ONLINE APPENDIX

Appendix A
Labor Supply Model with OddEven Driving Restrictions

Consider a two-stage model. In the first stage, workers choose their optimal commute mode (auto, public transit, or not working if they have discretion over their time). In stage two, they choose work time, leisure time, and goods consumption to maximize utility given their first-stage choice. Workers consider how their commute choice affects their utility so we solve the model by backward induction. For second-stage utilities, we modify a standard Cobb-Douglas labor supply function to accommodate commute mode choice and distinguish restricted from non-restricted days. We model the OddEven restrictions and consider each worker's utility over a representative two-day period: one non-restricted and one restricted day. With driving restrictions, the worker suffers a penalty for driving on the restricted day. Absent the policy, the two days are identical. We consider the OddEven policy because it is simpler to model than and generates the same intuition as the OneDay policy.[1]

There are two groups of workers: those with discretionary work time (D) and those with fixed work times (F) in proportions λ^D and $\lambda^F = 1-\lambda^D$ respectively. The distribution of workers in each group is given by the cumulative density functions $G^D(\theta)$ and $G^F(\theta)$ where $\theta = \{w, Y, c_i, t_i, M_i\}$. w is hourly wage, Y is two-day non-wage income, and i is commute mode. Possible commute modes are auto $(i = A)$, public transit $(i = P)$, and for those with discretion, not working $(i = 0)$. For mode i, c_i is daily commute cost and t_i time (with $t_0 = c_0 = 0$). M_i is the worker's daily non-monetary disutility from commuting by mode i. Commuting by either mode is unpleasant: $M_P, M_A > M_0 = 0$. A worker's two-day utility conditional on commute choices (i for the non-restricted and j for the restricted day) is:

(A1) $$U_{ij}(\theta) = L^{\alpha}_{Nij} X^{1-\alpha}_{Nij} L^{\alpha}_{Rij} X^{1-\alpha}_{Rij} - M_i - M_j - \mathrm{I}_{Policy}\mathrm{I}_{j=A}Q;\ i, j \in \{A, P, 0\},$$

with $(0 < \alpha < 1)$. This distinguishes the restricted (R) and non-restricted (N) days. L is daily leisure hours and X daily consumption of other goods. We ignore across-day discounting and assume that utility derived from each two-day period is independent of other two-day periods. I is an indicator variable equal to one when the condition is true and zero otherwise and $Policy$ is a logical variable distinguishing the policy period. Q is expected penalty (monetary and psychic) in utility terms of driving a car while restricted.

We assume perfect compliance and full-time work absent the restrictions and focus on short-run effects:

(A) Absent the restrictions, commute times and costs are low enough that it is optimal for all workers to work both days.
(B) Compliance costs are small enough that workers do not leave the workforce or transition between jobs with discretionary and fixed work times. This ensures that the restrictions do not change these proportions.
(C) Wages and house prices do not adjust, workers do not move their residences or change their workplace (*i.e.*, commute times and costs are fixed), and workers do not purchase a second car to comply with the restrictions.
(D) The penalty is great enough that it is never optimal to drive on a restricted day.
(E) License plate numbers are uniformly distributed with half restricted each day.

After solving the model for each worker we examine the aggregate effects on pollution and work time across the distributions of workers.

Second Stage: Discretionary Work Time: Those with discretion may choose to work either "full time" (both days) or "reduced time" (one day). Assumption (A) and diminishing marginal utility of consumption ensure that the worker will at most remain home on the restricted day.[2] We consider only

[1] It is straightforward to adapt the model to the OneDay policy and the results differ only in magnitude. The commute costs it imposes are lower making "reduced time" less likely. However, declining marginal utility makes "reduced time" more likely because goods consumption suffers less from not working one day out of five rather than one day out of two. A full analysis of the OneDay model is available from the authors.
[2] Appendix B shows that it is not optimal to work on the restricted day and instead stay home on the non-restricted day under fairly general conditions.

a representative two-day period so all restricted days are identical. As a result, "reduced time" means taking every other day off from work. A more general model with random variation in daily productivity and leisure options would allow for less regular and extreme reductions. This simple model is adequate since we do not use it for calibration or direct estimation. Ignoring the penalty Q, the worker's second-stage problem conditional on mode choices i and j is:

(A2) $$\underset{\left\{ \begin{matrix} H_{Nij}, L_{Nij}, X_{Nij}, \\ H_{Rij}, L_{Rij}, X_{Rij} \end{matrix} \right\}}{\mathrm{Max}} \quad U_{ij} = L_{Nij}^{\alpha} X_{Nij}^{1-\alpha} L_{Rij}^{\alpha} X_{Rij}^{1-\alpha} - M_i - M_j ;\, i, j \in \{A, P, 0\} \quad st:$$

(A3) $$Y + w\left(H_{Nij} + H_{Rij}\right) - \left(X_{Nij} + c_i\right) - \left(X_{Rij} + c_j\right) = 0,$$

(A4a) $$T - \left(H_{Nij} + t_i\right) - L_{Nij} = 0,$$ (A4b) $$T - \left(H_{Rij} + t_j\right) - L_{Rij} = 0,$$

(A5a) $$H_{Nij} \geq 0 \leftarrow \kappa_N ,$$ (A5b) $$H_{Rij} \geq 0 \leftarrow \kappa_R ;$$

where T is total available hours per day, H is daily working hours, and the κ's are Kuhn-Tucker multipliers. Equation (A3) is the resident's two-day budget constraint with the price of X normalized to one. Equations (A4a) and (A4b) are the resident's day-by-day time constraints. We assume that the budget and time constraints bind but that the constraints on positive working hours may not. Substituting (A3) and (A4) the problem becomes:

(A6) $$\underset{\{H_{Nij}, X_{Nij}, H_{Rij}\}}{\mathrm{Max}} \quad U_{ij} = \left(T - H_{Nij} - t_i\right)^{\alpha} X_{Nij}^{(1-\alpha)} \left(T - H_{Rij} - t_j\right)^{\alpha} \left(Y + wH_{Nij} + wH_{Rij} - X_{Nij} - c_i - c_j\right)^{1-\alpha} - M_i - M_j$$

The first-order conditions for the worker's problem are:

(A7a) $$\left[H_{Nij}\right]: \frac{\alpha\left(U_{ij} + M_i + M_j\right)}{T - H_{Nij} - t_i} = \frac{(1-\alpha)\, w\left(U_{ij} + M_i + M_j\right)}{Y + wH_{Nij} + wH_{Rij} - X_{Nij} - c_i - c_j},$$

(A7b) $$\left[H_{Rij}\right]: \frac{\alpha\left(U_{ij} + M_i + M_j\right)}{T - H_{Rij} - t_j} - \kappa = \frac{(1-\alpha)\, w\left(U_{ij} + M_i + M_j\right)}{Y + wH_{Nij} + wH_{Rij} - X_{Nij} - c_i - c_j},$$

(A8) $$\left[X_{Nij}\right]: \frac{(1-\alpha)\left(U_{ij} + M_i + M_j\right)}{X_{Nij}} = \frac{(1-\alpha)\left(U_{ij} + M_i + M_j\right)}{Y + wH_{Nij} + wH_{Rij} - X_{Nij} - c_i - c_j},$$

(A9a) $$\left[\kappa_R\right]: H_{Rij}\kappa_R = 0 ,$$ (A9b) $$\left[\kappa_N\right]: H_{Nij}\kappa_N = 0 .$$

There are two cases to solve: "full time" $\left(H_{Nij}, H_{Rij} > 0; i, j \in \{A, P\}\right)$ and "reduced time" ($H_{Ni0} > 0,$ $i \in \{A, P\}$; but $H_{Ri0} = 0$ or vice versa). Conditional on the commute mode choices i and j, define:

(A10a) $NT_{Ni} = T - t_i$ and $NT_{Rj} = T - t_j$, (A10b) $$NI_{ij} = \frac{Y - c_i - c_j}{w};$$

(A10c) $$\Delta t_{ji} = t_j - t_i ,$$ (A10d) $$\Delta c_{ji} = \left(c_j - ct_i\right)/w .$$

NT_{Ni} and NT_{Rj} are the time available net of commuting on restricted and non-restricted days while NI_{ij} is the two-day, non-wage income net of commute costs. Δt_{ji} and Δc_{ji} are the difference in commute times and costs respectively on the restricted versus non-restricted days. Both NI_{ij} and Δc_{ji} are converted to hours based on the opportunity cost of time.

Case 1): "Full Time" $\left(H_{Nij}, H_{Rij} > 0; i, j \in \{A, P\}\right)$. Solving the model (the Optional Appendix contains a detailed derivation), the results are:

(A11a) $$H_{Nij} = (1-\alpha)\, NT_{Ni} - \frac{\alpha}{2}\left[NI_{ij} - \Delta t_{ji}\right],$$ (A11b) $$H_{Rij} = (1-\alpha)\, NT_{Rj} - \frac{\alpha}{2}\left[NI_{ij} + \Delta t_{ji}\right];$$

(A12) $L_{Nij} = L_{Rij} = \alpha\left[NT_{Ni} + \frac{1}{2}\left(NI_{ij} - \Delta t_{ji}\right)\right]$,

(A13) $X_{Nij} = X_{Rij} = (1-\alpha) w\left[NT_{Ni} + \frac{1}{2}\left(NI_{ij} - \Delta t_{ji}\right)\right]$.

Two-day indirect utility is, where we re-introduce the penalty Q:

(A14) $U_{ij} = \left(kw^{(1-\alpha)}\right)^2 \left(NT_{Ni} + \frac{NI_{ij}}{2} - \frac{\Delta t_{ji}}{2}\right)^2 - M_i - M_j - \mathrm{I}_{Policy}\mathrm{I}_{j=A}Q; i, j \neq 0$ where $\left(k = \alpha^{\alpha}(1-\alpha)^{(1-\alpha)}\right)$.

Leisure time is equated across the days. For workers who prefer public transit the work day lengths are the same: $H_{RPP} - H_{NPP} = 0$. For those who prefer driving, their restricted work day will be shorter or longer than their non-restricted depending on whether their public transit commute is longer or shorter than by car ($H_{RAP} - H_{NAP} = (\alpha - 1)\Delta t_{PA}$).

Case 2): "Reduced Time" *(*$H_{Ni0} > 0, i \in \{A, P\}$ *but* $H_{Rij} = 0$*)*. We solve the model assuming zero hours on the restricted day. In this case $t_R = c_R = 0$. The results for instead working zero hours on the non-restricted days are symmetric but Appendix B shows that this is not optimal under fairly general conditions. Solving (the Optional Appendix contains a detailed derivation), the results are:

(A15a) $H_{Ni0} = \frac{2}{1+(1-\alpha)}\left[(1-\alpha) NT_{Ni} - \frac{\alpha}{2} NI_{i0}\right]$, (A15b) $H_{Ri0} = 0$;

(A16a) $L_{Ni0} = \frac{\alpha}{1+(1-\alpha)}\left[NT_{Ni} + NI_{i0}\right]$, (A16b) $L_{Ri0} = T$;

(A17a) $X_{Ni0} = \frac{(1-\alpha) w}{1+(1-\alpha)}\left[NT_i + NI_{i0}\right]$, (A17b) $X_{Ri0} = \frac{(1-\alpha) w}{1+(1-\alpha)}\left[NT_i + NI_{i0}\right]$.

Two-day indirect utility is:

(A18) $U_{i0} = \frac{\left(kw^{(1-\alpha)}\right)^2}{\left(1+(1-\alpha)\right)^{1+(1-\alpha)} \alpha^{\alpha}} \left(NT_{Ni} + NI_{i0}\right)^{1+(1-\alpha)} T^{\alpha} - M_i$, where $\left(k = \alpha^{\alpha}(1-\alpha)^{(1-\alpha)}\right)$.

The worker cannot balance leisure or work time across restricted and non-restricted days. The results for $H_{Nij} = 0$ but $H_{Rij} > 0$ are obtained by replacing N with R, i with 0, and 0 with j.

Second Stage: Fixed Work Times: Since daily work hours are fixed $\left(H_{Nij} = H_{Rij} = \overline{H} > 0; i, j \in \{A, P\}\right)$, the worker chooses only L_{Nij}, L_{Rij}, X_{Nij}, and X_{Rij}. Solving, (the Optional Appendix contains a detailed derivation), the results are:

(A19a) $L_{Nij} = T - \overline{H} - t_i$, (A19b) $L_{Rij} = T - \overline{H} - t_j$;

(A20) $X_{Nij} = X_{Rij} = w\left[\overline{H} + \frac{1}{2} NI_{ij}\right]$.

Two-day indirect utility is, where we re-introduce the penalty Q:

(A21) $U_{ij} = w^{2(1-\alpha)}\left[\left(T - \overline{H} - t_i\right)\left(T - \overline{H} - t_j\right)\right]^{\alpha}\left(\overline{H} + \frac{NI_{ij}}{2}\right)^{2(1-\alpha)} - M_i - M_j - \mathrm{I}_{Policy}\mathrm{I}_{j=A}Q; i, j \neq 0$.

The difference in leisure time on restricted versus non-restricted days depends on relative commute times for the chosen modes $\left(L_{Rij} - L_{Nij} = \Delta t_{ji}\right)$ but the difference is not shared across the two days.

This completes the second-stage solution for type θ. We now consider the first stage when workers choose their commute mode. Using the distributions of the θ's we can specify the share of each commute mode for both categories of workers: $s_{ij}^k, k \in \{D,F\}; i,j \in \{A,P,0\}$. We solve the first stage with and without the restrictions.

First Stage – Without Restrictions: Without the restrictions, the two days are identical and the worker makes the same choice across days ($i = j$). The shares of each mode are $(k = D,F)$:

(A22a) $s_{AA}^k = \int \{\theta \,|\, U_{AA}(\theta) > U_{ii}(\theta); i = P,0\} dG^k(\theta) d\theta$, (A22b) $s_{PP}^k = \int \{\theta \,|\, U_{PP}(\theta) > U_{ii}(\theta); i = A,0\} dG^k(\theta) d\theta$,

where U_{ij} is given by (A14) and Assumption (A) implies $s_{00}^k = 0$ so that $s_{AA}^k + s_{PP}^k = 1$.

First Stage – With Restrictions: Assumption (D) ensures that Q is great enough that no workers drive on their restricted day so that $i \in \{A,P\}$ and $j \in \{P,0\}$. Regardless of whether they have discretion or not, commuters who prefer public transit absent the restrictions will take public transit both days under the restrictions so that $\hat{s}_{PP}^k = s_{PP}^k; k \in \{D,F\}$ where we use hats to denote outcomes under the restrictions. This follows because $U_{PP}(\theta) > U_{AA}(\theta)$ implies $U_{PP}(\theta) > U_{AP}(\theta)$ in both Equations (A14) and (A21).

Workers who prefer to drive absent the restrictions will continue to drive on the non-restricted day. On the restricted day, those with fixed work times must take public transit on the restricted day so that $\hat{s}_{A0}^F = 0$ and $\hat{s}_{AP}^F = s_{AA}^F$. On the restricted day, those with discretion can either take public transit or not work. The shares doing each are:

(A23a) $\hat{s}_{AP}^D = \int \{\theta \,|\, U_{AP}(\theta) > U_{A0}(\theta)\} dG^D(\theta) d\theta$, (A23b) $\hat{s}_{A0}^D = \int \{\theta \,|\, U_{A0}(\theta) > U_{AP}(\theta)\} dG^D(\theta) d\theta$.

Given Assumption (B), we know that $\hat{s}_{AP}^D + \hat{s}_{A0}^D = s_{AA}^D$ and if some commuters find it optimal to stay home when restricted $\left(\hat{s}_{A0}^D > 0\right)$ then $\hat{s}_{AP}^D < s_{AA}^D$.

Extensive Margin Effects: For those with fixed work times, there is no effect on the extensive margin since they have no control over work time (*i.e.*, $\hat{s}_{AP}^F = s_{AA}^F$ and $\hat{s}_{PP}^F = s_{PP}^F$). This yields **Implication 1** in the main text.

Assumption (A) implies that absent the restrictions no workers with discretionary work time stay home on the restricted day.[3] With the restrictions, this increases to $\lambda^D \hat{s}_{A0}^D / 2$ – the density of workers choosing "reduced time." This yields **Implication 2** in the main text.

Under the restrictions, daily car density and pollution on Beijing roads decreases by $\frac{1}{2}\left(\lambda^D s_{AA}^D + \lambda^F s_{AA}^F\right)$. That is, half the drivers cannot drive on a given day. This yields **Implication 3** in the main text.

Intensive Margin Effects – Workers with Fixed Work Times: Those who took public transit absent the restrictions will still do so and their leisure time is unaffected $\left(\hat{L}_{NPP} - L_{NPP} = \hat{L}_{RPP} - L_{RPP} = 0\right)$ by Equation (A19). Those who prefer to drive, with density $\lambda^F s_{AA}^F / 2$, are forced to take public transit and leisure is unaffected on non-restricted $\left(\hat{L}_{NAP} - L_{NAA} = 0\right)$ but affected on restricted days $\left(\hat{L}_{RAP} - L_{RAA} = -\Delta t_{PA}\right)$ by Equation (A19). Since intensive margin effects are zero for those who

[3] In our data, this is not literally zero due to multiple daily work shifts, vacations, and sick days.

normally take public transit and ambiguous for those who normally drive, the total effect $\left(-\lambda^F s^F_{AA} \Delta t_{PA}/2\right)$ could be positive or negative. This yields **Implication 4** in the main text.

Intensive Margin Effects – Workers with Discretionary Work Time: Workers who prefer public transit absent the restrictions choose to work "full time" and there is no effect on leisure time: $\hat{L}_{NPP} - L_{NPP} = \hat{L}_{RPP} - L_{RPP} = 0$ by Equation (A12). Those who prefer driving absent the restrictions and choose to work "full time" must commute by public transit on the restricted day and their leisure time could increase or decrease depending on whether public transit commute times and costs are less than those by car or not: $\hat{L}_{NAP} - L_{NAA} = \hat{L}_{RAP} - L_{RAA} = -\alpha/2\left(\Delta c_{PA} + \Delta t_{PA}\right)$ by Equation (A12). Unlike those with fixed work times, commute costs also matter because daily labor supply is discretionary. Due to diminishing marginal utility, the worker equalizes leisure time across the work days and shares the difference in commute times and costs across the restricted and non-restricted days.

For workers who work "reduced time," leisure time most likely decreases on the non-restricted day. Equations (A12) and (A16a) imply:

(A24) $$\hat{L}_{NA0} - L_{NAA} = \frac{\alpha}{1+(1-\alpha)}\left[(\alpha-1)(T-t_A) + \frac{\alpha}{2}\frac{Y}{w} + (1-\alpha)\frac{c_A}{w}\right] \equiv \Upsilon \cdot$$

That the expression in Equation (A24) can be positive (negative) is most easily seen by setting α close to one (zero). This expression is more likely positive the greater Y, c_A, or t_A. The total effect across all workers with discretionary work time is $\lambda^D\left[\hat{s}^D_{A0}\Upsilon - \hat{s}^D_{AP}\alpha/2\left(\Delta c_{PA} + \Delta t_{PA}\right)\right]$, which could be positive or negative. This yields **Implication 5** in the main text.

Appendix B
Non-Optimality of Staying Home on Non-Restricted Day

Working on the restricted day but not on the non-restricted is not optimal under at least two general cases:

Case 1: $M_A = M_P$ and $c_A > c_P$. For a worker who prefers to commute by auto, $U_{AA} > U_{PP}$ which by Equation (A14) implies:

(B1) $$\left(NT_{NA} + \frac{NI_{AA}}{2}\right)^2 > \left(NT_{NP} + \frac{NI_{PP}}{2}\right)^2 \Rightarrow (t_P - t_A) > \frac{2}{w}(c_A - c_P)$$. Now:

(B2) $$c_A > c_P \Rightarrow \frac{1}{w}(c_A - c_P) < \frac{2}{w}(c_A - c_P) \Rightarrow (t_P - t_A) > \frac{1}{w}(c_A - c_P)$$ which implies:

(B3) $$\left(NT_{NA} + NI_{A0}\right) > \left(NT_{NP} + NI_{P0}\right) \Rightarrow \left(NT_{NA} + NI_{A0}\right)^{1+(1-\alpha)} > \left(NT_{NP} + NI_{P0}\right)^{1+(1-\alpha)}$$. This implies $U_{A0} > U_{P0}$ using Equation (A18).

Case 2: $t_A = t_P$ and $c_A = c_P$ but $M_A \neq M_P$. By Equation (A14) $U_{AA} > U_{PP} \Rightarrow M_P > M_A$. This implies $U_{A0} > U_{P0}$ using Equation (A18).

Assumption (A) ensures that the worker will remain home on at most the restricted day since the non-restricted day is unaffected and extra leisure is already enjoyed on the restricted day under "reduced-time" work.

Appendix C
Conditions for "Reduced-Time" Work for Discretionary Workers

We consider two cases:

Case 1: $M_A = M_P = 0$. Comparing Equations (A14) and (A18), $U_{A0} > U_{AP}$ when:

(C1) $$\frac{\left(NT_{NA}+NI_{A0}\right)^{1+(1-\alpha)}T^{\alpha}}{\left(NT_{NA}+NI_{A0}-\frac{c_P}{2}-\frac{\Delta t_{PA}}{2}\right)^2}>\left(1+\left(1-\alpha\right)\right)^{1+(1-\alpha)}\alpha^{\alpha}.$$

It follows immediately that this is more likely the greater c_P or Δt_{PA}.

Case2: $\left(M_P \gg 0\right)$. Since U_{A0} in Equation (A18) does not depend on M_P and U_{AP} in Equation (A14) is decreasing in M_P it follows directly that $U_{A0}>U_{AP}$ when M_P is sufficiently large $\left(M_P \gg 0\right)$.

Appendix D
Effect of Expanded Subway Capacity on Leisure Time

Expanded subway capacity reduces both public transit and auto commute times: $\tilde{t}_A < t_A$ and $\tilde{t}_P < t_P$, where tildes indicate outcomes after the expansion. Assume that the expansion has no effect on commute costs ($\tilde{c}_A = c_A$ and $\tilde{c}_P = c_P$) and does not change workers' optimal commute modes. Assuming all workers obey the restrictions and continue to work "full time" (*i.e.*, there is no extensive margin effect), compute the change in leisure time due to the subway expansion for each category of worker and commute mode. For those with discretionary work time who prefer driving and public transit respectively (by Equation (A12)):

(D1) $$\tilde{L}_{NAP}-L_{NAA}=\tilde{L}_{RAP}-L_{RAA}=\alpha\left[\left(t_A-\tilde{t}_A\right)+\frac{1}{2}\frac{c_A-c_P}{w}-\frac{1}{2}\left(t_P-\tilde{t}_A\right)\right],$$

(D2) $$\tilde{L}_{NPP}-L_{NPP}=\tilde{L}_{RPP}-L_{RPP}=\alpha\left(t_P-\tilde{t}_P\right).$$

For those with fixed work times who prefer driving and public transit respectively (by Equation (A19)):

(D3a) $$\tilde{L}_{NAP}-L_{NAA}=\left(t_A-\tilde{t}_A\right),$$

(D3b) $$\tilde{L}_{RAP}-L_{RAA}=\left(t_A-\tilde{t}_P\right);$$

(D4) $$\tilde{L}_{NPP}-L_{NPP}=\tilde{L}_{RPP}-L_{RPP}=\left(t_P-\tilde{t}_P\right).$$

All of the expressions on the right-hand sides of Equations (D1) through (D4) are weakly decreasing in both $\tilde{t}_A$ and $\tilde{t}_P$ and are strictly decreasing in one of them for at least one commute mode within each group of workers. This implies that leisure time increases for both groups due to the expansion.

Appendix E
Variable Descriptions and Data Sources

Variable	Description	Frequency/ Availability	Data Source
Aggregate API	Aggregate Air Pollution Index; see text for detailed description.	Daily	SEPA and BJEPA
Station-Level API	Air Pollution Index from 24 monitoring stations.	Daily	Andrews (2008)
Maximum Temperature	Maximum daily temperature in celcius.	Daily	CMDSSS
Average Humidity	Average percent humidity over the day.	Daily	CMDSSS
Total Rainfall	Total rainfall over the day in tens of centimeters.	Daily	CMDSSS
Wind Direction	Predominant direction of wind during the day divided into four quadrants (Northeast, Southeast, Southwest, Northwest).	Daily	CMDSSS
Max. Wind Speed	Maximum of the average wind speed over 15-minute increments across the day in meters per second.	Daily	CMDSSS
Sunshine	Number of total hours of sunlight during the day.	Daily	CMDSSS
Distance from Ring Road	Distance in kilometers of monitoring station from nearest Ring Road.	Once	Geographic Information System calculations
Average Wind Speed	Average daily wind speed in meters per second.	Daily	CMDSSS
Average Temperature	Average daily temperature in celsius.	Daily	CMDSSS
Television Viewership	Number of people in thousands watching television.	Hourly	CSM Media Research Television Audience Measurement (TAM)

CMDSSS refers to China Meteorological Data Sharing Service System, SEPA to State Environmental Protection Agency, and BJEPA to Beijing Environmental Protection Agency.

Appendix F
Construction of API Indices

A daily measure of particulate matter, sulfur dioxide, and nitrogen dioxide at each station s on day t is based on the average of 24 hourly (indexed by h) readings: $PM10_{st} = \frac{1}{24}\sum_{h=1}^{24} PM10_{sth}$, $SO2_{st} = \frac{1}{24}\sum_{h=1}^{24} S02_{sth}$, and $NO2_{st} = \frac{1}{24}\sum_{h=1}^{24} N02_{sth}$. The three measures are then scaled to reflect comparable severity $\left(\overline{PM10}_{st}, \overline{SO2}_{st}, \overline{NO2}_{st}\right)$. The piece-wise linear conversion formula for particulate matter is given in the table below – similar conversions are used for sulfur dioxide and nitrogen dioxide. Station-level API is:

(F1) $$API_{st}^{S} = \max\left\{\overline{PM10}_{st}, \overline{SO2}_{st}, \overline{NO2}_{st}\right\}.$$

The aggregate API is calculated as:

(F2) $API_t = \max\left\{\overline{PM10}_t, \overline{SO2}_t, \overline{NO2}_t\right\}$,

where $\left(\overline{PM10}_t, \overline{SO2}_t, \overline{NO2}_t\right)$ are the scaled versions of the average daily measures across all stations: $PM10_t = \frac{1}{S}\sum_{s=1}^{S} PM10_{st}$, $SO2_t = \frac{1}{S}\sum_{s=1}^{S} SO2_{st}$, and $NO2_t = \frac{1}{S}\sum_{s=1}^{S} NO2_{st}$.

We observe only API_{st}^{S}, API_t, and the identity of the "major pollutant" for each if the value exceeds 50. We do not observe daily data for all three pollutants for each station – we observe only the "major pollutant" for each station on each day – and we do not observe the underlying hourly data. The percentage of days that PM_{10} is the "major pollutant" at a station ranges from 68% to 91% across stations. At the aggregate level, PM_{10} is the "major pollutant" on 83% of the days.

What we observe about these indices limits their use. First, since the "major pollutant" at a station may differ from that at the aggregate level, we are unable to fully verify the construction of the aggregate API from the station-level APIs. Second, since the "major pollutant" for each station can vary day-by-day we cannot construct station-level PM_{10} measures over time. Finally, since the "major pollutant" varies across stations within a day and across days within a station, we cannot construct an alternative, aggregate pollution measure.

Conversion of PM_{10} to API

API	PM_{10}	Conversion Formula
0 – 50	0 – 50	API = PM_{10}
50 – 200	50 – 350	API = (1/2)*PM_{10} + 25
200 – 300	350 – 420	API = (10/7)*PM_{10} – 300
300 – 400	420 – 500	API = (5/4)*PM_{10} – 225
400 – 500	500 – 600	API = PM_{10} – 100

Based on Andrews (2008).

Appendix G
Placebo Tests of RD Design

	(1)	(2)	(3)	(4)	(5)	(6)
	Pre-OddEven - Mid-Point			Pre-OddEven - 3/4-Point		
	No Trend	Linear Trend	Quadratic Trend	No Trend	Linear Trend	Quadratic Trend
"OddEven" Placebo	0.4408 ***	0.2585	0.1784	-0.0233	-0.0405	0.1804
	(0.1385)	(0.1808)	(0.1679)	(0.0586)	(0.1351)	(0.1547)
R^2	0.6463	0.6481	0.6503	0.6415	0.6442	0.6502
N	566	566	566	566	566	566
	Post-OneDay - Mid-Point			Post-OneDay - 1/4-Point		
	No Trend	Linear Trend	Quadratic Trend	No Trend	Linear Trend	Quadratic Trend
"OneDay" Placebo	0.1613 ***	0.0341	0.0303	0.1676 ***	-0.1334	-0.1271
	(0.0573)	(0.1500)	(0.1357)	(0.0601)	(0.1130)	(0.1136)
R^2	0.7135	0.7138	0.7169	0.7113	0.7127	0.7134
N	446	446	446	446	446	446

Dependent variable is log aggregate daily API. Standard errors in parentheses. Newey-West standard errors used in all regressions with 8-day lag in top panel and 1-day lag in bottom panel. * = 10% significance, ** = 5% significance, *** = 1% significance. Week-of-year dummies, maximum temperature, average humidity, total rainfall, hours of sunshine, wind speed quartiles, wind direction dummies, interactions between wind speed and wind direction, and dummies for holidays and days with pollutant unknown included in all regressions. The top panel regressons include all days before the OddEven policy begins on July 20, 2008. The bottom panel regressions include all days after the OneDay policy begins on October 11, 2008. In the top panel separate time trends are allowed before, during, and after the placebo policies. In the bottom panel separate time trends are allowed before and after the placebo policies.

Appendix H
DD Estimates using Log Station-Level, Daily API (2007 – 2009) Including Time Trend Results

	(1)	(2)	(3)	(4)
	Distance to Ring Roads			Distance to Class I Roads
	Near/Far		Quadratic Distance	
OddEven	-0.1878***	-0.1876***	-0.3449***	-0.2054***
	[-0.2918, -0.0838]	[-0.2915, -0.0837]	[-0.5359, -0.1540]	[-0.3191, -0.0917]
Near*OddEven	-0.0457**	-0.0379**		-0.0304
	[-0.0868, -0.0046]	[-0.0797, 0.0040]		[-0.1389, 0.0782]
OddEven*Distance			0.1973	
			[-0.6466, 1.0412]	
OddEven*Distance^2			-0.0378	
			[-0.1663, 0.0907]	
OneDay	-0.1819***	-0.1807***	-0.2753***	-0.2125***
	[-0.2826, -0.0812]	[-0.2807, -0.0807]	[-0.4277, -0.1229]	[-0.3301, -0.0948]
Near*OneDay	-0.0300**	-0.0222**		-0.0412*
	[-0.0604, 0.0004]	[-0.0465, 0.0022]		[-0.0994, 0.0171]
OneDay*Distance			0.1715	
			[-0.1302, 0.4733]	
OneDay*Distance^2			-0.0836	
			[-0.3791, 0.2118]	
OneDay*Weekend	0.0632***	0.0631***	0.0632***	0.0878***
	[0.0299, 0.0965]	[0.0299, 0.0964]	[0.0299, 0.0965]	[0.0415, 0.1341]
Before OddEven Trend		0.0609**		0.0876*
		[-0.0079, 0.1297]		[-0.0225, 0.1978]
Near*(Before OddEven Trend)		-0.0339		-0.0019
		[-0.3339, 0.2660]		[-0.0039, 0.0001]
During OddEven/Before Olympics Trend		16.4666***		9.8977***
		[7.7885, 25.1447]		[3.9082, 15.8872]
Near*(During OddEven/Before Olympics Trend)		-0.3245		-0.4885
		[-0.8874, 0.2384]		[-1.5420, 0.5649]
During Olympics Trend		1.6463		-25.6476***
		[-22.8768, 26.1693]		[-39.8473, -11.4478]
Near*(During Olympics Trend)		-2.2969		-0.8528
		[-10.5043, 5.9105]		[-2.7225, 1.0170]
During OddEven/After Olympics Trend		-10.9026***		-12.2377***
		[-16.9388, -4.8664]		[-19.0130, -5.4632]
Near*(During OddEven/After Olympics Trend)		0.8949		-0.7844
		[-11.8714, 13.6612]		[-3.3768, 1.8080]
Break Trend		15.2044***		40.2736***
		[7.1915, 23.2173]		[19.0490,61.4983]
Near*(Break Trend)		2.3940		-6.4651**
		[-13.4220, 18.2100]		[-13.9298, 0.9996]
During OneDay Trend		0.4460***		0.4984***
		[0.2109, 0.6810]		[0.2357, 0.7611]
Near*(During OneDay Trend)		0.0112		0.0840
		[-0.0145, 0.0370]		[-0.0944, 0.2624]
R^2	0.6529	0.6521	0.6488	0.5041
Station Fixed Effects	Yes	Yes	Yes	Yes
Number of Stations	8	8	8	8
N	8,361	8,361	8,361	8,361

Dependent variable is log daily API at monitoring stations inside the retricted area. 95% confidence intervals based on wild bootstrap (Cameron, Gelbach, and Miller, 2008) using 10,000 iterations to control for group clustering in brackets. * = 10% significance, ** = 5% significance, *** = 1% significance based on percentile p-values. All regressions include week-of-year dummies, maximum temperature, average humidity, total rainfall, hours of sunshine, wind speed quartiles, wind direction dummies, interactions between wind speed and wind direction, and dummies for holidays, Olympics, weekends, interaction between weekends and OneDay, and days with pollutant missing. Interaction between near dummy and Olympics dummy included in Columns 2 and 4. Separate linear time trends are allowed for the regimes Before OddEven, During OddEven/Before Olympics, During Olympics, During OddEven/After Olympics, Break, and During OneDay and these are interacted with station fixed-effects in Columns 1 and 3. The number of observations is not evenly divisable by the number of stations due to missing values.

Appendix I
DD Estimates using Log Station-Level, Daily API in Discontinuity Samples

	(1) 45-Day Window	(2) 60-Day Window
OddEven	-0.1192***	-0.1899***
	[-0.1852, -0.0532]	[-0.2950, -0.0847]
"Near"*OddEven	-0.0447*	-0.0414
	[-0.1048, 0.0154]	[-0.1065, 0.0238]
R^2	0.8083	0.7248
Number of Stations	8	8
Station Fixed Effects	Yes	Yes
N	718	958

Dependent variable is log daily API at monitoring stations inside the restricted area. 95% confidence intervals based on wild bootstrap (Cameron, Gelbach, and Miller, 2008) using 10,000 iterations to control for group clustering in brackets. * = 10% significance, ** = 5% significance, *** = 1% significance based on percentile p-values. All regressions include the same control variables as in Table 5 (except time trend). The number of observations is not evenly divisable by the number of stations due to missing values.

Appendix J
Effect of Subway Line 5/Subway Fare and Bus Fare Reduction Policies

	(1)	(2)	(3)	(4)	(5)
	RD			DD	
	Line 5/ Subway Fare	Bus Fare Reduction	Both	Line 5/ Subway Fare	Bus Fare Reduction
OddEven	-0.1805**	-0.1786**	-0.1811**	-0.2174***	-0.2138***
	(0.0842)	(0.0845)	(0.0845)	[-0.3378, -0.0970]	[-0.3322, -0.0954]
OneDay	-0.2255***	-0.2119***	-0.2244***	-0.2232***	-0.1933***
	(0.0591)	(0.0502)	(0.0596)	[-0.3468, -0.0996]	[-0.3003, -0.0863]
Line 5 Opening/Subway Fare Reduction	-0.0325		-0.0305	-0.1055	
	(0.0798)		(0.0789)	[-0.2923, 0.0813]	
Bus Fare Reduction		0.0136	0.0077		0.0402
		(0.0786)	(0.0784)		[-0.1916, 0.2720]
Line 5 Opening/Subway Fare Reduction*Distance				-0.0225	
				[-0.0599, 0.0150]	
Line 5 Opening/Subway Fare Reduction*Distance^2				0.0680	
				[-1.5103, 1.6463]	
Subway Fare Reduction*Distance					0.0480
					[-0.0343, 0.1303]
Subway Fare Reduction*Distance^2					-0.0480
					[-0.1676, 0.0717]
R^2	0.6577	0.6576	0.6577	0.6532	0.6529

	(1)	(2)	(3)	(4)	(5)
	RD			DD	
	Line 5/ Subway Fare	Bus Fare Reduction	Both	Line 5/ Subway Fare	Bus Fare Reduction
Line 5 Opening/Subway Fare Reduction	0.1225		0.0769	0.0568	
	(0.0833)		(0.1240)	[-0.1753, 0.2889]	
Bus Fare Reduction		0.0828	0.0255		0.1840***
		(0.0929)	(0.1102)		[0.0398, 0.3282]
Line 5 Opening/Subway Fare Reduction*Distance				0.1230	
				[-2.8829, 3.1288]	
Line 5 Opening/Subway Fare Reduction*Distance^2				-0.0470	
				[-0.3380, 0.2440]	
Subway Fare Reduction*Distance					-0.0210
					[-0.0543, 0.0123]
Subway Fare Reduction*Distance^2					-0.0491
					[-0.3193, 0.2211]
R^2	0.6492	0.6507	0.6510	0.6445	0.6467
Number of Stations				8	8
N	1,096	1,096	1,096	8,361	8,361

RDD regressions: Dependent variable is log of aggregate, daily API. Standard errors in parentheses. Newey-West standard errors with 1-day lag. * = 10% significance, ** = 5% significance, *** = 1% significance. Regressions include all control variables used in Column 1 of Table 2. In the top panel separate linear time trends are included for the regimes Before Oddeven, During OddEven/Before Olympics, During Olympics, During OddEven/After Olympics, Break, and During OneDay. In the bottom panel linear and quadratic time trends before and after the policies are included in Columns 1 and 2; linear and quadratic time trends before the Line 5 policy, between the Line 5 and Bus Fare policy and after the Bus Fare policy included in Column 3. DD regressions: Dependent variable is log of daily API at monitoring stations inside the restricted area. 95% confidence intervals based on wild bootstrap (Cameron, Gelbach, and Miller ,2008) using 10,000 iterations to control for group clustering in brackets. * = 10% significance, ** = 5% significance, *** = 1% significance based on percentile p-values. Regressions include all control variables used in Column 3 of Table 5. In the top panel, separate linear time trends are allowed for the regimes Before OddEven, During OddEven/Before Olympics, During Olympics, During OddEven/After Olympics, Break, and During OneDay and these are interacted with station fixed effects. In the bottom panel, linear and quadratic time trends before and after the policies are interacted with station fixed effects in Columns 4 and 5. The number of observations in the DD regressions is not evenly divisible by the number of stations due to missing values.

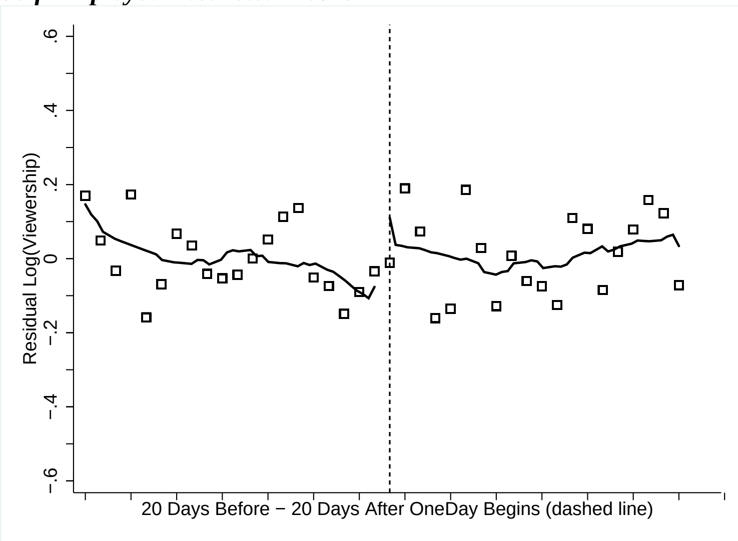
Appendix K
Sensitivity of Policy Coefficients to Order of Polynomial Daily Time Trend in Regression of Log Hourly Television Viewership, N = 26,303

	1-Order	2-Order	3-Order	4-Order
"Self-Employed"				
OneDay69*Restricted Hours	0.2110 ***	0.1734 ***	0.0772 **	0.0893 **
	(0.0214)	(0.0316)	(0.0361)	(0.0378)
OneDay78*Restricted Hours	0.2042 ***	0.1956 ***	0.1782 ***	0.1685 ***
	(0.0351)	(0.0387)	(0.0381)	(0.0385)
Prob > F (Time Trend)	0.0000	0.0000	0.0000	0.0000
AIC	36,117.8	36,008.8	35,987.1	35,985.8
"Hourly Workers"				
OneDay69*Restricted Hours	0.1317 ***	0.0024	-0.0379	-0.0329
	(0.0161)	(0.0229)	(0.0287)	(0.0286)
OneDay78*Restricted Hours	0.0522 *	-0.0904 ***	-0.0920 ***	-0.0833 ***
	(0.0277)	(0.0291)	(0.0284)	(0.0287)
Prob > F (Time Trend)	0.0000	0.0000	0.0000	0.0000
AIC	30,143.9	30,020.3	30,008.5	29,983.0

Coefficents on selected policy variables in regression of log viewership on control variables and a polynomial time trend as in Table 6. Dependent variable is log number of thousands of individuals watching television each hour. All regressions include the control variables shown in Table 6 as well as hour-of-day dummies, month-of-year dummies, and a dummy for the break period interacted with hour-of-day dummies. Standard errors clustered at the daily level in parentheses. * = 10% significance, ** = 5% significance, *** = 1% significance. Separate time trends are allowed for the regimes: Before Oddeven, During OddEven/Before Olympics, During Olympics, During OddEven/After Olympics, Break, and During OneDay. The F-test is the p-value for the joint significance level of the time trend variables. AIC is the value of Akaike's information criterion of model selection.

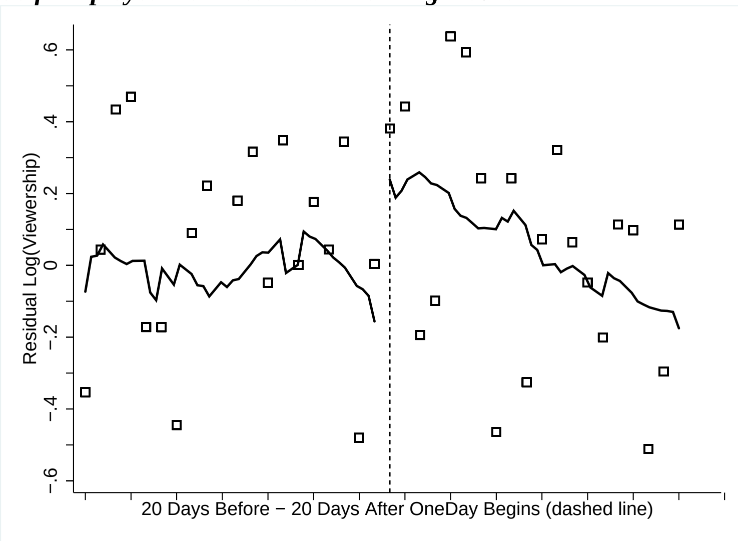
Appendix L
Viewership Discontinuity Samples (Twenty-Day Window around OneDay Policy)

Self-Employed Restricted Hours



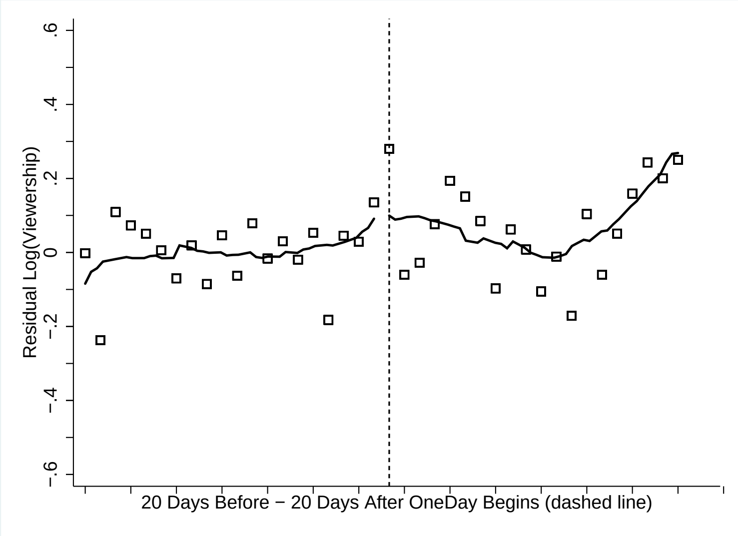
The square dots are average residuals across the restricted hours from a regression of log aggregate hourly viewership (all 24 hours) on the set of controls in Table 6 (except time trend) in the 20 days before and after the beginning of the OneDay policy (the vertical dashed line). The solid lines are fitted values of the average residuals from local linear regressions using a rectangular kernel and a bandwidth of 5 and standard errors clustered by day. The residuals display a jump of 18.5% at the policy date significant at the 8.5% level.

Self-Employed Non-Restricted Morning Hours



The square dots are average residuals across the morning non-restricted hours from a regression of log aggregate hourly viewership (all 24 hours) on the set of controls in Table 6 (except time trend) in the 20 days before and after the beginning of the OneDay policy (the vertical dashed line). The solid lines are fitted values of the average residuals from local linear regressions using a rectangular kernel and a bandwidth of 5 and standard errors clustered by day. The residuals display an insignificant jump of 48.2% at the policy date.

Self-Employed Non-Restricted Evening Hours

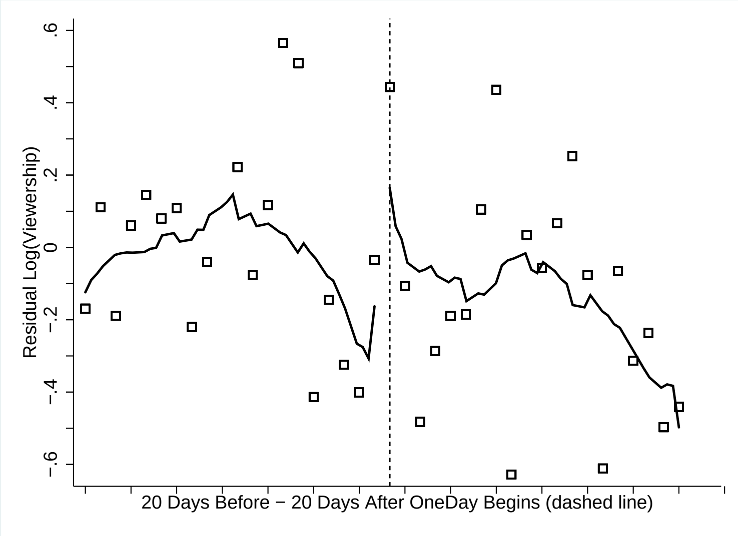


The square dots are average residuals across the evening non-restricted hours from a regression of log aggregate hourly viewership (all 24 hours) on the set of controls in Table 6 (except time trend) in the 20 days before and after the beginning of the OneDay policy (the vertical dashed line). The solid lines are fitted values of the average residuals from local linear regressions using a rectangular kernel and a bandwidth of 5 and standard errors clustered by day. The residuals display an insignificant drop of 2.9% at the policy date.

Hourly Workers Restricted Hours

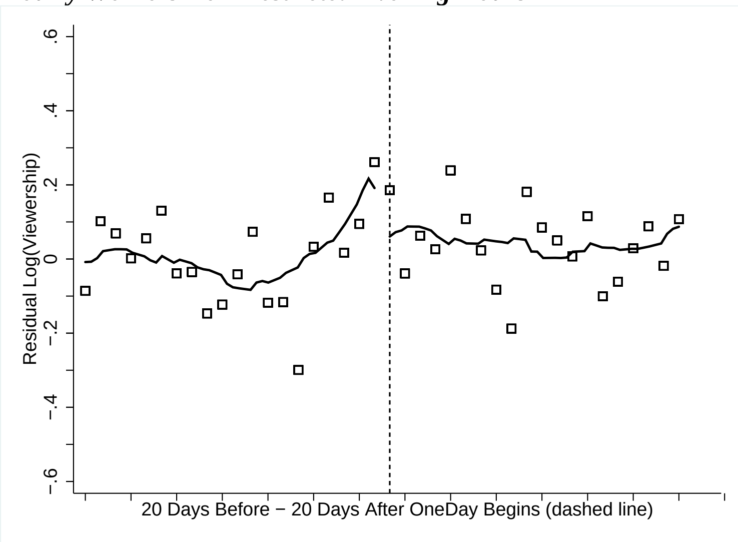
The square dots are average residuals across the restricted hours from a regression of log aggregate hourly viewership (all 24 hours) on the set of controls in Table 6 (except time trend) in the 20 days before and after the beginning of the OneDay policy (the vertical dashed line). The solid lines are fitted values of the average residuals from local linear regressions using a rectangular kernel and a bandwidth of 5 and standard errors clustered by day. The residuals display an insignificant drop of 8.7% at the policy date.

Hourly Workers Non-Restricted Morning Hours



The square dots are average residuals across the morning non-restricted hours from a regression of log aggregate hourly viewership (all 24 hours) on the set of controls in Table 6 (except time trend) in the 20 days before and after the beginning of the OneDay policy (the vertical dashed line). The solid lines are fitted values of the average residuals from local linear regressions using a rectangular kernel and a bandwidth of 5 and standard errors clustered by day. The residuals display an insignificant jump of 27.8% at the policy date.

Hourly Workers Non-Restricted Evening Hours



The square dots are average residuals across the evening non-restricted hours from a regression of log aggregate hourly viewership (all 24 hours) on the set of controls in Table 6 (except time trend) in the 20 days before and after the beginning of the OneDay policy (the vertical dashed line). The solid lines are fitted values of the average residuals from local linear regressions using a rectangular kernel and a bandwidth of 5 and standard errors clustered by day. The residuals display an insignificant drop of 16.9% at the policy date.

Appendix M
Detailed Welfare Benefit Estimates

Number of Restricted Activity Days: Matus, *et al.* (2012) provide an exposure-response (ER) function of 0.0541 (0.0475, 0.0608)[4] additional restricted activity days per year-adult-$\mu g/m^3$ increase in PM_{10} concentration. A 30.8 $\mu g/m^3$ decrease in PM_{10} concentration due to the driving restrictions and a Beijing adult population of 9.205 million implies 15.3 (13.5, 17.2) million fewer restricted activity days.

Number of Acute Mortality Cases: Matus, *et al.* (2012) provide an ER function of a 0.06% (0.04%, 0.08%) increase in the mortality rate per $\mu g/m^3$ increase in PM_{10} concentration. Given total Beijing population of 10.942 million and a mortality rate of 0.55% (2007 data from *Beijing Health Yearbook 2008*) this implies 1,114 (743, 1,485) fewer deaths per year from the pollution reduction under the driving restrictions.

Acute Mortality Value –Lower Bound: Death from acute exposure normally hastens death by about 0.5 years (Matus, *et al.*, 2008). Therefore, a human-capital estimate of the value of lost life is one-half year's wages or RMB 23,566 (average daily wage of RMB 189 for 125 work days per half-year). Applying this to the number of cases yields annual welfare gains of RMB 26 (18, 35) million.

Acute Mortality Value –Upper Bound: Hammitt and Zhou (2006) use a contingent valuation method to estimate a mean value-of-statistical-life (VOSL) in Beijing of RMB 147.3 thousand.[5] Applying the VOSL to the number of cases yields benefits of RMB 164 (109, 219) million.

Appendix N
Penalties for and Detection of Driving Restrictions Violations

Violation penalties include monetary and time costs and depend on the detection method. Violators are immediately fined RMB 100 and incur a time cost because payment requires going to the relevant police station for documentation and then to a bank to pay. The latter step can be done online but only if the recipient has an account at the Industrial and Commercial Bank of China. The driver can delegate these tasks to someone with a lower cost of time by loaning them their national identity card. If a police officer detects the violation, it must be paid within fifteen days or interest is accrued at RMB 3 per day. For violations detected by cameras there is no immediate deadline. Regardless of how detected, the fine must be paid before renewal of the vehicle's bi-annual registration. During our sample period, only one penalty could be issued per day.[6]

A first-time violation would also trigger the loss of several fee waivers. Those complying with the OddEven restrictions received a waiver of three months' vehicle taxes (about RMB 100)[7] and highway maintenance fees (about RMB 330).[8] During the OneDay period the waiver equaled one month's fees. During both the OddEven and OneDay periods, a driver received a discount on auto insurance equal to the number of days their car was restricted. Although the precise amount depended on individual premiums, the average reduction was RMB 65 during the OneDay69 period.[9]

Beijing had 1,958 traffic surveillance cameras as of March 31, 2009 and the number increased to 2,215 by the end of 2009. This equals 0.13 cameras per square kilometer if equally spaced.[10] As of October, 2010 Beijing had about five thousand police officers to direct traffic.[11]

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[4] We provide lower and upper bounds in parentheses.
[5] The authors estimate a value of USD 16,000 (in 1999 terms). We convert to RMB as of July 1, 1999 (www.xe.com) and adjust for inflation using "Beijing by Data: 30 Years since Reform and Opening" (China Statistic Press, 2008). The authors' survey methodology may understate VOSL by up to ten times (page 415). To be conservative, we use their main estimate.
[6] As of December 24, 2010 the law was changed to allow multiple citations to be issued per day.
[7] Annual vehicle taxes ranged from RMB 300 to 600 depending on vehicle size according to Beijing Local Taxation Bureau Document Nos. 329 (2004) and 339 (2007).
[8] Until December 31, 2008, monthly highway maintenance fees for passenger vehicles were RMB 22 for each seat of capacity according to the Beijing Highway Bureau (http://www.ylfzhj.bj.cn). For a common passenger vehicle with five seats the monthly fees would therefore be RMB 110. After December 31, 2008, the fees were absorbed into fuel taxes and not affected by a violation.
[9] According to China Insurance Regulatory Commission Beijing Bureau (http://www.china-insurance.com/newscenter/newslist.asp?id=132329).
[10] Data from Beijing Traffic Management Bureau, accessed at http://www.bjjtgl.gov.cn. Density calculated based on Beijing's land area of 16,411 square kilometers.
[11] According to http://www.chinanews.com/gn/2010/10-11/2579335.shtml.

Appendix O
Detailed Compliance Results

Panel A: Comparison of Expected (Weekend) and Observed (Weekday) Distributions of Ending License Plate Numbers Entering a Beijing Parking Garage during Restricted Hours (7:00 am - 8:00 pm) from June 27 to July 3, 2010 - Regular Parkers

The top panel shows the expected distribution from the two weekend days (June 27 and July 3). The second panel shows data for the Monday (June 28) restricted hours, when plate numbers "1" and "6" were banned:

- The first two rows show the observed distribution of plate numbers.
- The third row tests whether each plate's proportion during the restricted hours is significantly greater than zero using a one-tailed test. Plain text indicates that the proportion is not significantly greater than zero (plates "1," "4," and "6") and bold indicates that it is statistically greater than zero (all other plates).
- The fourth row tests whether the observed proportion of each non-restricted plate differs from the expected proportion using a two-tailed test. In doing so, we adjust the expected distribution for the fact that there should be no "1" and "6" plates (*i.e.*, we compute the expected proportion assuming only the presence of the eight other plates). Bold significance levels indicate that the plate appears in statistically greater proportion than expected (none), those in bold italics indicate that it appears in significantly lower proportion than expected (plates "2" and "3") and those in plain text that it is not significantly different (all others).

The data for the other weekdays is in the same format. Restricted numbers are shown in boxes.

Distribution	0	1	2	3	4	5	6	7	8	9	Total	No Plate
Expected Distribution (Weekend)												
Number	635	534	594	597	83	593	753	636	743	807	5,975	96
Percentage	10.6%	8.9%	9.9%	10.0%	1.4%	9.9%	12.6%	10.6%	12.4%	13.5%	100.0%	1.6%
Observed Distributions												
Monday (1, 6 Restricted)												
Number	398	45	312	315	54	380	67	400	486	490	2,947	28
Percentage	13.5%	1.5%	10.6%	10.7%	1.8%	12.9%	2.3%	13.6%	16.5%	16.6%	100.0%	1.0%
Different from Zero (SL)[1]	**0.0%**	20.2%	**0.0%**	**0.0%**	15.8%	**0.0%**	10.6%	**0.0%**	**0.0%**	**0.0%**		
Different from Expected (SL)[2]	54.7%		***3.2%***	***3.7%***	67.3%	34.5%		50.8%	14.1%	93.8%		
Tuesday (2, 7 Restricted)												
Number	357	319	50	325	63	339	436	63	440	456	2,848	26
Percentage	12.5%	11.2%	1.8%	11.4%	2.2%	11.9%	15.3%	2.2%	15.4%	16.0%	100.0%	0.9%
Different from Zero (SL)[1]	**0.0%**	**0.0%**	17.2%	**0.0%**	11.6%	**0.0%**	**0.0%**	11.6%	**0.0%**	**0.0%**		
Different from Expected (SL)[2]	34.3%	29.6%		18.8%	**4.8%**	44.9%	46.7%		31.2%	35.5%		
Wednesday (3, 8 Restricted)												
Number	353	270	327	31	43	351	453	393	75	447	2,743	29
Percentage	12.9%	9.8%	11.9%	1.1%	1.6%	12.8%	16.5%	14.3%	2.7%	16.3%	100.0%	1.1%
Different from Zero (SL)[1]	**0.0%**	**0.0%**	**0.0%**	27.6%	20.4%	**0.0%**	**0.0%**	**0.0%**	**7.3%**	**0.0%**		
Different from Expected (SL)[2]	35.4%	***4.7%***	30.4%		30.7%	26.4%	15.2%	**8.2%**		30.9%		
Thursday (4, 9 Restricted)												
Number	382	375	333	369	0	409	492	372	526	79	3,337	29
Percentage	11.4%	11.2%	10.0%	11.1%	0.0%	12.3%	14.7%	11.1%	15.8%	2.4%	100.0%	0.9%
Different from Zero (SL)[1]	**0.0%**	**0.0%**	**0.0%**	**0.0%**	N/A[4]	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**8.3%**		
Different from Expected (SL)[2]	29.9%	14.9%	***3.8%***	56.4%		22.1%	71.4%	13.6%	**5.7%**			
Friday (0, 5 Restricted)												
Number	69	349	340	373	46	68	402	348	497	533	3,025	39
Percentage	2.3%	11.5%	11.2%	12.3%	1.5%	2.2%	13.3%	11.5%	16.4%	17.6%	100.0%	1.3%
Different from Zero (SL)[1]	10.2%	**0.0%**	**0.0%**	**0.0%**	20.0%	10.6%	**0.0%**	**0.0%**	**0.0%**	**0.0%**		
Different from Expected (SL)[2]		26.8%	33.8%	66.6%	60.9%		***2.2%***	***8.8%***	**7.4%**	10.5%		

Ending license plate numbers of autos entering a Beijing parking garage inside the 4th Ring Road collected by authors. [1] SL = significance level. Bold indicates significantly greater than zero (at the 10% level or better) using a one-tailed equality of proportions test. [2] SL = significance level. Bold indicates significantly greater (at the 10% level or better) than expected proportion (assuming restricted plates occur in proportion zero) using a two-tailed equality of proportions test and bold, italics significantly lower. [3] No observations - significance level is undefined. Boxes indicate restricted plate numbers on that day.

Appendix O
Detailed Compliance Results

Panel B: Comparison of Expected (Weekend) and Observed (Weekday) Distributions of Ending License Plate Numbers Entering a Beijing Parking Garage during Non-Restricted Weekday Hours (9:00 pm - 6:00 am) from June 27 to July 3, 2010 - Regular Parkers

The top panel shows the expected distribution from the two weekend days (June 27 and July 3). The second panel shows data for the Monday (June 28) non-restricted hours:

- The first two rows show the observed distribution of plate numbers.
- The third row provides test statistics comparing the observed proportion of each plate to the expected based on a two-tailed test. Bold font indicates that the observed proportion is significantly greater than expected (none), bold italics lower (none), and plain text not significantly different (all plates).

The data for the other weekdays is in the same format. Restricted numbers are shown in boxes.

Distribution	0	1	2	3	4	5	6	7	8	9	Total	No Plate
Expected Distribution (Weekend)												
Number	635	534	594	597	83	593	753	636	743	807	5,975	96
Percentage	10.6%	8.9%	9.9%	10.0%	1.4%	9.9%	12.6%	10.6%	12.4%	13.5%	100.0%	1.6%
Observed Distributions												
Monday (1, 6 Restricted)												
Number	7	3	4	2	1	3	7	4	7	4	42	2
Percentage	16.7%	7.1%	9.5%	4.8%	2.4%	7.1%	16.7%	9.5%	16.7%	9.5%	100.0%	4.8%
Different from Expected (SL)1	20.6%	68.4%	92.8%	25.9%	58.5%	54.8%	42.9%	81.4%	40.8%	45.1%		
Tuesday (2, 7 Restricted)												
Number	13	9	2	9	1	4	11	6	14	7	76	2
Percentage	17.1%	11.8%	2.6%	11.8%	1.3%	5.3%	14.5%	7.9%	18.4%	9.2%	100.0%	2.6%
Different from Expected (SL)1	**7.0%**	37.9%	**3.4%**	59.3%	95.7%	17.6%	62.6%	43.9%	11.7%	27.5%		
Wednesday (3, 8 Restricted)												
Number	7	4	2	6	2	5	9	5	5	5	50	2
Percentage	14.0%	8.0%	4.0%	12.0%	4.0%	10.0%	18.0%	10.0%	10.0%	10.0%	100.0%	4.0%
Different from Expected (SL)1	44.2%	81.7%	16.1%	63.7%	11.9%	98.6%	25.3%	88.3%	60.3%	47.0%		
Thursday (4, 9 Restricted)												
Number	1	2	4	0	0	2	8	1	1	0	19	0
Percentage	5.3%	10.5%	21.1%	0.0%	0.0%	10.5%	42.1%	5.3%	5.3%	0.0%	100.0%	0.0%
Different from Expected (SL)1	44.8%	80.9%	10.7%	14.6%	60.5%	93.0%	**0.0%**	44.7%	34.4%	***8.5%***		
Friday (0, 5 Restricted)												
Number	6	9	13	10	3	3	14	9	11	5	83	0
Percentage	7.2%	10.8%	15.7%	12.0%	3.6%	3.6%	16.9%	10.8%	13.3%	6.0%	100.0%	0.0%
Different from Expected (SL)1	31.7%	54.6%	**8.5%**	53.5%	**8.9%**	***5.5%***	24.6%	95.3%	82.3%	***4.7%***		

Ending license plate numbers of autos entering a Beijing parking garage inside the restricted area collected by authors.[1] SL = significance level. Bold indicates significantly greater (at the 10% level or better) than expected proportion using a one-tailed equality of proportions test, bold italics indicates significantly less (at the 10% level or better) than expected proportion using a two-tailed equality of proportions test. Boxes indicate restricted plate numbers on that day.

Appendix O
Detailed Compliance Results

Panel C: Comparison of Expected (Weekend) and Observed (Weekday) Distributions of Ending License Plate Numbers Entering a Beijing Parking Garage during Restricted Hours (7:00 am - 8:00 pm) from June 27 to July 3, 2010 - Monthly Parkers

The top panel shows the expected distribution from the two weekend days (June 27 and July 3). The second panel shows data for the Monday (June 28) restricted hours, when plate numbers "1" and "6" were banned:

- The first two rows show the observed distribution of plate numbers.
- The third row tests whether each plate's proportion during the restricted hours is significantly greater than zero using a one-tailed test. Plain text indicates that the proportion is not significantly greater than zero (plates "1," "4", and "6") and bold indicates that it is statistically greater than zero (all other plates).
- The fourth row tests whether the observed proportion of each non-restricted plate differs from the expected proportion using a two-tailed test. In doing so, we adjust the expected distribution for the fact that there should be no "1" and "6" plates (*i.e.*, we compute the expected proportion assuming only the presence of the eight other plates). Bold significance levels indicate that the plate appears in statistically greater proportion than expected (plates "3" and "5"), those in bold italics indicate that it appears in significantly lower proportion than expected (plate "8") and those in plain text that it is not significantly different (all others).

The data for the other weekdays is in the same format. Restricted numbers are shown in boxes.

Distribution	0	1	2	3	4	5	6	7	8	9	Total	No Plate
Expected Distribution (Weekend)												
Number	14	20	15	7	1	9	27	20	29	26	168	3
Percentage	8.3%	11.9%	8.9%	4.2%	0.6%	5.4%	16.1%	11.9%	17.3%	15.5%	100.0%	1.8%
Observed Distributions												
Monday (1, 6 Restricted)												
Number	46	3	46	56	6	60	6	60	58	70	411	1
Percentage	11.2%	0.7%	11.2%	13.6%	1.5%	14.6%	1.5%	14.6%	14.1%	17.0%	100.0%	0.2%
Different from Zero (SL)[1]	**0.8%**	44.1%	**0.8%**	**0.1%**	38.3%	**0.1%**	38.3%	**0.1%**	**0.1%**	**0.0%**		
Different from Expected (SL)[2]	96.9%		77.4%	**1.6%**	57.6%	**3.3%**		66.7%	***1.3%***	31.0%		
Tuesday (2, 7 Restricted)												
Number	26	27	3	21	3	28	36	5	44	42	235	3
Percentage	11.1%	11.5%	1.3%	8.9%	1.3%	11.9%	15.3%	2.1%	18.7%	17.9%	100.0%	1.3%
Different from Zero (SL)[1]	**3.6%**	**3.1%**	42.2%	**7.6%**	42.2%	**2.6%**	**0.5%**	37.1%	**0.1%**	**0.1%**		
Different from Expected (SL)[2]	78.7%	39.3%		17.3%	61.9%	***9.3%***	28.4%		58.1%	80.7%		
Wednesday (3, 8 Restricted)												
Number	36	29	51	3	3	43	36	49	11	51	312	2
Percentage	11.5%	9.3%	16.3%	1.0%	1.0%	13.8%	11.5%	15.7%	3.5%	16.3%	100.0%	0.6%
Different from Zero (SL)[1]	**1.5%**	**4.2%**	**0.1%**	43.2%	43.2%	**0.4%**	**1.5%**	**0.1%**	26.3%	**0.1%**		
Different from Expected (SL)[2]	66.0%	10.3%	12.7%		80.4%	**2.6%**	***2.4%***	73.6%		51.9%		
Thursday (4, 9 Restricted)												
Number	25	23	21	27	0	34	38	26	31	11	236	2
Percentage	10.6%	9.7%	8.9%	11.4%	0.0%	14.4%	16.1%	11.0%	13.1%	4.7%	100.0%	0.8%
Different from Zero (SL)[1]	**4.3%**	**5.8%**	**7.6%**	**3.1%**	N/A[4]	**0.8%**	**0.3%**	**3.6%**	**1.5%**	23.2%		
Different from Expected (SL)[2]	72.1%	25.2%	68.3%	**2.4%**		**1.2%**	58.2%	46.0%	***8.8%***			
Friday (0, 5 Restricted)												
Number	1	47	41	54	3	9	66	61	59	66	407	4
Percentage	0.2%	11.5%	10.1%	13.3%	0.7%	2.2%	16.2%	15.0%	14.5%	16.2%	100.0%	1.0%
Different from Zero (SL)[1]	48.0%	**0.7%**	**1.6%**	**0.2%**	44.1%	32.6%	**0.0%**	**0.1%**	**0.1%**	**0.0%**		
Different from Expected (SL)[2]		54.1%	99.5%	**0.4%**	93.7%		58.5%	65.0%	15.1%	72.0%		

Ending license plate numbers of autos entering a Beijing parking garage inside the 4th Ring Road collected by authors. [1] SL = significance level. Bold indicates significantly greater than zero (at the 10% level or better) using a one-tailed test. [2] SL = significance level. Bold indicates significantly greater (at the 10% level or better) than expected proportion (assuming restricted plates occur in proportion zero) using a two-tailed test and bold, italics significantly lower. 3 No observations - significance level is undefined. Boxes indicate restricted plate numbers on that day.