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On the different approaches of measuring uncertainty shocks

Johannes Strobel *

University of Regensburg, Universitaetsstr. 31, 93040 Regensburg, Germany

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ABSTRACT

As uncertainty has become an increasingly prominent source of business cycle fluctuations, various uncertainty proxies have been proposed in the literature. This paper shows that uncertainty measures based on realized variables fluctuate more than the measures that are based on forecasts. More precisely, the variation in the realized cross-sectional standard deviation of profit growth and stock returns is larger than the variation in the forecast standard deviation. Moreover, the forecast standard deviation of profit growth and stock returns are negatively or uncorrelated, the uncertainty measures increase stock returns due to a risk premium, but they decrease profit growth.

1. Introduction

Uncertainty has become increasingly prominent as a source of business cycle fluctuations. Since there is no objective measure of uncertainty, various uncertainty proxies have been proposed in the literature, with "uncertainty" often formalized as time-varying second moment.[1] Bloom et al. (2012), for instance, use uncertainty proxies derived from both realized and forecast real variables to calibrate their model, while Bloom (2009) uses a measure of forecast stock market volatility. Chugh (2012) and Dorofeenko et al. (2014), in turn, derive uncertainty on a sectoral level based on realized real data.

This paper shows that ex ante, the standard deviation of profit growth and stock returns in the US economy, in the manufacturing sector and in the services sector fluctuates less than ex post by comparing the conditional standard deviation forecast to the realized cross-sectional standard deviation and to the interquartile range (IQR). This finding corroborates the argument of Leahy and Whited (1996, p. 68), that "since uncertainty relates to expectations and not to actual outcomes, it would be incorrect to use the ex post volatility of asset returns as a measure of the variability of the firm's environment. We therefore need an ex ante measure". Moreover, my results also show that the forecast standard deviation of profit growth and stock returns are negatively or at times uncorrelated.

I use a Generalized Autoregressive Conditional Heteroskedasticity-in-mean (GARCH-M) model to forecast the conditional standard deviation of profit growth and stock returns in the manufacturing sector, the services sector and the US economy. The results of the GARCH-M estimation also show that a higher conditional standard deviation increases stock returns due to a higher risk premium and decreases average profit growth.

2. Data

For the following analysis, two data sets used in Bloom (2009) are considered.[2] The first data set contains observations on pretax profits, sales and industry for a total of 347 firms, 242 of which are in manufacturing and 23 are in the services sector in the United States from 1964Q4 to 2005Q1. The growth rate of quarterly profits $\Delta\Pi_t$, normalized by sales S_t, is calculated as $\Delta\tilde{\Pi}_t = \frac{\Pi_t - \Pi_{t-4}}{1/2(S_t + S_{t-4})}$.[3] The second data set contains information on firm-level stock returns for firms in the United States included in the Center for Research in Securities Prices (CRSP) stock-returns file with 500 or more monthly observations.[4] The analysis focuses on the manufacturing sector, the services sector and the whole economy. In the absence of selection bias, mean, and standard deviation can be interpreted as return and risk per month from investing in a

* Tel.: +49 941 943 5063.
E-mail address: johannes.strobel@ur.de.

1 A comprehensive survey of the literature can be found in Bloom (2014).

2 A detailed description is included in the Appendix.

3 Profit growth is calculated year-on-year to account for seasonality.

4 More precisely, it contains data on 361 firms, 208 of which are in manufacturing and 10 are in the services sector, ranging from 1962M8 to 2006M12.

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0165-1765/

Table 1
Parameter estimates of the GARCH-M model based on mean profit growth (1964Q4–2005Q1), mean stock return (1962M8–2006M12) and TFP growth (1950Q1–2013Q4) in the manufacturing sector, in the services sector, in the US economy. The distribution for the maximum likelihood estimation is chosen based on the Kolmogorov–Smirnoff test. Test results are reported in Table 5 in the Appendix. * indicates 10%, ** indicates 5%, *** indicates 1% significance based on Bollerslev–Wooldridge robust standard errors.
Source: Compustat Database, CRSP, Federal Reserve Bank of San Francisco.

	Profit growth			Stock returns			TFP growth
	Manufacturing	Services	Economy	Manufacturing	Services	Economy	
Distribution	$t(8.93)$	normal	normal	normal	normal	normal	normal
μ	0.017***	0.014***	0.013***	0.004	0.004	0.003	0.006
θ	−16.48***	−0.906	−10.156	4.491	3.026*	5.806	6.053
α	0.470***	0.389**	0.411**	0.788***	0.070**	0.079**	0.065
β	0.477***	−0.599***	0.405	0.880***	0.907***	0.872***	0.883***
ω	0.000	0.000	0.000	0.000	0.000	0.000	0.000

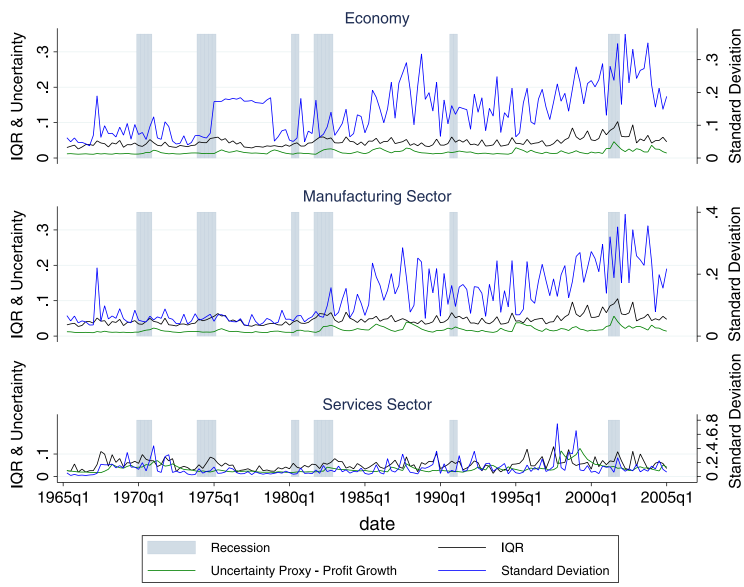

Fig. 1. IQR, standard deviation and uncertainty proxy for the manufacturing sector, the services sector and the US economy based on normalized profit growth from 1964Q4 to 2005Q1.
Source: Federal Reserve Economic Data (FRED), Compustat Database.

representative firm of the sectors or the economy.[5] As the data are constructed to reflect an average firm's mean and standard deviation of stock returns and profit growth, the conditional variance reflects uncertainty and innovations to the conditional variance mirror uncertainty shocks in a sector. Using a GARCH-M model, I can predict the conditional standard deviation of stock returns and profit growth of an average firm, test whether uncertainty shocks have an effect on profit growth or stock returns and compare them to the realized cross-sectional standard deviation. Due to its theoretical correspondence, the conditional variance of productivity growth complements the uncertainty proxies.[6]

The mean equation of the GARCH-M model is formulated as $x_t = \mu + \theta\sigma_t^2 + u_t$, $u_t|I_{t-1} \sim N(0, \sigma_t^2)$, while the conditional variance σ_t^2 is assumed to follow a GARCH(1,1) process with one-step-ahead predictions given by $\sigma_{t+1|t}^2 = \omega + \alpha u_t^2 + \beta\sigma_t^2$ (Engle et al., 1987). x_t corresponds to stock returns, profit growth or TFP growth, μ is the mean, σ_t^2 is the conditional variance and u_t is an uncorrelated but serially dependent error. Normality of u_t is a starting point and will be tested for. The one-period forecast of σ_t^2, based on TFP growth data is this paper's *Benchmark* uncertainty estimation. The usefulness of $\sigma_{t+1|t}$ as benchmark is due to four reasons. First, uncertainty shocks are identified as innovations to the conditional one period forecast of the variance. Second, heteroskedasticity is modeled conditional on past information. Third, the GARCH-M approach allows for the conditional variance to affect profit growth, stock returns or TFP and fourth, out of sample forecasts can be done easily.[7]

3. Results

Table 1 reports the distribution of u_t and parameter estimation results. The effect of the conditional variance on profit growth or stock return depends on the sector. A hypothetical increase of 50% in the variance across time decreases expected quarterly profit by 29% in the manufacturing sector and by 8% in the services sector, although only the former result is significant.[8]

The risk premia of 1.20% in the services sector, 1.03% in the manufacturing sector and 1.07% in the whole economy seem rather low and might be driven by aggregation and a downward bias, given a p-value of 9.6% in the services sector, 18.6% in the manufacturing sector and 10.8% in the US economy.[9]

Fig. 1 shows IQR, realized and forecast standard deviation per period, estimated as explained above using data on profit growth.

[5] Selection bias might be an issue, as only firms with 500 or more monthly data are included in the analysis. However, the bias is downward, potentially understating the impact of uncertainty.

[6] Quarterly data on TFP growth from Basu et al. (2006) from 1950Q1 to 2013Q4.

[7] Test results for the presence of ARCH effects using Engle's Lagrange multiplier (LM) test are reported in Table 3 in the Appendix.

[8] The change in expected quarterly profit growth in the manufacturing sector is calculated as $[(0.0182247 + 1.5 * 0.0003164 * (-20.9759))/(0.0182247 + 0.0003164 * (-20.9759))] - 1 = -0.2863$ and analogously in the services sector.

[9] The risk premium is calculated as e.g. $3.026 * \bar{\sigma}_t^2 = 1.20\%$ in the services sector.