3 Firm employment, energy prices and environmental policy stringency

Employment effects of tighter environmental policies are the focus of this chapter.[1] By increasing production costs, unilateral environmental policies might hamper the competitiveness of industries, leading to output contraction and job losses. The potential impacts on employment are probably the main concern for policy makers when implementing stricter environmental policies, but the empirical evidence on this effect is limited so far. This study provides an empirical evaluation of the impact of increased energy prices and more stringent environmental policies as measured by the OECD Environmental Policy Stringency (EPS) Indicator on employment. It uses a combination of firm- and sector-level datasets across OECD countries over the period 2000-14. The results at the sectoral level show a significant negative effect on average of changes in energy prices as well as of changes in the environmental policy stringency index. The magnitude of the effect is, however, small: a 10% increase in energy prices leads to a reduction of 0.7% in manufacturing employment. Energy-intensive sectors see a stronger decline in employment due to higher energy prices, but less energy-intensive sectors do not show any significant effect. The firm-level analysis shows that higher energy prices have a small positive effect on the employment level of surviving firms while increasing the probability of firm exit. Tighter environmental policies on the other hand show a small negative effect on the employment level of surviving firms while not affecting firm entry or exit.

Background

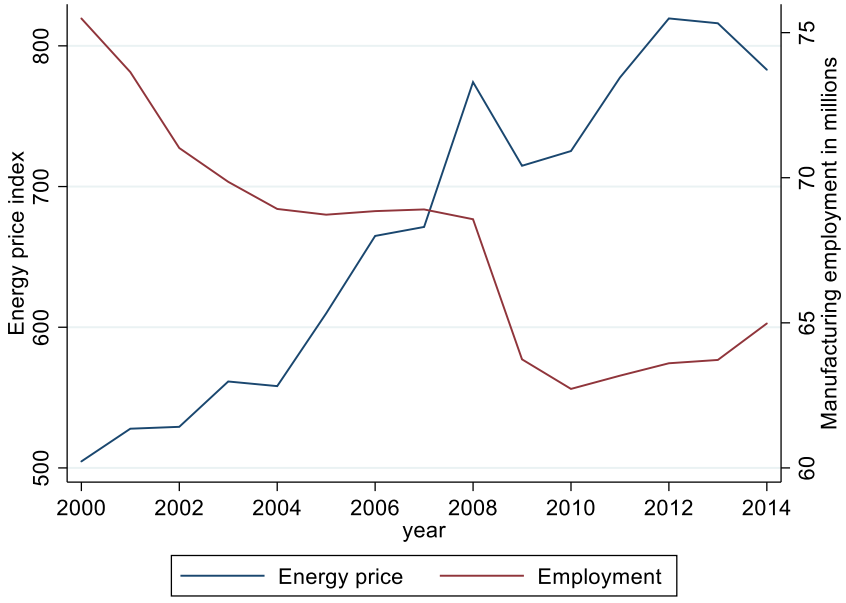
A strong negative correlation between energy prices and employment

Political debates often use the potential negative effects on employment as an argument against the introduction of tighter environmental policies. Additional compliance costs are assumed to increase production costs, thereby lowering the international competitiveness of the industry, leading to an output contraction and consequent lay-offs. Energy-intensive sectors are expected to be particularly affected. Figure 3.1. shows the evolution of employment in the manufacturing sector together with average energy prices across OECD countries between 2000 and 2014. A strong negative correlation can be observed, which – despite having no causal interpretation – helps explain why the debate around new or stricter environmental regulations is often framed in terms of "jobs versus the environment" (Morgenstern, Pizer and Shih, 2002[1]).

Theory predicts no long-run effects but potential short-term adjustments

Theoretically, in the long-run, there should be no sustained effects of tighter environmental policies on employment. Sectors losing out in terms of competitiveness might shed labour, but in the long term, an adjustment in the labour market should take place, shifting employment towards less polluting sectors, leaving total unemployment unchanged (Fankhauser, Sehhleier and Stern, 2008[2]). In the short term, there might, however, be adjustment costs through two effects: a demand effect (employment losses due to a contraction of output) and a substitution effect (a shift from capital towards labour in the production process due to an increase in the effective rental rate of productive capital). Whether the overall short-run employment effect is positive or negative depends in particular on the relative labour-intensity of polluting and non-polluting activities (Morgenstern, Pizer and Shih, 2002[1]; Dechenes, 2011[3]).

Figure 3.1. Employment and energy price trends over time for OECD countries



Note: The Figure shows average trends in energy prices and employment for OECD countries.
Source: Dechezleprêtre, Nachtigall and Stadler (2020[4]).

Empirical studies suggest a small negative effect on employment

Empirical studies that have evaluated the effects of more stringent environmental policies suggest that there is either no or a small negative employment effect in the short run, mostly in energy-intensive sectors (see Dechezleprêtre, Nachtigall and Stadler (2020[4]) for a detailed review of the literature). The approaches taken in the studies vary from investigating the United States Clean Air Act (Greenstone, 2002[5]; Kahn, 1997[6]; Walker, 2013[7]), using pollution abatement costs as a measure for environmental policy stringency (Morgenstern, Pizer and Shih, 2002[1]; Belova et al., 2013[8]), to comparing regulated to non-regulated plants (Berman and Bui, 2001[9]; Cole and Elliott, 2007[10]; Ferris, Shadbegian and Wolverton, 2014[11]). More recent studies have specifically looked at the effect of energy prices on employment (Dechenes, 2011[3]; Kahn and Mansur, 2013[12]; Hille and Möbius, 2019[13]), finding insignificant or weakly negative effects for the average industry and a negative effect for energy-intensive sectors. Studies looking specifically at employment effects of the European Union Emissions Trading Scheme find no statistically significant effects (see Dechezleprêtre, Nachtigall and Venmans (2018[14]) (summarised in Chapter 7); others include Martin et al. (2014[15]); Anger and Oberndorfer (Anger and Oberndorfer, 2008[16]); Commins et al. (2011[17]); Abrell, Ndoye Faye and Zachmann (2011[18]); Chan, Li and Zhang (2013[19]). Country-specific studies find reallocation effects in the labour market due to higher energy prices, implying that larger, energy-inefficient firms reduce their number of employees, while employment rises in energy-efficient firms, leaving overall employment at the industry level largely unaffected (see Dussaux (2020[20]) and Dechezleprêtre and Brucal (2021[21]), summarised in Chapter 8 and 9).

Contribution of this study – a large-scale dataset allowing for heterogeneous effects, investigating energy prices and environmental policies

This study offers three main contributions to the literature. First, it reassesses the existing evidence of environmental policies on manufacturing sector-level employment using both energy prices as well as the OECD's EPS indicator as measures of environmental policy stringency (see Box 1.3 in Chapter 1 for a discussion of different measures of environmental regulation). This analysis is based on data from the World Input Output Database, covering OECD countries over the period 2000 to 2014.[2] Second, the sector-level analysis is complemented by firm-level evidence based on a large-scale dataset, covering more than 500 000 firms located in 23 countries. The large dataset allows to identify heterogeneous effects among countries, sectors and firm types. The main limitation of firm-level data is that only surviving firms are observed. Third, to address this shortcoming, the analysis also looks at firm entry and exit, using the OECD-Eurostat Business Demography Statistics.

Empirical set-up

Assessing the effects of energy prices and other environmental policies

Climate change policies such as carbon taxes or carbon markets would primarily affect firms through raising energy prices. Therefore, energy prices are informative about the likely effect of future market-based policy interventions to reduce carbon emissions. However, price-based mechanisms which translate into higher energy prices are only one type of environmental policy. There also exist numerous other instruments such as emission standards or taxes on pollutants other than CO_2 (e.g. NO_x, SO_x) which are all reflected in the OECD's environmental policy stringency indicator (EPS). Therefore, both energy prices and the OECD EPS are used to investigate the employment effects of environmental policies. Interestingly, the correlation between within-country year-on-year changes in energy prices and in the EPS is very low (<0.1), so that both variables provide independent sources of variation which can be exploited in the empirical analysis.

Empirical model

The empirical model used here relies on a specification that is commonly used by most studies on this topic (e.g. Hille and Möbius (2019[13])) and is estimated for the industry- and firm-level. The following equation is estimated:

$$\ln(y_{cst}) = \beta_p \ln(p_{cst-1}) + \beta_s \ln(s_{ct-1}) + \beta_w \ln(w_{cst-1}) + \beta_x X_{cst-1} + \alpha_{cs} + \delta_t + \mu_{ct} + \chi_{st} + \varepsilon_{cst}$$

where $\ln(y_{cst})$ is the log employment of sector s (or firm i) in country *c* and in year t. p_{cst} indicates the energy price in sector *s* and country c in year *t*, and is measured as sector-specific consumption shares of different fuel types, using time-fixed weights for aggregation in order to filter out the changes in energy prices related to changes in fuel prices or energy taxes instead of capturing changes in fuel choices (Sato et al., 2019[22]). s_{ct-1} is the OECD environmental policy stringency indicator (which, for the firm-level analysis, is interacted with the sectoral energy-intensity). w_{cst-1} is the average hourly real wage in sector *s* and country *c*. The energy prices as well as the wage variable are lagged by one year to reduce problems of reverse causality and to account for potential time lags in the effect of energy prices on employment. The vector X_{cst-1} represents further control variables, namely the log of capital and the log of value added per worker (at the sector or firm level). α_{cs} represents sector (or firm) fixed effects, depending on the specification, to control for time-invariant differences across sectors or firms, which might be correlated with both employment and energy prices. δ_t represent year fixed effects, capturing global shocks common to all countries and sectors, such as changes in global crude oil prices. In the sector-level analysis, μ_{ct} captures quadratic trends at the country level, χ_{st} captures quadratic trends at the sector level. In the firm-level analysis, μ_{ct} and χ_{st} are country-by-year and sector-by-year fixed effects.[3] ε_{cst} represents the remaining error term.

Data

The final sample of the sector-level analysis covers 28 OECD countries and 19 different manufacturing sectors from 2000 to 2014. The sector-level wage data are sourced from the World Input Output Database (WIOD). The final sample of the firm-level analysis covers half a million firms, operating in 340 different sub-sectors, being located in 23 OECD economies, and spans the time period from 2000 to 2014. The firm-level employment data are drawn from the OECD version of the ORBIS database from the Bureau Van Dijk. The analysis uses energy prices from Sato et al. (2019), and the OECD EPS indicator (Botta and Koźluk, 2014[23]). As EPS varies at the country-year level, it is interacted with the sector-specific energy-intensity in the firm-level analysis, following the approach of Rajan and Zingales (1998[24]).

Results

Negative but small decline in employment in response to higher energy prices and tighter environmental policies

The empirical analysis uses changes in country- and sector-specific energy prices to estimate the effect on employment. The results of the main specification at the sector-level show a significant negative effect of changes in country-sector specific energy prices and of increasing sector-specific environmental policy stringency on employment (Table 3.1). However, the effects are small: a 10% increase in energy prices, which is experienced every four to five years in the typical country in the sample, would reduce employment by 0.7 per cent. Similarly, a 10% increase in the EPS indicator would lead to a reduction of employment by 0.58 per cent. The firm-level estimation shows a different picture: Increasing energy prices are on average found to be significantly positively related with firm employment while tighter environmental policy stringency measures by the EPS index is found to be significantly negatively related. Again, the effects are

small: A 10% increase in energy prices would increase employment by 0.66%, a 10% increase in EPS would reduce employment by 0.4%.

Table 3.1. Employment effects - main estimation results

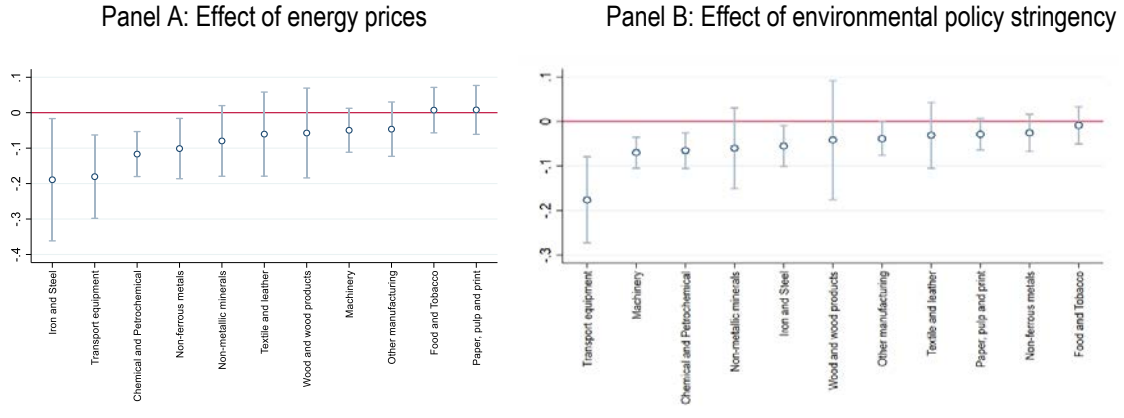
	Sector-level			Firm-level		
Dep. variable: log of employment	(1)	(2)	(3)	(1)	(2)	(3)
Log energy price (t – 1)	-0.070***	-0.054*		0.066***	0.057***	
	(-0.032)	(0.029)		(0.016)	(0.016)	
Log EPS (t - 1)	-0.058***		-0.049***	-0.040***		-0.031**
	(0.015)		(0.014)	(0.015)		(0.015)
Log hourly wage (t - 1)	-0.115***	-0.107***	-0.113***	-0.058***	-0.057***	-0.060***
	(0.041)	(0.042)	(0.040)	(0.008)	(0.008)	(0.008)
Log capital (t - 1)	0.187***	0.187***	0.185***	0.119***	0.119***	0.119***
	(0.042)	(0.042)	(0.041)	(0.001)	(0.001)	(0.001)
Log value added per worker (t - 1)	-0.014	-0.022	-0.013	-0.034***	-0.034***	-0.034***
	(0.039)	(0.038)	(0.039)	(0.001)	(0.001)	(0.001)
Number of observations	6494	7502	6566	2510413	2510413	2510413

Notes: Standard errors are shown in parentheses and are clustered at the firm or sector level, depending on the specification. Significance levels are given by: * p<0.1, ** p<0.05 and *** p<0.01.

Energy-intensive sectors face a larger negative effect on employment than other sectors

Interacting the energy price and the EPS variable with sector-specific dummy variables allows to estimate heterogeneous sectoral effects. Based on the sector-level results, these estimations show that the negative effect on employment is larger for more energy-intensive sectors, as shown in Figure 3.2. (Panel A). The iron and steel sector, transport equipment and petrochemicals are the most affected sectors when energy prices rise. Changes in the EPS mostly affect employment in the transport equipment sector, machinery and petrochemicals sector (Panel B in Figure 3.2.).

Figure 3.2. Sector heterogeneous effects on employment



Note: The figure shows the point estimates and 95% confidence intervals of the energy price variable and the EPS variable respectively on the log of employment.

Difference in industry- and firm-level results are driven by a positive effect on the exit of firms

A further analysis uses information on the entry and exit of firms and reveals that the difference in industry- and firm-level results comes from a positive effect of energy prices on firm exit. Higher energy prices increase the exit of firms. As higher energy prices trigger firms to exit the market, surviving firms are able to grow and increase the number of employees. There is evidence found in the analysis that surviving firms indeed expand in response to increasing energy prices through an increase in gross output. The aggregate effect on employment remains negative, however, explaining the divergent results found at the sector- and firm-level. Changes in the EPS do not have an effect on firm exit nor on gross output. The negative effect found at the firm level of increasing EPS seems to be the major driver for the negative results found at the sector-level.

Robustness checks of firm level analysis

The results are robust to several robustness checks. Different lag structures are tested, a first-difference specification is employed as an alternative way to account for firm-specific heterogeneity, and a range of further sector-level controls were introduced. None of these robustness checks show significantly different results.

Conclusion

A small employment effect on average – but stronger in energy-intensive sectors

The results of this study show that there is a small statistically significant negative effect of changes in energy prices as well as changes of environmental policy stringency on sector-level employment on average. At the firm-level, there is a slight statistically significant positive effect on firm-level employment of increasing energy prices, while the effect of a tightening of environmental policies remains negative at the firm-level. The different results at the firm- and sector-level for energy prices are explained by a rising level of firm exits due to rising energy prices. The effects are heterogeneous across sectors, with the most energy-intensive sectors facing the largest decline in employment. The magnitude of the effect in energy-intensive sectors is, however, small: in the iron and steel sector, a 10% increase in the price of energy reduces firm employment by 0.2%. For the United States, this number would translate into slightly more than 1 000 lost jobs per year, accounting for around 7% of total employment losses in the US steel sector.

An upper bound of the true effect?

The analysis has two main limitations. First, to the extent that changes in energy prices or environmental regulations induce a rapid shift in demand (and thus employment) from strict to less-strictly regulated sectors and regions, estimates of employment losses presented here would be biased upward. The extent of such general equilibrium effects are difficult to estimate, but the results should be understood as an upper-bound of the true effect of higher energy prices and stricter environmental policies. Second, the results are only valid in the short run. In the longer run, there might be no net effect on job losses as workers move from contracting or exiting firms to other firms or other sectors (in particular, the analysis focuses on the manufacturing sector, but affected workers might find jobs in the services sector).

Complementary policies to ease transition costs

The analysis clearly demonstrates that there exist transition costs in the short run, when stricter environmental policies are imposed, as some workers are forced to move away from affected firms and sectors, even if many of these job losses are unlikely to be permanent as laid-off workers may ultimately

find other jobs. Because these reallocation effects have redistributive implications and generate costs for laid-off workers, these results call for complementary labour market policies that minimise those costs on affected workers and ease between-firm adjustments in employment. Moreover, since these transition costs are typically highly localised in regions specialised in polluting activities, they can also translate into potentially significant regional effects and thus political costs.

Effects on types of workers and on wages remain outside of the scope of this study

The analysis could be complemented with an assessment of the effect of energy prices and EPS across different types of workers (high-skilled versus low-skilled) and across types of regions (e.g. rural versus urban). Another complementary analysis could focus on employees' wages rather than on the number of employees. Additional data on employees and on firm location would allow for such analyses.

Notes

[1] This chapter is a summary of the paper "The effect of energy prices and environmental policy stringency on manufacturing employment in OECD countries: Sector- and firm-level evidence" by A. Dechezleprêtre, D. Nachtigall and B. Stadler, *OECD Economics Department Working Papers* (2020), OECD Publishing, Paris.

[2] Energy price levels between 2000 and 2014 may not be entirely representative of energy price developments in more recent years. The empirical analysis does however not analyse the effect of energy price *levels*, but uses within-firm or within-sector *changes* in energy prices to identify the effect. To derive implications for future changes in energy prices, one needs to assume that past changes in energy prices and their effect on employment are representative of future changes in energy prices and their effect on employment. If energy prices change drastically in the future, the effects on employment may differ from the effects estimated based on past changes in energy prices.

[3] As EPS varies at the country-year level, it is interacted with the sector-specific energy-intensity in the firm-level analysis, following the approach of Rajan and Zingales (1998[24]).

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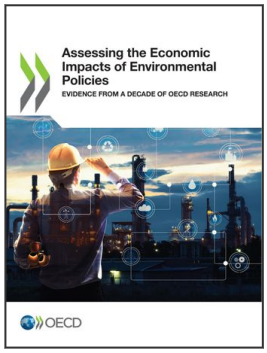

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