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Corrigendum: Particulate Pollution and the Productivity of Pear Packers[†]

By Tom Chang, Joshua S. Graff Zivin, Tal Gross, and Matthew J. Neidell*

Our 2016 paper published in the *American Econmomic Journal: Economic Policy* 8 (3): 141–69 involved an analysis of daily productivity records merged to six-day measures of pollution. We have since discovered that our understanding of how that pollution data was collected was incorrect.[1] We thought that the particulate matter (PM) measures were average daily measures based on a cumulative 6-day measure of $PM_{2.5}$, but the data actually consist of a 24-hour measure taken once every 6 days.[2]

As a result, we have re-estimated all of the regressions from our 2016 paper after restricting our sample to actual measurement days. The corrected version of the paper's primary results (Table 3 in the original paper) are presented below in Table 3C.[3] The results from the linear specifications (columns 1, 2, 5, and 6) are larger in magnitude with the same qualitative interpretation: $PM_{2.5}$ reduces labor productivity. The increase in the coefficient of interest is consistent with reduced measurement error introduced by our misunderstanding of the data. The results for the nonlinear specifications (columns 3, 4, 7, and 8) are quite different and prima facie implausible. As can be readily seen in Figures 4C and 5C, pollution at modest levels appears to decrease productivity while pollution at higher levels appears to increase productivity.

We believe that this pattern of results for the nonlinear regression specifications is being driven by the large number of fixed effects in our original specification. Our original model included both year-times-month and day-of-week fixed effects, which amounts to 18 dummy variables on what is now a sample with 33 observations (1,162 worker-days, but only 33 work days), including a single day for each of the three highest bins. After considering the 9 other variables in the model to control for co-pollutants and meteorology, this leaves too few degrees of freedom to reliably estimate a nonlinear response. Consistent with this notion, we find that the core

* Chang: Department of Finance and Business Economics, University of Southern California Marshall School of Business, 3670 Trousdale Parkway, Los Angeles, CA 90089-0804 (email: tychang@usc.edu); Graff Zivin: University of California, San Diego, 9500 Gilman Drive, MC 0519, La Jolla, CA 92093, and NBER (email: jgraffzivin@ucsd.edu); Gross: Mailman School of Public Health, Columbia University, 722 W. 168th Street, New York, NY 10032, and NBER (email: tg2370@columbia.edu); Neidell: Mailman School of Public Health, Columbia University, 722 W. 168th Street, New York, NY 10032, and NBER (email: mn2191@columbia.edu).

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1 We are grateful to Alberto Salvo for pointing out the error in our original paper.

2 Imputing pollution for days without measurement is complicated by the substantial and well-documented daily variation in $PM_{2.5}$ levels.

3 In an online Appendix, we reproduce all of the original tables and figures using only the 1-in-6-day pollution measure.

TABLE 3C—THE RELATIONSHIP BETWEEN $PM_{2.5}$ AND PRODUCTIVITY

Dependent variable:	Productivity				Logarithm of productivity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$PM_{2.5}$	−0.086	−0.091			−0.012	−0.017		
	(0.030)	(0.061)			(0.005)	(0.009)		
	[0.008]	[0.132]			[0.017]	[0.062]		
$PM_{2.5}$ 10–15			0.465	0.465			0.119	0.119
			(0.271)	(0.266)			(0.048)	(0.048)
			[0.086]	[0.081]			[0.012]	[0.013]
$PM_{2.5}$ 15–20			−5.107	−5.107			−1.043	−1.043
			(0.907)	(0.899)			(0.123)	(0.121)
			[0.000]	[0.000]			[0.000]	[0.000]
$PM_{2.5}$ 20–25			1.081	1.081			0.049	0.049
			(0.649)	(0.657)			(0.116)	(0.123)
			[0.096]	[0.100]			[0.676]	[0.693]
$PM_{2.5}$ >25			0.216				0.306	
			(0.740)				(0.074)	
			[0.770]				[0.000]	
Mean of dependent variable	6.986	7.003	6.986	7.003	1.832	1.835	1.832	1.835
Includes Biscuit Fire	Yes	No	Yes	No	Yes	No	Yes	No
R^2	0.332	0.333	0.342	0.342	0.252	0.257	0.261	0.265
Observations	1,162	1,143	1,162	1,143	1,162	1,143	1,162	1,143

Notes: Standard errors based on estimates clustered by date and worker are in parentheses; associated *p*-values are in brackets. The sample consists of worker-day observations over the 2001, 2002, and 2003 pear-packing season, but restricted solely to the days on which we observe $PM_{2.5}$. All columns present results from ordinary least squares regressions. All regressions include wind speed, a wind direction dummy variable, dew point, a rain dummy variable, day-of-week dummy variables, and year-month dummy variables. Productivity is measured as earnings per hour.

pattern of results from our original paper are restored when we estimate an alternative nonlinear specification that includes fewer fixed effects—replacing year-times-month with year and month and day-of-week with weekend fixed effects (as can be seen in Table 3P and Figure 5P in the online Appendix).[4]

In the end, the linear results continue to suggest that $PM_{2.5}$ outdoors leads to a statistically and economically significant decrease in the productivity of indoor workers in our setting. Our conclusions regarding the nonlinear results are more tempered. While we are reassured by the results from the more parsimonious model specification, data limitations hinder our ability to fully explore this relationship. We very much regret and apologize for our error.

[4] For the sake of completeness, the online Appendix presents all of the original tables and figures using this more parsimonious specification.

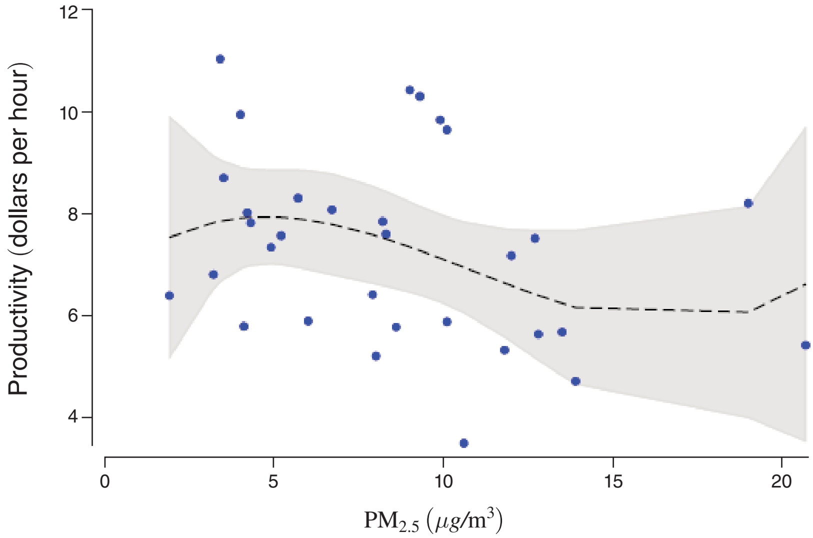

FIGURE 4C

Notes: This figure presents $PM_{2.5}$ levels versus the average earnings per hour of pear packers on the date corresponding to the pollution observation. The dashed line presents the predictions from a local polynomial regression (Epanechnikov kernel) of productivity on the $PM_{2.5}$ levels, with the shaded area indicating the 95 percent confidence interval. The sample consists of the 2001, 2002, and 2003 packing seasons. We exclude two observations during which air quality alerts occurred as a result of the Biscuit Fire.

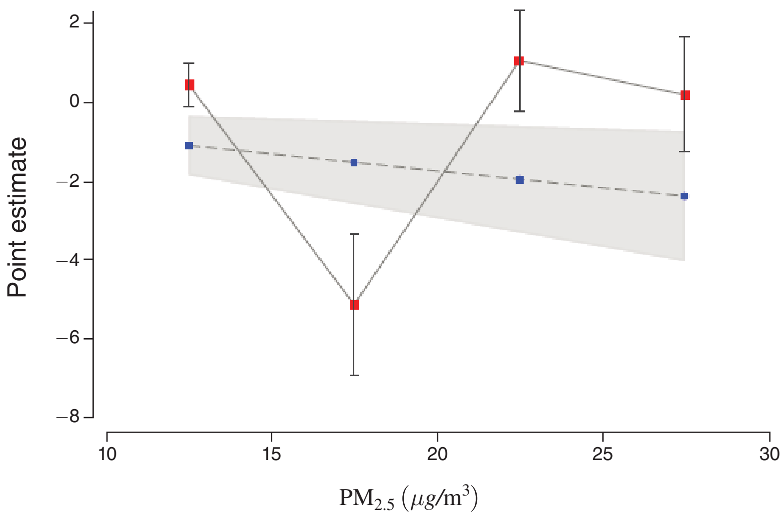

FIGURE 5C

Note: This figure presents the implied effects of $PM_{2.5}$ on productivity based on estimates reported in Table 3C, columns 1 (linear) and 3 (nonlinear).