Falling Rates and Rising Superstars*

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October 5, 2021

Abstract

Do low interest rates contribute to the rise in market concentration? Using data on firm financials and high frequency monetary policy shocks, we find that falling interest rates disproportionately benefit industry leaders, especially when the initial interest rate is already low. Falling rates raise the valuation of industry leaders relative to industry followers and this effect snowballs as the interest rate approaches zero. There are multiple channels through which falling rates disproportionately benefit industry leaders: (i) the cost of borrowing falls more for industry leaders, (ii) industry leaders are able to raise more debt, increase leverage, and buyback more shares, and (iii) capital investment and acquisitions increase more for industry leaders. All three of these effects also snowball as the interest rate approaches zero. The findings provide empirical support to the idea that extremely low interest rates and the rise of superstar firms are connected.

*We thank Keelan Beirne, Sebastian Hanson, Julio Roll, and Michael Varley for excellent research assistance, the Julis Rabinowitz Center for Public Policy and Finance at Princeton for financial support, and participants at U.C. Berkeley Haas and Northwestern University Kellogg for comments. Kroen: tkron@princeton.edu; Liu: ernestliu@princeton.edu; Mian: atif@princeton.edu; Sufi: amir.sufi@chicagobooth.edu.

1 Introduction

The large rise in market concentration in the United States has spurred a wide inquiry into its causes and consequences. The stakes are especially high given recent research suggesting a link between the rise in market concentration and the slowdown in productivity growth (e.g., Akcigit and Ates (2019), Olmstead-Rumsey (2019), Asriyan, Laeven, Martin, Van der Ghote and Vanasco (2021), Liu, Mian and Sufi (2021)). This study presents empirical evidence connecting the secular decline in interest rates to the rise of superstar firms that dominate markets. We find that a decline in interest rates benefits industry leaders relative to industry followers in financial and real terms, and that the relative benefit becomes stronger, or "snowballs," as the level of the interest rate approaches zero.

There is a dearth of research on the possible connections between the rate of interest and market competition. This is surprising given the centrality of both the interest rate and the nature of competition for the overall economy. There are sound theoretical reasons to expect a link between interest rates and market competition. For example, suppose that industry followers borrow at a constant spread δ over the interest rate r paid by industry leaders.[1] In this case, a declining r would give a natural advantage to industry leaders. The reason is that borrowing capacity of a dollar of pledgeable cash-flow stream growing at the rate g is proportional to $\frac{1}{r-g}$ for industry leaders and $\frac{1}{r+\delta-g}$ for industry followers. The difference between them is convex as r falls, and in fact goes to infinity as r gets close to g. As we show below, the spread δ that industry followers pay relative to industry leaders has actually become larger as interest rates have fallen, which only strengthens this effect. More generally, theoretical models with financial frictions often imply that low interest rates benefit industry leaders relative to followers (e.g., Chatterjee and Eyigungor (2020), Asriyan et al. (2021)).

A second independent channel translating low interest rates into an advantage for industry leaders is the differential strategic effect of lower rates shown in Liu et al. (2021). As they show, even when there are no financial frictions, a decline in interest rates, and especially a decline to near-zero interest rates, are harmful for competition. The reason is that a decline in the interest rate has an asymmetric strategic effect on industry leaders versus followers: a fall in the interest rate increases the strategic incentive for industry leaders to "escape" competition, but discourages industry followers as they now anticipate even tougher competition ahead. Moreover, this strategic effect becomes dominant as the interest rate moves closer to zero.

This paper formally investigates the empirical relationship between economy wide interest rates and the rise of superstar firms in the United States using the merged CRSP-Compustat data set from 1962 to 2019. We begin by analyzing the stock market reaction to an interest rate decline for industry leaders versus industry followers, where we define the top 5 percent of firms by value in an industry as "leaders" and the rest as "followers". We construct a "leader portfolio" that goes long industry leaders and shorts industry followers,

[1] This is related to the large body of research showing that large firms borrow at a lower interest rate relative to small firms. For example, Chodorow-Reich, Darmouni, Luck and Plosser (2021) find that "small firms (SMEs) obtain shorter maturity credit lines than large firms, post more collateral, have higher utilization rates, and pay higher spreads."

and we examine the portfolio's performance in response to changes in the ten year U.S. Treasury rate (r).

We find that the leader portfolio exhibits higher returns in response to a decline in r, and, more importantly, this response becomes stronger, or snowballs, when the initial r is low. We control for the the price to earnings ratio as a measure of implied duration, showing that the snowballing effect is not mechanically driven by industry leaders having higher duration. This suggests that lower r impacts relative firm valuations not only through changing the discount rate but also through possible endogenous changes in expected future cash flows that favor the current industry leader - a finding consistent with the strategic competition channel above.

Interest rate changes are endogenous to changes in the overall economy, and there is an obvious concern that omitted variables may be responsible for the results. For example, the interest rate decline is naturally correlated with negative news about future demand; if industry leaders have a larger option value on future demand, then the spurious correlation between the interest rate movement and expected demand will lead us to *underestimate* the true differential impact of the interest rate decline on industry leaders.

We address the possible endogeneity of interest rate movements by using plausibly exogenous high frequency monetary policy shocks that capture changes in expected Federal Funds rate within a 60-minute time window around FOMC meeting announcements (as in Gorodnichenko and Weber (2016)). Consistent with the logic that the simple OLS may underestimate the true impact of the interest rate on the leader portfolio, the estimated magnitude is larger when using high frequency monetary policy shocks. Since the impact is stronger at low levels of r, for expositional purposes we always report the predicted magnitude of our estimates at an interest rate of $r = 2\%$. We find that a 10 basis point reduction in r when $r = 2\%$ translates into a 0.53 percentage point larger increase in the market valuation of industry leaders relative to industry followers.

We investigate the possible reasons and mechanisms that lead to lower rates boosting the relative valuation of industry leaders. We find that a fall in r exhibits a stronger pass-through to the borrowing costs of industry leaders relative to industry followers, and this effect snowballs at lower r. In terms of magnitudes, a 10 basis point decline in r leads to a 14 basis point relative decline in the borrowing cost of industry leaders relative to followers at $r = 2\%$. When the initial r is very close to the zero lower bound, a 10 basis point decline in r leads to a 24 basis point relative decline.

Industry leaders take advantage of the lower cost of debt financing. There is a large relative increase in debt issued by industry leaders relative to industry followers, and the book leverage ratio of leaders also increases. The effects of a decline in r on these two financial outcomes also exhibit the snowballing effect: the effect of a decline in r is larger when the initial interest rate is lower. When the economy is close to the zero lower bound, a 10 basis point decline in r leads to a 5.2 percent relative increase in debt issued, and a 1 percentage point relative rise in the leverage ratio for industry leaders. Some of the additional debt raised is used to buy back shares, which also contributes to the rise in leverage we observe.

The final set of results concern the relative real effects of lower interest rates on industry leaders versus followers. These results largely follow the stock market and financial effects described above. We find that a decline in r leads to a relative increase in capital expenditures, cash acquisitions, and property, plants, and equipment (PPE) for industry leaders relative to followers. These real effects, like the valuation and financial effects, also snowball at lower levels of the initial interest rate. The results on investment provide empirical support to the prediction in Liu et al. (2021) that industry leaders respond more aggressively to a decline in the interest rate in order to "go for the kill" to ensure their claim on the more valuable future cash flows. Interestingly, one of the strongest results is on cash acquisitions, which suggests that industry leaders may be more likely to target their rivals when interest rates fall from very low levels.

Overall, our results have important implications for the broad literature on persistently low interest rates (or r^*) and their implications for the macroeconomy, including the literature on "secular stagnation" (e.g., Summers (2014)). Most of the work in this literature has focused on possible causes for the low interest rate, with explanations ranging from demographics, inequality, and low productivity growth. Our work suggests that there is a potentially important feedback effect from low r back to the real economy through market structure and industry competition.

Empirical evidence presented in this paper suggests that falling rates, especially as rates get close to zero, disproportionately benefit "superstar" firms. The growth of superstar firms and the accompanying decline in competition has been well-recognized in the literature. Our results provide support to the idea that these trends are partly driven by declining interest rates, especially as rates decline to a level close to zero. Therefore, while low interest rates are generally thought to be expansionary, very low interest rates might also have a contractionary impact on the economy via the rise in market concentration, a point made theoretically in Liu et al. (2021).[2] This study establishes an important link in this chain, showing that lower interest rates do in fact lead to a relative rise in valuation, debt financing, and investment of industry leaders relative to followers, and a relative decline in leaders' cost of borrowing. The snowballing results show that these effects are especially strong in very low interest rate environments.

The findings of this study are related to the large body of research exploring the rise in market concentration in the United States since the 1980s (e.g., Grullon, Larkin and Michaely (2019), Philippon (2019), Syverson (2019), De Loecker, Eeckhout and Unger (2020)). Scholars have proposed that the rise in concentration may be a reason behind weak investment and low productivity growth (e.g., Gutiérrez and Philippon (2017a,b), Crouzet and Eberly (2019), Liu et al. (2021)). A closely related area focuses on the rise of superstar firms, and the implications of superstar firms for the labor share and productivity patterns (e.g., Andrews, Criscuolo and Gal (2016), Berlingieri, Blanchenay and Criscuolo (2017), Olmstead-Rumsey (2019), Autor, Dorn, Katz, Patterson and Van Reenen (2020)). This paper suggests that falling interest rates may be one of the factors behind the important patterns documented in this extensive literature. The findings are also related to the

[2]See also the recent study by Asriyan et al. (2021) that argues that lower interest rates can crowd-out investment by more productive entrepreneurs.

empirical literature in asset pricing exploring the effects of interest rates on asset returns (e.g., Koijen, Lustig and Van Nieuwerburgh (2017), Van Binsbergen (2020)).

There is also a related literature exploring the role of financial constraints in the transmission of monetary policy to firm investment (e.g., Gertler and Gilchrist (1994), Ippolito, Ozdagli and Perez-Orive (2018), Ottonello and Winberry (2020), Vats (2020)). One measure of financial constraints used in this literature is firm size. Relative to this literature, this study emphasizes valuation effects more prominently, and it explores financing and acquisitions in addition to investment. Another related study is Morlacco and Zeke (2021), who show that in response to a decline in the interest rate, large firms increase their spending on customer capital significantly more than small firms. To the best of our knowledge, the empirical demonstration of the snowballing effect–that is, the stronger response of leader outcomes to a decline in interest rates when the initial interest rate is lower–is new to the literature.

2 Valuation effect of falling rates on industry leaders versus followers

2.1 Data

The data set for the analysis is the CRSP-Compustat merged data set from 1980 onward, which is used to compute excess returns for industry leaders versus followers in response to a change in interest rates. The 10-year Treasury yield is used as the default measure of the long-run interest rate, and robustness tests using the real interest rate and alternative definitions of the interest rate yield are also shown.[3]

The analysis focuses on 1980 onward as the default time period since this is the period over which the most consistent time series (e.g., for the real interest rate) is available. Nonetheless, robustness tests are shown for the earliest available CRSP-Compustat data set from 1960 onward. The 10-year yield is used because it is the longest available historical time series. The Fama-French definition is the default classification for industries, and results using alternative definitions of industries are shown as robustness tests.

The baseline definition of industry "leaders" is size as measured by market value. A firm is classified as an industry leader if it is in the top 5 percent of firms in the industry based on market value at the beginning of the period when excess returns are computed. We also use the top five firms in an industry for robustness. Robustness results in the appendix show similar results when sorting firms based on EBITDA and sales.

[3] We prefer using the nominal interest rate given the measurement error introduced in attempting to measure the real interest rate. Inflation expectations have been relatively well-anchored during the time period analyzed.

2.2 Valuation effects

As mentioned in the introduction, there are sound theoretical arguments for why a decline in interest rates should boost the value of industry leaders relative to industry followers, and for why this effect becomes stronger at low interest rates. For example, if industry followers can only raise financing at a constant spread δ over the interest rate r paid by industry leaders, then falling r benefits industry leaders more than industry followers. Borrowing capacity of a dollar of pledgeable cash-flow stream growing at the rate g is proportional to $\frac{1}{r-g}$ for industry leaders and $\frac{1}{r+\delta-g}$ for industry followers. The difference between them is convex as r falls, and in fact goes to infinity as r gets close to g. Alternatively, even in a world without a borrowing cost spread between industry leaders and industry followers, the model in Liu et al. (2021) shows that a decline in the interest rate has an asymmetric strategic effect that benefits industry leaders. Liu et al. (2021) show theoretically that this asymmetric effect becomes stronger, and snowballs, as the interest rate moves closer to zero.

These theoretical arguments motivate the following empirical specification:

$$R_{i,j,t} = \alpha_{j,t} + \beta_0 D_{i,j,t-1} + \beta_1 D_{i,j,t-1} * \Delta i_t + \beta_2 D_{i,j,t-1} * i_{t-1} + \beta_3 D_{i,j,t-1} * \Delta i_t * i_{t-1} + \varepsilon_{i,j,t} \quad (1)$$

where $R_{i,j,t}$ is the dividend and split-adjusted stock return of firm i in industry j from date $t-91$ days to t (i.e., one quarter growth), and $D_{i,j,t-1}$ is an indicator variable equal to 1 if firm i is in the top 5% of market capitalization in its industry j at date $t-91$. Firms with $D_{i,j,t-1}$=1 are called leaders while the rest are called followers. The variable i_t is the 10-year nominal U.S. Treasury interest rate, with i_{t-1} being the interest rate 91 days prior and Δi_t being the change in the interest rate from date $t-91$ to t. All regressions are value-weighted and standard errors are dually clustered by industry and date. The parameters $\alpha_{j,t}$ are industry-time period fixed effects.

The key coefficients of interest are β_1 and β_3. A negative estimate of β_1 implies that a decline in the interest rate leads to a larger increase in the stock return of industry leaders. A positive estimate of β_3 implies that this effect is stronger when the level of interest rates is lower. In other words, a negative estimate of β_1 and a positive estimate of β_3 signify that industry leaders experience higher excess returns when interest rates fall, and this effect is amplified when interest rates start from a low level.

Table 1 shows the results of estimating (1) on the merged CRSP-Compustat data set from 1980 onward. Only the relevant coefficients are displayed in the tables, but the actual regression includes all variables specified in equation (1). Column (1) estimates equation (1) without interactions with the level of interest rate. The coefficient β_1 is negative and significant; leaders earn positive excess returns when the interest rate falls.

Column (2) presents estimates from the full specification (1). The coefficient β_3 is positive and significant. Excess returns for leaders are higher in response to a fall in the interest rate when the level of the interest rate is lower. This is succinctly captured by β_1 which reflects the increase in excess returns when interest rates

Table 1: Differential Interest Rate Responses of Leaders vs. Followers: Top 5 Percent

	Stock Return					
	(1)	(2)	(3)	(4)	(5)	(6)
Top 5 Percent=1 x Δi	-1.205***	-3.611***	-4.262***	-3.341***	-3.968***	-3.614***
	(0.244)	(0.970)	(0.746)	(0.948)	(0.704)	(0.493)
Top 5 Percent=1 x Δi x Lagged i		0.267**	0.331***			0.252***
		(0.083)	(0.066)			(0.042)
Top 5 Percent=1 x Δi x Lagged real i (Clev)				0.524**	0.634***	
				(0.178)	(0.132)	
Firm β x Δi						12.51***
						(0.666)
Firm β x Δi x Lagged i						-1.136***
						(0.082)
Sample	All	All	All	All	All	All
Controls	N	N	Y	N	Y	
Industry-Date FE	Y	Y	Y	Y	Y	Y
N	65,944,610	65,944,610	47,399,717	64,113,949	46,579,398	64,608,224
R-sq	0.393	0.393	0.403	0.390	0.400	0.390

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the specification $R_{i,j,t} = \alpha_{j,t} + \beta_0 D_{i,j,t} + \beta_1 D_{i,j,t} \Delta i_t + \beta_2 D_{i,j,t} i_{t-1} + \beta_3 D_{i,j,t} \Delta i_t i_{t-1} + X_{i,j,t}\gamma_0 + \Delta i_t X_{i,j,t}\gamma_1 + i_{t-1} X_{i,j,t}\gamma_2 + \Delta i_t i_{t-1} X_{i,j,t}\gamma_3 + \varepsilon_{i,j,t}$ for firm i in industry j at date t. $R_{i,j,t}$ is defined here as the retrun to holding the stock (including dividends) of firm i in industry j from date $t-91$ to t (one quarter growth). $D_{i,j,t}$ is defined here as an indicator equal to 1 at date t when a firm i is in the top 5% of market capitalization in its industry j on date $t-91$. Firms with $D_{i,j,t}$=1 are called leaders while the rest are called followers. i_t is defined as the nominal 10-year Treasury yield, with i_{t-1} being the interest rate 91 days prior and Δi_t being the change in the interest rate from date $t-91$ to t. Controls X include a firm's asset-liability ratio, debt-equity ratio, book-to-market ratio, and percent of pre-tax income that goes to taxes. Industry classifications are the Fama-French industry classifications (FF). Lagged real rates were built using monthly 10-year inflation expectations from the Cleveland Fed and the daily 10-year Treasury yield at the beginning of each month (post-1982). Standard errors are dually clustered by industry and date.

fall near the zero lower bound (i.e., when $i_{t-1} \approx 0$). The excess return near the zero lower bound in column (2) (3.6) is three times the average excess return of 1.2 in column (1).

One concern with these results is that the measure of industry leaders is spuriously correlated with balance sheet factors that are more sensitive to interest rate movements. For example, perhaps leaders are more levered and a fall in the interest rate helps lower the interest burden. To test for this, and other related concerns, we include a number of firm level characteristics as controls by including all the interaction of the firm level characteristic with the change in interest rate as well as the level of the interest rate. We include the following firm-level characteristics, a firm's asset-liability ratio, debt-equity ratio, book-to-market ratio, and the percent of pre-tax income that goes to taxes. The number of observations decreases because we have to limit the sample to Compustat firms with the available data on firm financials. Column (3) shows that the inclusion of this extensive list of firm-level controls does not change the coefficients of interest materially.

Columns (4) and (5) use the ten year real interest rate for the level of the lagged interest rate in equation

(1). The change in the interest rate continues to be measured by the change in the 10-year nominal bond yield given that there are no reasonable estimates of the change in the real yield over short time intervals. Furthermore, the change in nominal and real yields over a short horizon is likely to be dominated by the change in the nominal interest rate. The real interest rate is calculated by subtracting 10-year inflation expectations published by the Cleveland Federal Reserve. Using the real interest rate, the snowballing coefficient (β_3) on the interaction term increases significantly.

Column (6) controls for another firm-level attribute that may lead to a bias in the estimate of the snowballing coefficient β_3. What if industry leaders are more cyclical? If a fall in the interest rate represents changing economic expectations, industry leaders might generally be more responsive to changing market conditions irrespective of the level of interest rate. To test for this possibility, the market beta of each firm is estimated using historical data as of $t-1$ and then it is interacted with both the change in the interest rate and the level of the interest rate in column (6). As before, the main coefficients of interest are not materially affected.

To assess how broad these core findings are across industries, Figure 1 presents estimates of β_1 and β_3 from equation (1) for each industry in the sample. The vertical axis is β_1 for an industry while the horizontal axis is β_3. The red dot is the average effect from Table 1. Almost all the points are in the lower right quadrant of the scatter plot, which indicates a positive estimate of β_3 and a negative estimate of β_1. For the grand majority of the industries, a decline in the interest rate boosts the value of the leaders relative to the followers (a negative β_1) , and this effect because stronger if the decline occurs from an already low level of interest rates (a positive β_3). The core findings are not driven by a few industries.

Table 2 performs a time-series version of the excess return test implemented in Table 1. In particular, the results are based on the following specification,

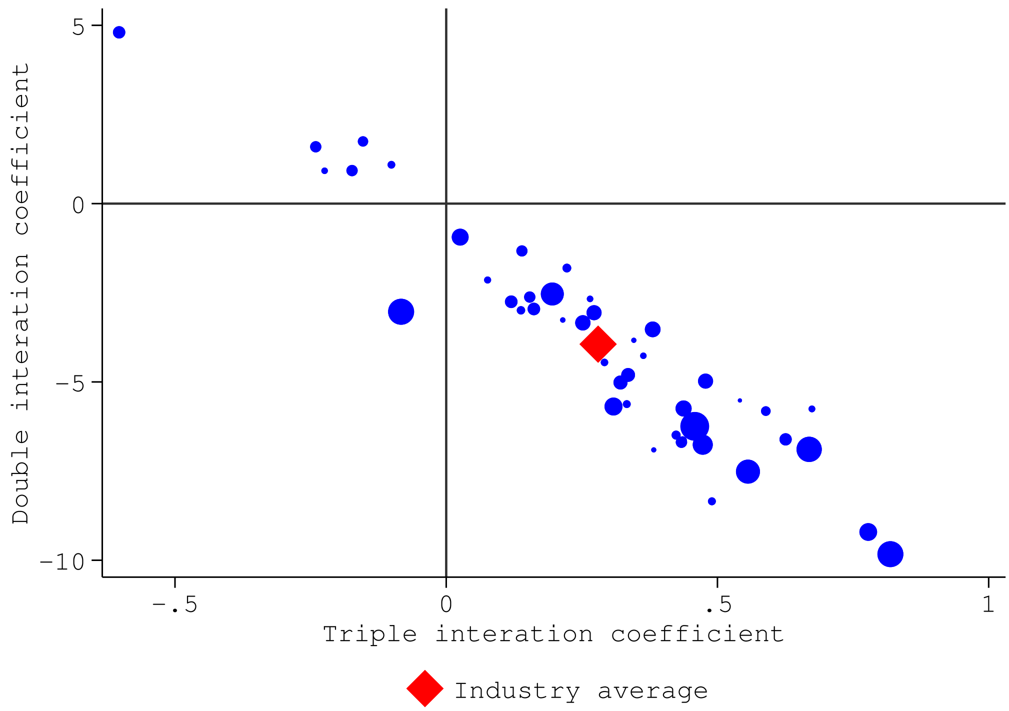
$$R_t = \alpha + \beta_0 i_{t-1} + \beta_1 \Delta i_t + \beta_2 \Delta i_t * i_{t-1} + \varepsilon_t \tag{2}$$

where R_t is the market-capitalization weighted average of returns for a stock portfolio that goes long industry-leader stocks and goes short industry-follower stocks from date $t-91$ to t. We refer to this portfolio as the "leader portfolio." More specifically, The leader portfolio returns R_t are calculated as the weighted average of leader less follower returns

$$R_t = \sum_{f=1}^{F} \omega_{f,t-1} (R_{f,t}^{leader} - R_{f,t}^{follower})$$

where $R_{f,t}^{leader}$ denotes leader returns in industry f at time t, and $\omega_{f,t}$ are the industry weights, equal to industry f's share of total market capitalization at time t. Let $\mathcal{L}_f$ be the set of leaders in industry f. Then

Figure 1: Coefficients at an industry level



The figure plots the coefficients β_2^j alongside β_3^j from the regression $R_{i,j,t} = \alpha_{j,t} + \beta_0 D_{i,j,t-1} + \beta_1 D_{i,j,t-1} * \Delta i_t + \beta_2^j D_{i,j,t-1} * i_{t-1} + \beta_3^j D_{i,j,t-1} * \Delta i_t * i_{t-1} + \varepsilon_{i,j,t}$ estimated for each Fama French industry j seperately. Points are weighted by the industry share of aggregate market capitalisation. The average values for each coefficient are indicated on each axis.

leader returns in industry f are calculated as

$$R_{f,t}^{leader} = \sum_{i \in \mathcal{L}_f} \gamma_{i,t-1} R_{i,t}$$

where $\gamma_{i,t} = \frac{V_{i,t}}{\sum_{j \in \mathcal{L}_f} V_{j,t}}$ denotes firm i's share of market capitalization among leaders in industry f. Follower returns are calculated equivalently. Given that observations have overlapping differences, we compute standard errors using a Newey-West procedure with a maximum lag length of 60 days to account for built-in correlation.

A negative estimate of coefficient β_1 would signify that a decline in interest rates boosts the return on the leader portfolio, while a positive estimate of β_2 would signify that the positive response of the return on the leader portfolio to a decline in interest rates is larger when the level of the interest rate is lower. In this specification, β_2 is the relevant snowballing coefficient.

The estimates reported in columns (1) and (2) confirm earlier results. A decline in the interest rate is associated with positive returns for the leader portfolio, and this positive return response to a decline in the interest rate is larger in magnitude when the interest rate is lower. Column (3) uses the 10-year real interest

Table 2: Portfolio Returns Response to Interest Rate Changes: Top 5 Percent

	Portfolio Return				
	(1)	(2)	(3)	(4)	(5)
Δi_t	-1.264***	-3.803***	-3.517***	-4.198***	-3.654***
	(0.313)	(0.595)	(0.540)	(0.891)	(0.787)
i_{t-1}		0.0572		0.154*	0.103
		(0.050)		(0.069)	(0.067)
$\Delta i_t \times i_{t-1}$		0.284***		0.363***	0.312**
		(0.057)		(0.078)	(0.106)
real i_{t-1} (Clev)			0.148		
			(0.080)		
$\Delta i_t \times$ real i_{t-1} (Clev)			0.553***		
			(0.117)		
$(\Delta i_t > 0)$=1 $\times \Delta i_t$				0.815	
				(1.676)	
$(\Delta i_t > 0)$=1 $\times \Delta i_t \times i_{t-1}$				-0.138	
				(0.173)	
PE Portfolio Return					-0.257***
					(0.070)
N	9,669	9,669	9,250	9,669	8,032
R-sq	0.051	0.093	0.090	0.096	0.187

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the specification $R_t = \alpha + \beta_0 i_{t-1} + \beta_1 \Delta i_t + \beta_2 \Delta i_t i_{t-1} + \varepsilon_t$ at date t. R_t is defined as the market-capitalization weighted average of returns for a stock portfolio that goes long in leader stocks and goes short in follower stocks from date $t-91$ to t. Leaders are defined as the firms in the top 5% of market capitalization in its FF industry on date $t-91$. i_t is defined as the nominal 10-year Treasury yield, with i_{t-1} being the interest rate 91 days prior and Δi_t being the change in the interest rate from date $t-91$ to t. Standard errors are Newey-West with a maximum lag length of 60 days prior. Real rates were built using monthly 10-year inflation expectations from the Cleveland Fed and the daily 10-year Treasury yield (post-1982).

rate level as before. The coefficient on the interaction between the real rate and the change in interest rate is even stronger than in Table 1.

Column (4) shows that the results are driven by both positive and negative changes in interest rates. In particular, the excess return results are materially unchanged whether only positive changes in interest rates or only negative changes in interest rate are used. Column (5) shows that the results are not driven by industry leaders that may have higher duration of cash flows for mechanical or spurious reasons. If industry leaders had higher duration for spurious reasons, then they would have a higher price to earnings (PE) ratio and the difference in the PE ratio between the industry leader and follower at the time of interest rate shock would explain our asymmetric valuation response to a decline in r. Column (5) controls for a "PE portfolio" that is long the top 5% of firms by PE in an industry and short the rest. Inclusion of the PE portfolio return does not change the coefficients of interest, and the return of the leader-minus-follower portfolio is itself negatively correlated with the return of the PE portfolio.[4] This result shows that lower r impacts relative firm valuations

[4]The number of observations declines because earnings data are missing on certain dates.

not only through changing the discount rate but also through the endogenous changes in future cash flows that favor the current leader.

Tables A1 and A2 in the appendix show the robustness of results in Tables 1 and 2 to using CRSP-Compustat data from 1960 onward.[5] Table A3 in the appendix shows robustness to alternative definitions: top 5 instead of top 5 percent for industry leadership, SIC codes instead of Fama French industry classification, and sorting on EBITDA and sales instead of market value for defining leadership. Overall, the snowballing coefficient is positive and significant across the specifications, indicating that a decline in interest rates boost the valuation of leaders relative to followers by more when the initial interest rate is low.

In empirical asset pricing tests of a portfolio's return, it is common to control for risk factors such as the excess market return or a growth minus value portfolio. However, it may be the case that the relative valuation effect from lower interest rates on the leader minus follower portfolio is due to a relative decline in risk for leaders relative to followers.[6] Indeed, an evaluation of credit spreads in Section 4 below suggests that the riskiness of the debt of leaders relative to followers falls as interest rates in the overall economy decline from low levels. As a result, controlling for risk factors in the estimation of equation 2 would be over-controlling; if a decline in interest rates from already low levels leads to positive valuation effects for leaders relative to followers because of exposure to risk factors, then that should be included in the overall estimate of how low interest rates benefit leaders.

Figure 2 helps visualize the snowballing effect, and the critical interest rate at which the snowballing effect becomes active. More specifically, the figure reports non-parametric estimates of the effect of a change in interest rates on the leader portfolio (β) at various grid points for i_{t-1}, which is the lagged 10-year nominal Treasury rate. Moving from right to left in the figure, the coefficient estimate of β becomes statistically significantly negative when the level of the nominal interest rate i_{t-1} falls into the 5 and 6% region. The 10 year nominal U.S. Treasury rate has been below 5% since 2000, with only a few exceptions.

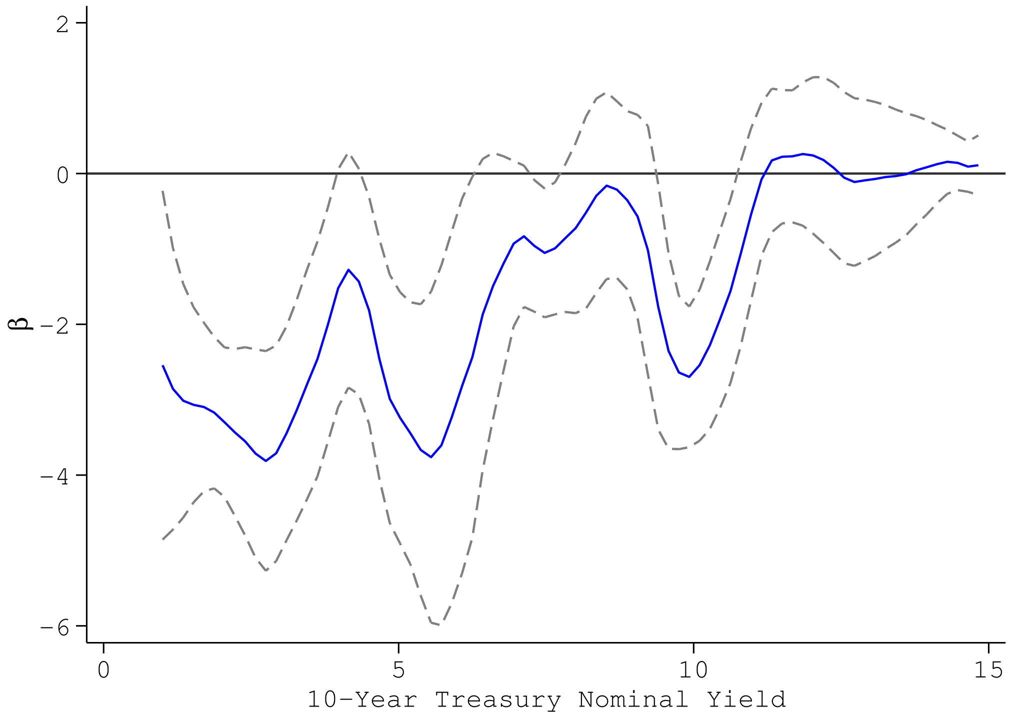
2.3 Timing

The changes in interest rates that should affect relative valuation should be those that are deemed more persistent. In theory, purely transitory changes in interest rates should not affect relative valuation of leaders and followers as it is the longer-term effect of a lower interest rate on endogenous cash flows that are critical. As a result, the baseline specification constructs returns and interest rate changes at a quarterly frequency. Figure 3 plots the histograms of interest rate changes in the sample, from daily to annual frequency. On average, interest rates declined during this time period. However, there is substantial variation with the change in the interest rate being positive on a high fraction of days. As already shown, the key findings are symmetric to whether the change in the interest rate is positive or negative.

[5]The real interest rate prior to 1980 is computed by subtracting realized inflation from the nominal rate.

[6]The model by Liu et al. (2021) can be intepreted as a micro-foundation for the why lower interest rates may increase the risk of followers relative to leaders.

Figure 2: Estimating $\beta(i^*) = \frac{\partial R_t}{\partial \Delta i_t}\Big|_{i_{t-1}=i^*}$

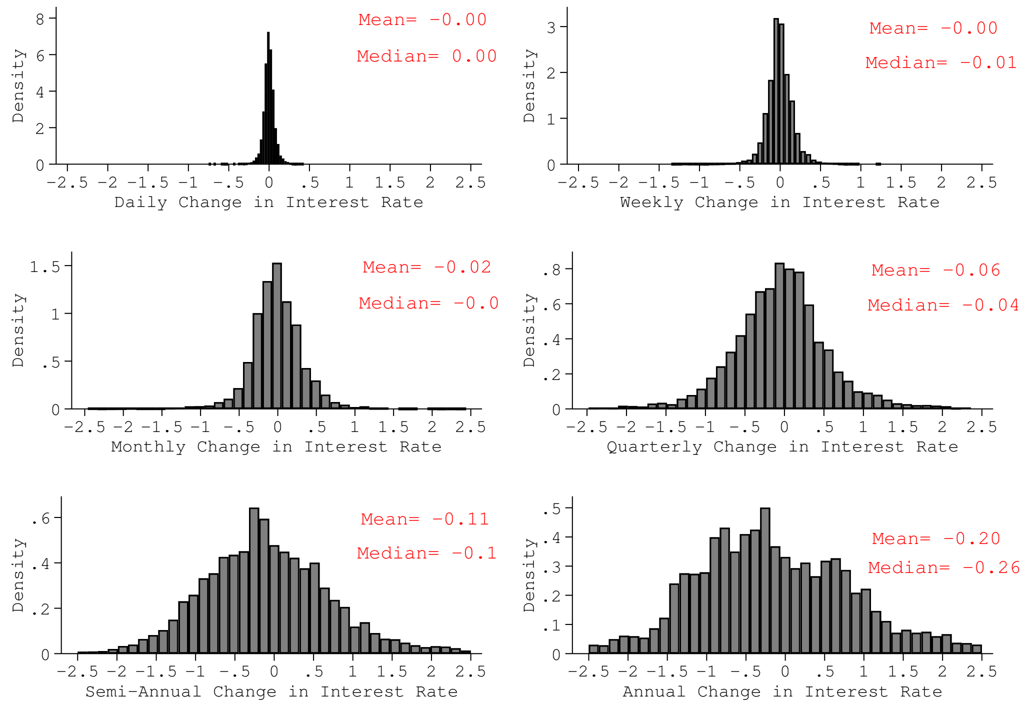


The figure plots coefficient β from the specification $R_t = \alpha + \beta \Delta i_t + \varepsilon_t$, where points are weighted using Epanechnikov's kernel centered at 0.1 increments on the x-axis grid point of nominal interest rates at $t-91$ days. The choice of bandwidth is determined using a Silverman bandwidth (Silverman (1986)) for such kernel (bandwidth = 0.68). R_t is defined as the market-capitalization weighted average of returns for a stock portfolio that goes long in leader stocks and goes short in follower stocks from date $t-91$ days to t. Leaders are defined as the firms in the top 5% of market capitalization in its FF industry on date $t-91$. Δi_t is the change in the 10-year treasury interest rate from date $t-91$ to t. Standard errors are Newey-West with a maximum lag length of 60 days prior.

As one moves from daily to annual frequency, the range of interest rate changes increases. This is another reason to focus on longer term differences; investors need sufficient time to incorporate a large change in interest rates when forming expectations. Table A4 in the appendix repeats the core specification for interest rate changes at frequencies ranging from daily to annual. The effect tends to be stronger when the interest rate change is computed over longer horizons, consistent with the idea that it is the more persistent decline in interest rates that boost the value of the leaders relative to the followers.

Another robustness test concerns the exact interest rate used in the specification. For example, do the excess return results depend on whether the change in the interest rate is at the short versus the long end of the yield curve? Statistically this is a somewhat hard test to perform because interest rate movements along the yield curve tend to be highly correlated. Table A5 in the appendix shows the correlation matrix of quarterly changes in forward rates of varying non-overlapping durations. The correlations are generally quite high, leading to problems of collinearity in joint testing. The lowest correlation is in the range of 0.7 to 0.75 between change in 0-2 forward rate and longer term forward rates (e.g. 10-30).

Figure 3: Distribution of Interest Rate Changes at Varying Frequencies



The panels plots the histograms of interest rate changes in our sample, from daily to annually.

Table 3 presents estimates of equation (2) using the forward rate of varying duration. The main takeaway is that the results shown above are similar for interest rate changes throughout the yield curve (columns (1) through (6)). When both the 0-2 and 10-30 forward rates are put in the specification together (columns (7) and (8)), both ends of the yield curve appear to be independently important, with some evidence that the longer end of the yield curve is more important.

Figure 4 plots the coefficients $\{\beta_{0,j}\}$ of the following specification:

$$R_{t+j} = \alpha_j + \beta_{0,j}\Delta i_t + \beta_{1,j}\Delta i_{t-1} + \beta_{2,j}\Delta i_t * i_{t-1} + \varepsilon_t \tag{3}$$

R_{t+j} is defined as the market-capitalization weighted average of returns for a stock portfolio that goes long in leader stocks and goes short in follower stocks from date t to $t+j$. In this specification, Δi_t is defined as the change in the interest rate from date t to $t+91$. The coefficients $\beta_{0,j}$ can be interpreted as the effect of a change in interest rates from $t-91$ to t on the returns of the leader portfolio from time t to time $t+j$ when the level of interest rates at $t-1$ is equal to zero. In other words, the figure represents the impulse response function at a daily frequency of the leader portfolio return to a change in interest rate over one quarter.

As the figure shows, the effect of a change in interest rates starts quickly but the full effect is not realized until about 90 days. Further, there is no evidence of reversal over the following quarter. The increase in the

Table 3: Portfolio Returns Response to Interest Rate Changes: Along the Yield Curve

	30-Year		2-Year		10-30 Forward		2-Year & 10-30 Fwd.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δi_t	-1.296***	-4.333***						
	(0.344)	(0.741)						
$\Delta i_t \times i_{t-1}$		0.335***						
		(0.073)						
$\Delta i_{t,0,2}$			-0.740**	-3.490***			-0.359	-2.303**
			(0.251)	(0.674)			(0.341)	(0.786)
$\Delta i_{t,0,2} \times i_{t-1}$				0.270***				0.160*
				(0.058)				(0.069)
$\Delta i_{t,10,30}$					-1.221***	-3.947***	-0.809	-2.657**
					(0.350)	(0.769)	(0.496)	(0.953)
$\Delta i_{t,10,30} \times i_{t-1}$						0.306***		0.247*
						(0.076)		(0.104)
N	9,669	9,669	9,669	9,669	9,669	9,669	9,669	9,669
R-sq	0.042	0.078	0.031	0.072	0.034	0.063	0.038	0.088

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the specification $R_t = \alpha + \beta_0 i_{t-1} + \beta_1 \Delta i_t + \beta_2 \Delta i_t i_{t-1} + \varepsilon_t$ at date t in columns 1-2 and $R_t = \alpha + \beta_0 i_{t-1} + \beta_{1,1}\Delta i_{t,0,2} + \beta_{1,2}\Delta i_{t,10,30} + \beta_{1,3}\Delta i_{t,0,10} + \beta_{2,1}\Delta i_{t,0,2} i_{t-1} + \beta_{2,2}\Delta i_{t,10,30} i_{t-1} + \beta_{2,3}\Delta i_{t,0,10} i_{t-1} + \varepsilon_t$ at date t in columns 3-8. R_t is defined as the market-capitalization weighted average of returns for a stock portfolio that goes long in leader stocks and goes short in follower stocks from date $t-91$ to t. Leaders are defined as the firms in the top 5% of market capitalization in its FF industry on date $t-J$. i_t is defined as the nominal 30-year Treasury yield, with i_{t-1} being the interest rate J days prior and Δi_t being the change in the interest rate from date $t-91$ to t. $i_{t,0,2}$, $i_{t,0,10}$ and $i_{t,10,30}$ are the 2-year and 10-year Treasury yield and 10 to 30 forward Treasury yield, respectively. Standard errors are Newey-West with a maximum lag length of 60 days prior. We cannot reject that the main and interaction coefficients in columns 7 and 8 are not equal.

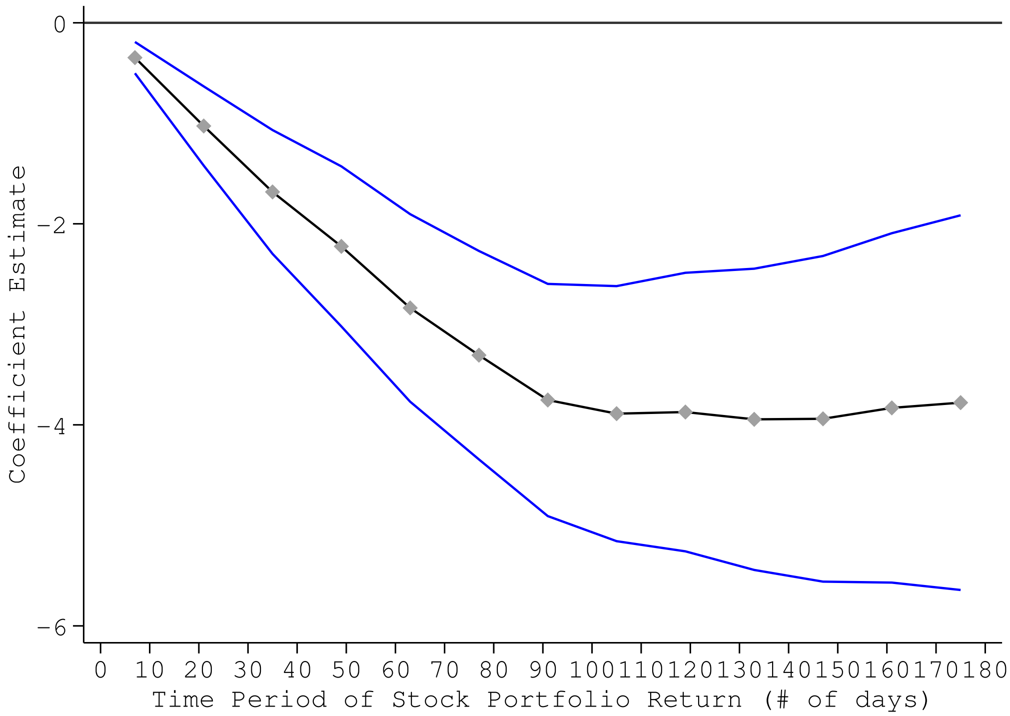
value of the leader portfolio is persistent.

3 Using high frequency monetary policy shocks

Changes in economy-wide interest rates are not exogenous, and so there remains a concern that the snowballing effect could be spuriously related to other variables moving with interest rates. This is an even larger concern when moving to investment outcomes, as done in the next section. In order to capture changes in interest rates that are less likely to be related to other economy-wide changes, the empirical analysis in the rest of the study uses high-frequency identified monetary policy shocks ϵ_t^m from Gorodnichenko and Weber (2016)[7]. The shocks are measured using the response of Federal Funds Rate Futures within a 60-minute time window (-20 minutes until +40 minutes) around FOMC meeting announcements. If no other macroeconomic announcements occur at the same time, the Futures response measures the exogenous response of interest rates to monetary policy. These shocks are available for the period between 1994 and 2019. The shocks only occur on days of Federal Open market committee meetings, which occur roughly once a month.

[7] Similar methodologies have been used by Nakamura and Steinsson (2018) and Ottonello and Winberry (2020). The original paper is Gürkaynak, Sack and Swanson (2005)

Figure 4: Impulse Response of Changes in Interest Rate when Rate is Zero



The figure plots the coefficients $\{\beta_{0,j}\}$ of the specification $R_{t+j} = \alpha_j + \beta_{0,j}\Delta i_t + \beta_{1,j}\Delta i_{t-1} + \beta_{2,j}\Delta i_t * i_{t-1} + \varepsilon_t$ at date t. R_{t+j} is defined as the market-capitalization weighted average of returns for a stock portfolio that goes long in leader stocks and goes short in follower stocks from date t to $t+j$. Δi_t is defined here as the change in the interest rate from date t to $t+91$. Leaders are defined as the firms in the top 5% of market capitalization in its FF industry on date t. Standard errors are Newey-West with a maximum lag length of 60 days prior.

Figure 5 plots the evolution of the Federal funds target rate since 1980, alongside the cumulative high frequency monetary policy shocks over the same period. The axis is compressed for the high frequency shocks. Two features of Figure 5 stand out. First, the overall time series patterns are similar. Second, the cumulative high frequency shocks are actually a substantial part of the overall decline in the target rate over the period. Put differently, the use of high frequency shocks captures a large part of the times series variation in monetary policy.

To address the economic power of these shocks further, we estimate the passthrough of the shocks to US Treasury yields at various maturities:

$$\Delta i_t^h = \alpha^h + \beta^h \epsilon_t^{HF} + \eta_t^h$$

where $\Delta i_t^h = i_t^h - i_{t-91}^h$ is the change in treasury yield of duration h between time $t-91$ and time t, while ϵ_t^{HF} is the sum of all high frequency shocks between time $t-91$ and t. We refer to the sum of the high frequency shocks at the quarterly level as "monetary policy shocks." Table 4 presents the estimates β^h of this pass-through along the yield curve.

Figure 5: Evolution of Federal Funds Target and Shocks

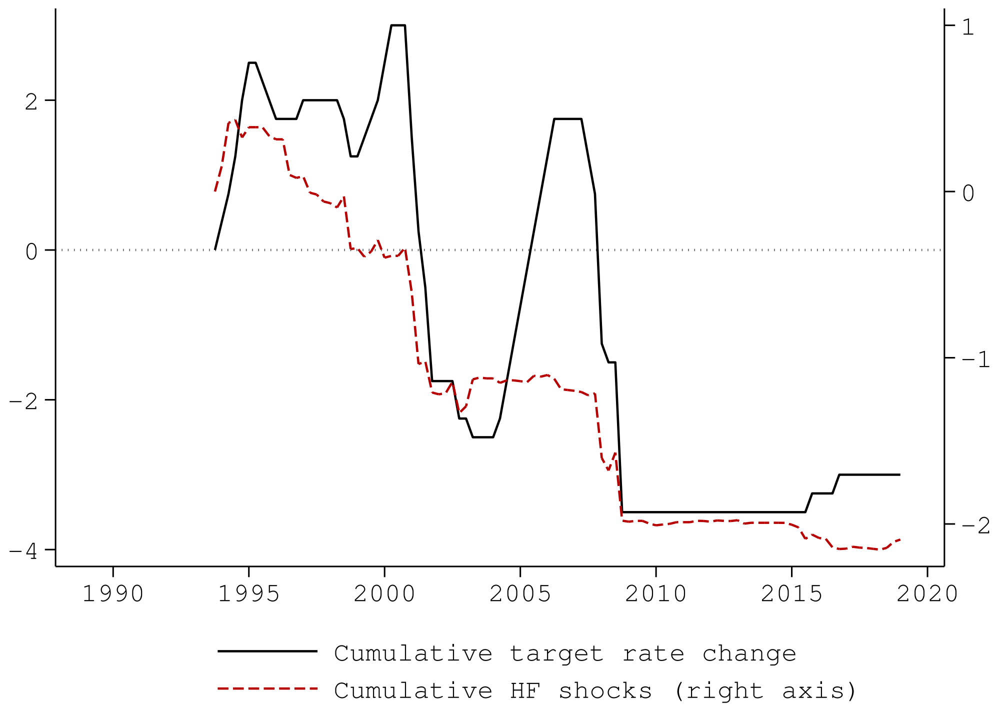


Table 4: Response to high frequency shocks along the yield curve

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	3 Mo	1 Yr	2 Yr	3 Yr	5 Yr	7 Yr	10 Yr	20 Yr	30 Yr
ϵ^{HF}	2.292***	2.404***	1.852***	1.599***	1.301***	1.048**	0.890*	0.524	0.560
	(0.307)	(0.319)	(0.375)	(0.385)	(0.392)	(0.379)	(0.388)	(0.323)	(0.329)
N	5,982	5,982	5,982	5,982	5,982	5,982	5,982	5,982	5,982
R-sq	0.259	0.256	0.131	0.093	0.063	0.044	0.036	0.016	0.019

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the specification $\Delta i_t^h = \alpha^h + \beta^h \epsilon_t^{HF} + \eta_t^h$ where $\Delta i_t^h = i_t^h - i_{t-91}^h$ is the change in treasury yield of duration h between time $t-91$ and time t, while ϵ_t^{HF} is the sum of all high frequency shocks between time $t-91$ and t. We consider yields on treasuries of three month duration alongside one, two, three, five, seven, ten, twenty and thirty year durations.

We can see that ten year yields move roughly one to one with monetary policy shocks at the quarterly frequency. Indeed monetary policy shocks shift the whole yield curve upwards, with larger effects at shorter durations. The one-for-one pass through of monetary policy shocks on 10 year Treasury yields is a convenient feature of the analysis, as the quantitative effect of monetary policy shocks on outcome variables can be directly compared to the quantitative effect of changes in 10 year yields.

We are now in a position to use the monetary policy shocks to estimate the effect of changes in interest rates on relative valuation. For the rest of the analysis, we use Compustat data recorded at a quarterly frequency, which allows us to investigate the response of a large array of firm level variables. We estimate the impact of monetary policy shocks on firms one quarter percent valuation change $R_{i,j,t} = \frac{\Delta P_{i,j,t}}{P_{i,j,t-1}}$ in the following local projection

$$R_{i,j,t} = \alpha_{j,t} + \alpha_i + \beta_0 D_{i,j,t} + \beta_1 D_{i,j,t}\epsilon_t^{HF} + \beta_2 D_{i,j,t} FFR_{t-1} + \beta_3 D_{i,j,t}\epsilon_t^{HF} FFR_{t-1} + X_{i,j,t}\gamma + \sum_{\ell=1}^{3} \boldsymbol{\delta}_\ell \boldsymbol{\omega}_{j,t-\ell} + \varepsilon_{i,j,t}$$

$R_{i,j,t}$ is defined here as the percentage valuation change of firm i in industry j from date $t-1$ to t (one quarter growth), while FFR_{t-1} being the federal funds target rate at the end of the previous quarter and ϵ_t^{HF} being the sum of high frequency shocks between time $t-1$ and t. Controls X include a firm's asset-liability ratio, debt-equity ratio, book-to-market ratio, and percent of pre-tax income that goes to taxes. The vector $\boldsymbol{\omega_{j,t}} = \{R_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}, X_{i,j,t}\}$ contains lagged values of all variables in the system. Real rates are built using monthly 10-year inflation expectations from the Cleveland Fed and the federal funds target rate at the end of each quarter (post-1982). The variable $D_{i,j,t}$ again defines leaders in a manner analogous to that of Section 2. Table 5 reports estimates of β_1 and β_2 from equation 3 on quarterly Compustat data from 1980 onward.

Table 5: Differential Responses of Leaders vs. Followers to Monetary Policy shocks: Quarterly data

	Stock Return				
	(1)	(2)	(3)	(4)	(5)
Top 5 Percent=1 x ϵ^{HF}	1.838	-12.53**	-13.51***	-12.46**	-13.44***
	(1.964)	(4.878)	(4.985)	(4.853)	(4.960)
Top 5 Percent=1 x ϵ^{HF} x lagged FFR		3.589***	3.885***		
		(1.198)	(1.222)		
Top 5 Percent=1 x ϵ^{HF} x lagged real FFR				3.598***	3.894***
				(1.200)	(1.224)
Controls	N	N	Y	N	Y
Industry-Date & firm FE	Y	Y	Y	Y	Y
N	359,039	359,039	340,731	359,039	340,731
R-sq	0.239	0.239	0.250	0.239	0.250

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the lag augmented local projection specification $R_{i,j,t} = \alpha_{j,t} + \alpha_i + \beta_0 D_{i,j,t} + \beta_1 D_{i,j,t}\epsilon_t^{HF} + \beta_2 D_{i,j,t} FFR_{t-1} + \beta_3 D_{i,j,t}\epsilon_t^{HF} FFR_{t-1} + X_{i,j,t}\gamma + \sum_{\ell=1}^{3} \boldsymbol{\delta}_\ell \boldsymbol{\omega}_{j,t-\ell} + \varepsilon_{i,j,t}$ for firm i in industry j at date t. $R_{i,j,t}$ is defined here as the percentage valuation change of firm i in industry j from date $t-1$ to t (one quarter growth). $D_{i,j,t}$ is defined here as an indicator equal to 1 at date t when a firm i is in the top 5% of market capitalization in its industry j on date $t-1$. Firms with $D_{i,j,t}$=1 are called leaders while the rest are called followers. i_t is defined as the nominal 10-year Treasury yield, with FFR_{t-1} being the federal funds target rate at the end of the previous quarter and ϵ_t^{HF} being the sum of high frequency shocks between time $t-1$ and t. Controls X include a firm's asset-liability ratio, debt-equity ratio, book-to-market ratio, and percent of pre-tax income that goes to taxes. Industry classifications are the Fama-French industry classifications (FF). The vector $\boldsymbol{\omega_{j,t}} = \{R_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}, X_{i,j,t}\}$ contains lagged values of all variables in the system. Real rates were built using monthly 10-year inflation expectations from the Cleveland Fed and the federal funds target rate at the end of each quarter (post-1982). Lag augmentation implies heteroskedasticity-robust standard errors are sufficient, according to Olea and Plagborg-Møller (2020).

Qualitatively, the results in Table support the existence of a snowballing effect. An expansionary monetary policy shock which lowers interest rates boosts the value of leaders relative to followers, and this effect is amplified when the initial interest rate is already low. However, the effects are substantially larger when using the monetary policy shocks. One potential reason is that economy-wide interest rates tend to fall when the overall economy is weak. A weaker economy may be associated with a decline in the size of the total pie in any industry, which would differentially lower the value of leaders who currently have a larger slice of the pie. This unobservable factor may be biasing the coefficient in Table 1 toward zero. Under this logic, the use of the endogenous economy-wide interest rate leads to a smaller valuation effect of the leader relative to the follower compared to the use of the exogenous monetary policy shocks.

4 Financial effects of falling interest rates

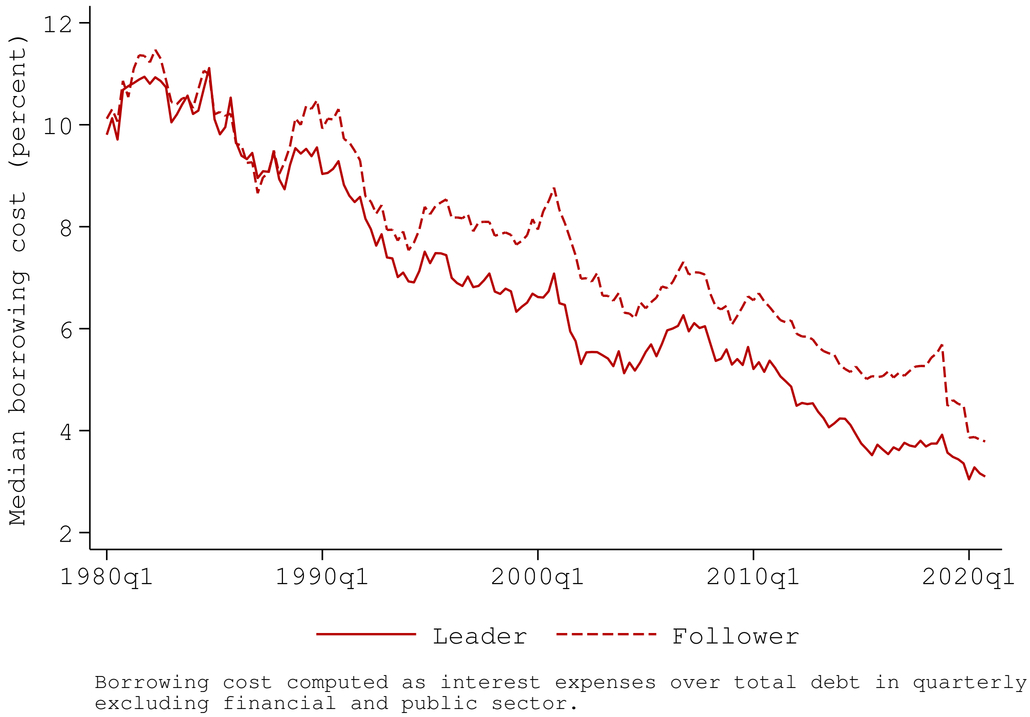
4.1 Pass-through of lower interest rates for industry leaders and followers

A decline in interest rates boosts the value of industry leaders relative to followers, and this effect snowballs as the level of the interest rate becomes lower. We now explore mechanism through which industry leaders gain relative to industry followers when interest rate declines. We first explore whether the decline in economy-wide interest rates such as the 10 year Treasury rate has been associated with a differential decline in the cost of debt financing for industry leaders relative to followers. A stronger pass-through of lower Treasury rates into the cost of debt financing for industry leaders represents another advantage of a low interest rate environment for leaders relative to followers.

As before, industry leaders are defined as the largest 5% of firms in each Fama-French industry, measured by market capitalization. We define each firms' borrowing cost as the the ratio of interest expense to total liabilities, which is simply average rate of interest paid on it's liabilities. We treat the largest 5% of borrowing costs in the sample as missing in order to exclude any outliers in the data. Figure 6 plots the evolution of the median borrowing cost faced by both leaders and followers, displaying both a clear downward trend and also a stark increase in spreads since 1980. The spread in the 1980s was 31 basis points whereas the spread in the 2010s is 127 basis points.

The interest rate spread between market leaders and market followers widened even though the level of interest rate fell considerably. We present estimates of the effect of a decline in interest rates as defined by the monetary policy shocks discussed in Section 3 on the cost of debt financing for industry leaders versus followers. As above, we measure borrowing costs using the average interest rate paid by the firm on all debt. We calculate this as the total interest expense divided by total debt. We exclude the top 5% observed values of borrowing costs, due to the presence of implausibly large values.

Figure 6: Borrowing costs for leaders and followers since 1980



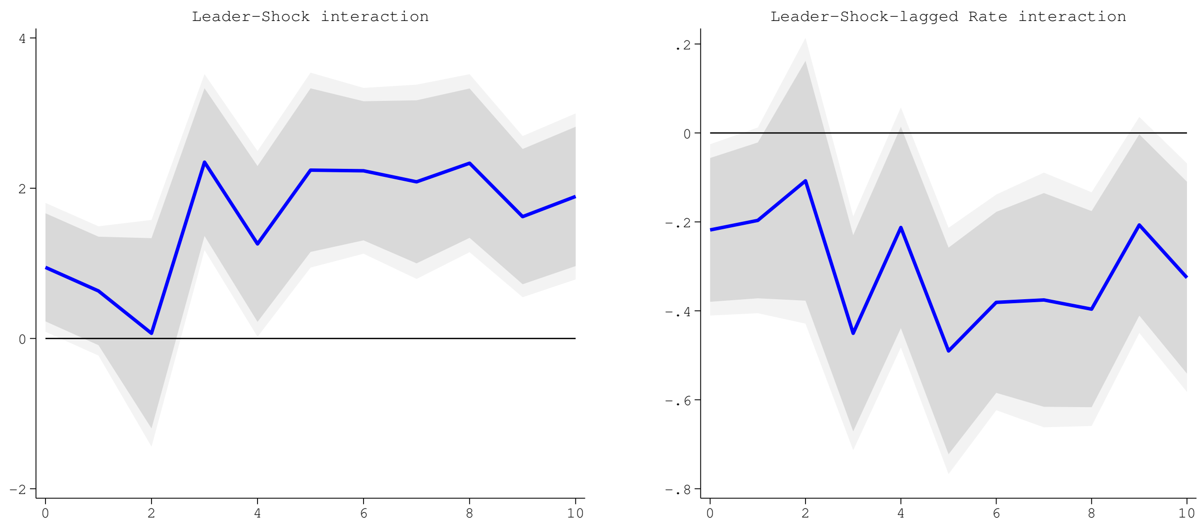
The baseline specification is given by

$$Y_{i,j,t+h} = \alpha_i + \alpha_{j,t} + \beta_{1,h}\epsilon_t^{HF} * D_{i,j,t-1} + \beta_{2,h}\epsilon_t^{HF} * D_{i,j,t-1} * FFR_{t-1} + \delta_h^1 D_{i,j,t-1} + \sum_{\ell=1}^{3} \Gamma_h' \boldsymbol{W}_{i,t-\ell} + \epsilon_{i,t+h} \quad (4)$$

where $Y_{i,t}$ is the outcome variable of interest for firm i, $D_{i,j,t-1}$ is an indicator variable equal to 1 if firm i is in the top 5% of market capitalization in its industry j at date $t-1$, while $\boldsymbol{W}_{i,t}$ is a vector containing all variables in the system. We also control for firm α_i and industry - time fixed effects $\alpha_{j,t}$. Olea and Plagborg-Møller (2020) show that augmenting the local projection with lags of each variable removes the need to correct standard errors for autocorrelation, meaning heteroskedasticity robust standard errors are appropriate when estimating equation 4. The estimates provided below are from letting Y equal to borrowing costs.

For this specification, the coefficients of interest are $\{\beta_{1,h}\}$and$\{\beta_{2,h}\}$, which give the differential response of the borrowing costs for leaders at the zero lower bound ($FFR_{t-1} = 0$), and the rate at which this effect changes as rates rise, respectively. Figure 7 plots the impulse responses of borrowing costs to a negative shock in interest rates. As it shows, a decline in the interest rate due to monetary policy shocks leads to a lower interest rate of leaders relative to followers (right panel), and this effect becomes larger as the level of the initial interest rate is lower (right panel). The effect of lower interest rates is persistent; it does not revert for the 10 years after the initial shock.

Figure 7: Response of borrowing cost to interest rate shock



The left panel plots estimates of $\beta_{1,h}$, while the right panel plots estimates of $\beta_{2,h}$, estimated from the local projection $r_{i,j,t+h} = \alpha_i + \alpha_{j,t} + \beta_{1,h}\epsilon_t^{HF} * D_{i,j,t-1} + \beta_{2,h}\epsilon_t^{HF} * D_{i,j,t-1} * FFR_{t-1} + \delta_h^1 D_{i,j,t-1} + \sum_{\ell=1}^{3} \Gamma_h' \boldsymbol{W}_{i,t-\ell} + \epsilon_{i,t+h}$ where r denotes the average interest rate of firm i and $\boldsymbol{W}_{i,t} = \{debt_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}\}$ is a vector of all variables in the system. The shading indicating 90% and 95% confidence intervals.

To estimate the medium run response of monetary policy shocks on borrowing costs, we take the four quarter average between $t+5$ and $t+8$ as $\bar{Y}_{i,j,t+6} = \frac{1}{4}\sum_{\ell=-1}^{2} Y_{i,j,t+6+\ell}$, which gives the average change one year ahead for these years. We then use this long run value in the LP estimation equation 4 to estimate medium run changes. Columns 1 and 2 of Table 6 report the estimated coefficients from the regression using borrowing costs as the left hand side variable. The estimate implies that when the Federal Funds rate is 2%, a 10 basis point decline in the Federal Funds rate (roughly one standard deviation) leads to a 15 basis point relative decline in the cost of borrowing of an industry leader relative to a follower. This effect is amplified to 24 basis points when the economy is very close to the zero lower bound.

In standard asset pricing models, the rise in the spread between industry leaders and industry followers would be compensation for additional risk. If industry followers become riskier relative to industry leaders when there is a decline in aggregate measures of interest rates, then this effect boosts the value of industry leaders relative to industry followers, and it therefore should be included as part of the advantage lower interest rates give to industry followers. There is a broader question of why lower interest rates boost the riskiness of followers relative to leaders; this is an interesting question for future research.

4.2 Capital structure adjustments

Industry leaders take advantage of the lower cost of debt financing, a fact shown in Figures 8 and 9. These figures plot $\{\beta_{1,h}\}$and$\{\beta_{2,h}\}$ from the estimation of equation 4 with the natural logarithm of debt as the left hand side variable in Figure 8 and the book total liabilities to total assets ratio in Figure 9. Both figures

Table 6: Differential long run responses to Monetary Policy shocks - Financial Variables

	Borrowing cost		Debt		Leverage		Shares	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Top 5 Percent=1 x ϵ^{HF}	2.431***	2.518***	-0.528***	-0.706***	-0.107***	-0.112***	0.232***	0.343***
	(0.474)	(0.479)	(0.143)	(0.143)	(0.020)	(0.020)	(0.089)	(0.074)
Top 5 Percent=1 x ϵ^{HF} x FFR_{t-1}	-0.476***	-0.495***	0.104***	0.149***	0.0236***	0.0249***	-0.0728***	-0.0976***
	(0.103)	(0.104)	(0.035)	(0.035)	(0.005)	(0.005)	(0.021)	(0.018)
Controls	N	Y	N	Y	N	Y	N	Y
Industry-Date & firm FE	Y	Y	Y	Y	Y	Y	Y	Y
N	137,167	134,646	186,851	182,403	235,655	228,093	248,627	236,949
R-sq	0.780	0.780	0.943	0.938	0.881	0.874	0.968	0.983

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

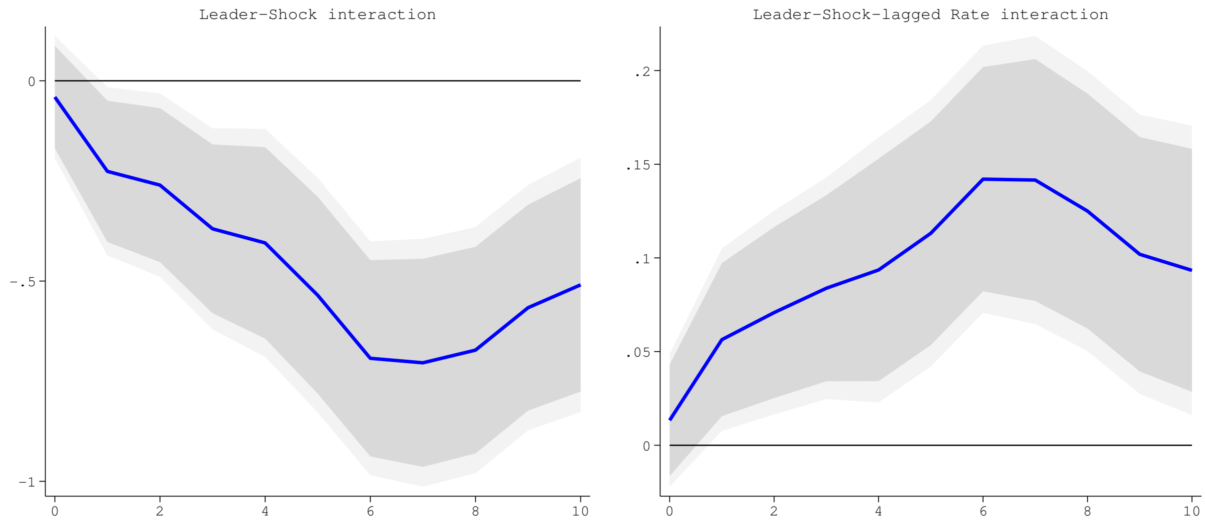
Regression results for the lag augmented local projection specification $\bar{Y}_{i,j,t+6} = \alpha_{j,t} + \alpha_i + \beta_0 D_{i,j,t} + \beta_1 D_{i,j,t} \Delta i_t + \beta_2 D_{i,j,t} i_{t-1} + \beta_3 D_{i,j,t} \epsilon_t^{HF} FFR_{t-1} + X_{i,j,t}\gamma + \sum_{\ell=1}^{3} \boldsymbol{\delta}_\ell \boldsymbol{\omega}_{j,t-\ell} + \varepsilon_{i,j,t}$ for firm i in industry j at date t. $\bar{Y}_{i,j,t+6} = \frac{1}{4}\sum_{\ell=-1}^{2} X_{i,j,t+6+\ell}$ is defined here as the four quarter average of variable X from period $t+5$ to $t+7$. We let Y be firm's debt, shares outstanding (log after average), borrowing costs and leverage. $D_{i,j,t}$ is defined here as an indicator equal to 1 at date t when a firm i is in the top 5% of market capitalization in its industry j on date $t-1$. Firms with $D_{i,j,t}$=1 are called leaders while the rest are called followers. i_t is defined as the nominal 10-year Treasury yield, with FFR_{t-1} being the federal funds target rate at the end of the previous quarter and ϵ_t^{HF} being the sum of high frequency shocks between time $t-1$ and t. Industry classifications are the Fama-French industry classifications (FF). The vector $\boldsymbol{\omega_{j,t}} = \{Y_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}, Z_{i,j,t}\}$ contains lagged values of all variables in the system. Controls Z include a total assets, real sales growth and the net current assets ratio of firm. Real rates were built using monthly 10-year inflation expectations from the Cleveland Fed and the federal funds target rate at the end of each quarter (post-1982). Lag augmentation implies heteroskedasticity-robust standard errors are sufficient, according to Olea and Plagborg-Møller (2020).

show a large and persistent effect of lower interest rates coming from monetary policy shocks on the capital structure of industry leaders relative to industry followers. Industry leaders raise debt financing in response to expansionary monetary policy shocks more than industry followers, and this effect snowballs as the level of the initial interest rate is lower. Ultimately, this has a persistent effect on the leverage ratio of leaders relative to followers.

Columns 3 through 6 of Table 6 help to quantify this effect. When the economy is very close to the zero lower bound, a 10 basis point decline in the Federal Funds rate leads to a 5.2% relative increase in debt issued and a 1 percentage point relative increase in the book leverage ratio.

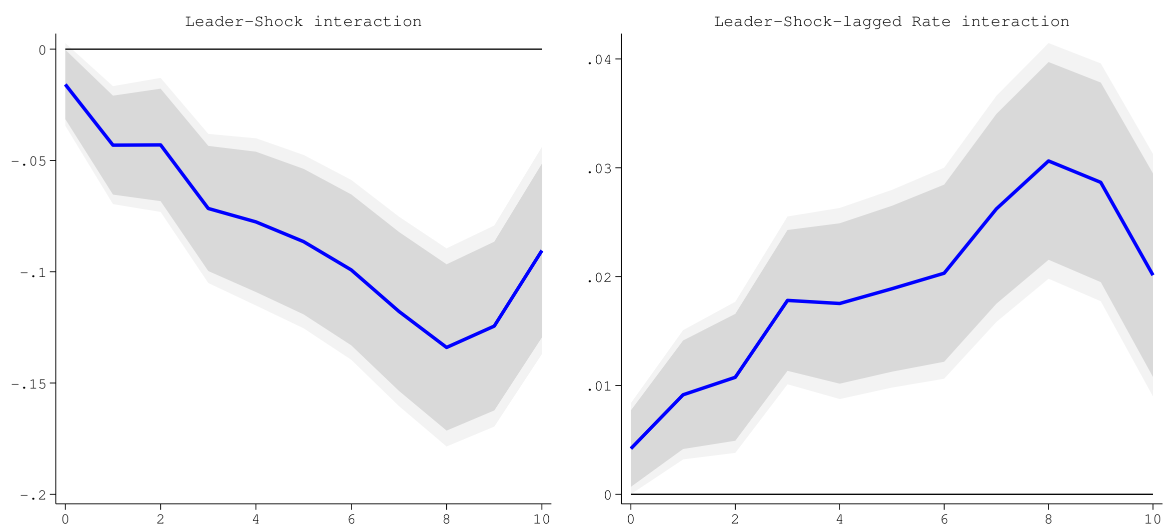
What do industry leaders use with the additional debt financing they raise in response to expansionary monetary policy shocks? This is a critical question given the tendency over time for companies to buy back shares using debt financing (e.g., Yardeni, Abbott and Quintana (2019)), and results from the literature that suggest that some firms use a lower cost of debt financing to buy back shares instead of boosting investment (e.g., Aramonte (2020)). Figure 10 shows evidence that at least some of the rise in debt financing is associated with share buybacks. More specifically, Figure 10 plots $\{\beta_{1,h}\}$and$\{\beta_{2,h}\}$ from the estimation of equation 4 using the natural logarithm of common shares outstanding from Compustat as the left hand side variable. Expansionary monetary policy reduces the number of shares outstanding for leaders relative to followers, and this effect gets stronger for expansionary monetary policy shocks when initial interest rates are already low. Columns 7 and 8 present the regression coefficients for common shares outstanding, which confirm the

Figure 8: Response of debt to interest rate shock



The left panel plots estimates of $\beta_{1,h}$, while the right panel plots estimates of $\beta_{2,h}$, estimated from the local projection $debt_{i,j,t+h} = \alpha_i + \alpha_{j,t} + \beta_{1,h}\epsilon_t^{HF} * D_{i,j,t-1} + \beta_{2,h}\epsilon_t^{HF} * D_{i,j,t-1} * FFR_{t-1} + \delta_h^1 D_{i,j,t-1} + \sum_{\ell=1}^{3} \Gamma'_h \boldsymbol{W}_{i,t-\ell} + \epsilon_{i,t+h}$ where $debt$ denotes the log of the total debt of firm i and $\boldsymbol{W}_{i,t} = \{debt_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}\}$ is a vector of all variables in the system. The shading indicating 90% and 95% confidence intervals.

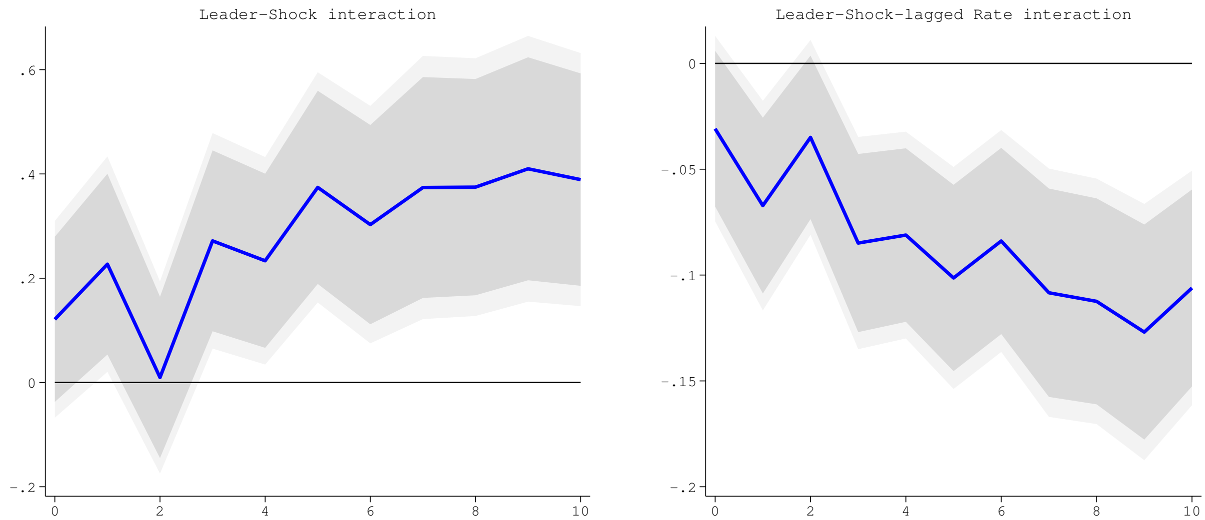
Figure 9: Response of leverage=liabilities/assets to interest rate shock



The left panel plots estimates of $\beta_{1,h}$, while the right panel plots estimates of $\beta_{2,h}$, estimated from the local projection $lev_{i,j,t+h} = \alpha_i + \alpha_{j,t} + \beta_{1,h}\epsilon_t^{HF} * D_{i,j,t-1} + \beta_{2,h}\epsilon_t^{HF} * D_{i,j,t-1} * FFR_{t-1} + \delta_h^1 D_{i,j,t-1} + \sum_{\ell=1}^{3} \Gamma'_h \boldsymbol{W}_{i,t-\ell} + \epsilon_{i,t+h}$ where $assets$ denotes the log of total assets held by firm i and $\boldsymbol{W}_{i,t} = \{lev_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}\}$ is a vector of all variables in the system. The shading indicating 90% and 95% confidence intervals.

patterns in the figure.

Figure 10: Response of log of common shares outstanding to interest rate shock



The left panel plots estimates of $\beta_{1,h}$, while the right panel plots estimates of $\beta_{2,h}$, estimated from the local projection $shares_{i,j,t+h} = \alpha_i + \alpha_{j,t} + \beta_{1,h}\epsilon_t^{HF} * D_{i,j,t-1} + \beta_{2,h}\epsilon_t^{HF} * D_{i,j,t-1} * FFR_{t-1} + \delta_h^1 D_{i,j,t-1} + \sum_{\ell=1}^{3} \Gamma_h' \boldsymbol{W}_{i,t-\ell} + \epsilon_{i,t+h}$ where $shares$ denotes the log of common shares of firm i outstanding and $\boldsymbol{W}_{i,t} = \{shares_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}, MV_{i,j,t}\}$ is a vector of all variables in the system. The shading indicating 90% and 95% confidence intervals.

5 Real effects of lower interest rates

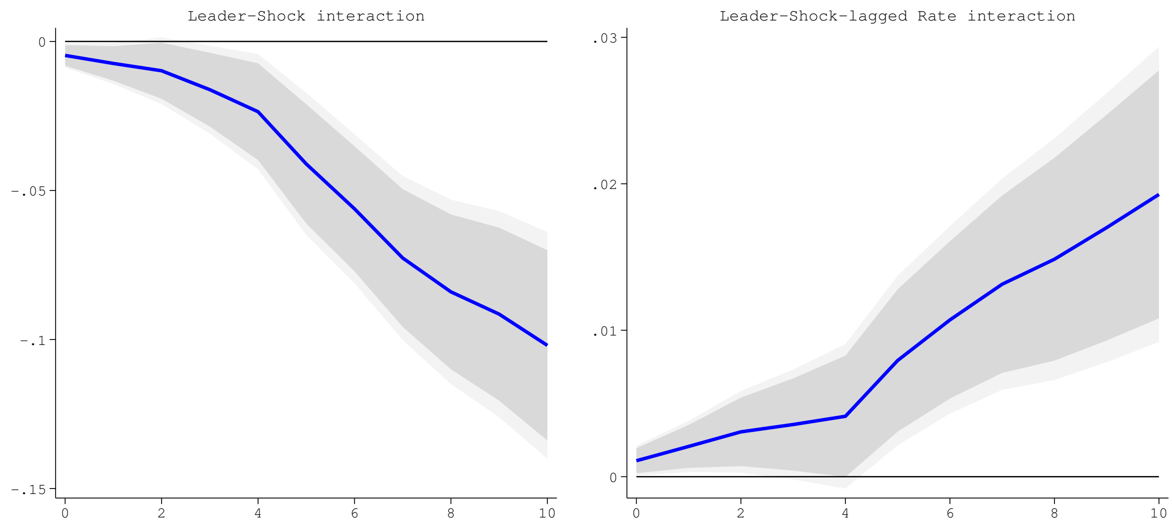
Expansionary monetary policy shocks have large effects on the financial policy of leaders versus followers, and these effects snowball at lower levels of the initial interest rate. This section explores the real effects of expansionary monetary policy shocks.

Figures 11b and 11a shows the estimates of equation (4) letting Y equal to cumulative capital expenditures and cash acquisitions respectively. The results show that in response to an expansionary monetary policy shock which sends interest rates lower, industry leaders boost capital expenditures and cash acquisitions by more than industry followers. Furthermore, this stronger effect gets even stronger if the initial interest rate is lower. Therefore, the snowballing effect applies to real effects.

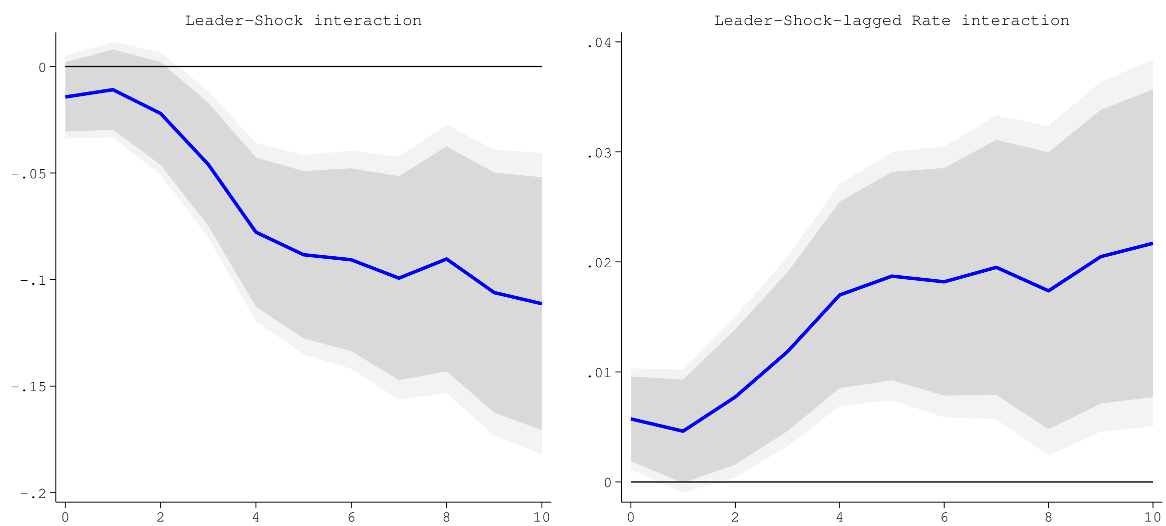
Table 7 shows these results in a regression format. For capital expenditure and cash acquisition specification, the left hand side variable is the sum of the quarterly flows from $t-1$ to $t+5$ scaled by assets as of $t-1$. As the results show, industry leaders boost capital expenditures and cash acquisitions by substantially more than followers when interest rates fall. When the economy is near the zero lower bound, a 10 basis point decline in the Federal Funds rate leads to a 0.4 percentage point rise in capital expenditures and a 1.0 percentage point rise in cash acquisitions relative to total assets. The snowballing effect is also present, but the result is statistically weaker for capital expenditures when including control variables. Overall, a 10 basis point decline in the Federal Funds rate near the zero lower bound is associated with a 2 percent rise in PPE for industry leaders relative to industry followers.

Figure 11: Capital Expenditures and Cash Acquisitions

(a) Capital investment



(b) Acquisitions



The left panels plots estimates of $\beta_{1,h}$, while the right panel plots estimates of $\beta_{2,h}$, estimated from the local projection $Y_{i,j,t+h} = \alpha_i + \alpha_{j,t} + \beta_{1,h}\epsilon_t^{HF} * D_{i,j,t-1} + \beta_{2,h}\epsilon_t^{HF} * D_{i,j,t-1} * FFR_{t-1} + \delta_h^1 D_{i,j,t-1} + \sum_{\ell=1}^{3} \Gamma_h' \boldsymbol{W}_{i,t-\ell} + \epsilon_{i,t+h}$ where $Y_{i,j,t+h} = \frac{\sum_{k=0}^{h} C_{i,j,t+k}}{assets_{i,j,t-1}}$ and C denotes firm i's net acquisitions or captal investment cash flows while $\boldsymbol{W}_{i,t} = \{Y_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}\}$ is a vector of all variables in the system. The shading indicating 90% and 95% confidence intervals.

Overall, the results on real effects show that industry leaders invest or acquire capital assets in response to a decline in interest rates more strongly than industry followers, and that this effect becomes stronger when initial interest rates are lower. This result hints at the importance of declining interest rates in explaining product market competition: the big get bigger when interest rates decline, especially as they decline toward zero. These findings also support the model proposed by Chatterjee and Eyigungor (2020), who argue that a

Table 7: Differential long run responses to Monetary Policy shocks - Real variables

	Capital Exp		Acquisitions		PPE	
	(1)	(2)	(3)	(4)	(5)	(6)
Top 5 Percent=1 x ϵ^{HF}	-0.0404***	-0.0294*	-0.100***	-0.0840***	-0.259***	-0.224***
	(0.015)	(0.015)	(0.026)	(0.027)	(0.069)	(0.070)
Top 5 Percent=1 x ϵ^{HF} x FFR_{t-1}	0.00771**	0.00536	0.0199***	0.0163***	0.0441***	0.0331**
	(0.003)	(0.003)	(0.006)	(0.006)	(0.016)	(0.016)
Controls	N	Y	N	Y	N	Y
Industry-Date & firm FE	Y	Y	Y	Y	Y	Y
N	265,981	253,227	248,767	236,285	251,459	240,551
R-sq	0.755	0.787	0.265	0.324	0.989	0.989

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the lag augmented local projection specification $\bar{Y}_{i,j,t} = \alpha_{j,t} + \alpha_i + \beta_0 D_{i,j,t} + \beta_1 D_{i,j,t}\Delta i_t + \beta_2 D_{i,j,t} i_{t-1} + \beta_3 D_{i,j,t}\epsilon_t^{HF} FFR_{t-1} + X_{i,j,t}\gamma + \sum_{\ell=1}^{3} \boldsymbol{\delta}_\ell \boldsymbol{\omega}_{j,t-\ell} + \varepsilon_{i,j,t}$ for firm i in industry j at date t. We let Y be the firm's capital investment and acquisitions cash flow and property, plant and equipment. When y is a cash flow, we have $\bar{Y}_{i,j,t} = \frac{\sum_{k=0}^{5} C_{i,j,t+k}}{assets_{i,j,t-1}}$ is defined here as the sum of cash flows between $t-1$ and $t+5$, scaled by initial total assets in $t-1$. When the dependent variable of interest $Y = \log(PPE)$ is property, plant and equipment, the left hand side variable is given by $\bar{Y}_{i,j,t} = \log\left(\frac{1}{4}\sum_{\ell=-1}^{2} PPE_{i,j,t+6+\ell}\right)$. $D_{i,j,t}$ is defined here as an indicator equal to 1 at date t when a firm i is in the top 5% of market capitalization in its industry j on date $t-1$. Firms with $D_{i,j,t}$=1 are called leaders while the rest are called followers. i_t is defined as the nominal 10-year Treasury yield, with FFR_{t-1} being the federal funds target rate at the end of the previous quarter and ϵ_t^{HF} being the sum of high frequency shocks between time $t-1$ and t. Industry classifications are the Fama-French industry classifications (FF). The vector $\boldsymbol{\omega_{j,t}} = \{Y_{i,j,t}, D_{i,j,t}, D_{i,j,t}\epsilon_t^{HF}, D_{i,j,t}\epsilon_t^{HF} FFR_{t-1}, Z_{i,j,t}\}$ contains lagged values of all variables in the system. Controls Z include a total assets, real sales growth and the net current assets ratio of firm. Real rates were built using monthly 10-year inflation expectations from the Cleveland Fed and the federal funds target rate at the end of each quarter (post-1982). Lag augmentation implies heteroskedasticity-robust standard errors are sufficient, according to Olea and Plagborg-Møller (2020).

lower risk-free rate benefits bigger firms because they can increase leverage by more than smaller firms, and therefore acquire more of the new product varieties arriving into the economy.

6 Conclusion

Using CRSP-Compustat merged data from 1962 onwards, we find that falling interest rates boost the relative valuation of industry leaders relative to industry followers, and the relative valuation effect becomes largest as the initial interest rate approaches zero. This result is robust to the use of high frequency monetary policy shocks as a source of variation in economy-wide interest rates. A decline in the interest rate disproportionately lowers the cost of borrowing of industry leaders, who take advantage of the lower cost of borrowing to raise additional debt financing, increase leverage, repurchase shares, boost capital investment, and conduct acquisitions. All of these effects snowball as the level of the interest rate decline; that is, a decline in interest rates has a stronger effect on all of these outcomes of leaders relative to followers when the initial level of the interest rate is already low. The findings provide empirical support to the idea that extremely low interest rates may be a culprit in explaining the rise of superstar firms in the U.S. economy.

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A Appendix

Table A1: Differential Interest Rate Responses of Leaders vs. Followers: Top 5 Percent (Full Sample)

	Stock Return					
	(1)	(2)	(3)	(4)	(5)	(6)
Top 5 Percent=1 x Δi	-0.923***	-2.935**	-4.021***	-1.961***	-2.901***	-3.083***
	(0.197)	(0.847)	(0.817)	(0.554)	(0.608)	(0.484)
Top 5 Percent=1 x Δi x Lagged i		0.225**	0.312***			0.229***
		(0.076)	(0.074)			(0.042)
Top 5 Percent=1 x Δi x Lagged real i (Clev and Fred)				0.294*	0.449***	
				(0.111)	(0.117)	
Firm β x Δi						10.22***
						(0.861)
Firm β x Δi x Lagged i						-0.980***
						(0.101)
Sample	All	All	All	All	All	All
Controls	N	N	Y	N	Y	
Industry-Date FE	Y	Y	Y	Y	Y	Y
N	74,103,576	74,103,576	46,832,612	74,103,576	46,832,612	73,745,550
R-sq	0.394	0.394	0.406	0.394	0.406	0.397

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the specification $R_{i,j,t} = \alpha_{j,t} + \beta_0 D_{i,j,t} + \beta_1 D_{i,j,t}\Delta i_t + \beta_2 D_{i,j,t} i_{t-1} + \beta_3 D_{i,j,t}\Delta i_t i_{t-1} + X_{i,j,t}\gamma + \varepsilon_{i,j,t}$ for firm i in industry j at date t. $R_{i,j,t}$ is defined here as the retrun to holding the stock (including dividends) of firm i in industry j from date $t-91$ to t (one quarter growth). $D_{i,j,t}$ is defined here as an indicator equal to 1 at date t when a firm i is in the top 5% of market capitalization in its industry j on date $t-91$. Firms with $D_{i,j,t}$=1 are called leaders while the rest are called followers. i_t is defined as the nominal 10-year Treasury yield, with i_{t-1} being the interest rate 91 days prior and Δi_t being the change in the interest rate from date $t-91$ to t. Controls X include a firm's asset-liability ratio, debt-equity ratio, book-to-market ratio, and percent of pre-tax income that goes to taxes. Industry classifications are the Fama-French industry classifications (FF). Lagged real rates were built using monthly 10-year inflation expectations from the Cleveland Fed and the daily 10-year Treasury yield at the beginning of each month (post-1982), and the CPI series from the FED (pre-1982). Standard errors are dually clustered by industry and date.

Table A2: Portfolio Returns Response to Interest Rate Changes: Top 5 Percent (Full Sample)

	Portfolio Return				
	(1)	(2)	(3)	(4)	(5)
Δi_t	-1.089***	-3.279***	-1.915***	-3.702***	-3.475***
	(0.280)	(0.580)	(0.465)	(0.854)	(0.815)
i_{t-1}		0.0340		0.0192	0.0554
		(0.048)		(0.072)	(0.063)
$\Delta i_t \times i_{t-1}$		0.251***		0.270***	0.347**
		(0.056)		(0.078)	(0.113)
$real\ i_{t-1}$ (Clev and Fred)			0.0239		
			(0.067)		
$\Delta i_t \times real\ i_{t-1}$ (Clev and Fred)			0.192*		
			(0.085)		
$(\Delta i_t > 0)$=1 $\times\ \Delta i_t$				0.482	
				(1.541)	
$(\Delta i_t > 0)$=1 $\times\ \Delta i_t \times i_{t-1}$				-0.0436	
				(0.167)	
PE Portfolio Return					-0.246***
					(0.053)
N	13,843	13,843	13,843	13,843	11,205
R-sq	0.031	0.053	0.039	0.054	0.130

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the specification $R_t = \alpha + \beta_0 i_{t-1} + \beta_1 \Delta i_t + \beta_2 \Delta i_t i_{t-1} + \varepsilon_t$ at date t. R_t is defined as the market-capitalization weighted average of returns for a stock portfolio that goes long in leader stocks and goes short in follower stocks from date $t-91$ to t. Leaders are defined as the firms in the top 5% of market capitalization in its FF industry on date $t-91$. i_t is defined as the nominal 10-year Treasury yield, with i_{t-1} being the interest rate 91 days prior and Δi_t being the change in the interest rate from date $t-91$ to t. Standard errors are Newey-West with a maximum lag length of 60 days prior. Real rates were built using monthly 10-year inflation expectations from the Cleveland Fed and the daily 10-year Treasury yield (post-1982), and the CPI series from the FED (pre-1982).

Table A3: Differential Interest Rate Responses of Leaders vs. Followers: Robustness Checks

	Top 5		SIC		EBITDA		SALES	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Top 5 Percent=1 x Δi	-1.132***	-3.518**	-1.239***	-3.655***	-1.383***	-4.145***	-1.132***	-3.200**
	(0.252)	(1.057)	(0.209)	(0.797)	(0.248)	(0.933)	(0.321)	(1.171)
Top 5 Percent=1 x Δi x Lagged i		0.268**		0.267***		0.318***		0.236*
		(0.092)		(0.069)		(0.082)		(0.100)
Sample	All	All	All	All	All	All	All	All
Industry-Date FE	Y	Y	Y	Y	Y	Y	Y	Y
N	65,944,610	65,944,610	65,908,099	65,908,099	41,953,229	41,953,229	51,625,374	51,625,374
R-sq	0.392	0.393	0.391	0.391	0.412	0.413	0.400	0.400

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the specification $R_{i,j,t} = \alpha_{j,t} + \beta_0 D_{i,j,t} + \beta_1 D_{i,j,t}\Delta i_t + \beta_2 D_{i,j,t} i_{t-1} + \beta_3 D_{i,j,t}\Delta i_t i_{t-1} + X_{i,j,t}\gamma + \varepsilon_{i,j,t}$ for firm i in industry j at date t. The definitions are the same as in Table 2 except for $D_{i,j,t}$. In columns 1 and 2, leaders are chosen by the top 5 number of firms by market capitalization within an industry and date. In columns 3 and 4, leaders are chosen by the top 5% of firms by market capitalization within an industry and date, where we change the definition of industry to be the 2-digit Standard Industry Classification (SIC) codes. In columns 5 and 6, leaders are chosen by the top 5% of firms by earnings before interest, taxes, depreciation, and amortization (EBITDA) within an industry and date. In columns 7 and 8, leaders are chosen by the top 5% of firms by sales within an industry and date. Standard errors are dually clustered by industry and date.

Table A4: Portfolio Returns Response to Interest Rate Changes: Top 5 Percent, Different Frequencies

	Yearly		Semi-Yearly		Monthly		Weekly		Daily	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δi_t	-1.301**	-5.554***	-1.388***	-4.530***	-1.003***	-2.443***	-0.943***	-1.734***	-0.829***	-1.139***
	(0.416)	(0.993)	(0.349)	(0.688)	(0.203)	(0.443)	(0.168)	(0.307)	(0.167)	(0.214)
i_{t-1}		0.178		0.0640		0.0227		0.0122*		0.00847***
		(0.135)		(0.079)		(0.019)		(0.005)		(0.001)
$\Delta i_t \times i_{t-1}$		0.466***		0.359***		0.160***		0.0899**		0.0370
		(0.096)		(0.069)		(0.040)		(0.035)		(0.027)
Sample	All	All	All	All	All	All	All	All	All	All
N	9,706	9,706	9,615	9,615	9,738	9,738	9,755	9,755	9,734	9,734
R-sq	0.036	0.099	0.053	0.107	0.035	0.051	0.030	0.037	0.018	0.023

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression results for the specification $R_t = \alpha + \beta_0 i_{t-1} + \beta_1 \Delta i_t + \beta_2 \Delta i_t i_{t-1} + \varepsilon_t$ at date t. R_t is defined as the market-capitalization weighted average of returns for a stock portfolio that goes long in leader stocks and goes short in follower stocks from date $t-91$ to t. Leaders are defined as the firms in the top 5% of market capitalization in its FF industry on date $t-J$. i_t is defined as the nominal 10-year Treasury yield, with i_{t-1} being the interest rate J days prior and Δi_t being the change in the interest rate from date $t-91$ to t. For columns 1 and 2, $J = 364$; columns 3 and 4, $J = 28$; columns 5 and 6, $J = 7$; columns 7 and 8, $J = 1$, where 1 is one trading day. Standard errors are Newey-West with a maximum lag length of 60 days prior.

Table A5: Correlation Table of Forward Rates

Variables	0-2	2-3	3-5	5-7	7-10	10-30
0-2	1.00					
2-3	0.85	1.00				
3-5	0.85	0.85	1.00			
5-7	0.80	0.76	0.67	1.00		
7-10	0.70	0.65	0.47	0.53	1.00	
10-30	0.80	0.77	0.93	0.95	0.94	1.00

Correlation table of forward rates. P-values in parentheses.