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Does Information Quality Explain Asymmetric Price Reactions?

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Outline



1. Introduction
2. The role of information quality
3. Measuring information and its precision
4. Empirical results
5. Conclusions



General topic: Understanding price discovery in financial markets

- Price adjustment processes to new information
- Efficiency of markets

Focus here: Explaining asymmetric price responses to news

- Intraday market response (here: T-Bond Futures)
to macroeconomic releases (here: US employment report)

Analyzed in detail:

- Direction of price adjustment
– in line with theoretical predictions e.g. Hardouvelis 1988, Edison 1996
- Average magnitude of price changes
– amount of unanticipated information e.g. Fleming/Remolona 1997
– timeliness / importance of news e.g. Hess 2004
- Speed of price adjustment
– almost instantaneously e.g. Fleming/Remolona 1999
- Volatility around announcements
– timing of releases e.g. Bollerslev/Cai/Song 2000
– amount of information e.g. Hautsch/Hess 2002
- Bid-Ask-Spreads, Trading Volume, ... e.g. Balduzzi/Elton/Green 2001



Less analyzed:

- Learning mechanism of market participants
 - Formation of beliefs, adjustment of beliefs
 - Valuation of new information
 - Assessment of information quality

- Asymmetries in the price impact of new information
 - What determines the strength of the price impact?
 - Circumstances under which prices react stronger to a given piece of information



Theoretical explanations for asymmetric price reactions

- Irrational investor behavior: Barberis, Shleifer, Vishny (1998), ...

- Rational expectations: Veronesi (1999)
 - News affects expected cash flow growth rate and risk perception
 - Stock market prices react stronger to bad news in good times
 - Empirical evidence by Cornell/Conrad/Landsman (2002)

- Bayesian Learning Models: Kim/Verrechia (1991), ...
 - Prices react stronger to more precise information
 - Precision of released data relative to precision of prior information
 - May explain asymmetric price reactions in stock and bond markets



Focus of this paper: Asymmetric price reactions in the bond market

- Bayesian learning: prices react stronger to more precise news
- Relative information precision (=quality) acts as a catalyst

Problem:

- Little empirical evidence due to a lack of data regarding the precision of announcements
- Krueger/Fortson (2002):
 - investigate sample enlargement of employment report in the 1980s
 - find no evidence of catalyzing effect on the basis of daily returns

Major contributions:

- Extraction of a release-specific precision measure based on additional detail information in the employment report
- Evidence of a stronger price response to more precise news based on high-frequency data

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2. The Role of Information Quality



Bayesian learning framework assuming (conditional) normality:

Time 1 (pre-announcement):

Traders form beliefs about some fundamental variable X (prior beliefs)

$$g(X) = N(\mu_F, 1/\rho_F)$$

Time 2 (announcement):

A noisy estimate of X is announced: $\mu_A = X + \varepsilon$

$$f(\mu_A | X) = N(X, 1/\rho_A)$$

This new information forces traders to update their beliefs about X (posterior beliefs)

$$g(X | \mu_A) = N(\mu_P, 1/\rho_P)$$

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Traders' mean posterior beliefs

$$\mu_P = (1 - \pi) \cdot \mu_F + \pi \cdot \mu_A$$

with relative precision $\pi = \frac{\rho_A}{\rho_F + \rho_A}$

Shift in mean beliefs:

$$\mu_P - \mu_F = \pi \cdot S$$

with surprise $S = \mu_A - \mu_F$

If prices are
proportional
to conditional
expectations

$$P = \begin{cases} c \cdot \mu_F & \text{in } t = 1 \\ c \cdot \mu_P & t = 2 \end{cases}$$

Then

$$\Delta P = c \cdot \pi \cdot S$$

Precision acts as a catalyst!

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Testable empirical implications arising from $\Delta P = c \cdot \pi \cdot S$

(1) Price changes are driven by unanticipated information (S)

$$\Delta P_\tau = \alpha + \beta \cdot S_\tau + \varepsilon$$

$$H_0 : \beta = 0$$

Urich/Wachtel 1981, Hardouvelis 1988, Cook/Korn 1991, Fleming/Remolona 1999,
Andersen/Bollerslev/Diebold/Vega 2002, Hess 2004, ...

(2) The price response is stronger if the announced information is
perceived to be less precise relative to the pre-announcement
information (i.e. if π is high)

$$\Delta P_\tau = \alpha + \beta^h \cdot D^{\pi \text{ high}} \cdot S_\tau + \beta^l \cdot D^{\pi \text{ low}} \cdot S_\tau + \varepsilon$$

$$H_0 : \beta^h = \beta^l$$

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Information components in the U.S. employment report

- ◇ Two related headline figures, derived from two independent surveys

NF: Nonfarm payrolls

- New jobs outside agricultural sector
- Establishment survey (390 000 est.)



Inflationary pressures arising from a tight labor market

UN: Unemployment rate

- Unemployed / total workforce
- Household survey (50 000 households)



- ◇ Additional detail information

Revisions of previously released NF figures
(disseminated along with headlines)



Precision?

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Measuring the release-specific relative precision

$$\pi_{\tau} = \frac{\rho_{A,\tau}}{\rho_{F,\tau} + \rho_{A,\tau}}$$

- (1) Measure of the (im)precision of pre-announcement information ($1/\rho_{F,\tau}$)

→ Cross-sectional variance of analysts' forecasts $\approx 1/\rho_{F,\tau}$
(median of forecasts $\approx \mu_{F,\tau}$)

- (2) Measure of the (im)precision of the announced information ($1/\rho_{A,\tau}$)

→ BLS sample-error estimates ('average' imprecision, time-invariant)

→ Revisions of previously released figures?

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Release date	Reported total payrolls		Reported	Forecasted	Regression variables	
	preliminary current month	1st revision previous month	change A_{NF}	change F_{NF}	S_{NF}	R_{NF}
April 2, 99	127,678	127,632	46	163	-117	22
May 7, 99	127,911	127,677	234	225	9	-1
June 4, 99	128,167	128,156	11	220	-209	245

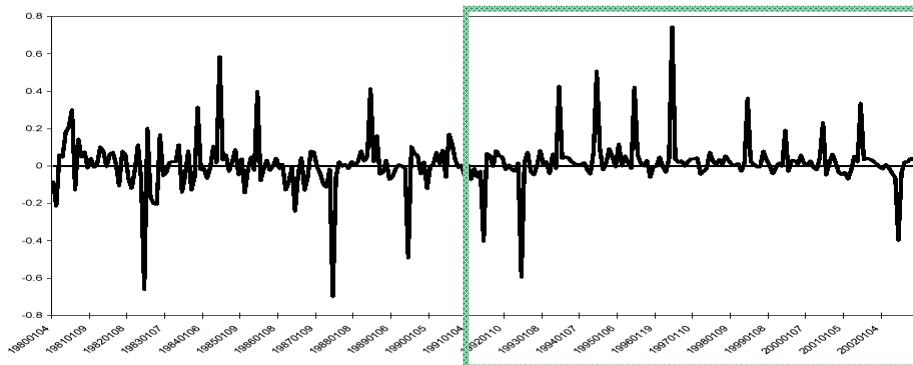
A large revision indicates a large measurement error in the *previous* release

- ⇒ Size of revision proportional to (im)precision of *previous* release
- ⇒ *One-step-ahead forecast* needed to infer precision of *current* release
- ⇒ GARCH model based on currently available history of NF revisions

$$\text{Var} [R_{NF,\tau+1} | R_{NF,\tau}, R_{NF,\tau-1}, R_{NF,\tau-2}, \dots] \approx \rho_{A,\tau}$$



Revisions of Nonfarm Payrolls
(extended sample: 1/1980 – 12/2002)



- Revisions itself not predictable
- But strong seasonality in absolute revisions
- ⇒ GARCH-Model with seasonal components (Flexible Fourier Transforms)

4. Empirical Results



Data:

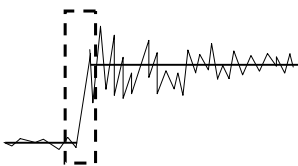
- 12 years sample 1/1991 - 12/2002
- Announcement data:
 - 144 monthly employment announcements (129 without overlap with other releases, 1 inadvertently early released)
 - Surprises measured as deviations of originally announced BLS data from MMS consensus forecasts
- Intraday return data:
 - 2-min log returns of CBOT T-bond futures
 - in 90-min windows around releases (8:22-9:52 EST)
 - concatenated time series: $128 \times 45 = 5760$ observations



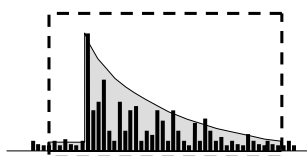
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Estimation Approach:

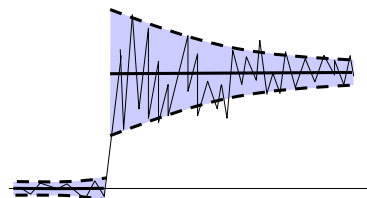
Price effects (1st moment studies)
e.g. Fleming/Remolona 1997



Volatility effects (2nd moments)
e.g. Bollerslev/Cai/Song 2000



Simultaneous modeling
of price and volatility effects
(1st and 2nd moments)
Hautsch/Hess 2002



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Estimation approach:

Intraday AR-ARCH-model with explained heteroskedasticity
(Hautsch/Hess 2002)

$$r_t = \alpha_0 + \sum_{\ell} \alpha_{\ell} r_{t-\ell} + \sum_{\tau=-1, \dots} \sum_i \beta_{i,\tau} S_{i,\tau} \cdot D_{\tau} + \dots + \varepsilon_t, \quad \varepsilon_t \sim N(0, h_t)$$

$$h_t = \gamma_0 + \sum_i \phi_i \varepsilon_{t-i}^2 + \sum_{q=1}^Q \gamma_q \text{FFF}_q + \sum_j \vartheta_j |S_{j,\tau}| + \dots$$

Mean function: captures price shifts due to unanticipated information,
allows for asymmetric price responses

Volatility function: controls for ARCH effects and
seasonal effects (related to the timing of news arrival)

Estimations results: Precision and strength of the price response



$S_{NF,t}$	β_4	-27.155 ***		
$S_{NF,t} \times D_{low}$	β_4^l		-23.171 ***	-23.185 ***
$S_{NF,t} \times D_{high}$	β_4^h		-32.048 ***	-31.783 ***
$S_{NF,t+1}$	β_5	-5.192 **	-4.971 **	
$S_{NF,t+1} \times D_{low}$	β_5^l			-2.086
$S_{NF,t+1} \times D_{high}$	β_5^h			-8.484 ***
$S_{UN,t}$	β_7	8.926 ***	9.082 ***	9.094 ***
R-sq.		0.2370	0.2404	0.2425
LL		-6157.97	-6153.50	-6151.66
AIC		-2.1476	-2.1464	-2.1461
LR test	$H_0 : \beta_4 = -\beta_7$	80.7879 *** (-6 198.36)		
	$H_0 : \beta_4^l = \beta_4^h$		8.9381 *** (-6 157.97)	8.6106 *** (-6 155.96)
	$H_0 : \beta_5^l = \beta_5^h$			3.6828 ** (-6 153.50)

AR(2)-ARCH(3) models, selected coefficient estimates; inference based on QML standard errors.



Estimation Results: Robustness against “bad-news effects” (Veronesi 1999)?

		(1)	(2)	(3)	(4)
$SNF_{i,t}$	β_4	-27.362 ***			
$SNF_{i,t} \times D_{low}$	β_4^l		-22.784 ***		
$SNF_{i,t} \times D_{high}$	β_4^h		-32.789 ***		
$SNF_{i,t} \times D_{good}$	β_4^g			-22.184 ***	
$SNF_{i,t} \times D_{bad}$	β_4^b			-35.764 ***	
$SNF_{i,t} \times D_{low} \times D_{good}$	$\beta_4^{l,g}$				-19.107 ***
$SNF_{i,t} \times D_{high} \times D_{good}$	$\beta_4^{h,g}$				-26.126 ***
$SNF_{i,t} \times D_{low} \times D_{bad}$	$\beta_4^{l,b}$				-29.648 ***
$SNF_{i,t} \times D_{high} \times D_{bad}$	$\beta_4^{h,b}$				-41.487 ***
$H_0: \beta_4^{l,\cdot} = \beta_4^{h,\cdot}$			11.4608 **		10.1299 ***
$H_0: \beta_4^{\cdot,g} = \beta_4^{\cdot,b}$				20.2563 ***	18.9254 ***

Parsimonious AR(2)-ARCH(3) models, selected coefficient estimates; inference based on QML standard errors.

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5. Conclusions



Confirmation of previous studies (efficient markets)

- Immediate price reactions
- Consistent price reactions to good / bad news

Strong empirical evidence in favor of Bayesian Learning

- Relative precision measure explains asymmetric price reactions
- Prices respond stronger to more precise news

Results robust against ‘bad’ news effects

- Prices respond stronger to ‘bad’ news than to ‘good’ news
- But price respond significantly stronger to ‘precise bad’ news than to ‘imprecise bad’ news

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