Competing for (fake) Certificates: The Case of Smog Checks

Francisco Gallego[1] Juan-Pablo Montero[1] José-Diego Salas[1]

[1]PUC - Chile

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Introduction I

- Automobile emissions are a major source of urban air pollution: CO, HC, NOx, and PM2.5.
- One of the most popular policies to curb tailpipe emissions are smog checks carried out by inspection stations.
- However, according to existing literature:
    - Corruption and fraud [Oliva, (2015)].
    - Differences in smog-checks' stations quality [Sanders and Sandler (2017), Hubbard (1998)]
    - High variance in emissions for the same car, fast deterioration of the repairs [Wenzel et al. (2004)].
    - etc...

Introduction II

- In this paper we study an aspect much overlooked in the literature: competition for certificates in the smog checks market.
  - What are the incentives to provide "quality" in the certification offered when stations face competition.
- We exploit the entry of new smog-check stations into several markets to understand how prices and *quality* are affected when stations face competition.

'They point out that there are also mechanical workshops that for $50,000 pesos ensure success to the user and that sometimes they have contacts in more than one plant.' Station Owner, 2013

'The corrections to this problems have been made in the new bidding rules. Could we say that everything is 100% guaranteed ?, Of course not. . . '

Ministry of Transport, 2013

Preview I

- There is a lot of heterogeneity in stations' certification *quality* before and after entry. Specially between stations.
- Before entry prices are similar between stations. After entry there is a ∼50% gap in prices between incumbents and entrants.
- We exploit the entry of new stations to understand how competition shapes the incentives to provide *quality* in certification.
- The increased competition has two main components: greater number of participants, and entrants have lower prices (about 50% lower).
- At this point, our main results suggest that, when incumbent stations face competition, they tend to relax their certification standards (i.e. they adjust *quality*), but not prices.

Preview II

- Entrants start with stricter certification standards, but they rapidly become more lax, although they are still stricter than incumbents.
- Relaxation in certification standards could suppose a welfare loss because of the resulting increase in air pollution, however, there is a reduction in average prices paid.
- Where there are local monopolies, we see that certification standards remain more or less constant and are 2-3 times stricter than in other places.

Literature Review

- There is some evidence that partially links smog checks, *quality*, and some market incentives.
  - Oliva (2015) develops an empirical test for corruption and fraud in smog checks stations and finds that around 9.6% of old-car owners paid bribes to circumvent the regulations.
  - Wenzel et al. (2004) argues that vehicle emissions volatility could explain rapid increases in fleet emissions observed in the data. For example, 20% of vehicles that failed and passed subsequently will fail in a new inspection.
  - Sanders and Sandler (2017) links smog checks data to local air pollution. They argue that the reduction in local air pollution levels are driven by high-*quality* stations and that low-*quality* stations have negligible impacts.
  - Hubbard (1998) finds that, in the auto repair and smog-checks inspections plants, which are vertically integrated in that context, firms have incentives to let consumers pass.

Regulatory Environment: Certification

- Private car owners have to conduct a comprehensive examination at least once a year. There is a pre-determined monthly schedule based on the plate number.
- This certification is needed in order to obtain a valid transit permit which is to be renewed in March of every year.
- A car that has approved the examination gets a visible sticker in the front windshield.
- The main focus of this work is on emission tests.
- Tailpipe emissions are measured for three pollutants: CO, HC, NOx. If any of the pollutants registered is above a certain threshold, the car is rejected and has to conduct a reinspection.

Regulatory Environment: Stations

- The number of stations was fixed before 2008 (when our data set starts).
- The number and location of new stations are defined according to the Ministry of Transportation.
- The first bidding process started at the end of 2013. However, due to administrative issues entries began on early 2015.
- Bidders have to comply with several requisites, and after the eligibility is determined, the bidder with lowest prices is allowed to enter the market: price competition subject to a minimum standard.
- The entry of the remaining stations was staggered due to the same set of issues.

Data

The data for this project combines two primary data sources:

- Car characteristics and the number of inspections at each plant come from a comprehensive dataset of all the smog checks conducted in the period between 2008 and 2017 provided by the Ministry of Transport.
- The dataset regarding the competitive environment of stations is constructed by the authors with public information of inspection prices, date of entry, and the geographical location of each station.

Descriptive Statistics

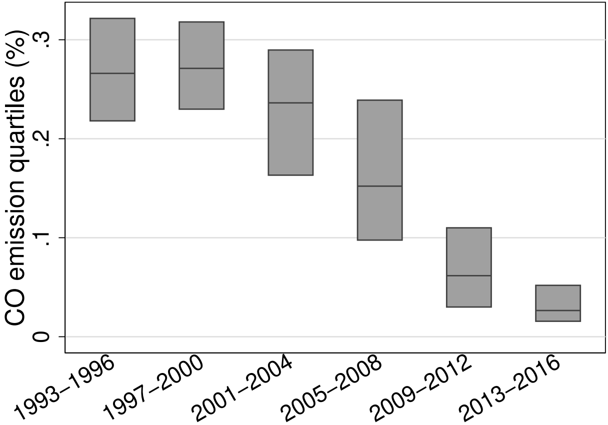
- The average rejection rate for all causes in our sample is 30%. For smog checks the rejection rate is 10%.
- There are 15.6 million observations in our data base, this corresponds to about 130 thousands inspections in one month in the system.
- At the beginning of our sample, in Santiago, there are 18 stations, and we have 19 entries in our period. There are “relabelling” episodes (change in ownership) and new stations.
- Emissions are highly convex in age (small group of high-polluters).

Table: Mean Rejection Rate and Number of Cars by Age Groups.

Age Group	1/5	6/10	11/15	16/20	21/25	26/+
Rejection Rate	1.36%	4.78%	8.39%	11.36%	14.31%	16.81%
N° of Cars	505.651	361.829	404.935	138.287	37.245	35.878

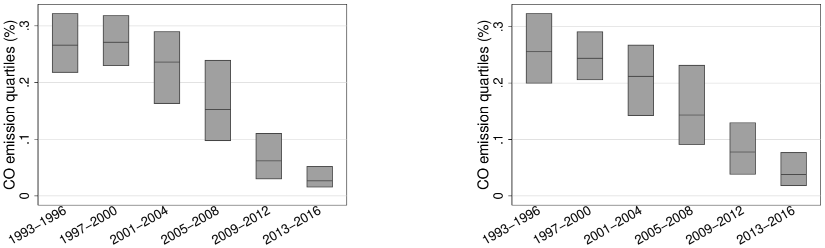
Smog-checks Rejection Rate Descriptive Statistics by Age. Year 2016 is considered for this calculations. The Average Rejection Rate for this year was around 6%.

Ratio of Total Emissions over Number of Cars by Age Groups



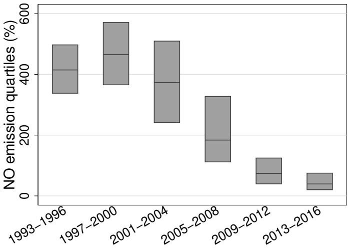
Ratio of Total Emissions over Total Number of Cars by Age Groups.

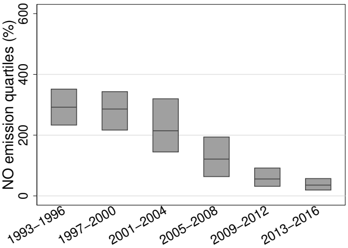
Carbon Monoxide Emissions by Age



Interquartile Range of CO Emissions. The left and right figures consider emissions registered at 24[km/h] and 40[km/h] respectively. Data for 2016 is considered.

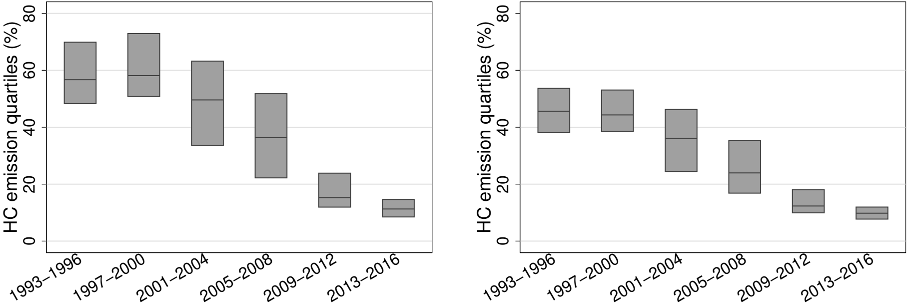
Nitrogen Oxide Emissions by Age





Interquartile Range of NO Emissions. The left and right figures consider emissions registered at 24[km/h] and 40[km/h] respectively. Data for 2016 is considered.

Hydrocarbons Emissions by Age



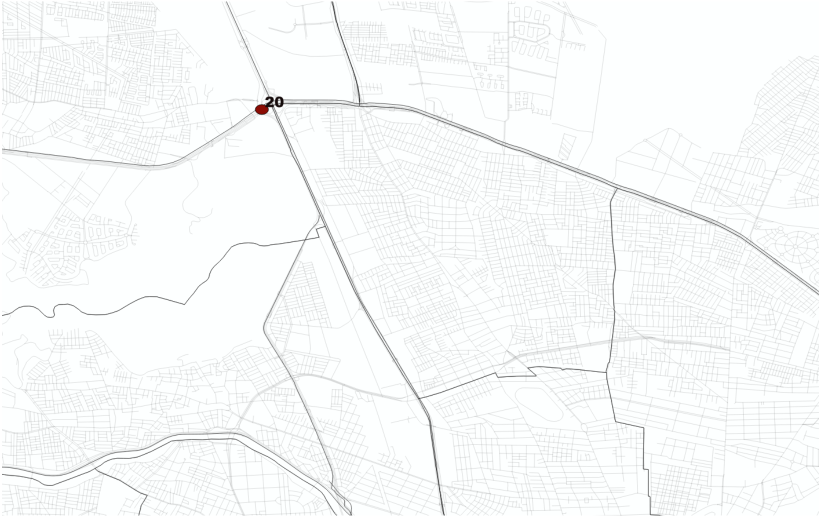
Interquartile Range of HC Emissions. The left and right figures consider emissions registered at 24[km/h] and 40[km/h] respectively. Data for 2016 is considered.

Example of Station Entry: New Station

Map of Santiago and its stations the year 2014.

Example of Station Entry: New Station

Zoom of one cluster and its stations the year 2014. Distance between this stations is less than 10 minutes by car.



Example of Station Entry: New Station

Zoom of one cluster and its stations the year 2015 (station 20 {$17370} faced the entry of station 31 {$8200}).

Example of Station Entry: Relabelling

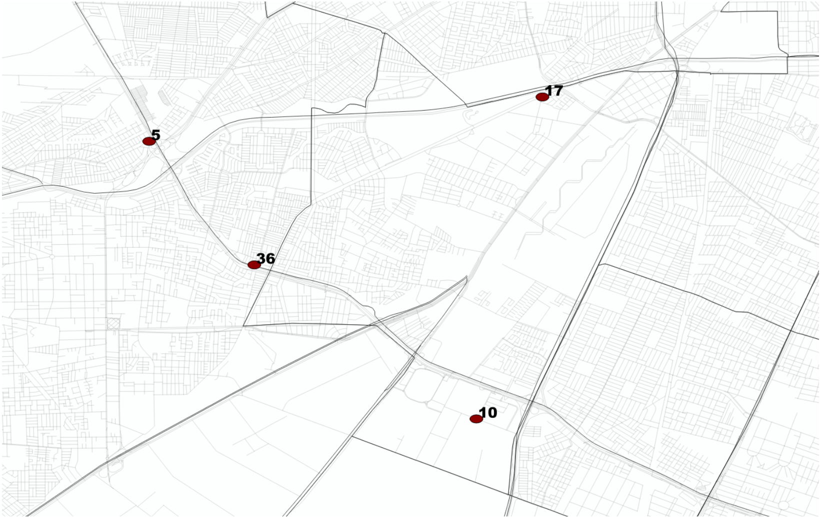
Map of Santiago and its stations the year 2014.

Example of Station Entry: Relabelling

Zoom of one cluster and its stations the year 2014. Distance between this stations is less than 10 minutes by car.

Example of Station Entry: Relabelling

Zoom of one cluster and its stations the year 2015 (station 4 {$19250} was replaced by station 36 {$9150}).



Station-Quality Measures I

- The main measure of station-quality comes from the California's STAR program (State of California (2014), Bureau of Automotive Repairs (2012)).
- Similar Vehicle Failure Rate (SVFR) which compares the initial test failure rate of certain vehicles at a determined station to the failure rate for similar vehicles in all stations.

$$SVFR_{st} = \frac{\frac{1}{\zeta_{st}(y,1)} \sum_{i \in \zeta_{st}(y,1)} fail_{i,y,1}}{\Phi(\zeta_{st}(y,1))}$$

- where $\Phi(\zeta_{st}(y,1)) = \frac{1}{\zeta_{st}(y,1)} \sum_{i \in \zeta_{st}(y,1)} \mathcal{P}(fail_{i,y,1} = 1 | k_i, t, X_{iky})$.
- ζ_{st} is the group of cars conducting their first inspection of year y at station s in month t. $fail_{i,y,1}$ is a dummy that takes the value 1 if car i in their first inspection of year y fails.
- and $\mathcal{P}(fail_{i,y,1} = 1 | k, t, X_{iky}) = \alpha_k + \eta_t + \beta X_{iky} + \epsilon_{ikty}$ is the predicted probability of rejection of car i, in year y. X_{iky} are observables of car i of type k in year y. α_k and η_t are car type (make/model/vintage/age) and month t fixed-effects.

Station-Quality Measures II

- "Similar Vehicle Failure Rate" (SVFR) means a calendar month comparison of the initial test failure rate of vehicles at an individual station to the initial test failure rate for similar vehicles inspected in the system for similar vehicles. [?]
- Since we are computing $\mathcal{P}(\mathit{fail}_{i,y,1} = 1)$ with data from all stations we are capturing *heterogeneity* in stations' behavior (i.e. if all stations behave in a similar way all stations will get the same SVFR).
- A $\mathit{SVFR} = 1$ means that, on average, the station is "rejecting" the number of cars that we would expected to be rejected. A SVFR lower (higher) than one, means that the station is rejecting less (more) than what it is expected.
- Notice that $\Phi(\zeta_{st}(y,1))$ can be interpreted as the average car-quality that a specific station is serving during a specific month. A higher Φ means a higher predicted rejection rate.

Event Studies

The main coefficients are estimated with an event study methodology:

$$Q_{sjt} = \gamma_t + \phi_j + \sum_{t=-48}^{24} (\beta_t \times E_{jt}) + \epsilon_{sjt}$$

where Q_{sjt} stands for the *quality* of station s that belongs to the market j at time t. β_t is the coefficient that represents the average change in the SVFR index at month t in markets after there has been an entry (i.e. $E_{jt} = 1$).

- The main regression has the SVFR as the outcome, but we also explore the effects of entry in $\Phi(\zeta_{st}(y,1), y, 1)$ (SVFR-denominator).
- For the ease of exposition/interpretation we plot the coefficients after adding the constant.
- We do this for incumbents, entrants, and we split our sample between the Metropolitan Region and Other Regions.

Preliminary Results I

Prices did not react after the entry of competitors charging about 50% less (variation is due to weighting-market shares, and inflation adjustability).

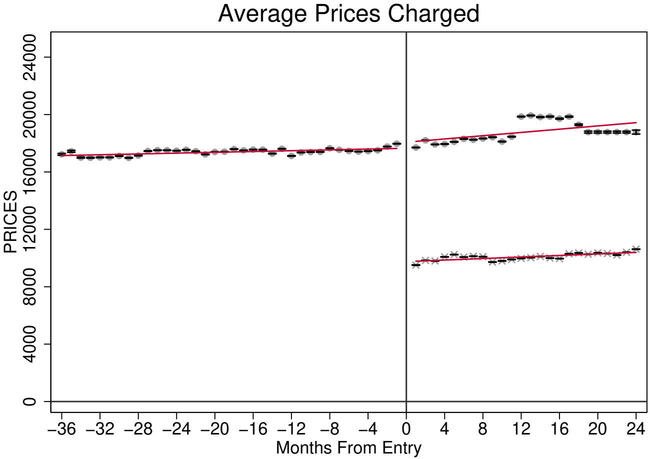


Figure: Evolution of Prices Charged.

Preliminary Results II

However, incumbents react strongly by lowering their certification quality after entry.

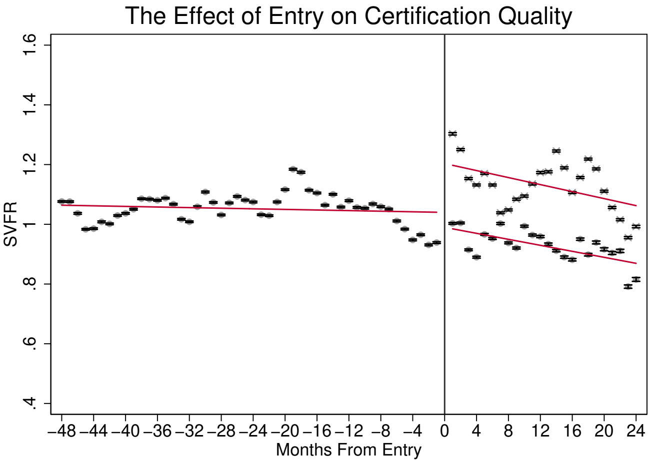


Figure: Evolution of the of the SVFR index.

Preliminary Results III

The average car quality of cars served worsens after entry.

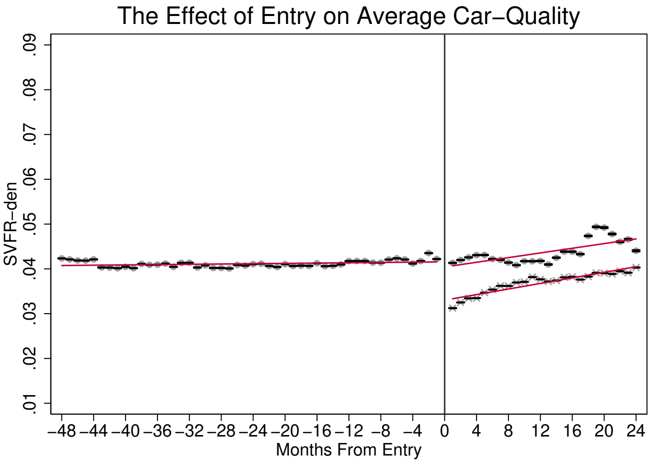


Figure: Evolution of the Denominator of the SVFR index (average car-quality).

Pollution Damages I

- We can estimate the increase in pollution damages due to the increase in competition and subsequent relaxation of certification standards:
  - Assume all cars were certified at new stations right after entry (*quality* benchmark).
  - Calculate their predicted rejection rate after controlling for all car observables.
  - Use that rejection rate to calculate how many cars should have been rejected at incumbent stations after entry.
  - Calculate the gap between the average emissions of rejected cars at benchmark stations and the emissions threshold.
- Change in Social Welfare is not direct:
  - Increase in pollution damages vs reduction in average prices paid.
  - Queuing is also an important factor, and people may need to drive further away to get a "fake" certificate.

Pollution Damages II

- In a little more than two years, there are 75,463 “missing rejections” (about 4% of the total inspected cars).
- The average emissions of one of these cars is 1,65, 1,229, and 305.86 for CO, NO, and HC respectively. This is around 2.5 times the allowed threshold.
- This means that we are letting pass, on average, 0.99, 322, and 165 for CO, NO, and HC respectively with each “missing car” (if we consider the threshold as our comparison point).
- Each “missing rejection” is, on average, 150%, 35%, and 135% over the threshold for CO, NO, and HC.
- In total, this is about 15.76%, 4%, and 13.4% of the total emissions readings at the equivalent time span for each pollutant respectively at affected stations.

The Road Ahead

- Relate this results to the existing IO literature on quality standards and differentiation.
- Estimate a simple model of demand to understand whether consumers (and what type of consumers) value *quality*.
- Robustness checks to reverse causality and omitted variables (i.e. stations being classified as low-*quality* due to high-*quality* vehicles based on non-observables).
  - One idea is to exploit the rejection threshold to study behavioral changes (i.e. discontinuity in the probability of moving to a "bad" station).
  - Validate the SVFR metric using the "Follow Up Pass Rate" (how cars certified at "bad" stations perform in their next inspection).
- Calculate changes in overall welfare because of the decreased *quality* in certification versus the decrease in average prices paid, and queuing.

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