Belief Dispersion and Order Submission Strategies in the Foreign Exchange Market

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Motivation

- Existing research has documented significant differences in economic agents expectations.
  - ◇ Frankel and Froot (1990), Mankiw, Reis and Wolfers (2003), Swanson (2006)
- Heterogeneity in expectations significantly impacts price dynamics and trading volume.
  - ◇ Shalen (1993), Berger et al. (2008), Jongen et al. (2008), Yan and Xiong (2009)

This paper

- Study the relationship between belief dispersion, information shocks and traders order submission decisions.
  - ◇ Using survey data before announcements, we construct a measure of private belief dispersion and ex-post announcement surprise
  - ◇ Examine the following:

  Q1. How does scheduled announcement arrival affect order submission decisions?

  Q2. How does belief dispersion affect order choice before announcements?

  Q3. Does belief dispersion continue to play a role after announcements? Do traders reactions to the announcement surprise depend on belief dispersion?

This Paper (cont'ed)

- **Q1 How does scheduled announcement affect traders order submission decisions?**
  - ◇ Carlson and Lo (2006)
- **Q2 How does belief dispersion affect order choice before announcements?**
  - ◇ Heterogeneous expectations affect trading volume and price dynamics (Shalen (1993), Berger et al.(2008), Yan and Xiong (2009)) and side of trades (Sarkar and Schwartx (2009)).
  - ◇ This paper examines the effect of heterogeneous beliefs on traders order submission decisions.

This Paper (cont'ed)

- **Q3 Does belief dispersion still play a role after announcements? Do traders react to surprises in the announcement and does the reaction depend on belief dispersion?**
  - ◇ The literature focuses on price discovery (Pasquariello and Vega (2007) and Green (2004)).
  - ◇ This paper examines the role of belief dispersion and public information shocks on order submission decision after announcements.
  - ◇ We examine whether the reaction to public information shocks depends on pre-announcement belief dispersion.

Summary of Findings

Q1. **Do scheduled announcements affect order submission decisions?**

- ◇ Traders are more sensitive to changes in the limit order book.

Q2. **How does belief dispersion affect order choice before announcements?**

- ◇ Traders tend to submit limit orders when belief dispersion is large.
- ◇ Impact of order book variables decreases.

Q3. **Does belief dispersion still have an impact after announcement? Do traders reactions to announcement surprises depend on belief dispersion?**

- ◇ Belief dispersion still influences the order submission decision but its role changes over time.
- ◇ Information shocks play significant role when belief dispersion is large

Overview

1. Market Structure and Data
2. Empirical Model
3. Results
   - ▷ Announcement Days vs Non-announcement Days
   - ▷ Role of belief dispersion before announcements
   - ▷ Role of belief dispersion and information shocks after announcements
4. Conclusion

Data: Limit Order Book

- Canadian dollar-U.S. dollar currency pair from Reuters during 2005.
- No market maker: traders submit limit orders or market orders. The orders remain in the market until matched or canceled
- Dealers observe the 5 most recent transactions and the depth at the best bid and ask quotes.
- Consists of 1,358,614 observations.

Data: Macroeconomic Data

- Forecasts and realizations of macroeconomic news announcements from Bloomberg.
- Belief dispersion is defined as

$$dis_t^k = \sqrt{\frac{\sum_{j=1}^{J}(forecast_{j,t}^k - \overline{forecast_t^k})^2 / \hat{\sigma}^{dis,k}}{J}}$$

where

  - $forecast_{j,t}^k$ is the j-th analyst's forecast for announcement k at time t
  - $\hat{\sigma}^{dis,k}$ sample standard deviation of $(forecast_{j,t}^k - \overline{forecast_t^k})^2$, for $t = 1, 2, \cdots, T$

- Standardized announcement surprise is defined as:

$$S_{kt} = \frac{A_{kt} - E_{kt}}{\hat{\sigma}}$$

where

  - $\diamond$ $A_{kt} =$ actual value of announcement k at time t,
  - $\diamond$ $E_{kt} =$ median of forecasts for announcement k at time t
  - $\diamond$ $\hat{\sigma} =$ sample standard deviation of $A_{kt} - E_{kt}$

Data: Macroeconomic News

CPI (Canada)	Employment Rate (Canada)	GDP (Canada)
Retail Sales (Canada)	Trade Balance (Canada)	Consumer Confidence(US)
CPI(US)	Durable Goods(US)	GDP (US)
Initial Unemployment Claims (US)	ISM index (US)	New Home Sales (US)
Change in Nonfarm Payroll (US)	PPI(US)	Retail Sales (US)

Empirical Model

- Model captures the joint order aggressiveness and order size decisions.
- Order aggressiveness: ordered probit model

$$
\begin{aligned}
I_t \;=\; & 1 \text{ if } -\infty < I_t^* \leq \mu_1 \text{ (limit orders behind the best quote)} \\
& 2 \text{ if } \mu_1 < I_t^* \leq \mu_2 \text{ (limit orders at the best quote)} \\
& 3 \text{ if } \mu_2 < I_t^* \leq \mu_3 \text{ (limit orders improving the best quote)} \\
& 4 \text{ if } \mu_4 < I_t^* \leq \infty \text{ (market order)}
\end{aligned}
$$

- Quantity: censored regression framework

$$
\begin{aligned}
qn_t \;=\; & 1 \text{ if } qn_t^* \leq 1 \\
= \; & qn_t^* \text{ if } qn_t^* > 1
\end{aligned}
$$

Empirical Model

- Simultaneous equations system:

$$\begin{aligned} I_t^* &= \beta_{qn} qn_t^* + \beta_x x_t + \varepsilon_t \\ qn_t^* &= a + b_I I_t^* + b_x x_t + e_t \end{aligned}$$

- Instruments:
  - z_t^I: number of orders submitted behind the best quotes on the same side of the market during the past 5-minute interval.
  - z_t^{qn}: average order size submitted behind the best quotes on the same side of the market during the past 5-minute interval.

Announcement VS Non-Announcement

- We examine the differences in dealers order submission strategies on announcement versus non-announcement days.
- Focus on the half-hour interval before and the half-hour interval after the announcement.
- Estimate:

$$
\begin{aligned}
I_t^* &= D_t^{news} + \beta_{qn} qn_t^* + \beta_{qn}^{news} qn^* D_t^{news} + \beta_x x_t + \beta_x^{news} x_t D_t^{news} + \varepsilon_t \\
qn_t^* &= a + D_t^{news} + b_I I_t^* + b_I^{news} I^* D_t^{news} + b_x x_t + b_x^{news} x_t D_t^{news} + e_t
\end{aligned}
$$

where:

- D_t^{news}: is 1 if there is a news announcement on day t and 0 otherwise.

Announcement VS Non-Announcement: Before Announcement

	I^*		qn^*	
	No news	News	No news	News
$news$		0.007	-0.223***	-0.57
$\hat{qn}^*$	0.144***	-0.027***		
$\hat{I}^*$			0.536***	0.107
$PriceImpact$	-0.034***	-0.029***	0.081***	0.091***
$Dpth^{bst}_{same}$	0.018***	0.024***	0.091***	0.055***
$Dpth^{bhd}_{same}$	-0.102***	-0.081***	0.154***	0.151***
$Dpth^{bst}_{opp}$	-0.050***	-0.027***	0.765***	0.665***
$Dpth^{bhd}_{opp}$	0.028***	0.043***	0.116***	0.080***
$Spread$	-0.006	-0.002	-0.072***	-0.082***
$Volatility$	0.013***	0.022***	-0.033*	0.027

Announcement VS Non-Announcement: After Announcement

	I^*		qn^*	
	No news	News	No news	News
$news$		-0.11*	-0.205***	0.157
$\hat{qn}^*$	0.179***	-0.051***		
$\hat{I}^*$			0.509***	0.048
$PriceImpact$	-0.005	-0.020***	0.021	0.056***
$Dpth^{bst}_{same}$	0.021***	0.023***	0.050***	0.044***
$Dpth^{bhd}_{same}$	-0.101***	-0.087***	0.146***	0.093***
$Dpth^{bst}_{opp}$	-0.064***	-0.017***	0.656***	0.573***
$Dpth^{bhd}_{opp}$	0.031***	0.061***	0.130***	0.128***
$Spread$	-0.013***	-0.010***	-0.064***	-0.002
$Volatility$	0.012***	0.007*	-0.007	0.062***

Role of Belief Dispersion

- Examine how the dispersion of beliefs around the announcement affects traders order submission strategies
- We examine the effects both before and after the announcements.
  - ◇ Does belief dispersion still have an effect after the announcement?
  - ◇ Does the effect change further away from the announcement?
- Estimate:

$$
\begin{aligned}
I_t^* &= \alpha_0 DIS_t + \beta_{qn} qn_t^* + \beta_{qn}^{DIS} qn_t^* DIS_t + \beta_x x_t + \beta_x^{DIS} x_t DIS_t + \varepsilon_t \\
qn_t^* &= a + a_0 DIS_t + b_I I_t^* + b_I^{DIS} I_t^* DIS_t + b_x x_t + b_x^{DIS} x_t DIS_t + e_t
\end{aligned}
$$

Role of Belief Dispersion: Before Announcements

	I^*		qn^*	
	$Variable$	$Variable \times Dis$	$Variable$	$Variable \times Dis$
DIS		-0.018***	-0.067	-0.038
$\hat{qn}^*$	0.155***	-0.018***		
$\hat{I}^*$			0.229	0.099*
$PriceImpact$	0.001	-0.020***	-0.033	0.065***
$Dpth^{bst}_{same}$	0.009	0.007	0.079	0.005
$Dpth^{bhd}_{same}$	-0.218***	0.052***	0.353***	-0.088***
$Dpth^{bst}_{opp}$	-0.064***	0.020***	0.789***	-0.056**
$Dpth^{bhd}_{opp}$	0.095***	-0.014**	0.135*	-0.022
$Spread$	-0.037***	0.014**	0.009	-0.033
$Volatility$	0.088***	-0.017***	-0.12	0.041

Role of Belief Dispersion: After Announcements (3,15min]

	I^*		qn^*	
	$Variable$	$Variable \times Dis$	$Variable$	$Variable \times Dis$
DIS		-0.041**	0.467*	-0.066
$\hat{qn}^*$	0.081***	0.016***		
$\hat{I}^*$			0.026	0.115
$PriceImpact$	0.027	-0.016**	-0.138*	0.071**
$Dpth^{bst}_{same}$	-0.029	0.025***	0.304***	-0.091***
$Dpth^{bhd}_{same}$	-0.125***	0.017***	-0.122	0.078***
$Dpth^{bst}_{opp}$	0.022	-0.015**	1.220***	-0.210***
$Dpth^{bhd}_{opp}$	0.163***	-0.041***	-0.08	0.068***
$Spread$	-0.021	0.007	-0.115*	0.031
$Volatility$	-0.040*	0.016*	0.220**	-0.053

Role of Belief Dispersion: After Announcements (15,30min]

	I^*		qn^*	
	$Variable$	$Variable \times Dis$	$Variable$	$Variable \times Dis$
DIS		-0.041**	-0.306	-0.044
$\hat{qn}^*$	0.077***	0.020***		
$\hat{I}^*$			0.511***	0.067
$PriceImpact$	0.025	-0.025***	0.007	0.042
$Dpth^{bst}_{same}$	-0.003	0.008	0.066	-0.009
$Dpth^{bhd}_{same}$	-0.100***	0.004	0.166**	-0.041
$Dpth^{bst}_{opp}$	0.032*	-0.018***	0.820***	-0.125***
$Dpth^{bhd}_{opp}$	0.092***	-0.006	0.261***	-0.052*
$Spread$	-0.018	-0.003	-0.061	0.04
$Volatility$	0.066**	-0.017*	-0.047	0.026

Do traders reactions to announcement surprises depend on the belief dispersion before the announcement?

- Divide the sample into two sub-samples based on the median dispersion: low dispersion vs. high dispersion.
- Examine how order submission decisions depend on the size of the public information shocks measured by $|SUR|$ in each subsample
- Estimate:

$$
\begin{aligned}
I_t^* &= \alpha_0|SUR|_t + \beta_{qn} qn_t^* + \beta_{qn}^{SUR} qn_t^*|SUR|_t + \beta_x x_t + \beta_x^{SUR} x_t|SUR|_t + \varepsilon_t \\
qn_t^* &= a + a_0|SUR|_t + b_I I_t^* + b_I^{SUR} I_t^*|SUR|_t + b_x x_t + b_x^{SUR} x_t|SUR|_t + e_t
\end{aligned}
$$

Role of Information Shock (3,15min]

	I^*		qn^*	
	$HighDIS$	$LowDIS$	$HighDIS$	$LowDIS$
$\|SUR\|$	-0.023	-0.095***	-0.101	0.789**
$\hat{qn}^* \times \|SUR\|$	-0.020***	0.014		
$\hat{I}^* \times \|SUR\|$			0.260	-0.509*
$PrImp \times \|SUR\|$	0.012*	-0.040	-0.048	0.157
$Dpth^{bst}_{same} \times \|SUR\|$	0.038**	-0.040	-0.132**	0.038
$Dpth^{bhd}_{same} \times \|SUR\|$	-0.029**	0.035	-0.026	-0.354**
$Dpth^{bst}_{opp} \times \|SUR\|$	0.029	0.096	0.466	-0.150
$Dpth^{bhd}_{opp} \times \|SUR\|$	0.070***	0.019	-0.057	-0.138
$Spread \times \|SUR\|$	0.032*	0.018	-0.230***	-0.399***
$Vlty \times \|SUR\|$	0.008	0.053	0.053	-0.289

Role of Information Shock (15,30min]

	I^*		qn^*	
	$HighDIS$	$LowDIS$	$HighDIS$	$LowDIS$
$\lvert SUR\rvert$	-0.012	-0.136***	0.140	-0.014
$\hat{qn}^* \times \lvert SUR\rvert$	-0.002	0.044***		
$\hat{I}^* \times \lvert SUR\rvert$			-0.071	0.126
$PrImp \times \lvert SUR\rvert$	0.017	-0.063*	0.034	0.297**
$Dpth^{bst}_{same} \times \lvert SUR\rvert$	0.028*	-0.010	-0.048	-0.125
$Dpth^{bhd}_{same} \times \lvert SUR\rvert$	0.012	-0.017	0.279***	0.000
$Dpth^{bst}_{opp} \times \lvert SUR\rvert$	0.013	-0.010	-0.159***	-0.659***
$Dpth^{bhd}_{opp} \times \lvert SUR\rvert$	-0.066*	-0.032	0.117	-0.033
$Spread \times \lvert SUR\rvert$	-0.036	-0.066	0.054	-0.014
$Vlty \times \lvert SUR\rvert$	-0.098***	0.065	0.358**	-0.072

Conclusion

- We study the relationship between belief dispersion, information shocks and order submission decisions.
- Traders more sensitive to changes in limit order book around announcements.
- Belief dispersion plays a critical role in order submission decisions. Specifically, traders tend to submit limit orders when belief dispersion is large, and the impact of limit order book variables decreases.
- After announcements, belief dispersion still influences order submission decisions but its role changes over time.
- Information shocks play a significant role when belief dispersion is large.