



# The effect of pollution on labor supply: Evidence from a natural experiment in Mexico City<sup>☆</sup>

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## ABSTRACT

Moderate effects of pollution on health may exert important influences on work. We exploit exogenous variation in pollution due to the closure of a large refinery in Mexico City to understand how pollution impacts labor supply. The closure led to a 19.7% decline in pollution, as measured by SO<sub>2</sub>, in the surrounding neighborhoods. The closure led to a 1.3 h (or 3.5%) increase in work hours per week. The effects do not appear to be driven by differential labor demand shocks nor selective migration.

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## 1. Introduction

In this paper, we estimate the relationship between pollution and labor supply in Mexico City. High levels of pollution may cause temporary illness, which in turn may cause lost work hours. Understanding the relationship between pollution and lost work hours is vital for assessing the benefits of more stringent environmental regulation, particularly for developing countries that are often hesitant to impose tougher environmental standards due to fears that they may hinder productivity and growth. Furthermore, understanding the magnitude of this effect is essential in designing optimal pollution taxes (Schwartz and Repetto, 2000; Williams, 2003).

The effect of pollution on work hours is theoretically ambiguous. On the one hand, if pollution damages the health of an individual or his or her dependents, then reductions in pollution will decrease the disutility from work and increase work hours. In other words, with better air

quality, individuals may work more since they (or their children) are less likely to be sick. On the other hand, there are also many reasons why reductions in pollution would not increase work hours. First, it is possible that the effect of pollution on adult health is not large enough to interfere with work, or that individuals already practice mitigating behaviors on high pollution days (such as staying indoors) to minimize illness. Second, if individuals enjoy leisure more due to better health or they substitute away from consumption of health-related goods, they might adjust their hours of work downwards. If these effects are large enough, the overall effect of pollution on work hours may even be negative. Finally, health-related improvements in worker productivity may increase wages, which would have ambiguous effects due to competing income and substitution effects. Given these opposing theoretical predictions, the relationship between pollution and work hours is ultimately an empirical question.<sup>1</sup>

Our study explores the short-run relationship between pollution and work hours.<sup>2</sup> Estimating this effect is complicated by confounding factors: for example, a decline in business activity might affect both pollution levels and employment patterns. To circumvent this problem, we exploit the exogenous variation in pollution that resulted from the closure of a large oil refinery in the Mexico City Metropolitan Area (MCMA) in March of 1991. The closure was mandated to reduce the high levels of pollution experienced during the 1980s.

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<sup>1</sup> See the online appendix for a theoretical discussion of these issues.

<sup>2</sup> Pollution can also have long-run work impacts (e.g. through lung diseases), but these are not the focus of this study.

Pollution, as measured by SO<sub>2</sub> fell in the vicinity of refinery: neighborhoods located within a 5 km radius of the refinery experienced, on average, a 19.7% reduction in sulfur dioxide (SO<sub>2</sub>) relative to neighborhoods far from the refinery. Using a fixed effects strategy, we exploit these changes to understand whether pollution levels affected labor supply. Specifically, we compare the changes in labor supply for individuals who lived in neighborhoods located near the refinery (that experienced a fall in pollution) with those who lived in neighborhoods far from the refinery (that did not experience so).

We find robust evidence that the refinery closure led to an increase in work hours: neighborhoods located within a 5 km radius of the refinery experienced, on average, a 1.3 h (or a 3.5%) increase in per week hours of work relative to those that were farther away from the refinery. The closure led to large changes across the distribution of work hours: areas affected by the closure experienced a 6 percentage point increase in the probability of working over 40 h a week and about a 2.5 percentage point increase in the probability of working more than 10 h per week. To provide a sense of the magnitude of the relationship between pollution and work behavior, we can instrument our pollution measure with the refinery closure. We estimate that that a one part per hundred million increase in SO<sub>2</sub> (or a 20% increase) results in a decrease of 1.04 to 1.30 in work hours per week (a 2.75 to 3.5% decline).

Our design is unique in that it exploits an environmental regulation that did not have direct effects on the labor market, and as such it allows us to disentangle the effect of reduced pollution on labor market activities that operate through the health channel from the direct effect on businesses that environmental regulations typically impose. As we discuss below, the refinery employed a small share of the labor force.<sup>3</sup> To be certain that direct local labor market effects of the closure are not driving our results, we estimate an additional empirical model. We exploit the variation in pollution levels between different altitudes and wind patterns within areas equidistant from the refinery; this is equivalent to a triple-difference approach where you interact the post variable with the distance variable with the characteristic of the census block (e.g. wind and altitude). Equidistant areas presumably experienced similar labor market shocks related to the refinery closure. Hence, the pollution effects that we find within these areas are not susceptible to bias from a labor market mechanism. Using this triple-difference approach, we find a relationship that is similar in magnitude and significance to the core results. Therefore, we can rule out a direct effect of the closure on hours worked.

A second concern when estimating these effects is that changes in air quality may result in selective sorting. More specifically, wealthier or more educated individuals may move into the newly cleaned neighborhoods and these individuals may be more likely to be employed or work long hours. This would cause us to overestimate the effect. To reduce the probability of bias from movements, we restrict our analysis to the five years around the closure. In addition, we test for sorting using information on migration and demographic characteristics. We do not observe increased migration rates near the refinery after the closure. Finally, we also conduct robustness checks where we control for demographics and conclusions do not change. Thus, we are confident that selective migration is not leading us to overestimate the impact of pollution on hours worked.

In sum, our findings imply that the economic gains from increased work helped offset the costs of the refinery closure. Our preferred estimates imply that the closure led to a 3.5% increase in hours worked for those who lived near the refinery. Given an average annual wage of 13,700 Mexican Pesos (USD 3600), this translates to a 480 Peso (USD 126) gain per worker over the course of a year.<sup>4</sup> More generally,

this substantial increase demonstrates the importance of accounting for work effort gains when calculating the economic benefits of environmental regulations.<sup>5</sup>

The paper proceeds as follows: Section 2 provides a brief discussion of related literature and the background of the refinery. Section 3 discusses the data. In Section 4, we describe our empirical strategy, while we present our findings in Section 5. Section 6 concludes.

## 2. Related literature and background

### 2.1. Related literature

The previous literature finds a fairly large association between pollution and lost work. For example, Pönka (1990) finds that SO<sub>2</sub> levels are associated with illness-related absenteeism; Ostro (1983) shows a statistically significant relationship between particulates and work loss; and Hausman et al. (1984) find that, controlling for city-specific effects, a standard deviation increase in particulates in the two weeks prior is associated with about a 10% increase in lost work days. However, while these two papers do control for some factors that may jointly affect pollution and work behaviors, there may remain other uncontrolled, unobservable factors that may drive the estimated relationships. More recently, studying rural households in Bangladesh, Carson et al. (2010) find that the widespread arsenic poisoning was associated with an 8% decrease in labor supply. Related to this literature, Currie et al. (2009), Ransom and Pope (1992), Gilliland et al. (2001), and Park et al. (2002) find significant effects of pollution on school absenteeism for children, which provides evidence that pollution may also have real effects on work hours if it induces higher absenteeism among workers who are responsible for child care.

In addition to affecting total hours worked, it is possible that pollution could also affect the productivity of a work hour, which in turn may affect wages and have secondary impacts on hours worked. There is increasing evidence that pollution affects productivity: Crocker and Horst (1981) and Graff and Neidell (2011) find a negative empirical relationship between air pollution and productivity for farm workers in California. Frankenberg et al. (2005) estimate that haze from fires in Indonesia caused older adults to be more likely to report having difficulty carrying a heavy load than older adults in non-haze areas.<sup>6</sup>

In this paper, we aim to contribute to this growing literature by estimating the causal impact of pollution on total work hours. Specifically, we exploit an environmental regulation that had a large effect on pollution, without a large accompanying direct effect on the labor market. This allows us to isolate the effect on labor supply that is driven by health.<sup>7</sup> Understanding this relationship is important for several reasons. First, if the effect is large, then it may be an important component in assessing the benefits of environmental regulation, as well as assessing the distributional impacts of regulation. Data limitations (e.g. lack of detailed health panels or housing data) often preclude the measurement of these benefits in developing countries; in contrast, many countries regularly collect detailed labor market data, and therefore, our paper provides an alternative method of estimating the benefits that can be replicated in other settings. Second, recent theoretical work (for example, Schwartz and Repetto, 2000; Williams, 2003) points to the importance of understanding the magnitude of the health-driven effect of air pollution on labor supply when designing optimal pollution taxes. If the effect is positive and

<sup>5</sup> Note that a full benefit calculation would also include any longer-run effects of pollution on adults, as well as immediate and long-run health gains for vulnerable populations, such as children and the elderly.

<sup>6</sup> In addition, there is a large medical literature linking iron supplements, which improve respiratory functioning, to productivity (for example, see Davies et al. (1984); Haas and Brownlie (2001); Zhu and Haas (1998); and Woodson et al. (1978)). In turn, there is evidence from experimental studies that iron supplements can improve work output and productivity (Basta et al., 1979; Thomas et al., 2003; Li et al., 1994).

<sup>7</sup> Recent papers, such as Walker (2011), study the effect of environmental regulations that impose additional costs on polluting firms.

<sup>3</sup> Given upward sloping labor supply, if there had been a reduction in labor demand from both the refinery itself and businesses located in the surrounding neighborhoods after the closure, this would likely lead us to underestimate the effect of pollution on hours worked. While less likely, one can also imagine cases where labor supply is downward sloping, causing the estimate to be upwardly biased.

<sup>4</sup> Source for yearly earnings: National Accounting System (SCN).

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