Cyclically adjusted price to earnings (CAPE) ratio and the federal funds rate*

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Abstract

We investigate the risk-taking channel of monetary policy phenomenon through a joint examination of the level of interest rate and the Cyclically Adjusted Price to Earnings (CAPE) ratio. First, using the methodology outlined by Bai and Perron (2003), we identify four distinct regimes in the federal funds rate. The CAPE ratio levels across the four federal fund regimes suggest that low rates are negatively correlated with the CAPE ratio. However, we estimate a SVAR and find that the level of the federal funds only has a significant effect in the high interest rate regime.

Keywords: Nonlinear, VAR, Risk, CAPE Ratio, Monetary Policy

JEL Classification: E1, E43, C01

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1 Introduction

Recently, there has been a renewed interest in the financial cycle and the role it plays in macroeconomics (e.g., Borio, 2014). One of the more obvious characteristics of the financial cycle is the rapid increase in credit followed by a boom in asset prices and a subsequent bust. As first described by Wicksell (1898) and more recently stated by Borio (2014) and Woodford (2012), deviations between the "natural" rate of interest and money interest rates may induce boom-bust cycles in the credit markets. The US and other advanced economies have exhibited historically low real interest rates prior to, during, and following, the financial crisis of 2007-2009.

Whether prolonged periods of low interest rates induce economic agents (individuals and financial intermediaries) to take on increasing amounts of risk has been a subject of debate within the macroeconomic literature. For example, Taylor (2010) asserts that much of the housing boom and bust in the United States was due to an excessively easy money policy of the Federal Reserve over the 2003 – 2005 time period. Banks may lend to riskier borrowers or lower credit standards, corporations may increase debt and increase stock buybacks, private investors may substitute out of low yielding fixed income securities in favor of equities. The overall change in investor behavior has been termed the "search-for-yield" (Rajan 2006; Borio and Zhu 2012; Boivin, Lane, and Meh 2010). Moreover, increased liquidity may lead to stock valuation as measured by price to earnings (PE) ratio or Shiller's cyclically adjusted price to earnings (CAPE) ratio.

Central banks primarily target short-term money interest rates to achieve their respective mandates. Moreover, since the financial crisis in 2007-2009, all the major G7 central banks have engaged in Quantitative Easing (QE) programs to stimulate their respective economies given the low level of interest rates. Bernanke (2010) argues (when explaining quantitative easing to the public), that

> "……easier financial conditions will promote economic growth. For example, lower mortgage rates will make housing more affordable and allow more homeowners to refinance. Lower corporate bond rates will encourage investment. *And higher stock prices* will boost consumer wealth and help

increase confidence, which can also spur spending."

Conversely, Richard Fisher (2014), the former President of the Dallas Federal Reserve Bank, echoes a sentiment similar to Taylor (2010) and argues that low interest rates and excessive liquidity from QE programs puts "beer goggles" on market participants. By "beer goggles" Fisher means that market participants' propensity to "reach-for-yield" is much higher because "things (potential investments) often look better when one is under the influence of free-flowing liquidity." Additionally, in 2019 President of the Kansas City Federal Reserve Bank, Esther George echoed a similar sentiment in a 2019 Wall Street Journal interview when discussing Quantitative Easing:[1]

> "……I understood that it (QE) was going to have likely some effect on long-term rates. And this idea that it would create a wealth effect, boost asset values, push risk around, that's what made me uncomfortable, because there, of course, we don't have much experience on how much, or where does that risk go? Do we understand the mispricing or the distortions that come with that?"

To the extent that deviations in the money interest rate from the natural rate are a driving force behind risk taking (as well as the propensity for central banks to purchase safe assets through QE programs and crowd out private investors), the association between the primary policy tool and market valuations is important. Our objective in this paper to evaluate equity valuations in different monetary regimes. Historically high valuations due to an increased appetite for risk will likely be manifested in equity ratios above their historical average. Figure 1 displays time series graphs of the Federal funds rate, P/E ratio, and Shiller's Cyclically Adjusted Price to Earning (CAPE) ratio of the S&P 500 over the 1954-2020 time period. Equity valuations are measured on the left axis and the Federal Funds rate is measured on the right hand axis. Note that equity valuations and interest rates have trended in opposite directions which

[1] https://www.wsj.com/articles/transcript-wsj-interview-with-kansas-city-fed-president-esther-george-11547673747. In addition, in a Fall 2019 speech at the University of Tulsa, Ms. George recounted an anecdotal story from a retired constituent. She stated that the retiree would complain to her about low rates on U.S. Treasuries; however, one day the retiree completely reversed his position and said that the Fed should cut rates because he shifted all of his retirement into equities.

provides some anecdotal evidence for Fisher's "beer goggles" hypothesis.

Figure 1a. Annual data

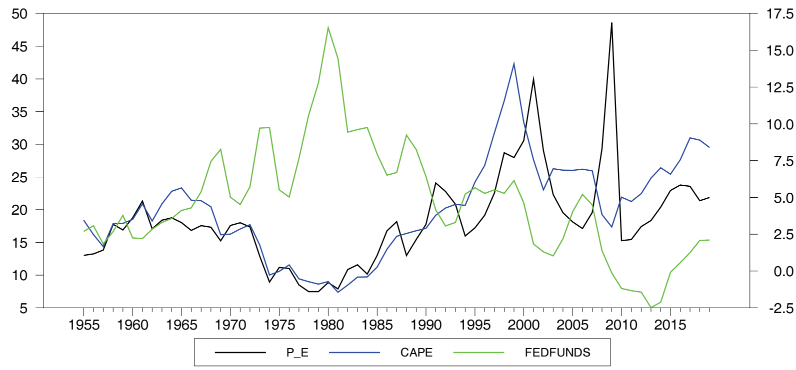
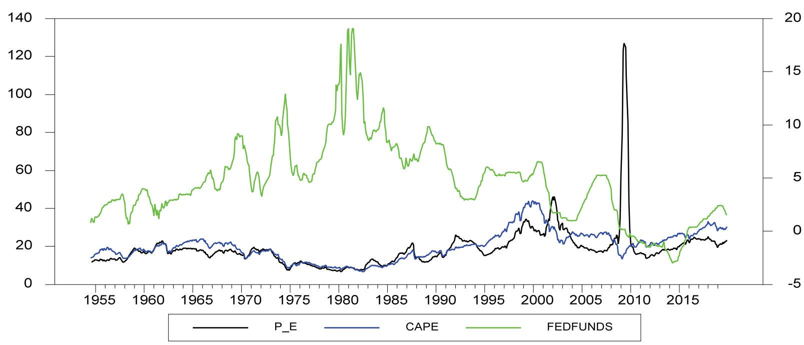


Figure 1b. Monthly data



Our objective is to understand the dynamics of Figure 1. However, we focus on our analysis on the CAPE measure rather than the P/E ratio. Shiller's CAPE ratio is inflation-adjusted average earnings over the previous 10 years. As such, it avoids the problem seen in P/E ratio in 2008 of shares looking obscenely expensive (the P/E ratio over 100) when profits collapse during recessions. We believe it provides a much better measure of valuations given that it averages across the business cycle. We first utilize the Bai and Perron (2003) methodology to test for structural breaks in the CAPE ratio using the federal funds as the threshold variable. Carlson, Pelz, and Wohar (2002) were the first to our knowledge to use the Bai and Perron methodology on financial ratios. Our paper is a natural extension of their work in that we use the policy rate as the threshold variable (we take into account QE programs by using the shadow Federal Funds Rate when the actual rate was at the zero lower bond). Secondly, in order to understand the dynamics in each regime, we estimate a SVAR with censored data. To preview our results, we find four regimes in the level of CAPE ratio conditional on the federal funds rate with breakpoints in the federal funds rate at 2.42, 4.73 and 6.54. Moreover, we do not find evidence of Fisher's "beer googles" hypothesis. Our results suggest that shocks to the Federal Funds rate only have a statistically significant effect in the high, not low, interest rate regimes. The rest of the paper proceeds as follows. Section 2 provides a brief literature review; section 3 discusses our methodology, section four presents our results and section 5 concludes.

2 Review of the Literature

Claessens and Kose (2017) provide a survey of the literature merging finance and asset prices. They argue there are primarily two channels. The first describes how changes in the balance sheets of borrowers affects their access to finance and the extent to which that then exacerbates and spreads financial shocks. The second channel focuses on the implications of banks' balance sheets for the supply of credit, liquidity and asset prices.

Borio and Zhu (2012) designate the term "risk-taking channel of monetary policy transmission" to characterize the link between expansionary monetary policy and increased risk-taking by banks. In the period following 2001, interest rates in the US and Europe decreased significantly. Borio and Zhu (2012) present three observations. First, they note that the influence of capital regulation on the behavior of financial institutions has had an increasingly larger effect on the level of risk financial institutions accept. They argue that the reason is due to the higher risk-sensitivity of the minimum capital requirement and also due to how financial firms measure, manage and price risks. Second, they observe that very little attention has been given to the linkage between the transmission mechanism of monetary policy and the pricing of risk by economic agents (i.e., risk-taking channel of monetary policy). Third, they suggest that significant aspects of the overall shape of the transmission mechanism can be missed if the risk-taking channel is not incorporated into the central bank's reaction function. Guntner and Afanasyeva (2017) find that banks may take on increased risk in credit booms arising due to informational frictions. Dell'Ariccia, Laeven, and Suarez (2017) also explore the bank lending channel using confidential data on banks' internal ratings and find that risk taking by banks is negatively associated with increases in level of short-term interest rates. Gaggl and Valderrama (2019) explore Austrian banks to examine the effects of the ECBs persistently low interest rates during 2003–2005. They find that policy likely caused Austrian banks to hold risker loan portfolios than they would have in its absence. Brana, Campmas, and Lapteacru (2019) use a nonlinear model and find that loosening monetary policy (via low interest rates and increasing central banks' liquidity) has a harmful effect on banks' risk, confirming the existence of the risk-taking channel. Buch, Eickmeier, and Prieto (2014) provide evidence on the link between monetary policy and bank risk taking. They employ a factor augmented vector autoregression model for the US economy over the period 1997-2008. In addition to macroeconomic indicators, they include factors summarizing information provided in the Federal Reserve's Survey of Terms of Business Lending (STBL). The data provide information about new loans of banks as well as interest rates for different loan risk categories. Their results find that following an expansionary monetary policy shock, small domestic banks increase their exposure to risk while large banks do not change their risk exposure.

Maddaloni and Peydro (2011) note that low interest rates increase the attractiveness of risky assets in the context of mean-variance portfolio framework. This is also true in habit formation models (Campbell and Cochrane 1999), where economic agents become less risk-averse during economic expansions because their consumption increases relative to their status quo. Thus, by increasing real economic activity, easy monetary policy that lowers interest rates may reduce investors' risk aversion (Manganelli and Wolswijk 2009). There could also be monetary illusion associated with low levels of interest rates. This would lead to higher risk-taking to increase asset returns (Shiller 2000; Adrian and Shin 2009). In addition, because banks finance their liabilities with short-term maturity assets and lend at longer maturities, a low short-term interest rate environment may increase the slope of the yield curve which may lead banks to soften their lending standards (Adrian, Estrella, and Shin 2010).

In addition, low short-term interest rates may lessen the adverse selection problems in credit markets and lead to a decrease in screening by banks (Dell'Ariccia and Marquez 2006). Finally, in an environment in which central banks are primarily focused on low inflation, short-term interest rates may be so low that they lead to increases in asset prices and credit bubbles (Borio and Lowe 2002; Borio and Zhu 2012).

3 Regime Identification and SVAR

3.1 Regime identification using bai and perron (2003)

Our aim is to examine whether average CAPE valuations are conditional on the level of the federal funds rate, consistent with the observation that low interest rates increase the attractiveness of risky investments (Maddaloni and Peydro 2011). Our analysis incorporates monthly data from 1954 to 2019. Historical data on CAPE ratio on the S&P 500 were obtained from Robert Shiller's website (http://www.econ.yale.edu/~shiller/) and federal funds rate data from the St. Louis Federal Reserve Bank's (FRED) database. We implement the methodology outlined in Bai and Perron (2003) to identify different regimes in the level of CAPE ratio using the level of the federal funds rate as the threshold variable.

Consider the following model with n breaks and $n+1$ regimes,

$$y_t = \alpha_j + \varepsilon_t \qquad \tau_{j-1} < z_t \leq \tau_j \tag{1}$$

for j = 1 ,…n + 1, where y_t is the CAPE ratio in period t and α_j is the mean of the CAPE ratio in the nth regime. Our contribution to the literature is to identify each regime using the Federal funds rate as the threshold variable z_t to determine each breakpoint. As noted in Bai and Perron (2003), the threshold variable need not enter (1) but must be observable. Bai and Perron (2003) treat the threshold point $(\tau_1,\dots,\tau_n)$ as unknown; as such, there are *n+1* unknown regimes. Thus, the objective is to estimate the unknown regression coefficients with the threshold points when T observations are available. Each estimate of α_j is obtained by minimizing the sum of squared residuals,

$$SSR(T_1,\dots,T_n) = \sum_{i=1}^{n+1} \sum_{t=T_{i-1}+1}^{T_i} (y_t - \alpha_k)^2. \quad (2)$$

Let $\hat{\alpha}(\{T_1,\dots,T_n\})$, where $\alpha = (\alpha_{1,\dots,}\alpha_{n+1})'$, be the estimated regression coefficient for a given regime, $(T_1,\dots,T_n)$. The estimated breakpoints will be obtained by substituting these into equation (2), subject to a set of restrictions on each n-partition (stated below), and are given by

$$\left(\widehat{T_1},\dots,\widehat{T_n}\right) = \arg min_{T_{1,\dots}T_n} SSR_t\,(T_1,\dots,T_n). \quad (3)$$

Thus, the breakpoint estimators correspond to the global minimum of the sum of squared residuals of the objective function.

3.2 Regime identification results

Tables 1a and 1b display the results from the above methodology using annual as well as monthly data. The columns in Table 1 correspond to each regime and the rows display summary statistics for CAPE ratio in each corresponding regime. We allowed for a maximum of five breaks in our sample. The first column displays the number of breaks, the second column displays the BIC for each number of breaks and columns 3 – 7 display the point estimates of the breaks. As reported in Tables 1a and 1b, the Bai and Perron (2003) methodology identify three breakpoints for the federal funds rate (2.42, 4.73, and 6.54) implying four regimes. Note that the breakpoints are similar using both annual and monthly data.

Table 1. Bai and perron (2003) structural break tests
1a. Annual results

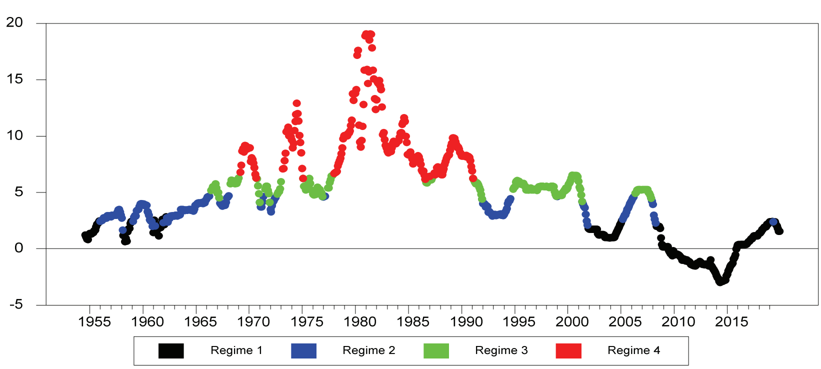
Breaks	BIC	Break Values				
0	4.04					
1	3.58	6.42				
2	3.56	5.02	6.14			
3	**3.49**	**2.20**	**5.02**	**6.14**		
4	3.56	2.20	3.57	5.02	6.14	
5	3.70	1.30	2.85	4.50	5.51	9.24

2a. Monthly data

Breaks	BIC	Break Values				
0	4.08					
1	3.66	6.54				
2	3.64	4.73	6.54			
3	**3.62**	**2.42**	**4.73**	**6.54**		
4	3.64	2.41	3.76	5.22	6.54	
5	3.65	1.01	2.63	3.98	5.25	6.54

Notes: The table displays the Bic and the structural breaks using Bai and Perron (2003) methodology. We allowed for a maximum of five breaks in our sample. The first column displays the number of breaks, the second column displays the BIC for each number of breaks and columns 3 – 7 display the point estimates of the breaks. In Regime 1 (federal funds rate < 2.42), Regime 2 (2.42 < federal funds rate < 4.73), in Regime 3 (4.73 < federal funds rate < 6.54), in Regime 4 (federal funds rate > 6.54).

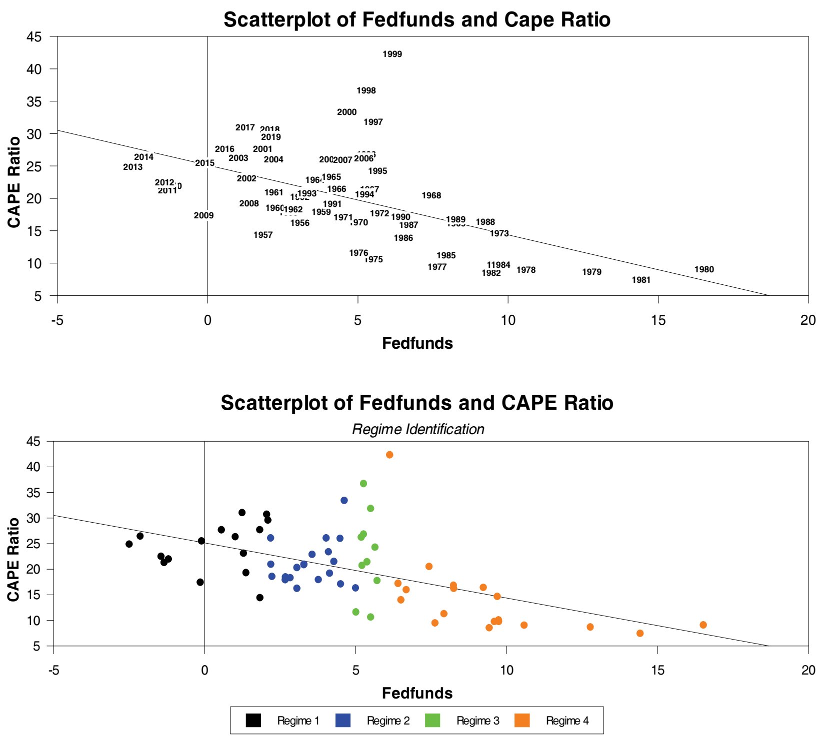
Figure 2. Time series plot of federal funds rate with identified regimes



Notes: The time series plot displays a time series graph identifying each regime identified using Bai and Perron (2003) methodology. In Regime 1 (federal funds rate < 2.42), Regime 2 (2.42 < federal funds rate < 4.73), in Regime 3 (4.73 < federal funds rate < 6.54), in Regime 4 (federal funds rate > 6.54).

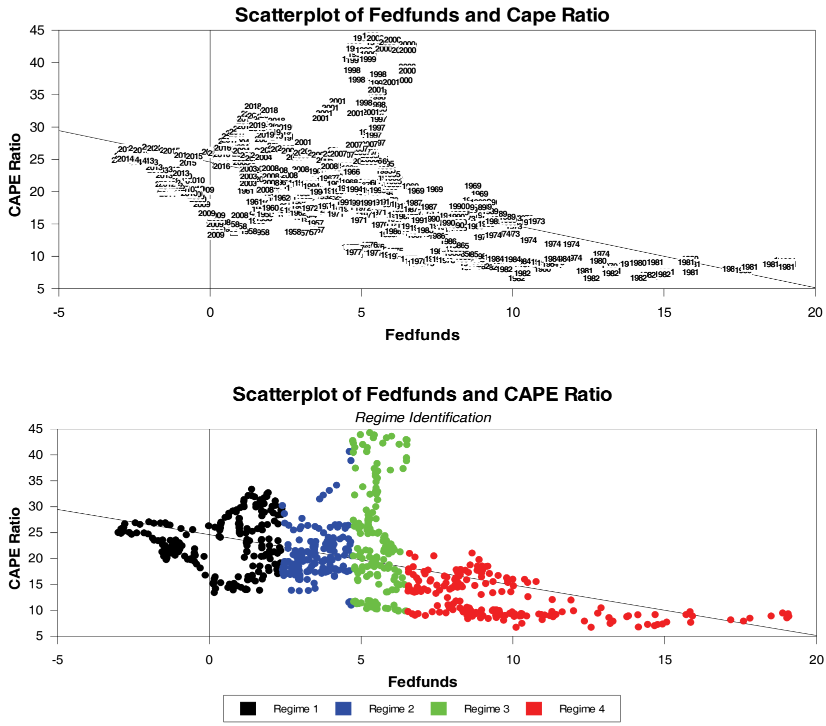
Figure 2 displays a time series plot of the federal funds rate over our sample period. The black dots indicate that the federal funds rate is in regime 1, the blue indicates that the federal funds rate is in regime 2, the green dots represent regime 3 and the red regime 4. To account for quantitative easing after the financial crisis we adopted the Wu-Xia (2015) shadow federal funds rate which explains the negative rates. The stagflation period in the 1970s and 1980s account for most of the observations in regime 4 whereas the recent period subsequently after the financial crisis accounts for many of the observations in regime 1.

Figure 3a. Regime identification



Notes: The above scatter plot displays monthly CAPE ratio from Robert Shiller's website (http://www.econ.yale.edu/~shiller/data.htm). The time series plot displays a time series graph identifying each regime identified using Bai and Perron (2003) methodology. In Regime 1 (federal funds rate < 2.42), Regime 2 (2.42 < federal funds rate < 4.73), in Regime 3 (4.73 < federal funds rate < 6.54), in Regime 4 (federal funds rate > 6.54).

Figure 3b. Monthly data



Notes: The above scatter plot displays monthly CAPE ratio from Robert Shiller's website (http://www.econ.yale.edu/~shiller/data.htm). The time series plot displays a time series graph identifying each regime identified using Bai and Perron (2003) methodology. In Regime 1 (federal funds rate < 2.42), Regime 2 (2.42 < federal funds rate < 4.73), in Regime 3 (4.73 < federal funds rate < 6.54), in Regime 4 (federal funds rate > 6.54).

As a preliminary, Figures 3a and 3b display a scatterplot with a simple linear regression line of the CAPE ratio (y axis) and the Federal funds rate (x-axis). The first panel in each figure displays the data with the coordinates labeled by year whereas the second panel color codes the coordinates by each identified regime. Figure 3a displays annual data whereas Figure 3b displays monthly data. As can be seen in both Figures, there is clearly a negative relationship between the CAPE ratio and the Federal Fed funds rate. Note that many of the highest CAPE ratio have occurred since 2000 with many of the lowest during the late 1970s and early 1980s. To further explore the relationship between the Fed funds rate and CAPE ratio follow Borio (2014) and estimate VARs to better understand the relationship between the federal funds, risk premium and equity valuations.

3.3 SVAR

Our interest is to understand the dynamics between risk and the equity valuations. As such, we opted to follow Killian and Vigfusson (2011) and estimate SVAR but with censored data. That is, in the censored macroeconomic VAR literature, researchers are often interested to know if macroeconomic aggregates react asymmetrically to a shock. For example, real GDP may respond differently to positive oil price shocks than to negative oil price shocks. In our case we are interested in understanding the relationship between the federal funds rate, and equity valuations in different interest rate environments. As noted in Killian and Vigfusson (2011), censored variables will result in unbiased estimates so long as the entire series is included in estimation. To be concrete, we define a federal funds variable for each regime. Define the entire federal funds rate series as ffr_t . We subsequently generate four different ($ffr_{1t}, ffr_{2t}, ffr_{3t}, ffr_{4t}$) federal funds rate variables based on our estimated thresholds as:

$$ffr_{1t} = \begin{cases} ffr_t, & \text{if } ffr < 2.42 \\ 0, & \text{if } ffr > 2.42 \end{cases} \quad (4)$$

$$ffr_{2t} = \begin{cases} ffr_t, & \text{if } 2.42 < ffr < 4.73 \\ 0, & \text{if } ffr < 2.42 \text{ or } ffr > 4.73 \end{cases} \quad (5)$$

$$ffr_{3t} = \begin{cases} ffr_t, & \text{if } 4.73 < ffr < 6.54 \\ 0, & \text{if } ffr < 4.73 \text{ or } ffr > 6.54 \end{cases} \quad (6)$$

$$ffr_{4t} = \begin{cases} ffr_t, & \text{if } ffr_t \geq 6.54 \\ 0, & ffr_t < 6.54 \end{cases} \quad (7)$$

We subsequently estimate the following SVAR[2]:

$$\mathbf{X_t = A_0 + B(L)X_{t-1} + e_t} \quad \mathbf{(8)}$$

[2] We included a dummy variable for the financial crisis as an exogenous variable. We also estimated a SVAR where output and inflation were included. The impulse responses were essentially unchanged.

where **B(L)** are lag polynomials, and $\mathbf{X}_t$ is a vector that contains $(ffr_{1t}, ffr_{2t}, ffr_{3t}, ffr_{4t}, Rp_t, Cape_t)$, where $ffr_{1t}, ffr_{2t}, ffr_{3t}, ffr_{4t}$ are defined above, $, Rp_t$ is the risk premium defined as the Moody's BAA minus the Moody's AAA rate, and $Cape_t$ is taken from Robert Shiller's website. Because $ffr_t = ffr_{1t} + ffr_{2t} + ffr_{3t} + ffr_{4t}$ the estimated SVAR results in unbiased coefficients and impulse response functions. Note above, our ordering implies that the federal funds rate has a contemporaneous effect on the risk premium and the CAPE ratio. Fisher's "beer Goggles" hypothesis suggests that the risk premium should have a larger effect on the CAPE ratio in low interest rate environments.

4 Results

As a benchmark we first estimate a three variable SVAR without the censored federal funds rate variables. That is, we estimate a three variable SVAR $((ffr_t, Rp_t, Cape_t))$ with twelve lags. Figure 4 displays the impulse response of our risk measure and the CAPE ratio to a one-standard deviation shock in the Federal Funds Rate. There is a small statistically significant effect for the first 6 months (approximately 0.05 basis points) on our risk measure but surprisingly, after twelve months the Federal Funds Rate does not have a statistically significant relationship on our risk measure (although the point estimate stay constant). However, the FFR shock does have a statistically significant negative relationship on the CAPE ratio. A one standard deviation shock in the FFR reduces the CAPE ratio by approximately 2.0 after twelve months. The sign is expected given the results presented above. Figures 5 and 6 display the results from our censored VAR. Note in Figure 5 that shocks to the Federal Funds Rate only have a statistically significant impact on the risk measure in regime 1 for the first four months although, as above, the point estimate is small (0.05). However, surprisingly, shocks to the Federal Funds rate do not have a significant impact on our measure of risk in any of the other regimes. The results in Figure 6 display impulse responses of the CAPE ratio to shocks in the Federal Funds Rate in each regime. Surprisingly, the negative relationship between shocks to the Federal Funds Rate only have an effect in the highest interest rate regime. That is, note in the bottom right panel of

Figure 6, Regime 4, that a positive (negative) shock to the Federal Funds Rate decreases (increases) the CAPE ratio by approximately 1.5 consistent with the results in Figure 4. The surprising result in Figure 6 is that the CAPE ratio appears to be more sensitive to Federal Funds Rate shocks when interest rates are high, not low.

Figure 4. Impulse responses to a shock in the FFR (full VAR)

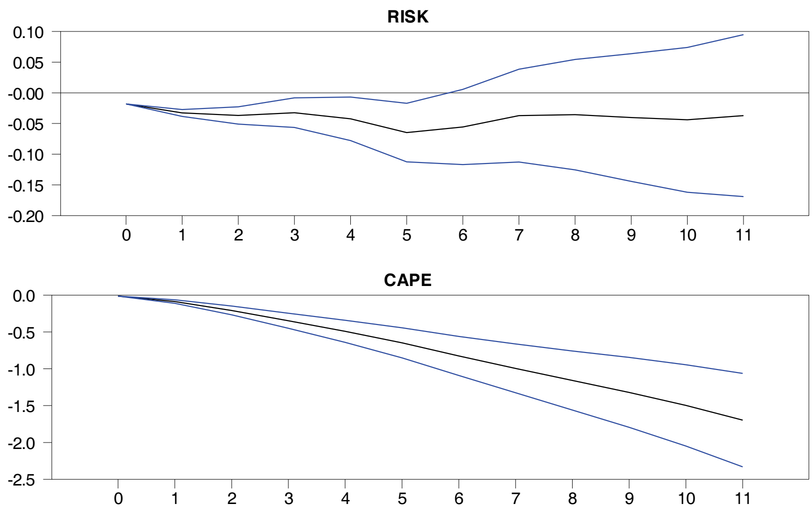


Figure 5. Impulse responses of risk to shocks in the federal funds rate in different regimes (censored variable SVAR)

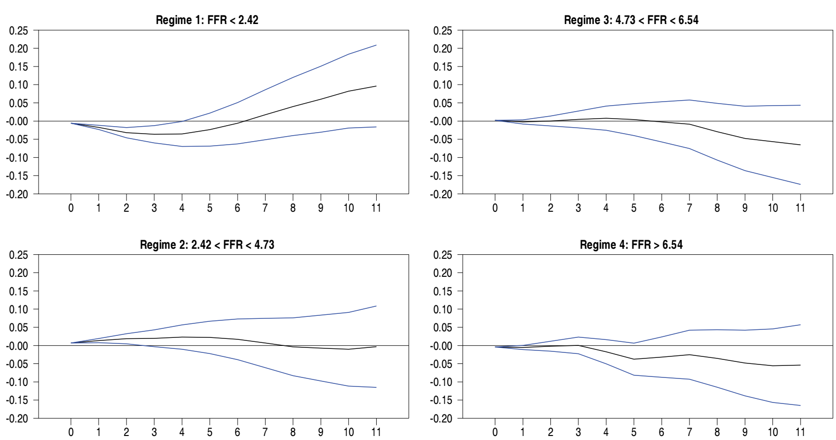
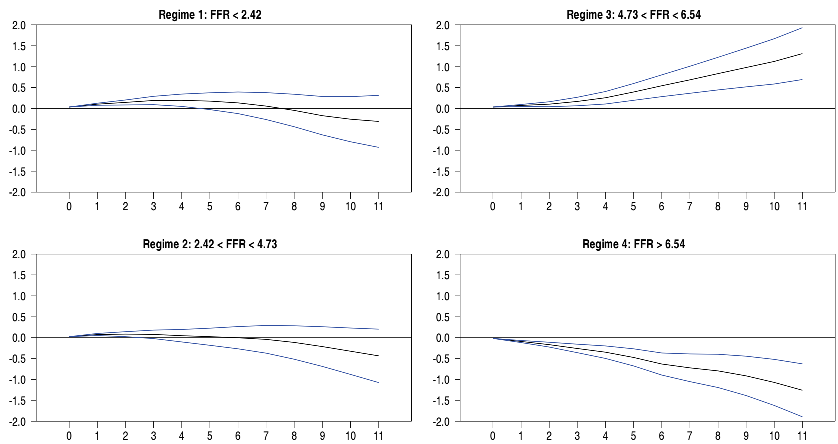


Figure 6. Impulse responses of CAPE to shocks in the federal funds rate in different regimes (censored variable SVAR)



As noted above, Figure 2 displays a time series plot of the federal funds rate over our sample period color coded by regime. As can be seen, Regime 4, the high interest rate regime, covers most of the 1970s and 1980s. As such, we believe there are several large macroeconomic events that may explain the SVAR results for regime 4. First, the Nixon shock occurred in the early 1970s in which the U.S. permanently left the gold standard. Second, the twin oil shocks occurred during 1973 and 1979, which resulted in substantial cost-push inflation. Likewise, in response to the rapid increases of inflation during the 1970s, Federal Reserve Chairman Volker increased the Federal Funds rate from 11% in 1979 to 20% in 1981. In short, inflation and expected inflation rapidly increased during the late 1970s forcing the Fed to raise rates. As such, we believe that the higher interest rates likely increased the discount rates applied to equities, which in turn drove down equity prices resulting in lower valuations.[3] As such, we do not find evidence for Fisher's "beer googles" hypothesis in terms of high equity valuations. In terms of policy recommendations, our results suggest that monetary policy's greatest effect on CAPE ratio was when interest rates were high in the 1970s and 1980s.

[3] We thank an anonymous referee for suggesting this mechanism to us.

5 Conclusion

Our primary aim was to better understand the relationship between the federal funds and aggregate equity valuations. Using Bai and Perron (2003) we identified four regimes in the CAPE ratio of the S&P 500 conditional upon the federal funds rate. We subsequently utilized SVAR to examine how CAPE ratio respond to FFR shocks. Our results suggest that there is a negative relationship between FFR and the CAPE ratio. However, our results should be taken with caution. Given the traditional Fisher equation $i_t = r_t + E_t\pi_{t+1}$, we are not able to distinguish why low interest rates prevail. That is, the low federal funds rates could be a result of very low expected inflation or a declining real interest rate. As such, we believe that future research should aim to disentangle the relationship between stock valuations, changing real interest rates, and changes in expected inflation. However, our results suggest that the Federal Funds rate only has a statistically significant effect in the high interest rate regimes. As such, we do not find evidence that low interest rates increase aggregate CAPE ratio.

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