The impact of energy price shock on jobs - a structural approach

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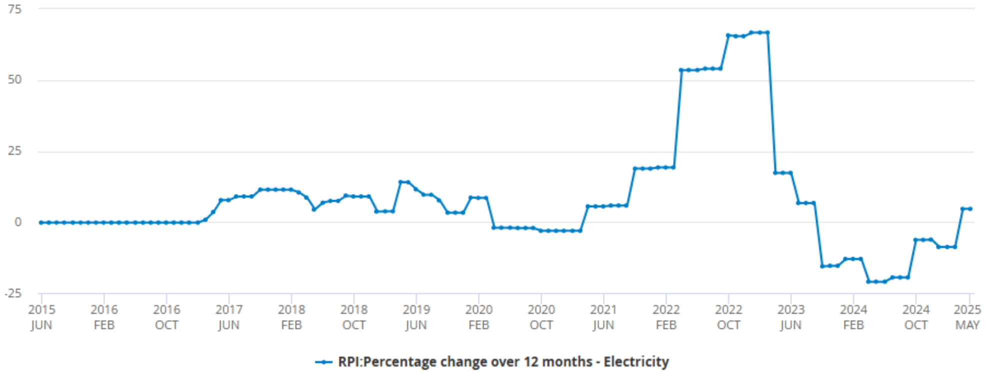
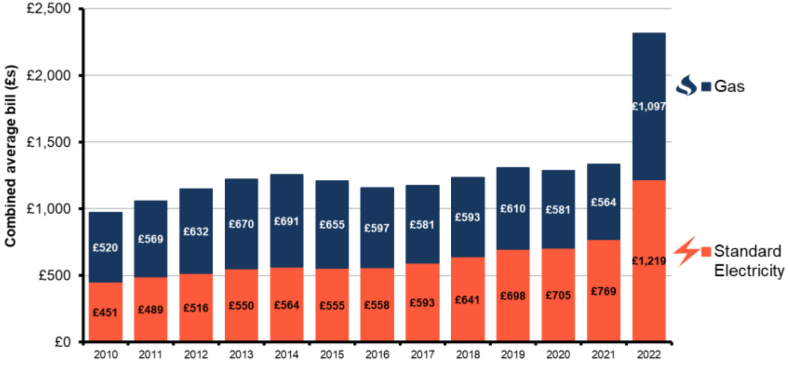
Motivation



Source: Office for National Statistics

Due to a sudden increase in natural gas prices, electricity prices rose close to 100% in the United Kingdom in 2022.

Motivation



Source: Office for National Statistics

Energy producers passed costs through in full to consumers—both firms and households—who saw their bills increase by nearly 100%.

Firms reacted by reducing their workforce – affecting the most vulnerable communities

Rising energy costs have caused 40% of British firms to stop hiring

To mitigate the impact of the rising energy costs, some UK firms have halted their recruitment of new staff, and others are downsizing their workforce.

Cost of living crisis + Add to myFT

'People are going to die': verdict from front line of Britain's energy crisis

Rundown community was already living on a financial 'knife edge' before huge rise in price cap

Research Questions

1. How do energy price shocks affect firm-level employment?
   - *We find that, on average, the UK workforce was reduced by 1% between 2022 and 2023.*
2. Do firms with higher energy elasticity experience greater job losses?
   - *Companies with higher energy intensity reduced their workforce more.*
3. How are regional labour markets impacted following a national energy shock?
   - *Regions with higher labour–energy cross-price elasticities are more vulnerable due to tighter regional labour markets.*

Roadmap

Contribution to the Literature

- **Energy Elasticity and Substitution in Production**

  Berndt and Wood (1986); Blanchard and Galí (2009); Hassler et al. (2012); Thompson and Taylor (1995)

  - Our contribution: We show how substitutability can vary regionally and have significant impact on local employment

- **Labor Market Effects of Energy Price Shocks**

  Davis and Haltiwanger (2001); Kilian (2009); Presidente et al. (2023)

  - Our contribution: Previous papers focussed on oil prices, we are able to distinguish between source of energy at firm level and isolating the impact of natural gas prices on employment

- **Regional Heterogeneity and Labor Market Adjustment**

  Diodato and Weterings (2014); Limão and Venables (2001); Meghir et al. (2010); Rentschler and Kornejew (2017)

  - Our contribution: We study the impact of a national energy shock on regional labour markets

- **The 2022 Energy Crisis**

  Alpino et al. (2024); Fetzer et al. (2024)

  - Our contribution: We focus on energy elasticities and substitutability at regional level.

Roadmap

Data

We use **UK firm-level administrative data** (representative of the **universe** of UK firms).

We observe firms for **2015 to 2018**, and then from **2021-23**.

We link firms using **unique reporting unit identifiers**; this allows us to measure:

- Energy expenditures; Employment; Turnover; Capital expenditure.

Data

SIC Section	n	Percent (%)
Manufacturing	4141	19.8
Wholesale & retail trade	4030	19.2
Administrative & support service	2147	10.2
Professional, scientific & technical	2142	10.2
Information & communication	1355	6.5
Construction	1227	5.9
Accommodation & food services	1220	5.8
Transportation & storage	1028	4.9
Health & social work	999	4.8

SIC Section	n	Percent (%)
Real estate activities	498	2.4
Arts, entertainment & recreation	545	2.6
Education	287	1.4
Water supply, sewerage & waste	289	1.4
Electricity, gas, steam & AC supply	262	1.3
Mining & quarrying	250	1.2
Other service activities	183	0.9
Financial & insurance activities	180	0.9
Agriculture, forestry & fishing	176	0.8

This table shows the distribution of firms by SIC section, which aligns closely with the UK universe's sectoral breakdown.

Data

Employees	n	Percent (%)
0–9	1,042	5.0
10–19	1,026	4.9
20–49	1,442	6.9
50–99	1,662	7.9
100–249	2,260	10.8
250+	13,527	64.5

By construction, our sample consists predominantly of medium- to large-sized enterprises.

Roadmap

Energy Elasticity: Shares vs. Elasticities

Energy Share:

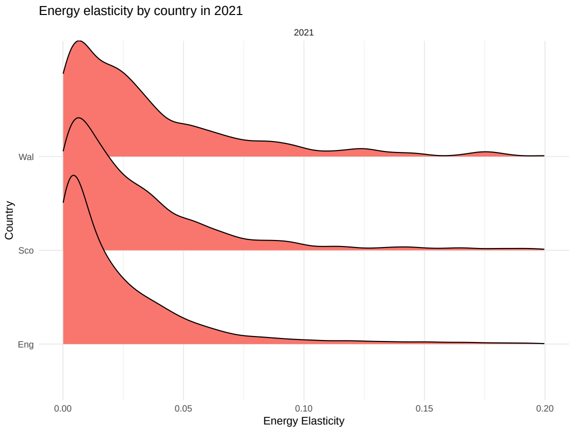
$$s_E = \frac{W_E \cdot E}{R}$$

Elasticity of Energy Demand:

$$\varepsilon_E = -\frac{s_E}{1 - \sum s_j}$$

- s_E captures cost burden, not behavioral response.
- ε_E captures substitution behavior in response to energy price changes.
- Useful in contexts where firms face exogenous energy price shocks.

Energy Elasticity by Country



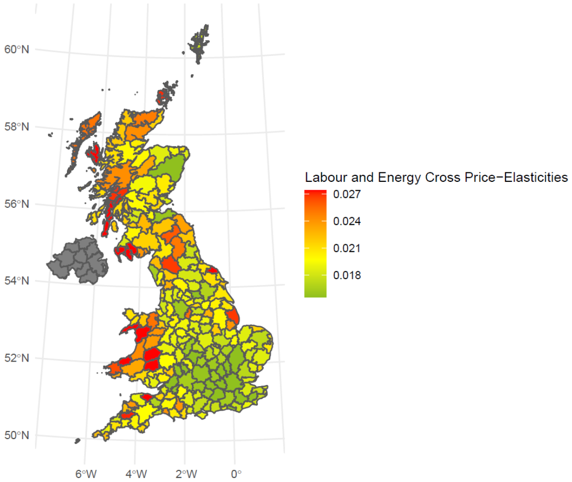
Firms in Wales and Scotland have higher energy elasticities than in England

Energy Elasticity by Sector and Region

SIC Section	Country	Mean Energy Elasticity
Electricity and gas	England	0.325
Electricity and gas	Scotland	0.218
Transportation	Wales	0.148
Water and Waste	Wales	0.085
Transportation	Scotland	0.083
Transportation	England	0.080
Water and Waste	England	0.077
Water and Waste	Scotland	0.064
Arts and Entertainment	Scotland	0.058
Information and Communication	Wales	0.056

Energy, Transportation and Water and Waste are the most vulnerable sectors, especially within Wales and Scotland.

Labour and Energy Cross Price Elasticities (Absolute)



Higher labour–energy cross-price elasticities in peripheral areas mean that higher energy costs lead firms to cut both energy use and workers.

Production Set-Up

Cobb–Douglas output (one capital input K, three variable inputs):

$$Q = A\,K^{\alpha_K}\,L^{\alpha_L}\,M^{\alpha_M}\,E^{\alpha_E}$$

- A = productivity (TFP)
- L = labour, M = materials, E = energy
- Exponents ($\alpha_\cdot$) measure each input's cost share

Short-run profit maximisation (capital fixed):

$$\max_{L,M,E}\; P\,Q - W_L L - W_M M - W_E E$$

Key first-order condition (labour vs. energy):

$$\frac{L}{E} = \frac{\alpha_L}{\alpha_E}\,\frac{W_E}{W_L}$$

Intuition

If energy becomes more expensive ($W_E \uparrow$), firms either use less E or substitute toward L, depending on α_L/α_E.

What Happens to Employment?

Approximate change in labour demand when W_E rises:

$$\Delta L \approx L_0 \underbrace{\left(\frac{\partial \ln L}{\partial \ln W_E} \right)}_{\text{labour–energy elasticity } \Phi_{LE}} \frac{\Delta W_E}{W_E}$$

- $\Phi_{LE} < 0$ (inputs are substitutes) $\Rightarrow$ smaller job loss
- $\Phi_{LE} \approx 0$ (near-complements) $\Rightarrow$ larger job loss

Policy take-aways

1. Sectors with high energy share (α_E large) are most vulnerable.
2. Flexible labour markets help workers move as firms re-optimise input mix.
3. Expect heterogeneous impacts across regions and industries.

Roadmap

Empirical Strategy: Difference-in-Differences

Main Specification:

$$\log(\text{Employment}_{it}) = \beta_1 \text{post}_t + \beta_2(\text{post}_t \times \text{energy}_i) + \alpha_i + \lambda_t + \varepsilon_{it}$$

- $post_t$: indicator for post-shock years (2022–2023)
- $energy_i$: firm-level energy elasticity or share (measured pre-shock)
- α_i: firm fixed effects; λ_t: year fixed effects
- SEs clustered at the firm level

Empirical Results: Difference-in-Differences

Dependent Variable: log(Employment)		
	(1)	(2)
post	-0.0424***	-0.0121***
	(0.0060)	(0.0011)
post:energy	-0.2582**	-0.2552**
	(0.0902)	(0.0897)
Observations	74,232	74,232
Firm Fixed Effects	Yes	Yes
Year Fixed Effects	No	Yes
Clustered SE (Firm)	Yes	Yes
Adj. R^2	0.9219	0.9221
Within R^2	0.0035	0.0068

Empirical Strategy: Difference-in-Differences - High vs. Low Exposure Firms

DiD Specification:

$$\log(\text{Employment}_{it}) = \beta_1 \text{post}_t + \beta_2 \text{treated}_i + \beta_3(\text{post}_t \times \text{treated}_i) + \alpha_i + \lambda_t + \varepsilon_{it}$$

- $treated_i = 1$ if firm is highly exposed to energy shocks
- *post:treat* captures relative employment losses in highly exposed firms

Empirical Results: Difference-in-Differences — High vs. Low Exposure Firms

Dependent Variable: log(Employment)	
	(1)
post	0.2099***
	(0.0181)
treated	0.0927*
	(0.0426)
post:treated	-0.0954***
	(0.0224)
Observations	29,693
Firm Fixed Effects	Yes
Standard Errors	Clustered (Firm Level)
Adjusted R^2	0.0020

Roadmap

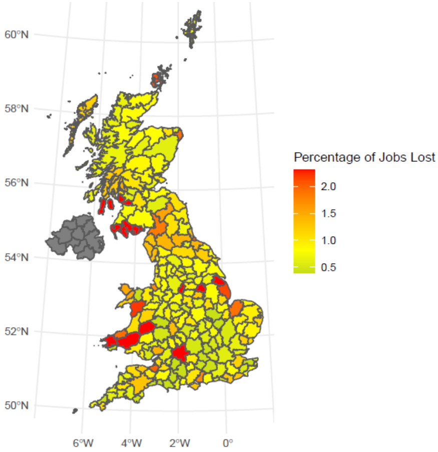
Employment Impact: Counterfactual Scenario

Scenario: No Energy Price Increase in 2021

$$\Delta L_{i,2022} = (\exp(-\beta_x \cdot \text{energy}_i) - 1) \cdot L_{i,2022}$$

- $\Delta L_{i,2022}$: estimated job losses due to energy price increases.
- β_x: coefficient from regression on energy elasticity or share.
- Energy shock accounts for **around 1%** of employment losses in 2022–2023.

Regional job losses



While the national impact is modest, it is highly concentrated in regions with tight labour markets—such as Wales, parts of Scotland, and Northern England.

Conclusion and Policy Implications

- Firms with higher energy elasticity faced greater post-shock job losses.
- **Elasticity matters more than share:** substitution capacity is key.
- **1% of jobs lost** in 2022–2023 due to energy cost shocks.
- Rural regions and tight labour markets most affected.

Future Steps:

- Estimate the conterfactuals by using a translog model

Thank You!

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