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The reallocative and heterogeneous effects of cap-and-trade

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HIGHLIGHTS

- We study the effect of a large-scale cap-and-trade program on manufacturing firms.
- Overall employment falls but the effect differs by firm age and firm size.
- The employment effect is driven by declines in older and larger firms.
- Employment increases in younger and smaller firms.
- Unlike command-and-control, cap-and-trade favors newer firms.

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ABSTRACT

This paper explores the heterogeneous response of manufacturing firms to the NOx Budget Trading Program (NBP), a large scale cap-and-trade program that was implemented in nineteen states in 2004. Specifically, we examine the differential effect of the program across firms of different ages and sizes. Results show that while overall employment in polluting industries declines, this decline is driven entirely by incumbent firms and that new firm activity increased following the NBP. The findings provide evidence that, unlike command-and-control programs, cap-and-trade results in reallocation of production from older to younger firms and changes the firm size distribution.

1. Introduction

A sizable economics literature has attempted to understand the costs that environmental regulations impose on firms and workers. While most research has explored the effect of command-and-control regulations (Greenstone, 2002; Berman and Bui, 2001), our understanding of the effects of market-based policies remains limited, particularly within the United States.

Recent research has made strides in understanding the effects of these policies on industrial economic activity (Yamazaki, 2017; Lee, 2017; Curtis, 2018; Yip, 2018). This paper extends the research of Curtis (2018) by examining the heterogeneous effects of the NOx Budget Trading Program (NBP) across firms of different ages and sizes. The NBP was a large-scale cap-and-trade program implemented in the United States in 2003 and 2004. Past research studying *command-and-control* programs has generally found that younger and smaller firms experience the largest negative impacts (Dean et al., 2000; List et al., 2003; Curtis, 2017). This can be due to economies of scale in abatement and fixed regulatory costs that may be more easily spread over large firms. Command-and-control regulations may also directly restrict the construction of new polluting sources, thus hindering new-firm development in regulated regions (List et al., 2003; Revesz and Lienke, 2016).

Cap-and-trade, however, provides firms flexibility to choose their own cost-minimizing strategy and does not mandate the installation of pollution abating capital or directly restrict new plant births. Under cap-and-trade firms can either acquire permits or reduce pollution levels if such reductions are cheaper than the cost of a permit. Thus, cap-and-trade favors innovative firms that can most cheaply reduce their emissions. If new-firm technology allows for cleaner production techniques, or environmental retrofits of existing firms are costly, then cap-and-trade may favor new firms over incumbent firms and reallocate industry activity away from older firms.[1]

[1] Fowlie et al. (2016) note that entry and exit decisions will also depend on the permit allocation mechanism. The NBP allocated permits to incumbent firms based on historical emissions. New emission sources were eligible to receive permits from a "new source set-aside." See Curtis (2018) for more details specific to the NBP.

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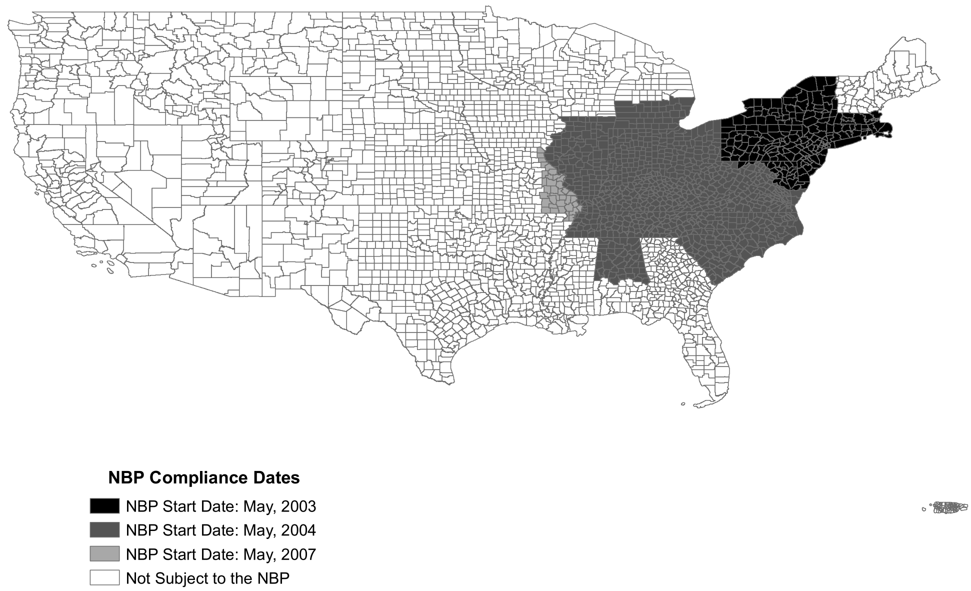

Fig. 1. NBP Compliance Region. Note: Following Curtis (2018) an area is defined as treated if its electricity provider is part of an Independent System Operator subject to the NBP.

Table 1
Employment results by firm age and size.

	(1) ln(emp)	(2) ln(emp)	(3) ln(emp)
All	−1.602*** (0.570)	−0.947** (0.408)	−0.903** (0.410)
New Firms Age 0–1	0.490 (2.106)	8.981* (4.450)	8.934** (4.436)
Old Firms Age 11+	−1.563** (0.634)	−1.156** (0.542)	−1.122** (0.532)
Firm Size 0–19 Emp	0.416 (0.764)	0.883** (0.368)	0.966*** (0.356)
Firm Size 20–49 Emp	−0.0287 (0.733)	−1.229** (0.493)	−1.205** (0.507)
Firm Size 50–99 Emp	0.0616 (0.612)	−0.552 (0.712)	−0.418 (0.704)
Firm Size 100–249 Emp	−3.472* (1.821)	−0.489 (0.743)	−0.489 (0.738)
Firm Size 500+ Emp	−2.349** (1.102)	−1.096 (0.775)	−1.066 (0.754)
N	33,560	33,560	33,560
State–Ind FE	Yes	Yes	Yes
Year FE	Yes		
State Linear Trend		Yes	
Ind–Year FE	Yes	Yes	Yes
State–Year FE			Yes
Ind–Region Trends		Yes	Yes

Note: All coefficients in this table are those estimated on the tripled interaction term $Post_{gt} \times NBP_g \times EnInt_k$ in Eq. (1).
Standard errors in parentheses.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

We test these questions in light of the NBP using a triple-difference technique that exploits variation in firms' exposure to the policy based on their industry and geographic location, before and after the program's implementation. The data come from the Quarterly Workforce Indicators (QWI), a relatively new United States Census dataset with information on employment, hiring rates and payrolls of firms by industry, regions and firm age and size categories.

Results show that while the NBP had negative *overall* effects on exposed manufacturing firms, new-firm activity actually increased. The negative overall effects are driven entirely by older firms. The program is also shown to change the firm size distribution. The findings contribute to our understanding of environmental policy and to recent literature studying the policy determinants of new-firm formation (Decker et al., 2016).

2. Data: Quarterly Workforce Indicators

The QWI is a publicly available dataset based on Census' Longitudinal Employer Household Dynamics program. It is the only publicly available data with detailed labor market data by geography, industry and firm-age/firm-size.[2]

We construct a separate dataset for each firm-size and age category where an observation in each dataset is at the State–Industry-quarter level and industry is measured at the 3-digit NAICS level. We use data from the 40 states whose data go back to at least 2000 and go through 2009.[3] We merge in three-digit industry energy-intensity data from the 2000 NBER Productivity Database and construct an energy intensity index for the 21 different manufacturing industries by dividing each industry's total energy expenditure by their total value of shipments. Curtis (2018) demonstrates an industry's energy intensity is a good proxy for the industry's exposure to the NBP. Energy intensity ranges from 0.6% in the computer and electronic product industry to 5.5% in the primary metal industry.

3. Empirical model

The identification strategy exploits the geographic, time and industry heterogeneity found in the data. As a first step towards exploiting this heterogeneity, we consider the following DDD model:

[2] See Abowd et al. (2006) for more detail.

[3] The firm age results focus on firms aged 0–1 and firms older than 10. Firms switch age categories from one year to the next so, for example, the 4–5 year category would be differentially exposed to the NBP during different post-treatment years. The results on firm size primarily demonstrate how the firm size distribution changed rather than how firms of a particular size were affected as, for example, the NBP may cause firms in the 250–499 category to drop into the 50–249 category. If this were the case, then these regressions could show positive impacts of the NBP on the 50–249 category.