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I Z A
World of Labor
Evidence-based policy making

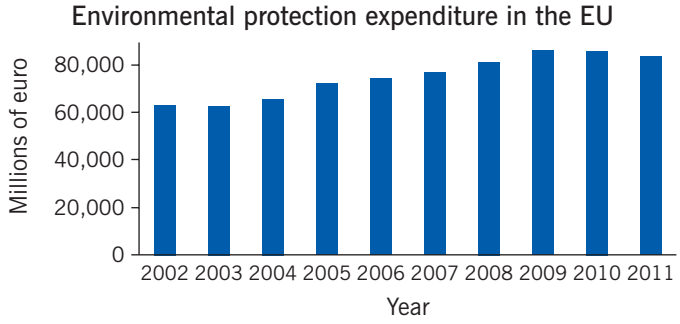
Environmental regulations and labor markets

Balancing the benefits of environmental regulations for everyone and the costs to workers and firms

Keywords: job displacement, employment, productivity, air quality standards, regulation

ELEVATOR PITCH

Environmental regulations such as air quality standards can lead to notable improvements in ambient air quality and to related health benefits. But they impose additional production costs on firms and may reduce productivity, earnings, and employment, especially in sectors exposed to trade and intensive in labor. The limited empirical evidence suggests that the benefits are likely to outweigh the costs.



KEY FINDINGS

Pros

- Stronger air quality regulations have improved ambient air quality.
- Ambient air quality and health indicators are linked (lower mortality rates, reductions in hospital admissions), so air quality regulations can contribute to better health outcomes.
- Efforts to improve air quality can boost productivity by motivating regulated firms to optimize their production processes and nudging less productive firms out of the market.

Cons

- Environmental regulations generally impose additional production costs by requiring pollution abatement equipment in certain industries.
- Environmental regulations can put affected plants and industries at a competitive disadvantage, reducing productivity and employment, especially in sectors exposed to trade and intensive in labor.
- Workers displaced by the regulations in polluting sectors may experience losses in long-term earnings as they make the transition to new jobs.

AUTHOR'S MAIN MESSAGE

Air quality standards generally have negative effects on industry employment, productivity, and worker earnings. But these private costs are small relative to the social benefits of better health outcomes for the population. New or stricter environmental regulations that affect labor markets should include job training, income support, and labor market reintegration programs for workers displaced by the regulations.

MOTIVATION

Environmental regulations, especially ambient air quality standards, are common in most industrialized countries and in some middle-income countries. Decisions about setting environmental standards are based in part on comparisons of the expected benefits and costs of regulation. As for air quality regulations, the monetized benefits are primarily better health outcomes in the population, as shown in hundreds of studies. Those benefits can be substantial.

As for the costs, many observers argue that stricter environmental standards increase production costs for polluting firms, and in turn reduce labor demand and productivity. But it is sometimes argued that more stringent regulations can increase productivity, as regulated firms gain an incentive to optimize their production processes and operations. Environmental regulations may also increase aggregate productivity if they induce less productive firms to exit. Therefore, before optimal policies can be developed, conclusive studies need to be conducted to determine the effects of environmental standards on firm behavior and labor market outcomes, particularly studies outside the US.

DISCUSSION OF PROS AND CONS

How environmental regulations might affect labor market outcomes

Conceptual framework

The effect of environmental regulation on labor markets is conceptualized using the neoclassical theory of labor demand [1], [2]. Environmental regulations generally require firms to install pollution abatement equipment that does not necessarily increase their productivity. So environmental regulations can be introduced in the standard labor demand model as an increase in the rental rate of productive capital. An increase in the cost of capital leads to lower output (output effect) and to a shift away from capital (substitution effect). As a result, the net effect on labor demand is indeterminate and depends on whether the output effect is larger than the substitution effect.

Theory of labor demand under environmental regulation

The key variable to evaluate the effect of regulations on labor demand is the cross-price elasticity associated with an increase in the rental price of capital.

The cross elasticity of demand measures the responsiveness of labor demand when the price of capital increases. A negative cross elasticity means that environmental regulations will reduce employment, while a positive cross elasticity indicates that environmental regulations will increase it.

There are three key sources of variation in the cross elasticity of labor demand to capital prices across industries. First, labor shares differ across industries. Second, market power varies across industries, and this power determines how much of the extra costs associated with the regulations firms in a sector can pass on to buyers. For example, industries more exposed to international trade are more likely to be affected by regulations. Third, differences in the production technology across sectors also contribute to differences in the responsiveness of labor demand to environmental regulations.

Changes in labor demand caused by regulations can also lead to reductions in workers' wages. The incidence of wage changes will depend on macro- and microeconomic attributes. If regulations lead to increases in labor demand, short-term wage gains are possible. If regulations reduce labor demand, workers exiting the regulated industry and moving to new industries may face transitional costs, depending on multiple factors. Frictional unemployment, arising from transitions between jobs, can open a large time gap between jobs. Displaced workers may lose industry-specific skills or industry rents and face a large wage penalty as they move across jobs. Studies of displaced workers typically show that less educated, longer-tenure, and older workers face larger wage losses [3]. So the incidence of the wage cost of environmental regulations is likely to vary across workers, reflecting differences in observable measures of productivity. There may also be wage losses for workers who remain in the regulated industries.

Research designs and data

Several factors make it difficult to identify credibly the effect of environmental regulations on labor market outcomes. In the ideal case for empirical evaluations, regulations would be randomly assigned across workers, firms, industries, and geographic areas. This would ensure that comparable workers and firms are observed across regulatory regimes in similar local labor markets. But this is not always the case. In the US, for example, more polluted areas are more likely to be regulated. They tend to be more densely populated, urbanized areas where polluting firms are older and larger [4]. In addition, there is considerable heterogeneity in wages across workers, firms, and locations. Thus, simple comparisons of wages or employment rates across areas or industries that face different environmental regulations are unlikely to reveal the true effect of regulations on labor market outcomes.

Credible studies (such as internally valid studies) must therefore use quasi-experimental research designs to identify and exploit exogenous sources of variation in regulatory pressure. A common approach is to leverage changes in local regulatory status that result from changes in national environmental standards. In the US, the design of the Clean Air Act has led to such variation in regulatory intensity across years, counties, and sectors.

Specifically, the 1977 Amendments to the Clean Air Act stipulate that, starting in 1978, every county in the US is designated annually as in-attainment or out-of-attainment (non-attainment) of the National Ambient Air Quality Standards. Polluting plants in non-attainment counties are subject to regulations requiring the installation and operation of specified pollution abatement equipment. But polluting plants in attainment areas face weaker regulatory standards and thus face substantially lower capital costs for pollution control (see **The Prevention of Significant Deterioration (PSD) permit program**). Those differences in capital cost can have differential effects on labor demand.

One approach to exploiting this variation is to compare the outcomes for workers in polluting plants of newly regulated counties, before and after the introduction of the regulations, with the outcomes for workers in similar plants in counties that remain unregulated. The most prominent studies of environmental regulation effects on employment and wages in the US are based on such comparisons [1], [2], [5], [6].

The Clean Air Act Amendments (CAAAs)

The Clean Air Act (1963) was introduced to control air pollution on a national level, requiring the Environmental Protection Agency to develop and enforce regulations to protect the public.

In 1970, the CAAA covered the restriction of the emission of pollutants into the air and demanded that National Ambient Air Quality Standards (NAAQS) for certain air pollutants are met by all states. These air pollutants included carbon monoxide, sulfur dioxide, total suspended particles, and ozone. In order to comply, states had to provide a State Implementation Plan outlining their plans to improve any areas that exceeded these new federal air quality guidelines. Despite a deadline of 1975, many states did not succeed in meeting the standards, due to insufficient resources to implement their plans and general confusion.

In 1977 the CAAA was passed due to the lack of progress. It brought in a system where every county in the US was annually declared "in-attainment" or "out-of-attainment" of the NAAQs, regarding each air pollutant. If any county is out-of-attainment, detailed plans have to be provided that lead to attainment imminently. Failure to reach the standards risks the loss of funding for public goods and services from federal monies.

The strict environmental regulations mean that any polluting plants joining or growing in an out-of-attainment area are automatically bound by the standard of "Lowest Achievable Emission Rate," regardless of cost. Often, plants need to install and operate specified pollution abatement equipment under these stringent regulations and any plant changes or expansion leads to that plant being put under stricter regulations. In addition, any new investment's emissions need to be offset by emissions reductions in existing plants in that area.

Source: Greenstone, M., J. A. List, and C. Syverson. *The Effects of Environmental Regulation on the Competitiveness of U.S. Manufacturing*. NBER Working Paper Series No. 18392, September 2012; pp. 6–9. Online at: http://www.nber.org/papers/w18392

An important matter of interpretation is that such difference-based estimators may overstate the national employment loss due to the regulation. This "double-counting" will occur when the workers displaced in the regulated sectors find new employment in the unregulated sectors [2]. Since there are frictions in labor and capital mobility, this overstatement may be limited in practice. But other measures of labor market sensitivity to environmental regulations, such as job destruction rates, should also be considered, since they are immune to double-counting [5].

An equally important challenge is to gather the data to exploit these research designs. The ideal data for studying the effect of regulation on labor market outcomes would be a panel of establishment-level micro-data, enabling individual-level wages and hours worked to be compared across establishments and over time (before and after changes in regulatory intensity). Moreover, the transitional costs of regulations can be identified only if individual workers (or groups of workers) can be tracked over time as some change their employer (and some remain with the same one). Finally, information on establishment-level regulatory status is needed to assign establishments to "treatment" and "control" groups. To date, studies based on such rich data collection have been implemented only in the US, even though other countries also maintain large employer–employee databases.

The Prevention of Significant Deterioration (PSD) permit program

Plants in National Ambient Air Quality Standards attainment areas have a more laidback regulatory standard: PSD. This allows new plants that might emit over 100 tons of a pollutant per year to use the "Best Available Control Technology (BACT)." It seems likely that installing the BACT in attainment areas is far cheaper than achieving the "Lowest Achievable Emission Rate" standard in out-of-attainment areas, meaning that new plants and expansions have pointedly lower pollution control capital construction costs in attainment than out-of-attainment.

Since existing plants in out-of-attainment areas need to provide regular State Implementation Plans, they undergo more regulatory scrutiny than those in attainment areas. The level of this regulation depends on the size of the plant. They also have emission limits set and have inspections and regulatory supervision more often than those in attainment areas.

To make sure that the Clean Air Act Amendments are met, the Environmental Protection Agency (EPA) and the states are provided with enforcement powers. States run their own inspection programs and non-compliers can be fined by the state. However, to ensure that the state regulation programs do not vary greatly in intensity, the EPA must approve all programs. The 1977 amendments made the plant-specific regulations both federal and state law. This means that the EPA can impose penalties on states that are not enforcing the regulations as well as on plants not following the regulations.

Source: Greenstone, M., J. A. List, and C. Syverson. *The Effects of Environmental Regulation on the Competitiveness of U.S. Manufacturing*. NBER Working Paper Series No. 18392, September 2012; pp. 6–9. Online at: http://www.nber.org/papers/w18392

A final challenge relates to the generalizability or external validity of the results derived from an internally valid empirical study. For example, is the evidence identified from regulatory changes in the 1970s and 1980s relevant for a correct evaluation of the welfare effects of a prospective environmental policy in 2013? In the presence of any significant change to the structure of labor markets and to the policy environment over time, this may not be the case. Thus, studies of the effect of environmental regulations on labor markets need to be carefully designed to strike the right balance between internal and external validity.

Characteristics of polluting industries

The incidence of environmental regulation depends on the industrial composition of a regulated sector and on the characteristics of workers in polluting plants. In the US, attainment (non-regulated) counties tend to be more rural, with lower population density, lower urban population shares, lower median household income, and lower median home values. Research on US manufacturing plants also indicates that polluting plants tend to be larger and older than non-polluting plants [2], [6]. In addition, workers in polluting firms are older, have higher than average education, and earn up to 25% more than workers in comparable, less polluting plants. These unadjusted differences between the polluting and non-polluting sectors show that job displacement caused by environmental regulation can lead to substantial earnings losses for the affected workers, since the cost of job displacement varies across workers of different ages and education levels.

Empirical evidence on the effects of environmental regulations on labor market outcomes

Employment

California introduced air quality regulations in the late 1970s that were more stringent than the federal standards under the Clean Air Act, providing variation in regulatory intensity between parts of California and the rest of the US. A 2001 plant-level analysis of the impact of increased local nitrogen oxides regulation in California's South Coast Air Basin (Los Angeles) area measured the effect of the added regulation on manufacturing plant outcomes—specifically on plant-level pollution-control capital investments, employment, and value added using data from the Annual Survey of Manufactures [1]. The study concluded that the added regulation resulted in sizable investments in abatement capital (especially in oil refineries and other highly polluting industries), without any significant effect on employment. The regulations did impose real costs on manufacturing firms, but had no detectable employment effects.

Another detailed study looked at the effect of the increased stringency of the emission standards under the 1970 and 1977 amendments to the Clean Air Act in the US [2]. These amendments represented the first air quality standards introduced in the country and the first attempt by the federal Environmental Protection Agency (EPA) to enforce them. The empirical analysis is based on detailed plant-level input and output data for more than 1.75 million plants drawn from the 1967–1987 US Census of Manufactures. The preferred empirical estimates suggest that carbon monoxide and ozone regulations have the strongest depressing effects on labor demand. A carbon monoxide non-attainment designation leads to a 3.3% reduction in annual employment in carbon monoxide-emitting plants, while an ozone non-attainment designation leads to a 1% reduction in annual employment in ozone-emitting plants. Regulations for excessive sulfur dioxide and suspended particulate emissions are not associated with significant changes in employment.

The study also examines the heterogeneity of the measured effect of the regulations on employment across industrial sectors. While the evidence suggests that regulatory effects on employment do not differ statistically across industries, the total impact of the regulations is particularly severe for industries that emit multiple pollutants in counties that are designated as non-attainment for those pollutants, particularly for the pulp and paper and the iron and steel industries.

Overall, the evidence suggests that in the first 15 years of implementation of the Clean Air Act (1972–1987), regulated non-attainment counties lost close to 600,000 jobs (relative to the unregulated counties) [2]. Ozone and carbon monoxide regulations were the prime source of the employment loss. Although the decline in manufacturing employment was substantial in non-attainment counties, it was modest in relation to the size of the entire manufacturing sector: the 600,000 jobs lost correspond to about 3.4% of total employment in the sector over the study period.

Other studies of the strengthened emission standards under the Clean Air Act amendments of the early 1990s in the US have used rich data on establishment-specific employment and payrolls to create a panel of plant-level observations by county, year, and sector over 1985–2005 [5], [6].

The analysis of employment rates in these studies is the most complete to date, since it precisely measures job dynamics for the affected sectors. In particular, the employer–

employee sample allows individual workers to be tracked over time as some are displaced from their jobs following increases in air quality regulatory pressure. The study shows a prolonged decline in employment associated with the new regulations. Employment in polluting sectors fell 15% in the ten years following the change in regulation. A decomposition of the overall employment effect indicates that employment losses were driven mostly by higher job destruction rates in regulated sectors (as opposed to lower job creation rates). So, workers displaced by the regulations may suffer significant costs associated with involuntary job loss. The results also indicate that sectors regulated because of violations of the ozone, particulate, and sulfur dioxide standards faced the largest reductions in employment over the long term.

The difference in the pollutant-specific employment effects reported in these studies highlights the change in pressure imposed on labor markets by the regulation of specific pollutants from the late 1970s and 1980s to the 1990s [2], [5].

A 2011 study reports the only credible empirical evidence of employment effects of environmental policies outside the US. It examines the effects of the climate change levy on manufacturing plant activity using data from the UK's production census [7]. The study compares outcomes between plants that have to pay the full tax rate under the levy and plants that were granted an 80% discount on the tax after voluntarily joining a climate change agreement (voluntary agreements containing targets to increase energy efficiency or reduce carbon dioxide emissions). Fixed-effect and instrumental variable methods are used to control for the selectivity of joining a climate change agreement. The study finds that the climate change levy leads to large declines in plant-level electricity use but has little effect on overall economic performance, employment, and productivity.

Productivity

Two studies measure the effects of environmental regulation on productivity in the manufacturing sector [8], [9], revisiting earlier studies that examined the role of environmental regulation in explaining the productivity slowdown of the 1970s (see [10] for a review of the earlier literature).

A 2012 large-scale analysis of the effect of US air quality regulations on manufacturing plant productivity, measured by plant-specific total factor productivity, used detailed plant-level production data for 1.2 million plants drawn from the 1972–1993 Annual Survey of Manufactures [9]. The main finding is that, for surviving polluting plants, stricter air quality regulations are associated with total factor productivity declines of about 2.6%. (In other words, output at regulated polluting plants declined by 2.6%, holding constant the labor, capital, and material inputs.) Once estimates are corrected for the confounding effects of price increases and output declines in the manufacturing sector over 1972–1993 and for selection based on plant survival, the measured effect of air quality regulations is a 4.8% decline in total factor productivity for polluting plants in regulated areas. Of individual air pollutants, regulation of ozone has the largest negative effect on productivity. By contrast, carbon monoxide regulations increase measured total factor productivity, especially among refineries. Together, the results indicate an annual economic cost of air quality regulations on manufacturing plants of US$21 billion (2010), or roughly 8.8% of average manufacturing sector profits over the study period.

In contrast to these results is an analysis of the relationship between measured environmental compliance costs and plant-level productivity, defined by the real value of shipments per worker [8]. In the 1980s and early 1990s, productivity and environmental compliance costs were weakly correlated.

Earnings

Only one study measures the effect of environmental regulations on wages [6]. The key starting point of the prior studies examining employment effects is that workers displaced by regulations generally find new employment, perhaps in new locations or industries. In the absence of frictional unemployment, workers move across jobs quickly, so measures of regulatory effects on job losses would not be informative about the costs of environmental policies. In reality, some displaced workers may experience long periods of unemployment following layoff and may lose industry- or job-specific skills. This study provides an important summary measure of these kinds of costs by studying the long-term wage effect of job displacement due to environmental regulations [6].

The analysis, based on longitudinal employer–employee data, tracks workers across jobs over time. This permits the measurement of long-term wage costs for workers who remain in regulated sectors and for workers displaced by the regulations. The results indicate that the earnings costs generated by the 1990 Clean Air Act amendments are significant: workers in sectors affected by the new regulations lose more than 5% of their pre-regulation earnings in the three years after the regulations' implementation, and the declines are persistent, since earnings begin to recover only five to six years after the regulations are introduced.

In other words, air quality regulations in the US appear to impose long-term costs on the affected workers. On average, affected workers in the regulated sectors experience a total earnings loss equivalent to 20% of their pre-regulatory earnings. These losses are almost entirely driven by workers displaced from the regulated sectors, rather than by workers who remain employed in the regulated sectors. Further, the evidence suggests that the effects are concentrated among older workers displaced from large plants in areas with weaker local labor markets. While the estimated aggregate wage displacement costs of the 1990 Clean Air Act amendments are large (US$5.4 billion in foregone earnings), they remain small compared with the estimated benefits associated with increased air quality. The EPA estimates that these benefits range from US$160 billion to US$1.6 trillion.

LIMITATIONS AND GAPS

Credible and conclusive empirical evidence remains limited to a handful of studies, almost all evaluating the effect of air quality regulations on labor market outcomes in the US. A sizable research agenda remains to expand this knowledge to other settings and countries. More research is needed to understand the effect of the generally stricter environmental regulations in European countries, where worker protection laws are typically stronger. Similarly, more research is needed in emerging economies, where ambient pollution levels are higher, labor markets more dynamic, and air quality standards weaker.

In all these countries, statistical agencies must accelerate and facilitate access to the required worker-level and plant-level employment and earnings data, and the regulatory incidence on the regulated plants or geographic areas. Ideally, researchers would have access to large employer–employee databases, with detailed worker-level information on demographic and job attributes, hours worked, and earnings for long periods. The US experience shows that such data can be made available while maintaining confidentiality standards—and can lead to important empirical studies.

SUMMARY AND POLICY ADVICE

After more than 40 years of empirical research, there is still a lively debate about the complicated relationships between environmental regulations, firm competitiveness, and employment. Supporters point to the large monetized health benefits associated with reduced air pollution, while opponents point out higher production costs for firms leading to reduced competitiveness, as well as possible employment, productivity, and wage effects.

In the last decade a new series of empirical studies has emerged, based on credible quasi-experimental designs and implemented using large-scale and detailed plant-level and employee–employer databases. The evidence suggests that regulations that affect firms in areas that fail to meet air quality standards generally lead to negative effects on industry employment. For long-term earnings, one study concludes that affected workers lose around 20% of their pre-regulatory earnings over a ten-year period. So the consequences for the affected workers are substantial. But the aggregate cost of the US Clean Air Act to the affected workers is very small compared with the estimated benefits of the policy for the overall population.

The employment and earnings effects of the US Clean Air Act are concentrated among the less skilled and older workers displaced by the regulation. Policymakers considering new or stricter environmental regulations that affect labor markets should therefore include programs for job training, labor market reintegration, and income support for the workers concerned. They should also promote scientific research on the effect of environmental regulations on workers and firms, and base policy decisions on credible empirical evidence.

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Competing interests

The IZA World of Labor project is committed to the *IZA Guiding Principles of Research Integrity*. The author declares to have observed these principles.

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