#### Puzzles in the Tokyo Fixing in the Forex Market: Order Imbalances and Bank Pricing

#### Takatoshi Ito (Columbia University) and Masahiro Yamada (Hitotsubashi University) SWET2016

# What is "Fixing" in the Forex market?

- Bank/Market determines ("fix") a uniform rate for all retail customers for the day, based on the spot transactions at a particular time window
  - Tokyo (Tokyo nakane, 9:55am), 00:55GMT
    - Each bank announces its own fixing rate based on their transaction
  - London (WM/R 4pm fix), 16:00GMT (or 15:00GMT DST)
    - Median of the transaction rate in one minutes window
    - Applicable to all banks
- Provides transparency of the rate determination, ensures equal treatment of retail customers, and reduces currency risk of retail customers
- Well known that transaction volumes soar around the fixing times

# Motivation

- Volume spikes are explicit; what about exchange rate behavior?
- London fix "scandal"
  - Collusion among major banks was found
    - Push the rate up or down depending on imbalances in the market to gain extra profits for banks at the expense of retail customers
- Tokyo fix rumors of mis-pricing (by individual banks)
  - No investigation

#### Why does Fixing matter? Extra profits for banks

 Financial institutions (usually banks) have incentive to manipulate the fixing price. Example:
Fixing rate is



Possibility of predatory trading by banks (Brunnermeier and Pedersen 2005)

### Intraday pattern of deals (case of USD/JPY).



- Four spikes: fixing, option cut, macro announcement, the opening and closing of each major market.
- The Tokyo and London fixings account for roughly 3% of one day trading volume for two minutes.

## **Example: Puzzles in the Tokyo fixing**



# **Major findings**

- Three puzzles for the Tokyo fixing
  - 1. Market prices tend to have "spikes" in the window despite of a high level of liquidity.
  - 2. Order imbalances to buy USDJPY always occur before the fixing.
  - 3. There is a gap between the announced rates and the market prices.
- Unique institutions of the Tokyo fixing may trigger the puzzles above.
  - Each bank has a liberty to announce its own fixing rate.
  - Importers are more likely to use banks for currency exchange than exporters => Excess of demand for USD.

# PUZZLE 1: TOO MANY PRICE SPIKES AT 9:55AM

# Large price shocks and "spikes"

- Large price shocks.
  - "Large" is defined as top and bottom 5% of one second returns.
- Large price shock (including spikes as a jump)



 Spikes = Large price shocks and if more than 80 % of the price change is reversed.



## Other ways to define the spikes



Find extreme observations for these variables.

### Intraday pattern of price spikes (USD/JPY)



- Many spikes occur at macro announcements and NY option cut.
- Spike at the Tokyo fixing is roughly every ten days.

#### **Comparison two fixings: liquidity and trading volume**

London fixing (GMT 14:55:15 – 15:04:45) Tokyo fixing (GMT 00:50:15 – 00:59:45)



## **Regression analysis**

	y = frequency of spikes						
	EUR/JPY	EUR/USD	USD/CHF	USD/JPY			
Tokyo fix							
b0055	-0.0979	-0.00509	-0.16 **	0.157 ***			
	(-1.23)	(-0.04)	(-2.16)	(3.33)			
j0055	0.885 ***	1.24 ***	0.469 ***	1.08 ***			
	(13.3)	(21.3)	(2.86)	(42.5)			
a0055	-0.133 *	0.063	0.0163	0.147 ***			
	(-1.42)	(0.738)	(0.192)	(4.1)			
London fix							
b1500	0.193 **	0.116 ***	0.103	0.116 ***			
	(2.25)	(3.01)	(1.16)	(4.41)			
j1500	0.254 *	-1.13 ***	-0.404 **	-1.01 ***			
	(1.31)	(-9.21)	(-2.31)	(-27.8)			
a1500	0.173 **	0.0613 *	0.138 *	0.136 ***			
	(1.92)	(1.28)	(1.45)	(4.14)			
BA spread	0.629 ***	9.77 ***	0.434 ***	1.29 ***			
	(3.75)	(64.3)	(27.4)	(79)			
depth	-1.32 ***	-0.663 ***	-0.823 ***	-2.11 ***			
	(-27.1)	(-11.3)	(-28.2)	(-45.1)			
quote count	0.609 ***	-0.251 ***	-0.307 ***	-0.113 ***			
	(9.23)	(-30)	(-14.3)	(-12.2)			
constant	-4.49 ***	-3.24 ***	-4.56 ***	-3.76 ***			
	(-186)	(-41.5)	(-279)	(-287)			
# of obs	1279423	1706061	1214228	1674521			
R squared	0.32566	0.43037	0.34424	0.44779			

- Dependent variable: frequency of spikes (minute by minute)
- Independent variables:
  - Dummy variables around events(announcement, option cut, LN/TK fixing)
    - Before 10 minutes
    - Around 1 minute
    - After 10 minutes
  - Controls of transactions and the state of limit order books (results are omitted)
    - Trading volume, size, VWAP
    - Bid and ask spread, depth, quote counts
- Negative binomial regression
- No evidence of frequent spikes at London fixing.
- Possible frequent spikes at Tokyo fixing.
  - $\Rightarrow$  The difference of regulations matters.

# **Regression analysis (Robustness)**

- Hold on/off the controls
- Use different time intervals
- Use a normalization for the count of spikes
  - E.g., Spike/Trade Number
- Use logit regression.
- $\Rightarrow$  The qualitative results are similar.

# PUZZLE 2: EXCESS OF BUYING ORDER IMBALANCES BEFORE THE FIXING

## Asymmetry of order flows (top) and spikes (bottom) (USD/JPY)



- At Tokyo fixing, there are more buying orders than selling.
  - This is only for USD/JPY and EUR/JPY.



 Positive spikes are more likely at Tokyo fixing.

#### Intraday pattern of liquidity: depth (USD/JPY)



- Many Liquidity is provided at the two fixings.
- Less liquidity provision at macro announcement.

#### **Return reversal around Tokyo fixing**

		EUR/JPY	EUR/USD	USD/JPY	
Sample	Interva l (min)	Tokyo Fix	Tokyo Fix	Tokyo Fix	
All	1	-0.00411	-0.0393 *	0.0154 *	
		(0.852)	(0.0738)	(0.0738)	
	5	-0.00594	0.0198	-0.00728	
		(0.787)	(0.367)	(0.367)	
	10	0.00503	0.000179	-0.00421	
		(0.819)	(0.994)	(0.994)	
Friday	1	-0.0376	-0.107 **	0.0525 **	
		(0.446)	(0.0296)	(0.0296)	
	5	-0.0251	-0.000843	0.0515	
		(0.611)	(0.986)	(0.986)	
	10	0.052	-0.0424	0.0473	
		(0.291)	(0.389)	(0.389)	
End-of Month	1	-0.0801	-0.0859	-0.0829	
		(0.438)	(0.405)	(0.405)	
	5	0.0438	0.257 **	0.0196 **	
		(0.672)	(0.0114)	(0.0114)	
	10	0.027	0.0342	0.0538	
		(0.794)	(0.741)	(0.741)	

- Return reversal is reported in London fixing (Evans 2015).
- Overall, the return reversal is moderate around Tokyo fixing.
- But... (next slide)

#### Long and Short around Tokyo fixing



- Hold a long position for 5-min before GMT time X, liquidate at GMT X, and then hold a short for 5-min after GMT X.
- The average return takes the maximum, 1.7bp, at GMT00:55 (Tokyo fixing).
- (This inefficiency began to diminish after 2014.)

# PUZZLE 3: GAPS BETWEEN THE ANNOUNCED RATES AND THE MARKET PRICES

# Market rate and the fixing rate: Are they the same? WM/R fixing case

WM/R fix - EBS median market rate

	mean	median	std	skew	kurt	q1	q99	Lowest day	2nd lowest	2nd highest	Highest day
AUD/USD	0.379	0.506	1.83	-0.154	11.6	-5.42	5.34	20090109	20081024	20081124	20081231
EUR/GBP	0.227	0.24	1.7	0.183	6.74	-4.73	5.55	20090123	20081216	20090713	20081006
EUR/JPY	0.489	0.399	1.52	0.413	7.27	-3.53	5.22	20000731	20111130	20081231	20101231
EUR/USD	0.29	0.319	2.62	1.89	58.4	-7.84	9.59	20050720	20050629	20050722	20050603
GBP/USD	0.159	0.207	1.48	0.342	10	-4.22	4.28	20080930	20090309	20091030	20090130
USD/CAD	0.399	0.468	1.92	0.488	6.87	-4.62	6.17	20071129	20090120	20100531	20081029
USD/CHF	0.131	0	0.976	-0.0401	5.83	-2.4	2.64	20110801	20110712	20081127	20130211
USD/JPY	0.143	0.406	2.31	-2.18	51	-8.17	6.15	20050603	20030418	20050831	20050429

The figures are in basis point.

• WM/R fixing rate and the market rates are closer than 0.5 basis point (or the bid and ask spread)

#### Market rate and the fixing rate: Tokyo fixing bias



- At Tokyo fixing, the fixing rates (of each banks) were different from the market rate.
  - Here, the market rate is calculated from the MAX(top) or MEDIAN(bottom) of the transaction prices during the one-minute window around 9:55am.
- This bias had been present before 2008 for both banks (Mizuho and UFJ).
- The direction of bias is consistent with the demand.
  - In Tokyo fixing there are more buying orders than selling.

# The level of the gaps can be explained by the US-Japan interest rate differentials



# **Regression analysis: Tokyo fixing bias**

$y_{day} = log(Fix_{day}) - log(P_{day})$ , independent variables are from the observation 9:00 to 9:54 (before fixing)					
	Mizuho, USD/JPY	UFJ, USD/JPY			
Volatility (before) (before)	-0.474 ***	-0.558 ***			
	[-5.77]	[-6.88]			
OIB (before)	3.96e-08	7.19e-08 ***			
	[1.24]	[2.34]			
Return (before)	0.00841 ***	0.00593 **			
	[2.43]	[2.1]			
Price - VWAP	0.0459 ***	0.065 ***			
	[3.8]	[6.07]			
Lag(1) of y	0.0568 ***	0.101 ***			
	[2.91]	[5.34]			
5th and 10th days	1.73e-05 **	5.17e-05 ***			
	[1.96]	[5.85]			
Friday	6.68e-05 ***	8.9e-05 ***			
	[6.76]	[9.63]			
End of Month	-1.24e-05	5.28e-05 ***			
	[-0.58]	[2.67]			
US FF rate – Call rate	6.8e-05 ***	7.59e-05 ***			
	[28.8]	[29.6]			
Constant	4.5e-05 ***	-1.4e-05			
	[3.76]	[-1.21]			
# of observation	2846	2846			
Adjusted R squared	0.3675	0.466			

- The bias is related to the order imbalance before the fixing. Potentially this indicates the "prehedging".
- The bias is also related to the particular day of the month when the needs for currency is high.

## **Comparing Tokyo fixing with London fixing**

- Tokyo fixing occurs at 9:55am.
  - At the early time of the trading day.
  - Banks provide the fixing rate after 10am. i.e., Clients can trade at the posted rates anytime. -> banks are exposed to risk of unbalanced orders
  - Each bank can provide a different rate (but should be based on the market rate) within the range that they made transactions.
  - Mutual funds barely use the Tokyo fix.
- London fixing occurs at 4pm.
  - At the end of each trading day (for London).
  - Clients agree to trade at the future rate.
  - WM/Reuters provides the common rate for all banks.
  - Mutual funds use the London fix at the end of month (Melvin 2014)

# Tokyo fixing: economic background

- The orders tend to be biased toward buying foreign currency (USD and EUR) rather than domestic currency (JPY).
  - This is because large importers (such as power and trade firms) transact FX with banks at the fix, but exporters (such as automobile and electric appliance firms) diversify the transaction time by themselves.

- Besides, importers cares less about the fixing rate.

# Conclusion

- The behavior of order flows and prices around the Tokyo fixing is very strange.
  - 1. There are many extreme transitory price shocks (or spikes) despite of the high level of liquidity.
  - 2. There are more orders of buying USD than selling. The price shows predictable patterns.
  - 3. There are gaps between the announced rate and market prices.

These puzzles can result from the unique institution of the Tokyo fixing; each bank can set their own rates. Banks may intend to trade at the extreme price and hedge the risk of offering the fixing prices.

### **Appendix: Forex Intraday Time Schedule**

	Winter time			Sumn	ner time			
GMT	LN	EST	JST	LN	EDT	JST	EVENT	Major Announcements
0:00	0:00	19:00	9:00	1:00	20:00	9:00	Tokyo open	
							Tokyo Fixing	
1:00	1:00	20:00	10:00	2:00	21:00	10:00	(9:55)	Australia: statistics (GMT1:30)
2:00	2:00	21:00	11:00	3:00	22:00	11:00		
3:00	3:00	22:00	12:00	4:00	23:00	12:00		Japan: monetary policy announcement
4:00	4:00	23:00	13:00	5:00	0:00	13:00		RBA policy rate (GMT4:30)
5:00	5:00	0:00	14:00	6:00	1:00	14:00		
6:00	6:00	1:00	15:00	7:00	2:00	15:00	Tokyo option cut	
7:00	7:00	2:00	16:00	8:00	3:00	16:00		Switzerland: policy rate and statistics
8:00	8:00	3:00	17:00	9:00	4:00	17:00	London open	
9:00	9:00	4:00	18:00	10:00	5:00	18:00		U.K.: statistics (BST10:30)
10:00	10:00	5:00	19:00	11:00	6:00	19:00		
11:00	11:00	6:00	20:00	12:00	7:00	20:00		
								U.K.: policy rate, ECB policy rate (GMT
12:00	12:00	7:00	21:00	13:00	8:00	21:00		12:45)
								U.S. (EDT8:30) and Canada (GMT12:00
13:00	13:00	8:00	22:00	14:00	9:00	22:00	NY open	and 12:30) statistics
14:00	14:00	9:00	23:00	15:00	10:00	23:00	NY Option cut	Canada: policy rate (GMT 14:00)
15:00	15:00	10:00	0:00	16:00	11:00	0:00	London Fixing	
16:00	16:00	11:00	1:00	17:00	12:00	1:00		
17:00	17:00	12:00	2:00	18:00	13:00	2:00		
								FOMC policy announcement (EDT 14:00
18:00	18:00	13:00	3:00	19:00	14:00	3:00		or 14:15)
19:00	19:00	14:00	4:00	20:00	15:00	4:00		
20:00	20:00	15:00	5:00	21:00	16:00	5:00	NY Close	
21:00	21:00	16:00	6:00	22:00	17:00	6:00		
22:00	22:00	17:00	7:00	23:00	18:00	7:00		
23:00	23:00	18:00	8:00	0:00	19:00	8:00		Japan: statistics (JST 8:30 and 8:50)

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