P/E Ratios and the

Risk Taking Channel of Monetary Policy

Jack Dorminey
College of Business and Economics
West Virginia University
jack.dorminey@mail.wvu.edu
Morgantown, WV 26506

Eric Olson
College of Business and Economics
West Virginia University
eric.olson@mail.wvu.edu
Morgantown, WV 26506

Mark E. Wohar[1]
College of Business
University of Nebraska-Omaha
mwohar@mail.unomaha.edu
Omaha, NE 68182

September 10, 2018

Abstract

We investigate the risk-taking channel of monetary policy phenomenon through a joint examination of the federal funds rate and the coincident price-to-earnings multiples in the equity markets. First, using the methodology outlined by Bai and Perron (2003), we identify three distinct regimes in the federal funds rate. The P/E ratio levels across the three federal fund regimes suggest that easy money conditions are associated with higher levels of leverage. Second, we estimate generalized impulse response functions and generalized variance decompositions (Diebold and Yilamz, 2012) and find that the effects of shocks in the federal funds rate, inflation, and output on the level of P/E ratio vary significantly depending upon the interest rate regime.

Key words: Nonlinear, VAR, Risk, P/E Ratio, Monetary Policy

[1] We would specifically like to thank Jeff Bredthauer and Chris Neely for comments and suggestions. This paper was previously circulated under the title "Beer Goggles, P/E Ratios, and the Risk Taking Channel of Monetary Policy."

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 too, 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.

Similarly, prior work suggests that in a low interest rate environment investors search for investment strategies that yield higher returns; a behavior that has been termed the “risk-taking channel of monetary policy”, or more casually “chasing the yield”. (Rajan 2006; Borio and Zhu 2012; Boivin, Lane and Meh 2010). Accordingly, periods of prolonged low interest rates may induce economic agents to accept higher than traditional levels of risk in pursuit of traditional levels of return. That is, in prolonged periods of low interest rates (during which the price of a given level of risk is less) only through increased risk are traditional levels of return possible. Central banks primarily target short-term money interest rates to achieve their respective mandates. The transmission of monetary policy to the broader economy can take place through several channels. The traditional channel taught in economic courses operates through both the level of interest rates and the exchange rate. Changes in short-term interest rates affect consumption and investment spending. The expected change in the exchange rate (adjusted for foreign exchange risk) is affected by the difference between domestic and foreign interest rates (Sarno and Taylor 2008). However, Bernanke (2010) argues 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 President of the Dallas Federal Reserve Bank, echoes a sentiment similar to Taylor (2010) and argues that liquidity and easier financial conditions puts "beer goggles" on market participants making "things often look better when one is under the influence of free-flowing liquidity" which is the primary reason the Federal Reserve is "to take away the punchbowl just as the party gets going."

To the extent that deviations in the money interest rate from the natural rate are a driving force behind risk taking, the association between the primary policy tool and risk/leverage is important. Where sustained low levels of federal funds leads to a "beer goggle" lens on the economic outlook, the level of risk taken on by economic agents is a direct consequence of low rates. Our aim is to evaluate equity valuations in different monetary regimes. Increased valuation due to higher leverage or increased appetite for risk could be manifested in P/E ratios above the historical average. The willingness of market participants to pay abnormally high multiples for financial assets, indicating an above normal appetite for leverage, may suggest a "beer goggle" lens to market valuation.

Figure I display scatter plots of monthly P/E ratios and CAPE[2] ratios of the S&P 500 and the federal funds over the 1954-2013 time period. The observed negative association between P/E ratios and the level of the federal funds rate provides prima facie support for Fisher's "beer goggles" hypothesis.

[Insert Figure 1 around here]

Our objective is to understand the dynamics of Figure I. First, we utilize the Bai and Perron (2003) methodology to test for, and identify regimes in the level of P/E ratios 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. As such, our paper is a natural extension of their work. Secondly, we estimate the generalized impulse response functions and generalized variance decompositions suggested in Diebold and Yilmaz (2012) in each of the identified regimes. To preview our results, we find three regimes in the level of P/E ratios conditional on the federal funds rate with breakpoints in the federal funds rate at 2.15 and 6.73. In the low interest rate regime (i.e. federal funds < 2.15) we find that 80% of the variation in P/E ratios is accounted for by the federal funds rate, inflation, risk and output; in the middle regime (i.e. 2.15 < federal funds < 6.73) the federal funds rate, inflation, risk and output only account for 9.0% of the variation in P/E ratios and in the high interest rate regime (i.e. federal funds > 6.73) the federal funds rate, inflation rate, risk, and output account for 69% of the variation in P/E ratio.

2. Review of the Literature

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-

[2] Cyclically adjusted price earnings (CAPE)

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.

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 as a way 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).

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.

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 2008).

3. Methodology

3.1 Regime Identification

Our aim is to examine whether average P/E 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 2013. Historical data on P/E ratios 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 P/E ratios using the level of the federal funds rate as the threshold variable.[3]

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

[3] In a previous version of the paper we estimate a partial structural change model in which lags of the federal funds rate, inflation, risk, P/E ratios, and output are included in (1). However, the results were not qualitatively different from those reported. As such, we opted for simplicity in the reporting of the paper.

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

for j = 1 ,…n + 1, where y_t is the P/E ratio in period t and α_j is the mean of the P/E ratio in the nth regime. In order to identify each regime we use the Federal funds rate as the threshold variable z_t to determine each breakpoint. For robustness, we also estimated (1) using lags of the Federal funds rate at the threshold variable but the results were identical. As noted in Bai and Perron (2003), the threshold variable need not enter into (1) but must be observable. Bai and Perron (2003) treat threshold point $(\tau_1, \ldots, \tau_n)$ as unknown meaning that 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,

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

Let $\hat{\alpha}(\{\mathrm{T}_1, \ldots, \mathrm{T}_n\})$, where $\alpha = (\alpha_{1,\ldots,}\alpha_{n+1})'$, be the estimated regression coefficient for a given regime, ($\mathrm{T}_1, \ldots, \mathrm{T}_n$). 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

$$\left(\widehat{T_1}, \ldots, \widehat{T_n}\right) = \arg min_{T_{1,\ldots}T_n} SSR_t\,(\mathrm{T}_1, \ldots, \mathrm{T}_n). \tag{3}$$

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

3.2 Regime Identification Results

Table 1 displays the results from the above methodology. The columns in Table 1 correspond to each regime and the rows display summary statistics for P/E ratios in each corresponding regime. As reported in Table 1, the Bai and Perron (2003) methodology identify two breakpoints for the federal funds rate (2.15 and 6.73) implying three regimes.

[Insert Table 1 around here]

In regime 1, when the federal funds rate is below 2.15%, the average P/E ratio is 26.15 and the standard deviation is 22.04.[4] When the federal funds rate is between 2.15 and 6.73, the average P/E ratio is 18.72 and the standard deviation id 5.36. In regime 3, the average P/E ratio is 11.58 and the standard deviation is 3.23.

Our results in Table 1 and Figure 1 are consistent with Maddaloni and Peydro (2011) and Fisher's (2014) hypothesis that easy money conditions are associated with higher levels of leverage as evidenced by mean and variance of the P/E ratios in Table 1. Given the three regimes identified above, we subsequently follow Borio (2013) and estimate VARs to better understand the relationship between macroeconomic variables (such as the business cycle) and P/E ratios. As such, we estimate Diebold and Yilamz (2012) generalized VARs and variance decompositions in each of the identified regimes.

3.3 Innovation Accounting

Diebold and Yilmaz (2012) use a generalized VAR framework to derive forecast error decompositions that are invariant to the variable ordering. We implement their methodology and consider a 5-variable VAR (*p*),

$$x_t = \sum_{i=1}^{p} \Phi_i \, x_{t-1} + \varepsilon_t,$$

Such that x_t'= [ffr_t, P/E_t, π_t, η_t, y_t] where ffr_t, P/E_t, π_t, η_t, and y_t are the federal funds rate, P/E ratio of the SP 500, inflation rate (as measured as the year of year change in the CPI), risk as measured by the spread on the Moody's Baa bond less the Aaa bond, and output as measured by

[4] Due to the financial crisis and the extreme valuations of P/E ratios during this period, we followed Whitehall and (2010) and winsorized P/E ratios to the 99 percentile.

the monthly percentage change in industrial production. $\varepsilon \sim (0, \Sigma)$ is a vector of independent and identically distributed error terms. The lag length of 2 month was selected using the Bayesian information criterion.[5]

Given the uncertainty regarding the ordering of the variables for identification, we follow Koop, Pesaran, and Potter (1996) to produce generalized impulse responses that are invariant to the ordering of the variables because of the use of the historically observed distribution of the errors. We subsequently follow Diebold and Yilmaz (2012) to produce variance decompositions allow one to assess the fraction of the *H-step-ahead* error variance in forecasting x_i that is due to shocks to x_j, $\forall\, j \neq i$, for each i. Diebold and Yilmaz (2012) use the structure of Koop, Pesaran, and Potter (1996) to produce variance decompositions that are again invariant to the ordering of the variables because of the use of the historically observed distribution of the errors.

Diebold and Yilmaz (2012) define the *own variance shares* as the fraction of the *H-step-ahead* error variances in forecasting x_i that are due to shocks to x_i for $i = 1,2,\ldots\ldots,N$ and *cross variance shares* as the fraction of the H-step-ahead error variances in forecasting x_i that are due to shocks to x_{ij} for $i,j = 1,2,\ldots\ldots,N$ such that $i \neq j$. The Koop, Pesaran, and Potter (1996) H-step-ahead forecast error variance decompositions are

$$\theta_{ij}^{g}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' A_h \Sigma e_j)^2}{\sum_{h=0}^{H-1} (e_i' A_h \Sigma e_i)}$$

where Σ is the variance matrix for the error vector ε, σ_{jj} is the standard deviation of the error term for the *j*th equation, and e_i is the selection vector, with one as the *i*th element and zeros otherwise. Because the sum of the elements in each row of the variance decomposition table

[5] We estimated our results using different lag lengths in the VAR; however, due to the number of variables in our VAR in conjunction with the limited number of observations in each regime, long lag lengths were not possible.

need not equal 1, Diebold and Yilmaz (2012) normalize each entry in the variance decomposition matrix by:

$$\tilde{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N} \theta_{ij}^{g}(H)}$$

such that by construction $\sum_{j=1}^{N} \theta_{ij}^{g}(H) = 1$. Diebold and Yilmaz (2012) then use the volatility contributions from the above generalized variance decomposition to construct the total spillover index as:

$$S^{g}(H) = \frac{\sum_{\substack{i,j=1 \\ i \neq j}}^{N} \tilde{\theta}_{ij}^{g}(H)}{N} * 100.$$

Thus, the total spillover index measures the contribution of volatility shocks across the five variables in our VAR to the total forecast error variance. The directional volatility spillovers Diebold and Yilmaz (2012) subsequently layout provides a decomposition of the total spillovers to those coming from (or to) a particular variable. The volatility spillover by variable *i* to all other variables *j* is

$$S_{i}^{g}(H) = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{N} \tilde{\theta}_{ij}^{g}(H)}{N} * 100.$$

Similarly, the directional volatility spillovers transmitted by variable *i* to all other variables *j* is

$$S_{i}^{g}(H) = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{N} \tilde{\theta}_{ji}^{g}(H)}{N} * 100.$$

The net spillover from variable *i* to all other variables *j* is

$$S_{i}^{g}(H) = S_{\cdot i}^{g}(H) - S_{i \cdot}^{g}(H).$$

The net pairwise volatility spillovers, are defined as

$$S_{i}^{g}(H) = \frac{\tilde{\theta}_{ji}^{g}(H) - \tilde{\theta}_{ij}^{g}(H)}{N} * 100.$$

4. Results

For each of our three identified regimes in previous section, we implement the methodology outlined above for the 1, 12, 24, 36, 48 month horizons. Tables 2-4 display the Diebold and Yilmaz (2012) volatility spillover measures at each of the estimated time horizons for each regime. In Tables 2-4, the *ij*th entry is the estimated contribution *to* the forecast error variance of variable *i*.[6] Thus, the off-diagonal column sums are the contribution from other variables to the forecast error variance of the variable listed in the row; the row sums are the contribution of the variable listed in the column to the forecast error variance of the variables listed in the columns. When summed across variables, the column and row sums are the numerator and denominator of the spillover index.

Regime 1 Results (Federal Funds Rate < 2.15)

Figure 2 displays the cumulative generalized impulse responses of P/E ratios from each of the other variables in the VAR. All shocks were standardized before being summed. Note in top right panel of Figure 2 that a one standard deviation shock in the federal funds rate initially causes P/E ratios to have 0.25 standard deviations and is marginally statistically different from zero after two months. However, the effect is quickly eliminated and eventually reversed after six months and subsequently a statistically significant 0.50 increase in P/E ratios after 24 months. A positive standard deviation shock to the P/E ratio produces a 0.5 standard deviation in valuations 24 months after the initial shock. Interestingly, a positive shock in the inflation ration induces a -0.5 contemporaneous standard deviation shock in P/E ratios which increases to -1.0 after 3 months. However, P/E ratios subsequently rebound over and after 24 months there is no statistically significant affect on valuations. Somewhat surprisingly, a positive shock to output

[6] Our tabulation replicates the format of Diebold and Yilmaz (2012) for ease of comparison.

has no statistically significant affect on P/E ratios until 15 months after the positive shock. After 24 months a positive output shock increases P/E ratios by 0.4 standard deviations. Seen in the last row of the second column in Figure 3, a positive shock to risk has a statistically positive effect on P/E ratios for the first 10 months but after 24 months the positive effect has dissipated and results in a -0.25 standard deviation reduction in P/E ratios.

As can be seen in the last column of the *1 Month* panel in Table 2, very little of the variation of our five variables of interest are explained by variables other than themselves at the 1 month time horizon. However, in the 12, 24, 36, and 48 month panels the results are much more intriguing. Again, note that the last column in all of the panels is the total amount of variation that is explained by the other variables in the VAR. At the 12 month horizon, 41% of the variation in the federal funds rate is explains by output whereas inflation explains less than 3%. For the variation in the P/E ratio, 24% percent is explained by inflation and 41% percent is explained by our risk measure meaning that 65% of the variation in the P/E ratio is explained by factors other than itself. The primary determinant of the variability of inflation, other than itself, is our measure of risk, which accounts for 23%. Likewise, 42% of the variation in our risk measure is explained by inflation with roughly 10% percent being explained by output. Inflation also accounts for 15% of the variation in output at the 12 month horizon.

[Insert Table 2 around here]

As can be seen in the row labeled "contribution to others" inflation and risk account for the most variation. Somewhat surprisingly, the variation in the federal funds rate contributes less than 10%. The 24 month panel yields similar results to those in the 12 month panel; however, note that the amount of P/E variation that inflation and risk explain at the 2 year horizon is reversed. Inflation now accounts for 44% of the variation whereas risk accounts for 27%. As such, the primary difference between the 12 and 24 month panels is that inflation contributes more to the variation of other variables and risk contributes less. Given that the rest of the results in the 36 and 48 month panels are qualitatively similar we will skip an in depth discussion of those results.

Regime 2 Results (2.15 < Federal Funds Rate < 6.73)

Similar to Figure 2, Figure 3 displays the cumulative generalized impulse responses of the P/E ratios to the variables in the VAR. Again, all impulse responses were standardized and then summed. The results in Regime 2 when the Federal Funds rate is between 2 and 6 percent are substantially different than when interest rates are below 2%. Seen in the first panel of column 1 of Figure 3, a positive shock to the federal funds rate has a statistically negative effect on P/E ratios over the 24month window. The negative affect appears to stabilize 10 months after the initial shock but P/E ratios remain -0.30 standard deviations lower. A effects of a positive shock to P/E ratios are again positive as in the low interest rate regime; however, the magnitude of the positive shock is double than in the low interest rate regime. Note in the third panel of column 1 in Figure 3 that a positive shock to inflation has a substantially more adverse affect in the middle interest rate regime than the low. The magnitude of the negative effects from the inflation shock in the two regimes are similar in the first few months after the shock but P/E ratios do not recover nearly as quickly in the middle interest rate regime. Moreover, P/E ratios are approximately -0.5 standard deviations lower 24 months after the initial shock. Most surprisingly is the negative affect that an output shock has on P/E ratios over the 24 month window. Note that the 24 month cumulative effect is -0.5 standard deviations lower after the positive shock. As in the low interest rate regime, a positive risk shock does increase P/E ratios by approximately 0.5 standard deviations 4 months after the initial shock. However, whereas P/E ratios converged back towards their initial level in the low interest rate regime, the rate of convergence is much slower in the middle interest rate regime.

Regarding the generalized variance decompositions, while the results in the 1 month panel are similar, the results at the other time horizons are substantially different. Each variable explains much more of its own variability at every time horizon as captured by the Dieblod and Yilmaz (2012) spillover index in each panel. Somewhat surprisingly, the federal funds rate contributes more to the variability of the other variables in the middle interest rate regime at every time horizon suggesting that monetary policy may be "pushing on a string" in the low interest rate regime. The most surprising result is that nearly all of the variation in P/E ratios is explained by itself at nearly every time horizon in the second regime.

[Insert Table 3 around here]

The variance decompositions for inflation are of interest as well. The federal funds rate accounts for more of the variability in the inflation rate at every time horizon in this regime than in the low interest rate regime. It accounts for 10% after 12 months and approximately 15% at 12, 24, 36 and 48 month horizon. Interestingly, the P/E ratio accounts for more of the variation in the inflation rate in Regime 2 than in the low interest rate regime; at the 48 month time horizon P/E ratios account for 22% of the variation in the inflation whereas when rates are below 2 (i.e. regime 1) the P/E ratio accounts for only 5% of the variation of the inflation rate. This result in conjunction with the negligible amount of variation the federal funds rate explains in output in regime 1 and 2 calls into question the efficacy of quantitative easing programs in achieving the Federal Reserve's dual mandate. One would expect the opposite result if the wealth effects Bernanke (2010) refers to in the introduction is accurate. Interestingly, risk explains approximately 20% of the variation in the federal funds rate over all time horizons whereas nearly all of the variation in output is explained by itself.

Regime 3 Results (Federal Funds Rate > 6.73)

Figure 4 displays the cumulative impulse responses of P/E ratios to the variables in the VAR. Somewhat surprisingly, the impulse responses in the high interest rate regime are quite similar to those in the middle interest rate regime. A positive shock to the federal funds rate induces a negative effect on P/E ratios but is statistically insignificant after 24 months. Shocks to the P/E ratio have an almost identical affect in the middle and high interest rate regimes. A positive shock to the inflation rate again causes a contemporaneously negative effect on the P/E ratio and lowers the P/E ratios by approximately -0.5 standard deviations after 24 months. Output again has statistically significant negative effect on the P/E ratio after 24 months. However, the negative effect in the high interest rate regime is almost double of that in the middle interest rate regime. Risk on the other hand, has a statistically positive effect on P/E ratios right after the shock but is not statistically significant 24 months after the shock.

Table 4 displays the generalized variance decompositions. Again, consistent with the previous 2 regimes, at the 1 month time horizon nearly all of the variation in the variables is explained by its own variation. However, the difference can easily be seen by the amount of variation explained in the *From Others* in Table 4. Forty four percent of the variation in the P/E ratio is explained by factors other than itself at the 12 month time horizon, 57% at the 24month time horizon, 65% at the 36 month horizon, and 69% after four years.

[Insert Table 4 around here]

Consistent with the results in Regime 1, inflation and risk account are the two variables which account for so much of the variation in P/E ratios. As can be seen in the row labeled

Contribution to others inflation and risk contribute a significant amount to the variation of others. Note that output explains much more of the variation in the federal funds in high interest rate regime at every time horizon (except at 12months).

IV. Conclusion

Our primary aim was to better understand the relationship between the federal funds and P/E ratios. Using Bai and Perron (2003) we identified three regimes in the P/E ratio of the S&P 500 conditional upon the federal funds rate. In the low interest rate regime (federal funds < 2.15), the average P/E ratio was 26 with a standard deviation of 22; in middle interest rate regime (2.15 < federal funds < 6.73) the average P/E ratio was 18 with a standard deviation of 5; and in the high interest rate regime (federal funds > 6.73) the average P/E ratio was 11 with a standard deviation of 3. We utilized generalized impulse response functions to evaluate the effects of macroeconomic variables in each of the three regimes. Positive shocks in the inflation rate and output growth rate have statically negative effects on P/E ratios in the middle and high interest rate regimes. Positive shocks in the Federal funds rate have a statistically positive effect on P/E ratios in the low interest rate regime but negative effects in the middle and high interest rate regimes. In addition we also utilized the methodology in Diebold and Yilmaz (2012) to obtain generalized variance decompositions and variance spillover measures to better understand the relationship between P/E ratios and economic variables. Our results suggest that inflation and risk account for over half of the variation in P/E ratios when in the low and high interest rate regimes. During time periods in which interest rates were closer to their historical average, nearly all of the variation in the variables in our sample is accounted for by its own variation.

References

Acharya, V. V. and M. Richardson, 2010, Restoring Financial Stability: How to Repair a Failed System (John Wiley & Sons New York).

Acharya, V. and H. Naqvi, 2010, The seeds of a crisis: A theory of bank liquidity and risk-taking over the business cycle, Mimeo.

Adrian, T., A. Estrella, and H. S. Shin, 2010, Monetary cycles, financial cycles, and the business cycle, Federal Reserve Bank of New York Staff Report No. 421.

Adrian, T., and H. S. Shin, 2009a, Money, liquidity, and monetary policy, American Economic Review Papers and Proceedings 99, 600-605.

Adrian T. and H. S. Shin, 2009b, Financial intermediation and monetary economics, Federal Reserve Bank of New York Staff Reports, No. 398.

Adrian, T. and H. S. Shin, 2010, Liquidity and leverage, Journal of Financial Intermediation 19(3), 418-437.

Adrian, T. and H. S. Shin, 2010, Financial intermediaries and monetary economics, in B. M. Friedman and M. Woodford, eds: Handbook of Monetary Economics (New York, Elsevier).

Agur, I., and M. Demertzis, 2010, Monetary policy and excessive bank risk taking, Discussion paper 2010-30S, Tilburg University, Center for Economic Research.

Altunbas, G. and D. Marques-Ibanez, 2011, Does monetary policy affect bank risk-taking? Working paper April 29.

Ashcraft, A. B., 2006, New evidence on the lending channel, Journal of Money, Credit, and Banking 38, 751-776.

Allen, F. and D. Gale, 2000, Bubbles and crises, *Economic Journal* 110, 236-256.

Allen, F. and D. Gale, 2007, Understanding Financial Crises (Oxford University Press, Oxford, UK).

Bai, J. and P. Perron, 2003, Critical values for multiple structural change tests, *Econometrics Journal* 6, 72-78.

Bank of Canada, 2011, Renewal of the inflation-control target: background information—November 2011, available at http://www.bankofcanada. ca/wp-content/uploads/2011/11/background_nov11.pdf.

Bernanke B., M. Gertler and S. Gilchrist, 1996, The financial accelerator and the flight to quality, The Review of Economics and Statistics, 78(1), 1-15.

Bernanke B. and K. N. Kuttner, 2005, What explains the stock market's reaction to federal reserve policy? Journal of Finance, 60(3), 1221-1257.

Bernanke, B. S. 2005, The global saving glut and the U.S. current account deficit. Speech at the Sandridge Lecture, Virginia Association of Economics, Richmond, March 10.

Bernanke, B. S. 2010, What the Fed did and why: supporting the recovery and sustaining price stability, The Washington Post, November 4, http://www.washingtonpost.com/wp-dyn/content/article/2010/11/03/AR2010110307372.html.

Bernanke, B. S. and M. Gertler, 1995, Inside the black box: The credit channel of monetary policy transmission, Journal of Economic Perspectives, 9(4), 27-48.

Boivin, J. 2011, How people think and how it matters, Speech to the Canadian Association for Business and Economics, Kingston, Ontario, August 23.

Boivin, J., T. Lane, and C. Meh, 2010, Should monetary policy be used to counteract financial imbalances? Bank of Canada Review, Summer, 23-36.

Borio, C. 2014, The financial Cycle and macroeconomics. What have we learnt? Journal of Banking and Finance, 45, 182-198.

Borio, C. and P. Lowe, 2002, Asset prices, financial and monetary stability: Exploring the nexus, BIS Working Paper No. 114.

Borio, C. and H. Zhu, 2012, Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism? Journal of Financial Stability, 8, 236-251.

Brissimis, S. N. and M. D. Delis, 2009, Bank heterogeneity and monetary policy transmission, European Central Bank Working Paper, No. 1233.

Brunnermeier M. K. and S, Nagel, 2004, Hedge funds and the technology bubble, Journal of Finance, 59(5), 2013-2040.

Buch, C.M, S. Eichmeier, and E. Prieto, 2014, forthcoming "In Search For Yield? Survey-Based Evidence on Bank Risk Taking, Journal of Economic Dynamics and Control, in-press

Calomiris, C. W., 2008, The subprime turmoil: What's old, what's new, what's next?, in *Macro-financial Linkages,* IMF Ninth Jacques Polak Annual Research Conference, Washington, DC.

Campbell, J. and J. Cochrane, 1999, By force of habit: A consumption-based explanation of aggregate stock market behavior, Journal of Political Economy, 107, 205-251.

Carney, M., 2010, Living with low for long, speech to the Economic Club of Canada, Toronto, Ontario, December 13.

Carlson, J. B., E. A. Pelz and M. E. Wohar, 2002, Will valuation ratios revert to historical means? The Journal of Portfolio Management, 28(4), 23-35.

Damar, H. E., C. Meh and Y. Terajima, 2010, Leverage, balance sheet size and wholesale funding, Bank of Canada Working Paper No. 2010-39.

Danielsson J., H. S. Shin, and J. P. Zigrand, 2004, The impact of risk regulation on price dynamics, Journal of Banking and Finance, 28(5), 1069-1087.

Delis, M. D. and G. P. Kouretas, 2011, Interest rates and bank risk-taking, Journal of Banking and Finance 35, 840-855.

Dell'Ariccia G. and R. Marquez, 2006, Lending booms and lending standards, Journal of Finance 61(5), 2511-2546.

Demirgtic-Kunt, A., E. Detragiache, and P. Gupta, 2006, Inside the crisis: an empirical analysis of banking systems in distress. Journal of International Money and Finance 25, 702-718.

Den Haan, W. J., S. Sumner, and G. Yamashiro, 2007, Bank loan portfolios and the monetary transmission mechanism, Journal of Monetary Economics 54, 904-924.

Diamond, D. W. and R. G. Rajan, 2006, Money in a theory of banking, American Economic Review 96, 30-53.

Diamond D. W. and R. G. Rajan, 2009, "lliquidity and interest rate policy, National Bureau of Economic Research Working Paper Series, No. 15197.

Diebold, F.X. and K. Yilmaz, 2009, Measuring financial asset return and volatility spillovers, with applications to global equity markets, The Economic Journal 119, 158-171.

Diebold, F.X. and K. Yilmaz, 2012, Better to give than to receive: Predictive directional measurement of volatility spillovers, International Journal of Forecasting 28, 57-66.

Festic, M., A. Kavkler, and S. Repina, 2011, The macroeconomic sources of systemic risk in the banking sectors of five new EU member states, Journal of Banking and Finance 35, 310-322.

Farhi E. and J. Tirole, 2009, Leverage and the central banker's put, American Economic Review, 99(2), 589-593.

Fisher, R., 2014, Remarks before the National Association of Corporate Directors. Dallas. January 14, https://www.dallasfed.org/news/speeches/fisher/2014/fs140114.cfm.

Forni, M. and Luca Gambetti, 2014. Sufficient Information in Structural VARs, Journal of Monetary Economics 66, 124 – 136.

Gambacorta, L., 2009, Monetary policy and the risk-taking channel, BIS Quarterly Review, December, 43-53.

Gropp, R. and F. Heider, in press, The determinants of bank capital structure, Review of Finance.

Ioannidou, V. P., S. Ongena, and J.-L. Peydro, 2010, Monetary policy, risk-taking, and pricing: evidence from a quasi-natural experiment, European Central Bank Working Paper, forthcoming.

Ioannidou V., S. Ongena, and J.-L. Peydro, 2009, Monetary policy and subprime lending: A tall tale of low federal funds rates, hazardous loans, and reduced loans spreads, European Banking Center Discussion Paper, No. 2009-04S.

Jimenez G., S. Ongena, J.-L. Peydro and J. Saurina, 2010a, Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? European Central Bank Working Paper, forthcoming.

Jimenez G., S. Ongena, J. L. Peydro, and J. Saurina, 2008, Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? Banco de Espana Working Paper, No. 0833.

Kashyap, A.K. and J. C. Stein, 2000, What do a million observations on banks say about the transmission of monetary policy? American Economic Review 90, 407-428.

Keeley, M. C., 1990, Deposit insurance, risk, and market power in banking, American Economic Review 80, 1183-1200.

Lown, C. and D. P. Morgan, 2006, The credit cycle and the business cycle: New findings using the loan officer opinion survey, Journal of Money, Credit, and Banking 38, 1575-1597.

Macklem, T., 2002, Information and analysis for monetary policy: Coming to a decision, Bank of Canada Review, Summer, 11-18.

Manganelli, S. and G. Wolswijk, 2009, What drives spreads in the euro-area government bond market? Economic Policy 48, 191-240.

Maddaloni, A. and J. Peydro, 2011, Bank risk-taking, securitization, supervision, and low interest rates: evidence from the euro-area and the U.S. lending standards, Review of Financial Studies, 24, 2121-2165

Rajan, R. G., 2006, Has finance made the world riskier? European Financial Management 12(4), 499-533.

Rajan, R. G., 2005, Has financial development made the world riskier? in The Greenspan Era.' Lessons for the Future, Federal Reserve Bank of Kansas City Symposium, Jackson Hole, WY. Reprinted in 2006. European Financial Management 12, 499-533.

Ruckes, M. E., 2004, Bank competition and credit standards, Review of Financial Studies, 17(4), 1073-1102.

Sarno, L. and M. P. Taylor, 2008, The Economics of Exchange Rates. (Cambridge University Press, Cambridge, UK).

Shiller, R., 2000, Irrational Exuberance (Princeton University Press, Princeton, NJ).

Shleifer, A. and R. Vishny, 2010, Unstable banking, Journal of Financial Economics 97, 306-318.

Taylor, J. B., 2007, Housing and monetary policy in Housing, Housing Finance, and Monetary Policy, Federal Reserve Bank of Kansas City Symposium, Jackson Hole, WY.

Taylor, J. B., 2009, The financial crisis and the policy responses: an empirical analysis of what went wrong, National Bureau of Economic Research Working Paper No. 14631.

Taylor, J., 2010. Macroeconomic lessons from the Great Deviation. In: Acemoglu, D., Woodford, M. (Eds.), NBER Macroeconomics Annual, vol. 25, pp. 387–95.

Wicksell, K., 1898. Interest and Prices: A Study of the Causes Regulating the Value of Money. Macmillan, London.

Figure 1

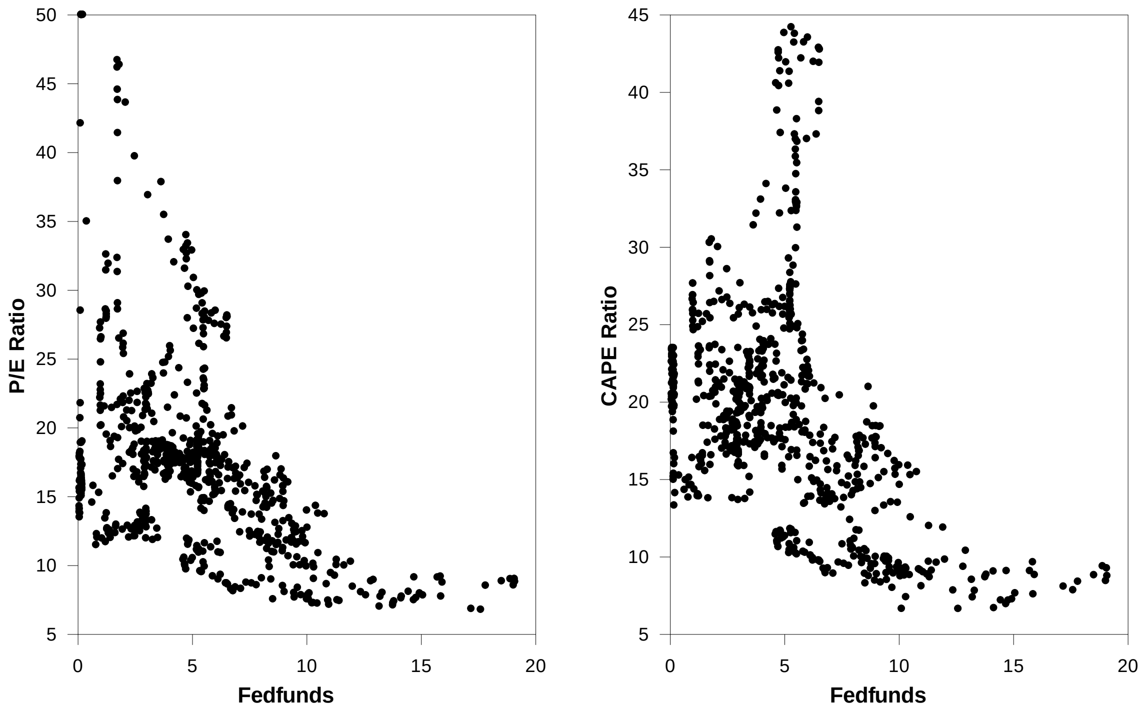

Figure 2: P/E Ratio Impulse Responses in Low Interest Rate Regime (Fed funds < 2.15)

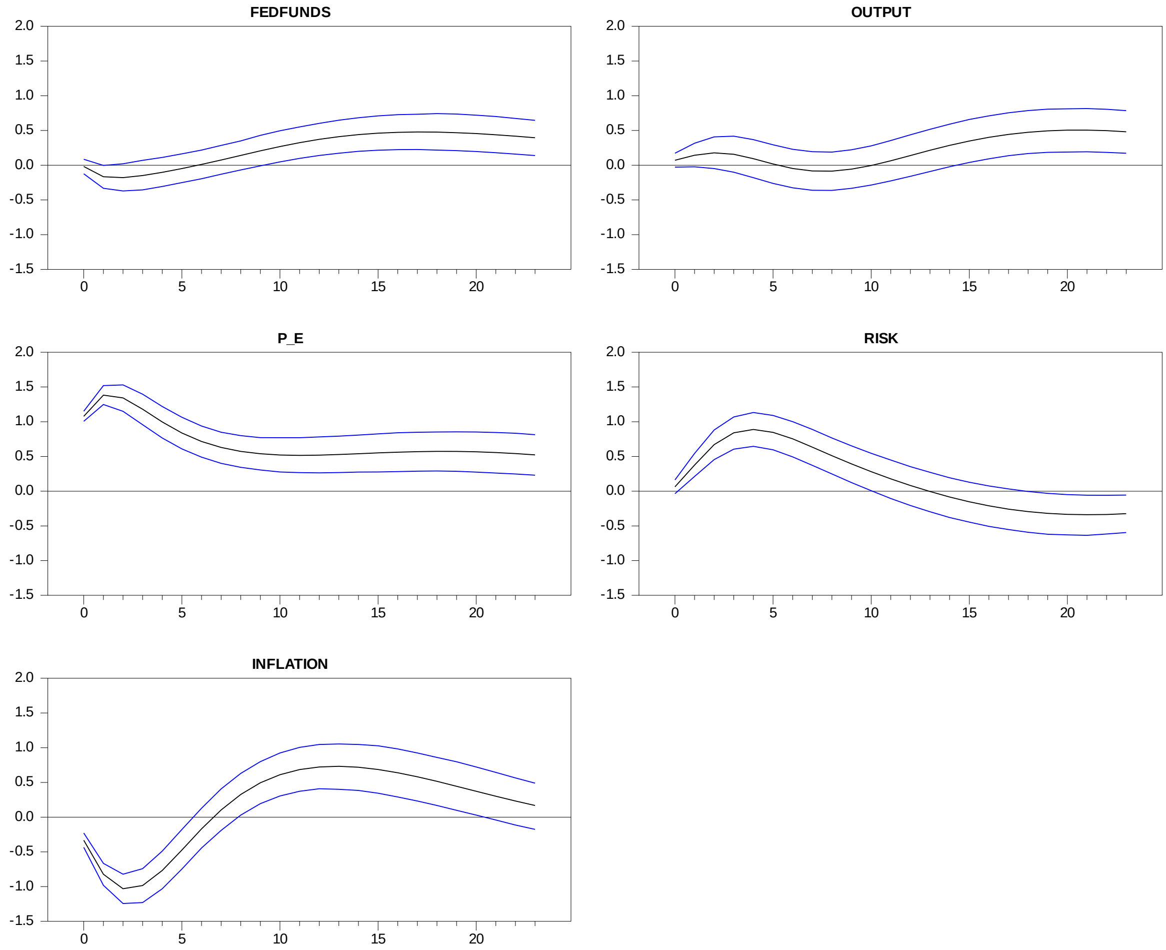

Figure 3: P/E Ratio Impulse Responses in Middle Interest Rate Regime (2.15<Fed funds<6.73)

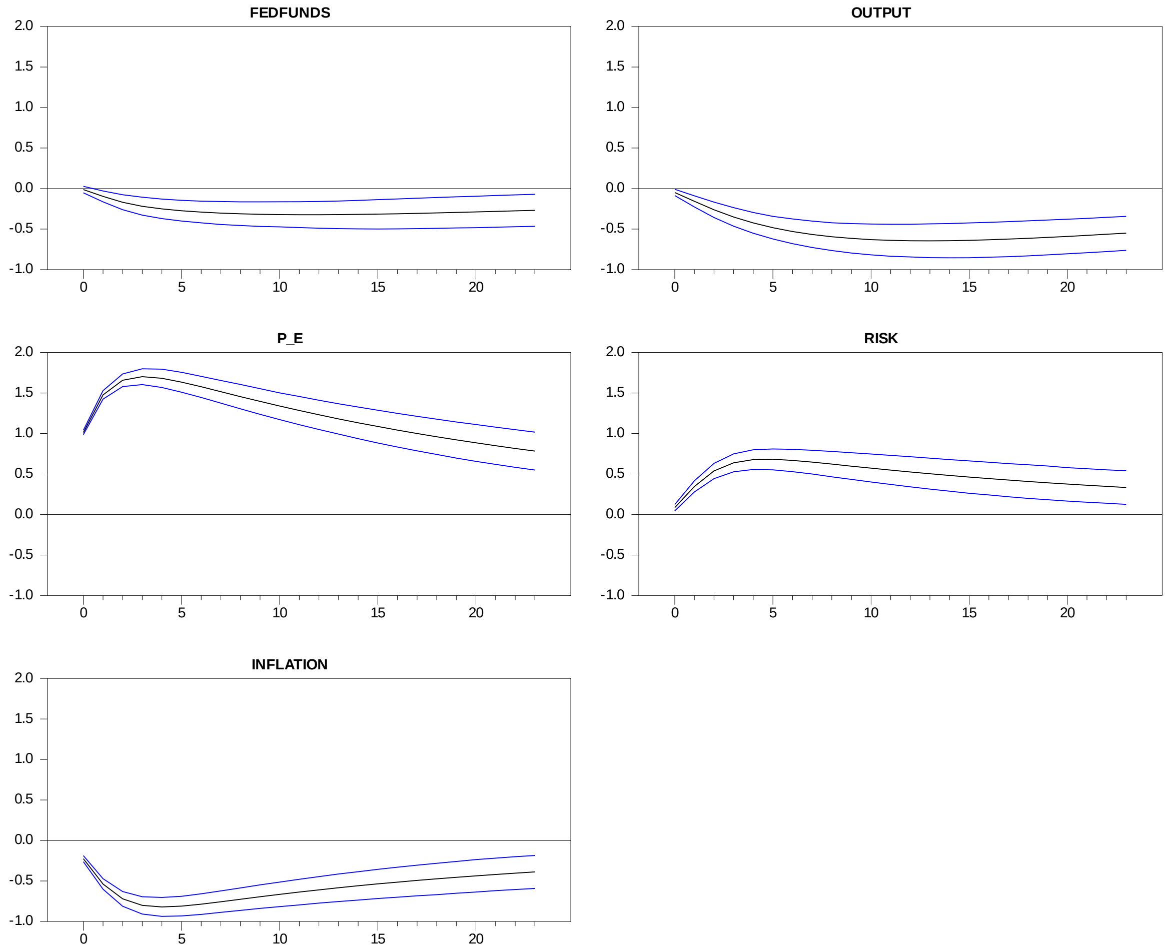

Figure 4: P/E Ratio Impulse Responses in High Interest Rate Regime (Fed funds>6.73)

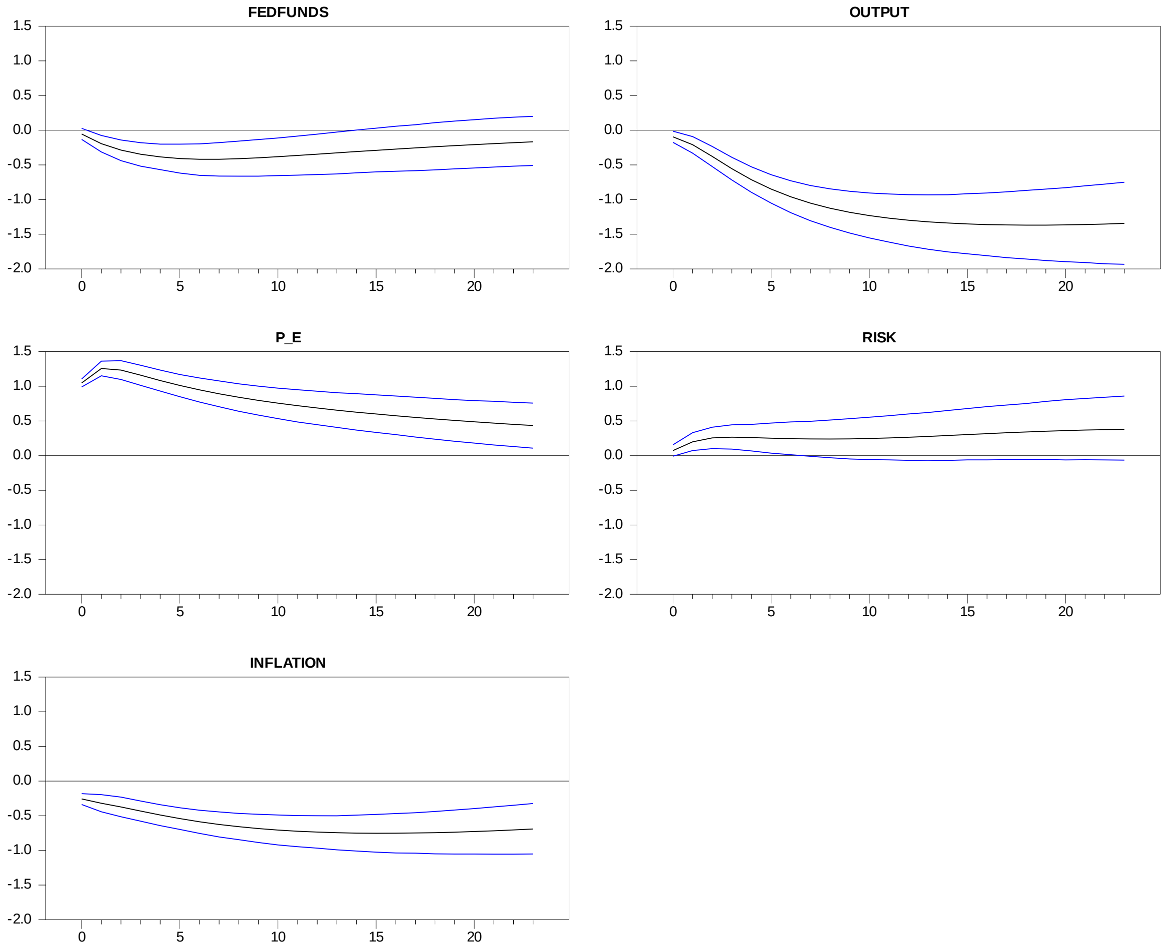

Table 1
Federal funds regime breaks

	Regime 1 Fedfunds < 2.15	Regime 2 2.15 > Fedfunds < 6.73	Regime 3 Fedfunds > 6.73
	N=134	*N=393*	*N=181*
Average	26.15	18.72	11.58
Standard Deviation	22.04	5.36	3.23

Table 2
Variance Decompositions - Federal Funds Regime #1

Panel A: 1 Month

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	95.20	1.10	1.50	2.10	0.00	5.00
P/E Ratio	1.10	95.90	2.70	0.00	0.30	4.00
Inflation	1.40	2.50	88.10	6.40	1.60	12.00
Risk	2.10	0.00	6.60	91.10	0.20	9.00
Output	0.00	0.30	1.80	0.20	97.70	2.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$)	5.00	4.00	13.00	9.00	2.00	32.00
Spillover Index						*0.06*

Panel B: 12 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	41.00	6.40	2.90	8.50	41.20	59.00
P/E Ratio	1.20	30.70	24.20	41.20	2.70	69.00
Inflation	2.10	5.80	64.60	23.00	4.40	35.00
Risk	2.50	0.30	42.20	45.40	9.70	55.00
Output	1.20	0.90	15.50	7.80	74.50	25.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$)	7.00	13.00	85.00	81.00	58.00	244.00
Spillover Index						*0.49*

Panel C: 24 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	37.50	7.00	6.20	7.60	41.80	62.00
P/E Ratio	5.40	20.60	44.30	27.00	2.70	79.00
Inflation	2.40	5.20	67.00	20.80	4.60	33.00
Risk	4.50	0.70	48.70	37.40	8.60	63.00
Output	2.00	1.10	16.50	7.80	72.50	27.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$)	14.00	14.00	116.00	63.00	58.00	265.00
Spillover Index						*0.53*

Table 2 (*cont.*)
Variance Decompositions - Federal Funds Regime #1

Panel D: 36 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	37.50	7.00	6.20	7.50	41.80	63.00
P/E Ratio	6.50	20.40	43.40	25.90	3.70	80.00
Inflation	2.60	5.30	66.80	20.60	4.70	33.00
Risk	4.90	1.00	48.30	36.90	8.90	63.00
Output	2.00	1.20	16.50	7.80	72.50	28.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$)	16.00	14.00	114.00	62.00	59.00	266.00
Spillover Index						*0.53*

Panel E: 48 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	37.40	7.00	6.20	7.50	41.80	63.00
P/E Ratio	6.70	20.40	43.20	25.80	3.90	80.00
Inflation	2.60	5.30	66.70	20.60	4.70	33.00
Risk	5.00	1.00	48.20	36.80	9.00	63.00
Output	2.10	1.20	16.50	7.80	72.50	28.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$)	16.00	15.00	114.00	62.00	59.00	266.00
Spillover Index						*0.53*

From others is defined as the variance other variables' contribute to the row variables' variance. For example, in row 1, 5.00 is obtained by the first row excluding the fed funds own variance share (p/e ratio+inflation+risk+output). *Contribution to others* is obtained by summing down the column excluding the column variable's own variance.

Table 3
Variance Decompositions - Federal Funds Regime #2

Panel A: 1 Month

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* (*i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	94.90	1.40	0.80	2.30	0.70	5.00
P/E Ratio	1.40	98.00	0.10	0.20	0.20	2.00
Inflation	0.80	0.10	98.00	0.50	0.60	2.00
Risk	2.30	0.20	0.50	96.70	0.20	3.00
Output	0.70	0.20	0.60	0.20	98.20	2.00
Contribution to others (*i.e.* $\sum_{j=1,j\neq i}^{5}$)	5.00	2.00	2.00	3.00	2.00	14.00
Spillover Index						*0.03*

Panel B: 12 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* (*i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	72.80	0.40	4.30	17.80	4.60	27.00
P/E Ratio	6.60	81.80	2.10	4.30	5.10	18.00
Inflation	10.20	2.80	85.90	0.80	0.40	14.00
Risk	1.80	5.20	2.50	88.20	2.30	12.00
Output	2.10	0.40	1.10	2.50	94.00	6.00
Contribution to others (*i.e.* $\sum_{j=1,j\neq i}^{5}$)	21.00	9.00	10.00	25.00	12.00	77.00
Spillover Index						*0.16*

Panel C: 24 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* (*i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	65.40	1.00	6.00	22.60	5.00	35.00
P/E Ratio	3.50	86.10	2.20	3.30	4.80	14.00
Inflation	14.80	8.00	74.30	1.90	1.00	26.00
Risk	2.80	5.80	5.70	83.50	2.20	16.00
Output	2.20	0.40	1.10	2.60	93.80	6.00
Contribution to others (*i.e.* $\sum_{j=1,j\neq i}^{5}$)	23.00	15.00	15.00	30.00	13.00	97.00
Spillover Index						*0.19*

Table 3 (*cont.*)
Variance Decompositions - Federal Funds Regime #2

Panel D: 36 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$*)*
Federal Funds Rate	61.90	2.80	6.50	23.60	5.20	38.00
P/E Ratio	2.30	89.20	2.00	2.20	4.30	11.00
Inflation	15.10	14.70	65.80	2.70	1.50	34.00
Risk	4.30	6.20	7.50	79.90	2.10	20.00
Output	2.20	0.40	1.10	2.60	93.70	6.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$ *)*	24.00	24.00	17.00	31.00	13.00	110.00
Spillover Index						*0.22*

Panel D: 48 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$*)*
Federal Funds Rate	59.30	5.70	6.50	23.30	5.30	41.00
P/E Ratio	1.90	90.90	1.80	1.60	3.80	9.00
Inflation	13.80	22.50	58.80	2.90	1.90	41.00
Risk	5.00	6.90	8.20	77.80	2.10	22.00
Output	2.20	0.40	1.10	2.60	93.70	6.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$ *)*	23.00	35.00	18.00	30.00	13.00	120.00
Spillover Index						*0.24*

From others is defined as the variance other variables' contribute to the row variables' variance. For example, in row 1, 5.00 is obtained by the first row excluding the fed funds own variance share (p/e ratio+inflation+risk+output). *Contribution to others* is obtained by summing down the column excluding the column variable's own variance.

Table 4
Variance Decompositions - Federal Funds Regime #3

Panel A: 1 Month

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	95.00	0.30	0.30	0.10	4.30	5.00
P/E Ratio	0.30	91.80	6.10	1.00	0.90	8.00
Inflation	0.30	6.00	90.40	2.50	0.80	10.00
Risk	0.10	1.00	2.60	93.70	2.60	6.00
Output	4.20	0.90	0.80	2.60	91.60	8.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$)	5.00	8.00	10.00	6.00	9.00	37.00
Spillover Index						*0.08*

Panel B: 12 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	52.70	1.30	8.80	6.10	31.10	47.00
P/E Ratio	2.20	56.20	14.90	14.80	11.90	44.00
Inflation	0.60	4.70	48.70	36.30	9.70	51.00
Risk	9.90	1.70	2.40	83.60	2.40	16.00
Output	6.60	1.20	2.00	17.10	73.10	27.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$)	19.00	9.00	28.00	74.00	55.00	186.00
Spillover Index						*0.37*

Panel C: 24 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others* *(i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	39.10	3.70	18.10	13.50	25.60	61.00
P/E Ratio	1.40	42.50	20.70	24.00	11.40	57.00
Inflation	1.50	3.60	37.30	50.40	7.20	63.00
Risk	9.10	5.70	10.50	69.90	4.90	30.00
Output	6.50	1.20	3.10	18.40	70.80	29.00
Contribution to others *(i.e.* $\sum_{j=1,j\neq i}^{5}$)	18.00	14.00	52.00	106.00	49.00	240.00
Spillover Index						*0.48*

Table 4 (*cont.*)
Variance Decompositions - Federal Funds Regime #3

Panel D: 36 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others (i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	30.60	3.70	20.30	24.30	21.00	69.00
P/E Ratio	1.50	34.60	21.80	31.90	10.20	65.00
Inflation	2.30	2.90	32.70	56.00	6.10	67.00
Risk	7.00	6.50	16.50	64.20	5.80	36.00
Output	6.50	1.20	3.50	19.60	69.30	31.00
Contribution to others (i.e. $\sum_{j=1,j\neq i}^{5}$)	17.00	14.00	62.00	132.00	43.00	269.00
Spillover Index						*0.54*

Panel E: 48 Months

	Fed Funds	P/E Ratio	Inflation	Risk	Output	*From Others (i.e.* $\sum_{i=1, i\neq j}^{5}$)
Federal Funds Rate	27.80	3.40	20.00	29.60	19.10	72.00
P/E Ratio	1.80	31.40	21.40	35.90	9.50	69.00
Inflation	2.80	2.90	31.20	57.30	5.80	69.00
Risk	6.30	5.90	17.70	64.50	5.60	36.00
Output	6.50	1.20	3.50	20.00	68.90	31.00
Contribution to others (i.e. $\sum_{j=1,j\neq i}^{5}$)	17.00	13.00	63.00	143.00	40.00	276.00
Spillover Index						*0.55*

From others is defined as the variance other variables' contribute to the row variables' variance. For example, in row 1, 5.00 is obtained by the first row excluding the fed funds own variance share (p/e ratio+inflation+risk+output). *Contribution to others* is obtained by summing down the column excluding the column variable's own variance.