

# A Supplemental Appendix to *Complementary bidding and the collusive arrangement: Evidence from an antitrust investigation*, by Robert Clark, Decio Coviello, and Adriano De Leverano

## A.1 Transport charges and final bids

We concentrate our main analysis on raw bids, but contract allocation is based on final bids. In Montreal, firms are asked to submit a raw bid for each asphalt type. Firms must also take into account the transport cost they face and submit transport charges for each type in each borough. The sum of the raw bid on transport charges is the final bid. In Québec City however, we do not have enough information to build a perfect measure of transport charges and thus, of final bids. We know only raw bids per asphalt type per borough and the aggregated final bid of each firm per borough. Since the contracts are won at the borough level, not the asphalt type level as in Montreal, firms submit an aggregated transport charge for a borough. Since prices per type are usually different, it is impossible for us to map an accurate transport charge per asphalt type. More precisely, for each aggregated auction we have:

$$\sum_{k=1}^K (\mathbf{P}_k + t_k) * \mathbf{Quantity}_k = \mathbf{Aggregated\ final\ bid}$$

where  $k$  is the asphalt type,  $t$  is the unknown transport charge and  $P$  is the raw bid (what we know is in bold text). We can rewrite the equation above as:

$$\begin{aligned} \sum_{k=1}^K (\mathbf{P}_k * \mathbf{Quantity}_k + t_k * \mathbf{Quantity}_k) &= \mathbf{Aggregated\ final\ bid} \\ \sum_{k=1}^K (t_k * \mathbf{Quantity}_k) &= \mathbf{Aggregated\ final\ bid} - \sum_{k=1}^K (\mathbf{P}_k * \mathbf{Quantity}_k) \\ \sum_{k=1}^K (t_k * \mathbf{Quantity}_k) &= \mathbf{Aggregated\ transport\ charge} \end{aligned}$$

since  $t_k$  is unknown for all  $k$ , the best we can do is compute the average transport charge:

$$\bar{T} = \frac{\mathbf{Aggregated\ transport\ charge}}{\sum_{k=1}^K (\mathbf{Quantity}_k)}$$

Similarly, we cannot compute final bids per type for Québec City<sup>39</sup>. This measure is imperfect, but we believe it is relevant to estimate DiD for transport charges and final bids.

## A.2 Normalization with average winning bid in Montreal pre-investigation

Chassang et al. (2022) are interested in the distribution of

$$\Delta_{i,a}^{CKNO} = \frac{b_{i,a} - \wedge \mathbf{b}_{-i,a}}{r}, \quad (5)$$

<sup>39</sup>Note that since there is one winner per borough, we know that the firm that bids the lowest aggregated final bid, which we observe, is the actual winner.

where  $b_{i,a}$  is bidder  $i$ 's bid in auction  $a$ ,  $\wedge \mathbf{b}_{-i,a}$  is the minimum bid by  $i$ 's rivals, and  $r$  is the reserve price in auction  $a$ . Since our auctions are for a homogeneous good, bids are in dollars per ton, and there is no reserve price, there is no need to normalize by the reserve price they way [Chassang et al. \(2022\)](#) do. This is why in the text, we focus on the following measure of bid differences:

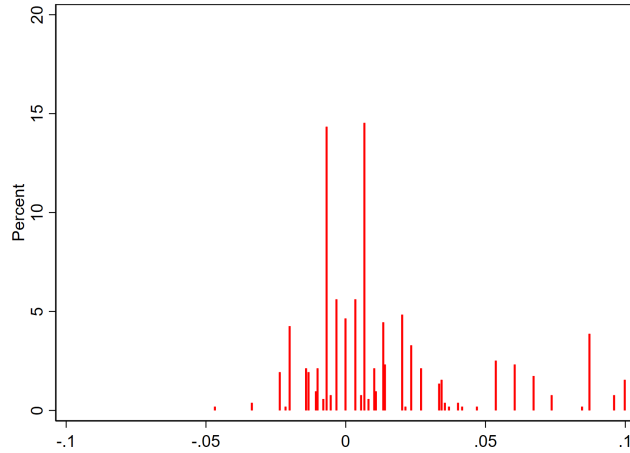
$$\Delta_{i,a}^1 = b_{i,a} - \wedge \mathbf{b}_{-i,a}. \quad (6)$$

As a check on this specification, here we present results in which we normalize by the average winning bid observed in Montreal in the period before the start of the investigation ( $\bar{b}_{mtl,pre}$ ). The measure of bid differences is then:

$$\Delta_{i,a}^{1,norm} = \frac{b_{i,a} - \wedge \mathbf{b}_{-i,a}}{\bar{b}_{mtl,pre}}. \quad (7)$$

Figures [A.1](#) and [A.2](#) replicate Figures [1](#) and [2](#) using this new definition of bid differences.

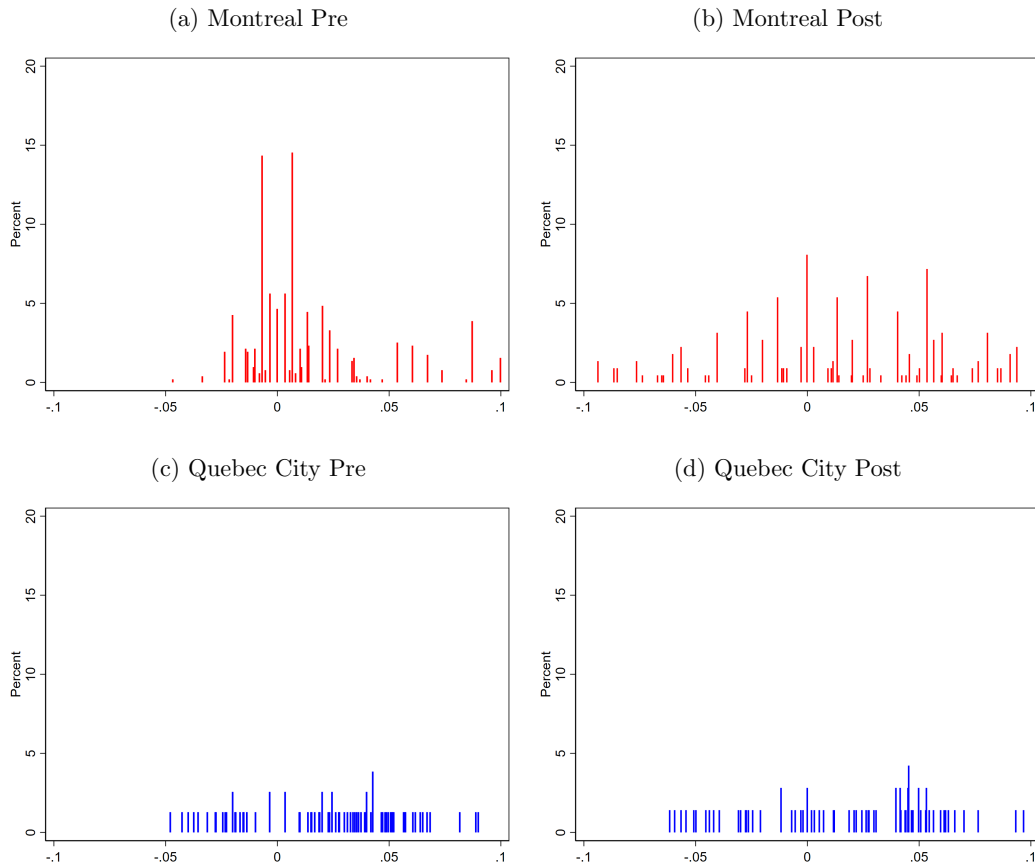
Figure A.1: Differences between own bid and most competitive bid (bid differences)




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This figure plots the differences between own bid and the most competitive bid in auctions as a fraction of the average winning bid in the period before the investigation, for asphalt procurement contracts in Montreal during the cartel period. Bid differences in \$ per ton.

Figure A.2:  $\Delta_{i,a}^{1,norm}$  for Montreal and Quebec City before and after the start of the police investigation.

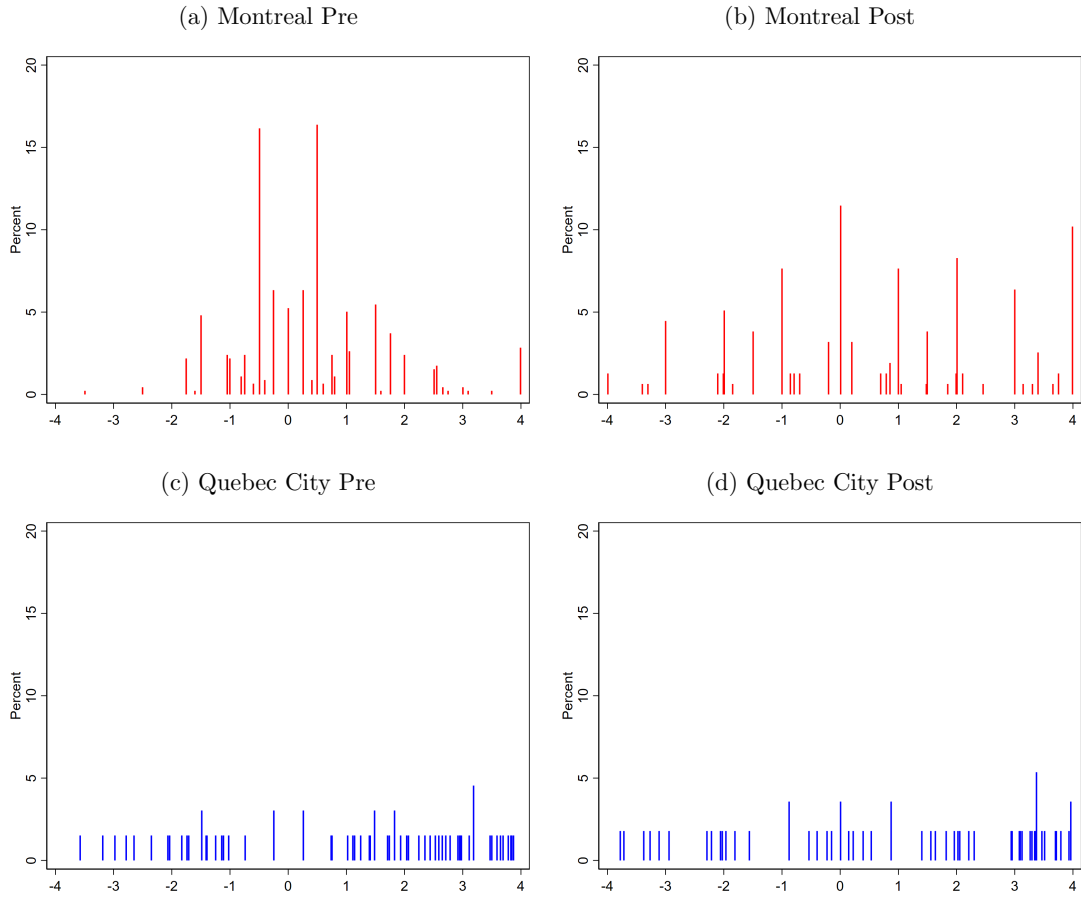



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Differences between own bid and the most competitive bid in auctions as a fraction of the average winning bid in the period before the investigation, for asphalt procurement contracts in Montreal during the cartel period. Bid differences in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton).

### A.3 Different intervals for bid differences

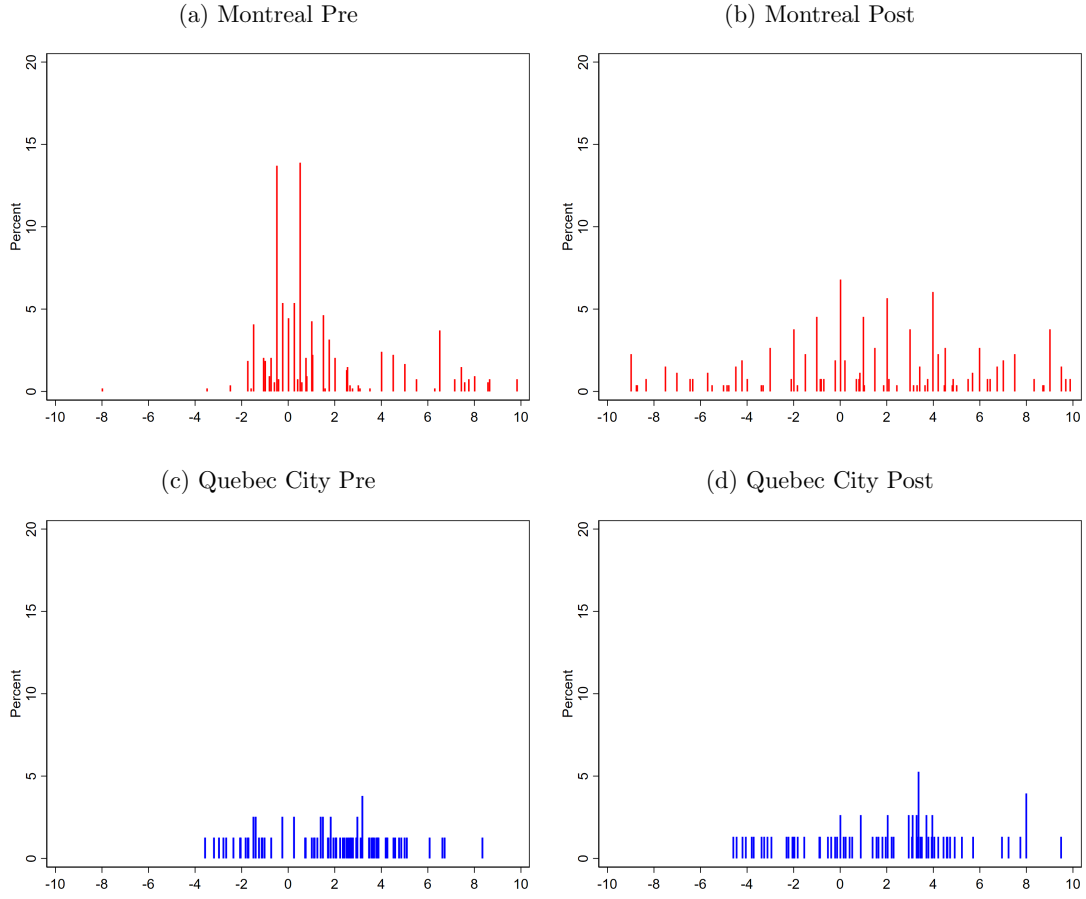
Figure A.3: Distribution of  $\Delta_{i,a}^1$ . Difference in \$ per ton. Interval of \$4 per ton.




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Differences between own bid and the most competitive bid in auctions. Bid differences in \$ per ton. The interval of bid differences is  $\pm 4$  dollars per ton.

Figure A.4: Distribution of  $\Delta_{i,a}^1$ . Difference in \$ per ton. Interval of \$10 per ton.

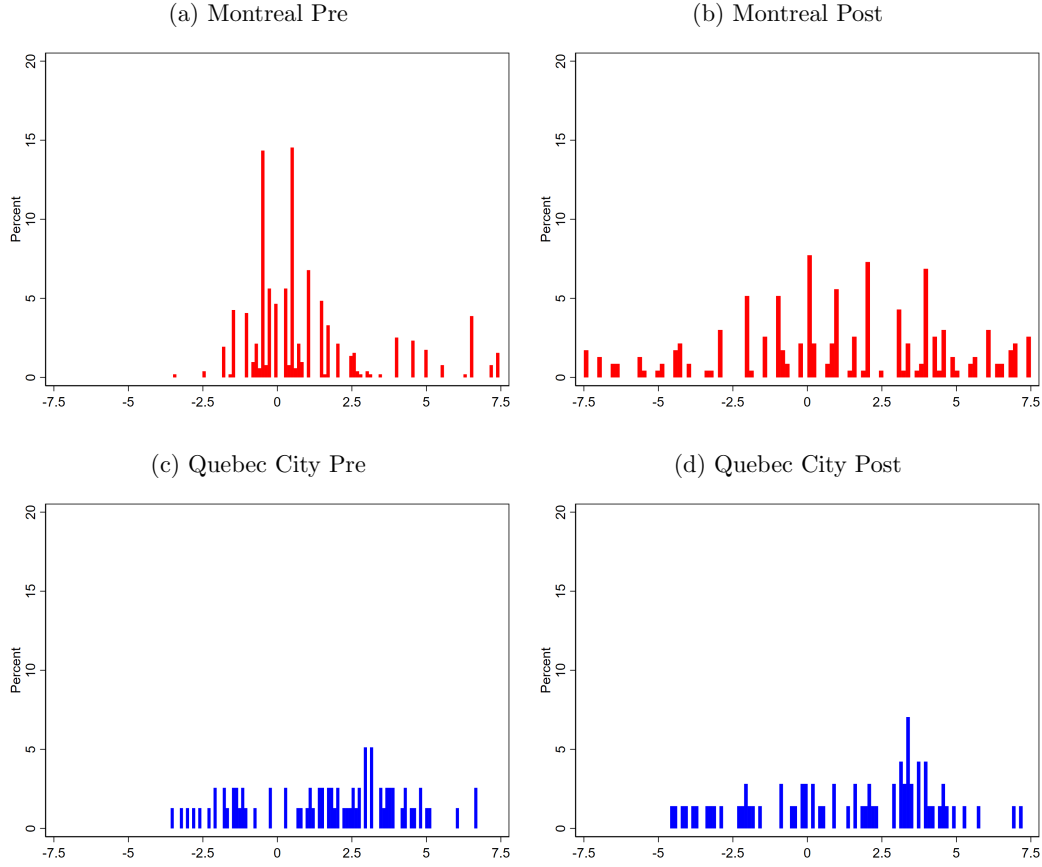



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Differences between own bid and the most competitive bid in auctions. Bid differences in \$ per ton. The interval of bid differences is  $\pm 10$  dollars per ton.

## A.4 Different bin size

Figure A.5: Distribution of  $\Delta_{i,a}^1$  for Montreal and Quebec City before and after the start of the police investigation. The number of bins is equal to 100.




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Bid differences in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton). The number of bins is equal to 100.

## A.5 Full regression results from the estimation of Equation 3

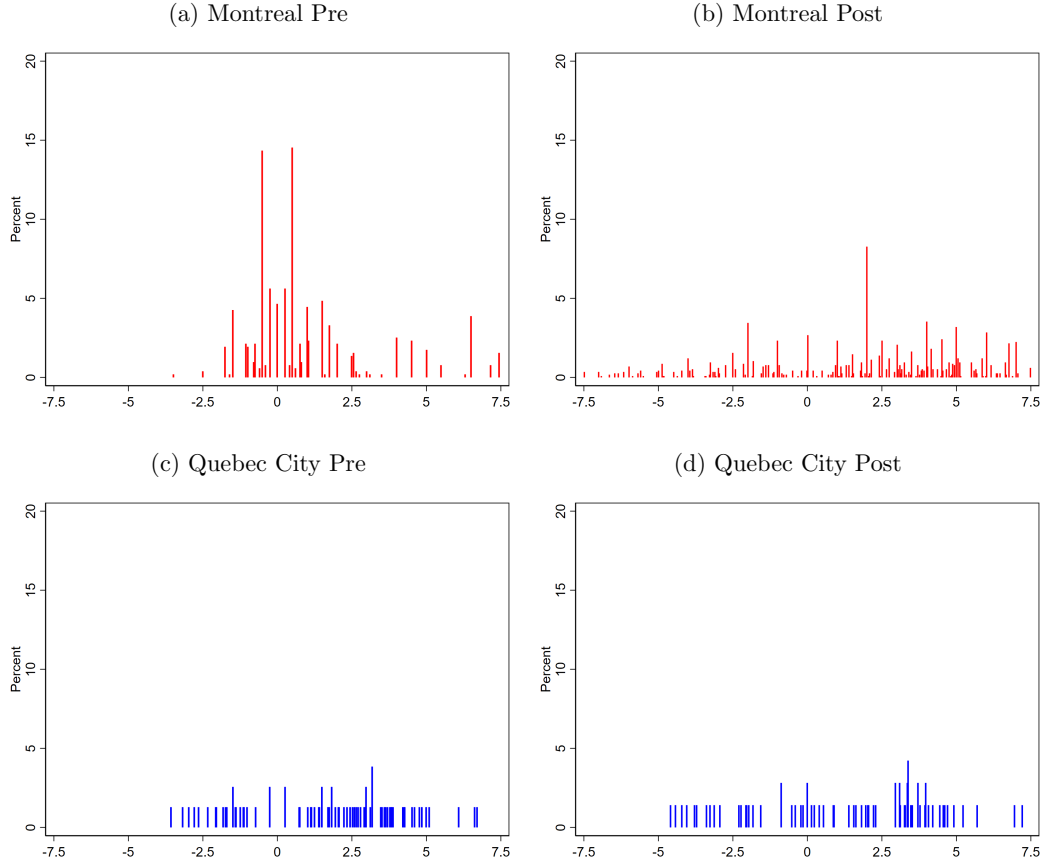
Table A.1: Distributional effect of the investigation on clustering & isolation

| Dep.Var                   | (1)<br>Pr(-2.5 -2]  | (2)<br>Pr(-2-1.5]     | (3)<br>Pr(-1.5-1]     | (4)<br>Pr(-1 -.5]     | (5)<br>Pr(-.5 -0)     | (6)<br>Pr[0]         | (7)<br>Pr(0 .5)       | (8)<br>Pr(.5 1)       | (9)<br>Pr[1 1.5]      | (10)<br>Pr[1.5 2)   | (11)<br>Pr[2 2.5]    |
|---------------------------|---------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|-----------------------|---------------------|----------------------|
| Panel A: Without controls |                     |                       |                       |                       |                       |                      |                       |                       |                       |                     |                      |
| Mtl×Marteau               | 0.0252<br>(0.033)   | -0.0394<br>(0.032)    | 0.0987***<br>(0.029)  | -0.1784***<br>(0.033) | -0.0582*<br>(0.031)   | -0.0115<br>(0.032)   | -0.0582*<br>(0.031)   | -0.1647***<br>(0.035) | 0.0666**<br>(0.032)   | -0.0394<br>(0.044)  | 0.0425<br>(0.039)    |
| Mtl                       | -0.0370*<br>(0.021) | 0.0241<br>(0.024)     | -0.0599**<br>(0.027)  | 0.1599***<br>(0.025)  | 0.0364<br>(0.022)     | 0.0444***<br>(0.015) | 0.0364<br>(0.022)     | 0.1494***<br>(0.027)  | -0.0340<br>(0.027)    | 0.0179<br>(0.033)   | -0.0414<br>(0.027)   |
| Marteau                   | 0.0136<br>(0.031)   | 0.0009<br>(0.029)     | -0.0988***<br>(0.026) | 0.0256<br>(0.024)     | 0.0133<br>(0.026)     | 0.0253<br>(0.025)    | 0.0133<br>(0.026)     | 0.0133<br>(0.026)     | -0.0861***<br>(0.029) | -0.0111<br>(0.042)  | -0.0111<br>(0.035)   |
| Constant                  | 0.0370*<br>(0.021)  | 0.0370*<br>(0.020)    | 0.0988***<br>(0.026)  | 0.0123<br>(0.012)     | 0.0247<br>(0.017)     | 0.0000<br>(0.000)    | 0.0247<br>(0.017)     | 0.0247<br>(0.016)     | 0.0988***<br>(0.026)  | 0.0617**<br>(0.030) | 0.0617**<br>(0.025)  |
| Observations              | 1.009               | 1.009                 | 1.009                 | 1.009                 | 1.009                 | 1.009                | 1.009                 | 1.009                 | 1.009                 | 1.009               | 1.009                |
| R-squared                 | 0.0226              | 0.00691               | 0.0103                | 0.0621                | 0.0104                | 0.00587              | 0.0104                | 0.0585                | 0.00680               | 0.00889             | 0.00805              |
| Borough FE                | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                    | No                  | No                   |
| Year FE                   | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                    | No                  | No                   |
| Type FE                   | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                    | No                  | No                   |
| Mean Y Pre Montreal       | .                   | -1.58                 | -1.03                 | -.55                  | -.27                  | 0                    | .27                   | .55                   | 1.02                  | 1.6                 | 2                    |
| Panel B: With controls    |                     |                       |                       |                       |                       |                      |                       |                       |                       |                     |                      |
| Mtl×Marteau               | -0.0076<br>(0.038)  | -0.0484<br>(0.046)    | 0.0945**<br>(0.037)   | -0.1312***<br>(0.044) | -0.0642<br>(0.043)    | -0.0282<br>(0.047)   | -0.0642<br>(0.043)    | -0.1251***<br>(0.046) | 0.0554<br>(0.041)     | -0.0457<br>(0.061)  | 0.0022<br>(0.038)    |
| Mtl                       | -0.1756*<br>(0.106) | -0.0036<br>(0.062)    | -0.0334<br>(0.083)    | 0.1992*<br>(0.101)    | 0.1082<br>(0.089)     | 0.1902<br>(0.147)    | 0.1082<br>(0.089)     | 0.2473**<br>(0.113)   | -0.0964<br>(0.112)    | 0.0388<br>(0.102)   | 0.0137<br>(0.113)    |
| Marteau                   | -0.1023<br>(0.332)  | -0.5933**<br>(0.227)  | -0.2074<br>(0.293)    | 1.1732***<br>(0.375)  | -0.3230<br>(0.234)    | -0.5791<br>(0.353)   | -0.3230<br>(0.234)    | 1.0470***<br>(0.380)  | -0.2460<br>(0.316)    | -0.3983<br>(0.352)  | -0.6855**<br>(0.316) |
| Crude oil lag             | 0.0009<br>(0.002)   | 0.0035***<br>(0.001)  | 0.0006<br>(0.002)     | -0.0066***<br>(0.002) | 0.0020<br>(0.001)     | 0.0032<br>(0.002)    | 0.0020<br>(0.001)     | -0.0059***<br>(0.002) | 0.0010<br>(0.002)     | 0.0023<br>(0.002)   | 0.0044**<br>(0.002)  |
| Quantity                  | -0.0000<br>(0.000)  | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | 0.0000<br>(0.000)     | 0.0000<br>(0.000)    | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | -0.0000<br>(0.000)  | -0.0000<br>(0.000)   |
| HHI                       | -0.0568<br>(0.119)  | -0.1406<br>(0.106)    | 0.0550<br>(0.091)     | 0.2678***<br>(0.071)  | -0.3949***<br>(0.097) | -0.0709<br>(0.087)   | -0.3949***<br>(0.097) | 0.2232***<br>(0.082)  | 0.0912<br>(0.095)     | -0.1986<br>(0.132)  | -0.0460<br>(0.117)   |
| Constant                  | -0.1954<br>(0.826)  | -1.5494***<br>(0.527) | -0.2556<br>(0.739)    | 2.9355***<br>(0.988)  | -0.8663<br>(0.595)    | -1.5622*<br>(0.898)  | -0.8663<br>(0.595)    | 2.6085**<br>(0.997)   | -0.3772<br>(0.799)    | -0.9576<br>(0.857)  | -1.8277**<br>(0.786) |
| Observations              | 1.009               | 1.009                 | 1.009                 | 1.009                 | 1.009                 | 1.009                | 1.009                 | 1.009                 | 1.009                 | 1.009               | 1.009                |
| R-squared                 | 0.0877              | 0.0991                | 0.105                 | 0.176                 | 0.169                 | 0.151                | 0.169                 | 0.169                 | 0.0796                | 0.125               | 0.118                |
| Borough FE                | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  |
| Year FE                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  |
| Type FE                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  |
| Mean Y Pre Montreal       | .                   | -1.58                 | -1.03                 | -.55                  | -.27                  | 0                    | .27                   | .55                   | 1.02                  | 1.6                 | 2                    |

Dep. variable is the probability that bid differences fall in a given interval. *Marteau* is a dummy equal to 1 if the contract is awarded after the start of the investigations in October 2009. *Mtl* indicates that the contract was for Montreal. Panel A without controls. Panel B includes controls as well as borough, year and asphalt type effects. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

## A.6 Sample of auctions: Original sample plus auctions with entrants

Figure A.6: Distribution of  $\Delta_{i,a}^1$  for Montreal and Quebec City before and after the start of the police investigation. Original sample plus auctions with entrants.




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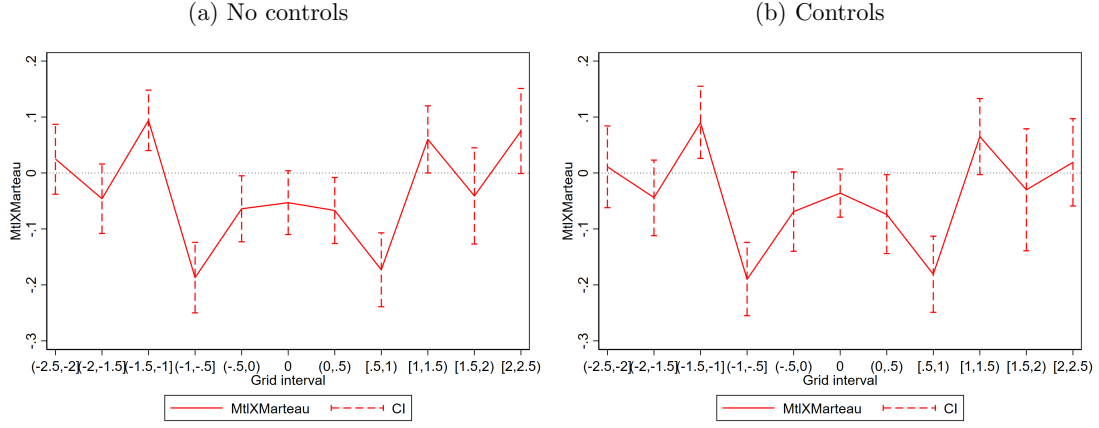
Bid difference in bids in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton).

Table A.2: Distributional effect of the investigation on clustering & isolation. Original sample plus auctions with entrants.

| Dep.Var                   | (1)<br>Pr(-2.5 -2]    | (2)<br>Pr(-2-1.5]   | (3)<br>Pr(-1.5-1]     | (4)<br>Pr(-1 -.5]     | (5)<br>Pr(-.5 -0)     | (6)<br>Pr[0]          | (7)<br>Pr(0 .5)       | (8)<br>Pr[.5 1)       | (9)<br>Pr[1 1.5]      | (10)<br>Pr[1.5 2)   | (11)<br>Pr[2 2.5]     |
|---------------------------|-----------------------|---------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|---------------------|-----------------------|
| Panel A: Without controls |                       |                     |                       |                       |                       |                       |                       |                       |                       |                     |                       |
| Mtl×Marteau               | 0.0246<br>(0.032)     | -0.0463<br>(0.032)  | 0.0941***<br>(0.028)  | -0.1873***<br>(0.032) | -0.0639**<br>(0.030)  | -0.0527*<br>(0.029)   | -0.0672**<br>(0.030)  | -0.1729***<br>(0.034) | 0.0601*<br>(0.031)    | -0.0409<br>(0.044)  | 0.0749*<br>(0.039)    |
| Mtl                       | -0.0370*<br>(0.021)   | 0.0241<br>(0.024)   | -0.0599**<br>(0.027)  | 0.1599***<br>(0.025)  | 0.0364<br>(0.022)     | 0.0444***<br>(0.015)  | 0.0364<br>(0.022)     | 0.1494***<br>(0.027)  | -0.0340<br>(0.027)    | 0.0179<br>(0.032)   | -0.0414<br>(0.027)    |
| Marteau                   | 0.0136<br>(0.031)     | 0.0009<br>(0.029)   | -0.0988***<br>(0.026) | 0.0256<br>(0.024)     | 0.0133<br>(0.026)     | 0.0253<br>(0.025)     | 0.0133<br>(0.026)     | 0.0133<br>(0.026)     | -0.0861***<br>(0.029) | -0.0111<br>(0.042)  | -0.0111<br>(0.035)    |
| Constant                  | 0.0370*<br>(0.021)    | 0.0370*<br>(0.020)  | 0.0988***<br>(0.026)  | 0.0123<br>(0.012)     | 0.0247<br>(0.017)     | 0.0000<br>(0.000)     | 0.0247<br>(0.017)     | 0.0247<br>(0.016)     | 0.0988***<br>(0.026)  | 0.0617**<br>(0.030) | 0.0617**<br>(0.025)   |
| Observations              | 2,220                 | 2,220               | 2,220                 | 2,220                 | 2,220                 | 2,220                 | 2,220                 | 2,220                 | 2,220                 | 2,220               | 2,220                 |
| R-squared                 | 0.00988               | 0.0136              | 0.00551               | 0.0985                | 0.0196                | 0.00677               | 0.0246                | 0.0896                | 0.00593               | 0.0124              | 0.0119                |
| Borough FE                | No                    | No                  | No                    | No                    | No                    | No                    | No                    | No                    | No                    | No                  | No                    |
| Year FE                   | No                    | No                  | No                    | No                    | No                    | No                    | No                    | No                    | No                    | No                  | No                    |
| Type FE                   | No                    | No                  | No                    | No                    | No                    | No                    | No                    | No                    | No                    | No                  | No                    |
| Mean Y Pre Montreal       | .                     | -1.58               | -1.03                 | -.55                  | -.27                  | 0                     | .27                   | .55                   | 1.02                  | 1.6                 | 2                     |
| Panel B: With controls    |                       |                     |                       |                       |                       |                       |                       |                       |                       |                     |                       |
| Mtl×Marteau               | 0.0109<br>(0.037)     | -0.0443<br>(0.034)  | 0.0903***<br>(0.033)  | -0.1895***<br>(0.033) | -0.0692*<br>(0.036)   | -0.0357<br>(0.022)    | -0.0735**<br>(0.036)  | -0.1810***<br>(0.035) | 0.0652*<br>(0.035)    | -0.0303<br>(0.056)  | 0.0187<br>(0.040)     |
| Mtl                       | -0.1710<br>(0.112)    | 0.0222<br>(0.057)   | -0.0150<br>(0.081)    | 0.1543<br>(0.105)     | 0.1521*<br>(0.089)    | 0.2206<br>(0.139)     | 0.1542*<br>(0.089)    | 0.2006*<br>(0.119)    | -0.0687<br>(0.110)    | 0.0647<br>(0.100)   | -0.0542<br>(0.130)    |
| Marteau                   | -0.8581***<br>(0.292) | -0.2941*<br>(0.171) | 0.1216<br>(0.282)     | 0.6156**<br>(0.243)   | -0.2917*<br>(0.159)   | -0.5082**<br>(0.211)  | -0.3002*<br>(0.155)   | 0.5422**<br>(0.251)   | 0.1292<br>(0.305)     | 0.0073<br>(0.261)   | -1.5008***<br>(0.298) |
| Crude oil lag             | 0.0053***<br>(0.002)  | 0.0017*<br>(0.001)  | -0.0013<br>(0.002)    | -0.0031**<br>(0.001)  | 0.0018**<br>(0.001)   | 0.0028**<br>(0.001)   | 0.0019**<br>(0.001)   | -0.0028**<br>(0.001)  | -0.0012<br>(0.002)    | -0.0003<br>(0.001)  | 0.0091***<br>(0.002)  |
| Quantity                  | -0.0000*<br>(0.000)   | 0.0000<br>(0.000)   | 0.0000<br>(0.000)     | -0.0000***<br>(0.000) | 0.0000<br>(0.000)     | 0.0000<br>(0.000)     | 0.0000<br>(0.000)     | -0.0000*<br>(0.000)   | 0.0000<br>(0.000)     | 0.0000<br>(0.000)   | -0.0000**<br>(0.000)  |
| HHI                       | -0.0813<br>(0.120)    | -0.1503<br>(0.101)  | 0.0116<br>(0.089)     | 0.2658***<br>(0.071)  | -0.3646***<br>(0.096) | -0.0661<br>(0.072)    | -0.3663***<br>(0.096) | 0.2237***<br>(0.079)  | 0.0541<br>(0.093)     | -0.2336*<br>(0.132) | -0.0799<br>(0.121)    |
| Constant                  | -2.1675***<br>(0.721) | -0.7101*<br>(0.363) | 0.6632<br>(0.710)     | 1.3556**<br>(0.609)   | -0.8196**<br>(0.347)  | -1.4145***<br>(0.532) | -0.8483**<br>(0.333)  | 1.1670*<br>(0.624)    | 0.6573<br>(0.775)     | 0.1988<br>(0.601)   | -3.9196***<br>(0.736) |
| Observations              | 2,220                 | 2,220               | 2,220                 | 2,220                 | 2,220                 | 2,220                 | 2,220                 | 2,220                 | 2,220                 | 2,220               | 2,220                 |
| R-squared                 | 0.0560                | 0.0610              | 0.0723                | 0.167                 | 0.116                 | 0.0874                | 0.123                 | 0.152                 | 0.0605                | 0.0763              | 0.0974                |
| Borough FE                | Yes                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                 | Yes                   |
| Year FE                   | Yes                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                 | Yes                   |
| Type FE                   | Yes                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                 | Yes                   |
| Mean Y Pre Montreal       | .                     | -1.58               | -1.03                 | -.55                  | -.27                  | 0                     | .27                   | .55                   | 1.02                  | 1.6                 | 2                     |

Dep. variable is the probability that bid differences fall in a given interval. *Marteau* is a dummy equal to 1 if the contract is awarded after the start of the investigations in October 2009. *Mtl* indicates that the contract was for Montreal. Panel A without controls. Panel B with controls. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

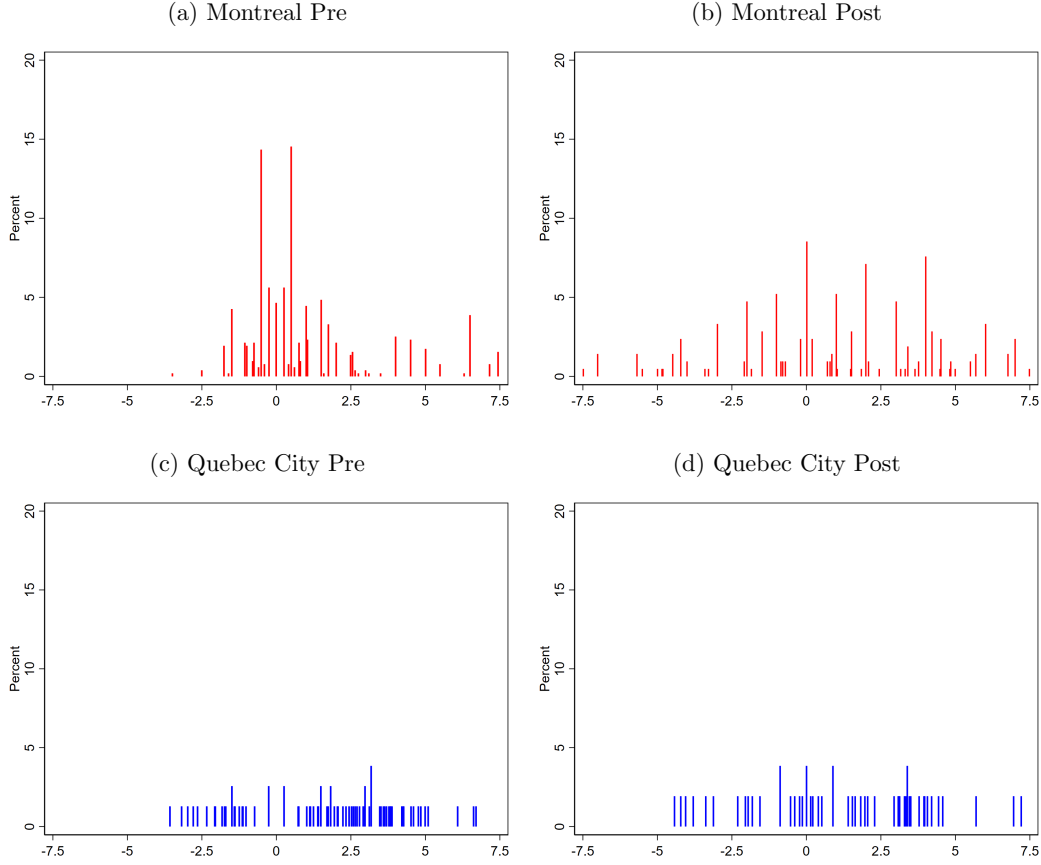
Figure A.7: Graphical representation of the distributional effect of the investigation on clustering & isolation. Original sample plus auctions with entrants.



This figure reports the estimated coefficient for  $Mtl \times Marteau$ , along with confidence intervals, from Table [A.2](#). Confidence intervals are computed with standard errors clustered at the borough and year levels.

## A.7 Sample of auctions: Original sample minus year 2010

Figure A.8: Distribution of  $\Delta_{i,a}^1$  for Montreal and Quebec City before and after the start of the police investigation. Original sample minus year 2010




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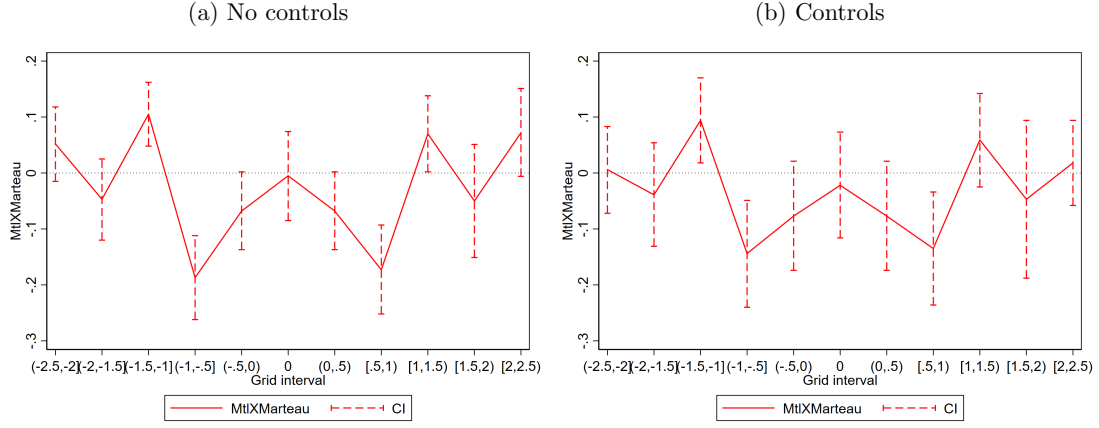
Bid difference in bids in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton).

Table A.3: Distributional effect of the investigation on clustering & isolation. Original sample minus year 2010.

| Dep.Var                   | (1)<br>Pr[-2.5 -2]  | (2)<br>Pr[-2-1.5]     | (3)<br>Pr[-1.5-1]     | (4)<br>Pr[-1 -.5]     | (5)<br>Pr[-.5 -0]     | (6)<br>Pr[0]         | (7)<br>Pr[0 .5]       | (8)<br>Pr[.5 1]       | (9)<br>Pr[1 1.5]     | (10)<br>Pr[1.5 2]   | (11)<br>Pr[2 2.5]    |
|---------------------------|---------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|----------------------|---------------------|----------------------|
| Panel A: Without controls |                     |                       |                       |                       |                       |                      |                       |                       |                      |                     |                      |
| MtlXMarteau               | 0.0515<br>(0.034)   | -0.0472<br>(0.037)    | 0.1048***<br>(0.029)  | -0.1871***<br>(0.038) | -0.0677*<br>(0.036)   | -0.0055<br>(0.041)   | -0.0677*<br>(0.036)   | -0.1725***<br>(0.041) | 0.0698**<br>(0.035)  | -0.0501<br>(0.052)  | 0.0722*<br>(0.040)   |
| Mtl                       | -0.0370*<br>(0.021) | 0.0241<br>(0.024)     | -0.0599**<br>(0.027)  | 0.1599***<br>(0.025)  | 0.0364<br>(0.022)     | 0.0444***<br>(0.015) | 0.0364<br>(0.022)     | 0.1494***<br>(0.027)  | -0.0340<br>(0.027)   | 0.0179<br>(0.033)   | -0.0414<br>(0.027)   |
| Marteau                   | -0.0026<br>(0.031)  | 0.0147<br>(0.034)     | -0.0988***<br>(0.026) | 0.0394<br>(0.030)     | 0.0270<br>(0.032)     | 0.0345<br>(0.033)    | 0.0270<br>(0.032)     | 0.0270<br>(0.032)     | -0.0815**<br>(0.031) | 0.0072<br>(0.050)   | -0.0272<br>(0.035)   |
| Constant                  | 0.0370*<br>(0.021)  | 0.0370*<br>(0.020)    | 0.0988***<br>(0.026)  | 0.0123<br>(0.012)     | 0.0247<br>(0.017)     | -0.0000<br>(.)       | 0.0247<br>(0.017)     | 0.0247<br>(0.016)     | 0.0988***<br>(0.026) | 0.0617**<br>(0.030) | 0.0617**<br>(0.026)  |
| Observations              | 924                 | 924                   | 924                   | 924                   | 924                   | 924                  | 924                   | 924                   | 924                  | 924                 | 924                  |
| R-squared                 | 0.0273              | 0.00441               | 0.00964               | 0.0530                | 0.00786               | 0.00866              | 0.00786               | 0.0491                | 0.00466              | 0.00548             | 0.0121               |
| Borough FE                | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                   | No                  | No                   |
| Year FE                   | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                   | No                  | No                   |
| Type FE                   | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                   | No                  | No                   |
| Mean Y Pre Montreal       | .                   | -1.58                 | -1.03                 | -.55                  | -.27                  | 0                    | .27                   | .55                   | 1.02                 | 1.6                 | 2                    |
| Panel B: With controls    |                     |                       |                       |                       |                       |                      |                       |                       |                      |                     |                      |
| MtlXMarteau               | 0.0056<br>(0.040)   | -0.0387<br>(0.047)    | 0.0937**<br>(0.039)   | -0.1445***<br>(0.048) | -0.0765<br>(0.050)    | -0.0215<br>(0.048)   | -0.0765<br>(0.050)    | -0.1350**<br>(0.051)  | 0.0586<br>(0.043)    | -0.0471<br>(0.072)  | 0.0180<br>(0.039)    |
| Mtl                       | -0.0956<br>(0.071)  | -0.0031<br>(0.061)    | -0.0174<br>(0.083)    | 0.1737<br>(0.118)     | 0.1143<br>(0.099)     | 0.2079<br>(0.149)    | 0.1143<br>(0.099)     | 0.2173*<br>(0.126)    | -0.1113<br>(0.129)   | 0.0551<br>(0.101)   | 0.0890<br>(0.084)    |
| Marteau                   | -0.2007<br>(0.335)  | -0.6248**<br>(0.242)  | -0.2121<br>(0.315)    | 1.0774***<br>(0.391)  | -0.3068<br>(0.236)    | -0.5243<br>(0.364)   | -0.3068<br>(0.236)    | 0.9424**<br>(0.396)   | -0.2721<br>(0.333)   | -0.5305<br>(0.370)  | -0.6600**<br>(0.312) |
| Crude oil lag             | 0.0014<br>(0.002)   | 0.0037***<br>(0.001)  | 0.0007<br>(0.002)     | -0.0060**<br>(0.002)  | 0.0019<br>(0.001)     | 0.0028<br>(0.002)    | 0.0019<br>(0.001)     | -0.0053**<br>(0.002)  | 0.0012<br>(0.002)    | 0.0030<br>(0.002)   | 0.0041**<br>(0.002)  |
| Quantity                  | -0.0000<br>(0.000)  | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | 0.0000<br>(0.000)     | 0.0000<br>(0.000)    | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)   | -0.0000<br>(0.000)  | -0.0000<br>(0.000)   |
| HHI                       | -0.0482<br>(0.124)  | -0.1530<br>(0.111)    | 0.0676<br>(0.094)     | 0.2608***<br>(0.070)  | -0.4029***<br>(0.102) | -0.0578<br>(0.086)   | -0.4029***<br>(0.102) | 0.2142**<br>(0.082)   | 0.1019<br>(0.097)    | -0.2063<br>(0.141)  | -0.0395<br>(0.122)   |
| Constant                  | -0.5004<br>(0.828)  | -1.6094***<br>(0.565) | -0.2894<br>(0.793)    | 2.6990**<br>(1.038)   | -0.8583<br>(0.602)    | -1.4368<br>(0.916)   | -0.8583<br>(0.602)    | 2.3621**<br>(1.046)   | -0.4219<br>(0.842)   | -1.3153<br>(0.902)  | -1.8026**<br>(0.772) |
| Observations              | 924                 | 924                   | 924                   | 924                   | 924                   | 924                  | 924                   | 924                   | 924                  | 924                 | 924                  |
| R-squared                 | 0.104               | 0.106                 | 0.110                 | 0.171                 | 0.171                 | 0.154                | 0.171                 | 0.163                 | 0.0800               | 0.131               | 0.127                |
| Borough FE                | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                  | Yes                 | Yes                  |
| Year FE                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                  | Yes                 | Yes                  |
| Type FE                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                  | Yes                 | Yes                  |
| Mean Y Pre Montreal       | .                   | -1.58                 | -1.03                 | -.55                  | -.27                  | 0                    | .27                   | .55                   | 1.02                 | 1.6                 | 2                    |

Dep. variable is the probability that bid differences fall in a given interval. *Marteau* is a dummy equal to 1 if the contract is awarded after the start of the investigations in October 2009. *Mtl* indicates that the contract was for Montreal. Panel A without controls. Panel B with controls. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

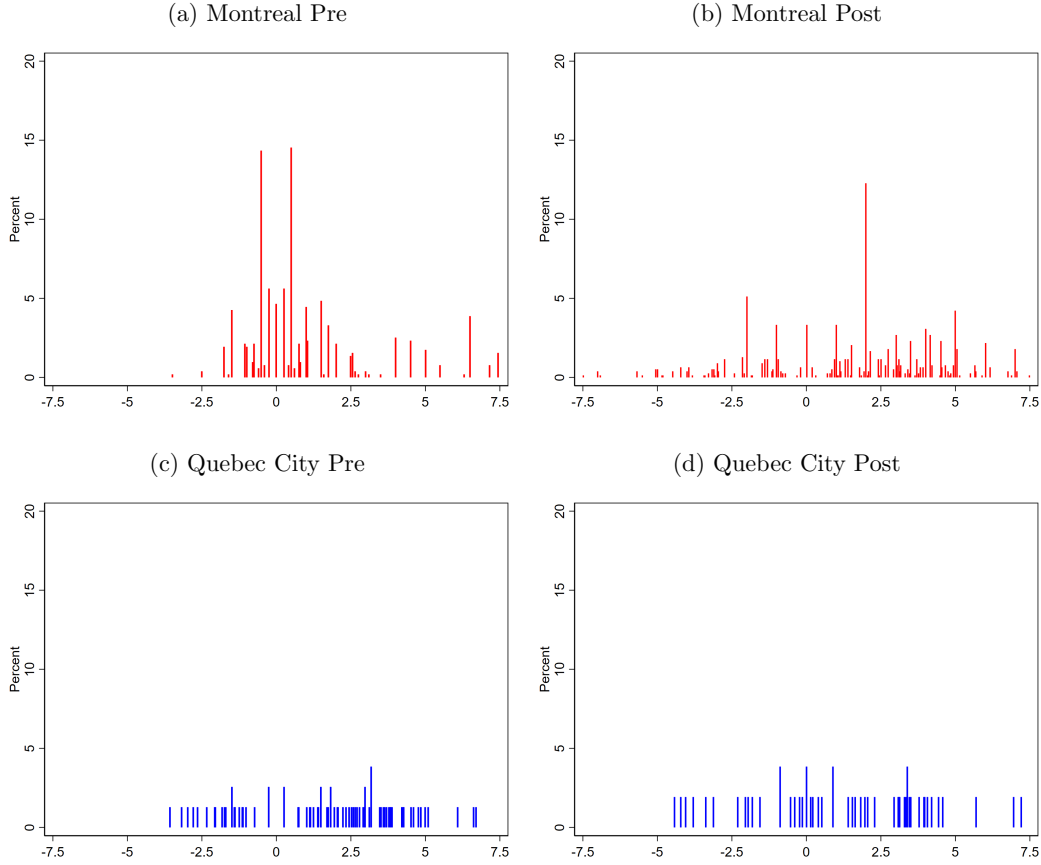
Figure A.9: Graphical representation of the distributional effect of the investigation on clustering & isolation. Original sample minus year 2010.



This figure reports the estimated coefficient for  $Mtl \times Marteau$ , along with confidence intervals, from Table [A.3](#). Confidence intervals are computed with standard errors clustered at the borough and year levels.

## A.8 Sample of auctions: Original sample plus auctions with entrants, minus year 2010

Figure A.10: Distribution of  $\Delta_{i,a}^1$  for Montreal and Quebec City before and after the start of the police investigation. Original sample plus auctions with entrants, minus year 2010.



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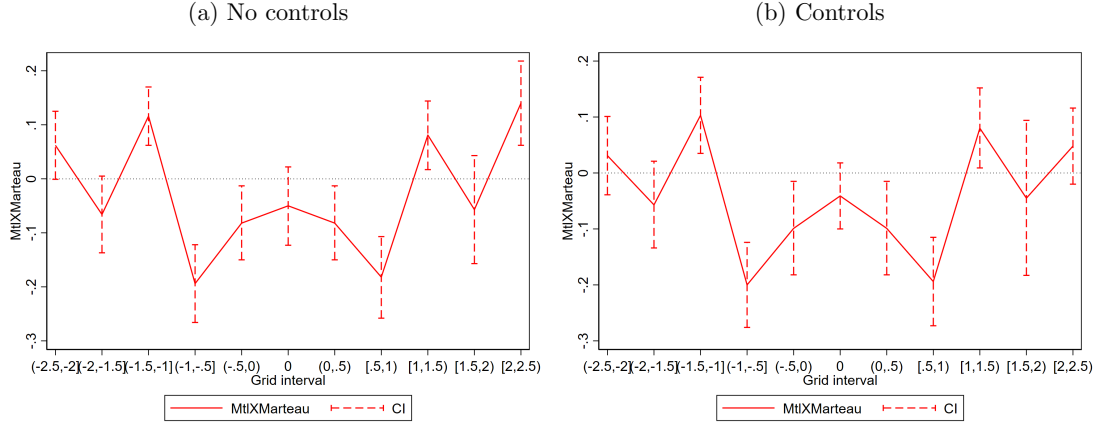
Bid difference in bids in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton).

Table A.4: Distributional effect of the investigation on clustering & isolation. Original sample plus auctions with entrants, minus year 2010

| Dep.Var                   | (1)<br>Pr[-2.5 -2]    | (2)<br>Pr[-2-1.5]    | (3)<br>Pr[-1.5-1]     | (4)<br>Pr[-1 -.5]     | (5)<br>Pr[-.5 -0]     | (6)<br>Pr[0]         | (7)<br>Pr[0 .5]       | (8)<br>Pr[.5 1]       | (9)<br>Pr[1 1.5]     | (10)<br>Pr[1.5 2]   | (11)<br>Pr[2 2.5]     |
|---------------------------|-----------------------|----------------------|-----------------------|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|----------------------|---------------------|-----------------------|
| Panel A: Without controls |                       |                      |                       |                       |                       |                      |                       |                       |                      |                     |                       |
| Mtl×Marteau               | 0.0620*<br>(0.032)    | -0.0659*<br>(0.036)  | 0.1160***<br>(0.028)  | -0.1940***<br>(0.037) | -0.0815**<br>(0.035)  | -0.0503<br>(0.037)   | -0.0815**<br>(0.035)  | -0.1824***<br>(0.038) | 0.0806**<br>(0.033)  | -0.0571<br>(0.051)  | 0.1401***<br>(0.040)  |
| Mtl                       | -0.0370*<br>(0.021)   | 0.0241<br>(0.024)    | -0.0599**<br>(0.027)  | 0.1599***<br>(0.025)  | 0.0364<br>(0.022)     | 0.0444***<br>(0.015) | 0.0364<br>(0.022)     | 0.1494***<br>(0.027)  | -0.0340<br>(0.027)   | 0.0179<br>(0.032)   | -0.0414<br>(0.027)    |
| Marteau                   | -0.0026<br>(0.031)    | 0.0147<br>(0.034)    | -0.0988***<br>(0.026) | 0.0394<br>(0.030)     | 0.0270<br>(0.032)     | 0.0345<br>(0.033)    | 0.0270<br>(0.032)     | 0.0270<br>(0.032)     | -0.0815**<br>(0.031) | 0.0072<br>(0.049)   | -0.0272<br>(0.035)    |
| Constant                  | 0.0370*<br>(0.021)    | 0.0370*<br>(0.020)   | 0.0988***<br>(0.026)  | 0.0123<br>(0.012)     | 0.0247<br>(0.017)     | -0.0000<br>(0.000)   | 0.0247<br>(0.017)     | 0.0247<br>(0.016)     | 0.0988***<br>(0.026) | 0.0617**<br>(0.030) | 0.0617**<br>(0.025)   |
| Observations              | 1,587                 | 1,587                | 1,587                 | 1,587                 | 1,587                 | 1,587                | 1,587                 | 1,587                 | 1,587                | 1,587               | 1,587                 |
| R-squared                 | 0.0211                | 0.0198               | 0.00577               | 0.0802                | 0.0243                | 0.00350              | 0.0243                | 0.0782                | 0.00236              | 0.0117              | 0.0359                |
| Borough FE                | No                    | No                   | No                    | No                    | No                    | No                   | No                    | No                    | No                   | No                  | No                    |
| Year FE                   | No                    | No                   | No                    | No                    | No                    | No                   | No                    | No                    | No                   | No                  | No                    |
| Type FE                   | No                    | No                   | No                    | No                    | No                    | No                   | No                    | No                    | No                   | No                  | No                    |
| Mean Y Pre Montreal       | .                     | -1.58                | -1.03                 | -.55                  | -.27                  | 0                    | .27                   | .55                   | 1.02                 | 1.6                 | 2                     |
| Panel B: With controls    |                       |                      |                       |                       |                       |                      |                       |                       |                      |                     |                       |
| Mtl×Marteau               | 0.0310<br>(0.036)     | -0.0567<br>(0.040)   | 0.1026***<br>(0.035)  | -0.1998***<br>(0.039) | -0.0985**<br>(0.042)  | -0.0410<br>(0.030)   | -0.0985**<br>(0.042)  | -0.1943***<br>(0.040) | 0.0803**<br>(0.036)  | -0.0447<br>(0.071)  | 0.0481<br>(0.035)     |
| Mtl                       | -0.0749<br>(0.073)    | 0.0047<br>(0.059)    | 0.0005<br>(0.081)     | 0.1438<br>(0.131)     | 0.1295<br>(0.096)     | 0.2231<br>(0.141)    | 0.1295<br>(0.096)     | 0.1871<br>(0.140)     | -0.0904<br>(0.131)   | 0.0626<br>(0.105)   | 0.0614<br>(0.090)     |
| Marteau                   | -0.8824***<br>(0.304) | -0.3503**<br>(0.175) | 0.1168<br>(0.291)     | 0.5520**<br>(0.265)   | -0.3304**<br>(0.152)  | -0.4854**<br>(0.218) | -0.3304**<br>(0.152)  | 0.4622*<br>(0.267)    | 0.1155<br>(0.314)    | -0.0824<br>(0.266)  | -1.4782***<br>(0.318) |
| Crude oil lag             | 0.0053***<br>(0.002)  | 0.0021**<br>(0.001)  | -0.0014<br>(0.002)    | -0.0027*<br>(0.001)   | 0.0021***<br>(0.001)  | 0.0027**<br>(0.001)  | 0.0021***<br>(0.001)  | -0.0023<br>(0.001)    | -0.0012<br>(0.002)   | 0.0004<br>(0.001)   | 0.0087***<br>(0.002)  |
| Quantity                  | -0.0000*<br>(0.000)   | 0.0000<br>(0.000)    | 0.0000<br>(0.000)     | -0.0000***<br>(0.000) | 0.0000<br>(0.000)     | 0.0000<br>(0.000)    | 0.0000<br>(0.000)     | -0.0000***<br>(0.000) | 0.0000<br>(0.000)    | 0.0000<br>(0.000)   | -0.0000***<br>(0.000) |
| HHI                       | -0.0737<br>(0.124)    | -0.1693<br>(0.107)   | 0.0318<br>(0.092)     | 0.2545***<br>(0.071)  | -0.3908***<br>(0.098) | -0.0524<br>(0.073)   | -0.3908***<br>(0.098) | 0.2081**<br>(0.081)   | 0.0689<br>(0.096)    | -0.2438*<br>(0.143) | -0.0788<br>(0.125)    |
| Constant                  | -2.2529***<br>(0.752) | -0.8679**<br>(0.368) | 0.6496<br>(0.733)     | 1.2188*<br>(0.675)    | -0.9615***<br>(0.327) | -1.3889**<br>(0.541) | -0.9615***<br>(0.327) | 0.9915<br>(0.673)     | 0.6686<br>(0.797)    | -0.0810<br>(0.611)  | -3.8404***<br>(0.793) |
| Observations              | 1,587                 | 1,587                | 1,587                 | 1,587                 | 1,587                 | 1,587                | 1,587                 | 1,587                 | 1,587                | 1,587               | 1,587                 |
| R-squared                 | 0.0708                | 0.0801               | 0.0804                | 0.161                 | 0.151                 | 0.0983               | 0.151                 | 0.155                 | 0.0604               | 0.105               | 0.112                 |
| Borough FE                | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                  | Yes                 | Yes                   |
| Year FE                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                  | Yes                 | Yes                   |
| Type FE                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                  | Yes                 | Yes                   |
| Mean Y Pre Montreal       | .                     | -1.58                | -1.03                 | -.55                  | -.27                  | 0                    | .27                   | .55                   | 1.02                 | 1.6                 | 2                     |

Dep. variable is the probability that bid differences fall in a given interval. *Marteau* is a dummy equal to 1 if the contract is awarded after the start of the investigations in October 2009. *Mtl* indicates that the contract was for Montreal. Panel A without controls. Panel B with controls. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

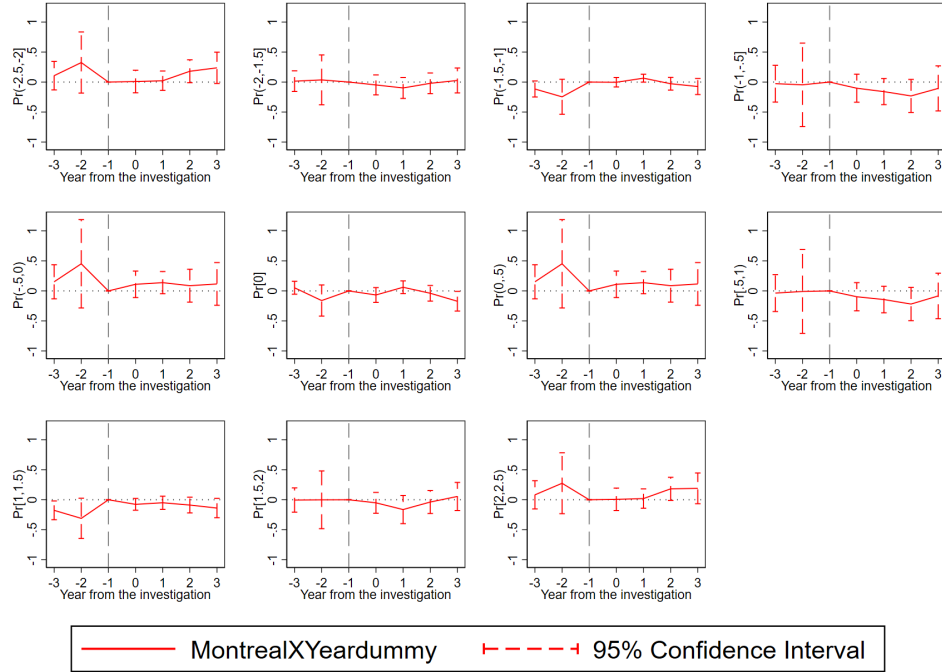
Figure A.11: Graphical representation of the distributional effect of the investigation on clustering & isolation. Original sample plus auctions with entrants, minus year 2010



This figure reports the estimated coefficient for  $Mtl \times Marteau$ , along with confidence intervals, from Table [A.4](#). Confidence intervals are computed with standard errors clustered at the borough and year levels.

## A.9 Parallel trend

Figure A.12: Event study graphs.



Notes: Plot of the coefficients (red line) and the associated confidence intervals of the interaction term between the dummy  $Mtl$  equal to 1 if the auctions is in Montreal and a dummy indicating whether the call for tender is published x years to/from the investigation, with  $x = -3, -2, 0, 1, 2, 3$ . The base group is the year 2009. The model includes also year, asphalt type and borough effects, together with auction-level controls (number of tons in the call, lagged price of crude oil and the Herfindahl index of each city at the year level). SEs are clustered at the borough-year level.  $CI$  are 95% confidence intervals.

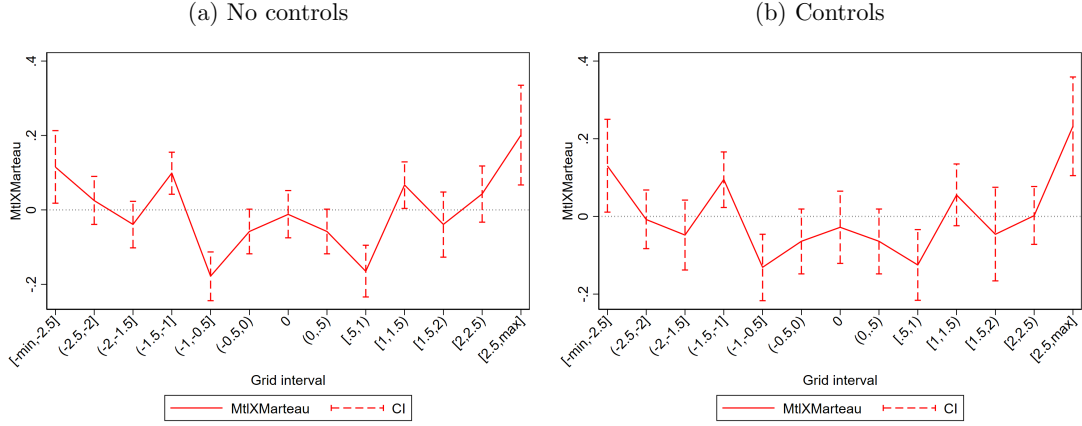
## A.10 Main results – robustness

Table A.5: Distributional effect of the investigation on clustering & isolation – entire distribution

| Dep.Var.                  | (1)<br>Pr[min -2.5]  | (2)<br>Pr(-2.5 -2)  | (3)<br>Pr(-2 -1.5)    | (4)<br>Pr(-1.5 -1)    | (5)<br>Pr(-1 -.5)     | (6)<br>Pr(-.5 0)      | (7)<br>Pr[0]         | (8)<br>Pr(0 .5)       | (9)<br>Pr(.5 1)       | (10)<br>Pr(1 1.5)     | (11)<br>Pr(1.5 2)   | (12)<br>Pr(2 2.5)    | (13)<br>Pr[2.5 max]   |
|---------------------------|----------------------|---------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|-----------------------|---------------------|----------------------|-----------------------|
| Panel A: Without controls |                      |                     |                       |                       |                       |                       |                      |                       |                       |                       |                     |                      |                       |
| Mtl×Marteau               | 0.1154**<br>(0.050)  | 0.0252<br>(0.033)   | -0.0394<br>(0.032)    | 0.0987***<br>(0.029)  | -0.1784***<br>(0.033) | -0.0582*<br>(0.031)   | -0.0115<br>(0.032)   | -0.0582*<br>(0.031)   | -0.1647***<br>(0.035) | 0.0666**<br>(0.032)   | -0.0394<br>(0.044)  | 0.0425<br>(0.039)    | 0.2014***<br>(0.068)  |
| Mtl                       | -0.0543**<br>(0.026) | -0.0370*<br>(0.021) | 0.0241<br>(0.024)     | -0.0599**<br>(0.027)  | 0.1599***<br>(0.025)  | 0.0364<br>(0.022)     | 0.0444***<br>(0.015) | 0.0364<br>(0.022)     | 0.1494***<br>(0.027)  | -0.0340<br>(0.027)    | 0.0179<br>(0.033)   | -0.0414<br>(0.027)   | -0.2420***<br>(0.049) |
| Marteau                   | 0.0649<br>(0.041)    | 0.0136<br>(0.031)   | 0.0009<br>(0.029)     | -0.0988***<br>(0.026) | 0.0256<br>(0.024)     | 0.0133<br>(0.026)     | 0.0253<br>(0.025)    | 0.0133<br>(0.026)     | 0.0133<br>(0.026)     | -0.0861***<br>(0.029) | -0.0111<br>(0.042)  | -0.0111<br>(0.035)   | 0.0369<br>(0.060)     |
| Constant                  | 0.0617**<br>(0.025)  | 0.0370*<br>(0.021)  | 0.0370*<br>(0.020)    | 0.0988***<br>(0.026)  | 0.0123<br>(0.012)     | 0.0247<br>(0.017)     | 0.0000<br>(0.000)    | 0.0247<br>(0.017)     | 0.0247<br>(0.016)     | 0.0988***<br>(0.026)  | 0.0617**<br>(0.030) | 0.0617**<br>(0.025)  | 0.4568***<br>(0.042)  |
| Observations              | 1,009                | 1,009               | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009                | 1,009                 | 1,009                 | 1,009                 | 1,009               | 1,009                | 1,009                 |
| R-squared                 | 0.0930               | 0.0226              | 0.00691               | 0.0103                | 0.0621                | 0.0104                | 0.00587              | 0.0104                | 0.0585                | 0.00680               | 0.00889             | 0.00805              | 0.0685                |
| Borough FE                | No                   | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                    | No                  | No                   | No                    |
| Year FE                   | No                   | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                    | No                  | No                   | No                    |
| Type FE                   | No                   | No                  | No                    | No                    | No                    | No                    | No                   | No                    | No                    | No                    | No                  | No                   | No                    |
| Mean Y Pre Montreal       | -4.12                | .                   | -1.58                 | -1.03                 | -.55                  | -.27                  | 0                    | .27                   | .55                   | 1.02                  | 1.6                 | 2                    | 5.6                   |
| Panel B: With controls    |                      |                     |                       |                       |                       |                       |                      |                       |                       |                       |                     |                      |                       |
| Mtl×Marteau               | 0.1304**<br>(0.061)  | -0.0076<br>(0.038)  | -0.0484<br>(0.046)    | 0.0945**<br>(0.037)   | -0.1312***<br>(0.044) | -0.0642<br>(0.043)    | -0.0282<br>(0.047)   | -0.0642<br>(0.043)    | -0.1251***<br>(0.046) | 0.0554<br>(0.041)     | -0.0457<br>(0.061)  | 0.0022<br>(0.038)    | 0.2319***<br>(0.065)  |
| Mtl                       | -0.2163<br>(0.130)   | -0.1756*<br>(0.106) | -0.0036<br>(0.062)    | -0.0334<br>(0.083)    | 0.1992*<br>(0.101)    | 0.1082<br>(0.089)     | 0.1902<br>(0.147)    | 0.1082<br>(0.089)     | 0.2473**<br>(0.113)   | -0.0964<br>(0.112)    | 0.0388<br>(0.102)   | 0.0137<br>(0.113)    | -0.3802**<br>(0.187)  |
| Marteau                   | 1.0891**<br>(0.497)  | -0.1023<br>(0.332)  | -0.5933**<br>(0.227)  | -0.2074<br>(0.293)    | 1.1732***<br>(0.375)  | -0.3230<br>(0.234)    | -0.5791<br>(0.353)   | -0.3230<br>(0.234)    | 1.0470***<br>(0.380)  | -0.2460<br>(0.316)    | -0.3983<br>(0.352)  | -0.6855**<br>(0.316) | 0.1486<br>(0.644)     |
| Crude oil lag             | -0.0061**<br>(0.003) | 0.0009<br>(0.002)   | 0.0035***<br>(0.001)  | 0.0006<br>(0.002)     | -0.0066***<br>(0.002) | 0.0020<br>(0.001)     | 0.0032<br>(0.002)    | 0.0020<br>(0.001)     | -0.0059***<br>(0.002) | 0.0010<br>(0.002)     | 0.0023<br>(0.002)   | 0.0044**<br>(0.002)  | -0.0012<br>(0.004)    |
| Quantity                  | 0.0000<br>(0.000)    | -0.0000<br>(0.000)  | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | 0.0000<br>(0.000)     | 0.0000<br>(0.000)    | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | -0.0000<br>(0.000)  | -0.0000<br>(0.000)   | 0.0000*<br>(0.000)    |
| HHI                       | 0.3268***<br>(0.111) | -0.0568<br>(0.119)  | -0.1406<br>(0.106)    | 0.0550<br>(0.091)     | 0.2678***<br>(0.071)  | -0.3949***<br>(0.097) | -0.0709<br>(0.087)   | -0.3949***<br>(0.097) | 0.2232***<br>(0.082)  | 0.0912<br>(0.095)     | -0.1986<br>(0.132)  | -0.0460<br>(0.117)   | 0.3387**<br>(0.163)   |
| Constant                  | 2.8442**<br>(1.277)  | -0.1954<br>(0.826)  | -1.5494***<br>(0.527) | -0.2556<br>(0.739)    | 2.9355***<br>(0.988)  | -0.8663<br>(0.595)    | -1.5622*<br>(0.898)  | -0.8663<br>(0.595)    | 2.6085**<br>(0.997)   | -0.3772<br>(0.799)    | -0.9576<br>(0.857)  | -1.8277**<br>(0.786) | 1.0696<br>(1.696)     |
| Observations              | 1,009                | 1,009               | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009                | 1,009                 | 1,009                 | 1,009                 | 1,009               | 1,009                | 1,009                 |
| R-squared                 | 0.183                | 0.0877              | 0.0991                | 0.105                 | 0.176                 | 0.169                 | 0.151                | 0.169                 | 0.169                 | 0.0796                | 0.125               | 0.118                | 0.132                 |
| Borough FE                | Yes                  | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  | Yes                   |
| Year FE                   | Yes                  | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  | Yes                   |
| Type FE                   | Yes                  | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  | Yes                   |
| Mean Y Pre Montreal       | -4.12                | .                   | -1.58                 | -1.03                 | -.55                  | -.27                  | 0                    | .27                   | .55                   | 1.02                  | 1.6                 | 2                    | 5.6                   |

Dep. variable is the probability that bid differences fall in a given interval. *Marteau* is a dummy equal to 1 if the contract is awarded after the start of the investigations in October 2009. *Mtl* indicates that the contract was for Montreal. Panel A without controls. Panel B with controls. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

Figure A.13: Graphical representation of the distributional effect of the investigation on clustering & isolation. Entire distribution.



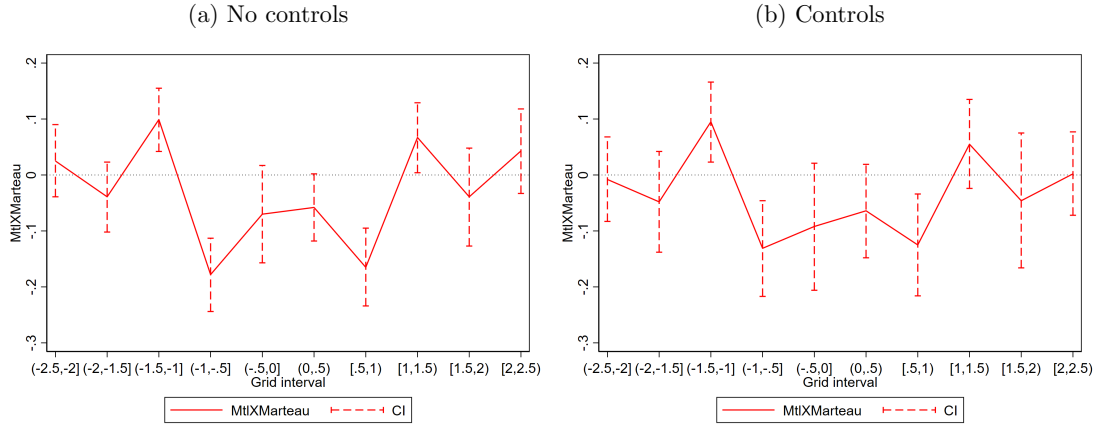
This figure reports the estimated coefficient for  $Mtl \times Marteau$ , along with confidence intervals, from Table A.5. Confidence intervals are computed with standard errors clustered at the borough and year levels.

Table A.6: Distributional effect of the investigation on clustering & isolation – no separate bin for 0.

| Dep.Var                   | (1)<br>Pr[-2.5 -2]  | (2)<br>Pr[-2-1.5]     | (3)<br>Pr[-1.5-1]     | (4)<br>Pr[-1 -.5]     | (5)<br>Pr[-.5 -0]     | (6)<br>Pr(0 .5)       | (7)<br>Pr[.5 1)       | (8)<br>Pr[1 1.5)      | (9)<br>Pr[1.5 2)    | (10)<br>Pr[2 2.5)    |
|---------------------------|---------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|---------------------|----------------------|
| Panel A: Without controls |                     |                       |                       |                       |                       |                       |                       |                       |                     |                      |
| Mtl×Marteau               | 0.0252<br>(0.033)   | -0.0394<br>(0.032)    | 0.0987***<br>(0.029)  | -0.1784***<br>(0.033) | -0.0697<br>(0.044)    | -0.0582*<br>(0.031)   | -0.1647***<br>(0.035) | 0.0666**<br>(0.032)   | -0.0394<br>(0.044)  | 0.0425<br>(0.039)    |
| Mtl                       | -0.0370*<br>(0.021) | 0.0241<br>(0.024)     | -0.0599**<br>(0.027)  | 0.1599***<br>(0.025)  | 0.0809***<br>(0.026)  | 0.0364<br>(0.022)     | 0.1494***<br>(0.027)  | -0.0340<br>(0.027)    | 0.0179<br>(0.033)   | -0.0414<br>(0.027)   |
| Marteau                   | 0.0136<br>(0.031)   | 0.0009<br>(0.029)     | -0.0988***<br>(0.026) | 0.0256<br>(0.024)     | 0.0386<br>(0.035)     | 0.0133<br>(0.026)     | 0.0133<br>(0.026)     | -0.0861***<br>(0.029) | -0.0111<br>(0.042)  | -0.0111<br>(0.035)   |
| Constant                  | 0.0370*<br>(0.021)  | 0.0370*<br>(0.020)    | 0.0988***<br>(0.026)  | 0.0123<br>(0.012)     | 0.0247<br>(0.017)     | 0.0247<br>(0.017)     | 0.0247<br>(0.016)     | 0.0988***<br>(0.026)  | 0.0617**<br>(0.030) | 0.0617**<br>(0.025)  |
| Observations              | 1,009               | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009               | 1,009                |
| R-squared                 | 0.0226              | 0.00691               | 0.0103                | 0.0621                | 0.00746               | 0.0104                | 0.0585                | 0.00680               | 0.00889             | 0.00805              |
| Borough FE                | No                  | No                    | No                    | No                    | No                    | No                    | No                    | No                    | No                  | No                   |
| Year FE                   | No                  | No                    | No                    | No                    | No                    | No                    | No                    | No                    | No                  | No                   |
| Type FE                   | No                  | No                    | No                    | No                    | No                    | No                    | No                    | No                    | No                  | No                   |
| Mean Y Pre Montreal       | .                   | -1.58                 | -1.03                 | -.55                  | -.16                  | .27                   | .55                   | 1.02                  | 1.6                 | 2                    |
| Panel B: With controls    |                     |                       |                       |                       |                       |                       |                       |                       |                     |                      |
| Mtl×Marteau               | -0.0076<br>(0.038)  | -0.0484<br>(0.046)    | 0.0945**<br>(0.037)   | -0.1312***<br>(0.044) | -0.0924<br>(0.058)    | -0.0642<br>(0.043)    | -0.1251***<br>(0.046) | 0.0554<br>(0.041)     | -0.0457<br>(0.061)  | 0.0022<br>(0.038)    |
| Mtl                       | -0.1756*<br>(0.106) | -0.0036<br>(0.062)    | -0.0334<br>(0.083)    | 0.1992*<br>(0.101)    | 0.2984**<br>(0.129)   | 0.1082<br>(0.089)     | 0.2473**<br>(0.113)   | -0.0964<br>(0.112)    | 0.0388<br>(0.102)   | 0.0137<br>(0.113)    |
| Marteau                   | -0.1023<br>(0.332)  | -0.5933**<br>(0.227)  | -0.2074<br>(0.293)    | 1.1732***<br>(0.375)  | -0.9021**<br>(0.382)  | -0.3230<br>(0.234)    | 1.0470***<br>(0.380)  | -0.2460<br>(0.316)    | -0.3983<br>(0.352)  | -0.6855**<br>(0.316) |
| Crude oil lag             | 0.0009<br>(0.002)   | 0.0035***<br>(0.001)  | 0.0006<br>(0.002)     | -0.0066***<br>(0.002) | 0.0051**<br>(0.002)   | 0.0020<br>(0.001)     | -0.0059***<br>(0.002) | 0.0010<br>(0.002)     | 0.0023<br>(0.002)   | 0.0044**<br>(0.002)  |
| Quantity                  | -0.0000<br>(0.000)  | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | 0.0000<br>(0.000)     | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | -0.0000<br>(0.000)  | -0.0000<br>(0.000)   |
| HHI                       | -0.0568<br>(0.119)  | -0.1406<br>(0.106)    | 0.0550<br>(0.091)     | 0.2678***<br>(0.071)  | -0.4657***<br>(0.101) | -0.3949***<br>(0.097) | 0.2232***<br>(0.082)  | 0.0912<br>(0.095)     | -0.1986<br>(0.132)  | -0.0460<br>(0.117)   |
| Constant                  | -0.1954<br>(0.826)  | -1.5494***<br>(0.527) | -0.2556<br>(0.739)    | 2.9355***<br>(0.988)  | -2.4285**<br>(0.965)  | -0.8663<br>(0.595)    | 2.6085**<br>(0.997)   | -0.3772<br>(0.799)    | -0.9576<br>(0.857)  | -1.8277**<br>(0.786) |
| Observations              | 1,009               | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009                 | 1,009               | 1,009                |
| R-squared                 | 0.0877              | 0.0991                | 0.105                 | 0.176                 | 0.180                 | 0.169                 | 0.169                 | 0.0796                | 0.125               | 0.118                |
| Borough FE                | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  |
| Year FE                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  |
| Type FE                   | Yes                 | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                 | Yes                  |
| Mean Y Pre Montreal       | .                   | -1.58                 | -1.03                 | -.55                  | -.16                  | .27                   | .55                   | 1.02                  | 1.6                 | 2                    |

Dep. variable is the probability that bid differences fall in a given interval. *Marteau* is a dummy equal to 1 if the contract is awarded after the start of the investigations in October 2009. *Mtl* indicates that the contract was for Montreal. Panel A without controls. Panel B with controls. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

Figure A.14: Graphical representation of the distributional effect of the investigation on clustering & isolation.



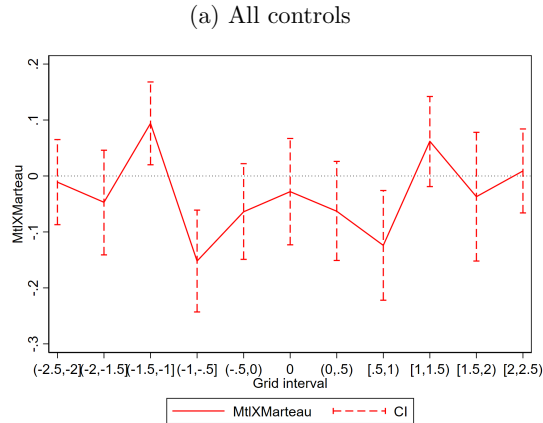
This figure reports the estimated coefficient for  $Mtl \times Marteau$ , along with confidence intervals, from Table [A.6](#). Confidence intervals are computed with standard errors clustered at the borough and year levels.

Table A.7: Distributional effect of the investigation. The estimation includes all controls in [Clark et al. \(2018\)](#).

| Dep.Var                | (1)<br>Pr(-2.5 -2] | (2)<br>Pr(-2-1.5]     | (3)<br>Pr(-1.5-1]   | (4)<br>Pr(-1 -.5]     | (5)<br>Pr(-.5 -0)     | (6)<br>Pr[0]        | (7)<br>Pr(0 .5)       | (8)<br>Pr[.5 1)       | (9)<br>Pr[1 1.5)   | (10)<br>Pr[1.5 2)    | (11)<br>Pr[2 2.5)    |
|------------------------|--------------------|-----------------------|---------------------|-----------------------|-----------------------|---------------------|-----------------------|-----------------------|--------------------|----------------------|----------------------|
| Panel A: With controls |                    |                       |                     |                       |                       |                     |                       |                       |                    |                      |                      |
| Mtl×Marteau            | -0.0109<br>(0.039) | -0.0474<br>(0.048)    | 0.0940**<br>(0.038) | -0.1520***<br>(0.046) | -0.0636<br>(0.044)    | -0.0277<br>(0.048)  | -0.0626<br>(0.045)    | -0.1242**<br>(0.050)  | 0.0617<br>(0.041)  | -0.0372<br>(0.059)   | 0.0089<br>(0.038)    |
| Mtl                    | -0.1709<br>(0.106) | -0.0204<br>(0.062)    | -0.0425<br>(0.085)  | 0.1902*<br>(0.104)    | 0.0766<br>(0.088)     | 0.1907<br>(0.148)   | 0.1243<br>(0.087)     | 0.2956**<br>(0.115)   | -0.1047<br>(0.111) | 0.0410<br>(0.101)    | -0.0017<br>(0.114)   |
| Marteau                | -0.1330<br>(0.329) | -0.5994**<br>(0.232)  | -0.2169<br>(0.301)  | 1.1662***<br>(0.413)  | -0.3079<br>(0.239)    | -0.5957<br>(0.361)  | -0.4530*<br>(0.244)   | 0.8665***<br>(0.312)  | -0.1924<br>(0.308) | -0.4469<br>(0.354)   | -0.6552**<br>(0.325) |
| Crude oil lag          | 0.0011<br>(0.002)  | 0.0035***<br>(0.001)  | 0.0007<br>(0.002)   | -0.0065***<br>(0.002) | 0.0018<br>(0.001)     | 0.0032<br>(0.002)   | 0.0027**<br>(0.001)   | -0.0048***<br>(0.002) | 0.0007<br>(0.002)  | 0.0025<br>(0.002)    | 0.0041**<br>(0.002)  |
| Capacity               | 0.0000<br>(0.000)  | -0.0000***<br>(0.000) | -0.0000*<br>(0.000) | -0.0000***<br>(0.000) | -0.0000***<br>(0.000) | 0.0000<br>(0.000)   | 0.0000***<br>(0.000)  | 0.0000***<br>(0.000)  | -0.0000<br>(0.000) | 0.0000***<br>(0.000) | -0.0000<br>(0.000)   |
| Quantity               | -0.0000<br>(0.000) | 0.0000<br>(0.000)     | -0.0000<br>(0.000)  | -0.0000<br>(0.000)    | 0.0000<br>(0.000)     | 0.0000<br>(0.000)   | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000) | -0.0000<br>(0.000)   | -0.0000<br>(0.000)   |
| Distance               | -0.0004<br>(0.001) | 0.0007<br>(0.001)     | 0.0003<br>(0.001)   | -0.0017<br>(0.002)    | 0.0011<br>(0.001)     | 0.0001<br>(0.001)   | 0.0001<br>(0.001)     | -0.0009<br>(0.001)    | 0.0007<br>(0.001)  | 0.0009<br>(0.001)    | 0.0011<br>(0.001)    |
| CON                    | 0.0119<br>(0.017)  | 0.0355<br>(0.035)     | 0.0243<br>(0.021)   | 0.0662<br>(0.043)     | 0.0569**<br>(0.027)   | 0.0056<br>(0.009)   | 0.0241<br>(0.032)     | -0.0173<br>(0.039)    | -0.0211<br>(0.022) | 0.0003<br>(0.023)    | 0.0033<br>(0.020)    |
| HHI                    | -0.0519<br>(0.119) | -0.1480<br>(0.112)    | 0.0514<br>(0.090)   | 0.2591***<br>(0.072)  | -0.4120***<br>(0.096) | -0.0687<br>(0.086)  | -0.3723***<br>(0.100) | 0.2671***<br>(0.095)  | 0.0827<br>(0.094)  | -0.1902<br>(0.126)   | -0.0554<br>(0.118)   |
| Constant               | -0.2808<br>(0.830) | -1.4603**<br>(0.571)  | -0.2150<br>(0.760)  | 3.1751***<br>(1.082)  | -0.6138<br>(0.633)    | -1.6163*<br>(0.929) | -1.3516**<br>(0.608)  | 1.7696**<br>(0.830)   | -0.2312<br>(0.785) | -1.1869<br>(0.861)   | -1.7020**<br>(0.793) |
| Observations           | 1.009              | 1.009                 | 1.009               | 1.009                 | 1.009                 | 1.009               | 1.009                 | 1.009                 | 1.009              | 1.009                | 1.009                |
| R-squared              | 0.0908             | 0.111                 | 0.109               | 0.203                 | 0.219                 | 0.151               | 0.213                 | 0.253                 | 0.0827             | 0.135                | 0.125                |
| Borough FE             | Yes                | Yes                   | Yes                 | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   | Yes                | Yes                  | Yes                  |
| Year FE                | Yes                | Yes                   | Yes                 | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   | Yes                | Yes                  | Yes                  |
| Type FE                | Yes                | Yes                   | Yes                 | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   | Yes                | Yes                  | Yes                  |
| Mean Y Pre Montreal    | .                  | -1.58                 | -1.03               | -.55                  | -.27                  | 0                   | .27                   | .55                   | 1.02               | 1.6                  | 2                    |

The outcome is the probability that bid differences fall in a given interval of values. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. *Capacity* is the firm's potential capacity, defined as the maximum quantity ever bid on by the firm (for Montreal it is based only on post-cartel years). *CON* is the percentage of all contracts won in a borough by a firm in the previous year. *Distance* is the distance from the firm to the delivery point of the borough where the job is located. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

Figure A.15: Graphical representation of the distributional effect of the investigation on clustering & isolation. The estimation includes all controls in [Clark et al. \(2018\)](#)



This figure reports the estimated coefficient for *Mtl* × *Marteau* in Table [A.7](#) along with confidence intervals. Confidence intervals are computed with standard errors clustered at the borough-year level.

Table A.8: Distributional effect of the investigation on clustering & isolation. Finer grid – 0.25

| Dep.Var.                  | (1)<br>Pr(-2.25;-2]  | (2)<br>Pr(-2;-1.75]   | (3)<br>Pr(-1.75;-1.5] | (4)<br>Pr(-1.5;-1.25] | (5)<br>Pr(-1.25;-1]  | (6)<br>Pr(-1;-0.75]  | (7)<br>Pr(-0.75;-0.5] | (8)<br>Pr(-0.5;-0.25] | (9)<br>Pr(-0.25;0] | (10)<br>Pr(0;-0.25]  | (11)<br>Pr(0.25;-0.5] | (12)<br>Pr(0.5;-0.75] | (13)<br>Pr(0.75;-1]   | (14)<br>Pr(1;-1.25] | (15)<br>Pr(1.25;-1.5] | (16)<br>Pr(1.5;-1.75] | (17)<br>Pr(1.75;-2] | (18)<br>Pr(2;-2.25]   | (19)<br>Pr(2.25;-2.5] |
|---------------------------|----------------------|-----------------------|-----------------------|-----------------------|----------------------|----------------------|-----------------------|-----------------------|--------------------|----------------------|-----------------------|-----------------------|-----------------------|---------------------|-----------------------|-----------------------|---------------------|-----------------------|-----------------------|
| Panel A: Without controls |                      |                       |                       |                       |                      |                      |                       |                       |                    |                      |                       |                       |                       |                     |                       |                       |                     |                       |                       |
| Mtx-Marteau               | 0.0256<br>(0.029)    | -0.0283<br>(0.022)    | -0.0111<br>(0.025)    | 0.0494**<br>(0.022)   | 0.0493**<br>(0.024)  | -0.0426**<br>(0.020) | -0.1364***<br>(0.030) | -0.0491*<br>(0.025)   | -0.0091<br>(0.018) | -0.0115<br>(0.032)   | -0.0091<br>(0.018)    | -0.0491*<br>(0.025)   | -0.1383***<br>(0.030) | -0.0264<br>(0.025)  | 0.0266<br>(0.024)     | 0.0400<br>(0.026)     | -0.0294<br>(0.033)  | -0.0101<br>(0.027)    | 0.0272<br>(0.034)     |
| Mtl                       | -0.0247<br>(0.017)   | 0.0062<br>(0.013)     | 0.0179<br>(0.021)     | -0.0494**<br>(0.022)  | -0.0105<br>(0.022)   | 0.0296***<br>(0.007) | 0.1302***<br>(0.003)  | 0.0364<br>(0.022)     | -0.0000<br>(0.015) | 0.0444***<br>(0.006) | 0.0364<br>(0.022)     | 0.0364<br>(0.022)     | 0.1321***<br>(0.003)  | 0.0173<br>(0.014)   | 0.0154<br>(0.022)     | -0.0494**<br>(0.022)  | 0.0235<br>(0.021)   | -0.0056<br>(0.021)    | -0.0167<br>(0.022)    |
| Marteau                   | 0.0133<br>(0.027)    | 0.0130<br>(0.021)     | -0.0120<br>(0.021)    | -0.0494**<br>(0.022)  | -0.0494**<br>(0.022) | 0.0253<br>(0.017)    | 0.0003<br>(0.012)     | -0.0120<br>(0.021)    | 0.0253<br>(0.017)  | 0.0253<br>(0.017)    | 0.0253<br>(0.017)     | -0.0120<br>(0.021)    | 0.0003<br>(0.012)     | 0.0130<br>(0.021)   | -0.0494**<br>(0.022)  | 0.0006<br>(0.026)     | 0.0006<br>(0.026)   | -0.0117<br>(0.029)    | 0.0009<br>(0.029)     |
| Constant                  | 0.0247<br>(0.017)    | 0.0123<br>(0.012)     | 0.0247<br>(0.017)     | 0.0494**<br>(0.022)   | 0.0494**<br>(0.022)  | -0.0000<br>(0.012)   | 0.0123<br>(0.017)     | 0.0247<br>(0.017)     | 0.0000<br>(0.006)  | 0.0000<br>(0.006)    | 0.0000<br>(0.006)     | 0.0247<br>(0.017)     | 0.0123<br>(0.012)     | 0.0130<br>(0.021)   | 0.0494**<br>(0.022)   | 0.0494**<br>(0.022)   | 0.0247<br>(0.017)   | 0.0370*<br>(0.020)    | 0.0370*<br>(0.020)    |
| Observations              | 1,009                | 1,009                 | 1,009                 | 1,009                 | 1,009                | 1,009                | 1,009                 | 1,009                 | 1,009              | 1,009                | 1,009                 | 1,009                 | 1,009                 | 1,009               | 1,009                 | 1,009                 | 1,009               | 1,009                 | 1,009                 |
| R-squared                 | 0.0085               | 0.0044                | 0.0046                | 0.0046                | 0.0046               | 0.0045               | 0.0006                | 0.0229                | 0.0119             | 0.0057               | 0.0119                | 0.0229                | 0.0016                | 0.0201              | 0.0075                | 0.0298                | 0.0053              | 0.0034                | 0.0034                |
| Borough FE                | No                   | No                    | No                    | No                    | No                   | No                   | No                    | No                    | No                 | No                   | No                    | No                    | No                    | No                  | No                    | No                    | No                  | No                    | No                    |
| Year FE                   | No                   | No                    | No                    | No                    | No                   | No                   | No                    | No                    | No                 | No                   | No                    | No                    | No                    | No                  | No                    | No                    | No                  | No                    | No                    |
| Type FE                   | No                   | No                    | No                    | No                    | No                   | No                   | No                    | No                    | No                 | No                   | No                    | No                    | No                    | No                  | No                    | No                    | No                  | No                    | No                    |
| Mean Y Pre Montreal       | -1.75                | -1.75                 | -1.5                  | .                     | -1.03                | -77                  | -5                    | -27                   | .                  | -1.75                | .                     | .27                   | .5                    | .77                 | 1.02                  | .                     | 1.5                 | 1.75                  | 2                     |
| Panel B: With controls    |                      |                       |                       |                       |                      |                      |                       |                       |                    |                      |                       |                       |                       |                     |                       |                       |                     |                       |                       |
| Mtx-Marteau               | 0.0164<br>(0.034)    | 0.0043<br>(0.011)     | -0.0527<br>(0.046)    | 0.0694**<br>(0.028)   | 0.0341<br>(0.029)    | -0.0296<br>(0.027)   | -0.1015***<br>(0.036) | -0.0365<br>(0.029)    | -0.0277<br>(0.026) | -0.0282<br>(0.047)   | -0.0277<br>(0.026)    | -0.0365<br>(0.029)    | -0.1087***<br>(0.036) | -0.0163<br>(0.030)  | -0.0095<br>(0.031)    | 0.0649**<br>(0.028)   | -0.0810<br>(0.059)  | 0.0353*<br>(0.020)    | 0.0239<br>(0.035)     |
| Mtl                       | -0.1834*<br>(0.099)  | -0.0095<br>(0.020)    | 0.0059<br>(0.057)     | 0.1430**<br>(0.068)   | -0.1764**<br>(0.071) | 0.0060<br>(0.085)    | 0.1932***<br>(0.072)  | 0.0621<br>(0.072)     | 0.0461<br>(0.042)  | 0.1902<br>(0.147)    | 0.0461<br>(0.042)     | 0.0621<br>(0.072)     | 0.1900***<br>(0.072)  | 0.0573<br>(0.088)   | -0.1398**<br>(0.070)  | 0.0434<br>(0.108)     | 0.0365<br>(0.061)   | 0.0023<br>(0.057)     | 0.0176<br>(0.100)     |
| Marteau                   | -0.2241<br>(0.294)   | -0.4231***<br>(0.143) | -0.1702<br>(0.174)    | 0.0403<br>(0.074)     | -0.2477<br>(0.287)   | 0.1640<br>(0.221)    | 1.0091***<br>(0.320)  | -0.4181***<br>(0.157) | 0.0951<br>(0.152)  | -0.5791<br>(0.353)   | 0.0951<br>(0.152)     | -0.4181***<br>(0.157) | 0.9657***<br>(0.312)  | 0.0813<br>(0.228)   | -0.1502<br>(0.284)    | -0.0658<br>(0.114)    | -0.2318<br>(0.198)  | -0.1665<br>(0.260)    | -0.7839***<br>(0.291) |
| Crude oil lag             | 0.0014<br>(0.002)    | 0.0025***<br>(0.001)  | 0.0010<br>(0.001)     | -0.0005<br>(0.006)    | 0.0012<br>(0.002)    | -0.0011<br>(0.001)   | -0.0054***<br>(0.002) | 0.0022***<br>(0.001)  | -0.0003<br>(0.001) | 0.0032<br>(0.002)    | -0.0003<br>(0.001)    | 0.0022***<br>(0.001)  | -0.0052***<br>(0.001) | -0.0007<br>(0.001)  | 0.0008<br>(0.001)     | 0.0002<br>(0.001)     | 0.0015<br>(0.001)   | 0.0008<br>(0.001)     | 0.0048***<br>(0.002)  |
| Quantity                  | -0.0000<br>(0.000)   | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | 0.0000<br>(0.000)     | -0.0000<br>(0.000)   | -0.0000<br>(0.000)   | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | 0.0000<br>(0.000)  | 0.0000<br>(0.000)    | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | -0.0000<br>(0.000)  | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    | -0.0000<br>(0.000)  | -0.0000<br>(0.000)    | -0.0000<br>(0.000)    |
| HHI                       | -0.1497**<br>(0.060) | -0.3121***<br>(0.038) | -0.0085<br>(0.095)    | 0.0995<br>(0.065)     | -0.0446<br>(0.092)   | 0.0235<br>(0.033)    | 0.2443***<br>(0.069)  | -0.4565***<br>(0.073) | 0.0616<br>(0.046)  | -0.0769<br>(0.046)   | 0.0616<br>(0.046)     | -0.4565***<br>(0.073) | 0.2298**<br>(0.072)   | -0.0054<br>(0.095)  | 0.0130<br>(0.052)     | 0.0782<br>(0.049)     | -0.0388<br>(0.105)  | -0.1598***<br>(0.071) | -0.1064<br>(0.171)    |
| Constant                  | -0.3960<br>(0.753)   | -1.1128***<br>(0.361) | -0.4366<br>(0.373)    | 0.0697<br>(0.156)     | -0.3253<br>(0.731)   | 0.6540<br>(0.004)    | 2.2866***<br>(0.815)  | -0.9370**<br>(0.377)  | 0.0707<br>(0.403)  | -1.5622*<br>(0.588)  | 0.0707<br>(0.403)     | -0.9370**<br>(0.377)  | 2.1701***<br>(0.792)  | 0.4884<br>(0.622)   | -0.2004<br>(0.724)    | -0.1768<br>(0.264)    | -0.6414<br>(0.452)  | -0.3162<br>(0.654)    | -1.9044***<br>(0.741) |
| Observations              | 1,009                | 1,009                 | 1,009                 | 1,009                 | 1,009                | 1,009                | 1,009                 | 1,009                 | 1,009              | 1,009                | 1,009                 | 1,009                 | 1,009                 | 1,009               | 1,009                 | 1,009                 | 1,009               | 1,009                 | 1,009                 |
| R-squared                 | 0.0988               | 0.181                 | 0.103                 | 0.135                 | 0.103                | 0.112                | 0.183                 | 0.193                 | 0.0771             | 0.151                | 0.0771                | 0.193                 | 0.180                 | 0.115               | 0.0847                | 0.106                 | 0.103               | 0.222                 | 0.125                 |
| Borough FE                | Yes                  | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                   | Yes                   | Yes                | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   |
| Year FE                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                   | Yes                   | Yes                | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   |
| Type FE                   | Yes                  | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                   | Yes                   | Yes                | Yes                  | Yes                   | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   |
| Mean Y Pre Montreal       | .                    | -1.75                 | -1.5                  | .                     | -1.03                | -77                  | -5                    | -27                   | .                  | -1.75                | .                     | .27                   | .5                    | .77                 | 1.02                  | .                     | 1.5                 | 1.75                  | 2                     |

Dep. variable is the probability that bid differences fall in a given interval. *Marteau* is a dummy equal to 1 if the contract is awarded after the start of the investigations in October 2009. *Mtl* indicates that the contract was for Montreal. Panel A without controls. Panel B with controls. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*)

Table A.9: Distributional regression doubling intervals around 0.

| Dep.Var                   | (1)<br>Pr(-4 -3]     | (2)<br>Pr(-3 -2]     | (3)<br>Pr(-2 -1]      | (4)<br>Pr(-1 0)       | (5)<br>Pr[0]         | (6)<br>Pr(0 1)        | (7)<br>Pr[1, 2)      | (8)<br>Pr[2 3)        | (9)<br>Pr[3 4)        |
|---------------------------|----------------------|----------------------|-----------------------|-----------------------|----------------------|-----------------------|----------------------|-----------------------|-----------------------|
| Panel A: Without controls |                      |                      |                       |                       |                      |                       |                      |                       |                       |
| MtlXMarteau               | -0.0113<br>(0.031)   | 0.0459<br>(0.039)    | 0.0593<br>(0.040)     | -0.2366***<br>(0.039) | -0.0115<br>(0.032)   | -0.2229***<br>(0.044) | 0.0272<br>(0.048)    | 0.0950*<br>(0.048)    | -0.0133<br>(0.045)    |
| Mtl                       | -0.0228<br>(0.017)   | -0.0704**<br>(0.028) | -0.0358<br>(0.031)    | 0.1963***<br>(0.027)  | 0.0444***<br>(0.015) | 0.1858***<br>(0.034)  | -0.0160<br>(0.033)   | -0.1191***<br>(0.037) | -0.1531***<br>(0.035) |
| Marteau                   | 0.0386<br>(0.030)    | -0.0108<br>(0.038)   | -0.0978***<br>(0.035) | 0.0389<br>(0.033)     | 0.0253<br>(0.025)    | 0.0266<br>(0.039)     | -0.0972**<br>(0.044) | -0.0969**<br>(0.045)  | 0.0674<br>(0.044)     |
| Constant                  | 0.0247<br>(0.017)    | 0.0741***<br>(0.028) | 0.1358***<br>(0.028)  | 0.0370*<br>(0.019)    | 0.0000<br>(0.000)    | 0.0494*<br>(0.028)    | 0.1605***<br>(0.031) | 0.1728***<br>(0.036)  | 0.1605***<br>(0.034)  |
| Observations              | 1,009                | 1,009                | 1,009                 | 1,009                 | 1,009                | 1,009                 | 1,009                | 1,009                 | 1,009                 |
| R-squared                 | 0.0205               | 0.0252               | 0.00849               | 0.0739                | 0.00587              | 0.0707                | 0.0128               | 0.0177                | 0.0880                |
| Borough FE                | No                   | No                   | No                    | No                    | No                   | No                    | No                   | No                    | No                    |
| Year FE                   | No                   | No                   | No                    | No                    | No                   | No                    | No                   | No                    | No                    |
| Type FE                   | No                   | No                   | No                    | No                    | No                   | No                    | No                   | No                    | No                    |
| Mean Y Pre Montreal       | -3.5                 | -2.5                 | -1.36                 | -.48                  | 0                    | .48                   | 1.34                 | 2.34                  | 3.15                  |
| Panel B: With controls    |                      |                      |                       |                       |                      |                       |                      |                       |                       |
| Mtl×Marteau               | 0.0074<br>(0.029)    | 0.0462<br>(0.050)    | 0.0462<br>(0.061)     | -0.1954***<br>(0.058) | -0.0282<br>(0.047)   | -0.1893***<br>(0.059) | 0.0098<br>(0.068)    | 0.0595<br>(0.060)     | 0.0299<br>(0.047)     |
| Mtl                       | -0.2071**<br>(0.095) | -0.1490<br>(0.107)   | -0.0370<br>(0.090)    | 0.3074**<br>(0.129)   | 0.1902<br>(0.147)    | 0.3555**<br>(0.155)   | -0.0576<br>(0.116)   | -0.0749<br>(0.129)    | -0.2152*<br>(0.121)   |
| Marteau                   | 0.3332<br>(0.272)    | 0.0002<br>(0.351)    | -0.8007**<br>(0.366)  | 0.8502**<br>(0.414)   | -0.5791<br>(0.353)   | 0.7240*<br>(0.424)    | -0.6443<br>(0.437)   | -1.2761***<br>(0.406) | 0.1004<br>(0.326)     |
| Crude oil lag             | -0.0018<br>(0.002)   | 0.0000<br>(0.002)    | 0.0042**<br>(0.002)   | -0.0046*<br>(0.002)   | 0.0032<br>(0.002)    | -0.0040<br>(0.002)    | 0.0033<br>(0.002)    | 0.0070***<br>(0.002)  | -0.0004<br>(0.002)    |
| Quantity                  | 0.0000<br>(0.000)    | -0.0000<br>(0.000)   | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    | 0.0000<br>(0.000)    | -0.0000<br>(0.000)    | -0.0000<br>(0.000)   | 0.0000<br>(0.000)     | -0.0000<br>(0.000)    |
| HHI                       | 0.1062<br>(0.065)    | 0.1027<br>(0.107)    | -0.0857<br>(0.121)    | -0.1270<br>(0.116)    | -0.0709<br>(0.087)   | -0.1717<br>(0.128)    | -0.1074<br>(0.128)   | -0.1542<br>(0.168)    | 0.1718*<br>(0.102)    |
| Constant                  | 0.9857<br>(0.721)    | 0.1151<br>(0.885)    | -1.8050**<br>(0.905)  | 2.0691*<br>(1.093)    | -1.5622*<br>(0.898)  | 1.7422<br>(1.112)     | -1.3348<br>(1.098)   | -2.8787***<br>(0.979) | 0.3601<br>(0.822)     |
| Observations              | 1,009                | 1,009                | 1,009                 | 1,009                 | 1,009                | 1,009                 | 1,009                | 1,009                 | 1,009                 |
| R-squared                 | 0.0891               | 0.0951               | 0.115                 | 0.152                 | 0.151                | 0.149                 | 0.137                | 0.0865                | 0.145                 |
| Borough FE                | Yes                  | Yes                  | Yes                   | Yes                   | Yes                  | Yes                   | Yes                  | Yes                   | Yes                   |
| Year FE                   | Yes                  | Yes                  | Yes                   | Yes                   | Yes                  | Yes                   | Yes                  | Yes                   | Yes                   |
| Type FE                   | Yes                  | Yes                  | Yes                   | Yes                   | Yes                  | Yes                   | Yes                  | Yes                   | Yes                   |
| Mean Y Pre Montreal       | -3.5                 | -2.5                 | -1.36                 | -.48                  | 0                    | .48                   | 1.34                 | 2.34                  | 3.15                  |

The outcome is the probability that bid differences fall in a given interval of values. *Quantity* represents the number of tons in the call. *Crude oil lag* represents the lagged price of crude oil. *HHI* is the Herfindahl index of each city at the year level. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

## A.11 Full regression results from the estimation of Equation 4

Table A.10: Estimation of the parametric screen (equation 4) comparing bid differences  $\Delta_{i,a}^1$  with respect to  $\Delta_{i,a}^2$  in Montreal and Quebec City before and after the investigation.

| Dep.Var                      | (1)<br>Pr(-2.5 -2]   | (2)<br>Pr(-2-1.5]     | (3)<br>Pr(-1.5-1]     | (4)<br>Pr(-1 -.5]    | (5)<br>Pr(-.5 -0)    | (6)<br>Pr[0]         | (7)<br>Pr(0 .5)      | (8)<br>Pr[.5 1)      | (9)<br>Pr[1 1.5]     | (10)<br>Pr[1.5 2)    | (11)<br>Pr[2 2.5]    |
|------------------------------|----------------------|-----------------------|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Panel A: Montreal Pre        |                      |                       |                       |                      |                      |                      |                      |                      |                      |                      |                      |
| $\mathbb{1}(\Delta_{i,a}^1)$ | -0.0408**<br>(0.020) | -0.0949***<br>(0.034) | 0.0194<br>(0.017)     | 0.0276<br>(0.023)    | 0.0684***<br>(0.021) | 0.0163<br>(0.034)    | 0.0684***<br>(0.021) | 0.0197<br>(0.026)    | 0.0527***<br>(0.016) | -0.1119**<br>(0.048) | -0.0248<br>(0.027)   |
| Constant                     | 0.0408**<br>(0.020)  | 0.1735***<br>(0.032)  | 0.0306**<br>(0.013)   | 0.1939***<br>(0.026) | 0.0102<br>(0.010)    | 0.0408<br>(0.027)    | 0.0102<br>(0.010)    | 0.2041***<br>(0.028) | 0.0306**<br>(0.013)  | 0.2143***<br>(0.042) | 0.0510**<br>(0.021)  |
| Observations                 | 518                  | 518                   | 518                   | 518                  | 518                  | 518                  | 518                  | 518                  | 518                  | 518                  | 518                  |
| R-squared                    | 0.0334               | 0.0158                | 0.00130               | 0.000687             | 0.0117               | 0.000800             | 0.0117               | 0.000348             | 0.00627              | 0.0177               | 0.00316              |
| Controls                     | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Borough FE                   | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Year FE                      | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Type FE                      | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Panel B: Montreal Post       |                      |                       |                       |                      |                      |                      |                      |                      |                      |                      |                      |
| $\mathbb{1}(\Delta_{i,a}^1)$ | -0.0119<br>(0.045)   | 0.0231<br>(0.024)     | 0.0014<br>(0.044)     | -0.0393<br>(0.031)   | -0.0083<br>(0.026)   | 0.0555<br>(0.066)    | -0.0083<br>(0.026)   | -0.0303<br>(0.035)   | 0.0061<br>(0.054)    | 0.0411<br>(0.025)    | -0.0292<br>(0.047)   |
| Constant                     | 0.1200***<br>(0.033) | 0.0400*<br>(0.021)    | 0.1067***<br>(0.026)  | 0.0933***<br>(0.023) | 0.0533**<br>(0.021)  | 0.1067***<br>(0.038) | 0.0533**<br>(0.021)  | 0.0933***<br>(0.023) | 0.1200***<br>(0.032) | 0.0400*<br>(0.021)   | 0.1733***<br>(0.043) |
| Observations                 | 186                  | 186                   | 186                   | 186                  | 186                  | 186                  | 186                  | 186                  | 186                  | 186                  | 186                  |
| R-squared                    | 0.000340             | 0.00252               | 5.21e-06              | 0.00571              | 0.000359             | 0.00616              | 0.000359             | 0.00317              | 8.33e-05             | 0.00673              | 0.00156              |
| Controls                     | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Borough FE                   | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Year FE                      | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Type FE                      | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Panel C: Quebec Pre          |                      |                       |                       |                      |                      |                      |                      |                      |                      |                      |                      |
| $\mathbb{1}(\Delta_{i,a}^1)$ | -0.0161<br>(0.067)   | -0.0161<br>(0.063)    | 0.0191<br>(0.082)     | -0.0209<br>(0.043)   | 0.0048<br>(0.049)    |                      | 0.0048<br>(0.049)    | 0.0048<br>(0.036)    | -0.0042<br>(0.086)   | 0.0119<br>(0.085)    | 0.0119<br>(0.078)    |
| Constant                     | 0.0930**<br>(0.044)  | 0.0930**<br>(0.044)   | 0.1860***<br>(0.053)  | 0.0465<br>(0.032)    | 0.0465<br>(0.032)    |                      | 0.0465<br>(0.032)    | 0.0465<br>(0.032)    | 0.2093***<br>(0.052) | 0.1163**<br>(0.046)  | 0.1163**<br>(0.046)  |
| Observations                 | 82                   | 82                    | 82                    | 82                   | 82                   |                      | 82                   | 82                   | 82                   | 82                   | 82                   |
| R-squared                    | 0.000828             | 0.000828              | 0.000578              | 0.00308              | 0.000122             |                      | 0.000122             | 0.000122             | 2.64e-05             | 0.000331             | 0.000331             |
| Controls                     | No                   | No                    | No                    | No                   | No                   |                      | No                   | No                   | No                   | No                   | No                   |
| Borough FE                   | No                   | No                    | No                    | No                   | No                   |                      | No                   | No                   | No                   | No                   | No                   |
| Year FE                      | No                   | No                    | No                    | No                   | No                   |                      | No                   | No                   | No                   | No                   | No                   |
| Type FE                      | No                   | No                    | No                    | No                   | No                   |                      | No                   | No                   | No                   | No                   | No                   |
| Panel D: Quebec Post         |                      |                       |                       |                      |                      |                      |                      |                      |                      |                      |                      |
| $\mathbb{1}(\Delta_{i,a}^1)$ | 0.0976<br>(0.076)    | 0.0643<br>(0.068)     | -0.2500***<br>(0.069) | -0.0071<br>(0.064)   | 0.0286<br>(0.073)    | 0.0667<br>(0.067)    | 0.0286<br>(0.073)    | 0.0286<br>(0.057)    | -0.2167**<br>(0.083) | 0.0619<br>(0.084)    | 0.0976<br>(0.076)    |
| Constant                     | 0.0357<br>(0.036)    | 0.0357<br>(0.036)     | 0.2500***<br>(0.069)  | 0.1071*<br>(0.057)   | 0.0714<br>(0.048)    | 0.0000<br>(0.000)    | 0.0714<br>(0.048)    | 0.0714<br>(0.048)    | 0.2500***<br>(0.069) | 0.0714<br>(0.048)    | 0.0357<br>(0.036)    |
| Observations                 | 58                   | 58                    | 58                    | 58                   | 58                   | 58                   | 58                   | 58                   | 58                   | 58                   | 58                   |
| R-squared                    | 0.0302               | 0.0161                | 0.147                 | 0.000137             | 0.00259              | 0.0333               | 0.00259              | 0.00259              | 0.0986               | 0.0103               | 0.0302               |
| Controls                     | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Borough FE                   | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Year FE                      | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |
| Type FE                      | No                   | No                    | No                    | No                   | No                   | No                   | No                   | No                   | No                   | No                   | No                   |

The outcome is the probability that bid differences fall in a given interval of values.  $\mathbb{1}(\Delta_{i,a}^1)$  is an indicator variable equal to 1 if the observation is derived from the distribution of  $\Delta_{i,a}^1$  and 0 if derived from the distribution of  $\Delta_{i,a}^2$ . Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*)

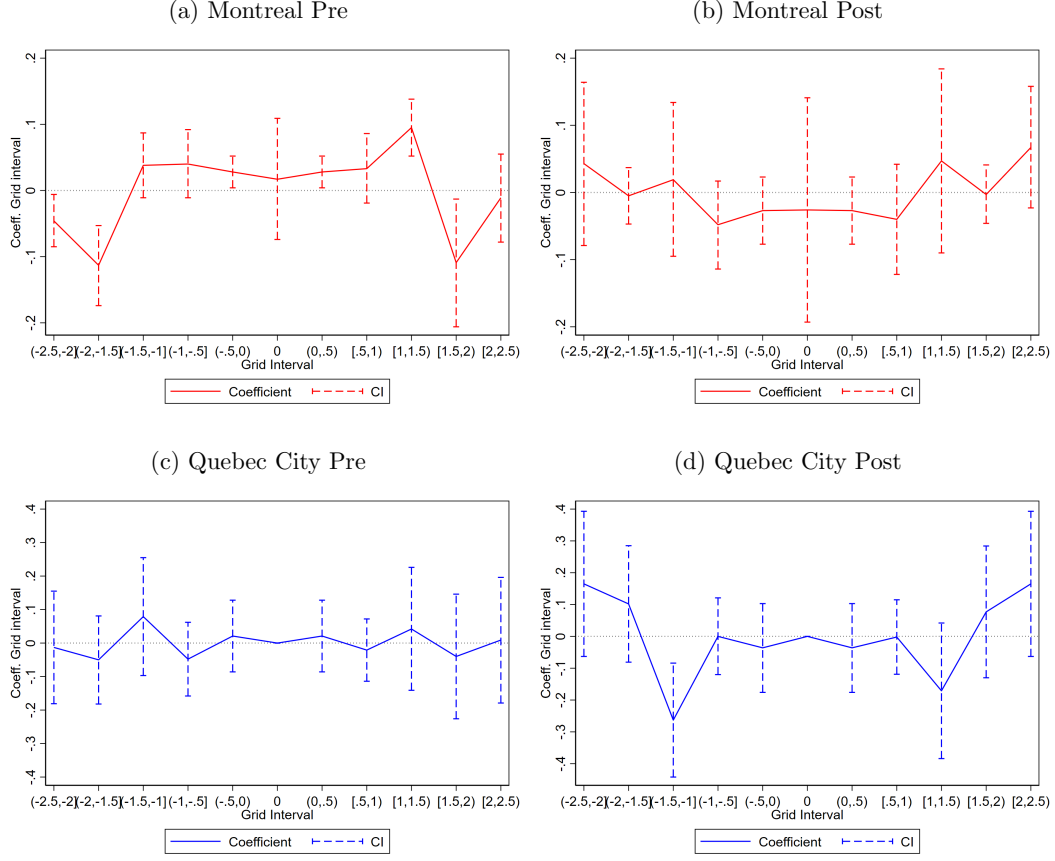
## A.12 Test adding controls

Table A.11: Estimation of the parametric screen (equation [4](#)) comparing bid differences  $\Delta_{i,a}^1$  with respect to  $\Delta_{i,a}^2$  in Montreal and Quebec City before and after the investigation. Controls are added in this specification.

| Dep.Var                      | (1)<br>Pr(-2.5 -2]    | (2)<br>Pr(-2-1.5]     | (3)<br>Pr(-1.5-1]     | (4)<br>Pr(-1 -.5]    | (5)<br>Pr(-.5 -0)    | (6)<br>Pr[0]         | (7)<br>Pr(0 .5)      | (8)<br>Pr[.5 1]      | (9)<br>Pr[1 1.5]      | (10)<br>Pr[1.5 2]    | (11)<br>Pr[2 2.5]     |
|------------------------------|-----------------------|-----------------------|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|----------------------|-----------------------|
| Panel A: Montreal Pre        |                       |                       |                       |                      |                      |                      |                      |                      |                       |                      |                       |
| $\mathbb{I}(\Delta_{i,a}^1)$ | -0.0455**<br>(0.020)  | -0.1132***<br>(0.031) | 0.0379<br>(0.025)     | 0.0402<br>(0.026)    | 0.0279**<br>(0.012)  | 0.0174<br>(0.047)    | 0.0279**<br>(0.012)  | 0.0334<br>(0.027)    | 0.0947***<br>(0.022)  | -0.1094**<br>(0.049) | -0.0113<br>(0.034)    |
| Constant                     | 0.0889***<br>(0.032)  | -0.1794<br>(0.127)    | 0.1302***<br>(0.043)  | 0.1495<br>(0.115)    | 0.0657<br>(0.058)    | 0.4545***<br>(0.095) | 0.0657<br>(0.058)    | 0.1823<br>(0.123)    | 0.0112<br>(0.075)     | -0.0829<br>(0.132)   | 0.1143***<br>(0.034)  |
| Observations                 | 518                   | 518                   | 518                   | 518                  | 518                  | 518                  | 518                  | 518                  | 518                   | 518                  | 518                   |
| R-squared                    | 0.115                 | 0.125                 | 0.136                 | 0.111                | 0.219                | 0.266                | 0.219                | 0.104                | 0.107                 | 0.128                | 0.0816                |
| Controls                     | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Borough FE                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Year FE                      | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Type FE                      | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Panel B: Montreal Post       |                       |                       |                       |                      |                      |                      |                      |                      |                       |                      |                       |
| $\mathbb{I}(\Delta_{i,a}^1)$ | 0.0426<br>(0.062)     | -0.0046<br>(0.021)    | 0.0193<br>(0.058)     | -0.0483<br>(0.033)   | -0.0270<br>(0.026)   | -0.0263<br>(0.085)   | -0.0270<br>(0.026)   | -0.0401<br>(0.042)   | 0.0468<br>(0.070)     | -0.0029<br>(0.022)   | 0.0674<br>(0.046)     |
| Constant                     | 0.1178<br>(0.541)     | -0.1820<br>(0.277)    | -0.7902***<br>(0.216) | 1.2452***<br>(0.373) | 0.3637<br>(0.246)    | -0.3398<br>(0.760)   | 0.3637<br>(0.246)    | 1.3908***<br>(0.428) | -0.8285***<br>(0.214) | 0.4858<br>(0.379)    | -0.8267<br>(0.775)    |
| Observations                 | 186                   | 186                   | 186                   | 186                  | 186                  | 186                  | 186                  | 186                  | 186                   | 186                  | 186                   |
| R-squared                    | 0.158                 | 0.302                 | 0.206                 | 0.158                | 0.273                | 0.299                | 0.273                | 0.149                | 0.233                 | 0.276                | 0.235                 |
| Controls                     | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Borough FE                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Year FE                      | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Type FE                      | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Panel C: Quebec Pre          |                       |                       |                       |                      |                      |                      |                      |                      |                       |                      |                       |
| $\mathbb{I}(\Delta_{i,a}^1)$ | -0.0126<br>(0.086)    | -0.0503<br>(0.067)    | 0.0793<br>(0.090)     | -0.0477<br>(0.056)   | 0.0207<br>(0.055)    |                      | 0.0207<br>(0.055)    | -0.0211<br>(0.047)   | 0.0423<br>(0.094)     | -0.0400<br>(0.095)   | 0.0088<br>(0.096)     |
| Constant                     | 0.1204<br>(0.242)     | -0.1695<br>(0.266)    | 0.9796***<br>(0.337)  | -0.0647<br>(0.114)   | -0.5158**<br>(0.204) |                      | -0.5158**<br>(0.204) | -0.1352<br>(0.146)   | 1.1370***<br>(0.270)  | 0.0279<br>(0.291)    | 0.1362<br>(0.163)     |
| Observations                 | 82                    | 82                    | 82                    | 82                   | 82                   |                      | 82                   | 82                   | 82                    | 82                   | 82                    |
| R-squared                    | 0.106                 | 0.164                 | 0.123                 | 0.122                | 0.171                |                      | 0.171                | 0.152                | 0.112                 | 0.124                | 0.0795                |
| Controls                     | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  |                      | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Borough FE                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  |                      | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Year FE                      | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  |                      | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Type FE                      | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  |                      | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Panel D: Quebec Post         |                       |                       |                       |                      |                      |                      |                      |                      |                       |                      |                       |
| $\mathbb{I}(\Delta_{i,a}^1)$ | 0.1650<br>(0.117)     | 0.1020<br>(0.093)     | -0.2629**<br>(0.092)  | 0.0003<br>(0.061)    | -0.0365<br>(0.071)   | -0.0000<br>(0.000)   | -0.0365<br>(0.071)   | -0.0020<br>(0.060)   | -0.1713<br>(0.109)    | 0.0770<br>(0.106)    | 0.1650<br>(0.117)     |
| Constant                     | -1.0604***<br>(0.331) | -0.4438<br>(0.376)    | 0.2031<br>(0.482)     | 0.6112<br>(0.926)    | 0.7708<br>(0.668)    | 1.0000***<br>(0.000) | 0.7708<br>(0.668)    | 0.8829<br>(0.921)    | 0.2199<br>(0.570)     | -0.8942<br>(0.601)   | -1.0604***<br>(0.331) |
| Observations                 | 58                    | 58                    | 58                    | 58                   | 58                   | 58                   | 58                   | 58                   | 58                    | 58                   | 58                    |
| R-squared                    | 0.158                 | 0.161                 | 0.226                 | 0.133                | 0.261                | 1                    | 0.261                | 0.161                | 0.193                 | 0.218                | 0.158                 |
| Controls                     | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Borough FE                   | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Year FE                      | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |
| Type FE                      | Yes                   | Yes                   | Yes                   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                   | Yes                  | Yes                   |

The outcome is the probability that bid differences fall in a given interval of values.  $\mathbb{I}(\Delta_{i,a}^1)$  is an indicator variable equal to 1 if the observation is derived from the distribution of  $\Delta_{i,a}^1$  and 0 if derived from the distribution of  $\Delta_{i,a}^2$ . Controls include *Quantity* which represents the number of tons in the call, *Crude oil lag* which represents the lagged price of crude oil and *HHI* which represents the Herfindahl index of each city at the year level. Standard errors are clustered at the borough and year levels. Significance at 10% (\*), 5% (\*\*), and 1% (\*\*\*).

Figure A.16: Graphical representation of the parametric screen. Controls are added in this specification.



This figure reports the coefficients  $\beta_q$  estimated from equation (4), along with confidence intervals, obtained separately for each city/time period. Confidence intervals are computed with standard errors clustered at the borough and year levels.

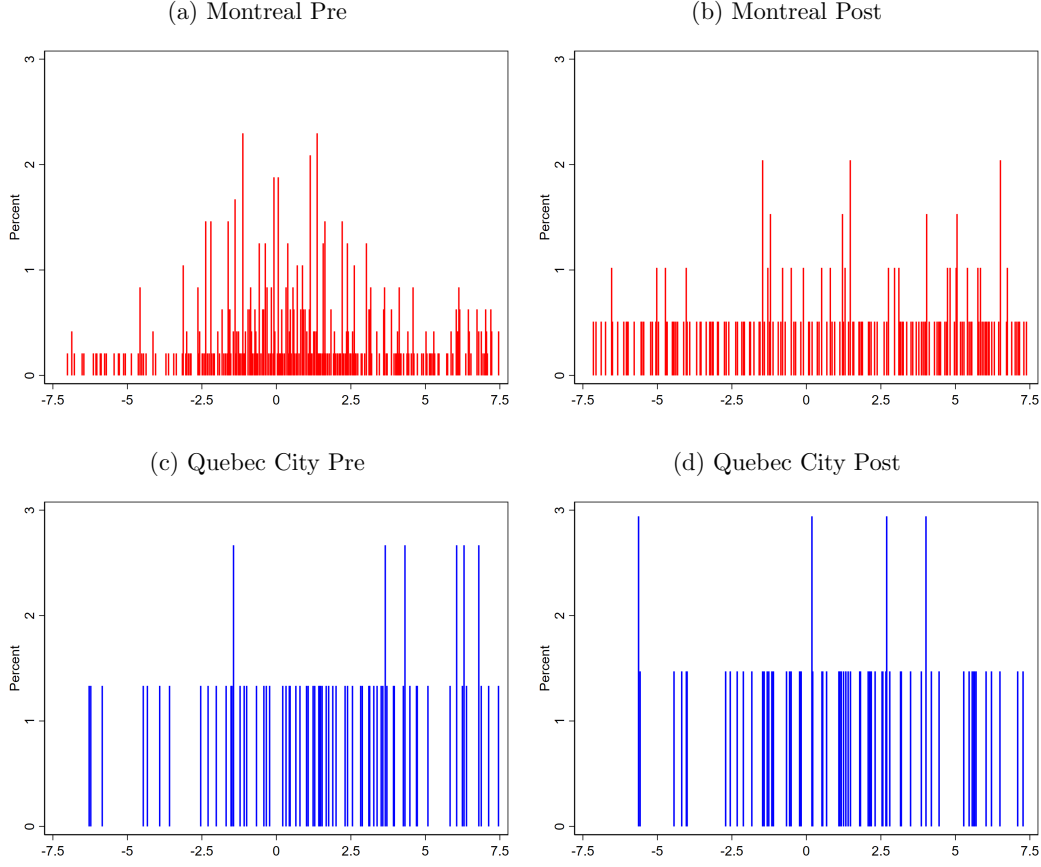
Table A.12: Nonparametric implementation of the screen

|             | Pre Anti-Collusion Investigation | Post Anti-Collusion Investigation |
|-------------|----------------------------------|-----------------------------------|
| Montreal    | 0.008                            | 0.709                             |
| Quebec City | 0.946                            | 0.531                             |

Values are the  $p$ -values from the Kolmogorov-Smirnov test of  $H_0 : f^1(\Delta^1 | \Delta^1 \in [-H, H]) = f^2(\Delta^2 | \Delta^2 \in [-H, H])$  for  $H > 0$  and  $H \rightarrow 0$ .

### A.13 Total bids

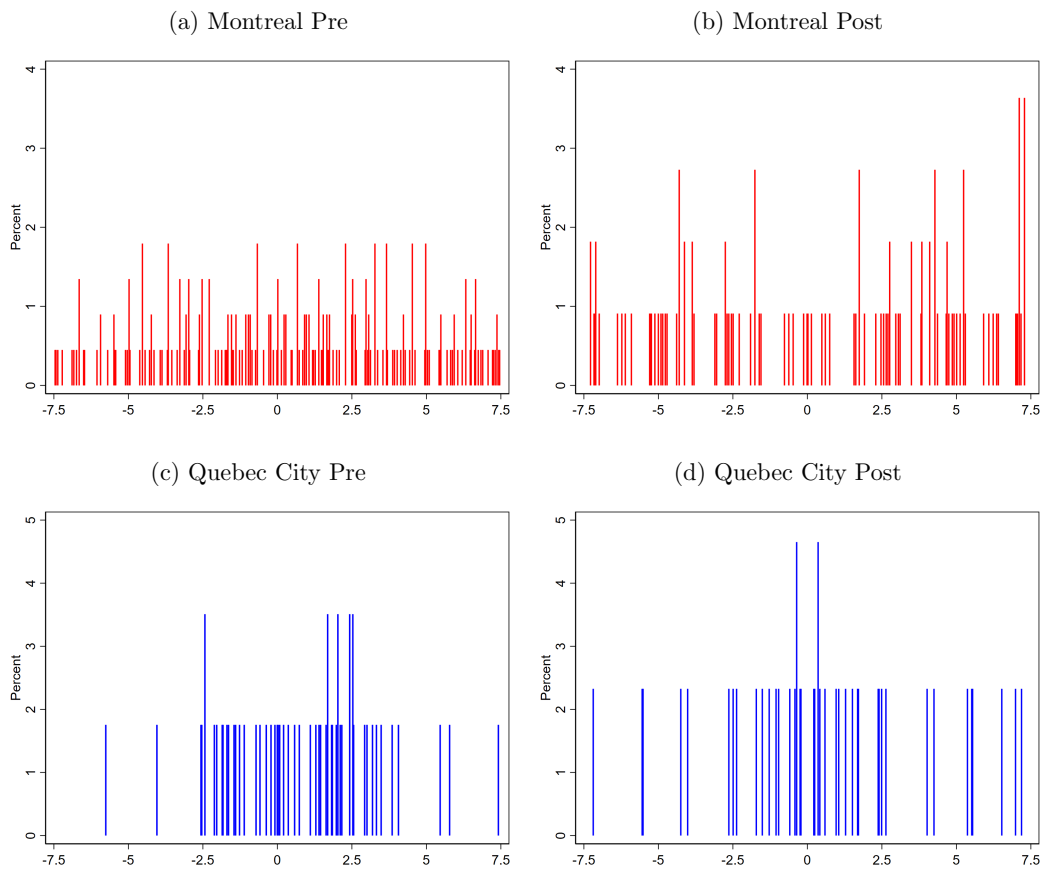
Figure A.17:  $\Delta_{i,a}^1$  for Montreal and Quebec City before and after the start of the police investigation.




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Bid differences in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton). The number of bins is equal to 500.

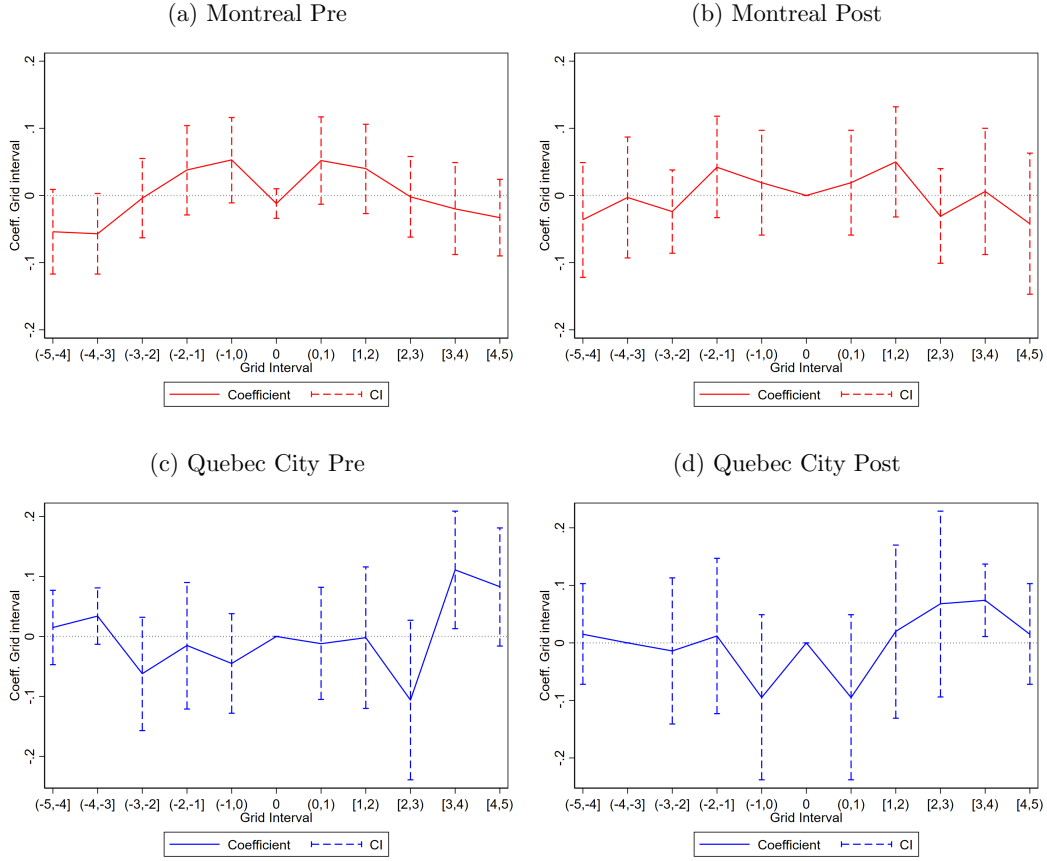
Figure A.18:  $\Delta_{i,a}^2$  for Montreal and Quebec City before and after the start of the police investigation.




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Bid differences in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton). The number of bins is equal to 500.

Figure A.19: Graphical representation of the parametric screen on total bids



This figure reports the coefficients  $\beta_q$  estimated from equation [4](#) along with confidence intervals, obtained separately for each city/time period. Confidence intervals are computed with standard errors clustered at the borough and year levels.

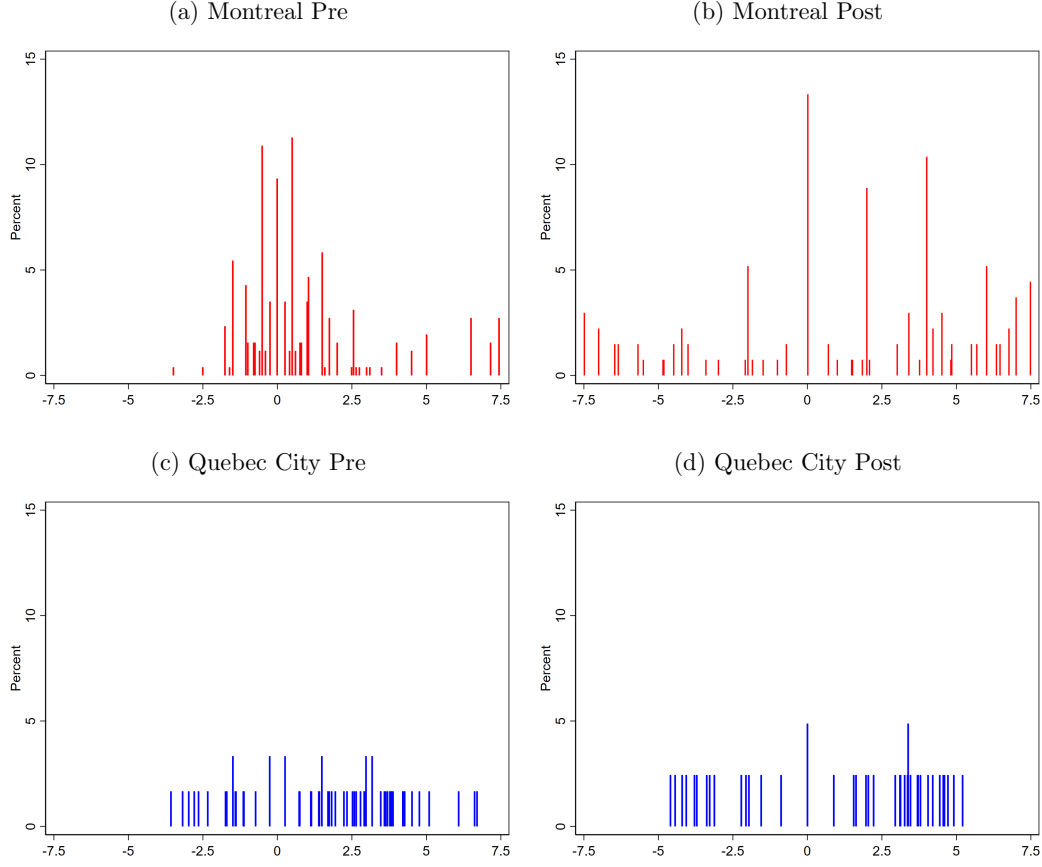
Table A.13: Nonparametric implementation of the screen on total bids

|             | Pre Anti-Collusion Investigation | Post Anti-Collusion Investigation |
|-------------|----------------------------------|-----------------------------------|
| Montreal    | 0.011                            | 0.488                             |
| Quebec City | 0.207                            | 0.289                             |

Values are the *p-values* from the Kolmogorov-Smirnov test of  $H_0 : f^1(\Delta^1 | \Delta^1 \in [-H, H]) = f^2(\Delta^2 | \Delta^2 \in [-H, H])$  for  $H > 0$  and  $H \rightarrow 0$ .

## A.14 Lowest raw bidder = final winner

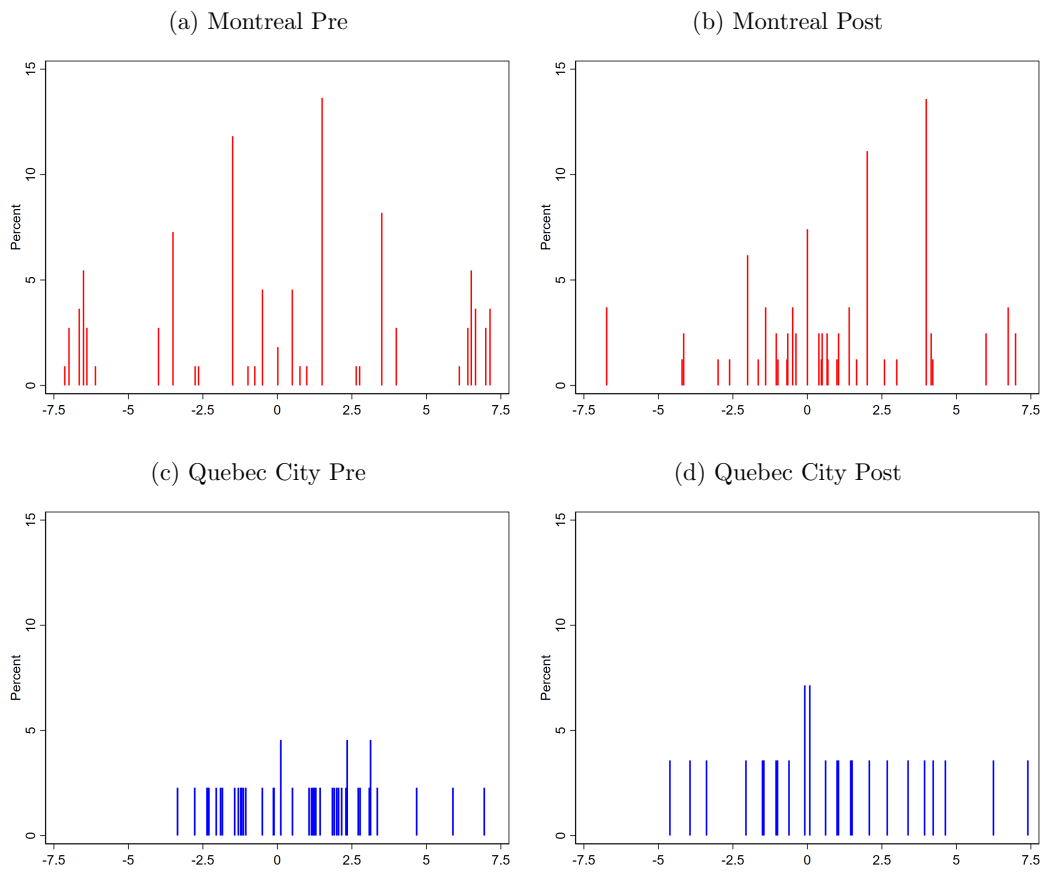
Figure A.20:  $\Delta_{i,a}^1$  for Montreal and Quebec City before and after the start of the police investigation.




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Bid differences in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton). The number of bins is equal to 500.

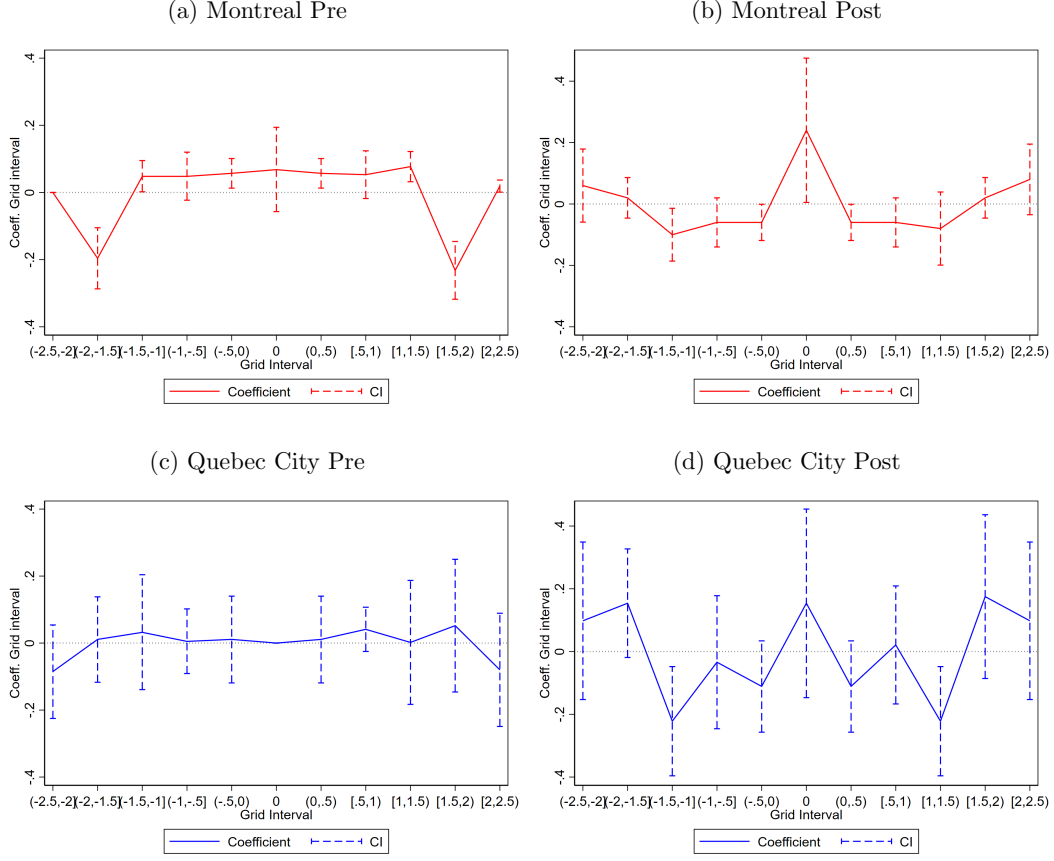
Figure A.21:  $\Delta_{i,a}^2$  for Montreal and Quebec City before and after the start of the police investigation.




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Bid differences in \$ per ton. The interval of bid differences is  $\pm 10\%$  of the winning bid in Montreal before the start of the investigation (\$7.5 per ton). The number of bins is equal to 500.

Figure A.22: Graphical representation of the parametric screen on auctions in which lowest raw bidder = final winner



This figure reports the coefficients  $\beta_q$  estimated from equation 4, along with confidence intervals, obtained separately for each city/time period. Confidence intervals are computed with standard errors clustered at the borough and year levels.

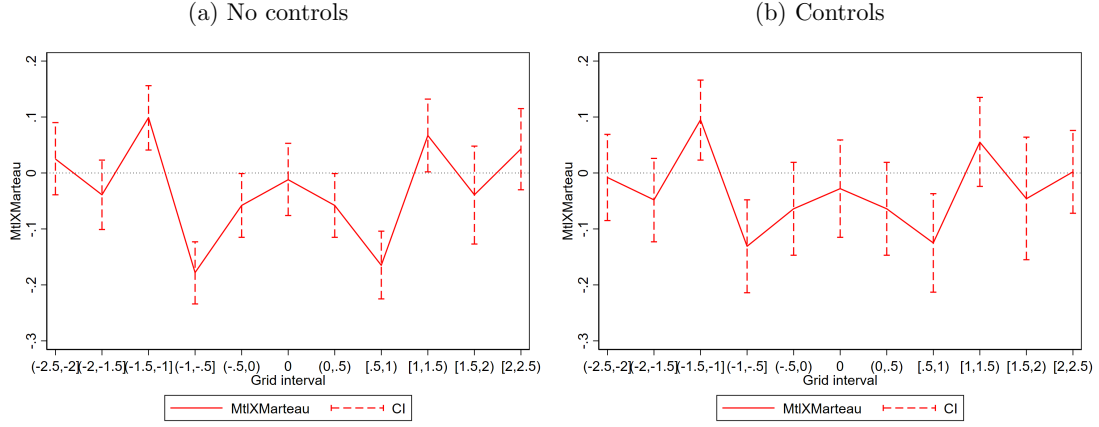
Table A.14: Nonparametric implementation of the screen

|             | Pre Anti-Collusion Investigation | Post Anti-Collusion Investigation |
|-------------|----------------------------------|-----------------------------------|
| Montreal    | 0.062                            | 0.717                             |
| Quebec City | 0.842                            | 0.304                             |

Values are the  $p$ -values from the Kolmogorov-Smirnov test of  $H_0 : f^1(\Delta^1 | \Delta^1 \in [-H, H]) = f^2(\Delta^2 | \Delta^2 \in [-H, H])$  for  $H > 0$  and  $H \rightarrow 0$ .

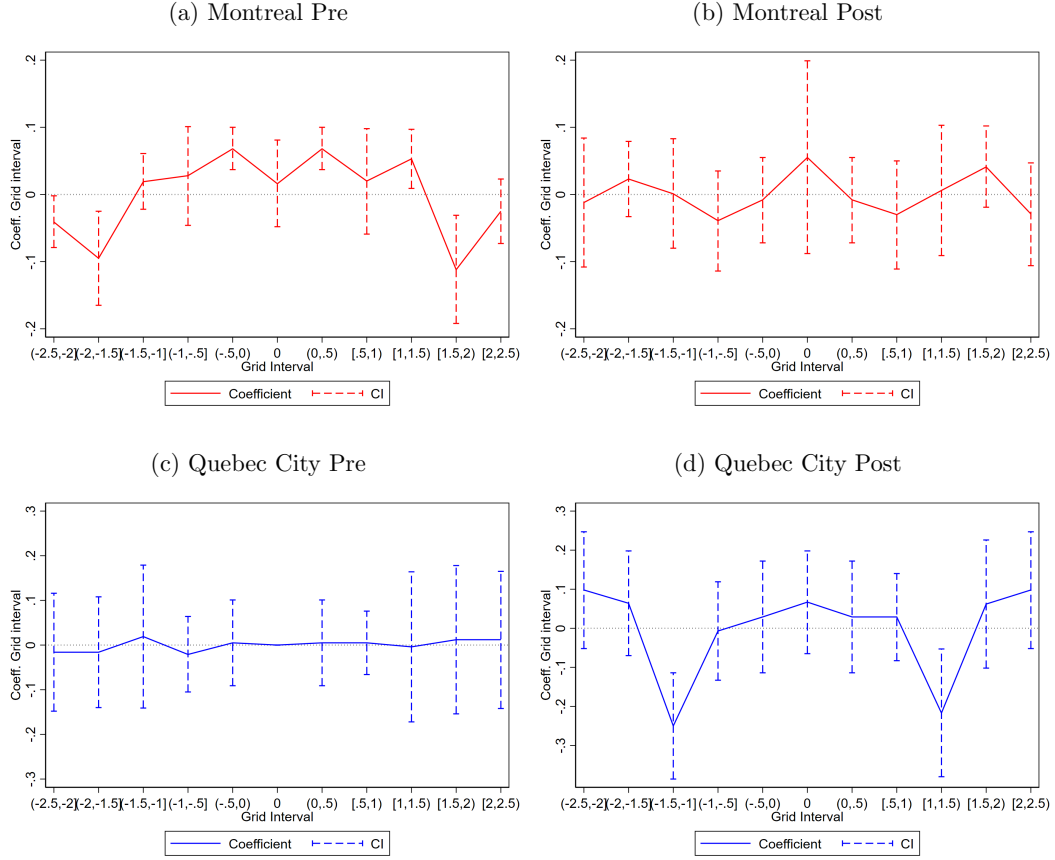
## A.15 Clustering of Standard Errors at the auction level

Figure A.23: Graphical representation of the distributional effect of the investigation on clustering & isolation. Standard errors are clustered at the auction level.



This figure reports the estimated coefficient for  $Mtl \times Marteau$ , along with confidence intervals, from Table A.1. Confidence intervals are computed with standard errors clustered at the auction level.

Figure A.24: Graphical representation of the parametric screen. Standard errors are clustered at the auction level.



This figure reports the coefficients  $\beta_q$  estimated from equation 4, along with confidence intervals, obtained separately for each city/time period. Confidence intervals are computed with standard errors clustered at the auction level.

## A.16 Implementation of the test

**Parametric version (with and without controls)** The steps required for the implementation of the screen are:

1. Construct  $\Delta_{i,a}^1$ , using the entire sample of contracts and bids.
2. Construct  $\Delta_{i,a}^2$ , using the same approach as for  $\Delta_{i,a}^1$  but excluding winning bids.
3. Append the two sets of bid differences constructed in steps 1 and 2. This will be the sample of  $\Delta_{i,a}$  that we will use for the screen.
4. Generate an indicator variable  $\mathbb{1}(f(\Delta_{i,a}^1))$  equal to 1 when bid differences  $\Delta_{i,a}$  are from the distribution of  $\Delta_{i,a}^1$ , and equal to 0 when they come from the distribution of  $\Delta_{i,a}^2$ .
5. Generate an indicator variable  $y_{i,a,q}$  equal to 1 if a bid difference  $\Delta_{i,a}$  is within a given interval  $q$ , and to 0 otherwise but still in the interval  $[-H, H]$
6. Run  $Q$  linear probability models, represented by equation (4), in the market suspected of collusion.
7. Check the statistical significance of coefficients  $\beta_q$ , which indicate a statistical significant difference between the distributions of  $\Delta_{i,a}^1$  and  $\Delta_{i,a}^2$  in the interval  $q$ . Under the null of competitive behavior the two distributions should not be statistically different for intervals  $q$  within  $-H$  and  $H$ .
8. Repeat steps 6 and 7 adding controls

### Non-parametric version (no controls)

The steps required for the implementation of the screen are:

1. Construct  $\Delta_{i,a}^1$ , using the entire sample of contracts and bids.
2. Construct  $\Delta_{i,a}^2$ , using the same approach as for  $\Delta_{i,a}^1$  but excluding winning bids.
3. Append the two sets of bid differences constructed in steps 1 and 2. This will be the sample of  $\Delta_{i,a}$  that we will use for the screen.
4. On the samples of  $\Delta_{i,a}$  within  $-H$  and  $H$ , implement the two-sample KS test to check the statistical difference between the two distribution of  $\Delta_{i,a}$ s within  $-H$  and  $H$
5. Extract the  $p$ -value of the test

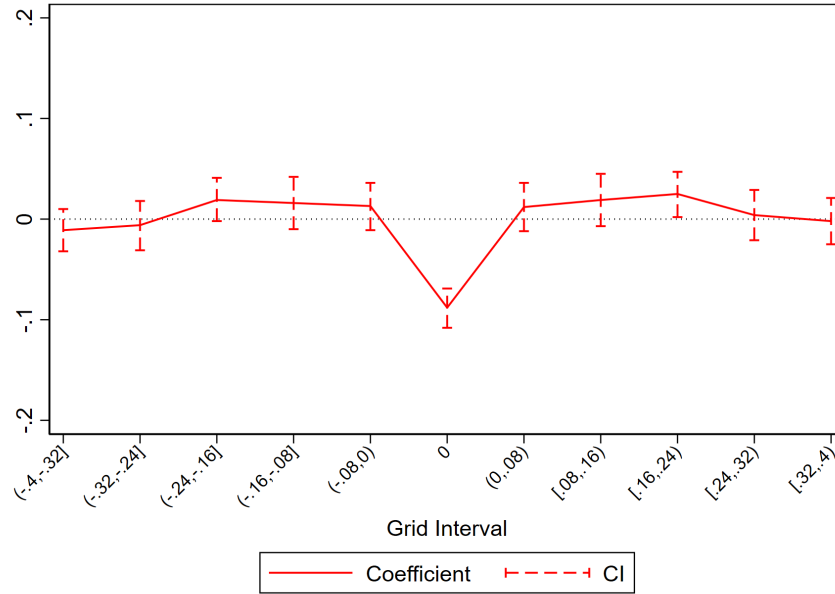
**Non-parametric version (with controls)** The steps required for the implementation of the screen are:

1. Construct  $\Delta_{i,a}^1$ , using the entire sample of contracts and bids.
2. Construct  $\Delta_{i,a}^2$ , using the same approach as for  $\Delta_{i,a}^1$  but excluding winning bids.
3. Append the two sets of bid differences constructed in steps 1 and 2. This will be the sample of  $\Delta_{i,a}$  that we will use for the screen.
4. Run an OLS regression of  $\Delta_{i,a}^1$  and  $\Delta_{i,a}^2$  on auction characteristics to obtain residuals.
5. Implement the two-sample KS test on the residuals to check the statistical difference between the residualized distribution of  $\Delta_{i,a}$ s within  $-H$  and  $H$
6. Extract the  $p$ -value of the test

## A.17 Ohio school milk cartel

According to [Porter and Zona \(1999\)](#), the Ohio school milk cartel featured collusion. We apply our screen in the Ohio school milk dataset made publicly available by [Wachs and Kertész \(2019\)](#). Results for the parametric test are reported in Figure [A.25](#). The  $p$ -value of the KS test is 0.044. The  $p$ -value is from the Kolmogorov–Smirnov test of  $H_0 : f^1(\Delta^1 | \Delta^1 \in [-H, H]) = f^2(\Delta^2 | \Delta^2 \in [-H, H])$  for  $H > 0$  and  $H \rightarrow 0$ . Both tests reject the null of competition.

Figure A.25: Graphical representation of the parametric screen between  $[-H, H]$ . Ohio school milk public procurement auctions.

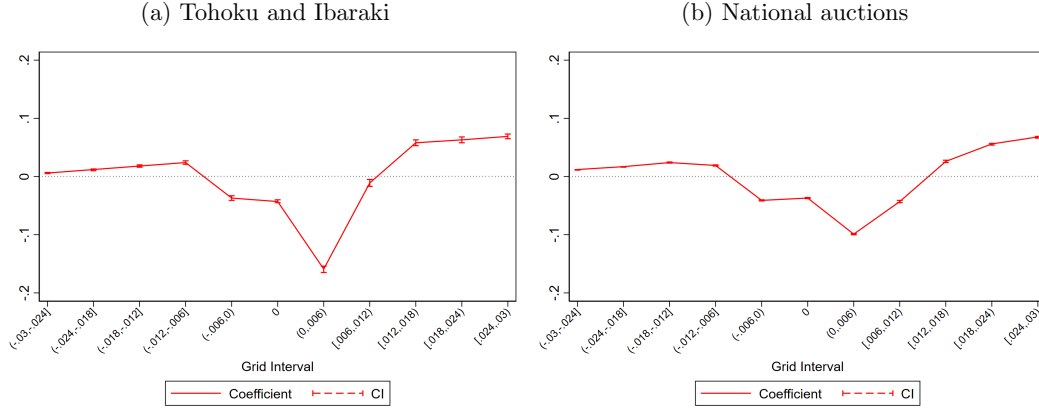


This figure reports the coefficients  $\beta_q$  estimated from equation [4](#), along with confidence intervals. Confidence intervals are computed with robust standard errors.

## A.18 Japanese auctions

According to Chassang et al. (2022), Japanese auctions featured collusion. The dataset is in the replication package by Chassang et al. (2022). We have repeated our test on the following samples: (i) the entire sample of city auctions, and (ii) the entire sample of national auctions. Bid differences are expressed as fraction of the reserve price. Results are reported in Figure A.26 and Table A.15. The tests reject the null of competition.

Figure A.26: Graphical representation of the parametric screen between  $[-H, H]$ . Japanese public procurement auctions.



This figure reports the coefficients  $\beta_q$  estimated from equation 4 along with confidence intervals. Confidence intervals are computed with robust standard errors.

Table A.15: KS test on  $[-H, H]$

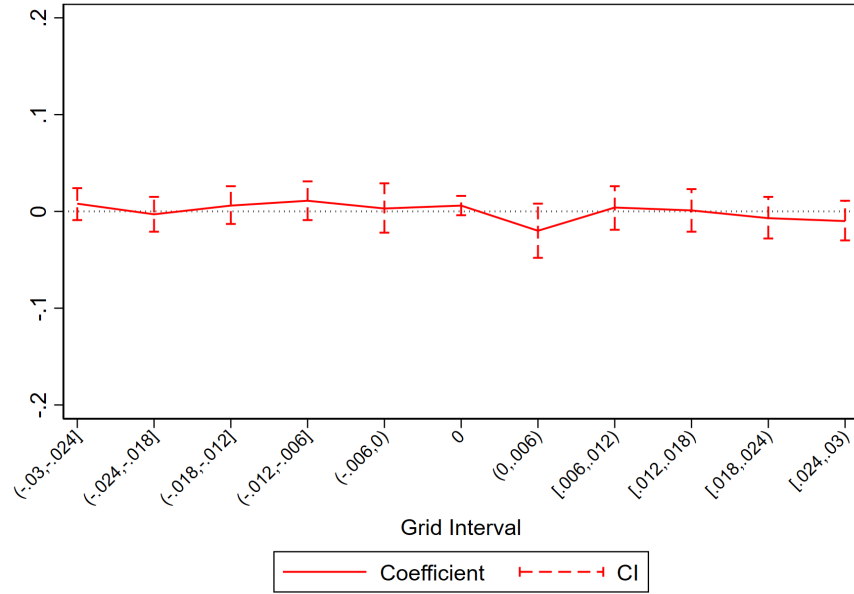
|                    | <i>p-value</i> KS test |
|--------------------|------------------------|
|                    | Pre                    |
| Tohoku and Ibaraki | 0.000                  |
| National auctions  | 0.000                  |

Values are the *p-values* from the Kolmogorov-Smirnov test of  $H_0 : f^1(\Delta^1 | \Delta^1 \in [-H, H]) = f^2(\Delta^2 | \Delta^2 \in [-H, H])$  for  $H > 0$  and  $H \rightarrow 0$ .

## A.19 Georgian first-price auctions

Wachs and Kertész (2019) also provided a dataset on Georgian public procurement auctions. Kawai et al. (2022) examine this market and find no evidence of collusion. We also applied our screen in this context. To the best of our knowledge, the Georgian antitrust authority up to now did not pursue any firm with bid-rigging. Thus, we apply the test using the first-price auctions observed in the dataset. Bid differences are expressed as fraction of the reserve price. We should expect no statistical significant differences in the distribution of  $\Delta_{i,a}^1$  with respect to  $\Delta_{i,a}^2$  around 3% of the reserve price. Figure A.27 provides the results for the parametric test. The  $p$ -value of the KS test is 0.425. Both tests do not reject the null of competition.

Figure A.27: Graphical representation of the parametric screen between  $[-H, H]$ . Georgian public procurement auctions.



This figure reports the coefficients  $\beta_q$  estimated from equation 4, along with confidence intervals. Confidence intervals are computed with robust standard errors.