Collusion by Exclusion in Public Procurement

Regina Seibel\textsuperscript{1} & Samuel Škoda\textsuperscript{2}

August 2022

\textsuperscript{1}Department of Economics, University of Zurich, Email: regina.seibel@econ.uzh.ch
\textsuperscript{2}Department of Economics, University of Zurich, Email: samuel.skoda@econ.uzh.ch
Motivation

- Public authorities in the EU spend around 14% of GDP on the purchase of services, works and supplies ($\approx € 2$ trillion per year)
- Bid rigging is considered to be a major threat to an efficient procurement process
- Literature mostly considers single-stage (standard) auction formats
  - Open auctions are more prone to collusion than sealed-bid auctions [Athey et al., 2011]
  - Minimum prices make it harder to collude [Chassang and Ortner, 2019]
- In practice an “invitation to quote” often precedes the actual auction
- Opening bids submitted there are used for preselection of bidders
Motivation

- Public authorities in the EU spend around 14% of GDP on the purchase of services, works and supplies (≈ €2 trillion per year)
- Bid rigging is considered to be a major threat to an efficient procurement process
- Literature mostly considers single-stage (standard) auction formats
  - Open auctions are more prone to collusion than sealed-bid auctions [Athey et al., 2011]
  - Minimum prices make it harder to collude [Chassang and Ortner, 2019]
- In practice an “invitation to quote” often precedes the actual auction
- Opening bids submitted there are used for preselection of bidders

Do opening bids affect strategy and profitability of cartels?
Contribution

Theory:

- Requesting opening bids results in a two-stage auction where a limited number of firms is allowed to proceed after the first stage.
- In private value settings: auctioning off entry rights may increase efficiency, e.g. [Ye, 2007, Bhattacharya et al., 2014, Sweeting and Bhattacharya, 2015].
- In common value settings: a sealed-bid auction stage followed by an opening descending auction combines the best of two worlds, leads to aggressive price competition and low collusion incentives [Klemperer, 1998].

⇒ We consider a different (and widely used) auction format for the entry stage and show that cartels may achieve higher cartel profits with preselection.

---

3 See also [Maurer and Barroso, 2011].
Contribution

Empirics:

- Detection of bid-rigging via collusion markers informed by theory
  [Bajari and Ye, 2003, Kawai and Nakabayashi, 2022, Chassang et al., 2022]
- Comparing different auction format w.r.t. cartel’s ability to rig them
  - Open vs. closed [Athey et al., 2011]
  - minimum price [Chassang and Ortner, 2019]

⇒ We use theory-informed collusion markers to make a new comparison both under competition and collusion

A reform in 2017 Slovakia allows us to observe outcomes for two-stage and standard auctions
Overview

1. Theory

2. Auction rules and reform

3. Empirical Analysis
   - Data description
   - Collusive marker
   - Effect of the reform

4. Conclusion
Theory
Model Setup

- \( N \) risk-neutral firms \( i \in \{1, \ldots, N\} \). \( K \subset N \) coordinate their bids.

- Cost of providing a good to the procurer follows i.i.d. cumulative distribution function \( F(c) \) on support \([c, \bar{c}]\)

- Timeline:
  1. Preselection stage: Each firm \( i \) submits a sealed bid \( b_i \leq r \). \( n \) firms with lowest \( b_i \) get preselected
  2. Main auction: Preselected firms are allowed to participate in a modified English auction with opening bid \( b_i \) as binding first bid. The firm with the lowest final bid \( q_i \) wins.
Model Setup

- $N$ risk-neutral firms $i \in \{1, ..., N\}$. $K \subset N$ coordinate their bids.
- Cost of providing a good to the procurer follows i.i.d. cumulative distribution function $F(c)$ on support $[c, \overline{c}]$
- Timeline:
  1. **Preselection stage**: Each firm $i$ submits a sealed bid $b_i \leq r$. $n$ firms with lowest $b_i$ get preselected
  2. **Main auction**: Preselected firms are allowed to participate in a modified English auction with opening bid $b_i$ as binding first bid. The firm with the lowest final bid $q_i$ wins.
- Hence, in the main auction (**Lemma 1**):
  - The firm with the lowest cost among preselected will win the main auction.
  - Final price will be either lowest cost among non-colluding rival firms or own opening bid.
Proposition 1

Under competition, changing the preselection rule from \( n < N \) to \( N \) neither affects firm profits nor overall savings.
Proposition 1

Under competition, changing the preselection rule from \( n < N \) to \( N \) neither affects firm profits nor overall savings.

Intuition:

- Bidding in the preselection stage is not restricting potential bids in the main auction, hence outcomes are the same
- Essentially: Revenue Equivalence since IPV setting with risk-neutral, symmetric and competitive agents, no entry cost.
Proposition 2

Suppose there exists a cartel. If competitive rivals are not aware of it, changing the preselection rule from $n < N$ to $N$ decreases cartel profits and increases savings.
Proposition 2

Suppose there exists a cartel. If competitive rivals are not aware of it, changing the preselection rule from \( n < N \) to \( N \) decreases cartel profits and increases savings.

Intuition:

- \((Lemma 3)\) In case with preselection rule \( n < N \), at least \( n \) cartel members submit the same cartel bid in equilibrium.
- Cartel members have nothing to lose from this strategy because only the lowest cartel bid matters for the main auction.
- But coordinating on the same bid has the huge potential of being jointly preselected.
  
  \( \Rightarrow \) With preselection a cartel can, in addition to eliminating competition from within the cartel, also eliminate competition from outside the cartel!
What's the point of preselection?

- The focus of the previous section is to show how cartels can exploit preselection.
- But there is also a potential benefit of preselection in competitive settings.
- Entry costs lead to endogenous entry into auctions.
  - Then the number of bidders in the main auction is random:
    1. Too few bidders → little competition
    2. Too many bidders → not worth the total entry costs

⇒ Introducing preselection by an entry-rights auction may increase surplus as it ensures a more stable number of bidders.
⇒ Under appropriate assumptions, our opening-bid format is revenue-equivalent to previously considered auction formats, but optimal collusive bidding strategy continues to hold.
Theoretical predictions

Main predictions:

1. With preselection, frequent close bidding in the preselection stage is indicative of being a member of a partial bid-rigging cartel.

2. Joint participation of cartel firms is less likely without preselection compared to with preselection

3. Removing preselection is more beneficial for the procurement agency when a cartel is present
Auction rules and reform
E-Public Procurement Auctions and Reform in Slovakia

**Preparation phase**
The procurer specifies: good, technical specifications, CPV codes and reserve price $r$.

**Preselection stage**
Firms submit initial bids $b_i \leq r$.

**Preselection rule reform**

- **Before Feb 2017**: Only 3 bidders with lowest initial bids proceed to main auction
- **After Feb 2017**: All bidders from preselection stage proceed to main auction

**Main auction**
English descending auction with initial bid $b_i$ as binding upper bound on further bidding.

- Bidder with lowest final bid $q_i$ wins the tender.

Timeline:
- Tender published
- 72 hours (or more if specified)
- 15 min break
- 20 min + 2 min extensions
Empirical Analysis
We have the universe of public procurement auctions published on ECS:

- Sample period is February 2016 - January 2020: 77,694 auctions worth €1.2 billion
- > 6,000 distinct bidders, of which ≈ 4,500 won at least one auction
- > 3,000 procurement agencies from 1,300 different municipalities in Slovakia
Data

We have the universe of public procurement auctions published on ECS:
- Sample period is February 2016 - January 2020: 77,694 auctions worth €1.2 billion
- > 6,000 distinct bidders, of which ≈ 4,500 won at least one auction
- > 3,000 procurement agencies from 1,300 different municipalities in Slovakia
Collusive Markers exploit Suspicious Bid Pattern before the Reform

Step 1: With preselection, cartel members should bid closely to be able to exclude rivals

- **Close Bidding**: Identify auctions where at least 3 firms submit bids in a value range of 0.1% of the reserve price of each other in the selection stage
  
  [Robustness: consider 0.5% and 0.05%]
Collusive Markers exploit Suspicious Bid Pattern before the Reform

Step 1: With preselection, cartel members should bid closely to be able to exclude rivals

- **Close Bidding**: Identify auctions where at least 3 firms submit bids in a value range of 0.1% of the reserve price of each other in the selection stage
  [Robustness: consider 0.5% and 0.05%]

Step 2: We are interested in colluders, not auctions per se

- **Potential Colluders**: Mark firms as potentially collusive, if they frequently participate in close bidding: more than 90% of firms in our sample
  [Robustness: consider 85% and 95%]

Distribution
Collusive Markers exploit Suspicious Bid Pattern before the Reform

Step 1: With preselection, cartel members should bid closely to be able to exclude rivals
- **Close Bidding**: Identify auctions where at least 3 firms submit bids in a value range of 0.1% of the reserve price of each other in the selection stage
  [Robustness: consider 0.5% and 0.05%]

Step 2: We are interested in colluders, not auctions per se
- **Potential Colluders**: Mark firms as potentially collusive, if they frequently participate in close bidding: more than 90% of firms in our sample
  [Robustness: consider 85% and 95%]

How well does this capture cartels?
Validation I: Overlap with convicted cartel

Share of firms

Sentenced colluders

90th percentile

Share of auctions where firms are involved in close bidding

More on the cartel

More on the cartel
Validation II: Close bidding in stable groups
Validation III: Little competition in main auction

![Graph showing the number of active bidders in the main auction. The x-axis represents the number of bidders, ranging from 1 to 5+. The y-axis shows the number of active bidders, ranging from 0 to 2. The graph includes data points for both 'Not pot. rigged' and 'Potentially rigged' categories, with 95% confidence intervals.](image-url)
The Effect of the Reform on Facing Colluder

Regression specification:

\[ \text{CartelOpponent}_{ia} = \alpha_0 + \alpha_1 \text{Post} + \alpha_2 \text{PotentialColluder}_i \times \text{Post} + \gamma_t + \delta_p + \theta_c + \omega_i + \epsilon_{ia}, \]  

- \( \gamma_t \): Year and Months FE
- \( \delta_p \): Procurer FE
- \( \theta_c \): CPV category FE
- \( \omega_i \): Bidder FE
- Standard errors clustered at the bidder level
The Effect of the Reform on Facing Colluder

With Preselection

Without Preselection

Probability of facing potential colluder

Quarters from the reform

Competitive bidders

Collusive bidders
The Effect of the Reform on Savings

Auction is Potentially rigged if at least one colluder participates

Regression specification:

\[
Savings_a = \alpha_0 + \alpha_1 Post + \alpha_2 PotentiallyRigged_a \times Post \\
+ \alpha_3 PotentiallyRigged_a + \beta_1 Bidder \#2_a + \beta_2 Bidder \#2_a \times Post_t \\
+ \beta_3 Bidder \#3_a + \beta_4 Bidder \#3_a \times Post_t \\
+ \beta_5 Bidder \#4_a + \beta_6 Bidder \#4_a \times Post_t \\
+ \beta_7 Bidder \#5_a + \beta_8 Bidder \#5_a \times Post_t + \gamma_t + \delta_p + \theta_c + \epsilon_i,
\]
The Effect of the Reform on Savings

With Preselection vs. Without Preselection

- **With Preselection**: Savings decrease sharply after the reform, with some fluctuations, but overall a noticeable drop.
- **Without Preselection**: Savings show a more erratic pattern, with a slight overall decrease, indicative of variability.

Analysis:
- The reform appears to have a significant impact on savings with preselection, potentially rigging the outcome.
- Without preselection, the effect is less predictable but still shows a trend towards lower savings, not potentially riggable.

**Potential Insights**:
- Preselection may introduce bias in the savings data, affecting the reform's true impact.
- Understanding the dynamics without preselection could provide insights into the reform's broader effects without selection biases.

**Recommendations**:
- Further analysis should consider controlling for preselection to accurately assess the reform's impact.
- Longitudinal studies could help in understanding the longer-term effects of the reform.

**Conclusion**:
- The reform has a discernible effect on savings, especially when preselection is considered.
- Future research should explore the implications of selection bias in savings analysis.
So how much did bid rigging cost the procurement authorities?

- In the year before the reform, contracts with a total value of €256 million were published on the platform.
- Auctions where a collusive bidder participated were worth €73.1 million.
- Procurement agencies ended up paying €63.6 million: Savings of €9.5 million.
- Their savings could have been **14.7% higher** on these contracts had they introduced post-reform rules one year earlier.
Conclusion
Cartels can exploit preselection rules and thereby decrease savings below what would be possible without preselection.
Conclusion

Cartels can exploit preselection rules and thereby decrease savings below what would be possible without preselection

- The profitability of selective procedures, among others, depends on the prevalence of cartels in the bidder population
- Procurement agents need to strike the right balance


Some Background on Slovakia

- Attractive data: the system reliably tracks the identity of procurer and bidder and is one of the most transparent.
- Comparable to other European countries according to indicators based on different public procurement aspects (competitiveness, transparency, SME inclusion).

Slovakia: Institutional Background

**Over-the-threshold contracts (OTC):** governed by EU law

**Under-the-threshold contracts (UTC):** Slovak rules apply: tenders are required to use the electronic contracting system (EKS) for standardized goods and services

**Low-value contracts (LV):** Use of ECS optional
## Table: Summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) Full Sample</th>
<th>(2) Before Feb 2017</th>
<th>(3) After Feb 2017</th>
<th>(4) Difference (2) – (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td>Savings</td>
<td>0.14</td>
<td>0.17</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Savings realized in Stage 1</td>
<td>0.05</td>
<td>0.11</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Reserve price (k€)</td>
<td>15.50</td>
<td>37.37</td>
<td>0</td>
<td>1860.00</td>
</tr>
<tr>
<td>Final bid (k€)</td>
<td>14.33</td>
<td>35.224</td>
<td>0</td>
<td>1855.00</td>
</tr>
<tr>
<td>Notified contractors</td>
<td>418.09</td>
<td>209.20</td>
<td>0.00</td>
<td>2396.00</td>
</tr>
<tr>
<td>No. of bidders</td>
<td>3.10</td>
<td>2.09</td>
<td>1.00</td>
<td>24.00</td>
</tr>
<tr>
<td>No. of bidders in Stage 2</td>
<td>1.57</td>
<td>1.46</td>
<td>0.00</td>
<td>11.00</td>
</tr>
<tr>
<td>No. of bids in Stage 2</td>
<td>26.12</td>
<td>55.80</td>
<td>0.00</td>
<td>2185.00</td>
</tr>
</tbody>
</table>

Notes: The table summarizes auction-level variables for the sample used in our analysis, covering auctions on the EKS platform from February 2016 to January 2020. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
First look at the reform: Huge shift in Competition

![Graph showing savings with and without preselection over quarters from the reform.](image-url)
In May 2021, the competition authority convicted 6 companies of rigging EKS auctions. Court case describes derived strategy: cartel members bid in groups of 3 with close opening bids, inactive afterwards. Case was supported by hard evidence: bidding from the same IP address. We correctly predict 5 out of 6 colluding firms. 276 auctions investigated (251 pre-reform, 23 post-reform). 6 firms, highly asymmetric in size. Biggest firm ca. 200 employes, revenue €10 million, manufacturing of workwear, shoes, gloves. The rest much smaller < 15 employees, retail. 2 most active won contracts worth of ca. €1.5 million EUR, fined only €162.000 and €8.600. Largest firm participated in 10 and won 1 contract (€5.900) but fined €0.9 million.
### Investigated auctions

<table>
<thead>
<tr>
<th></th>
<th>(1) No rivals present</th>
<th>(2) Rivals excluded</th>
<th>(3) Rivals not excluded</th>
<th>(4) Rivals not excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Savings</td>
<td>0.03</td>
<td>0.04</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>Preselection savings</td>
<td>0.03</td>
<td>0.04</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>Reserve price</td>
<td>7.53</td>
<td>6.66</td>
<td>12.14</td>
<td>22.35</td>
</tr>
<tr>
<td>Main auction bidders</td>
<td>0.19</td>
<td>0.54</td>
<td>0.05</td>
<td>0.37</td>
</tr>
<tr>
<td>Preselection bidders</td>
<td>2.53</td>
<td>0.77</td>
<td>5.67</td>
<td>2.32</td>
</tr>
<tr>
<td>Total bids</td>
<td>2.90</td>
<td>1.28</td>
<td>8.37</td>
<td>6.60</td>
</tr>
<tr>
<td>Cartel bidder</td>
<td>2.53</td>
<td>0.77</td>
<td>3.01</td>
<td>0.12</td>
</tr>
<tr>
<td>Cartel winner</td>
<td>1.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Observations</td>
<td>73</td>
<td>73</td>
<td>44</td>
<td>61</td>
</tr>
</tbody>
</table>
## The Effect of the Reform on Facing Colluder

<table>
<thead>
<tr>
<th></th>
<th>(1) OLS</th>
<th>(2) OLS</th>
<th>(3) OLS</th>
<th>(4) OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>-0.031**</td>
<td>-0.009</td>
<td>0.006</td>
<td>0.033*</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.012)</td>
<td>(0.014)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Pot. Colluder × Post</td>
<td>-0.219***</td>
<td>-0.195***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td>(0.050)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.258***</td>
<td>0.256***</td>
<td>0.252***</td>
<td>0.250***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Bidder FE</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Month FE</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Procurer FE</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CPV Category FE (2-digit)</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>CPV Category FE (full)</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.34</td>
<td>0.34</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>Avg. Outcome</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>N</td>
<td>182724</td>
<td>182724</td>
<td>112944</td>
<td>112944</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
<table>
<thead>
<tr>
<th></th>
<th>(1) OLS</th>
<th>(2) OLS</th>
<th>(3) OLS</th>
<th>(4) OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>-0.018***</td>
<td>-0.018**</td>
<td>-0.007</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.008)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Potentially rigged</td>
<td>-0.053***</td>
<td>-0.032***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pot. rigged × Post</td>
<td>0.018***</td>
<td>0.019***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bidder #2</td>
<td>0.067***</td>
<td>0.090***</td>
<td>0.090***</td>
<td>0.092***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Bidder #3</td>
<td>0.067***</td>
<td>0.072***</td>
<td>0.064***</td>
<td>0.067***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Bidder #4</td>
<td>0.044***</td>
<td>0.046***</td>
<td>0.037***</td>
<td>0.039***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Bidder #5</td>
<td>0.067***</td>
<td>0.075***</td>
<td>0.061***</td>
<td>0.067***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Bidder #2 × Post</td>
<td>-0.006*</td>
<td>-0.007**</td>
<td>-0.012**</td>
<td>-0.013***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Bidder #3 × Post</td>
<td>0.011**</td>
<td>0.008</td>
<td>0.015**</td>
<td>0.012*</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Bidder #4 × Post</td>
<td>0.001</td>
<td>0.000</td>
<td>0.006</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Bidder #5 × Post</td>
<td>0.019***</td>
<td>0.013*</td>
<td>0.015*</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.022***</td>
<td>0.024***</td>
<td>0.021***</td>
<td>0.023***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>yes</th>
<th>yes</th>
<th>yes</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month FE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year FE</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Procurer FE</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CPV Category FE (2-digit)</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>CPV Category FE (full)</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.38</td>
<td>0.39</td>
<td>0.45</td>
<td>0.46</td>
</tr>
<tr>
<td>Avg. Outcome</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>N</td>
<td>59101</td>
<td>59101</td>
<td>37046</td>
<td>37046</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001