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Predicting firm-level volatility in the United States: The role of monetary policy uncertainty

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Abstract

This paper provides novel evidence for the predictive power of monetary policy uncertainty (MPU) over stock return volatility at the firm level based on a dataset constructed from 9,458 U.S. firms. Our findings show that monetary policy uncertainty contains significant predictive information over realized and implied volatilities at both the firm- and industry-level, with higher policy uncertainty predicting higher volatility in subsequent periods. While the strongest possible volatility effect is observed in the case of Retail Trade, we observe opposite results for Mining with high policy uncertainty predicting lower volatility in this sector. We argue that the dual nature of the underlying commodity for Mining companies, both as a consumption and investment asset, drives the negative effect of policy uncertainty on volatility in this sector. Nevertheless, the findings highlight the predictive information captured by monetary policy actions on the idiosyncratic component of equity market volatility.

Keywords: monetary policy rate uncertainty; firm-level realized and implied volatilities; risk-free rate
JEL Classification Codes: C1, C5, C14

1. Introduction

Monetary policy decisions have implications for both the real economy and financial markets. Numerous papers in the literature establish a relationship between stock market dynamics and monetary policy decisions (e.g. Rigobon and Sack, 2004; Bernanke and Kuttner, 2005) and policy uncertainty (e.g. Pastor and Veronesi, 2012, 2013), while Tsai (2018) argues that policy uncertainty provides an environment conducive to the occurrence of flash crashes in stock markets. While the evidence in the literature generally points to a positive (negative) effect of expansionary (contractionary) monetary policy on the stock market, one can argue the presence of several channels in which monetary policy can affect asset prices in financial markets. First, monetary policy decisions can have an indirect effect on expected cash flows, thus stock

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valuations, by lowering (or raising) the cost of financing for business operations. Second, as noted by several studies including Rajan (2006), Adrian and Shin (2008) and Borio and Zhu (2008), monetary policy can affect stock market valuations via its effects on risk taking behaviour in financial markets, thus opening a discount rate channel. Given these considerations, it can be argued that the effect of monetary policy would not necessarily be limited to asset valuations, but also drive volatility in financial markets. Considering the evidence in the literature, one can argue that uncertainty regarding monetary policy can contribute to volatility in stock markets via: (i) a cash flow channel by creating uncertainty regarding future cash flow projections due to the effect of interest rate uncertainty on financing costs; (ii) a discount rate channel in which monetary policy uncertainty affects risk appetite in the marketplace, which in turn, creates fluctuations in the required returns applied to stock valuations; and also (iii) a "leverage effect" channel that establishes an asymmetric relation between stock market returns and volatility (Gospodinov and Jamali, 2012).

Indeed, the literature provides ample evidence suggesting that stock market volatility is affected by monetary policy decisions (e.g. Chen and Clements, 2007; Farka, 2009; Konrad, 2009 and Vahamaa and Aijo, 2011, among others). Noting that the monetary policy (i.e. short-term risk-free) rate is a key pricing factor for financial assets and so there should be a strong link between monetary policy rate uncertainty and equity return volatility, Kaminska and Roberts-Sklar (2018) show that monetary policy rate uncertainty has significant predictive power for equity return volatility in developed markets over the last two decades. This finding is later corroborated by Gupta and Wohar (2019) using a long history of data over January, 1833 to July, 2018 for the UK.[1] Most of these studies, however, have focused on aggregate market volatility without exploring the implications on firm-level volatility. However, the distinction between aggregate and firm-level volatility is an important one given the evidence of an idiosyncratic volatility (IV) anomaly in which IV captures a significant risk premium in the cross-section of stock returns (e.g. Ang et al., 2006, 2009; Fu, 2009) along with the argument that idiosyncratic volatility may be associated with real option opportunities with a firm (Chen and Petkova, 2012). To that end, while predictions of aggregate market volatility could be an important consideration for any theory on risk and return (Poon and Granger, 2003; Rapach et al., 2008), industry and firm-level components of volatility is also of high importance given that (i) many investors are not necessarily well-diversified, either due to corporate compensation policies or practical limitations on the number of stocks that can be held in a portfolio, thus exposing them to idiosyncratic risks; and, (ii) arbitrageurs are often interested in asset-specific pricing patterns, rather than the cross-section applied to many assets, thus exposing themselves to large pricing errors due to idiosyncratic asset-specific risks. Given these considerations, this paper contributes to the literature by exploring the predictive role of monetary policy uncertainty over firm-level volatility using a large set of firms as complied by Alfaro et al., (2018).

The literature on stock market volatility documents a noticeable increase in firm-level volatility over the past several decades (e.g. Campbell et al., 2001; Comin and Philippon, 2005, Comin and Mulani 2006). At the same time, studies including McConnell and Perez-Quiros (2000), Stock and Watson (2002), Comin and Philippon (2005) and Boivin and Giannoni (2006) document a decline in aggregate market volatility. Comin and Philippon (2005) suggest the decline in the correlation patterns across sectors as a factor for the decline in aggregate volatility, while they argue that the rise in firm-level volatility is driven by (i) higher competition in the goods market; (ii) deregulation; (iii) high research and development activity;

[1] Given that, incorporating jumps into volatility models can improve their overall performance, due to their dominance in the volatility process (Todorov and Tauchen, 2011), Bouri et al., (forthcoming), provided evidence of the role of monetary policy rate uncertainty in affecting volatility jumps, and hence an indirect channel through which the overall volatility gets affected.

and (iv) more access to financing through debt and equity markets. Considering these possible drivers of firm-level volatility and the link between monetary policy and risk aversion and uncertainty in the marketplace (Bekaert et al., 2013), one can argue that monetary policy uncertainty would capture predictive information on firm-level volatility as it can have serious implications on funding conditions in the economy and deter firms from undertaking new investment opportunities. In fact, in a recent application to the Greek market, Panagioditis and Printzis (2019) analyse the investment patterns from a large panel of 25,000 Greek firms and document a negative uncertainty effect on the investment decisions at the firm level, implying a real option channel created by uncertainty that drives firms towards a wait and see approach. Against this background, we look at the effect of a news-based monetary policy rate metric of uncertainty as developed by Baker et al., (2016) on the realized and implied volatility of 9,458 firms as provided by Alfaro et al., (2018). We not only analyse the impact on overall firm-level volatility, but also explore industry-specific patterns by categorizing the firms based on the 4-digit Standard Industrial Classification (SIC). To the best of our knowledge, this is the first attempt to analyse the impact of monetary policy rate uncertainty on firm-level volatility in the US.

From the perspective of econometric modelling, we combine ordinary least squares (OLS) estimation on our panel data model with fixed effects (FE) with the quantile version of the model to analyse how the effect of monetary policy rate uncertainty has evolved conditional on the state of firm-level volatility. The state-specific specification also allows us to implicitly conduct sub-sample analyses, i.e., contingent on the size of the volatility, which is necessary, given that our sample period includes the Global Financial Crisis (GFC), and periods of conventional and unconventional monetary policy actions. The remainder of the paper is organized as follows: Section 2 discusses the data and the methodology, while Section 3 presents the results and Section 4 concludes.

2. Data and econometric models

Our empirical analysis involves two primary variables namely, firm-level volatility and monetary policy uncertainty. As far as firm-level volatility is concerned, we use two measures as provided by Alfaro et al., (2018), i.e. the Center for Research in Security Prices (CRSP) realized volatility and 365-day option-implied volatility. In particular, realized volatility (RV) is estimated as the 12-month standard deviation of daily CRSP returns (usually based on 252 days of trading return data in a year, with a minimum of 200 days), and implied volatility (IV) is constructed using 365-day implied volatility of at-the-money-forward call options. The data for 9,458 US firms based on SIC codes is available for download from: http://policyuncertainty.com/firm_uncertainty.html.

Uncertainty, in general is a latent process, and multiple ways exist to measure it (see Gupta et al., 2018 for a detailed discussion in this regard). In our case, we rely on the news-based measure of uncertainty related to monetary policy as developed by Baker et al., (2016), and is available for download from: http://policyuncertainty.com/categorical_epu.html. This index is derived using results from the Access World News database of over 2,000 US newspapers. In addition to the three terms in (economic, uncertainty, and policy), the newspaper articles comprising the index include the following additional phrases as well: federal reserve, the fed, money supply, open market operations, quantitative easing, monetary policy, fed funds rate, overnight lending rate, Bernanke, Volcker, Greenspan, central bank, interest rates, fed chairman, fed chair, lender of last resort, discount window, European Central Bank, ECB, Bank of England, Bank of Japan, BOJ, Bank of China, Bundesbank, Bank of France, Bank of Italy.[2]

[2] Recently, Husted et al., (2019) have developed an alternative news-based measure of MPU for the US, which differs from that of Baker et al., (2016), with respect to scaling factors, (narrower) newspaper coverage and term

The monetary policy uncertainty (MPU) index is available monthly, but since our firm-level measures of volatilities, i.e., RV and IV are only available annually over 1997 to 2016, we take 12-month average of the MPU to match the frequencies of the variables of interest. We also work with natural logarithmic values of RV, IV and MPU, which are plotted in Figure A1 in the Appendix of the paper.

Having described the data, we outline below our empirical framework. The benchmark model is estimated using fixed effects as follows:

$$\ln(RV_{f,i,t}) = \beta \ln(MPU_{f,t-1}) + \delta_f + \alpha_i + \varepsilon_{f,i,t} \quad (1)$$

where δ_f and α_i are the firm and industry fixed effects. We use the same controls when IV is the dependent variable so Equation (1) remains unchanged. The data is also split into its aggregate SIC categories and the model is re-estimated to allow MPU to vary over the categories, but without the industry fixed effects.

As noted earlier, we also estimate the model using quantile fixed effects regression.[3] The estimated equation is given as follows:

$$\ln(RV^q_{f,i,t}) = \beta^q \ln(MPU_{f,t-1}) + \delta^q_f + \alpha^q_i + \varepsilon^q_{f,i,t} \quad (2)$$

where q represents the quantiles at 20th, 50th, and 80th of the conditional distribution of the dependent variable. Again, the same model in Equation (2) is estimated for IV. Note that the quantile regression offers several advantages including less sensitivity to outliers and bias due to misspecification of the estimating equation (Wooldridge, 2010).

3. Empirical results

Table 1 reports the OLS-FE results. Consistent with the theory, we observe that the lagged value of MPU is positively, and in a statistically significant manner (at the 1% level), related to both RV and IV, suggesting that higher monetary policy uncertainty predicts an increase in firm-level volatility in the following year.[4,5] Clearly, high level of policy uncertainty is associated with higher firm-level volatility in subsequent periods. This is not unexpected considering the aforementioned channels in which monetary policy uncertainty can drive volatility is stock markets; however, the positive effect on firm-level volatility could be associated with higher required returns investors require for compensation as greater policy uncertainty drives changes in risk taking behaviour and trading activity. Nevertheless, considering the finding that idiosyncratic volatility captures a significant risk premium in the cross-section of stock returns (e.g. Ang et al., 2006, 2009; Fu, 2009), it can be argued that policy uncertainty serves as a contributing factor behind the IV premium embedded in stock valuations. Although beyond the scope of this particular study, a significant investment implication of this finding is whether or not MPU captures a risk premium over and above that is associated with the IV effect and if this

sets, and used it to analyse its impact on firm-level investment. Given this, we checked for the robustness of our results using this alternative measure of MPU and found qualitatively similar results. This was also the case when we used the MPU indexes of Istrefi and Mouabbi (2018), which are in turn, based on forecasts of short- (3 month) and long-term (10-year) interest rates, 3- and 12-months-ahead, stemming from Consensus Economics surveys. The measures account for two components: disagreement among forecasters and the perceived variability of future aggregate shocks. All these results are available upon request from the authors.

[3] The estimations are performed using *xtqreg* in Stata 15 which was developed by Machado and Santos Silva (2018).

[4] Our results are robust to the use of the contemporaneous value of MPU rather than its lagged value, and also to the inclusion of one lag of RV or IV in our current model (with lagged MPU) to capture persistence in the volatility process. Moreover, when we included a second lag of MPU, the corresponding coefficient turned out to be insignificant. Complete details of these results are available upon request from the authors.

[5] Based on the suggestion of an anonymous referee who was concerned with cross-sectional dependence, we used multi-way clustering on the firm and year, and obtained qualitatively similar findings to those reported in Table 1. Complete details of these results are available upon request from the authors.

premium could be captured by adopting a portfolio strategy that takes long/short positions based on the risk exposure to the MPU factor.

Examining the results from the FE-quantile regression (FE-QR) reported in Table 2, we see that the positive monetary policy uncertainty effect on firm-level volatility is also robust and highly significant across the various quantiles. Interestingly, however, we observe a monotonic increase in the effect of policy uncertainty on volatility as we move from the highest (0.80) quantile to the lowest (0.20) quantile.[6] This suggests that the effect of MPU on volatility is stronger if volatility is initially low, implying a policy uncertainty effect that is in part driven by the volatility state. In an application to the German stock market, Konrad (2009) shows that the effect of monetary policy on German stock return volatility is much bigger in bearish periods than bull periods. To that end, the stronger results observed at lower quantiles can be a manifestation of a "market state effect" on the volatility-policy uncertainty relationship. Nevertheless, the findings point to a robust monetary policy uncertainty effect on firm-level volatility, consistent with the earlier findings for aggregate volatility decisions (e.g. Chen and Clements, 2007; Farka, 2009; Konrad, 2009 and Vahamaa and Aijo, 2011, among others).

Next in Table 3, we present the OLS-FE results at the industry-level based on 4-digit SIC of the 9,458 firms in the dataset. This classification results in eight sectors including Agriculture, Forestry and Fishing; Mining; Construction; Manufacturing; Transportation, Wholesale Trade;

Table 1. Ordinary Least Squares Regressions with Fixed Effects (OLS-FE).

Model Specifications	***Realized Volatility (RV)***	***Implied Volatility (IV)***
MPU_{t-1}	0.202***	0.179***
	(0.005)	(0.005)
Firm FE	Yes	Yes
SIC FE	Yes	Yes
Adjusted-R^2	0.044	0.066
Observations	59474	33271

Note: Standard errors in parentheses; * p<0.10, ** p<0.05, *** p<0.01; FE: Fixed-Effects.

Table 2. Quantile Regressions with Fixed Effects (QR-FE).

Panel A: Realized Volatility (RV)			
		Quantile	
Model Specifications	0.20	0.50	0.80
MPU_{t-1}	0.217***	0.204***	0.162***
	(0.006)	(0.004)	(0.015)
Firm FE	Yes	Yes	Yes
SIC FE	Yes	Yes	Yes
Observations	59474	59474	59474
Panel B: Implied Volatility (IV)			
		Quantile	
Model Specifications	0.20	0.50	0.80
MPU_{t-1}	0.196***	0.182***	0.162***
	(0.069)	(0.004)	(0.007)
Firm FE	Yes	Yes	Yes
SIC FE	Yes	Yes	Yes
Observations	33271	33271	33271

Note: See Notes to Table 1.

[6] We also estimated versions of the FE-OLS and FE-QR, where we decompose the lagged MPU into its unconditional quantiles, and found that the positive impact on RV and IV are primarily driven by the upper quantiles (beyond the median) of the MPU, i.e., by higher values of monetary policy uncertainty. Complete details of these results are available upon request from the authors.

Table 3. Ordinary Least Squares Regressions with Fixed Effects (OLS-FE) for Industries Categorized based on 4-Digit SIC.

Panel A: Realized Volatility (RV)								
	Industry							
Model Specifications	***Agriculture, Forestry and Fishing***	***Mining***	***Construction***	***Manufacturing***	***Transportation, Communications, Electric, Gas and Sanitary Service***	***Wholesale Trade***	***Retail Trade***	***Services***
MPU_{t-1}	0.143*	-0.096***	0.149***	0.206***	0.218***	0.203***	0.262***	0.236***
	(0.083)	(0.023)	(0.029)	(0.006)	(0.021)	(0.022)	(0.014)	(0.010)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SIC FE	No	No	No	No	No	No	No	No
Adjusted-R^2	0.016	0.008	0.022	0.042	0.039	0.043	0.067	0.049
Observations	185	2746	891	13304	31463	2453	4911	13304
Panel B: Implied Volatility (IV)								
	Industry							
Model Specifications	***Agriculture, Forestry and Fishing***	***Mining***	***Construction***	***Manufacturing***	***Transportation, Communications, Electric, Gas and Sanitary Service***	***Communications, Electric, Gas and Sanitary Service***	***Wholesale Trade***	***Retail Trade***
MPU_{t-1}	0.096	-0.062***	0.194***	0.184***	0.202***	0.174***	0.232***	0.201***
	(0.087)	(0.023)	(0.029)	(0.006)	(0.020)	(0.022)	(0.014)	(0.011)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SIC FE	No	No	No	No	No	No	No	No
Adjusted-R^2	0.008	0.006	0.084	0.063	0.064	0.047	0.088	0.065
Observations	96	1831	527	17438	2168	1164	3038	7009

Note: See Notes to Table 1.

Retail Trade; Wholesale Trade, and Services. We observe that the positive policy uncertainty effect on volatility is generally robust across the industries, with the strongest effect observed in the case of Retail Trade. The strong policy uncertainty effect on Retail Trade could be due to the effect of monetary policy uncertainty on consumption as well as investment decisions by individuals and firms via its effects on financing costs. Similarly, following the argument by Comin and Philippon (2005), the strong positive policy uncertainty effect could be a manifestation of higher competition experienced by firms in this industry, creating further instability in earnings projections due to heterogeneity in firm-level exposure to monetary policy risk.

Interestingly, however, while we observe a positive volatility effect on all sectors, we see that the opposite holds for the Mining sector. Higher policy uncertainty is found to predict lower volatility for Mining implied by a statistically significant (at the 1% level) decline in both RV and IV during the next year.[7] The distinct pattern observed for Mining indeed presents an interesting case given the recent evidence in Panagioditis and Printzis (2019) that Mining and Agriculture happen to be the least affected sectors from uncertainty. One can argue that the distinct pattern observed for Mining could be due to the dual nature of the commodities like precious metals both as a consumption and an investment asset. In fact, numerous studies in the literature have examined the relationship between gold and mining company stocks, suggesting that gold mining company stocks have a greater exposure to gold price fluctuations than that of the stock market (e.g. Blose and Shieh, 1995; Tufano, 1998). Given this association between mining company stocks and the underlying commodity price, and considering that precious metals like gold and silver are often considered traditional safe havens against market downturns, one can argue that investors' expectation of a loose monetary policy in response to a market downturn could balance out the negative equity market-related risks on mining stocks with a positive effect driven by safe haven demand, thus reducing volatility. Furthermore, as easing of monetary policy by the central bank helps cut the cost of holding inventory for mining companies due to lower interest rates, such an expectation by investors could also be a factor in driving volatility lower. To that end, the negative volatility effect observed in the case of Mining can be explained by the supply and demand side factors that affect the underlying commodity price.

Overall, the findings clearly confirm the predictive information captured by monetary policy uncertainty on stock market volatility, both at the firm- and industry-levels, while some heterogeneity is observed across industries, in particular the Mining sector. The findings at the firm level suggest that policy uncertainty could be the driving factor behind the idiosyncratic volatility effect documented in the literature. If that is the case, it would be interesting to see whether or not MPU captures a significant risk premium in the cross-section of stock returns. Similarly, the heterogeneity observed across industries, particularly Mining, could be exploited in industry rotation strategies in which investors shift funds in and out of particular industries based on their assessment of the state of uncertainty regarding monetary policies.

4. Conclusion

Volatility is a key concept in asset pricing, risk management and portfolio diversification. While aggregate market volatility is highlighted in theories of risk and return, firm-level volatility is also shown to matter as a systematic risk factor as well as a predictor of future returns. Although

[7] As with the FE-QR model for all the firms, the positive impact (barring the negative effect on Mining) of lagged MPU on RV and IV was found to decrease at the upper conditional quantiles of the two measures of volatility also for the 8 industries. Complete details of these results are available upon request from the authors.

numerous studies in the literature document a strong link between monetary policy rate uncertainty and equity return volatility, these studies generally focus on aggregate volatility proxies without exploring the implications at the firm- or sector-level. However, in practice, idiosyncratic risk does indeed matter as most investors deal with under-diversified portfolios and arbitrageurs are often exposed to asset-specific risks rather than aggregate volatility. Against this background and given the evidence in the literature of a rise in firm-level volatility over the past several decades, while aggregate volatility has experienced a decline, this paper examines the relationship between monetary policy uncertainty and firm-level volatility using a dataset of realized and implied volatility obtained from 9,458 firms. Specifically, we test whether uncertainty about the future path of interest rates help in predicting future realized and implied variance of equity returns at both the firm- and industry-level. Consistent with theory, we find that the lagged monetary policy rate uncertainty is positively and in a statistically significant manner related to firm-level uncertainty. This result continues to hold under various robustness analyses involving quantile regressions (with the effect being weaker at conditionally higher-levels of realized and implied volatilities), and 4-digit SIC categorization of the firms into 8 industries (barring the case of the Mining sector). The findings suggest that the views of investors on monetary policy rate developments may indeed be embedded in variation of equity prices, both at the individual firm and industry levels. If the predictive power of monetary policy uncertainty over volatility is driven by its effect on risk taking behaviour by investors, i.e. the discount rate channel, the findings could be used as a guideline to build models of expected returns in which monetary policy uncertainty is included as a risk factor, perhaps associated with time-varying risk aversion. The results could also be used by arbitrageurs in their attempts to predict near term asset-specific volatility, thus help avoid large pricing errors.

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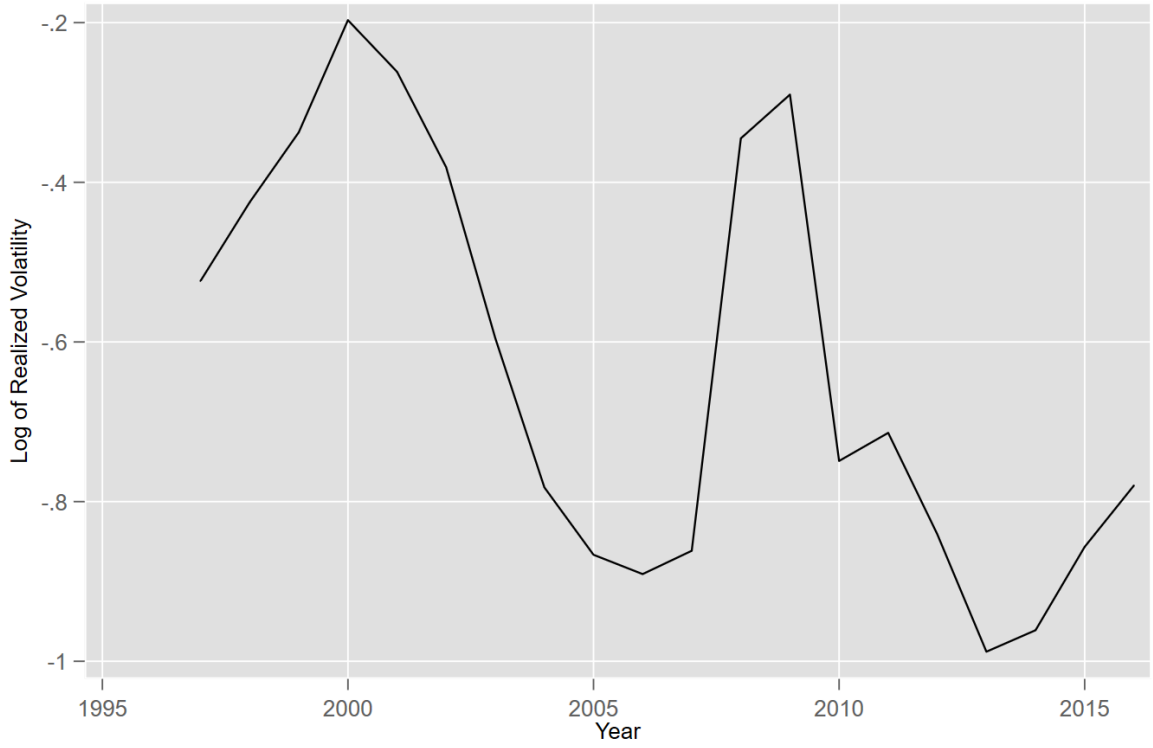
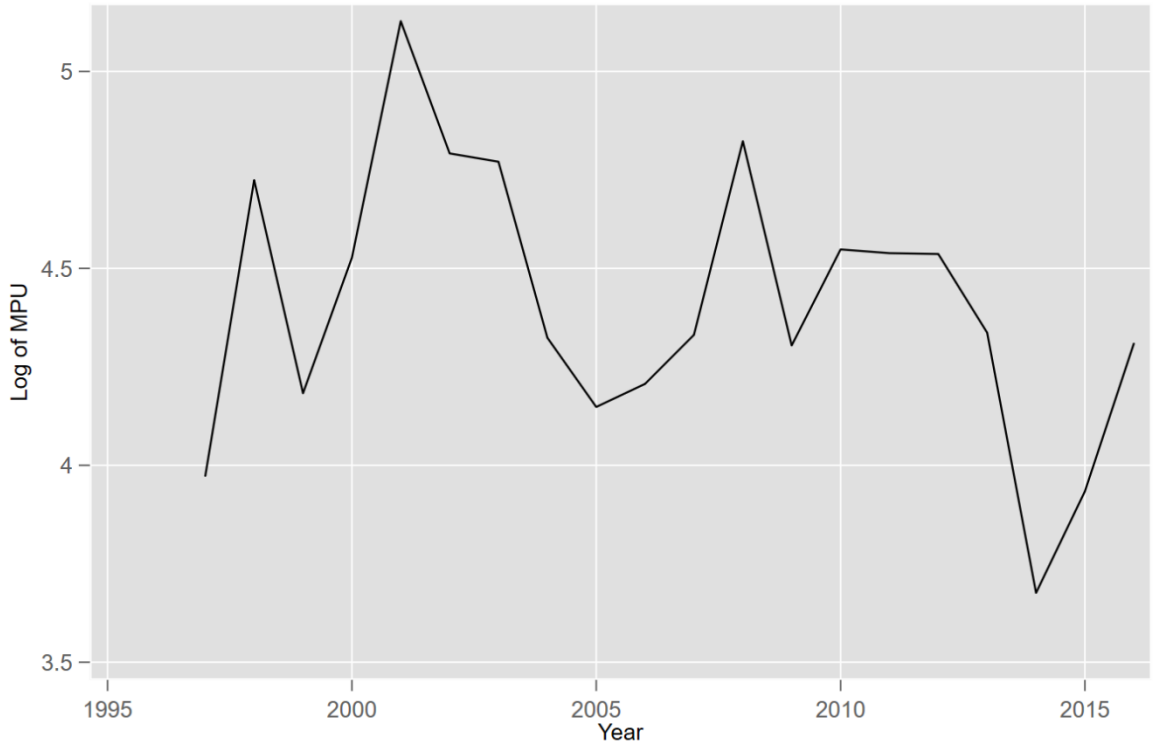
Appendix A – Additional figures

Figure A1. Data Plots.



A1(a). Realized Volatility (RV).

A1(b). Implied Volatility (IV).



A1(c). Monetary Policy Uncertainty (MPU).