Examining Transaction Costs in LME Metals

Marex Spectron & Deltix Joint Research Project

Introduction

Our study examines the risk/reward trade-off of various execution methods in the six major LME metals; Aluminium (AHD3M, LMAHDS03 Comdty), Copper (CAD3M, LMCADS03 Comdty), Nickel (NID3M, LMNIDS03 Comdty), Lead (PBD3M, LMPBDS03 Comdty), Tin (SND3M, LMSNDS03 Comdty) and Zinc (ZSD3M, LMZSDS03 Comdty).

Using midprice at point of entry as our benchmark, this report looks at whether increasing passivity in execution can improve overall transaction cost versus a market order.

We find that increasing our time spent on the passive side of the order book does indeed improve transaction cost, but at the expense of increased variance in said transaction cost. For some metals, due to their wider spread, changing the reference point for passivity can better alleviate this variance whilst maintaining an overall improvement in transaction cost.

Methodology

Marex Spectron has provided LME tick data in the six metals for the period March 1, 2016 to May 13, 2016 inclusive. Marex Spectron also provided volume profile data for each of the metals in question.

The Deltix Product Suite was used for conducting the research and Marex and Deltix's research teams worked closely together during the project. The market and volume profile data were loaded into Deltix's TimeBase and a set of execution strategies were implemented and back-tested on market depth data in Deltix's QuantOffice research and back-testing product.

In order to avoid trying to calculate the potential market impact of any execution, we used an order size of one lot in each metal. We performed 2,158 executions per day (split evenly between buy order and sell orders). Five different execution methods were used, as detailed in Table 1.

Table 1: Execution Methods

Execution Method	Explanation
Market	Places a market order on execution. We assume the order is filled immediately.
Limit-Primary	Places a limit order at the primary price level (bid for buy orders, offer for sell orders). If this order is not filled after 10 seconds, replaces the limit order with a market order. We use FIFO methodology for the order queue.
Limit-Midprice	Places a limit order at the midprice of the bid and offer, rounding down for buys and up for sells. We assume that our order is the first at that price level. Again, if the order is not filled after 10 seconds, we replace the limit order with a market order.
Pegged-Primary	Places a limit order at the primary price level and replaces on bid/offer updates. If the order is not filled over various time scales (from 1 second to 1 hour), it is replaced by a market order.
Pegged-Midprice	Places a limit order at the midprice and replaces on bid/offer updates. Again, if the order is not filled over various time scales (from 1 second to 1 hour), it is replaced by a market order.

When executing orders, we made the following further assumptions:

- Each execution is independent and there is no mutual impact.
- Midprice orders, whilst updating the order book, do not change market participants' behaviour.
- Executions were weighted according to 22-day volume profiles.
- There was hidden liquidity present in the market.

To calculate hidden liquidity in the market we used the empirical probability discovered when comparing trade execution prices to the current bid and offer. If the execution price was inside the bid-offer spread, we assumed the execution was executed against a hidden order. The ratio of these hidden executions to total executions gave us a conservative estimate of the probability (ρ) of an order matching against intra-spread hidden liquidity. When executing a market order, we assumed a one tick improvement against the aggressive side of the order book with probability of ρ. For a table of intra-spread execution probabilities please see the appendix.

We then examined the following statistics;

1. **Transaction Cost.** The difference between the executed price of our order and the midprice of the market at the original submission time. We measure this in USD ($) and ticks. The USD value is then multiplied by the contract size to give the overall transaction cost of execution.
2. **Standard Deviation of Transaction Cost.** Sample unbiased standard deviation of the transaction cost.
3. **Average Time to Fill.** The mean time between order submission and fill.
4. **Limit Order Fill %.** For non-market orders, the percentage of orders that are filled as a limit order, without being converted to a market order.

Results

In this section, you will find scatter graphs and data tables for each of the metals we have examined. Each graph plots transaction cost (in USD) against standard deviation of transaction cost (in USD) for each execution strategy per metal. The data tables provide the raw data behind these graphs, along with the calculated statistics.

Summary of results achieved:

(1) Across all evaluated strategies, the **Market** execution method has the highest expected transaction cost and the lowest risk associated with it.
(2) When using peg intervals of short duration (up to 30-60 seconds depending on the market), the **Pegged-Midprice** execution method provides both lower expected transaction costs and risk compared to the **Pegged-Primary** execution method.
(3) Only **Pegged-Primary** (and not **Pegged-Midprice**) demonstrates steady improvement of the transaction cost when using peg intervals of longer duration (above 60 seconds). However, this improvement comes at the cost of additional risk.

Figure 1: Aluminium Scatter Plot. Source: Marex, Deltix, LME

Figure 2: Copper Scatter Plot. Source: Marex, Deltix, LME

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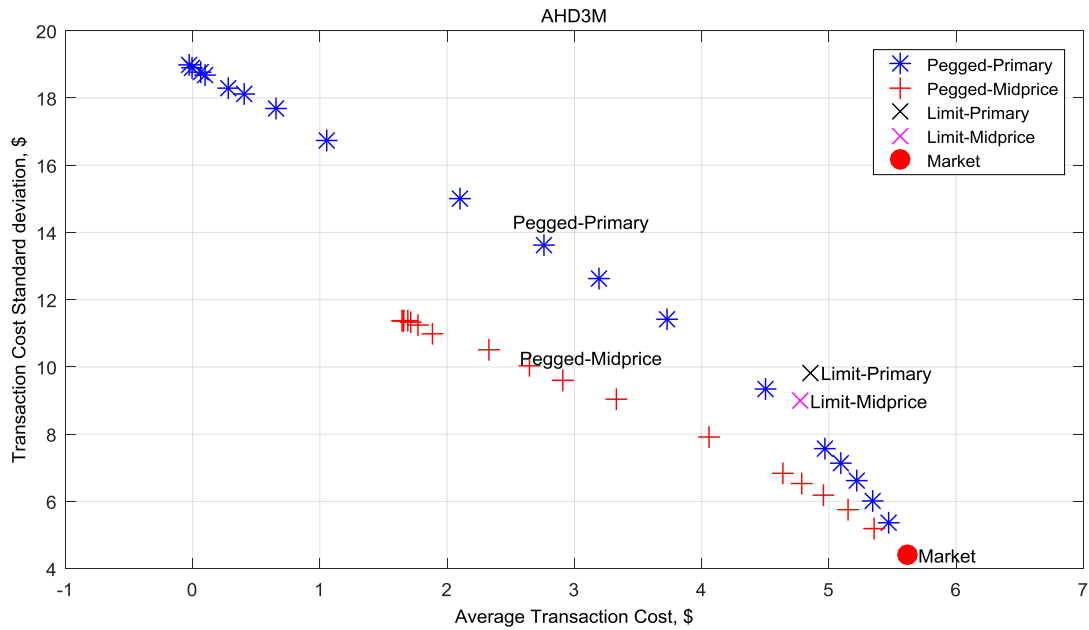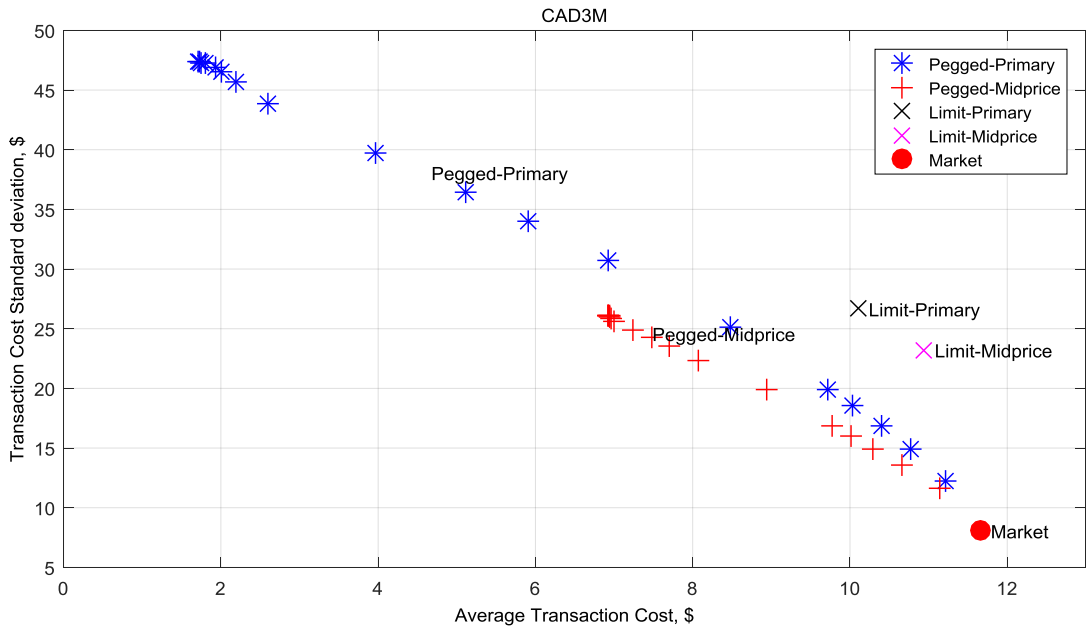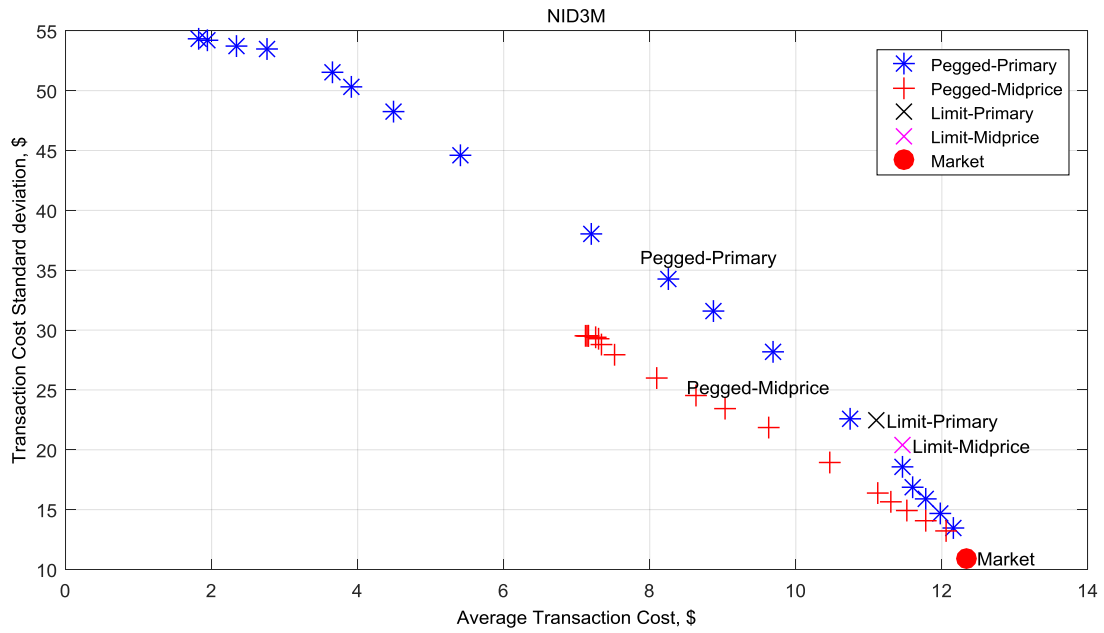**Figure 3: Nickel Scatter Plot. Source: Marex, Deltix, LME**

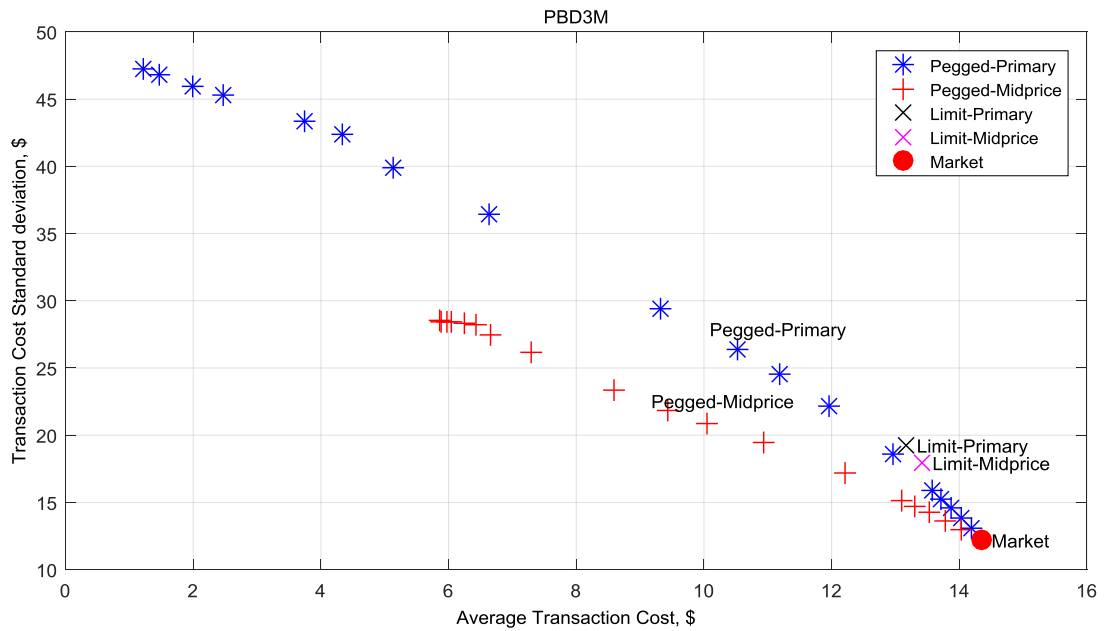**Figure 4: Lead Scatter Plot. Source: Marex, Deltix, LME**
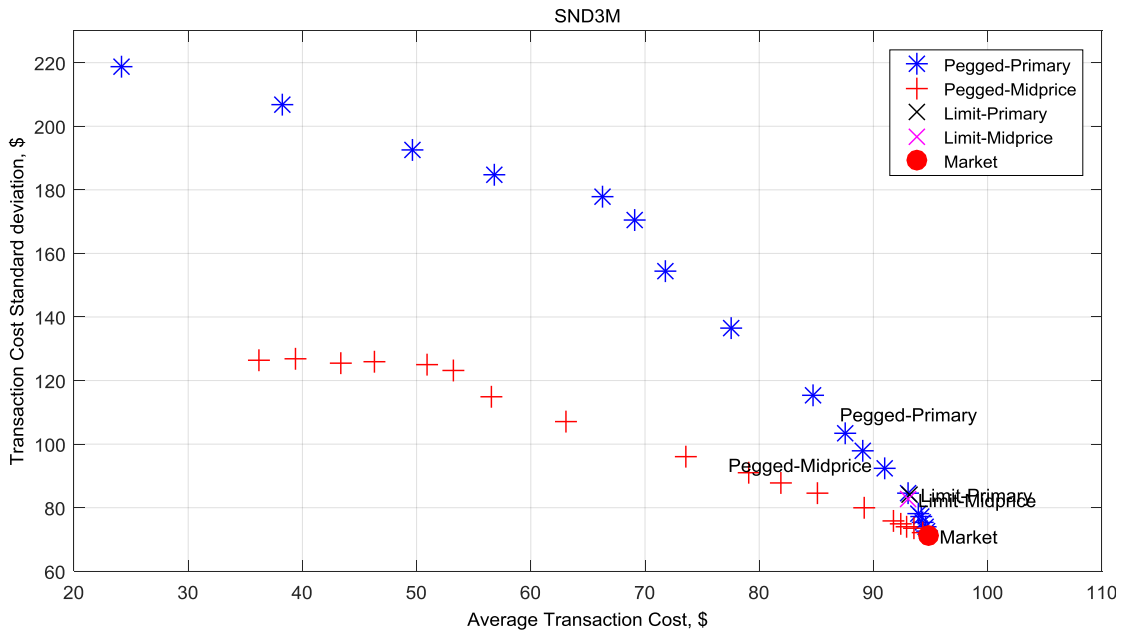
Figure 5: Tin Scatter Plot. Source: Marex, Deltix, LME
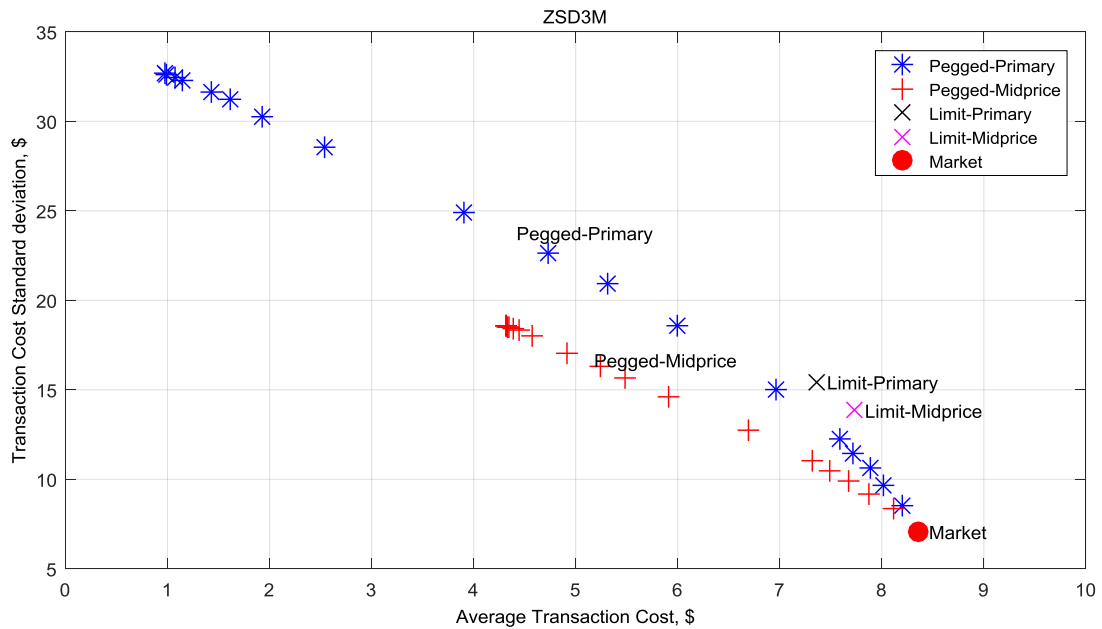

Figure 6: Zinc Scatter Plot. Source: Marex, Deltix, LME

Table 2: Aluminium Data. Source: Marex, Deltix, LME

Execution Strategy	Limit Active Time	Average Transaction Cost	Standard Deviation of TC ($)	Average Time to Fill	Limit Order Fill %
		Aluminium			
Market	00:00:00	$5.62	$4.40	00:00:00	0.00%
Pegged-Primary	00:00:01	$5.47	$5.35	00:00:01	2.28%
Pegged-Midprice	00:00:01	$5.36	$5.21	00:00:01	5.35%
Pegged-Primary	00:00:02	$5.34	$6.03	00:00:02	4.41%
Pegged-Midprice	00:00:02	$5.16	$5.74	00:00:02	9.98%
Pegged-Primary	00:00:03	$5.22	$6.63	00:00:03	6.52%
Pegged-Midprice	00:00:03	$4.96	$6.17	00:00:03	14.25%
Pegged-Primary	00:00:04	$5.09	$7.13	00:00:04	8.58%
Pegged-Midprice	00:00:04	$4.78	$6.53	00:00:04	18.15%
Pegged-Primary	00:00:05	$4.97	$7.59	00:00:05	10.45%
Pegged-Midprice	00:00:05	$4.64	$6.83	00:00:04	21.68%
Pegged-Primary	00:00:10	$4.50	$9.32	00:00:09	18.87%
Pegged-Midprice	00:00:10	$4.06	$7.90	00:00:08	35.66%
Limit-Primary	00:00:10	$4.85	$9.83	00:00:09	17.66%
Limit-Midprice	00:00:10	$4.77	$8.99	00:00:09	27.04%
Pegged-Primary	00:00:20	$3.73	$11.40	00:00:16	32.08%
Pegged-Midprice	00:00:20	$3.33	$9.02	00:00:13	53.76%
Pegged-Primary	00:00:30	$3.19	$12.64	00:00:23	42.03%
Pegged-Midprice	00:00:30	$2.91	$9.61	00:00:18	64.74%
Pegged-Primary	00:00:40	$2.76	$13.63	00:00:28	49.74%
Pegged-Midprice	00:00:40	$2.65	$10.04	00:00:21	72.27%
Pegged-Primary	00:01:00	$2.10	$15.02	00:00:37	61.19%
Pegged-Midprice	00:01:00	$2.33	$10.52	00:00:25	81.65%
Pegged-Primary	00:02:00	$1.06	$16.74	00:00:53	79.95%
Pegged-Midprice	00:02:00	$1.89	$10.98	00:00:32	93.28%
Pegged-Primary	00:03:00	$0.66	$17.70	00:01:03	88.85%
Pegged-Midprice	00:03:00	$1.77	$11.24	00:00:35	97.08%
Pegged-Primary	00:04:00	$0.41	$18.11	00:01:08	93.39%
Pegged-Midprice	00:04:00	$1.71	$11.32	00:00:36	98.57%
Pegged-Primary	00:05:00	$0.28	$18.29	00:01:11	95.40%
Pegged-Midprice	00:05:00	$1.69	$11.36	00:00:36	99.16%
Pegged-Primary	00:10:00	$0.10	$18.66	00:01:19	98.33%
Pegged-Midprice	00:10:00	$1.66	$11.38	00:00:38	99.76%
Pegged-Primary	00:15:00	$0.06	$18.79	00:01:23	98.97%
Pegged-Midprice	00:15:00	$1.66	$11.38	00:00:38	99.86%
Pegged-Primary	00:30:00	$0.00	$18.91	00:01:29	99.52%
Pegged-Midprice	00:30:00	$1.65	$11.39	00:00:39	99.95%
Pegged-Primary	01:00:00	-$0.03	$18.99	00:01:32	99.82%
Pegged-Midprice	01:00:00	$1.65	$11.39	00:00:40	99.98%

Table 3: Copper Data. Source: Marex, Deltix, LME

			Copper		
Execution Strategy	Limit Active Time	Average Transaction Cost	Standard Deviation of TC ($)	Average Time to Fill	Limit Order Fill %
Market	00:00:00	$11.66	$8.06	00:00:00	0.00%
Pegged-Primary	00:00:01	$11.22	$12.29	00:00:01	3.83%
Pegged-Midprice	00:00:01	$11.14	$11.63	00:00:01	10.57%
Pegged-Primary	00:00:02	$10.77	$14.90	00:00:02	7.61%
Pegged-Midprice	00:00:02	$10.66	$13.54	00:00:02	19.32%
Pegged-Primary	00:00:03	$10.41	$16.90	00:00:03	11.00%
Pegged-Midprice	00:00:03	$10.30	$14.93	00:00:03	26.47%
Pegged-Primary	00:00:04	$10.03	$18.51	00:00:04	14.10%
Pegged-Midprice	00:00:04	$10.01	$16.02	00:00:03	32.24%
Pegged-Primary	00:00:05	$9.73	$19.94	00:00:05	17.00%
Pegged-Midprice	00:00:05	$9.77	$16.91	00:00:04	37.39%
Pegged-Primary	00:00:10	$8.47	$25.15	00:00:08	28.81%
Pegged-Midprice	00:00:10	$8.93	$19.87	00:00:07	55.43%
Limit-Primary	00:00:10	$10.10	$26.66	00:00:08	28.58%
Limit-Midprice	00:00:10	$10.94	$23.22	00:00:07	44.00%
Pegged-Primary	00:00:20	$6.93	$30.68	00:00:15	44.74%
Pegged-Midprice	00:00:20	$8.07	$22.37	00:00:10	73.82%
Pegged-Primary	00:00:30	$5.91	$34.02	00:00:20	55.36%
Pegged-Midprice	00:00:30	$7.70	$23.59	00:00:12	82.84%
Pegged-Primary	00:00:40	$5.12	$36.38	00:00:24	63.10%
Pegged-Midprice	00:00:40	$7.47	$24.24	00:00:14	87.97%
Pegged-Primary	00:01:00	$3.97	$39.76	00:00:30	73.87%
Pegged-Midprice	00:01:00	$7.24	$24.93	00:00:15	93.48%
Pegged-Primary	00:02:00	$2.61	$43.91	00:00:41	88.86%
Pegged-Midprice	00:02:00	$7.00	$25.57	00:00:17	98.29%
Pegged-Primary	00:03:00	$2.19	$45.64	00:00:46	94.39%
Pegged-Midprice	00:03:00	$6.95	$25.91	00:00:18	99.35%
Pegged-Primary	00:04:00	$2.01	$46.52	00:00:47	97.04%
Pegged-Midprice	00:04:00	$6.94	$26.01	00:00:18	99.68%
Pegged-Primary	00:05:00	$1.94	$46.84	00:00:48	98.10%
Pegged-Midprice	00:05:00	$6.94	$26.07	00:00:19	99.81%
Pegged-Primary	00:10:00	$1.79	$47.23	00:00:52	99.32%
Pegged-Midprice	00:10:00	$6.93	$26.07	00:00:19	99.95%
Pegged-Primary	00:15:00	$1.75	$47.29	00:00:53	99.62%
Pegged-Midprice	00:15:00	$6.93	$26.08	00:00:19	99.97%
Pegged-Primary	00:30:00	$1.73	$47.37	00:00:54	99.85%
Pegged-Midprice	00:30:00	$6.93	$26.09	00:00:19	99.99%
Pegged-Primary	01:00:00	$1.72	$47.37	00:00:55	99.91%
Pegged-Midprice	01:00:00	$6.93	$26.08	00:00:19	100.00%

Table 4: Nickel Data. Source: Marex, Deltix, LME

			Nickel		
Execution Strategy	Limit Active Time	Average Transaction Cost	Standard Deviation of TC ($)	Average Time to Fill	Limit Order Fill %
Market	00:00:00	$12.34	$10.97	00:00:00	0.00%
Pegged-Primary	00:00:01	$12.17	$13.48	00:00:01	1.58%
Pegged-Midprice	00:00:01	$12.05	$13.22	00:00:01	4.63%
Pegged-Primary	00:00:02	$11.97	$14.68	00:00:02	3.15%
Pegged-Midprice	00:00:02	$11.78	$14.06	00:00:02	8.78%
Pegged-Primary	00:00:03	$11.79	$15.85	00:00:03	4.61%
Pegged-Midprice	00:00:03	$11.53	$14.91	00:00:03	12.50%
Pegged-Primary	00:00:04	$11.60	$16.90	00:00:04	6.04%
Pegged-Midprice	00:00:04	$11.30	$15.70	00:00:04	15.86%
Pegged-Primary	00:00:05	$11.46	$18.51	00:00:05	7.38%
Pegged-Midprice	00:00:05	$11.13	$16.37	00:00:04	19.00%
Pegged-Primary	00:00:10	$10.75	$22.58	00:00:09	13.64%
Pegged-Midprice	00:00:10	$10.46	$18.91	00:00:08	31.46%
Limit-Primary	00:00:10	$11.10	$22.46	00:00:09	13.64%
Limit-Midprice	00:00:10	$11.45	$20.36	00:00:09	23.55%
Pegged-Primary	00:00:20	$9.69	$28.12	00:00:17	23.64%
Pegged-Midprice	00:00:20	$9.64	$21.80	00:00:14	47.91%
Pegged-Primary	00:00:30	$8.87	$31.64	00:00:25	31.60%
Pegged-Midprice	00:00:30	$9.03	$23.44	00:00:19	58.76%
Pegged-Primary	00:00:40	$8.25	$34.31	00:00:31	38.02%
Pegged-Midprice	00:00:40	$8.63	$24.57	00:00:23	66.50%
Pegged-Primary	00:01:00	$7.20	$37.97	00:00:42	48.06%
Pegged-Midprice	00:01:00	$8.09	$25.98	00:00:28	76.65%
Pegged-Primary	00:02:00	$5.41	$44.65	00:01:07	66.83%
Pegged-Midprice	00:02:00	$7.52	$27.94	00:00:38	90.08%
Pegged-Primary	00:03:00	$4.50	$48.20	00:01:24	77.29%
Pegged-Midprice	00:03:00	$7.35	$28.74	00:00:42	95.10%
Pegged-Primary	00:04:00	$3.91	$50.33	00:01:35	84.24%
Pegged-Midprice	00:04:00	$7.30	$29.31	00:00:44	97.44%
Pegged-Primary	00:05:00	$3.66	$51.50	00:01:43	88.15%
Pegged-Midprice	00:05:00	$7.26	$29.39	00:00:45	98.40%
Pegged-Primary	00:10:00	$2.76	$53.42	00:02:06	94.99%
Pegged-Midprice	00:10:00	$7.16	$29.48	00:00:47	99.54%
Pegged-Primary	00:15:00	$2.34	$53.71	00:02:16	97.39%
Pegged-Midprice	00:15:00	$7.16	$29.52	00:00:49	99.76%
Pegged-Primary	00:30:00	$1.95	$54.27	00:02:30	99.07%
Pegged-Midprice	00:30:00	$7.14	$29.49	00:00:49	99.89%
Pegged-Primary	01:00:00	$1.83	$54.38	00:02:37	99.64%
Pegged-Midprice	01:00:00	$7.13	$29.49	00:00:51	99.95%

Table 5: Lead Data. Source: Marex, Deltix, LME

		Lead			
Execution Strategy	Limit Active Time	Average Transaction Cost	Standard Deviation of TC ($)	Average Time to Fill	Limit Order Fill %
Market	00:00:00	$14.34	$12.20	00:00:00	0.00%
Pegged-Primary	00:00:01	$14.19	$13.06	00:00:01	1.13%
Pegged-Midprice	00:00:01	$14.04	$12.98	00:00:01	3.14%
Pegged-Primary	00:00:02	$14.03	$13.86	00:00:02	2.25%
Pegged-Midprice	00:00:02	$13.78	$13.64	00:00:02	6.03%
Pegged-Primary	00:00:03	$13.86	$14.64	00:00:03	3.36%
Pegged-Midprice	00:00:03	$13.53	$14.26	00:00:03	8.72%
Pegged-Primary	00:00:04	$13.72	$15.27	00:00:04	4.43%
Pegged-Midprice	00:00:04	$13.30	$14.74	00:00:04	11.23%
Pegged-Primary	00:00:05	$13.58	$15.88	00:00:05	5.39%
Pegged-Midprice	00:00:05	$13.09	$15.18	00:00:05	13.46%
Pegged-Primary	00:00:10	$12.95	$18.60	00:00:09	10.03%
Pegged-Midprice	00:00:10	$12.22	$17.14	00:00:09	23.22%
Limit-Primary	00:00:10	$13.17	$19.26	00:00:10	9.54%
Limit-Midprice	00:00:10	$13.42	$17.96	00:00:09	16.35%
Pegged-Primary	00:00:20	$11.97	$22.13	00:00:18	17.44%
Pegged-Midprice	00:00:20	$10.93	$19.44	00:00:16	37.49%
Pegged-Primary	00:00:30	$11.18	$24.57	00:00:26	23.63%
Pegged-Midprice	00:00:30	$10.05	$20.81	00:00:22	47.65%
Pegged-Primary	00:00:40	$10.53	$26.43	00:00:33	29.08%
Pegged-Midprice	00:00:40	$9.43	$21.80	00:00:26	55.23%
Pegged-Primary	00:01:00	$9.32	$29.41	00:00:47	38.16%
Pegged-Midprice	00:01:00	$8.59	$23.34	00:00:34	65.95%
Pegged-Primary	00:02:00	$6.63	$36.44	00:01:17	58.39%
Pegged-Midprice	00:02:00	$7.30	$26.16	00:00:48	83.68%
Pegged-Primary	00:03:00	$5.13	$39.86	00:01:38	70.66%
Pegged-Midprice	00:03:00	$6.65	$27.45	00:00:56	91.39%
Pegged-Primary	00:04:00	$4.35	$42.35	00:01:53	79.09%
Pegged-Midprice	00:04:00	$6.43	$28.23	00:00:59	95.24%
Pegged-Primary	00:05:00	$3.75	$43.30	00:02:04	83.61%
Pegged-Midprice	00:05:00	$6.25	$28.30	00:01:02	96.89%
Pegged-Primary	00:10:00	$2.47	$45.28	00:02:38	92.15%
Pegged-Midprice	00:10:00	$6.04	$28.44	00:01:07	98.86%
Pegged-Primary	00:15:00	$2.00	$45.99	00:02:55	95.35%
Pegged-Midprice	00:15:00	$5.97	$28.48	00:01:09	99.41%
Pegged-Primary	00:30:00	$1.47	$46.76	00:03:18	98.17%
Pegged-Midprice	00:30:00	$5.88	$28.46	00:01:12	99.76%
Pegged-Primary	01:00:00	$1.22	$47.28	00:03:36	99.15%
Pegged-Midprice	01:00:00	$5.85	$28.53	00:01:15	99.90%

Table 6: Tin Data. Source: Marex, Deltix, LME

		Tin			
Execution Strategy	Limit Active Time	Average Transaction Cost	Standard Deviation of TC ($)	Average Time to Fill	Limit Order Fill %
Market	00:00:00	$94.86	$71.09	00:00:00	0.00%
Pegged-Primary	00:00:01	$94.75	$72.74	00:00:01	0.23%
Pegged-Midprice	00:00:01	$94.27	$72.32	00:00:01	0.84%
Pegged-Primary	00:00:02	$94.51	$74.22	00:00:02	0.44%
Pegged-Midprice	00:00:02	$93.57	$73.34	00:00:02	1.67%
Pegged-Primary	00:00:03	$94.36	$75.59	00:00:03	0.66%
Pegged-Midprice	00:00:03	$92.97	$74.20	00:00:03	2.48%
Pegged-Primary	00:00:04	$94.16	$77.00	00:00:04	0.88%
Pegged-Midprice	00:00:04	$92.34	$75.04	00:00:04	3.25%
Pegged-Primary	00:00:05	$93.94	$78.32	00:00:05	1.12%
Pegged-Midprice	00:00:05	$91.74	$75.91	00:00:05	3.99%
Pegged-Primary	00:00:10	$93.06	$84.35	00:00:10	2.23%
Pegged-Midprice	00:00:10	$89.20	$79.87	00:00:10	7.40%
Limit-Primary	00:00:10	$93.20	$84.17	00:00:10	1.80%
Limit-Midprice	00:00:10	$92.98	$82.55	00:00:10	3.42%
Pegged-Primary	00:00:20	$90.97	$92.24	00:00:20	4.30%
Pegged-Midprice	00:00:20	$85.09	$84.55	00:00:19	13.19%
Pegged-Primary	00:00:30	$89.01	$97.98	00:00:29	6.31%
Pegged-Midprice	00:00:30	$81.91	$87.76	00:00:27	18.21%
Pegged-Primary	00:00:40	$87.50	$103.48	00:00:38	8.20%
Pegged-Midprice	00:00:40	$79.09	$91.03	00:00:35	22.85%
Pegged-Primary	00:01:00	$84.76	$115.34	00:00:56	11.95%
Pegged-Midprice	00:01:00	$73.64	$96.19	00:00:49	31.12%
Pegged-Primary	00:02:00	$77.51	$136.44	00:01:46	21.62%
Pegged-Midprice	00:02:00	$63.04	$107.03	00:01:25	49.22%
Pegged-Primary	00:03:00	$71.77	$154.24	00:02:31	28.57%
Pegged-Midprice	00:03:00	$56.56	$115.05	00:01:52	61.84%
Pegged-Primary	00:04:00	$69.10	$170.44	00:03:12	34.75%
Pegged-Midprice	00:04:00	$53.22	$122.98	00:02:12	70.93%
Pegged-Primary	00:05:00	$66.30	$177.75	00:03:49	38.49%
Pegged-Midprice	00:05:00	$50.88	$125.04	00:02:27	76.09%
Pegged-Primary	00:10:00	$56.83	$184.87	00:06:42	45.32%
Pegged-Midprice	00:10:00	$46.28	$126.14	00:03:26	83.10%
Pegged-Primary	00:15:00	$49.65	$192.39	00:09:18	50.12%
Pegged-Midprice	00:15:00	$43.37	$125.31	00:04:10	87.27%
Pegged-Primary	00:30:00	$38.23	$206.95	00:15:49	60.88%
Pegged-Midprice	00:30:00	$39.41	$126.65	00:05:34	92.83%
Pegged-Primary	01:00:00	$24.13	$218.84	00:25:12	73.70%
Pegged-Midprice	01:00:00	$36.23	$126.29	00:06:50	96.89%

Table 7: Zinc Data. Source: Marex, Deltix, LME

Execution Strategy	Limit Active Time	Average Transaction Cost	Standard Deviation of TC ($)	Average Time to Fill	Limit Order Fill %
		Zinc			
Market	00:00:00	$8.36	$7.08	00:00:00	0.00%
Pegged-Primary	00:00:01	$8.19	$8.55	00:00:01	2.22%
Pegged-Midprice	00:00:01	$8.11	$8.33	00:00:01	6.27%
Pegged-Primary	00:00:02	$8.02	$9.68	00:00:02	4.42%
Pegged-Midprice	00:00:02	$7.88	$9.20	00:00:02	11.85%
Pegged-Primary	00:00:03	$7.89	$10.61	00:00:03	6.49%
Pegged-Midprice	00:00:03	$7.68	$9.90	00:00:03	16.74%
Pegged-Primary	00:00:04	$7.72	$11.46	00:00:04	8.52%
Pegged-Midprice	00:00:04	$7.49	$10.48	00:00:04	21.11%
Pegged-Primary	00:00:05	$7.59	$12.24	00:00:05	10.41%
Pegged-Midprice	00:00:05	$7.32	$11.03	00:00:04	24.98%
Pegged-Primary	00:00:10	$6.96	$14.98	00:00:09	18.68%
Pegged-Midprice	00:00:10	$6.70	$12.72	00:00:08	40.33%
Limit-Primary	00:00:10	$7.36	$15.44	00:00:09	18.38%
Limit-Midprice	00:00:10	$7.73	$13.85	00:00:08	30.44%
Pegged-Primary	00:00:20	$5.99	$18.58	00:00:16	31.75%
Pegged-Midprice	00:00:20	$5.91	$14.60	00:00:13	59.22%
Pegged-Primary	00:00:30	$5.31	$20.92	00:00:23	41.79%
Pegged-Midprice	00:00:30	$5.48	$15.62	00:00:16	70.35%
Pegged-Primary	00:00:40	$4.73	$22.62	00:00:28	49.62%
Pegged-Midprice	00:00:40	$5.24	$16.28	00:00:19	77.39%
Pegged-Primary	00:01:00	$3.91	$24.94	00:00:37	61.05%
Pegged-Midprice	00:01:00	$4.92	$17.06	00:00:22	85.88%
Pegged-Primary	00:02:00	$2.54	$28.59	00:00:54	79.75%
Pegged-Midprice	00:02:00	$4.58	$18.02	00:00:28	94.95%
Pegged-Primary	00:03:00	$1.92	$30.28	00:01:03	88.26%
Pegged-Midprice	00:03:00	$4.44	$18.31	00:00:30	97.93%
Pegged-Primary	00:04:00	$1.61	$31.26	00:01:09	92.91%
Pegged-Midprice	00:04:00	$4.39	$18.44	00:00:30	99.01%
Pegged-Primary	00:05:00	$1.43	$31.59	00:01:12	95.06%
Pegged-Midprice	00:05:00	$4.35	$18.46	00:00:31	99.39%
Pegged-Primary	00:10:00	$1.15	$32.24	00:01:21	98.34%
Pegged-Midprice	00:10:00	$4.33	$18.53	00:00:32	99.82%
Pegged-Primary	00:15:00	$1.07	$32.44	00:01:24	99.17%
Pegged-Midprice	00:15:00	$4.32	$18.57	00:00:32	99.92%
Pegged-Primary	00:30:00	$0.99	$32.57	00:01:28	99.70%
Pegged-Midprice	00:30:00	$4.32	$18.59	00:00:33	99.97%
Pegged-Primary	01:00:00	$0.97	$32.68	00:01:30	99.87%
Pegged-Midprice	01:00:00	$4.32	$18.60	00:00:33	99.99%

Conclusion

It is quite clear that as we increase our time on the passive side of the order book, we allow for an improvement in transaction cost, but naturally this comes with additional risk (in the form of an increased standard deviation of costs). We see immediate improvements in transaction cost for a small increase in passivity, for a relatively mild increase in standard deviation. As time spent on the passive side increases, we find that the linear improvement (and linear progression of risk) can give way to a tendency to converge to a value. This is due to the high percentage of orders being filled within our time on the passive side (if 100% of orders are filled after 30 minutes, increasing the passive time to 1 hour will make no difference!).

For each metal, we see that the average time to fill tends to between 19 seconds (Copper, **Pegged-Midprice**) and 3 minutes, 36 seconds (Lead, **Pegged-Primary**) for all metals (excluding Tin). The time to fill per metal is reflective of the observed volatility and average spreads in these markets (see **Marex Market Microstructure** *passim* for more information). Increasing the time spent passively allows for a greater percentage of orders to be filled during this period and contributes to an understanding of how to work orders under different conditions.

We also note the importance of following the primary price (i.e. the bid or the offer) when working a passive order – our direct comparison between a pegged order and placing a limit order (i.e. not following the market), in this case over a 10 second period, results in both a higher transaction cost *and* a higher standard deviation of transaction cost.

Obviously, as with all such analysis, there are simplifications and assumptions inherent in our research that mean we cannot simply accept all results as a complete picture of any market. However, we hope to have reasonably shown the benefits and risks of a more passive execution strategy. We continue to research, test and improve and we gladly welcome any further discussion.

Appendix

Table 8: Intra-spread Execution Probabilities

Metal	Intra-spread Execution Probability (empirically observed)
Aluminium (AHD3M)	0.269
Copper (CAD3M)	0.384
Nickel (NID3M)	0.360
Lead (PBD3M)	0.439
Tin (SND3M)	0.524
Zinc (ZSD3M)	0.376

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Further Information

If you are interested in learning more about doing your own advanced execution analysis, Deltix published a brief blog post discussing the advantages of recording your own market data for execution analysis. In addition, Stuart Farr wrote an article on DIY Execution Analysis published by *CTA Intelligence*.

If you are interested in Deltix' research on signal generation, you might find these research studies useful:

Generating Alpha Using IPO and Secondary Issue Data

Generating Alpha with Earnings Date Revisions

To learn more about how Marex Spectron can help you access the London Metals Exchange, please email our LME team.

About Marex

Marex Spectron was formed in 2011 by the merger of London's leading Metals broker, Marex Financial, and Europe's premier energy broker, Spectron Group.

The Group is headquartered in London, with the North America business managed from New York, and Asia operations from Hong Kong and Singapore.

The strength of our European base has enabled us to grow rapidly in North America and Asia and create an integrated, global service for clients who need a partner that can reach every major commodity market in the world in the way that works best for them: by voice, on electronic platforms or through trading floors.

The Group has over 500 experienced market professionals clearing around 1,000,000 contracts daily for clients trading off-exchange and through the London Metal Exchange (where we are a Category 1, Ring Dealing, member), the CME Group exchanges, ICE US, ICE Futures, NYSE Liffe and Eurex.

Our clients are predominantly commodity producers and consumers, banks, hedge funds, asset managers, brokers, commodity trading advisors and professional traders.

In addition to our core operations, our scale and expertise in broking commodity derivatives as well as physical product has enabled us to respond to client demand and offer broking services for financial futures & options and foreign exchange.

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Deltix is a leading provider of software and services for quantitative research, algorithmic and automated systematic trading. Deltix software enables a complete straight through processing environment for the development and deployment of closely-integrated alpha generation and/or execution strategies. Deltix has won ten industry awards since 2012 and was most recently recognised as the "Best Complex Event Processing (CEP) Platform" in February 2016. Deltix is headquartered in Natick, Massachusetts, and has offices in New York, Minsk and St. Petersburg, Russia. For more information, please visit http://www.deltixlab.com .

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Deltix provide software and technical support services for Deltix software to Marex Spectron.

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