Discussion Paper No. 14-093

Information Ambiguity and Firm Value

Katrin Hussinger and Sebastian Pacher

ZEW

Zentrum für Europäische
Wirtschaftsforschung GmbH

Centre for European
Economic Research

Discussion Paper No. 14-093

Information Ambiguity and Firm Value

Katrin Hussinger and Sebastian Pacher

Information Ambiguity and Firm Value[1]

Katrin Hussinger [a,b,c] and Sebastian Pacher [d]

[a] *University of Luxembourg (Luxembourg)*
[b] *K.U. Leuven, Dept. of Managerial Economics, Strategy and Innovation (Belgium)*
[c] *Centre for European Economic Research (ZEW), Mannheim (Germany)*
[d] *Kienbaum Management Consulting (Germany)*

October 2014

This paper is forthcoming in *Applied Economics Letters*

Abstract

A recent theoretical model by Epstein and Schneider (2008) predicts that a firm's assets will be undervalued by the market if the information surrounding these assets is ambiguous. The model further predicts that this effect is amplified if the underlying fundamentals are volatile. This paper provides an empirical test.

[1] Authors appear in alphabetic order. Corresponding author: Katrin Hussinger, University of Luxembourg, CREA, Avenue de la Faiencerie 162, 1511 Luxembourg, Luxembourg, phone: +352 46 66 44 6404, E-Mail: katrin.hussinger@uni.lu

1. Introduction

Recent advances in asset pricing strategy analyze financial market reactions to new information when knowledge about the quality of this information is incomplete (Epstein and Schneider, 2008; Zhang, 2006). When information quality is difficult to judge, investors treat signals as ambiguous. Ambiguous information is defined as information with uncertain implications for a firm's value (Zhang, 2006). Investors are assumed to be ambiguity-averse so that they require compensation. The market's discomfort with difficult-to-interpret information is expected to negatively impact firm value. Epstein and Schneider (2008) further predict that the negative impact of information ambiguity is larger when the underlying fundamentals are volatile. This paper provides empirical evidence for these theoretical predictions by Epstein and Schneider (2008).

2. Sample and variables' definitions

We assemble a rich dataset of annual firm-level data from a variety sources. Firm-level accounting data is taken from the Compustat database. We link this information to the Institutional Brokers Estimates System (I/B/E/S) database, which covers information on analyst forecasts which we use to derive a measure for information ambiguity.[2] We supplement the firm data by patent data in order to account for the fact that intangibles account for a large share of the companies' market value. We use all U.S. utility patents granted between 1975 and 2006 and the citations that these patents receive (we have citation data until 2010) from the United States Patent and Trademark Office (USPTO). We further retrieve data on daily stock-price data from the Centre of Research in Security Prices (CRSP) in order to derive a measure for the idiosyncratic risk. We

[2] Following prior research, we use the unadjusted summary dataset (Diether et al., 2002).

include all stocks listed on the AMEX, NYSE, and NASDAQ. Lastly, we retrieved daily Fama and French (1993) risk factors from Kenneth French's homepage.

Our dependent variable capturing firms' market value is Tobin's q – the ratio of firms' market value to the replacement costs of assets – as dependent variable. We compute the market value of assets as the sum of firm's market capitalization (shares outstanding multiplied by share price), long-term debt, and preferred stock. The replacement costs of assets are defined as the sum of property, plant, and equipment, inventories, and net short term assets.

Our main regressors are proxies for information ambiguity and idiosyncratic risk. Information ambiguity is defined based on analyst forecast dispersion, i.e. the standard deviation of all outstanding analyst forecasts scaled by the mean consensus forecast for each calendar month, following. Forecast dispersion is a widely accepted measure of information uncertainty, parameter risk, or estimation risk (Anderson et al., 2005, 2009; Doukas et al., 2006; Dittmar and Thakor, 2007; Erickson et al., 2012; Güntay and Hackbarth, 2010; Johnson, 2004; Kumar et al., 2008). Dispersion is a measure for disagreement among analysts and among market participants in general. We aggregate forecast dispersion by computing the mean forecast dispersion over all month prior to a firm's earnings announcement.

To ensure that the standard deviation of analysts' earnings forecast is a meaningful proxy for information uncertainty, we require all firms to be covered by at least two analysts in each calendar month in order to be included in the sample. Following prior literature (Hall et al., 2005), we restrict our study to firms in manufacturing industries (SIC 20-39). We exclude all firms for which we have less than two consecutive observations with non-missing data. Our final sample is an unbalanced panel with 3,670 firm-year observations corresponding to 382 firms in the manufacturing sector between 1992 and 2006.

Our measure for fundamental risk is based on the idiosyncratic volatility of stock prices. We compute idiosyncratic volatility from daily stock returns and two Fama and French (1993) risk factors. The advantage of using high-frequency stock market data for measuring risk is that stock prices, in principle, include all factors in a firm's environment that investors perceive to be important. Similar to Ang et al. (2009) and Fu (2009), we estimate idiosyncratic volatility as the standard deviation of the residual obtained from (1).

$$(r_{it_d} - r^f_{t_d}) = \alpha_i + \beta^M_i (r^M_{t_d} - r^f_{t_d}) + \beta^{SMB}_i SMB_{t_d} + \beta^{HML}_i HML_{t_d} + u_{it_d}\,, \tag{1}$$

where i indexes firms, t_d indexes trading days in year t. r_i denotes the firm's daily stock return, r^f the one-month treasury bill rate (i.e., the risk-free rate), r^M the value-weighted return on the market as a whole, *SMB* the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks, and *HML* the difference between the return of a portfolio of high book-to-market stocks and the return on the portfolio of low book-to-market stocks. Measuring uncertainty by stock market data is widely accepted in the economics literature (e.g. Baum et al., 2007; Bloom and Van Reenen, 2002; Bloom et al., 2007). We use the logarithm of analyst dispersion and fundamental risk in order to take the skewness of the variables' distributions into account.

We further control for knowledge assets of the company. We define R&D intensity as the ratio between a firm's R&D stock and the book value of assets. R&D stocks are calculated as the perpetual inventory of firms' past and contemporaneous R&D expenditures. We use a constant annual depreciation rate (δ) for R&D of 15% and compute R&D stocks as:[3]

$$RD^{stock}_{it} = (1-\delta) \times RD^{stock}_{i,t-1} + RD^{flow}_{it} \tag{2}$$

where the flow variable is a firm's current year R&D expenditure as reported by Compustat. We construct patent stocks based on the same formula (Hall et al., 2005). We further control for the patent citation stock that the firms' patents receive. Descriptive statistics are presented in Table1.

[3] See also Hall (2005) for a discussion on the appropriate depreciation rate for R&D.

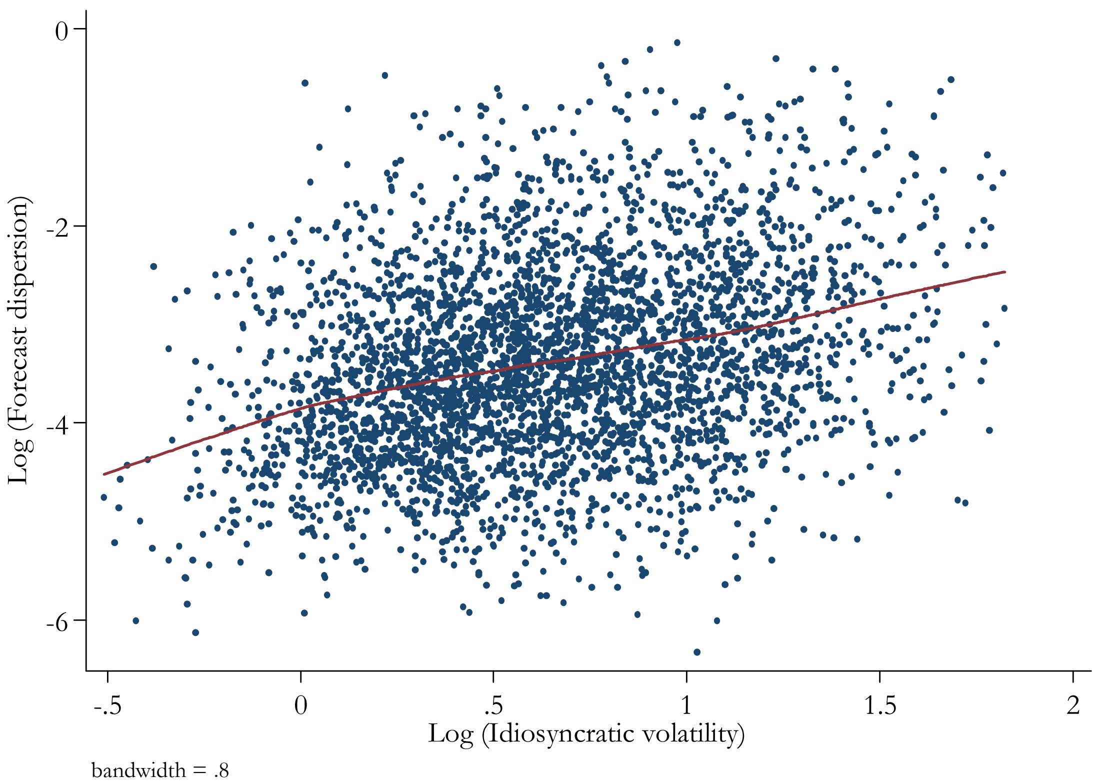
It is also worth noting that the correlation between the measures for forecast dispersion and idiosyncratic risk is low with a correlation coefficient of 0.233. See Figure1 for a graphical illustration.

Table 1: Summary statistics

Variable	Mean	S.D.	Min.	Median	Max.
Idiosyncratic volatility	2.096	0.928	0.602	1.866	6.196
Forecast dispersion	0.058	0.080	0.002	0.032	0.868
Tobin's q	2.480	1.780	0.491	1.909	19.413
Presample mean of Tobin's q	2.402	2.07	0.551	1.788	23.209
R&D stock/Assets	0.241	0.233	0.000	0.166	1.985
Patent stock/R&D stock	3.670	23.304	0.000	0.312	495.647
Citation stock/Patent stock	14.330	9.684	0.000	11.929	65.791

Notes: N = 3,670 firm-year observations. Year and industry dummies are omitted for space reasons.

Figure 1
Log (Idiosyncratic volatility) vs. Log (Forecast dispersion)



3. Empirical model and results

Our empirical analysis is based on the market value approach (e.g. Hall et al., 2005). The market value approach draws from the hedonic price model viewing firms as bundles of assets and capabilities, from plants and equipment to intangible assets such as brand names, good will and knowledge. We start with the standard market value equation with V_{it} denoting Tobin's Q, *A* representing the physical assets and *K* the knowledge assets of firm *i* at time *t*.:

$$V_{it}(A_{it}, K_{it}) = q(A_{it} + \gamma K_{it})^{\sigma} \tag{3}$$

We add volatility of the firms' fundamentals v_{it} and information ambiguity σ_{it}:

$$V_{it}(A_{it}, K_{it}) = q v_{it} \sigma_{it} (A_{it} + \gamma K_{it})^{\sigma} \tag{4}$$

We take the logarithms of equation (4) and estimate the following model:

$$\log q_{it} = lo\,g\frac{V_{it}}{A_{it}} = \log q + [\log(\square)]\ 1 + \gamma\frac{K_{it}}{A_{it}}\Big)^{\square} + \alpha v_{it} + \beta\sigma_{it} + e_{it} \tag{5}$$

In order to test whether information ambiguity has a stronger effect if fundamentals are volatile we incorporate an interaction term of v_{it} and σ_{it} in a second specification.

The results from non-linear least squares (NLLS) regressions and OLS regressions are presented in Table 2. We control for unobserved heterogeneity across firms by including the pre-sample mean of log Tobin's q from a five-year pre-sample period (e.g. Lach and Schankerman, 2008). The results clearly support the theoretical predictions by Epstein and Schneider (2008). First, we find that information ambiguity has a significant negative impact on the firm's market value. Second, we confirm the theoretical prediction that information ambiguity has a stronger negative effect if the underlying fundamentals are volatile which is shown by the significant negative interaction effect of information ambiguity and idiosyncratic volatility. The estimated effects for the innovation parameters are in line with prior literature (e.g. Hall et al., 2005).

Table 2
Uncertainty and the market value of R&D

Dependent variable: Log (Tobin's q)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variable	NLLS	NLLS	NLLS	NLLS	NLLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
R&D stock/Assets	0.737***	0.727***	0.902***	0.896***	0.923***	0.386***	0.388***	0.479***	0.477***	0.489***
	(0.195)	(0.191)	(0.194)	(0.194)	(0.198)	(0.106)	(0.105)	(0.102)	(0.102)	(0.102)
Patent stock/R&D stock	0.002*	0.002*	0.002**	0.002**	0.002*	0.001**	0.001**	0.001**	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Citation stock/Patent stock	0.015***	0.015***	0.014***	0.014***	0.015***	0.008***	0.009***	0.008***	0.008***	0.008***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Log (Idiosyncratic volatility)		-0.190***		-0.031	-0.229**		-0.195***		-0.037	-0.231**
		(0.043)		(0.042)	(0.091)		(0.043)		(0.042)	(0.093)
Log (Forecast dispersion)			-0.152***	-0.148***	-0.104***			-0.152***	-0.148***	-0.105***
			(0.012)	(0.013)	(0.019)			(0.013)	(0.013)	(0.019)
Log (Idiosyncratic volatility)					-0.058**					-0.057**
× Log (Forecast dispersion)					(0.024)					(0.025)
Presample-mean of Tobin's q	0.219***	0.236***	0.230***	0.233***	0.237***	0.228***	0.245***	0.237***	0.240***	0.244***
	(0.040)	(0.037)	(0.035)	(0.034)	(0.034)	(0.041)	(0.038)	(0.035)	(0.035)	(0.035)
Constant	0.368**	0.464***	-0.072	-0.045	0.103	0.417**	0.513***	-0.028	0.005	0.150
	(0.182)	(0.166)	(0.141)	(0.143)	(0.151)	(0.188)	(0.171)	(0.146)	(0.148)	(0.157)
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of observations	3,670	3,670	3,670	3,670	3,670	3,670	3,670	3,670	3,670	3,670
R-Squared	0.434	0.445	0.492	0.493	0.495	0.413	0.425	0.473	0.474	0.475

Notes: ***,**,* indicate statistical significance at the 1%, 5% and 10% level.

7. Conclusions

We provide an empirical test for the predictions made by Epstein and Schneider (2008). Our results confirm that 1. information ambiguity has a negative impact on the firm's market value, 2. that the effect of information ambiguity is stronger if the underlying fundamentals are volatile.

References

Anderson, E.W., Ghysels, E., Juergens, J.L. 2005. Do heterogeneous beliefs matter for asset pricing? The Review of Financial Studies, 18: 875-924.

Ang, A., Hodrick. R.J., Xing, Y., Zhang, X. 2009. High idiosyncratic volatility and low returns: International and further U.S. evidence. Journal of Financial Economics, 2009: 1-23.

Baum, C. F., Caglayan, M., Talavera, O. 2008. Uncertainty determinants of firm investment. Economics Letters, 98: 282-287.

Bloom, N., Van Reenen, J. 2002. Patents, real options and firm performance. The Economic Journal, 112: C97-C116.

Bloom, N., Bond, S., Van Reenen, J. 2007. Uncertainty and investment dynamics. The Review of Economic Studies, 74: 391-415.

Doukas, J.A., Kim, C., Pantzalis, C. 2006. Divergent opinions and the performance of value stocks. Financial Analysts Journal, 60: 55-64.

Diether, K.B., Malloy, C.J., Scherbina, A. 2002. Differences in opinion and the cross section of stock returns. Journal of Finance, 57: 2113-2141.

Epstein, L.G., Schneider, M. 2008. Ambiguity, information quality, and asset pricing. The Journal of Finance, 63: 197-228.

Erickson, M., Wang, S., Zhang, X.F. 2012. The change in information uncertainty and acquirer wealth losses. The Review of Accounting Studies, 17: 913-943.

Fama, E., French, K. 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics, 33(1): 3-56.

Fu, F. 2009. Idisyncratic risk and the cross-section of expected stock returns. Journal of Financial Economics 91: 24-37.

Güntay, L., Hackbarth, D. 2010. Corporate bond credit spreads and forecast dispersion. Journal of Banking & Finance, 34, 2328-2345.

Hall, B.H., Jaffe, A.B., Trajtenberg, M. 2005. Market value and patent citations. The R&D Journal of Economics*,* 36: 16-38.

Johnson, T.C. 2004. Forecast dispersion and the cross section of expected returns. Journal of Finance, 59: 1957-1978.

Lach, S. and M. Schankerman (2008). Incentives and Invention in Universities. *RAND Journal of Economics* 39(2): 403-433.

Zhang, X.F. 2006. Information uncertainty and stock returns. The Journal of Finance, 61: 105–137.