Supplementary Material

Evaluation of road safety policies and their enforcement in Mexico City, 2015-2019: An Interrupted Time Series Study

Carolina Quintero Valverde, Carolina Pérez Ferrer, Luis Chías Becerril, Armando Martínez, Héctor Reséndiz Lopez, Javier Prado Galbarro, Alex Quistberg, Ana V. Diez-Roux, Tonatiuh Barrientos-Gutierrez

Table of contents for supplementary material

Figure S1. Location of automatic traffic enforcement devices in Mexico City, 2015.................................................................2
Data processing and cleaning..........................................................................................................................................................2
   Table S1. Results of validation process .................................................................................................................................2
   Figure S2. Collisions within and outside Mexico City ..............................................................................................................3
Equation 2. Controlled interrupted time series analyses .............................................................................................................4
Table S2. Periods of analyses and number of data-points ...........................................................................................................5
Table S3. Effect of 2015 intervention on total collisions and collisions resulting in injury in enforcement and no-enforcement municipalities ...........................................................................................................5
Table S4. Total collisions, ITS CDMX, Sensitivity Analyses .......................................................................................................6
Table S5. Collisions resulting in injury, ITS CDMX, Sensitivity Analyses ....................................................................................7
Table S6. Mortality due to road traffic collisions, ITS CDMX, Sensitivity Analyses .................................................................8
Figure S3. Interrupted Time Series of mortality with redistributed garbage codes in Mexico City.................................................9
Figure S1. Location of automatic traffic enforcement devices in Mexico City, 2015

*Red squares are automatic traffic enforcement devices that detect 9 dangerous behaviors. Blue triangles are speed cameras. Original figure created by the research team.

Data processing and cleaning

Table S1. Results of validation process

| Year                                    | 2015     | 2016     | 2017     | 2018     | 2019     | Total    |
|-----------------------------------------|----------|----------|----------|----------|----------|----------|
|                                         | Total number | %      | Total number | %      | Total number | %      | Total number | %      | Total number | %      |
| Mexico City consistent in geographical coordinates and location variable | 87,406    | 91.0    | 84,889    | 90.0    | 74,159    | 91.9    | 65,496    | 91.4    | 55,237    | 92.6    | 367,187    | 91.3    |
| Mexico City consistent in geographical coordinates and inconsistent in location variable | 77        | 0.1     | 194       | 0.2     | 37        | 0.0     | 32        | 0.0     | 255       | 0.4     | 595       | 0.1     |
| Mexico City consistent in location variable and inconsistent in geographical coordinates | 8,556     | 8.9     | 9,193     | 9.8     | 6,502     | 8.1     | 6,151     | 8.6     | 4,194     | 7       | 34,596     | 8.6     |
| Mexico City Total                       | 96,039   | 100     | 94,276    | 100     | 80,698    | 100     | 71,679    | 100     | 59,681    | 100     | 402,378    | 100     |
Figure S2. Collisions within and outside Mexico City

Note: Yellow polygon is Mexico City. Original figure created by the research team.
Equation 2. Controlled interrupted time series analyses

Equation 2.

\[ Y_t = \beta_0 + \beta_1 T + \beta_2 X_t + \beta_3 TX_t + \beta_4 G + \beta_5 GT + \beta_6 GX_t + \beta_7 GTX_t \]

where \( Y_t \) is the outcome variable at time \( t \), \( \beta_0 \) represents the intercept at \( T=0 \), \( \beta_1 \) is the change in outcome per time unit increase (representing the underlying pre-intervention trend), \( \beta_2 \) is the level change following the intervention and \( \beta_3 \) indicates the slope change following the intervention (using the interaction between time centered and intervention: \( TX_t \) \( \beta_4 \) represents the difference in intercept at \( T=0 \) between enforcement and no enforcement municipalities, \( \beta_5 \) represents the difference in the time slope in municipalities with and without enforcement in the pre-intervention period, \( \beta_6 \) represents the difference in the level change associated with the intervention in enforcement compared to no-enforcement municipalities and \( \beta_7 \) represents the difference in the time slope following the intervention in enforcement compared to no-enforcement municipalities. These two parameters (\( \beta_6 \) and \( \beta_7 \)) therefore capture whether enforcement modifies the effect of the intervention (on level \( \beta_6 \) and on the change in slope post intervention \( \beta_7 \)). We checked for parallel pre-intervention trends between enforcement and no-enforcement municipalities by evaluating statistical significance of \( \beta_5 \).
Table S2. Periods of analyses and number of data-points

| Pre-policy dates | Number of data-points* | Post-policy dates | Number of data-points* |
|------------------|------------------------|-------------------|------------------------|
| 2015 policy      |                        |                   |                        |
| 1st Jan 2015 - 14 Dec 2015 | 50                  | 15 Dec 2015 - 31st Dec 2018 | 158                  |
| 15 Dec 2015 - 7 June 2019 | 181            | 8 June 2019 - 31st Dec 2019 | 29                    |
| 2019 policy      |                        |                   |                        |
| 15 Dec 2015 - 7 June 2019 | 181            | 8 June 2019 - 31st Dec 2019 | 29                    |

* weeks

Table S3. Effect of 2015 policy on total collisions and collisions resulting in injury in enforcement and no-enforcement municipalities

|                      | Total collisions | Collisions resulting in injury |
|----------------------|------------------|-------------------------------|
|                      | IRR   | P    | 95%CI  | IRR    | P   | 95%CI  |
| Time (β1)            | 1.000 | 0.627| 0.998 1.003 | 0.998 | 0.472| 0.994 1.003 |
| Intervention (β2)    | 1.058 | 0.228| 0.965 1.160 | 1.066 | 0.401| 0.919 1.237 |
| Time X intervention (β3) | 0.996 | 0.004| 0.993 0.999 | 0.997 | 0.169| 0.993 1.001 |
| Enforcement (β4)     | 1.044 | 0.447| 0.934 1.168 | 1.043 | 0.641| 0.872 1.248 |
| Enforcement X time (β5) | 0.999 | 0.975| 0.996 1.004 | 0.999 | 0.832| 0.993 1.005 |
| Enforcement X intervention (β6) | 0.957 | 0.510| 0.840 1.091 | 0.959 | 0.691| 0.779 1.180 |
| Enforcement X time X intervention (β7) | 0.999 | 0.995| 0.996 1.004 | 1.001 | 0.641| 0.995 1.008 |

*In bold, coefficients of interest to test the hypothesis of a difference in level changes between enforcement and no-enforcement municipalities (β6), and difference in slope differences between enforcement and no-enforcement municipalities (β7)
Table S4. Total collisions, ITS CDMX, Sensitivity Analyses

|                          | Main analyses | Gasoline shortage | Private vehicles selected | 2015 intervention moved to June 2016 |
|--------------------------|---------------|-------------------|---------------------------|-------------------------------------|
|                          | IRR       | p        | 95%CI           | IRR       | p        | 95%CI           | IRR       | p        | 95%CI           | IRR       | p        | 95%CI           |
| **2015**                 |            |          |                 |            |          |                 |            |          |                 |            |          |                 |
| Step level change 2015   | 1.057     | 0.197    | 0.971, 1.151    | 1.004     | 0.931    | 0.921, 1.094   | 1.053     | 0.142    | 0.983, 1.128   |            |          |                 |
| Pre-2015 trend (Jan-Dec 2015) | 0.998 | 0.084    | 0.995, 1.000    | 0.998     | 0.234    | 0.996, 1.001   | 0.998     | 0.001    | 0.997, 0.999   |            |          |                 |
| Post-2015 trend (Jan 2016-Dec 2018) | 0.997 | 0.000    | 0.997, 0.997    | 0.998     | 0.000    | 0.997, 0.998   | 0.997     | 0.000    | 0.996, 0.997   |            |          |                 |
| Slope difference – 2015 intervention | 0.999 | 0.536    | 0.997, 1.002    | 0.999     | 0.636    | 0.997, 1.002   | 0.999     | 0.052    | 0.997, 1.000   |            |          |                 |
| **2019**                 |            |          |                 |            |          |                 |            |          |                 |            |          |                 |
| Step level change 2019   | 1.028     | 0.600    | 0.927, 1.140    | 1.024     | 0.652    | 0.924, 1.134   |            |          |                 |            |          |                 |
| Pre-2019 trend (Jan 2016 – 7 June 2019) | 0.997 | 0.000    | 0.997, 0.997    | 0.997     | 0.000    | 0.997, 0.997   |            |          |                 |            |          |                 |
| Post-2019 trend (8 June 2019 - 31st Dec 2019) | 0.997 | 0.358    | 0.991, 1.003    | 0.997     | 0.341    | 0.991, 1.003   |            |          |                 |            |          |                 |
| Slope difference – 2019 intervention | 1.000 | 0.973    | 0.994, 1.006    | 1.000     | 0.994    | 0.994, 1.006   |            |          |                 |            |          |                 |
### Table S5. Collisions resulting in injury, ITS CDMX, Sensitivity Analyses

|                      | Main analyses | Gasoline shortage | Private vehicles selected | 2015 Intervention moved June 2016 |
|----------------------|---------------|-------------------|---------------------------|---------------------------------|
|                      | IRR  | p     | 95%CI          | IRR  | p     | 95%CI          | IRR  | p     | 95%CI          | IRR  | p     | 95%CI          |
| **2015**             |      |       |                |      |       |                |      |       |                |      |       |                |
| Step level change 2015 | 1.031 | 0.595 | 0.922, 1.153  |      |       |                | 1.091 | 0.059 | 0.901, 1.130  |      |       |                |
| Pre-2015 trend (Jan-Dec 2015) | 0.996 | 0.019 | 0.993, 0.999  | 0.996 | 0.018 | 0.993, 0.999  | 0.996 | 0.000 | 0.994, 0.998  |      |       |                |
| Post-2015 trend (Jan 2016-Dec 2018) | 0.997 | 0.000 | 0.996, 0.997  | 0.997 | 0.000 | 0.997, 0.998  | 0.996 | 0.000 | 0.995, 0.997  |      |       |                |
| Slope difference – 2015 intervention | 1.000 | 0.795 | 0.997, 1.004  |      |       |                | 1.001 | 0.523 | 0.998, 1.004  |      |       |                |
| **2019**             |      |       |                |      |       |                |      |       |                |      |       |                |
| Step level change 2019 | 1.066 | 0.435 | 0.909, 1.250  | 1.074 | 0.373 | 0.918, 1.258  |      |       |                |      |       |                |
| Pre-2019 trend (Jan 2016 – 7 June 2019) | 0.996 | 0.000 | 0.996, 0.997  | 0.996 | 0.000 | 0.996, 0.997  |      |       |                |      |       |                |
| Post-2019 trend (8 June 2019 - 31st Dec 2019) | 1.011 | 0.028 | 1.001, 1.021  | 1.011 | 0.032 | 1.001, 1.020  |      |       |                |      |       |                |
| Slope difference – 2019 intervention | 1.015 | 0.003 | 1.005, 1.025  | 1.014 | 0.003 | 1.005, 1.024  |      |       |                |      |       |                |
### Table S6. Mortality due to road traffic collisions, ITS CDMX, Sensitivity Analyses

|                         | Main Analyses | Gasoline shortage | Private vehicles selected | 2015 Intervention moved to June 2016 | Redistribution of garbage codes |
|-------------------------|---------------|-------------------|---------------------------|-------------------------------------|----------------------------------|
|                         | IRR  | p    | 95%CI | IRR  | p    | 95%CI | IRR  | p    | 95%CI | IRR  | p    | 95%CI | IRR  | p    | 95%CI |
| **2015**                |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Step level change       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2015                    | 0.960 | 0.580 | 1.111 | 0.998 | 0.998 | 1.000 | 0.999 | 0.099 | 1.000 | 0.997 | 0.002 | 0.999 | 0.997 | 0.000 | 0.998 |
| Pre-2015 trend (Jan-Dec 2015) | 0.999 | 0.099 | 1.000 | 0.997 | 0.002 | 0.999 | 0.999 | 0.003 | 1.000 | 0.997 | 0.000 | 0.998 | 0.997 | 0.000 | 0.998 |
| Post-2015 trend (Jan 2016-Dec 2018) | 0.997 | 0.000 | 0.998 | 0.996 | 0.995 | 0.996 | 0.997 | 0.000 | 0.998 | 0.997 | 0.000 | 0.996 | 0.997 | 0.000 | 0.996 |
| Slope difference – 2015 intervention | 0.998 | 0.038 | 1.000 | 0.998 | 0.177 | 1.000 | 0.998 | 0.058 | 1.000 | 1.000 | 0.910 | 1.000 | 1.000 | 0.910 | 1.000 |
| **2019**                |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Step level change       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2019                    | 0.788 | 0.133 | 1.075 | 0.774 | 0.105 | 1.055 | 0.568 | 0.568 | 0.997 | 0.996 | 0.997 | 0.996 | 0.997 | 0.996 | 0.997 |
| Pre-2019 trend (Jan 2016 – 7 June 2019) | 0.996 | 0.000 | 0.997 | 0.996 | 0.000 | 0.997 | 0.999 | 0.013 | 0.998 | 0.999 | 0.013 | 0.998 | 0.999 | 0.013 | 0.998 |
| Post-2019 trend (8 June 2019 -31st Dec 2019) | 1.023 | 0.008 | 1.041 | 1.023 | 0.008 | 1.041 | 1.006 | 1.006 | 1.000 | 1.002 | 0.802 | 1.000 | 1.002 | 0.802 | 1.000 |
| Slope difference – 2019 intervention | 1.027 | 0.002 | 1.045 | 1.027 | 0.002 | 1.045 | 1.002 | 1.002 | 1.000 | 1.002 | 0.689 | 1.000 | 1.002 | 0.689 | 1.000 |
Figure S3. Interrupted Time Series of mortality with redistributed garbage codes in Mexico City.

Blue dots=estimated road traffic deaths after redistribution in Mexico City. Continuous lines=trends. Vertical lines: delineate the interventions in December 2015 and June 2019. Panel a. model that adjusts for seasonality (consistent with table S6), Panel b. model without adjusting for seasonality (consistent with main analyses). Original figures created by the research team.