of activities in terms of employment and financial indicators. Over the period from 2000 to 2016, the average annual growth rate of employment for S&P500 was 3.5%, growth in sales and growth in market value of equity were 7% and 11.4% respectively (Authors' calculations). Over the period 2000–2016, the U.S. Federal Reserve (*hereinafter* FED) adopted different monetary policies that substantially affected the financial and employment activities of firms as well as investors' choices of financing methods between internally (retained earnings) and/or externally (debt or equity). In an effort by the FED to maximize employment and stabilize prices, a structural change in monetary policy can be identified over the period 2009–2015. The authors note that the FFR assisted a change to a range of zero to 0.25 percent (Klee et al., 2015).

In the light of this decision, this paper aims to provide an insight on whether the FFR policy impacts the growth decisions of S&P500 firms in terms of employment and financial activities over the period 2000–2016. Furthermore, this paper tests whether there is a significant structural change in the financing behavior (internal and external financing) of those firms that go in parallel with the change in Federal Reserve monetary policy. Conspicuously, dynamic growth of S&P 500 is a fundamental question. On the macro level, their annual growth can be a strategic issue for the financial market, job market, value added, and even the economic growth of the host countries. On a micro level, growth should be the optimal goal of any company as it benefits all *stakeholders* rather than focusing on share price only (Dobson, 2004).

The rest of the paper is divided as follows. The second section reviews the literature related to the role of interest rates in corporate financing. The third section offers a brief description of FFR trends. The fourth section discusses the data and the statistical estimation methods. The fifth section discusses the results. The sixth section concludes.

2. Interest rates and corporate financing decisions

The literature on corporate financing includes many studies that examine the effect of interest rate on corporate borrowing. The focal point is that firms offset the benefits and costs of internal financing versus external financing. Bosworth (1971), White (1974) and Taggart (1977) examine the effects of market interest rates on the decision to issue debt. They conclude that both the level and structure of interest rates are important determinants of the level of long-term debt issues. The interest rate affects both the cost of debt and subsequently cost of issuing new equity and thus affects

the weighted average cost of capital (WACC) as a whole. Barnea et al. (1981) presents a model of equilibrium analysis of debt financing under tax and agency consideration where they assert that agency costs of debt are shifted to debtholders in the form of lower interest rates. In Graham and Harvey (2001) survey, they reported that firms try to time interest rates by issuing debt when they feel that market rates are particularly low. Moreover, market timing is especially important for large firms, which implies that firms are more likely to time interest rates. Timing the debt issuance was thoroughly discussed in Klein et al. (2002) where they analyzed how timing the securities issue can signal the quality of the firm. This paper examines the effect of the current market interest rate as an indicator to the extent to which firms are timing market interest rate. Myers (1984) and Fama and French (2002) state that firms with positive net present value investments will follow the “Pecking Order” theory for financing investment needs. This implies that in the absence of internal funds, debt financing will be the only resort. The pecking order theory of corporate financing considers external financing as the last resort based on the assumption that interest rates might have negative impact that deters debt financing. Nevertheless, Eldomiaty et al. (2018) conclude that pecking order theory might work in a reverse manner. That is, debt financing might be preferred than equity financing. The pecking order theme is considered a reflection of the changes in FFR. In this respect, this paper aims to connect this finding with the monetary policy. In particular, the question is how does shifts in monetary policy affect the growth as well as the financing behavior of firms? In this case, certain econometric estimation techniques can be well adapted to provide a robust answer to this question. The literature cites an important relationship between debt financing and corporate growth as Frank and Goyal (2005) who found a negative relationship between debt financing and corporate growth. Besides, Bougheas et al. (2006) show that tight monetary policy has an adverse effect on the financing of firms. For the purpose of assessing the impact of interest rate policy on financial constraints, Foley-Fisher et al. (2016) show that the capital structure of firms is affected by the monetary policy adopted by the central banks. Despite the obvious negative effect of interest rates on growth of the firm (Gertler and Karadi, 2013; and Shleifer and Vishny, 2011; Greenwood and Hanson, 2013), a gap in previous literature appears in the linearity or non-linearity of this relationship. The authors carry out different threshold econometric models (Threshold fixed effect model, Threshold First Difference Generalized Method of Moments) as the main empirical methodology for this study. In fact, standard models (Fixed effect, Random effect, Generalized Method of Moments) might not consider the significant structural changes in the monetary policy of Federal Reserves, especially over the period 2009–2015. This might lead to a downward bias while measuring the impact of monetary policy on the growth of firms.

3. A review of FFR trends and financing decisions of US firms

This section illustrates the storyline of FFR over the period 2000–2016 and how changes in FFR could alter the financing behavior of firms.

3.1. FFR trends over the period 2000–2016

The U.S. monetary policy witnessed several phases over the period 2000–2016 that started by adopting a tight monetary policy and ended by adopting a loose « accommodative » monetary policy. The below figure highlights the high fluctuation in the FFR over the sample period from more than 6% at the beginning of the sample period dropping to less than 1% after the 2008 financial crises.

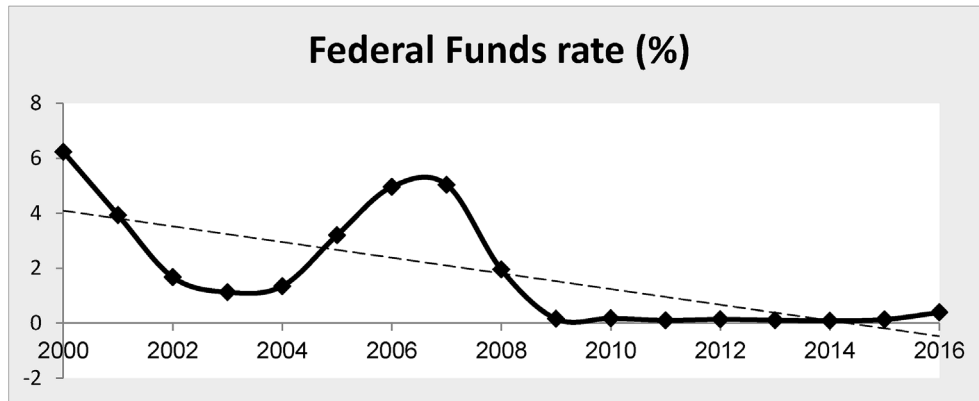


Fig. 1. Federal Funds Rate in percentage over the period (2000–2016).
Source: Authors' construction using Federal Reserve Database, 2017.

Following the September 2001 incidents, The FED adopted a loose monetary policy « accommodative policy » for the period 2001–2004 by setting the FFR around one percent in 2004 as noted in Fig. 1. As a response, the surge in energy prices caused an increase in inflation rate to reach 3.4% in 2004 (This compares to 1.9 percent in 2003). Hence, the Federal Open Market Committee (FOMC) decided that the loose « accommodative » stance of the monetary policy will be progressively removed. Nevertheless, inflationary pressures continued throughout the 2005–2008 period causing FOMC to shift to a tightening policy, yet inflation rate averaged 4.5 percent over the first three quarters of year 2008.

The financial crisis in 2008 was coupled with a decline in the global demand for oil and inflation rate that reached a low of negative 0.4 percent in 2009. In response to the weak economic activity and financial strains caused by the financial crisis, the FED followed an accommodative monetary policy by reducing the FFR to the range of zero to 0.25 percent throughout 2009–2015. The FED, 2005 report suggests that the FFR is expected to remain below the levels expected to prevail in the long run despite the US economy continuing to make progress towards the monetary policy goals.

3.2. Relationship between FFR and financing behavior of US firms

Fig. 2 above provide a visual account for the response of the financial leverage (as measured by debt to total assets and debt to equity respectively) of S&P 500 firms to the dramatic changes that in the FFR, over the period 2000–2016. The surge in Federal Fund Rate that occurred in 2005–2008 resulted in a decrease in both debt to total assets ratio and debt to equity ratio of S&P 500 firms. On the other hand, the prolonged period of zero interest rate policy that prevailed since 2009 following the financial crisis was coupled with an increase in the above ratios that continued steadily throughout the years 2010–2016 period.

The response of the S&P 500 firms' financial leverage to the historical changes in FFR explained above raise the need to assess the role of the FED's zero interest rate policy in the growth decision of S&P 500 firms.

4. Data and statistical estimation

4.1. Data

The data cover the years 2000–2016 for non-financial firms listed in S&P500. The data is obtained from Thomson Reuters Database (DataStream). The FFR data are obtained from Federal Reserve Economic Data (FRED). The macro variables are obtained

from world bank database.

4.2. Dependent variables

The literature on capital structure theories includes rigorous treatment of the effect of growth of the firm on financing decisions.. The common measures of growth of the firm include total assets, sales revenue, fixed assets, and number of employees (Harris and Raviv, 1991; Ghosh et al., 2000; Myers, 1977; Titman and Wessels, 1988). Delmar (1997), Ardishvili et al. (1998), Eldomiaty, 2010, Eldomiaty and Rashwan (2013), Kumar et al. (2017) refer to a list of commonly used proxies for growth of the firms; growth in assets, growth in sales, employability, market share, profit, and physical output. The three measures that are widely used due to availability and relevance are growth in sales, growth in assets, and employability (growth of number of Employees). Kirchhoff and Norton (1992) and Delmar et al. (2003) assert that the three measures are interchangeable. In this paper, the three main measures are adopted as dependent variables to assess firm's expansion, or growth, over the period 2000–2017.

4.3. Independent variables²

Table 1 presents the main independent variables used in the study. Besides, the table provides for each variable the exact definition and unit of measurement.

The estimating equation is as follows.

$$growth_{it} = \sum_{i=1}^t \beta' X_{it} + \beta' x_{it}(\gamma) + \mu_i + \delta_t + \vartheta_s + e_{it} \quad (1)$$

Where:

Growth refers to growth of the firm that is experimented using total assets, sales revenue and number of employees. β' presents the estimated coefficients of two types of explanatory variables (X_{it}) as follows.

- a) Macro-level variables that include the growth of gross domestic product (GDP) and percentage of domestic credit/GDP.

² See appendix for descriptive statistics of the variables. Data points that have missed observations have dropped.

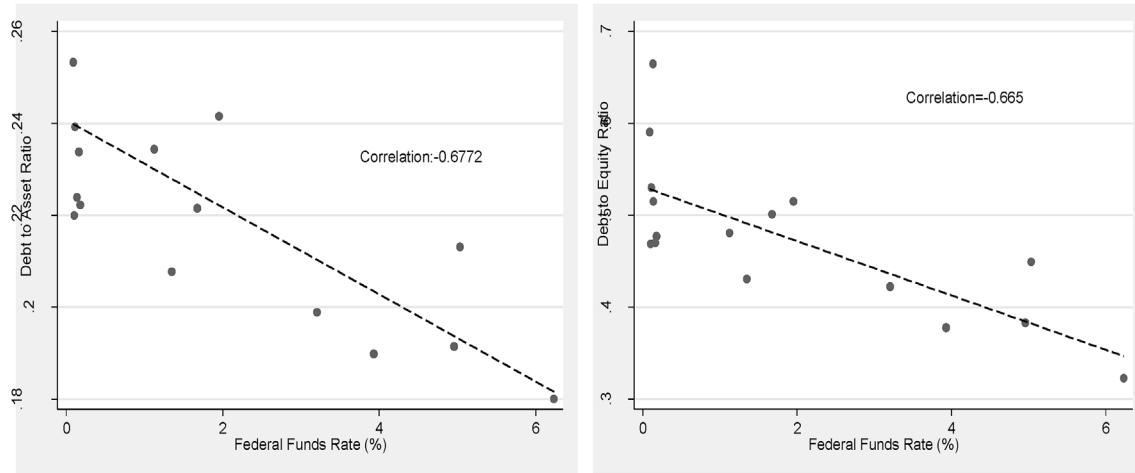


Fig. 2. Correlation between Federal Fund Rate, Debt to asset ratio and Debt to Equity ratio of S&P 500 firms (2000–2016)¹¹.

Source: Thomson Reuters DataStream and Federal Reserve Database, 2017

Table 1
Variables definitions and measurements.

Variables		Definition and Measurement
Dependent Variable	Growth	Growth of the firm being measured by: - Log of Total Assets in U.S. dollars. - Log of Sales Revenue in U.S. dollars. - Log of Number of Employees on the firm level.
Main Independent Variable	FFR	Annual U.S. Federal Funds Rate. This variable is treated as a threshold (in percentage).
Control Variables	Sales Markup	Markup ratio is calculated as follows: $\frac{\text{Sales} - \text{Cost of Good Sold (COGS)}}{\text{COGS}}$
	Debt-to- Equity ratio	Total debt to equity ratio at firm level (in ratio)
	GDPg	Annual growth of USA Gross domestic product at constant prices in US dollars (in percentage)
	Credit/GDP	Domestic credit to private sector in USA as a percentage of GDP (in percentage)
	Innovation	Natural log of R&D expenditure in U.S. dollars

- b) Firm-level financial variables that include Sales Markup, Debt-to-Equity ratio and expenditure in R&D (proxy for innovation)
- c) x_{it} refers to Federal Funds Rate (FFR) which is used to develop a threshold.
- d) μ_i is the individual fixed effects, δ_t is the time fixed effect and finally ϑ_s is the sector fixed effects.

4.3.1. Model estimation

The authors argue that Fixed effect regression and Dynamic First-Difference Generalized Method of Moments (*hereinafter* FDGMM) underestimate the impact of FFR on growth of firms. Therefore, the authors use a “Threshold fixed effect model” to identify whether there is a threshold effect of FFR on growth of the firms. Then, First Difference Generalized Method of Moments and Threshold Difference Generalized Method of Moments are utilized. Several reasons explain the advantages of threshold estimation relative to standard linear models: (1) Linearity test rejects the null hypothesis that the relationship between firm growth and FFR is linear.³ (2) Introducing a threshold estimation is predicted to provide a better explanation for the relationship between firm growth and FFR as this estimation takes into account the non-linear relationship between the two variables. (3) The response of US firms is assumed to be non linear to FFR and their investment plans are

likely to be totally changed if the monetary policy changes its strategies and/or objectives.

To test for different FFR threshold points, the authors follow the threshold fixed effect model as proposed by Hansen (1999).

$$y_{it} = \beta' x_{it}(\gamma) + \mu_i + e_{it} \quad (2)$$

$$x_{it}(\gamma) \begin{cases} x_{it} I(q_{it} \geq \gamma) \\ x_{it} I(q_{it} < \gamma) \end{cases} \quad (3)$$

y_{it} is growth of the firm i at time t , x_{it} is a matrix of explanatory variables that explain the growth of the US firms, γ is the threshold point from which the firm growth is likely to change as a response to FFR change. This threshold point represents different regimes for the FFR policy. q_{it} is the vector of FFR values. μ_i is the firm fixed effects β identifies different slopes for Federal Fund Rate β_1 and β_2 , $I(\cdot)$ represents the indicator function.

$$\beta = (\beta_1' \quad \beta_2')$$

To estimate the model, each variable is defined as a deviation from its mean:

$$y_{it}^* = \beta' x_{it}^*(\gamma) + e_{it}^* \quad (4)$$

The estimation can be identified as follows.

$$\hat{\gamma} = \underset{\gamma}{\operatorname{argmin}} S_1(\gamma) \quad (5)$$

³ The authors implement linearity test to test the relationship between FFR and firm growth.

Where $S_1(\gamma)$ is defined as the sum squared errors.

$$S_1(\gamma) = e_{it}^*(\gamma)'e_{it}^*(\gamma) \tag{6}$$

Where $e_{it}^*(\gamma)$ is the vector of regression residuals.

Using an inference tool, the authors test the existence of a threshold effect using the algorithms that follow.

$$H_0 : \beta_1 = \beta_2$$

$$F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\sigma^2} \tag{7}$$

$$S_0 = e_{it}^*'e_{it}^* \tag{8}$$

The values of the x_{it} and the threshold variable q_{it} are treated as fixed in different bootstrap samples. As Hansen (1996) states, the P -values that are constructed from bootstrap are asymptotically valid. Finally, a Likelihood Ratio (LR) test is defined as follows.

$$H_0 : \gamma = \gamma_0$$

$$LR = \frac{S_1(\gamma) - S_1(\hat{\gamma})}{\sigma^2} \tag{9}$$

LR test follows ε which is a random variable with the following distribution function

$$P(\varepsilon \leq x) = \left(1 - \exp\left(-\frac{x}{2}\right)\right)^2 \tag{10}$$

The authors repeat the steps to test for the existence of more than one threshold FFR cutoff point.

5. Empirical results and discussion

This section discusses the results at two dimensions. The first dimension is related to the Threshold fixed effect model estimation. The second dimension is related to First Difference Generalized Method of Moments. In order to deal with any potential endogeneity in the empirical results, the authors use the lag of the explanatory variables. Conspicuously, the authors assess the impact of any explanatory variable in the previous year on the firm growth variables in the current year. This strategy was already introduced by different econometricians and by the previous study of Hansen (1999).

5.1. Threshold fixed effect model estimation

The main assumption behind this specification is that FFRs do not have the same impact on growth of the firm at different levels. To determine the number of thresholds, Equation (1) is estimated allowing for zero, one, and two thresholds. The results are reported

Table 2
The results of threshold test.

Threshold	γ	F-stat
Single	1.35%	487.25***
Double	3.20%	171.98***
Triple	4.1	53.50

*** Significant at 1%.

in Table 2.

Table 2 reports the estimates of threshold points in addition to F test. The results show evidence for the existence of two significant threshold points of FFR at approximately 1.35% and 3.20%. This result shows that the impact of FFR is neither linear nor symmetric on the growth of firms. Conspicuously, a deviation of the interest rate from 1.35% to 3.20% is associated with structural change the growth of firms.

To better grasp the effects of structural change of FFR on the growth of firms, Table 3 reports the estimates around the two significant threshold points estimated in Table 2. According to Hansen (1999), the threshold fixed effect regression assumes a balanced panel data. Therefore, the number of firms in the sample is reduced from 500 to 211 due to missing observations. This fixed effect estimation procedure is also followed by Driscoll and Kraay (1998) where the results turn out robust to general forms of cross-sectional (“country”) dependence.

The authors attempt to control for endogeneity that might exist between interest rate and growth of the firm by including various controls in the Xit matrix, such as time and individual fixed effects as well as the lagged values of the explanatory variables (Ayad and Abd El-Aziz, 2018). Recent tests developed by Pesaran (2004) confirm that introducing the fixed effects especially for controlling time effects results in significant decreases in cross-sectional correlations of error terms. According to Hausman Test, Chi square statistic = 196.16 with a P-value of 0.000. This result guides the authors to implement Fixed effect in this case.

The results in Table 3 show consistent and robust estimates. That is, the significance and the trend of the results remain the same across the three regression equations, although using different measures of growth of the firm. In terms of firm-specific variables, the results show evidence that innovation supports growth of firms. Kueng et al. (2014) conclude that large firms have a high propensity to innovate due to an accumulated knowledge (Said et al., 2018; Sami & El Bedawy, 2019a,b). That is, firms grow by generating new product lines through technology. Moreover, Markup has a negative effect on growth of firms. Foster et al. (2016) offer recent empirical evidence that firms set low markups to boost more sales on the short run and guarantee growth through an accumulation of demand in the long run.

Table 3
Threshold fixed effect regression.

VARIABLES	(1)	(2)	(3)
	Assets	Sales	Employees
Innovation _{t-1}	0.128*** (0.043)	0.135*** (0.049)	0.118*** (0.040)
Sales Markup _{t-1}	-0.016*** (0.001)	-0.066*** (0.002)	-0.015*** (0.001)
Debt to Equityratio _{t-1}	0.124 (0.10)	0.055 (0.07)	0.047 (0.09)
GDP _{t-1}	0.470*** (0.160)	0.228* (0.123)	0.260* (0.141)
Percentage credit to DP _{t-1}	0.404*** (0.088)	0.170** (0.086)	0.086 (0.058)
FFR < 1.35%	-0.477*** (0.042)	-0.413*** (0.048)	-0.382*** (0.115)
1.35% < FFR < 3.2%	-0.130*** (0.011)	-0.151*** (0.013)	-0.148*** (0.038)
FFR > 3.2%	-0.082*** (0.008)	-0.059*** (0.009)	-0.017*** (0.006)
Constant	14.737*** (0.400)	14.535*** (0.442)	8.547*** (0.367)
Observations	2769	2769	2769
R-squared	0.452	0.358	0.215
F-Statistics	444.26***	432.32***	74.14***

Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.

¹ The figures showing the trends per FFR, Debt to Asset Ratio and Debt to Equity ratio are presented in the appendix (Fig. A.1. and Fig. A.2.).

In terms of macro effects, the results show that GDP growth and percentage of credit to GDP have positive effects on growth of the firms (Montout and Sami, 2016; Sami & El Bedawy, 2019a,b). In this view, Kueng et al. (2014) show that financial frictions substantially affect the extensive margin of investment.

Unsurprisingly, the FFRs have negative effects on growth of firms. In addition, the results show important differences between the coefficients of the FFR while deviating from the first threshold percentage 1.35%. In particular, the impact of FFR on growth of the firm is, on average, four times more important below the 1.35% threshold point than in the range between 1.35% and 3.2% (in model 1 = $[(-0.539/-0.168 = 3.2 \text{ times})]$, in model 2 = $(-0.496/-0.102 = 4.8 \text{ times})$, in model 3 = $(-0.188/-0.044 = 4.2)$).

These results indicate that an increase in FFR causes quadruple negative effects on growth of the firms. The past literature offers ground support to these results. That is, the theorem offered by Balkema and de Haan (1974) and Pickands (1975) show that when interest rate exceeds a threshold, it can be approximated by the Generalized Pareto Distribution (GPD). Selcuk and Gencay (2001) use the GPD to reach a threshold of interest rate that helps preventing a crisis significantly. Poltavets (2002) offers an extended benefit to threshold interest rate for preventing credit constraints in the economy. Dell'Ariccia et al. (2011) show the benefits of threshold interest to foreign investors. The firm is able to obtain a lower interest rate loan as foreign lenders have a lower threshold for lending. Panizza (2015) argues that Debt Sustainability Framework (DSF) requires thresholds for debt and interest rates above which debt is deemed to be unsustainable and then assessing whether these thresholds are likely to be breached. The benefits of threshold interest rate to banks are also documented in the literature. Memmel (2011, 2019), Memmel and Schertler (2013) and Busch and Memmel (2016) find that the exceedance of a regulatory threshold leads to a reduction of the interest rate risk, or exposure, in the future. At country level, in Nigeria, threshold interest rates turn out an important determinant of aggregate credit volume to the agricultural sector and helped in the country's economic growth significantly (Onyishi et al., 2015). Threshold interest rate is also used to promote financing sustainable development projects which is adopted by the World Bank as "Clean Technology Fund" (World Bank Group, 2017; Borio, and Gambacorta, 2017).

The benefits of threshold interest rate are also extended to the firm level. Kamal Uddin and Saima (2015) show that the consumer loan premium adjusts to the threshold faster when the deposit rates fall relative to the lending rates than when the deposit rates move in the opposite direction.

In addition, the impact of FFR above 3.2% drops to nearly 62% as compared to the range between the two threshold points. Thus, the elasticity of the expansion decisions is substantial when the FFR is below 1.35%. As far as actual interest rates are fluctuating around zero percent, the results show that each one percent increase in the FFR is associated with a decrease in the firm size by 0.5 percent (Model 1).

The results show that funding of growth using debt financing becomes a critical tool for the growth of firms, especially when the FFR drops below 1.35 percent to reach the minimum level zero percent. Unlike Cooley and Quadrini (2001), the empirical results show that the external finance is critical for the growth of the largest and most productive firms. This can be explained by the significant decrease in the cost of external credits from 2008 as announced by the FED. The results also match well with the facts previously discussed in section 2 see (Fig. 1) and (Fig. 2). External debt of S&P500 firms is correlated negatively with the level of FFR in USA.

5.2. First difference Generalized Method of Moments (FDGMM)

The FDGMM is an alternative method of estimating the impact of FFR and its threshold points. The authors implement Arellano and Bond (1991) estimation which starts by transforming regressors, through differencing and implementing the Generalized Method of Moments (Hansen, 1982). Three main advantages are offered by this specification. First, it assumes that the dependent variables (growth variables) are realized through a dynamic process determined by their own past realizations. Second, this specification considers that some regressors are correlated with their past realization. Third, fixed effects are still considered throughout all estimations.

Table 4 reports the results of difference GMM by including the standard FFR values as well as the threshold values. The results show that the coefficients of FFR remain robust which conclude that threshold points in the FFR should be considered since standard difference GMM underestimates the impact of FFR on growth of the firm. The negative estimate of Debt to Equity in the employees' regression indicate that high leverage causes firms to be financially constrained by cash flows committed to interest and principal payments. In this case, the cost of external debt is likely to increase if firms reach maximum debt capacity. In this respect, firms tend to rely on internally generated funds as they grow to avoid costly external credit especially as their investment needs escalate. These results carry significant updates about theories of capital structure, especially the relationship between interest rates and corporate capital structure. That is, at low levels of interest rates, the assumption of pecking order theory is reversed by reliance on debt financing first, then equity financing. While at high levels of interest rates, the assumption of free cash flow holds. These results match conclusions about costly debt financing and default reached by Cooley and Quadrini (2001). In addition, high leverage firms are more likely to reduce investments and shed off more workers (Sharpe, 1994) (see Table 5).

5.2.1. Robustness check

As a robustness check, the authors kept the top firms existing for the whole period 2000–2016. The results remain robust as the response of the firm growth to the FFR policy is non linear and is dependent on the threshold (regime variable). As far as the Fund rates become closer to zero, the growth of US firms becomes more sensitive to any change in FFR policy. In particular, the impact of FFR on growth of the firm is much more important below the 1.35% threshold point than in the range between 1.35% and 3.2% as previously shown in Table 3 and Table 4.

6. Conclusion

This paper introduces the Threshold fixed effect model as a novel strategy in order to assess the impact of monetary policy on the growth of S&P500 firms over the period 2000–2017. Like the previous studies, this paper show that the monetary policy affects significantly the growth of S&P500. However, this paper extends the previous studies by showing that the relationship between Federal Funds Rate and the growth of S&P-500 is non-linear. Conspicuously, the elasticity of growth of the firm to Federal Funds Rate is much more important as the FFR approaches to zero [below 1.35%].

The general results show that FFR is a significant driver of growth of the firm below the 1.35 percent point. As firms move towards the zero-low bound, the elasticity of firm expansion increases substantially. Additionally, firms will tend to invest more in growth opportunities as cost of debt decreases. In terms of theories of corporate capital structure, it appears that capital structure does

Table 4
Difference GMM results.

VARIABLES	Dynamic	GMM		Threshold	Dynamic GMM	
	(1)	(2)	(3)	(4)	(5)	(6)ss
	Assets	Sales	Employees	Assets	Sales	Employees
Firm variables						
FirmGrowth _{t-1} ⁽¹⁾	0.702*** (0.005)	0.802*** (0.005)	0.944*** (0.004)	0.687*** (0.006)	0.787*** (0.005)	0.945*** (0.004)
Innovation _{t-1}	0.127*** (0.041)	0.118*** (0.043)	0.092** (0.043)	0.130*** (0.040)	0.119*** (0.043)	0.092** (0.043)
SalesMarkeup _{t-1}	-0.048*** (0.004)	-0.113*** (0.005)	-0.060*** (0.004)	-0.044*** (0.005)	-0.112*** (0.003)	-0.060*** (0.003)
Debt to Equityratio _{t-1}	0.187 (0.126)	-0.152 (0.156)	-0.294 (0.216)	0.176* (0.094)	-0.171 (0.154)	-0.297 (0.217)
Macro variables						
GDP _{t-1}	0.552 (0.355)	0.404 (0.389)	0.0628 (0.364)	0.439 (0.370)	0.370 (0.424)	0.062 (0.396)
Percentage credit toGDP _{t-1}	0.426*** (0.130)	0.332** (0.149)	0.288** (0.139)	0.428*** (0.152)	0.183 (0.178)	0.238 (0.167)
FFR _{t-1}	-0.066*** (0.009)	-0.065*** (0.011)	-0.030*** (0.010)			
FFR < 1.35%				-0.476*** (0.092)	-0.257*** (0.036)	-0.056*** (0.014)
1.35% < FFR < 3.2%				-0.127*** (0.014)	-0.161*** (0.020)	-0.041*** (0.019)
FFR > 3.2%				-0.082*** (0.011)	-0.071*** (0.016)	-0.030** (0.015)
Constant	14.554*** (0.302)	14.454*** (0.319)	8.942*** (0.353)	14.742*** (0.310)	14.546*** (0.354)	8.951*** (0.379)
Observations	2769	2769	2769	2769	2769	2769
Wald (Chi2)	474.8***	1451.06***	1431.12***	812.10***	2676.04***	1446.58***

Robust standard errors in parentheses ***p < 0.01 **p < 0.05, *p < 0.1, () is the lag growth of the firms the variable includes respectively (per regression column): Assets, Sales and Employees.

affect growth of the firm based mainly on employment due to firms becoming financially constrained as their debt levels rise in relation to equity. This finding extends the findings of [Sharpe \(1994\)](#) and [Cantor \(1990\)](#) who prove that high leverage increases the financial vulnerability of firms causing high employment volatility. The findings also offer evidence that growth is driven by the significant

Table 5
Threshold Dynamic GMM for top firms existing for the whole period (2000–2016).

VARIABLES	(1)	(2)	(3)
	Assets	Sales	Employees
FirmGrowth _{t-1} ⁽¹⁾	0.649*** (0.008)	0.774*** (0.007)	0.964*** (0.007)
Innovation _{t-1}	0.006*** (0.001)	0.034*** (0.002)	0.005*** (0.002)
Sales arkeup _{t-1}	-0.109*** (0.034)	-0.139*** (0.032)	-0.092 (0.024)
Debt to Equityratio _{t-1}	-0.738 (0.934)	-0.616 (0.857)	-0.206 (0.976)
GDP _{t-1}	0.014 (0.013)	0.025 (0.016)	0.035 (0.022)
Percentage credit toGDP _{t-1}	-0.029 (0.114)	-0.106 (0.104)	-0.119 (0.118)
FFR < 1.35%	-0.122*** (0.014)	-0.136*** (0.010)	-0.084*** (0.008)
1.35% < FFR < 3.2%	-0.086*** (0.009)	-0.082*** (0.008)	-0.052*** (0.007)
FFR > 3.2%	-0.030*** (0.003)	-0.013*** (0.003)	-0.012*** (0.003)
Constant	6.201*** (0.128)	8.751*** (0.074)	-0.008*** (0.001)
Observations	1445	1445	1445
Wald (Chi2)	1019.5***	1409.7***	2685.5***

Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1, () is the lag growth of the firms the variable includes respectively (per regression column): Assets, Sales and Employees.

decrease in the cost of external credits following the financial crisis as the FED drove down interest rates to near zero levels. Apparently, the growth of U.S. firms after the financial crisis is partially driven by the changes in monetary policy particularly the decline in FFR that caused a shift towards debt financing. This downward shift enabled firms to maintain growth rates, employment levels and market value of equity. The question that requires further examination is whether the anticipated probability of an upward trend in the FFR would enable firms to sustain projected growth rates especially with economic projections depicting a probability of an upward trend in FFR that might exceed 3 percent by 2020.⁴

6.1. Implications for public policy making

Regulators such as central banks can use the results to help tailor the monetary policy to achieve the goals in macroeconomic economic growth. In various countries, changes in interest rates are normally a subsequent reaction to follow changes in exchange rates and inflation rates. The results of this study suggest that central banks should be very cautious to the sensitivity of changes in interest rates and their impact on corporate growth. A threshold could be calculated for each country to help understand how further increases or reductions in current interest rates would affect corporate growth. As for the financial institutions, they can use the results to estimate the future demand for credit to facilitate the growth in corporate sector.

⁴ Federal Open Market Committee (FOMC), Economic Projections report, September 26, 2018 at <https://www.federalreserve.gov/monetarypolicy/files/fomcprojtbl20180926.pdf>

6.2. Scope for future research

Future research could expand these findings by examining the effects of changes in interest rates or estimating the threshold point for other economies such as developing countries where fluctuations in interest rates are higher. Moreover, the changes in FFR could affect other aspects rather than corporate growth that future research could examine such as stock returns, for example. Lastly, a possible area for research is to explore how the stability of interest rates would affect corporate growth on the long-run.

Declaration of competing interest

None.

Appendix

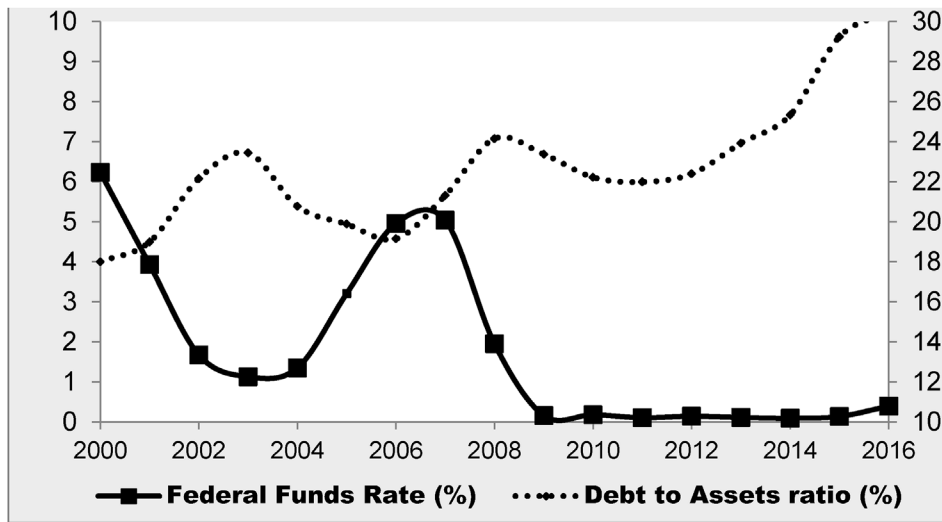


Fig. A.1. Debt to Asset Ratio and FFR over the period 2000–2016. Source: Thomson Reuters DataStream and Federal Reserve Database, 2017

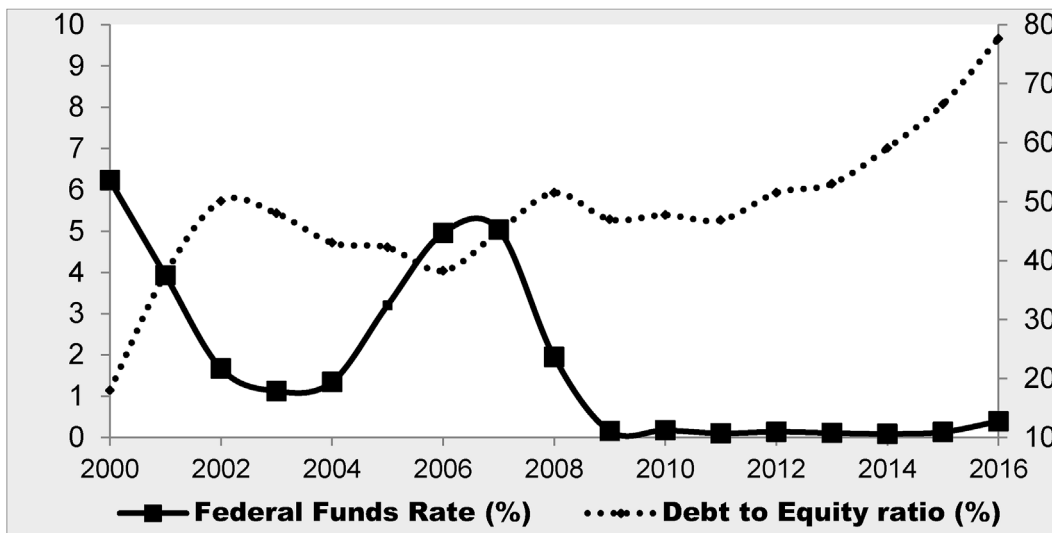


Fig. A.2. Debt to Equity Ratio and FFR over the period 2000–2016. Source: Thomson Reuters DataStream and Federal Reserve Database, 2017

Table A.1
Descriptive Statistics

	Mean	Std. Dev.	Min	Max
Log Total Assets	16.04	1.38	11.46	20.50
Log Sales	15.75	1.47	6.78	19.89
Log Employees	9.80	1.41	5.18	13.20
Innovation "in log"	9.39	5.55	0.00	16.59
Sales Markeup	0.50	0.22	0.04	1.00
Debt to Equity ratio	0.80	0.15	0.29	1.26
GDP	1.85	1.58	-2.78	3.79
Credit to GDP	186.38	11.78	162.30	206.67
FFR	1.81	2.07	0.09	6.23

Table A.2
Correlation Matrix

	Sales	MVC	Employees	Innovation	Mark-up	Debt to Equity ratio	GDP growth	Credit	FFR
Sales	1.00								
MVC	0.78	1.00							
Employees	0.81	0.62	1.00						
Innovation	0.14	0.22	0.22	1.00					
Markup	0.26	0.18	0.28	0.31	1.00				
Debt to Equity ratio	-0.25	-0.19	-0.26	-0.05	0.16	1.00			
GDP growth	-0.04	-0.01	-0.02	-0.01	-0.02	0.01	1.00		
Credit to Private Sector	0.15	0.22	0.06	0.02	0.06	-0.04	-0.21	1.00	
FFR	-0.13	-0.17	-0.05	-0.01	-0.05	-0.02	0.29	-0.14	1.00

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