Online Appendix for "Electoral Competition, Party System Fragmentation, and Air Quality in Mexican Municipalities"

A. Controlling for the PRI Rule:

Mexican political system underwent a seismic transition at 2000 during which the Institutional Revolutionary Party (PRI) lost the control of the central government. Did the regime change have any impact on air pollution? Did municipalities that were still under the PRI dominance perform differently? Even though we did not model the effect of national level political transition as a variable, our regression analysis controls for its effect by including year fixed effects. Our panel data includes four time periods – 1999, 2004, 2009, and 2014:[1] year fixed effects are able to pick up national level exogenous shocks including the transition away from a PRI rule in 2000. In the manuscript, we did not display the estimates of the fixed effects largely because of space limit: in this online appendix, we particularly look at the estimates of the year-fixed effects:

	effect	cluster s.e.
Year.1999	-0.0084	0.0295
Year.2004	0.0272	0.0161
Year.2009	-0.0036	0.0073
Year.2014	0.0000	0.0000

Year 2014 is the baseline year: its effect is set as 0 in the regression analysis. Compared with 2014, 1999 and 2009 have lower level of PM2.5; 2004 has a higher level of PM2.5 – all the three year-fixed effects are statistically significant. Also note that we have controlled for fixed municipality effects and a battery of relevant municipality level variables.[2] It seems that there is no clear pattern in the year-fixed effects concerning the difference between the pre-2000 and the post-2000 period. Of course, other temporoal changes might also have happened along with the political transition in 2000, which would also be picked up by the year-fixed effects.

To better capture the effect associated with a PRI rule, we coded two variables: *PRI* is a dummy variable indicating whether the municipal mayor elected is from the PRI – this is therefore a *PRI dominant town;* a second dummy variable *PRI in Coalition* is a dummy variable indicating either the major is from the PRI or from a party coaliton that incudes the PRI – this is therefore a munipalitiy in which at least the PRI is in the governing coaltion. *PRI in Coalition*, therefore, represents a broader PRI rule (also through party coalition) than the *PRI* variable. We ran our regression analysis after adding these two variables. We find that neither of these two variables has a statistically significant effect on PM2.5. See Table 1 of appendix which follows Table 1 from the manuscript, but adding the *PRI* and the *PRI in coalition* variables: for intance,

[1] This is because municipal level industrial and economic data at are only available for these years; the five year period between the time periods guarantees at least one municipal election in between – for each year of the 4 years included in the analysis; we construct the effective number of parties and the margin of victory variables using the latest previous election outcome data.

[2] Including density of economic activity, GDP per capita and its square term, municipal resources per capita, population, urban area ratio, density of federal regulated industries, and a spatial lag of the dependent variable.

the *PRI in coalition* variable always has a positive coefficient estimate, but it never reaches the 0.10 statistical significance level.

At the same time, our main results regarding the effects associated with the *Effective Number of Parties* and *Effective Number of Parties*^{2} variables do not change. Part of our theory argues that when the number of effective parties is low (a PRI single party rule or any single party rule would be the extreme case: the *Effective Number of Parties* variable takes the value 1), the incumbent would have much less incentive to provide environmental public goods because of the lack of competition from other parties: this argument receives further empirical support even after we control for the particular nature of the party in power: PRI rule or PRI in governing coalition in this exercise.

B. Checking and Dealing with potential multicollinearity in the data:

Our regression includes two variables and their square terms: Effective Number of Parties/Effective Number of Parties^2 and GDP per capita (log)/GDP per capita (log)^2; naturally, there is a high correlation between a variable and its square term. But usually a variable and its square term would not cause a collinearity problem because collinearity is due to a (almost) perfect linear relationship between variables; a variable and its square term are not linearly correlated: one is not a linear transformation of the other by definition.

In case of a collinearity issue caused by including a variable and its square term as regressors, one simple way of reducing collinearity is to "center" (or de-mean) this variable before regression: first, subtract the mean of the variable from the original variable, take the square of this de-meaned variable, and then regress the dependent variable on the demeaned variable and its square term. We conducted this "de-meaning" exercise for Effective Number of Parties, Effective Number of Parties^2, GDP per capita (log), and GDP per capita (log)^2. Centering a variable and its square term often reduces their correlation by a lot; in our case, for instance, GDP per capita (log) and GDP per capita (log)^2 is correlated at 0.9 before centering/de-meaning; after we center both variables, their correlation is 0.01.

Table 2 of this appendix presents a regression using the original Effective Number of Parties/Effective Number of Parties^2 and GDP per capita (log)/GDP per capita (log)^2 variables (model 1; this is also model 4 of Table 2 in the manuscript) and a regression using the de-meaned versions of these variables (*Effective Number of Parties* $_{de\text{-}meaned}$ and Effective *Number of Parties*$^2_{de\text{-}meaned}$). The results concerning other variables are identical. Effective Number of Parties and Effective Number of Parties^2 achieve the same statistical significance levels.

For other variables that do not have an associated square term, we calculate the VIF (Variance inflation factor), which measure the inflation in the variances of the parameter estimates due to collinearities that exist among the predictors. It is a measure of how much the variance of the estimated regression coefficient is "inflated" by the existence of correlation among the predictor variables in the model. A VIF of 1 means that there is no correlation among a predictor and the remaining predictor variables. The general rule of thumb is that VIFs exceeding 4 warrant further investigation. Table 3 of this appendix shows the VIFs of these variables: none of them exceeds 4.

Table 1: Testing the relationship between effective numbre of parties and air pollution, using municipalities with population larger than 36,466.

	Dependent variable: log(PM2.5)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Effective Number of Parties	−0.120***	−0.046***	−0.037**	−0.040**	−0.120***	−0.047***	−0.038**	−0.041***
	(0.044)	(0.015)	(0.016)	(0.016)	(0.043)	(0.015)	(0.016)	(0.016)
Effective Number of Parties^2	0.014*	0.007**	0.005**	0.006**	0.014*	0.007**	0.006**	0.006**
	(0.008)	(0.003)	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.003)
Margin of Victory (%)				−0.0003				−0.0003
				(0.0002)				(0.0002)
Density of Economic Activity (log)			0.880	0.919			0.909	0.950
			(2.603)	(2.654)			(2.618)	(2.672)
GDP per capita (log)			−0.889	−0.928			−0.917	−0.959
			(2.602)	(2.654)			(2.617)	(2.671)
GDP per capita (log)^2			−0.001	−0.001			−0.001	−0.001
			(0.002)	(0.002)			(0.002)	(0.002)
Municipal Resources per capita (log)			0.023	0.023			0.023	0.023
			(0.015)	(0.015)			(0.015)	(0.015)
Population (log)			−0.893	−0.932			−0.922	−0.962
			(2.605)	(2.657)			(2.621)	(2.674)
Urban Area Ratio			0.155*	0.154*			0.155*	0.154*
			(0.091)	(0.090)			(0.091)	(0.090)
Density of Fed. Regulated Industries (log)			0.001	0.001			0.001	0.002
			(0.003)	(0.003)			(0.003)	(0.003)
Spatial Lag$_{t-1}$		0.853***	0.842***	0.840***		0.853***	0.842***	0.840***
		(0.032)	(0.033)	(0.033)		(0.032)	(0.033)	(0.033)
PRI	−0.010	0.0004	0.002	0.002				
	(0.017)	(0.009)	(0.009)	(0.009)				
PRI in Coalition					0.014	0.006	0.006	0.007
					(0.016)	(0.008)	(0.008)	(0.008)
Fixed municipal effects	√	√	√	√	√	√	√	√
Fixed year effects	√	√	√	√	√	√	√	√
Clustered s.e. (municipal)	√	√	√	√	√	√	√	√
N. of municipality	523	523	523	523	523	523	523	523
Observations	1,838	1,838	1,838	1,838	1,838	1,838	1,838	1,838
Adjusted R^2	0.814	0.951	0.952	0.952	0.814	0.951	0.952	0.952

Note: years covered by the analysis are 1999, 2004, 2009, and 2014; *p<0.1; **p<0.05; ***p<0.01.

Table 2: Testing the relationship between the effective numbre of parties and air pollution, using de-meaned effective number of parties and GDP per capita variables.

	Dependent variable: log(PM2.5)	
	(1)	(2)
Effective Number of Parties	−0.040**	
	(0.016)	
Effective Number of Parties^2	0.006**	
	(0.003)	
Effective Number of Parties $_{\text{de-meaned}}$		−0.012**
		(0.005)
Effective Number of Parties$^2_{\text{de-meaned}}$		0.006**
		(0.003)
Margin of Victory (%)	−0.0003	−0.0003
	(0.0002)	(0.0002)
Density of Economic Activity (log)	0.908	0.908
	(2.645)	(2.645)
GDP per capita (log)	−0.917	
	(2.644)	
GDP per capita (log)^2	−0.001	
	(0.002)	
GDP per capita (log) $_{\text{de-meaned}}$		−0.920
		(2.645)
GDP per capita (log)$^2_{\text{de-meaned}}$		−0.001
		(0.002)
Municipal Resources per capita (log)	0.023	0.023
	(0.015)	(0.015)
Population (log)	−0.921	−0.921
	(2.648)	(2.648)
Urban Area Ratio	0.154*	0.154*
	(0.090)	(0.090)
Density of Fed. Regulated Industries (log)	0.001	0.001
	(0.003)	(0.003)
Spatial Lag$_{t-1}$	0.840***	0.840***
	(0.033)	(0.033)
Fixed municipal effects	√	√
Fixed year effects	√	√
Clustered s.e. (municipal)	√	√
N. of municipality	523	523
Observations	1,838	1,838
Adjusted R^2	0.952	0.952

Note: *p<0.1; **p<0.05; ***p<0.01.

Table 3: VIF (Variance inflation factor) for variables.

Variable Name	VIF
Margin of Victory (%)	1.660617
Density of Economic Activity	2.403768
Municipal Resources per capita	2.12944
Population	1.44601
Urban Area Ratio	2.424945
Density of Fed. Regulated Industries	1.296034