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

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**Abstract**

What is the impact of energy price shocks on jobs? This paper examines how an increase in energy prices affects employment using the 2022 energy price crisis as a natural experiment. While interesting in its own right it is also indicative of the employment effects of further carbon pricing which - like the 2022 fuel price shock - lead to an increase of carbon intensive fossil fuels such as oil and gas. While the sharp price increase of 2022 induced by the Russian attack on Ukraine was largely uniform across firms, we derive its impact by examining the differential employment response of firms with varying cross price elasticities between energy and employment. Thus we use a shift-share design where the energy price shock becomes the shift and cross price elasticities are the shares.

Using the energy crisis of 2022 as a natural setting and detailed administrative UK firm-level data, we exploit variation in firms' energy dependence by combining two measures of exposure: cross price elasticities between labor and energy, and energy cost shares. We estimate the heterogeneous impacts of rising energy costs on firms' employment decisions. Our results show that higher energy prices led to modest job losses, with less than one percent of jobs in our sample lost over 2022 and 2023 due to increased energy costs. However, the impact was far from uniform. The contraction in employment is concentrated in energy intensive sectors such as Electricity and Gas, Water and Waste, and Transportation, and is particularly evident in rural and peripheral regions where labor markets are less flexible and alternative job opportunities are limited. We also find that mid-sized firms bear a disproportionate share of the employment adjustment compared to both small and very large firms. These findings show how energy price volatility can generate uneven effects across sectors, regions, and firm sizes, highlighting the importance of targeted policy responses such as energy price stabilisation and support for workforce mobility to help reduce adverse labor market impacts during periods of energy price shocks.

**Keywords**: Energy, Price Shocks, Labor Market, Spatial Analysis

**JEL Codes**: E23, J2, L16, Q41, R23

# 1 Introduction

The surge in global energy prices in 2022 had profound economic repercussions, particularly for firms and households in Europe. The post-pandemic recovery and geopolitical disruptions (most notably the war in Ukraine) led to sharp increases in natural gas and electricity prices, creating substantial cost pressures for businesses reliant on energy-intensive production processes. While much attention has been given to the implications of rising energy costs for inflation and household consumption, less is known about how firms adjust their labor demand in response to energy price shocks. This paper investigates the extent to which higher energy costs translate into labor market adjustments, leveraging detailed firm administrative data from the UK. Our main contribution is to discover how the impact of an increase in energy prices is highly heterogeneous. We uncover that the contraction in employment is concentrated in energy intensive sectors such as Electricity and Gas, Water and Waste, and Transportation, and is particularly evident in rural and peripheral regions where labor markets are less flexible and alternative job opportunities are limited.

Energy is a critical input in the production process, and firms' ability to substitute away from energy towards other inputs varies significantly across industries, firm sizes, and locations. The degree of substitutability between energy and other production inputs has been widely studied in the context of firm cost minimization and production efficiency (Berndt and Wood, 1986; Hassler et al., 2012). We test whether firms with high cross price elasticities, those whose other inputs are more responsive to changes in energy prices, are more vulnerable to price fluctuations, with a specific focus on employment. These firms face a steeper trade-off between maintaining output and managing rising expenses, as higher energy price sensitivity implies greater adjustments in labor demand when energy costs increase.

In a standard Cobb-Douglas production function, input elasticity determines how firms adjust to cost shocks: firms with higher cross price elasticities should exhibit stronger labor market responses to energy price increases (Blanchard and Galí, 2009). Our empirical analysis confirms this hypothesis, demonstrating that employment declines are concentrated in firms with high energy dependencies, consistent with the literature on energy price pass-through and employment effects (Davis and Haltiwanger, 2001).

Using rich UK administrative firm-level data on firms' purchases and costs, we estimate the impact of an energy price spike on employment decisions. Our identification strategy exploits variation in firm-level energy intensity, while showing the results at a granular spatial level exploiting differences in spatial energy exposure. By leveraging fine geographic data, we account for local market conditions and infrastructure constraints which could influence firms' ability to adjust to energy price shocks (Rentschler and Kornejew, 2017).

We find that the labor demand contraction is particularly pronounced in energy-intensive industries, where higher operating costs necessitate reductions in labor input. Additionally, we document spatial heterogeneity, with firms in more rural areas having higher cross price elasticities than firms in large metropolitan areas. This finding is of particular relevance as labor markets in rural regions tend to be less flexible, with fewer alternative employment opportunities and lower worker mobility (Meghir et al., 2010). These results align with prior evidence that energy-intensive firms, typically large manufacturers, are more vulnerable to energy price shocks due to their reliance on fixed energy-intensive capital (Amaglobeli et al., 2024). Moreover, rural firms may face higher adjustment costs due to weaker infrastructure, limited access to credit, and smaller local labor pools, exacerbating employment losses in response to energy price shocks (Limão and Venables, 2001).

The policy implications of our findings are substantial. If energy price volatility persists, firms in energy-intensive sectors may continue to shed jobs or scale back operations, exacerbating sectoral labor market frictions. Understanding how firms respond to these shocks is crucial for designing policies that mitigate adverse employment effects. In particular, our results suggest that energy price stabilization measures or targeted support for energy-intensive firms could help sustain employment levels in vulnerable sectors.

Our study makes several key contributions to the literature on energy price shocks and firm behavior. First, we adopt a granular approach, leveraging firm-level administrative data to analyze the impact of energy price shocks. While much of the existing research has focused on macro-level effects, our granular data allow us to identify firm-specific responses and heterogeneity across firms of different sizes, energy intensities, and locations. This complements prior studies that have primarily examined the effects of energy price shocks on aggregate productivity and investment (Kilian, 2009).

Second, we focus explicitly on the substitutability between labor and energy inputs, whereas previous research has largely analyzed firm profitability, investment, and cost pass-through. The standard Cobb-Douglas production framework suggests that firms adjust labor and capital in response to changes in energy input prices (Thompson and Taylor, 1995). Our empirical findings confirm that firms with higher cross price elasticities are more likely to reduce employment, consistent with theoretical predictions. Importantly, we provide heterogeneous treatment effects, showing that firms in energy-intensive industries are particularly affected.

Third, we introduce a regional dimension to the analysis by assessing spatial variation in firms' energy exposure. Unlike previous research that has primarily examined sectoral differences, we provide evidence of how regional disparities in energy intensity, infrastructure, and labor market frictions could shape firm responses to energy price volatility. This aligns with broader work on regional labor market adjustments and

firm resilience to shocks (Limão and Venables, 2001; Meghir et al., 2010). Our results indicate that rural firms, in particular, experience greater employment losses, possibly due to weaker infrastructure, limited access to credit, and smaller local labor pools, which constrain their ability to adjust (Diodato and Weterings, 2014).

Finally, while several papers have examined the 2022 energy crisis (Fetzer et al., 2024; Alpino et al., 2024), they have primarily focused on energy share as a production cost or have restricted their analysis to the manufacturing sector, without considering broader employment and regional dimensions. Our study fills this gap by focussing on cross price elasticities as a way to more closely estimate a Cobb-Douglas production framework and by providing a comprehensive analysis that accounts for regional heterogeneity, sectoral differences, and cross-sectoral labor market effects. This is crucial for understanding the full impact of energy shocks on firms and workers beyond a narrow focus on production costs.

Our findings have important policy implications for labor market stability and economic resilience in the face of energy price volatility. Previous research suggests that temporary shocks to production costs can have long-lasting effects on employment, particularly in industries where re-hiring and training costs are high (Presidente et al., 2023). Understanding the channels through which energy price shocks propagate into labor markets is crucial for designing targeted interventions to support affected workers and firms.

The remainder of this paper is structured as follows. In Section 2, we present a simple theoretical framework that illustrates how energy price shocks can affect firms' input choices and employment levels. Section 3 provides institutional background on the UK energy crisis and discusses the main drivers of recent energy price increases. Section 4 describes the firm-level administrative data we use, the construction of our key variables, and summary statistics. In Section 5, we detail our empirical strategy for estimating the impact of energy shocks on employment, and present our main results, including difference-in-differences estimates and spatial patterns. Finally, Section 6 concludes with a discussion of the main findings and their implications for policy and future research.

# 2 The Model

## 2.1 Basic set-up

Consider a Cobb-Douglas production function with four production factors: labor ($L$), capital ($K$), energy ($E$), and other intermediates ($M$). As in Forlani et al. (2023), we assume that while labor, materials, and energy are flexible inputs whose quantities can vary in the short term, capital is a fixed input in the short run. We define $\mathbb{V}$ as the set

of variable production factors and $\mathbb{F}$ as the set of fixed factors, with $\mathbb{S} = \mathbb{F} \cup \mathbb{V}$.

The firm's Cobb-Douglas production function is given by:

$$Q = AK^{\alpha_K} L^{\alpha_L} M^{\alpha_M} E^{\alpha_E} = A \prod_{z \in \mathbb{S}} X_z^{\alpha_z},$$

where $A$ represents total factor productivity (TFP), and $z$ indexes the production inputs in the set $\mathbb{S} = \{L, M, E, K\}$.

Firms maximize their profit, given input prices for labor ($W_L$), energy ($W_E$), and other inputs ($W_M$). Since capital is fixed in the short run, the firm's short-run profit maximization problem is:

$$\max_{\mathbb{V}} \left( QP - \sum_{z \in \mathbb{V}} W_z X_z \right), \tag{1}$$

where $P$ is the output price.

## 2.2 Impact of Energy Price Increases on Employment

We assume that firms face the following (log-linear) demand function:

$$Q = \Lambda^{\eta - 1} P^{-\eta}, \tag{2}$$

where $\Lambda$ is a firm- and time-specific demand shifter, and $\eta = \frac{\mu}{\mu - 1}$ is the firm's demand elasticity. The corresponding markup is given by $\mu = \frac{\eta}{\eta - 1}$. This implies:

$$PQ = (Q\Lambda)^{\frac{1}{\mu}}. \tag{3}$$

Now, considering the first-order conditions (FOCs) for labor and energy, we derive:

$$\frac{\partial Q}{\partial L} = \alpha_L Q / L = W_L / P, \tag{4}$$

$$\frac{\partial Q}{\partial E} = \alpha_E Q / E = W_E / P. \tag{5}$$

From these conditions, the ratio of labor to energy is:

$$\frac{L}{E} = \frac{\alpha_L}{\alpha_E} \times \frac{W_E}{W_L}. \tag{6}$$

This equation illustrates the elasticity of substitution between labor and energy: as the price of energy increases ($W_E \uparrow$), the firm reduces energy use and adjusts labor demand accordingly.

Given this structure, a positive shock to energy prices (e.g., an energy crisis) will affect employment in the following ways: - If labor and energy are complements ($\alpha_L/\alpha_E$ is low), firms will reduce both labor and energy use, leading to larger employment losses. - If labor and energy are substitutes ($\alpha_L/\alpha_E$ is high), firms can replace energy with labor to some extent, leading to less severe employment losses.

### 2.3 Quantifying the Impact on Employment

A change in energy prices between $t$ and $t+1$ will lead to a change in employment, $\Delta L = L_{t+1} - L_t$, which can be expressed as:

$$\Delta L = L_t \Phi_{LE,t}^{-1} \frac{\Delta W_E}{W_E}, \tag{7}$$

where $\Phi_{LE,t}^{-1}$ is the labor-energy substitution elasticity, determining the responsiveness of labor demand to energy price fluctuations.

### 2.4 Implications of the Model

This framework identifies key channels through which energy price increases lead to employment contractions. Firms with higher energy intensity ($\alpha_E$ large) are particularly vulnerable, experiencing greater reductions in labor demand as rising energy costs constrain production. When labor and energy are highly complementary, job losses tend to be more pronounced, as firms have limited ability to substitute between inputs. Moreover, labor market rigidity exacerbates regional disparities, with areas characterized by lower workforce mobility and fewer alternative employment opportunities facing the most severe employment declines. These insights are essential for understanding both sectoral and geographic heterogeneity in labor market responses to energy price shocks.

## 3 Institutional Background - The UK Energy Crisis

In recent years, the United Kingdom has witnessed a significant escalation in energy prices, profoundly impacting businesses across various sectors. This upward trajectory in energy costs is attributable to a confluence of domestic and international factors, including supply chain disruptions, geopolitical tensions, and structural transformations within energy markets. Between 2021 and 2022, the United Kingdom experienced significant increases in energy prices for industrial consumers, the average price (excluding

the Climate Change Levy[1]) for electricity between July and September 2022 was 21.56 pence per kWh, up by 8.34 pence per kWh (63.1%) compared to the same period in 2021 (UK Government, 2022). Figures 1 and A1 in Appendix show how electricity and gas prices escalated drastically in 2022. These escalating costs have directly translated into higher operational expenses for businesses, placing considerable financial strain on firms, particularly those in energy-intensive industries.

Several pivotal factors have contributed to the surge in energy prices in the UK. Firstly, the post-pandemic economic recovery led to a sharp increase in global energy demand as industrial activities resumed, thereby exerting significant pressure on energy supplies. Secondly, geopolitical tensions, notably the Russian invasion of Ukraine in February 2022, exacerbated energy price volatility. Russia's substantial reduction in gas exports to Europe compelled countries, including the UK, to seek alternative, often more expensive, energy sources. Thirdly, supply chain constraints, coupled with the UK's limited natural gas storage capacity, amplified price fluctuations. The relatively small size of the UK's gas storage facilities, compared to other European nations, offered minimal buffer against such shocks.

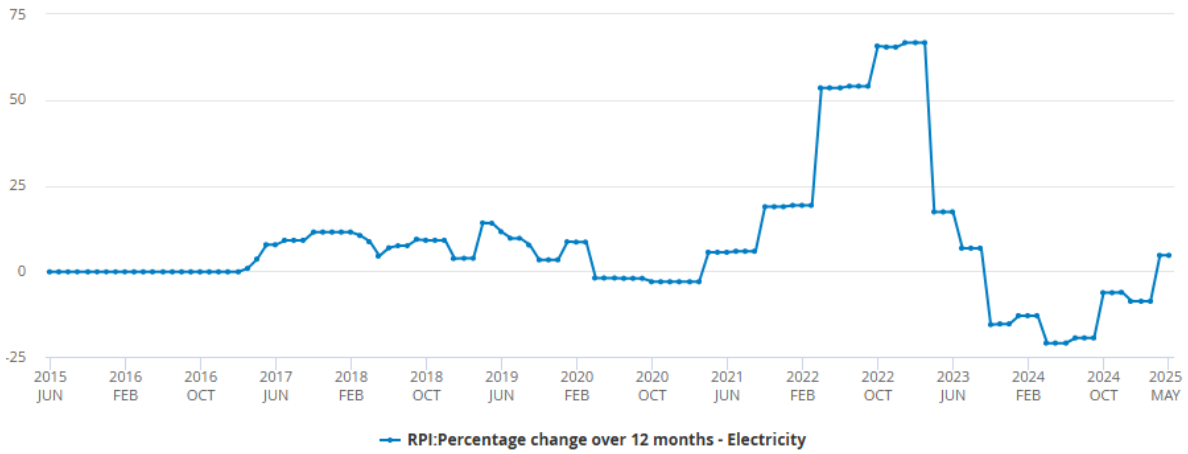



Figure 1: RPI: Percentage change - Electricity

***Note**: Data from Office for National Statistics (ONS)*

[1]The Climate Change Levy (CCL) is an environmental tax charged on the energy that businesses use. A means of encouraging businesses to be more energy efficient in how they operate, the CCL aims to reduce the overall emissions that businesses produce SEFE Energy UK (n.d.).

# 4 Data

## 4.1 Office for National Statistics (ONS) firm-level databases

Our dataset consists of UK firm level data from the Office for National Statistics (ONS), we use mostly two business surveys the Annual Business Survey (ABS) and the Annual Purchase Survey (APS) from 2015 to 2018 and then from 2021 to 2022. The reason why we do not use 2019 and 2022 is because the ONS did not collect the APS during those two years due to reduced capacity during COVID19. The ABS is the main structural business survey, it contains financial information from businesses representing the UK non-financial business economy (about two-thirds of the UK economy). The financial variables covered include turnover, purchases, employment costs, capital expenditure and stocks. The ABS does not contain Northern Ireland as the Northern Ireland Statistics and Research Agency (NISRA) does not allow sharing of micro data to external researcher. ABS is essential in our analysis as it contains information on capital expenditures which allow us to compute the capital shares. The APS collects information about business' expenditure on energy, services, goods, and materials that are used up or transformed by the business activity. The survey includes raw materials, power and fuel, rental on buildings, and business services. We supplement the ABS and APS with data from the Business Structure Database (BSD) which provides a version for researchers of the quasi-exhaustive Inter-Departmental Business Register (IDBR) which covers 2.1 million businesses, representing nearly 99 per cent of UK economic activity.[2] We use this additional data for two reason (i) it helps us identifying where the firm is located (ii) at the time of the analysis the BSD had employment in 2023 while ABS and APS only to 2022.

APS and ABS are two independent surveys carried out at various time intervals, they are both sub-samples of the IDBR. Businesses are added to the IDBR if they are registered for Value Added Tax (VAT) with the UK tax authority His Majesty Revenue and Customs (HMRC), registered for a Pay As You Earn (PAYE) scheme with HMRC, the system British employers or pension providers use to take tax contributions before they pay wages or pension, and an incorporated business registered at Companies House, the UK register of firms.

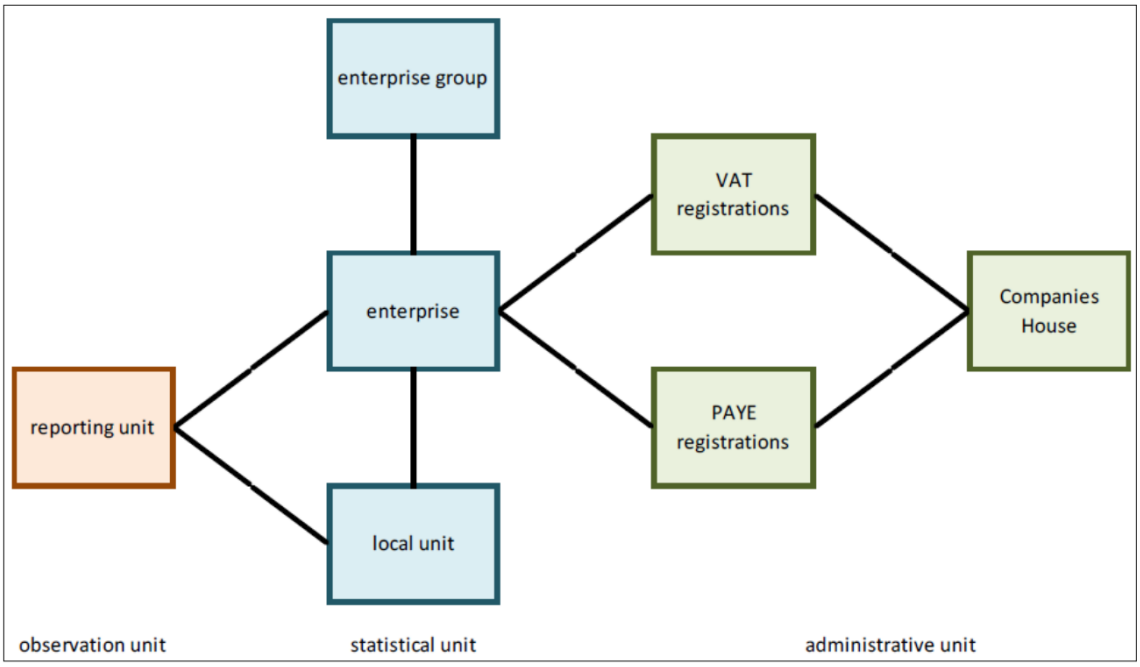
The APS samples covers approximately 33,000 businesses, sample selection is carried out using a stratified random sample design. Similar reporting units (businesses) are grouped into strata as defined by three variables employment size band, SIC, geographical region.

[2]Businesses are added to the IDBR if they are registered for Value Added Tax (VAT) with the UK tax authority His Majesty Revuenue and Customs (HMRC), registered for a Pay As You Earn (PAYE) scheme with HMRC, the system British employers or pension providers use to take tax contributions before they pay wages or pension, and an incorporated business registered at Companies House, the UK register of firms (ONS).

Sample selection occurs independently for each stratum. All businesses with 250 or more in employment are selected every year. The APS also uses inclusion markers to select businesses with low employment but high turnover. APS also excludes certain SIC sectors: (i) part of agriculture, forestry and fishing (01.1 to 01.5), (ii) part of financial and insurance activities (64110 to 64290 and 65300), (iii) public administration and defence (section O), (iv) activities of households as employers (section T), and (v) activities of extraterritorial organisations and bodies (section U).

The ABS covers approximately 62,000 businesses each year and contains financial information from businesses representing the UK non-financial business economy (about two-thirds of the UK economy). The financial variables covered include turnover, purchases, employment costs, capital expenditure and stocks.

For both surveys the business unit to which questionnaires are sent is called the reporting unit, the response from the reporting unit can cover the enterprise as a whole, or parts of the enterprise identified by lists of local units, figure 2 shows the reporting hierarchy. For this reason we will consider the reporting unit the enterprise, which may consist of one or more sub-units (called local units), for example, the head office for a group of shops.




Source: ABS technical Guide

Figure 2: ONS Reporting Unit Hierarchy

**Merging databases and sample representativeness** To estimate the cross impacts of energy and employment we need information from both APS and ABS (and 2023 information from BSD). We thus have merged the databases by using the ruref (reporting unit reference) identifier and the year reported. At the moment to facilitate the computation of factor shares we have not included in our sample firms reporting zero turnover. Table 1 shows a comparison between the universe and our matched sample, in which the majority of firms (64.5%) have over 250 employees, unlike in the universe of firms sampled, this is to be expected due to how ONS sample firms and our need to have a balanced panel. Table B1 in the Appendix shows the distribution of our sample within sectors, the majority of our sample is in manufacturing and wholesale/retail trade.

Table 1: IDBR and sample used in the analysis comparison between 2021 and 2022 by company employees size

| **Employees** | **ABS APS Matched Sample** | | **IDBR** | |
|---|---|---|---|---|
| | **n** | **Percent** | **n** | **Percent** |
| 0-9 | 1,042 | 0.05 | 4,410,953 | 0.893 |
| 10-19 | 1,026 | 0.049 | 285,543 | 0.058 |
| 20-49 | 1,442 | 0.069 | 153,511 | 0.031 |
| 50-99 | 1,662 | 0.079 | 48,862 | 0.010 |
| 100-249 | 2,260 | 0.108 | 26,106 | 0.005 |
| 250+ | 13,527 | 0.645 | 17,241 | 0.003 |

Note: The table shows the comparison between the IDBR and our sample for the years 2021-2022 by number of employees. Due to how ABS and APS are sampled and our need to have a balanced panel it is expected that our sample is skewed towards larger businesses.

# 5 Cross Price Elasticity of Demand between Labor and Energy and Energy Share

## 5.1 Estimation Cross Price Elasticities from Shares via CES Regression

In analyzing firm production decisions, it is important to distinguish between factor shares and cross price elasticities. In the context of energy and labor usage, the *energy share* $s_E$ and the *labor share* $s_L$ represent the proportions of a firm's turnover allocated to each input:

$$s_E \;=\; \frac{W_E\,E}{R}, \qquad s_L \;=\; \frac{W_L\,L}{R}, \tag{8}$$

where $W_E$ and $W_L$ are the unit prices of energy and labor, $E$ and $L$ their respective quantities, and $R$ total turnover[3]. Shares capture the static cost burden but not how firms substitute between inputs when relative prices change.

In order to estimate the cross price elasticity of demand between labor and energy[4], rather than assuming a particular functional form for demand, we exploit the constant-elasticity-of-substitution (CES) relationship in its log-ratio form:

$$\ln\frac{s_L}{s_E} \;=\; \sigma\,\ln\frac{W_L\,L}{W_E\,E} \;=\; \sigma\,\ln\frac{W_L}{W_E} \;+\; \sigma\,\ln\frac{L}{E}.$$

Under constant returns to scale and fixed capital in the short run, one can show that this simplifies to

$$\ln\frac{s_L}{s_E} \;=\; \beta\,\ln\frac{W_L}{W_E},$$

where $\beta = 1-\sigma$. We therefore estimate by OLS across firms:

$$\underbrace{\ln\frac{s_L}{s_E}}_{\text{log_ratio_shares}} \;=\; \beta\;\;\underbrace{\ln\frac{W_L\,L}{W_E\,E}}_{\text{log_ratio_prices}} \;+\varepsilon,$$

From the estimated slope $\hat{\beta}$, we recover the substitution parameter

$$\hat{\sigma} \;=\; 1-\hat{\beta}.$$

Finally, the cross price elasticity of labor demand with respect to the energy price for firm $i$ is

$$\eta^{(i)}_{L,p_E} \;=\; \hat{\sigma} \;\times\; s^{(i)}_E.$$

Analogously,

$$\eta^{(i)}_{E,p_L} = \hat{\sigma} \;\times\; s^{(i)}_L.$$

This two-step procedure ensures our estimated elasticities are consistent with the CES framework while leveraging easily observed expenditure shares. cross price elasticities provide dynamic insight into firms' substitution possibilities. Two firms with identical shares may exhibit very different $\eta_{L,p_E}$ if one can more easily switch from energy to labor, for example by using more manual processes or labor-intensive technologies (Labandeira

[3]Energy costs by type (coal, electricity, gas, etc.) and labor costs are observed in our APS data.

[4]For simplicity in the rest of the paper we are going to refer to them as cross price elasticities.

et al., 2017; Pindyck, 1979). In the short run, fixed capital amplifies these substitution effects, making cross price elasticities a key metric for assessing the employment impacts of energy price shocks (Kilian, 2009).

## 5.2 Descriptive Statistics

This section provides evidence of the shares and elasticities in our sample, for better comprehension and ease of comparison across the two we have presented the results in absolute values but is worth noting that the shares are always positive and the elasticities are always negative[5]. Table 2 presents a comparison of energy, labor, and material elasticities alongside their respective factor shares. This comparison highlights differences in input responsiveness, where labor and material inputs exhibit higher average elasticities and shares compared to energy.

Table 2: Comparison of absolute values of shares and elasticities distribution

| Metric | Energy Elasticity / Share | Labour Elasticity / Share | Material Elasticity / Share |
|---|---|---|---|
| Min | 0.000 / 0.000 | 0.000 / 0.000 | 0.000 / 0.000 |
| 1st Quartile | 0.005 / 0.002 | 0.336 / 0.135 | 0.202 / 0.065 |
| Median | 0.017 / 0.008 | 0.565 / 0.264 | 0.386 / 0.182 |
| Mean | 0.035 / 0.021 | 0.545 / 0.320 | 0.420 / 0.270 |
| 3rd Quartile | 0.038 / 0.022 | 0.764 / 0.455 | 0.626 / 0.433 |
| Max | 1.000 / 1.000 | 1.000 / 1.000 | 1.000 / 1.000 |

Note: The Table shows the Energy, labor and Material Elasticities and Shares compared. For ease of comparison, we present the values in absolute terms.

Our descriptive analysis shows that in recent years, cross price elasticities have increased, albeit very modestly (Figures A2). Larger firms, measured by employment, tend to exhibit higher cross price elasticities and energy shares (Figure 3), but smaller companies tend to have more outliers. Additionally, sectors with the highest cross price elasticities and shares are primarily associated with electricity, oil and gas, and transportation (Table 3), this can be also seen in Figure A3, with the shape of SIC sections D ( electricity and gas) and H (transportation and storage). Both Figure 3 and Table 3 demonstrate that, across firms, the energy cost share greatly exceeds the estimated cross-price elasticity of labor, this is because the CES substitution parameter $\hat{\sigma}$ typically lies well below unity, it follows that

$$\eta^{(i)}_{L,p_E} = \hat{\sigma}\, s^{(i)}_E \ll s^{(i)}_E \,.$$

Hence, the observed responsiveness of labor to energy price changes is almost entirely a *scale effect*—firms with larger $s_E$ incur greater alterations in total cost and therefore labor

[5]For the elasticities this is due to construction, while for the share this is because we have excluded firms with negative values.

expenditure—while the pure *substitution effect* (captured by $\hat{\sigma}$) plays a negligible role. In practical terms, energy price shocks translate predominantly into changes in firms' overall cost burdens rather than inducing meaningful shifts in their capital-labor-energy input mix.

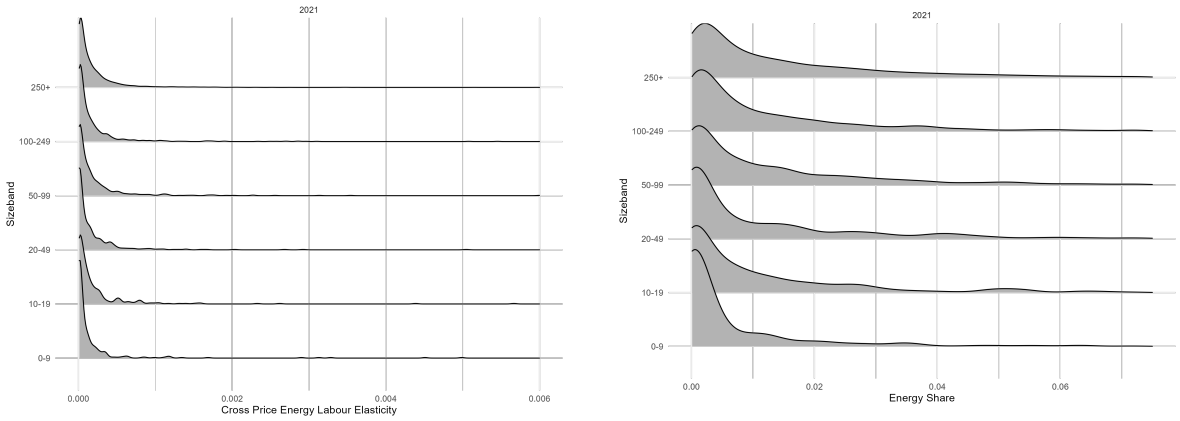



Figure 3: Cross Price Elasticities and Energy Shares by company employment in 2021
Note: The graphs show a comparison between cross price elasticities and shares by firm employment size.

Table 3: Comparison of Highest Cross Price Elasticity and Energy Shares by SIC Sector at Six-Digit Level in 2021

| **Industry** | **Cross Price Elasticity** | **Industry** | **Energy Share** |
|---|---|---|---|
| Mineral oil refining | 0.004 | Mineral oil refining | 0.359 |
| Production of electricity | 0.003 | Production of electricity | 0.246 |
| Manufacture of chemicals | 0.002 | Manufacture of chemicals | 0.188 |
| Trade of electricity | 0.002 | Manufacture of oils and fats | 0.141 |
| Manufacture of oils and fats | 0.001 | Trade of electricity | 0.133 |
| Passenger land transport | 0.001 | Passenger land transport | 0.132 |
| Freight transport by road | 0.001 | Freight transport by road | 0.111 |
| Other passenger land transport | 0.001 | Other passenger land transport | 0.101 |
| Distribution of gas | 0.001 | Distribution of gas | 0.084 |
| Electricity distribution | 0.001 | Passenger water transport | 0.078 |

*Note:* The tables show the top ten energy cross price elasticities and shares in 2021 by SIC sector at the six-digit level. Due to ONS regulations, we cannot report statistics with fewer than 10 observations. Some sectors may thus have been excluded from this list.

## 5.3 Geographical distribution of elasticities and shares

### 5.3.1 Country level analysis

Cross price elasticities and energy shares are consistently higher in Wales and Scotland than in England (Figure 4). Sectors such as Electricity and Gas (SIC Section D), Water and Waste (Section E), and Transportation (Section H) tend to exhibit higher cross price elasticities and larger energy shares, as shown in Figures A4 and A5 in the Appendix. Table 4 presents the top ten SIC sectors by country in terms of cross price elasticity and energy share for 2021, confirming that Electricity and Gas, Water and Waste, and Transportation consistently rank among the most energy-intensive and price-sensitive sectors across countries. Table 5 extends this comparison to the six-digit SIC level, highlighting that electricity production and distribution, as well as passenger transport activities, account for a substantial share of the observed cross price elasticities and energy cost exposure in our sample.

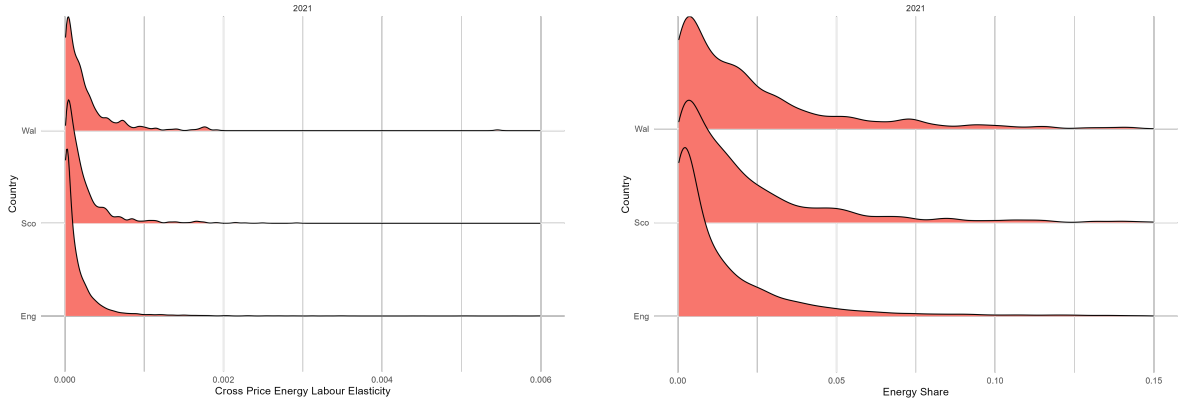



Figure 4: Cross Price Elasticities and Energy Shares by country in 2021

Note: The graphs show a comparison between Cross Price Elasticities and Energy Shares in 2021 by country. Northern Ireland is not included because the Northern Ireland Statistics and Research Agency (NISRA) does not allow sharing of micro data to external researcher.

### 5.3.2 Travel to Work level analysis

Conducting spatial analysis at the country level might not capture regional labor market and local industry conditions. For this reason in this paper we have conducted most of the spatial analysis at Travel to Work Areas (TTWAs). TTWAs are a geography created to approximate labor market areas. In other words, they are derived to reflect self-contained areas in which most people both live and work. TTWAs are useful for helping build an understanding of local labor markets, for framing local labor market analysis, and in particular for examining the spatial mismatch between labor supply and

Table 4: Comparison of Highest Cross Price Elasticities and Energy Shares by SIC Sector and Country in 2021

| SIC Section | Country | Cross Price Elasticity |
|---|---|---|
| Electricity and gas | England | 0.0018 |
| Transport | Wales | 0.0011 |
| Transport | Scotland | 0.0007 |
| Transport | England | 0.0006 |
| Water and Waste | England | 0.0005 |
| Arts, entertainment and recreation | Scotland | 0.0005 |
| Water and Waste | Scotland | 0.0005 |
| Accommodation and food | Wales | 0.0004 |
| Arts, entertainment and recreation | Wales | 0.0004 |
| Accommodation and food | Scotland | 0.0004 |

| SIC Section | Country | Energy Share |
|---|---|---|
| Electricity and gas | England | 0.1574 |
| Electricity and gas | Scotland | 0.1195 |
| Transport | Wales | 0.1016 |
| Transport | Scotland | 0.0619 |
| Transport | England | 0.0581 |
| Water and Waste | England | 0.0490 |
| Arts, entertainment and recreation | Scotland | 0.0482 |
| Water and Waste | Scotland | 0.0423 |
| Accommodation and food | Wales | 0.0412 |
| Accommodation and food | Scotland | 0.0374 |

Note: The tables shows the ten highest cross price elasticities and energy shares in 2021 by country and SIC Sector. To note due to ONS regulations we are cannot report statistics with less than 10 observations so some sectors might have been excluded from this list.

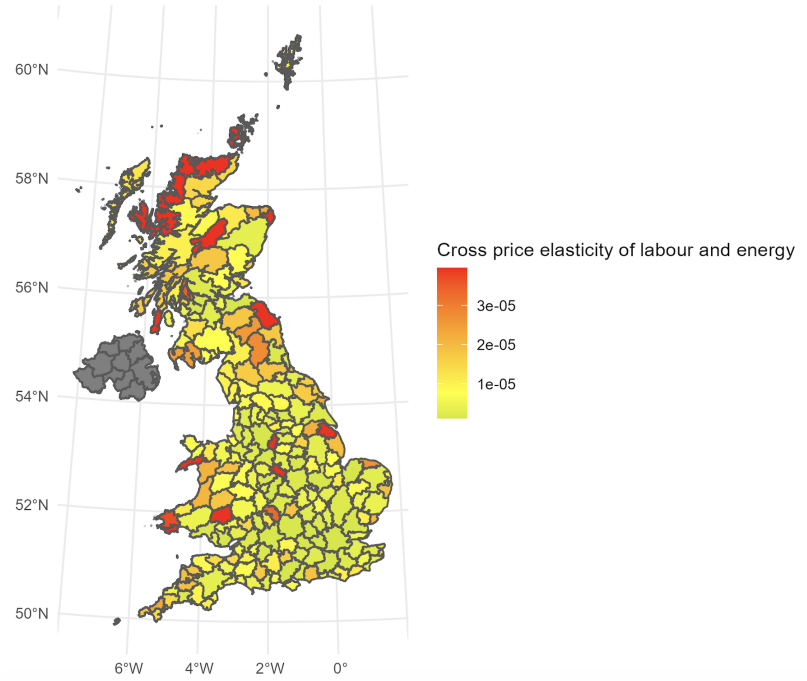
Table 5: Comparison of Highest Cross Price Elasticities and Energy Shares by SIC Sector at six digit level and Country in 2021

| SIC Code | Country | Cross Price Elasticity |
|---|---|---|
| Electricity production | Wales | 0.0038 |
| Mineral oil refining | England | 0.0037 |
| Electricity production | England | 0.0026 |
| Electricity production | Scotland | 0.0020 |
| Electricity distribution | Scotland | 0.0018 |
| Tour operator activities | Wales | 0.0017 |
| Passenger land transport | Wales | 0.0017 |
| Manufacture of chemicals | England | 0.0017 |
| Electricity trade | England | 0.0017 |
| Passenger land transport | Scotland | 0.0016 |

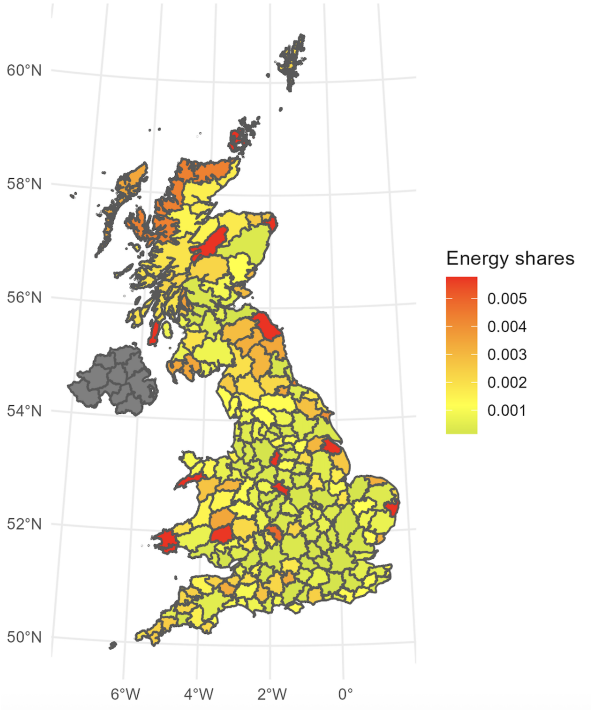
| SIC Code | Country | Energy Share |
|---|---|---|
| Electricity production | Wales | 0.3371 |
| Mineral oil refining | England | 0.3360 |
| Electricity distribution | Scotland | 0.2231 |
| Electricity production | England | 0.2117 |
| Passenger land transport | Scotland | 0.1842 |
| Freight transport by road | Wales | 0.1828 |
| Tour operator activities | Wales | 0.1761 |
| Passenger land transport | Wales | 0.1725 |
| Freight transport by road | Scotland | 0.1547 |
| Electricity production | Scotland | 0.1495 |

Note: The tables shows the ten highest cross price elasticities and energy shares in 2021 by country and SIC Sector at six digit level. To note due to ONS regulations we are cannot report statistics with less than 10 observations so some sectors might have been excluded from this list.

demand (Office for National Statistics, 2016). In Figure 5 we portray the cross price elasticities and energy shares by TTWA in 2021. Figure 5a shows that in London and South East of England cross price elasticities are lower, while in Scotland and part of Wales this seems to be the opposite. When comparing these findings with energy shares (Figure 5b) we notice a similar picture. These resuls would corroborate the hypothesis that any significant change in employment is mostly due to a scale effect rather than a substitution effect.




(a) Cross Price Elasticities by TTWA in 2021




(b) Energy shares by TTWA in 2021

Figure 5: Energy exposure measured by Cross Price Elasticity and Energy Share by TTWA in 2021

# 6 Empirical Methodology and Results

We estimate the impact of the energy price shock on employment using a difference-in-differences specification with firm fixed effects, where the intensity of treatment varies continuously with each firm's ex-ante energy dependence, this specification is similar to Autor et al. (2013) and Hsiang (2010). The dependent variable is the logarithm of firm employment. We define a post-treatment indicator (*post*) that equals one for observations in 2022 and 2023, capturing the period after the energy shock. We then interact this post indicator with the firm's cross price elasticity or energy share (*energy coefficient*) measured in 2021, or the earliest available year if 2021 data is missing.[6]

The resulting regression model is specified as:

$$\log(\text{Employment}_{it}) = \beta_1 \, \text{post}_t + \beta_2 \, (\text{post}_t \times \log(\text{energy coefficient}_i)) + \alpha_i + \varepsilon_{it}, \quad (9)$$

where $\alpha_i$ denotes firm fixed effects. The coefficient of interest, $\beta_2$, identifies the differential employment response for firms with higher ex-ante energy exposure compared to less exposed firms. Standard errors are clustered at firm level.

| **Dependent Variable:** | (1) log(Employment) | (2) |
|---|---|---|
| *Variables* | | |
| Post | $-0.0506^{*}$ | $-0.0253$ |
| | (0.0284) | (0.0162) |
| Post × log(Cross Elasticity) | $-0.0090^{***}$ | |
| | (0.0031) | |
| Post × log(Energy Share) | | $-0.0120^{***}$ |
| | | (0.0034) |
| Observations | 16,738 | 16,717 |
| Firm Fixed Effects | Yes | Yes |
| $R^2$ | 0.98556 | 0.98629 |

Table 6: Empirical Results: Impact of the interaction of Cross Price Elasticities and Energy Shares with the post period on Employment

Notes: Standard errors (in parentheses) are clustered at the firm level. $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Column one measures the specification using cross elasticity, while column 2 uses energy share. The post period captures the years after 2021.

[6] If the cross price elasticity or energy share is unavailable for 2021, we use 2018 data; if not available in 2018, we use the closest preceding year. This is primarily relevant for smaller firms that are not surveyed annually.

Table 6 compares two specifications examining the effect of the period following the energy crisis and its interaction with firm-level characteristics on log employment. In column (1), the interaction between the post period and log(Cross Elasticity) is negative and statistically significant, suggesting that firms with higher cross price elasticities tend to reduce employment more after the event. In column (2), the interaction between the post period and log(Energy Share) is also negative and highly significant, indicating that firms with higher energy intensity similarly experience greater employment declines. The direct effect of the post period alone is negative in both specifications but only weakly significant or insignificant. Notably, the magnitude of the coefficient on the energy share interaction is larger in absolute terms than that of the cross price elasticity, suggesting that energy intensity is a stronger driver of post-period employment adjustments. Overall, the results imply that firms with higher energy dependence experience greater employment declines, and that this channel may dominate the input substitution effect captured by the cross elasticity.

## 6.1 Employment Impact under a No-Price-Change Scenario

To further quantify the effect of energy dependency on employment, we estimate the counterfactual change in employment for firms if energy prices had remained constant. Specifically, we define the employment change for firm $i$ in 2022 as:

$$\Delta L_{i,post} = (\exp(-\beta_x \cdot \text{energy coefficient}_i) - 1) \cdot L_{i,post} \tag{10}$$

where $\Delta L_{i,post}$ represents the estimated change in employment for firm $i$ following 2021 under a scenario where energy prices do not change, $\beta_x$ is the estimated coefficient capturing the effect of energy dependency on employment, energy coefficient$_i$ is the firm's cross price elasticity or energy share, and $L_{i,post}$ is the observed employment level of firm $i$ after 2021. When we use cross price elasticities, the results suggest that higher energy prices led to a reduction of about 0.3% of jobs in our sample in both 2022 and 2023. By contrast, when exposure is measured using energy shares, the estimated employment loss rises to approximately 0.6% per year.

Figure 6 presents a binned scatterplot comparing the employment loss estimates based on cross price elasticities (horizontal axis) and energy shares (vertical axis). Each hexagon's color intensity reflects the density of observations, with areas containing fewer than 10 observations obscured to preserve confidentiality. The fitted line indicates a strong positive relationship between the two measures: firms with higher estimated job losses under the cross price elasticity approach also tend to show higher losses when using energy shares. However, the slope above the 45-degree line suggests that the energy share estimates are systematically larger than those based on cross price elasticities,

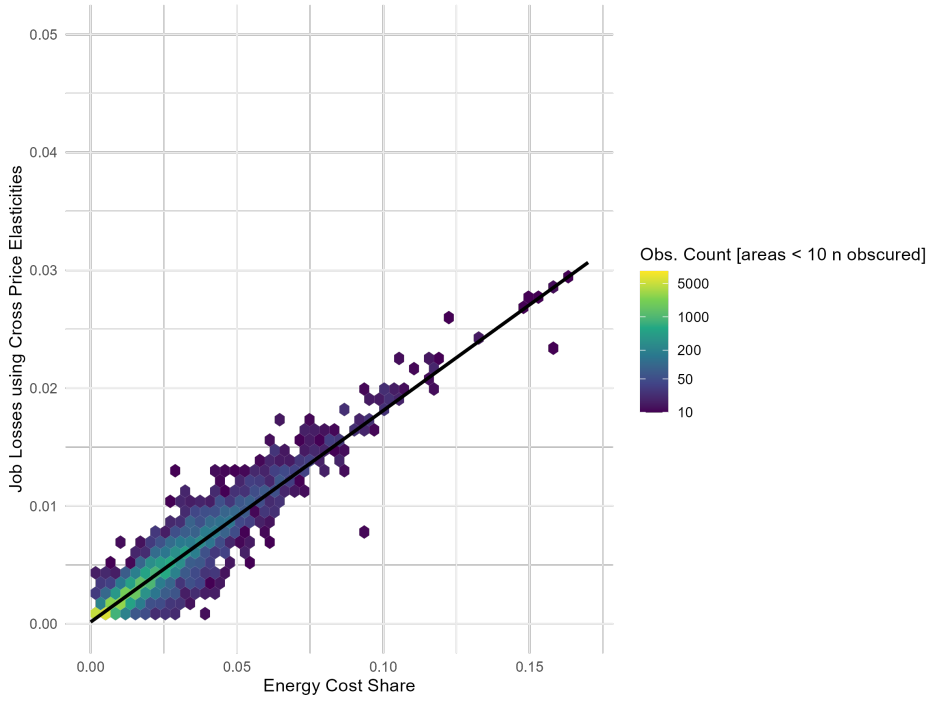



Figure 6: Scatterplot comparing Energy Shares with Jobs Lost by using Cross Price Elasticities

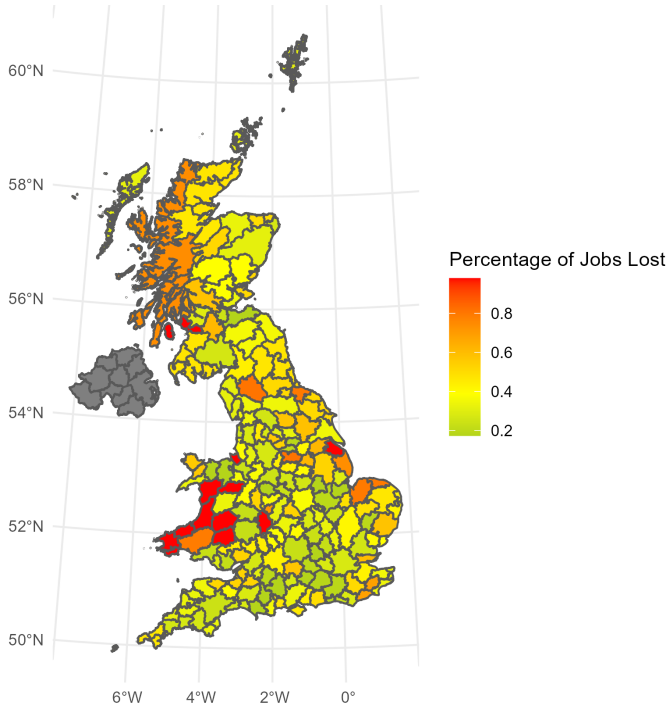
consistent with the descriptive results showing that the implied employment effect is roughly twice as large when using energy shares.

## 6.2 Heterogeneity Analysis of Employment Impact

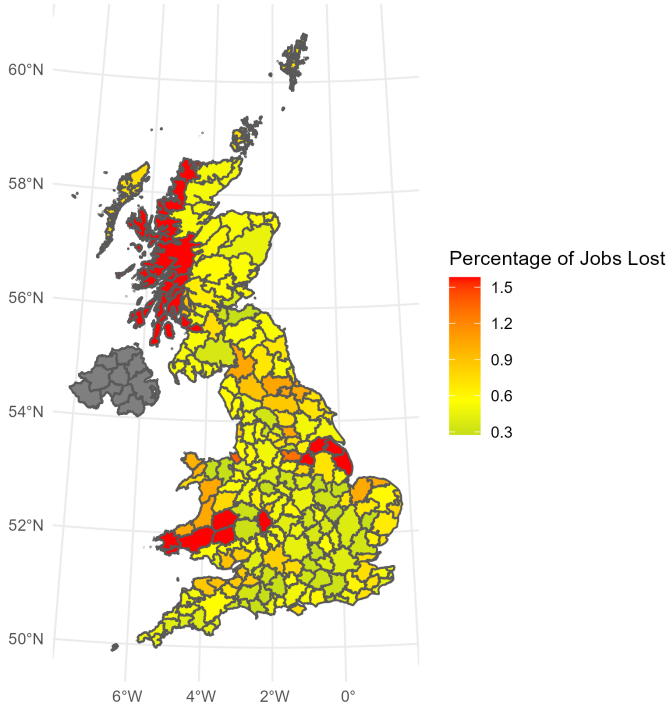
**Geographical Analysis of Employment Impact** To visualize the spatial dimension of the effects described above Figure 7 shows the counterfactual employment losses across Travel-to-Work Areas (TTWAs), aggregated from the firm-level estimates using Equation 10[7]. Due to data constraints in some TTWAs (i.e., fewer than ten observations), we merge geographically adjacent units using both the 2001 and 2011 TTWA classifications to ensure meaningful coverage [8].

[7]For data readability we have windsorised the map results, full results are available at Table **??**

[8]TTWA codes and sometimes confines are different when using the 2001 and 2011 nomenclature, we ensured consistency by manually comparing the results




(a) Job Losses Estimated with Cross Price Elasticities




(b) Job Losses Estimated with Energy Shares

Figure 7: Comparison of Percentage of Jobs Lost by TTWA Using Different Measures of Energy Exposure

Figure 7a shows the spatial pattern of job losses calculated with cross price elasticities, while Figure 7b displays the same outcome using energy shares. Both maps reveal clear regional disparities, with certain areas in Wales, Scotland, and parts of northern England experiencing the highest estimated employment impacts. However, the magnitudes differ substantially: under the cross price elasticity approach, job losses are lower than when using energy shares. These results have been winsorised at the 2nd and 98th percentiles to improve map readability.

In the Appendix, Table B3 and Table B4 report the corresponding un-winsorised estimates for the grouped TTWA areas, based on cross price elasticities and energy shares, respectively. Examining these results reveals that certain regions, particularly in Scotland and Wales, exhibit job losses of up to 4–5% under both measures of energy exposure. However, the estimates based on energy shares are consistently larger across areas compared to those based on cross price elasticities.

This comparisons highlight that when using energy shares, the estimated employment impact is both larger and more spatially concentrated in specific regions. Overall, these maps and tables illustrate that the choice of firm-level energy exposure measure has important implications for assessing the local labor market effects of energy price shocks.

**Sectoral Analysis of Employment Impact** In this subsection, we focus on sectoral heterogeneity in job losses by examining how the impact of rising energy costs varies across broad SIC sections. Tables 7 and 8 present the estimated percentage of jobs lost by SIC section using cross price elasticities and energy shares, respectively. While the overall ranking of sectors is broadly similar across both measures, the estimates based on energy shares tend to be slightly larger than those derived from cross price elasticities, particularly for sectors such as Electricity and Gas and Water and Waste. This reflects the fact that the energy share captures direct exposure more mechanically, whereas cross price elasticities account for firms' substitution possibilities across inputs. However, regardless of the measure used, the sectors experiencing the highest proportional job losses are Electricity and Gas, Water and Waste, and Transportation. This is consistent with the earlier descriptive evidence highlighting these sectors as among the most energy-intensive in the economy.

Table 7: Percentage of Jobs Lost by SIC Section using Cross Price Elasticities

| SIC Section | Description | Employment | Percentage Jobs Lost |
|---|---|---|---|
| C | Manufacturing | 1,111,602 | 0.4951 |
| D | Electricity and Gas | 133,915 | 1.2351 |
| E | Water and Waste | 98,997 | 1.1320 |
| F | Construction | 260,144 | 0.2023 |
| G | Wholesale and Retail Trade | 1,928,039 | 0.2003 |
| H | Transportation | 546,041 | 1.0924 |
| I | Accommodation and Food Services | 780,390 | 0.5477 |
| J | Information and Communication | 391,077 | 0.1365 |
| K | Financial and Insurance | 120,860 | 0.0138 |
| L | Real Estate | 120,819 | 0.1912 |
| M | Professional and Scientific Services | 639,839 | 0.0706 |
| N | Administrative Services | 1,032,475 | 0.1406 |
| P | Education | 71,166 | 0.2580 |
| Q | Health and Social Work | 458,972 | 0.2674 |
| R | Arts and Entertainment | 207,434 | 0.6535 |
| S | Other Services | 41,937 | 0.4095 |

*Notes*: The table shows the percentage of jobs lost by SIC section using cross price elasticities. Companies that did not report their sector have been excluded from this analysis. It is important to note that these results rely on a balanced panel that requires firms to be observed repeatedly over time. Consequently, the sample may not be fully representative of the entire universe of firms within each SIC section.

**Firm Size Analysis of Employment Impact** In this subsection, we focus on firm size heterogeneity in job losses by examining how the impact of rising energy costs varies across firm sizes. Tables 9 and 10 summarise the percentage of jobs estimated to be lost across different firm size bands, using cross price elasticities and energy shares, respectively. While the underlying approach differs, both measures indicate that larger firms tend to experience a greater absolute number of job losses due to their scale, but the share of jobs lost relative to employment varies in important ways across size bands.

In both specifications, mid-sized firms (those employing between 50 and 249 workers) tend to show higher percentages of job losses compared to the smallest size bands (0–9 and 10–19 employees) and even compared to the largest firms (250+). This pattern may reflect that mid-sized firms are large enough to be significantly exposed to energy costs but not as diversified or resilient as the very largest employers. It is important to note that these estimates are based on balanced panel data, requiring consistent reporting over time, which likely results in a sample that over-represents larger, more stable firms relative to the wider business population.

Table 8: Percentage of Jobs Lost by SIC Section using Energy Shares

| SIC Section | Description | Employment | Percentage Jobs Lost |
|---|---|---|---|
| C | Manufacturing | 1,111,602 | 0.5942 |
| D | Electricity and Gas | 133,915 | 2.5467 |
| E | Water and Waste | 98,997 | 1.6773 |
| F | Construction | 260,144 | 0.2775 |
| G | Wholesale and Retail Trade | 1,928,039 | 0.2694 |
| H | Transportation | 546,041 | 1.6060 |
| I | Accommodation and Food Services | 780,390 | 0.6995 |
| J | Information and Communication | 391,077 | 0.1882 |
| K | Financial and Insurance | 120,860 | 0.0399 |
| L | Real Estate | 120,819 | 0.2626 |
| M | Professional and Scientific Services | 639,839 | 0.1047 |
| N | Administrative Services | 1,032,475 | 0.2039 |
| P | Education | 71,166 | 0.3732 |
| Q | Health and Social Work | 458,972 | 0.4165 |
| R | Arts and Entertainment | 207,434 | 0.9072 |
| S | Other Services | 41,937 | 0.6384 |

*Notes*: The table shows the percentage of jobs lost by SIC section using energy shares. Companies that did not report their sector have been excluded from this analysis. It is important to note that these results rely on a balanced panel that requires firms to be observed repeatedly over time. Consequently, the sample may not be fully representative of the entire universe of firms within each SIC section.

Table 9: Percentage of Jobs Lost by Firm Size using Cross Price Elasticities

| Firm Size | Employment | Percentage Jobs Lost |
|---|---|---|
| 0–9 | 1,639 | 0.2275 |
| 10–19 | 2,976 | 0.3614 |
| 20–49 | 32,252 | 0.2046 |
| 50–99 | 43,765 | 0.4006 |
| 100–249 | 185,538 | 0.4089 |
| 250+ | 7,677,537 | 0.3584 |

*Notes*: This table shows the percentage of jobs lost by firm size category, estimated using cross price elasticities. Companies that did not report firm size have been excluded. These results are based on a balanced panel requiring firms to be observed over multiple years. As a result, the sample may not fully represent the universe of firms and could be skewed towards larger, longer-surviving firms.

Table 10: Percentage of Jobs Lost by Firm Size using Energy Shares

| **Firm Size** | **Employment** | **Percentage Jobs Lost** |
|---|---|---|
| 0–9 | 1,639 | 0.2664 |
| 10–19 | 2,976 | 0.6050 |
| 20–49 | 32,252 | 0.2668 |
| 50–99 | 43,765 | 0.5692 |
| 100–249 | 185,538 | 0.8393 |
| 250+ | 7,677,537 | 0.4964 |

*Notes*: This table shows the percentage of jobs lost by firm size category, estimated using energy shares. Companies that did not report firm size have been excluded. These results are based on a balanced panel requiring firms to be observed over multiple years. As a result, the sample may not fully represent the universe of firms and could be skewed towards larger, longer-surviving firms.

# 7 Conclusion

This paper provides new empirical evidence on how sharp energy price shocks affect employment, using rich administrative data and exploiting variation in firms' energy dependence. By comparing estimates based on both cross price elasticities and energy shares, we highlight that firms with higher energy intensity and lower substitution possibilities are particularly vulnerable to rising energy costs.

Our results indicate that the 2022 energy crisis led to a small contraction in employment, with less than 1% of jobs in our sample lost over 2022 and 2023 as a direct consequence of elevated energy prices. However the impact was not homogeneous across regions, sectors, or firm of different sizes. Sectors such as Electricity and Gas, Water and Waste, and Transportation show the highest proportional losses, reflecting their structural dependence on energy inputs. Moreover, we find clear spatial heterogeneity: rural and peripheral regions experience larger job losses, likely due to less flexible labor markets, weaker infrastructure, and fewer alternative employment opportunities. Our firm size analysis suggests that mid-sized firms (50–249 employees) face relatively larger percentage employment losses than both the smallest and largest firms. This likely reflects their greater exposure to energy costs, combined with more limited diversification and resilience compared to very large firms.

Taken together, our findings underscore the importance of considering both production structure and local labor market conditions when assessing the labor market impacts of energy shocks and formulating policy responses. From a policy perspective, targeted interventions—such as energy price stabilization, incentives for energy efficiency upgrades, and support for labor mobility—could help mitigate adverse employment effects, particularly in energy-intensive sectors and vulnerable regions.

Finally, this study demonstrates the value of using detailed firm-level elasticities and energy shares to better understand the channels through which energy price volatility translates into employment outcomes. Future research could build on these insights by examining longer-term firm adaptation strategies, such as technological investments or shifts in production processes, and by comparing how institutional contexts shape firms' resilience to similar shocks.

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# Appendix

## A Model

What is the immediate impact of carbon pricing on firms? In particular how is employment in firms that face carbon pricing and/or higher energy prices affected? If we can model this well we can also easily provide evidence on the impact on sectors or regions. Here we develop a simple Cobb-Douglas production function framework. There are $n$ factors in particular that we would want to allow to vary between firms that determine the impact of carbon pricing. These include:

1. The factor intensity of a firm in terms of carbon intensive inputs
2. The elasticity of substitution between such inputs and others (notably labour)
3. The ability of firms to pass through any cost increases to their customers

**Framework to measure the impact of price changes** We consider a production function comprising of a set of production factors, some fixed in the short run and some variable. We aim to anticipate what are the changes in the variable factors when faced with changes in prices of a factor.

## B Notations

- For the sake of ease of reading, we drop all subscript $X_{it}$ indicating sector/firm and time.
  - Note that the coefficients are the production functions are not time or firm specific. Prices, quantities and shares are both time and firm specific.
  - The mark-up rate $\mu$ is time and firm specific
- Lower letters indicate log transformation, such as $\forall X, x = \ln X$
- $\mathbb{V}$ is the set of factors that are variable in the short term. $\mathbb{F}$ is the set of factors that are *not* variable in the short term.
- The set of all factors is $\mathbb{S} = \mathbb{F} \cup \mathbb{V}$
  - Throughout this paper, we consider that only one factor is fixed in the short-run: capital $K$ ($|\mathbb{F}| = 1$)
  - There are $n$ factors in $\mathbb{V}$, hence $n + 1$ factors in total ($|\mathbb{S}| = n + 1$)

- We index price ($W$), quantity ($X$), cost share in revenues ($S$) and the coefficients of the productions functions ($\alpha$) by the position of each factor on the production factors list. $\forall X, X_z$ stands for the $z$-th position on the list of production factors.
  - We use an abusive notation for $\mathbb{F}$ since $K$ is the only factor, we index price, quantity, share and coefficients by $K$ and not $n+1$ to avoid confusion with factors from $\mathbb{V}$.

# C Set-up

### Hypotheses

1. K is a fixed factor in the short run, $K \in \mathbb{V}$
2. Homogeneity of degree $\gamma$ of the production function

We consider 4 inputs: K, L, M, E (Capital, Labour, Material, Energy).

**Function** The Cobb-Douglas production function is

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

or in log form:

$$q = a + \alpha_L l + \alpha_M m + \alpha_E e.$$

To adopt a more general notation where $z$ is the position of the factor in the set $\mathbb{\$} = c(L, M, E, K)$, we write:

$$Q = A \prod_{z \in \mathbb{\$}} X_z^{\alpha_z}.$$

Thus, in log, we write the Cobb-Douglas function as

$$q = a + \sum_{z \in \mathbb{\$}} \alpha_z x_z, \tag{11}$$

where $q$ is a function of all the inputs $x_i, \forall i$. We denote it as $q((x_i)_{i \in \mathbb{\$}})$.

**Homogeneity** We impose the homogeneity of the production function.

In all generality, the homogeneity of degree $\gamma$ of a production function $F$ and its inputs $(X_i)_{i\in 1:n}$ means that for any $S \in \mathbb{R}$:

$$F(SX_1, SX_2, \cdots, SX_n) = S^\gamma \cdot F(X_1, X_2, \cdots, X_n)$$

In the case of the Cobb-Douglas in log form, it means that for any $s \in \mathbb{R}$,

$$q((x_i)_{i\in\mathbb{S}} + s) = q((x_i)_{i\in\mathbb{S}}) + \gamma s.$$

$$\begin{aligned} q((x_i)_{i\in\mathbb{S}} + s) &= a + \sum_{z\in\mathbb{S}} \alpha_z (s + x_z) \\ &= a + \sum_{z\in\mathbb{S}} \alpha_z x_z + \sum_{z\in\mathbb{S}} \alpha_z s. \end{aligned}$$

Hence, the Cobb-Douglas function is homogeneous of degree $\gamma$ if and only if:

$$\sum_{z\in\mathbb{S}} \alpha_z = \gamma. \tag{12}$$

**Marginal productivity** From equation (11), it comes that:

$$\forall j \in \mathbb{V}, \frac{\partial q}{\partial x_j} = \alpha_j \tag{13}$$

Thus, we can rewrite eq. (11) as:

$$q = a + \sum_{z\in\mathbb{S}} \frac{\partial q}{\partial x_z} \cdot x_z. \tag{14}$$

Note that for fixed factors, ($K \in \mathbb{F}$),

$$\frac{\partial q}{\partial k} = \alpha_K = \gamma - \sum_{j\in\mathbb{V}} \alpha_j.$$

Hence, using homogeneity (12) and marginal productivity expression (13),

$$\frac{\partial q}{\partial k} = \gamma - \sum_{j\in\mathbb{V}} \frac{\partial q}{\partial x_j}. \tag{15}$$

**Demand shifter** We assume that a representative firms faces the following (log linear) demand:

$$Q = \Lambda^{\eta-1} P^{-\eta}, \tag{16}$$

where

- $\Lambda$ is a firm and time specific demand shifter,
- $P$ is the price of the final good (output),
- $\eta = \frac{\mu}{\mu-1}$ is the firm elasticity of demand (time and firm specific), and
- $\mu = \frac{\eta}{\eta-1}$ is the mark-up rate (dependant on the elasticity of demand). Note that $\frac{\eta-1}{\eta} = \frac{1}{\mu}$.

We can express the total revenues of the firm $PQ$:

$$\begin{aligned} Q = \Lambda^{\eta-1} P^{-\eta} &\iff Q^{-\frac{1}{\eta}} = \Lambda^{\frac{1-\eta}{\eta}} P \\ &\iff P = Q^{-\frac{1}{\eta}} \Lambda^{\frac{\eta-1}{\eta}} \\ &\iff PQ = Q^{1-\frac{1}{\eta}} \Lambda^{\frac{\eta-1}{\eta}} \\ &\iff PQ = (Q\Lambda)^{\frac{\eta-1}{\eta}} . \end{aligned}$$

Hence,

$$PQ = (Q\Lambda)^{\frac{1}{\mu}} . \tag{17}$$

**Problem of the firm** Assuming that capital is fixed, firms face the following short run problem where they maximise profit $\pi$ only on variable factors. The optimal use of factor, $(X_i)^*_{i\in\mathbb{V}}$, is the argument of:

$$\begin{aligned} \max_{\mathbb{V}} \pi &= \max_{\mathbb{V}} \left( QP - \sum_{z\in\mathbb{V}} W_z X_z \right) \\ &= \max_{\mathbb{V}} \left( (Q\Lambda)^{\frac{1}{\mu}} - \sum_{z\in\mathbb{V}} W_z X_z \right) \end{aligned} \tag{18}$$

This leads to the following short run first-order condition of the firm's profit maximisation problem:

$$\forall j \in \mathbb{V}, \frac{d}{dX_j}\left((Q\Lambda)^{\frac{1}{\mu}} - \sum_{z\in\mathbb{V}} W_z X_z\right) = 0. \tag{19}$$

To solve it, note that:

- $\frac{\partial x}{\partial X} = \frac{1}{X}$,
- $\frac{\partial \Lambda}{\partial X_z} = 0$,
- $Q = A\prod_{z\in\mathbb{V}} X_z^{\alpha_z}$,
- $\frac{\partial Q}{\partial X_j} = A\alpha_j X_j^{\alpha_j - 1}\prod_{z\neq j\in\mathbb{V}} X_z^{\alpha_z} = \alpha_j X_j^{\alpha_j-1}\frac{1}{X_j^{\alpha_j}}Q$,
  hence, $\frac{\partial Q}{\partial X_j} = \alpha_j \frac{1}{X_j}Q$, and
- $\frac{\partial q}{\partial x_j} = \alpha_j$.

Therefore,

$$\begin{aligned}
\forall j \in \mathbb{V}, &\frac{d}{dX_j}\left((Q\Lambda)^{\frac{1}{\mu}} - \sum_{z\in\mathbb{V}} W_z X_z\right) = 0 \\
&\iff \Lambda^{\frac{1}{\mu}}\frac{1}{\mu}\frac{\partial Q}{\partial X_j}Q^{\frac{1}{\mu}-1} - W_j = 0 \\
&\iff \Lambda^{\frac{1}{\mu}}\frac{1}{\mu}Q^{\frac{1}{\mu}-1}\alpha_j\frac{1}{X_j}Q = W_j \\
&\iff \Lambda^{\frac{1}{\mu}}\frac{1}{\mu}Q^{\frac{1}{\mu}}\frac{\partial q}{\partial x_j}\frac{1}{X_j} = W_j.
\end{aligned}$$

We can rewrite it as

$$\frac{\frac{\partial q}{\partial x_j}}{\mu} = \frac{X_j W_j}{\Lambda^{1/\mu}Q^{1/\mu}}. \tag{20}$$

And since $\Lambda^{1/\mu}Q^{1/\mu} = PQ$, we can interpret the right hand side $(X_jW_j/PQ)$ as the cost share of input $j$, that we denote $S_j$ for all $j$ in $\mathbb{V}$.

Hence,

$$\frac{\frac{\partial q}{\partial x_j}}{\mu} = S_j, \tag{21}$$

i.e. the log derivative of the production function w.r.t to variable factors over markups is equal to the cost share in revenue of a factor.

Note that due to non-constant returns to scales ($\gamma \neq 1$), the sum of the shares does not necessarily sum up to 1.

$$\sum_{j \in \mathbb{V}} S_j = \sum_{j \in \mathbb{V}} \frac{a_j}{\mu} = \frac{\gamma - \alpha_K}{\mu} \neq 1$$

Passing equation (20) in log (Note that $\mu$ has no upper case):

$$\frac{1}{\mu}(\lambda + q) - \ln \mu + \ln \left( \frac{\partial q}{\partial x_j} \right) - x_j = w_j. \tag{22}$$

Then, by taking the total derivative with respect to all factor $x_o$ in $\mathbb{V}$(and not $\mathbb{F}$ since $\forall z \in \mathbb{F}, dx_z = 0$) we write:

$$dw_j = \frac{1}{\mu} \sum_{o \in \mathbb{V}} \frac{\partial q}{\partial x_o} dx_o - dx_j, \tag{23}$$

since $\frac{\partial q}{\partial x_j} = \alpha_j$ is a constant, it means that

$$\sum_{z \in \mathbb{V}} \frac{\partial \left( \frac{\partial q}{\partial x_j} \right)}{\partial x_z} dx_z = 0.$$

Using the factor share defined in equation (21), we have

$$dw_j = \sum_{z \in \mathbb{V}} S_z dx_z - dx_j, \tag{24}$$

which can be written in matrix form,

$$\mathbf{\Phi dx} = \mathbf{dw}. \tag{25}$$

With

$$\Phi_{ij} = \begin{cases} S_j & \text{if } i \neq j \\ S_j - 1 & \text{if i=j,} \end{cases} \tag{26}$$

$$\mathbf{\Phi} = \begin{bmatrix} S_1 - 1 & \cdots & S_j & \cdots & S_n \\ \vdots & & \vdots & & \vdots \\ S_1 & \cdots & S_j - 1 & \cdots & S_n \\ \vdots & & \vdots & & \vdots \\ S_1 & \cdots & S_j & \cdots & S_n - 1 \end{bmatrix}.$$

Equation (26) defines a system of $n$ equations (with $n = |\mathbb{V}|$. We can invert the matrix $\Phi$ to solve the system:

$$\begin{aligned} &\mathbf{\Phi dx} = \mathbf{dw} \\ \Longleftrightarrow &\mathbf{dx} = \mathbf{\Phi}^{-1}\mathbf{dw}. \end{aligned} \tag{27}$$

We have that (proof below):

$$|\mathbf{\Phi}| = (-1)^n \left(1 - \sum_{o \in \mathbb{V}} S_o\right). \tag{28}$$

We rewrite it as

$$|\mathbf{\Phi}| = (-1)^n \left(1 - \frac{\gamma - \alpha_K}{\mu}\right)$$

Hence, the matrix $\Phi$ fails to be invertible if and only if $\frac{\gamma - \alpha_K}{\mu} = 1$. Which is the case when

$$\sum_{j \in \mathbb{V}} S_j = 1,$$

that $\Phi$ is not invertible where there is no fixed factor ($\mathbb{V} = \mathbb{S}$), no mark-up ($\mu = 1$), and constant returns to scale ($\gamma = 1$). The matrix $\Phi$ is invertible if any of these three conditions is not true.

**Determinant of $\mathbf{\Phi}$**. Proof of equation (28)

Let's denote the determinant of the matrix $\mathbf{\Phi}$ as $\mathcal{D}_n$, with

$$\mathbf{\Phi} = \begin{bmatrix} S_1 - 1 & \cdots & S_j & \cdots & S_n \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ S_1 & \cdots & S_j - 1 & \cdots & S_n \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ S_1 & \cdots & S_j & \cdots & S_n - 1 \end{bmatrix}. \tag{29}$$

We use the properties of the determinant as a linear map between vectorial spaces, thus preserving linear combinations, i.e. adding to a column any linear combination of others columns does not change the value of the determinant. Since $\det(\mathcal{D}) = \det(\mathcal{D}^T) =$, it also works with rows.

Let us prove by induction that:

$$\forall n \in \mathbb{N}*, \mathcal{D}_n = (-1)^n \left(1 - \sum_{o \in \mathbb{V}} S_o\right). \tag{30}$$

For n=1, $\mathcal{D}_1 = -(S_1 - 1) = 1 - S_1$.
For n=2,

$$\begin{aligned}\mathcal{D}_2 &= \begin{vmatrix} S_1 - 1 & S_2 \\ S_1 & S_2 - 1 \end{vmatrix} \\ &= (S_1 - 1)(S_2 - 1) - S_1 S_2 \\ &= 1 - S_1 - S_2.\end{aligned}$$

Let us then assume that for any $n$,

$$\mathcal{D}_{n-1} = \begin{vmatrix} S_1 - 1 & S_2 & \cdots & S_{n-1} \\ S_1 & S_2 - 1 & \cdots & S_{n-1} \\ \vdots & \vdots & \ddots & \vdots \\ S_1 & S_2 & \cdots & S_{n-1} \\ S_1 & S_2 & \cdots & S_{n-1} - 1 \end{vmatrix} = (-1)^{n-1} \left( 1 - \sum_{o=1}^{n-1} S_o \right).$$

Let us consider $\mathcal{D}_n$ the determinant of the matrix $\Phi$ defined in eq. (29). By adding the second row to the first, and adding to each row the following one, except of the last one gives us a simpler determinant for $\mathcal{D}_n$

$$\begin{aligned}\mathcal{D}_n &= \begin{vmatrix} S_1 - 1 & S_2 & \cdots & S_{n-1} & S_n \\ S_1 & S_2 - 1 & \cdots & S_{n-1} & S_n \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ S_1 & S_2 & \cdots & S_{n-1} & S_n \\ S_1 & S_2 & \cdots & S_{n-1} - 1 & S_n \\ S_1 & S_2 & \cdots & S_{n-1} & S_n - 1 \end{vmatrix} \\ &= \begin{vmatrix} -1 & 1 & \cdots & 0 & 0 \\ 0 & -1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & 0 \\ 0 & 0 & \cdots & -1 & 1 \\ S_1 & S_2 & \cdots & S_{n-1} & S_n - 1 \end{vmatrix}.\end{aligned} \tag{31}$$

Developing by the first column (using Laplace expansion),

$$\mathcal{D}_n = (-1)\cdot \begin{vmatrix} -1 & \cdots & 0 & 0 \\ \vdots & \ddots & \vdots & \vdots \\ 0 & \cdots & 1 & 0 \\ 0 & \cdots & -1 & 1 \\ S_2 & \cdots & S_{n-1} & S_n - 1 \end{vmatrix} + (-1)^{n+1} S_1 \begin{vmatrix} 1 & 0\cdots & 0 & 0 & \\ -1 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & 0 \\ 0 & 0 & \cdots & -1 & 1 \end{vmatrix}. \tag{32}$$

The first of the two minors in (32) is simply $\mathcal{D}_{n-1}$ with a change in indexing starting from $S_2$ to $S_n$. The second minor is triangular (no element above the diagonal), it's determinant is the product of the diagonal elements (all 1 in this case).

$$\begin{aligned} \mathcal{D}_n &= (-1)^n \left(1 - \sum_{o=2}^{n} S_o\right) + (-1)^{n+1} S_1 \\ &= (-1)^n \left(1 - \sum_{o=2}^{n} S_o - S_1\right) \\ &= (-1)^n \left(1 - \sum_{o=1}^{n} S_o\right). \end{aligned}$$

# A Appendix Figures

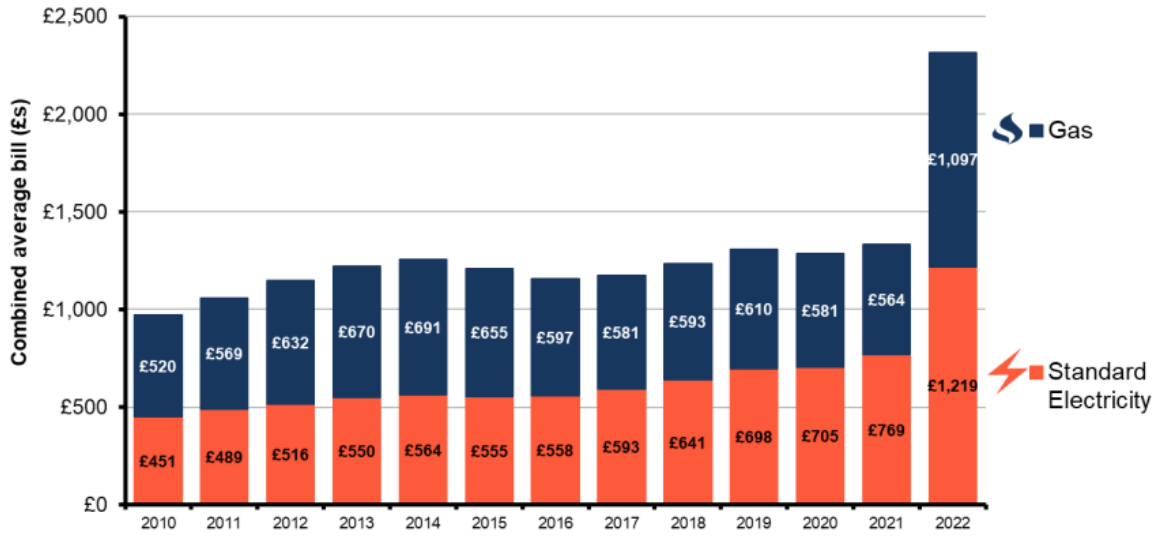



Figure A1: Average Standard Electricity and Gas bills - 2010 to 2022

***Note**: Data from Department for Business, Energy & Industrial Strategy*

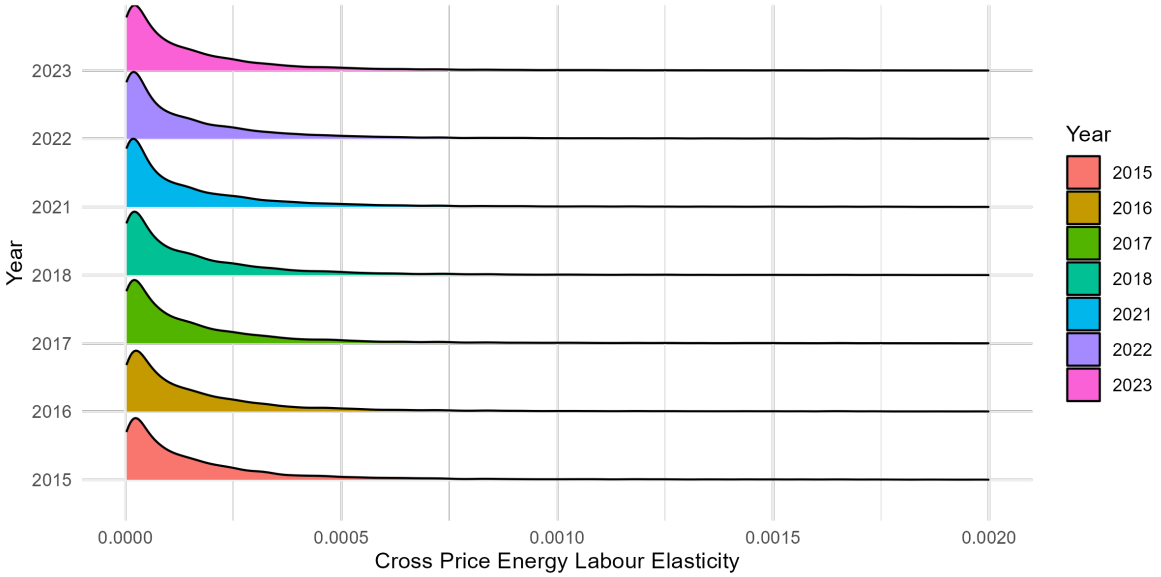



Figure A2: Cross-Price elasticities by year

Note: The graphs show cross-price elasticities between labor and energy 2015 to 2018 and from 2021 to 2023.

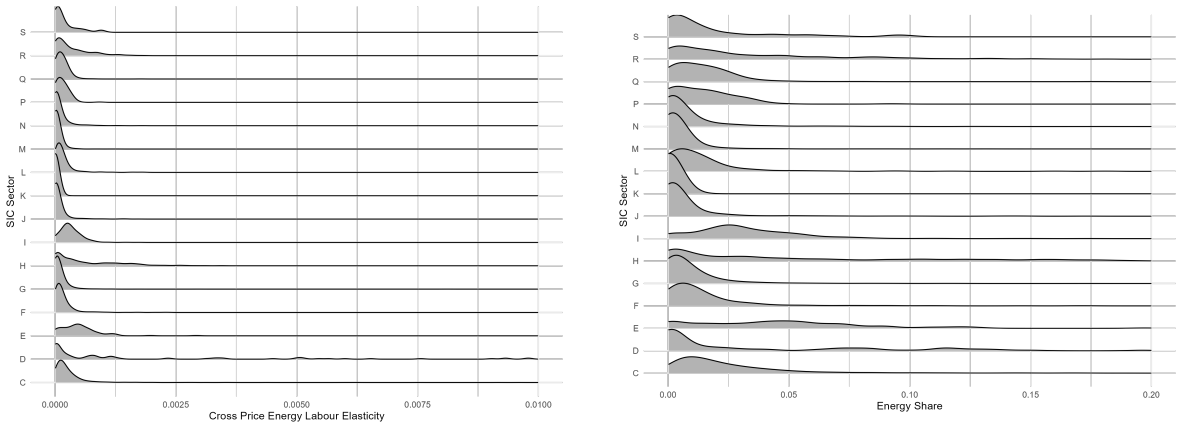



Figure A3: Cross price elasticities and energy shares by SIC sector in 2021

Note: The graphs show a comparison between cross price elasticities and shares by SIC sector.

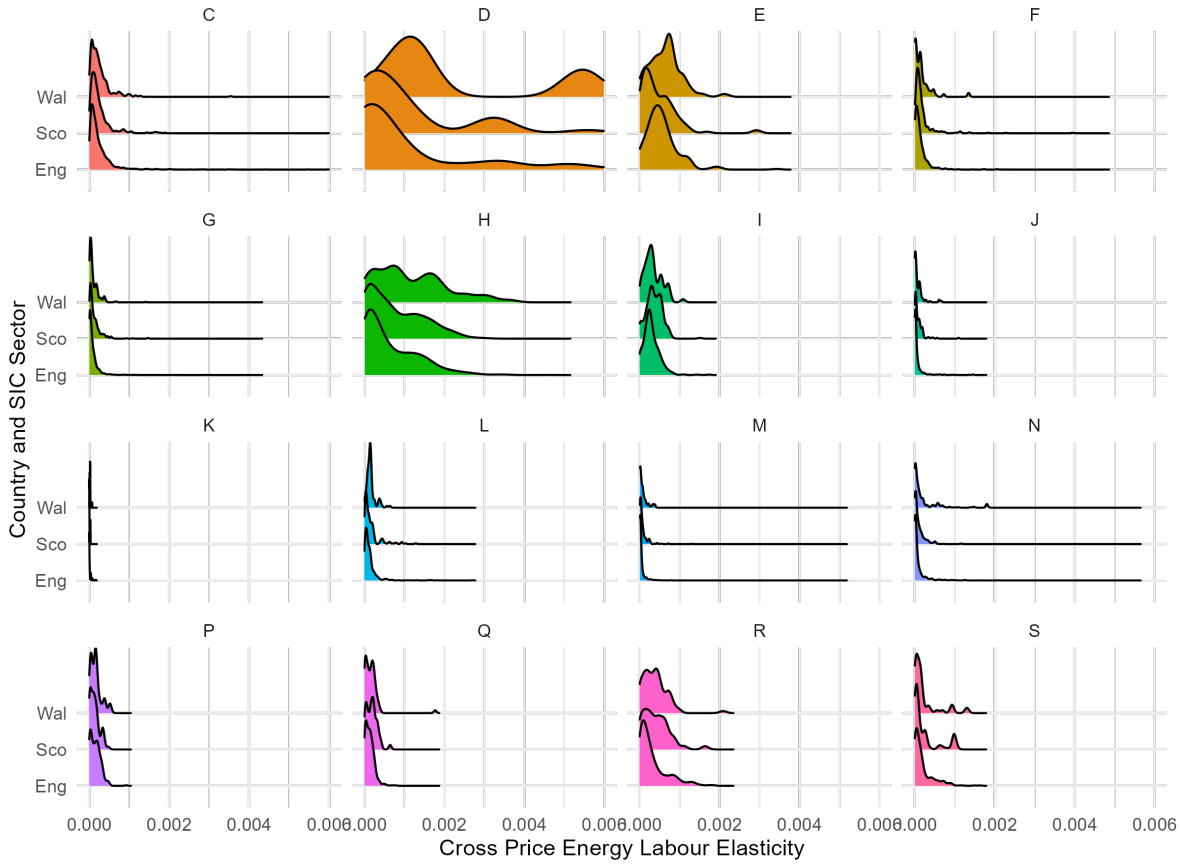



Figure A4: Cross Price Elasticities by sector and country in 2021

Note: The graphs show Cross Price Elasticities in 2021 by country and SIC sector. Northern Ireland is not included because the Northern Ireland Statistics and Research Agency (NISRA) does not allow sharing of micro data to external researcher.

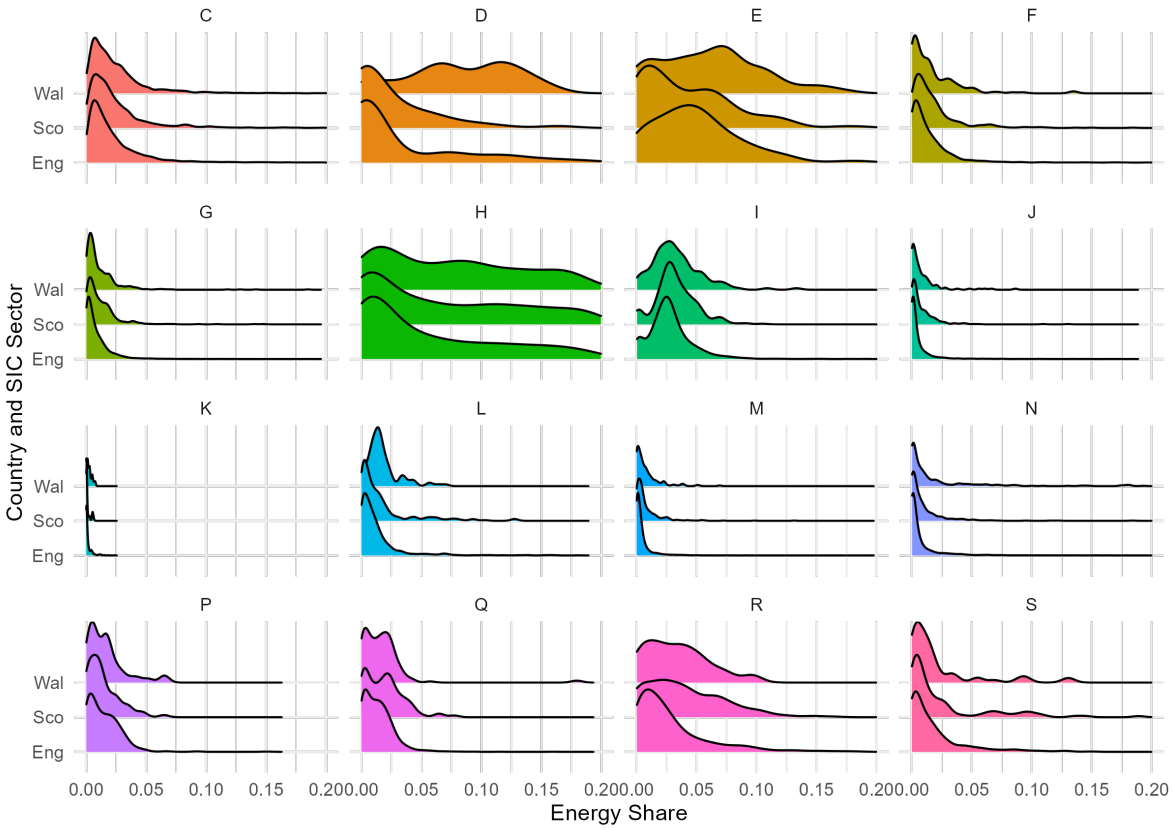



Figure A5: Energy Shares by country and sector in 2021

Note: The graphs show Energy Shares in 2021 by country and SIC sector. Northern Ireland is not included because the Northern Ireland Statistics and Research Agency (NISRA) does not allow sharing of micro data to external researcher.

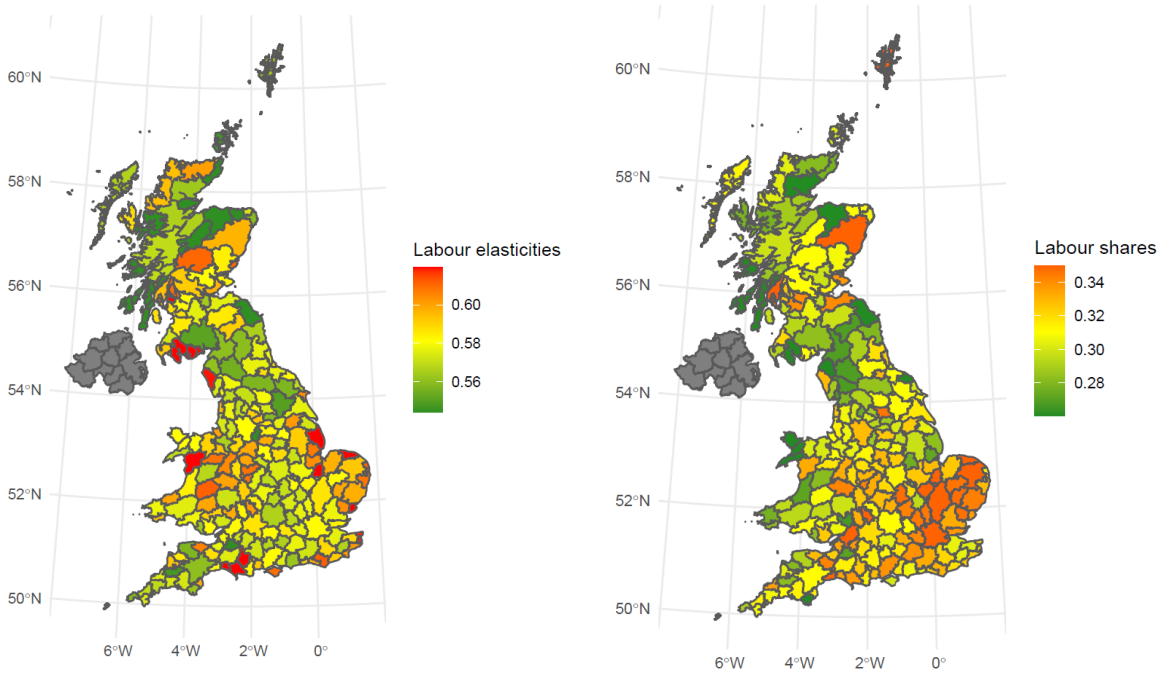



Figure A6: Labour elasticities and shares by TTWA in 2021

# B Appendix Tables

Table B1: Sample by SIC section in 2021 and 2022

| SIC Section | n | Percent |
|---|---|---|
| Agriculture, Forestry and Fishing | 176 | 0.008 |
| Mining and Quarrying | 250 | 0.012 |
| Manufacturing | 4141 | 0.198 |
| Electricity, gas, steam and air conditioning supply | 262 | 0.013 |
| Water supply, sewerage, waste management and remediation activities | 289 | 0.014 |
| Construction | 1227 | 0.059 |
| Wholesale and retail trade; repair of motor vehicles and motorcycles | 4030 | 0.192 |
| Transportation and storage | 1028 | 0.049 |
| Accommodation and food service activities | 1220 | 0.058 |
| Information and communication | 1355 | 0.065 |
| Financial and insurance activities | 180 | 0.009 |
| Real estate activities | 498 | 0.024 |
| Professional, scientific and technical activities | 2142 | 0.102 |
| Administrative and support service activities | 2147 | 0.102 |
| Education | 287 | 0.014 |
| Human health and social work activities | 999 | 0.048 |
| Arts, entertainment and recreation | 545 | 0.026 |
| Other service activities | 183 | 0.009 |

Note: The table shows the sample sectors distribution for the years 2021-2022.

Table B2: Sample compared with ABS and APS 2018-2018 and 2021-2022

| Year | Sample | ABS Universe | APS Universe |
|---|---|---|---|
| 2015 | 8,290 | 45,652 | 22,500 |
| 2016 | 9,614 | 45,481 | 23,063 |
| 2017 | 10,071 | 46,725 | 24,410 |
| 2018 | 9,711 | 46,493 | 23,916 |
| 2021 | 9,789 | 44,304 | 19,541 |
| 2022 | 11,170 | 47,217 | 24,748 |

Note: The table shows the sample used in the analysis compared to the full sample of the APS and ABS from 2015 to 2018 and from 2021 to 2022.

Table B3: Jobs Lost by TTWA using Cross Price Elasticities

| TTWA Code(s) | Employment | Percentage Jobs Lost |
|---|---|---|
| K01000002, W22000023, W22000011, W22000016, W22000009 | 3544 | 5.198679 |
| S22000069, S22000023 | 18828 | 4.214910 |
| E30000211, E30000056 | 12253 | 1.668892 |
| E30000073, E30000289, E30000152 | 60565 | 1.421539 |
| E30000168, E30000149 | 20189 | 1.265958 |
| K01000007, K01000014 | 7229 | 1.114294 |
| W22000025, W22000005, W22000021, W22000001, W22000033, W22000013 | 5725 | 0.978808 |
| E30000121, E30000261 | 130386 | 0.813240 |
| E30000106 | 19847 | 0.811146 |
| E30000093 | 25099 | 0.798039 |
| E30000198, E30000042, E30000074, E30000225 | 7413 | 0.794294 |
| W22000006, W22000028 | 8844 | 0.790088 |
| S22000073, S22000034, S22000011, S22000058, S22000030, S22000086, S22000062, S22000029, S22000032, S22000005 | 11841 | 0.741234 |
| E30000264, E30000123, E30000083 | 13930 | 0.740261 |
| E30000048, E30000202 | 45140 | 0.706235 |
| E30000002, E30000160, E30000061 | 27385 | 0.684595 |
| S22000085, S22000019, S22000054, S22000007 | 4852 | 0.664392 |
| E30000154, E30000291, E30000119, E30000260 | 33593 | 0.618831 |
| S22000071, S22000027 | 29467 | 0.614263 |
| E30000126, E30000268 | 51155 | 0.605078 |
| E30000158, E30000294 | 60092 | 0.585925 |
| S22000061, S22000042, S22000014 | 23141 | 0.585214 |
| E30000069, E30000222 | 36237 | 0.580694 |
| E30000059, E30000214 | 13557 | 0.575303 |
| E30000066, E30000219 | 18338 | 0.572123 |
| E30000178, E30000263, E30000065, E30000021, E30000157, E30000293 | 6503 | 0.563032 |
| E30000029 | 16553 | 0.561201 |
| W22000002, W22000010, W22000022, W22000018 | 7847 | 0.560749 |
| E30000097, E30000244 | 26212 | 0.556599 |
| K01000006, K01000013 | 43254 | 0.533807 |
| E30000116, E30000038, E30000195 | 77196 | 0.529264 |
| E30000019, E30000176, E30000274, E30000146, E30000285 | 22162 | 0.526431 |
| E30000080, E30000231 | 37505 | 0.525854 |
| E30000134, E30000278 | 25057 | 0.518911 |
| S22000041, S22000015, S22000051 | 6760 | 0.518549 |
| E30000151, E30000095 | 22719 | 0.516860 |
| E30000020, E30000177, E30000118, E30000259, E30000147, E30000088, E30000238 | 7728 | 0.510940 |
| E30000043, E30000199, E30000215, E30000060, E30000012, E30000203 | 19804 | 0.510732 |
| E30000140, E30000281 | 15992 | 0.508003 |
| S22000084, S22000016, S22000004, S22000081 | 3415 | 0.497472 |
| E30000035, E30000191 | 11479 | 0.497069 |
| E30000150, E30000287, E30000135 | 7933 | 0.484258 |
| E30000131, E30000275 | 38435 | 0.479233 |
| E30000245, E30000098 | 189026 | 0.475587 |

*Continued on next page*

| TTWA Code(s) | Employment | Percentage Jobs Lost |
|---|---|---|
| S22000044, S22000046, S22000080, S22000083, S22000066, S22000006, S22000021, S22000048 | 2995 | 0.472381 |
| S22000072, S22000033, S22000043, S22000079, S22000053, S22000026, S22000051, S22000064, S22000002 | 9857 | 0.472254 |
| E30000173, E30000096, E30000064 | 7431 | 0.470341 |
| E30000017, E30000175 | 22177 | 0.467125 |
| E30000107, E30000252, E30000139, E30000257, E30000051 | 7454 | 0.466903 |
| E30000101, E30000248 | 47619 | 0.465955 |
| S22000068, S22000022 | 12360 | 0.458632 |
| E30000070 | 16283 | 0.456789 |
| E30000170, E30000013 | 24655 | 0.453019 |
| W22000029, W22000014, W22000008 | 10917 | 0.442288 |
| E30000053, E30000209, K01000005 | 20395 | 0.441382 |
| K01000003, K01000010 | 23411 | 0.435941 |
| E30000254, E30000111 | 56363 | 0.434904 |
| E30000276, E30000132 | 35295 | 0.433364 |
| E30000185, E30000028, E30000092, E30000190, E30000034 | 43141 | 0.432664 |
| E30000087, E30000242 | 92597 | 0.431637 |
| E30000055, E30000210, E30000235, E30000084 | 29032 | 0.420813 |
| E30000058, E30000030, E30000186 | 123480 | 0.413182 |
| E30000045, E30000201 | 12255 | 0.411107 |
| E30000037, E30000193 | 28715 | 0.403922 |
| E30000090, E30000240 | 49137 | 0.398510 |
| E30000122, E30000262 | 13813 | 0.396365 |
| E30000161, E30000003 | 32120 | 0.394315 |
| E30000041, E30000197 | 18061 | 0.391465 |
| S22000009, S22000056 | 8039 | 0.388942 |
| E30000192, E30000036, E30000277, E30000133 | 21412 | 0.387681 |
| S22000076, S22000036, S22000074, S22000038 | 10984 | 0.385511 |
| E30000205, E30000033, E30000189 | 25278 | 0.381003 |
| E30000081, E30000233 | 96378 | 0.375126 |
| E30000143, E30000288 | 36963 | 0.373100 |
| E30000079, E30000230 | 157599 | 0.371696 |
| K01000009, K01000001, S22000067, S22000020, S22000024, S22000063, S22000017 | 50814 | 0.358530 |
| K01000008, W22000034 | 17570 | 0.356926 |
| E30000110 | 48113 | 0.354777 |
| E30000187, E30000031 | 23282 | 0.348281 |
| E30000067, E30000220 | 83178 | 0.347798 |
| E30000246, E30000114, E30000162, E30000099, E30000005 | 17739 | 0.342617 |
| E30000223, E30000071, E30000076 | 34533 | 0.341698 |
| E30000129, E30000272 | 46020 | 0.340307 |
| E30000047, E30000208, E30000052 | 20662 | 0.338222 |
| S22000057, S22000010, S22000025 | 21690 | 0.337149 |
| E30000226, E30000075, E30000105, E30000279, E30000137 | 11027 | 0.336425 |
| E30000227, E30000103, E30000125, E30000267 | 140950 | 0.335412 |
| E30000145, E30000228 | 30760 | 0.334402 |
| W22000030 | 6370 | 0.333792 |

*Continued on next page*

| TTWA Code(s) | Employment | Percentage Jobs Lost |
|---|---|---|
| E30000009, E30000166 | 56975 | 0.328632 |
| S22000060, S22000031 | 5676 | 0.328314 |
| E30000024, E30000181, E30000010, E30000167, E30000224, E30000282, E30000141 | 5742 | 0.327027 |
| E30000229, E30000078 | 222279 | 0.326424 |
| E30000091, E30000241 | 6472 | 0.319443 |
| E30000011, E30000169 | 206620 | 0.319016 |
| S22000035, S22000013, S22000039 | 3360 | 0.317933 |
| E30000144, E30000284 | 99413 | 0.316566 |
| E30000148, E30000163, E30000286, E30000006, E30000290, E30000153 | 18330 | 0.314651 |
| S22000047, S22000001 | 59654 | 0.314420 |
| E30000018 | 35945 | 0.310650 |
| E30000008, E30000165 | 10594 | 0.309260 |
| S22000065, S22000018 | 210896 | 0.298184 |
| E30000016, E30000174 | 17146 | 0.295106 |
| W22000003 | 11601 | 0.293061 |
| E30000204, E30000049 | 4366 | 0.284038 |
| E30000194, E30000100, E30000247, E30000072 | 84637 | 0.281507 |
| E30000112, E30000255 | 85347 | 0.281410 |
| E30000182, E30000025 | 8502 | 0.280762 |
| E30000266, E30000082, E30000234 | 1490429 | 0.276975 |
| E30000001, E30000159 | 7068 | 0.276000 |
| E30000015, E30000239, E30000089 | 355207 | 0.271069 |
| E30000232, E30000180, E30000253, E30000270, E30000127, E30000109, E30000023 | 206764 | 0.268507 |
| S22000037, S22000075 | 3754 | 0.267412 |
| E30000044, E30000200 | 49934 | 0.267089 |
| S22000008, S22000055 | 7202 | 0.264673 |
| E30000014, E30000171 | 45865 | 0.262085 |
| E30000102, E30000249 | 72049 | 0.258423 |
| E30000039, E30000188, E30000032 | 32865 | 0.257476 |
| E30000068, E30000221 | 12279 | 0.251904 |
| E30000130, E30000273 | 52542 | 0.243922 |
| S22000070, S22000028 | 25537 | 0.242029 |
| E30000136, E30000050, E30000206 | 49047 | 0.238873 |
| E30000094, E30000243 | 38565 | 0.236479 |
| E30000183, E30000026 | 10186 | 0.235329 |
| K01000004, K01000011 | 28706 | 0.234960 |
| E30000179, E30000022 | 54270 | 0.234845 |
| W22000032, W22000020 | 83076 | 0.227547 |
| E30000104, E30000250 | 51688 | 0.226687 |
| E30000086, E30000237 | 148674 | 0.224875 |
| E30000085, E30000236, E30000063, E30000216 | 12485 | 0.220578 |
| W22000024, W22000004 | 73699 | 0.220375 |
| E30000004 | 46781 | 0.206600 |
| E30000113, E30000256 | 111662 | 0.201658 |
| E30000108 | 41154 | 0.195004 |
| E30000138, E30000280 | 19962 | 0.194313 |
| E30000040, E30000196 | 87516 | 0.193199 |
| E30000184, E30000027 | 34224 | 0.191891 |
| E30000142, E30000283 | 170268 | 0.188419 |
| E30000057, E30000212 | 111653 | 0.183043 |

*Continued on next page*

| TTWA Code(s) | Employment | Percentage Jobs Lost |
|---|---|---|
| E30000124, E30000054 | 49484 | 0.173093 |
| W22000031, W22000019, W22000026, W22000012 | 18680 | 0.171739 |
| S22000059, S22000012 | 116721 | 0.170219 |
| E30000007, E30000164 | 30130 | 0.169728 |
| E30000218, E30000156 | 73862 | 0.168670 |
| E30000155, E30000292 | 18628 | 0.141943 |
| E30000128, E30000271 | 9912 | 0.136854 |
| E30000117, E30000258 | 6750 | 0.134489 |
| E30000120, E30000172, E30000046 | 7723 | 0.124554 |

Notes: We calculated the jobs lost by TTWA (both 2001 and 2011 classification) for 2022 and 2023 by using cross price elasticities. For TTWAs with fewer than 10 observations (firms), we merged the analysis with neighboring TTWAs.

Table B4: Jobs Lost by TTWA using Energy Shares

| TTWA Code(s) | Employment | Percentage Jobs Lost |
|---|---|---|
| S22000069, S22000023 | 18828 | 5.637081 |
| K01000002, W22000023 | 3948 | 4.670149 |
| E30000211, E30000056 | 12266 | 2.347716 |
| E30000154, E30000291, E30000119, E30000260 | 33593 | 2.322247 |
| E30000073, E30000289, E30000152 | 60565 | 2.070062 |
| W22000006, W22000028 | 8844 | 1.937170 |
| E30000264, E30000123, E30000083 | 13930 | 1.587568 |
| S22000073, S22000034, S22000011, S22000058, S22000030, S22000086, S22000062, S22000029, S22000032, S22000005 | 11841 | 1.581219 |
| E30000168, E30000149 | 20511 | 1.376713 |
| E30000121, E30000261 | 130686 | 1.305750 |
| E30000229, E30000078 | 222629 | 1.050057 |
| E30000043, E30000199, E30000215, E30000060, E30000012, E30000203 | 19806 | 1.049874 |
| K01000003, K01000010 | 23970 | 1.040294 |
| W22000025, W22000005, W22000021, W22000001, W22000033, W22000013 | 5725 | 1.035114 |
| E30000093 | 25252 | 1.028006 |
| E30000198, E30000042, E30000074, E30000225 | 7419 | 1.025547 |
| W22000002, W22000010, W22000022, W22000018 | 7847 | 0.990406 |
| E30000151, E30000095 | 22719 | 0.904107 |
| E30000106 | 19847 | 0.898655 |
| W22000024, W22000004 | 74185 | 0.897521 |
| S22000085, S22000019, S22000054, S22000007 | 4852 | 0.885168 |
| E30000246, E30000114, E30000162, E30000099, E30000005 | 17739 | 0.858463 |
| E30000014, E30000171 | 45910 | 0.852149 |
| E30000019, E30000176, E30000274, E30000146, E30000285 | 22451 | 0.849222 |
| K01000006, K01000013 | 43259 | 0.831821 |
| E30000048, E30000202 | 45140 | 0.831141 |
| E30000276, E30000132 | 35300 | 0.822955 |

*Continued on next page*

| TTWA Code(s) | Employment | Percentage Jobs Lost |
|---|---|---|
| E30000178, E30000263, E30000065, E30000021, E30000157, E30000293 | 6503 | 0.794217 |
| E30000090, E30000240 | 49137 | 0.790816 |
| E30000055, E30000210, E30000235, E30000084 | 29032 | 0.780735 |
| W22000015 | 6370 | 0.765557 |
| W22000030 | 6370 | 0.765557 |
| E30000066, E30000219 | 18338 | 0.760515 |
| E30000142, E30000283 | 170268 | 0.754967 |
| S22000071, S22000027 | 29534 | 0.743912 |
| E30000087, E30000242 | 92602 | 0.743497 |
| S22000035, S22000013, S22000039 | 3360 | 0.742785 |
| E30000070 | 16283 | 0.734991 |
| E30000126, E30000268 | 51254 | 0.725805 |
| E30000059, E30000214 | 13557 | 0.717830 |
| E30000002, E30000160, E30000061 | 27385 | 0.715055 |
| E30000080, E30000231 | 38222 | 0.710569 |
| E30000020, E30000177, E30000118, E30000259, E30000147, E30000088, E30000238 | 7728 | 0.708298 |
| E30000192, E30000036, E30000277, E30000133 | 21412 | 0.700140 |
| E30000173, E30000096, E30000064 | 7444 | 0.695892 |
| E30000150, E30000287, E30000135 | 7933 | 0.694267 |
| E30000069, E30000222 | 36606 | 0.665918 |
| E30000131, E30000275 | 38435 | 0.665168 |
| S22000061, S22000042, S22000014 | 25467 | 0.655339 |
| E30000029 | 16553 | 0.651486 |
| E30000134, E30000278 | 25057 | 0.640060 |
| E30000045, E30000201 | 12255 | 0.637874 |
| E30000037, E30000193 | 28715 | 0.625291 |
| E30000097, E30000244 | 26235 | 0.625135 |
| E30000140, E30000281 | 16102 | 0.617481 |
| E30000035, E30000191 | 11586 | 0.611200 |
| E30000144, E30000284 | 101893 | 0.597253 |
| S22000041, S22000015, S22000051 | 6760 | 0.597152 |
| E30000116, E30000038, E30000195 | 77199 | 0.595617 |
| S22000084, S22000016, S22000004, S22000081 | 3415 | 0.585642 |
| E30000101, E30000248 | 47887 | 0.585308 |
| K01000008, W22000034 | 17570 | 0.585054 |
| S22000037, S22000075 | 3754 | 0.581286 |
| S22000076, S22000036, S22000074, S22000038 | 10990 | 0.580944 |
| E30000185, E30000028, E30000092, E30000190, E30000034 | 43141 | 0.580078 |
| E30000148, E30000163, E30000286, E30000006, E30000290, E30000153 | 18330 | 0.576883 |
| E30000053, E30000209, K01000005 | 20662 | 0.575847 |
| E30000136, E30000050, E30000206 | 49356 | 0.568143 |
| E30000081, E30000233 | 98740 | 0.565303 |
| E30000001, E30000159 | 7074 | 0.559803 |
| E30000086, E30000237 | 151664 | 0.558263 |
| E30000017, E30000175 | 21840 | 0.553759 |
| W22000032, W22000020 | 83076 | 0.552212 |
| E30000170, E30000013 | 24993 | 0.548971 |
| W22000029, W22000014, W22000008 | 10917 | 0.547873 |
| S22000009, S22000056 | 8041 | 0.540664 |

*Continued on next page*

| TTWA Code(s) | Employment | Percentage Jobs Lost |
|---|---|---|
| K01000007, K01000014 | 7234 | 0.534300 |
| K01000009, K01000001, S22000067, S22000020, S22000024, S22000063, S22000017 | 50814 | 0.534190 |
| S22000068, S22000022 | 12360 | 0.532425 |
| S22000060, S22000031 | 5676 | 0.527622 |
| E30000187, E30000031 | 23282 | 0.523051 |
| E30000205, E30000033, E30000189 | 25286 | 0.522137 |
| E30000016, E30000174 | 17146 | 0.520426 |
| E30000245, E30000098 | 189542 | 0.520324 |
| S22000072, S22000033, S22000043, S22000079, S22000053, S22000026, S22000051, S22000064, S22000002 | 10263 | 0.520014 |
| E30000254, E30000111 | 56363 | 0.510748 |
| S22000044, S22000046, S22000080, S22000083, S22000066, S22000006, S22000021, S22000048 | 2995 | 0.509241 |
| E30000204, E30000049 | 4366 | 0.508526 |
| E30000143, E30000288 | 36712 | 0.505522 |
| S22000065, S22000018 | 212440 | 0.504124 |
| E30000112, E30000255 | 86062 | 0.503022 |
| E30000024, E30000181, E30000010, E30000167, E30000224, E30000282, E30000141 | 5742 | 0.502622 |
| E30000067, E30000220 | 83193 | 0.501777 |
| E30000011, E30000169 | 205659 | 0.497275 |
| E30000158, E30000294 | 60127 | 0.493803 |
| E30000015, E30000239, E30000089 | 361551 | 0.492322 |
| E30000227, E30000103, E30000125, E30000267 | 141405 | 0.490925 |
| E30000107, E30000252, E30000139, E30000257, E30000051 | 8893 | 0.489272 |
| E30000122, E30000262 | 13813 | 0.489198 |
| E30000129, E30000272 | 46020 | 0.487288 |
| E30000110 | 48113 | 0.482276 |
| E30000223, E30000071, E30000076 | 35630 | 0.479239 |
| E30000161, E30000003 | 32246 | 0.478947 |
| E30000091, E30000241 | 6526 | 0.469021 |
| E30000041, E30000197 | 18061 | 0.464299 |
| E30000079, E30000230 | 157897 | 0.461928 |
| E30000183, E30000026 | 10186 | 0.457724 |
| E30000226, E30000075, E30000105, E30000279, E30000137 | 11027 | 0.457582 |
| S22000047, S22000001 | 62389 | 0.453407 |
| E30000047, E30000208, E30000052 | 20662 | 0.445490 |
| E30000104, E30000250 | 51799 | 0.435396 |
| W22000003 | 11601 | 0.430147 |
| E30000008, E30000165 | 10594 | 0.412677 |
| E30000145, E30000228 | 31244 | 0.410537 |
| K01000004, K01000011 | 28706 | 0.408044 |
| E30000018 | 35978 | 0.402560 |
| E30000266, E30000082, E30000234 | 1534372 | 0.401371 |
| E30000232, E30000180, E30000253, E30000270, E30000127, E30000109, E30000023 | 215143 | 0.399529 |
| E30000130, E30000273 | 52542 | 0.395566 |
| E30000058, E30000030, E30000186 | 124056 | 0.391871 |
| E30000102, E30000249 | 72590 | 0.387651 |

*Continued on next page*

| TTWA Code(s) | Employment | Percentage Jobs Lost |
|---|---|---|
| S22000057, S22000010, S22000025 | 21690 | 0.365272 |
| E30000094, E30000243 | 45214 | 0.362195 |
| E30000179, E30000022 | 54270 | 0.358729 |
| E30000009, E30000166 | 57256 | 0.357255 |
| S22000008, S22000055 | 7202 | 0.352791 |
| E30000004 | 46805 | 0.339665 |
| E30000194, E30000100, E30000247, E30000072 | 85260 | 0.337381 |
| E30000182, E30000025 | 8502 | 0.336183 |
| E30000039, E30000188, E30000032 | 32868 | 0.332976 |
| E30000007, E30000164 | 30275 | 0.326654 |
| E30000138, E30000280 | 20728 | 0.326187 |
| E30000044, E30000200 | 57376 | 0.322508 |
| E30000108 | 41154 | 0.318588 |
| S22000070, S22000028 | 25537 | 0.317096 |
| E30000057, E30000212 | 116277 | 0.312921 |
| E30000040, E30000196 | 88616 | 0.307895 |
| E30000085, E30000236, E30000063, E30000216 | 12854 | 0.300443 |
| E30000068, E30000221 | 12281 | 0.281363 |
| S22000059, S22000012 | 117504 | 0.280301 |
| E30000113, E30000256 | 115199 | 0.279146 |
| E30000184, E30000027 | 34224 | 0.257280 |
| E30000218, E30000156 | 73862 | 0.256032 |
| E30000155, E30000292 | 18707 | 0.218827 |
| W22000031, W22000019, W22000026, W22000012 | 18724 | 0.218081 |
| E30000128, E30000271 | 9912 | 0.207840 |
| E30000120, E30000172, E30000046 | 9047 | 0.193245 |
| E30000117, E30000258 | 6750 | 0.164103 |
| E30000124, E30000054 | 49484 | 0.103352 |

Notes: We calculated the jobs lost by TTWA (both 2001 and 2011 classification) for 2022 and 2023 by using energy shares. For TTWAs with fewer than 10 observations (firms), we merged the analysis with neighboring TTWAs.

Table B5: TTWA codes and names according to the 2001 nomenclature

| **TTWA** | **Area** | **TTWA** | **Area** |
|---|---|---|---|
| E30000001 | Andover | E30000002 | Ashford |
| E30000003 | Banbury | E30000004 | Barnsley |
| E30000005 | Barnstaple | E30000006 | Barrow-in-Furness |
| E30000007 | Basingstoke | E30000008 | Bath |
| E30000009 | Bedford | E30000010 | Bideford |
| E30000011 | Birmingham | E30000012 | Bishop Auckland and Barnard Castle |
| E30000013 | Blackburn | E30000014 | Blackpool |
| E30000015 | Bolton | E30000016 | Boston |
| E30000017 | Bournemouth | E30000018 | Bradford |
| E30000019 | Bridgwater | E30000020 | Bridlington and Driffield |
| E30000021 | Bridport and Lyme Regis | E30000022 | Brighton |
| E30000023 | Bristol | E30000024 | Bude and Holsworthy |
| E30000025 | Burnley, Nelson and Colne | E30000026 | Burton upon Trent |
| E30000027 | Bury St Edmunds | E30000028 | Buxton |
| E30000029 | Calderdale | E30000030 | Cambridge |
| E30000031 | Canterbury | E30000032 | Chelmsford and Braintree |
| E30000033 | Cheltenham and Evesham | E30000034 | Chesterfield |
| E30000035 | Chichester and Bognor Regis | E30000036 | Clacton |
| E30000037 | Colchester | E30000038 | Coventry |
| E30000039 | Craven | E30000040 | Crawley |
| E30000041 | Crewe and Northwich | E30000042 | Cromer and Sheringham |
| E30000043 | Darlington | E30000044 | Derby |
| E30000045 | Doncaster | E30000046 | Dorchester and Weymouth |
| E30000047 | Dover | E30000048 | Dudley and Sandwell |
| E30000049 | Eastbourne | E30000050 | Exeter and Newton Abbot |
| E30000051 | Falmouth and Helston | E30000052 | Folkestone |
| E30000053 | Gloucester | E30000054 | Grantham |
| E30000055 | Great Yarmouth | E30000056 | Grimsby |

| TTWA | Area | TTWA | Area |
|---|---|---|---|
| E30000057 | Guildford and Aldershot | E30000058 | Harlow and Bishop's Stortford |
| E30000059 | Harrogate and Ripon | E30000060 | Hartlepool |
| E30000061 | Hastings | E30000062 | Hawes and Leyburn |
| E30000063 | Hereford and Leominster | E30000064 | Hexham and Haltwhistle |
| E30000065 | Honiton and Axminster | E30000066 | Huddersfield |
| E30000067 | Hull | E30000068 | Huntingdon |
| E30000069 | Ipswich | E30000070 | Isle of Wight |
| E30000071 | Kendal | E30000072 | Kettering and Corby |
| E30000073 | Kidderminster | E30000074 | King's Lynn and Fakenham |
| E30000075 | Kingsbridge and Dartmouth | E30000076 | Lancaster and Morecambe |
| E30000077 | Launceston | E30000078 | Leeds |
| E30000079 | Leicester | E30000080 | Lincoln |
| E30000081 | Liverpool | E30000082 | London |
| E30000083 | Louth and Horncastle | E30000084 | Lowestoft and Beccles |
| E30000085 | Ludlow | E30000086 | Luton and Watford |
| E30000087 | Maidstone and North Kent | E30000088 | Malton and Pickering |
| E30000089 | Manchester | E30000090 | Mansfield |
| E30000091 | Margate, Ramsgate and Sandwich | E30000092 | Matlock |
| E30000093 | Middlesbrough and Stockton | E30000094 | Milton Keynes and Aylesbury |
| E30000095 | Minehead | E30000096 | Morpeth, Ashington and Alnwick |
| E30000097 | Newbury | E30000098 | Newcastle and Durham |
| E30000099 | Northallerton and Thirsk | E30000100 | Northampton and Wellingborough |
| E30000101 | Norwich | E30000102 | Nottingham |
| E30000103 | Okehampton | E30000104 | Oxford |
| E30000105 | Paignton and Totnes | E30000106 | Penrith and Appleby |
| E30000107 | Penzance and Isles of Scilly | E30000108 | Peterborough |
| E30000109 | Plymouth | E30000110 | Poole |
| E30000111 | Portsmouth | E30000112 | Preston |

| TTWA | Area | TTWA | Area |
|---|---|---|---|
| E30000113 | Reading and Bracknell | E30000114 | Richmond and Catterick |
| E30000115 | Rochdale and Oldham | E30000116 | Rugby |
| E30000117 | Salisbury | E30000118 | Scarborough |
| E30000119 | Scunthorpe | E30000120 | Shaftesbury and Blandford Forum |
| E30000121 | Sheffield and Rotherham | E30000122 | Shrewsbury |
| E30000123 | Skegness | E30000124 | South Holland |
| E30000125 | Southampton | E30000126 | Southend and Brentwood |
| E30000127 | St Austell | E30000128 | Stafford |
| E30000129 | Stevenage | E30000130 | Stoke-on-Trent |
| E30000131 | Sunderland | E30000132 | Swindon |
| E30000133 | Taunton | E30000134 | Telford and Bridgnorth |
| E30000135 | Thetford and Mildenhall | E30000136 | Tiverton |
| E30000137 | Torquay | E30000138 | Trowbridge and Warminster |
| E30000139 | Truro, Redruth and Camborne | E30000140 | Tunbridge Wells |
| E30000141 | Wadebridge | E30000142 | Wakefield and Castleford |
| E30000143 | Walsall and Cannock | E30000144 | Warrington and Wigan |
| E30000145 | Warwick and Stratford-upon-Avon | E30000146 | Wells and Shepton Mallet |
| E30000147 | Whitby | E30000148 | Whitehaven |
| E30000149 | Wirral and Ellesmere Port | E30000150 | Wisbech |
| E30000151 | Wolverhampton | E30000152 | Worcester and Malvern |
| E30000153 | Workington and Keswick | E30000154 | Worksop and Retford |
| E30000155 | Worthing | E30000156 | Wycombe and Slough |
| E30000157 | Yeovil and Chard | E30000158 | York |
| K01000001 | Berwick | K01000002 | Brecon |
| K01000003 | Carlisle | K01000004 | Chester and Flint |
| K01000005 | Monmouth and Cinderford | K01000006 | Newport and Cwmbran |

| TTWA | Area | TTWA | Area |
|---|---|---|---|
| K01000007 | Oswestry | K01000008 | Wrexham and Whitchurch |
| S22000001 | Aberdeen | S22000002 | Ayr and Kilmarnock |
| S22000003 | Badenoch | S22000004 | Banff |
| S22000005 | Campbeltown | S22000006 | Dornoch and Lairg |
| S22000007 | Dumbarton | S22000008 | Dumfries and Annan |
| S22000009 | Dundee | S22000010 | Dunfermline |
| S22000011 | Dunoon and Bute | S22000012 | Edinburgh |
| S22000013 | Eilean Siar | S22000014 | Falkirk |
| S22000015 | Forfar and Montrose | S22000016 | Fraserburgh |
| S22000017 | Galashiels and Peebles | S22000018 | Glasgow |
| S22000019 | Greenock | S22000020 | Hawick |
| S22000021 | Invergordon | S22000022 | Inverness and Dingwall |
| S22000023 | Irvine and Arran | S22000024 | Kelso and Jedburgh |
| S22000025 | Kirkcaldy and Glenrothes | S22000026 | Kirkcudbright |
| S22000027 | Lanarkshire | S22000028 | Livingston and Bathgate |
| S22000029 | Lochaber | S22000030 | Lochgilphead |
| S22000031 | Moray | S22000032 | Mull and Islay |
| S22000033 | Newton Stewart and Wigtown | S22000034 | Oban |
| S22000035 | Orkney Islands | S22000036 | Perth and Blairgowrie |
| S22000037 | Peterhead | S22000038 | Pitlochry |
| S22000039 | Shetland Islands | S22000040 | Skye and Lochalsh |
| S22000041 | St Andrews and Cupar | S22000042 | Stirling and Alloa |
| S22000043 | Stranraer | S22000044 | Thurso |
| S22000045 | Ullapool and Gairloch | S22000046 | Wick |
| W22000001 | Aberystwyth and Lampeter | W22000002 | Bangor, Caernarfon and Llangefni |
| W22000003 | Bridgend | W22000004 | Cardiff |
| W22000005 | Cardigan | W22000006 | Carmarthen and Llandovery |
| W22000007 | Dolgellau and Barmouth | W22000008 | Ebbw Vale and Abergavenny |
| W22000009 | Haverfordwest and Fishguard | W22000010 | Holyhead |
| W22000011 | Llandrindod Wells and Builth Wells | W22000012 | Llandudno and Colwyn Bay |

| TTWA | Area | TTWA | Area |
|---|---|---|---|
| W22000013 | Machynlleth and Tywyn | W22000014 | Merthyr Tydfil and Aberdare |
| W22000015 | Newtown and Welshpool | W22000016 | Pembroke and Tenby |
| W22000017 | Porthmadog and Ffestiniog | W22000018 | Pwllheli |
| W22000019 | Rhyl and Denbigh | W22000020 | Swansea Bay |

Table B6: TTWA codes and names according to the 2011 nomenclature

| **TTWA** | **Area** | **TTWA** | **Area** |
|---|---|---|---|
| E30000004 | Barnsley | E30000018 | Bradford |
| E30000029 | Halifax | E30000039 | Skipton |
| E30000046 | Dorchester and Weymouth | E30000051 | Falmouth |
| E30000054 | Grantham | E30000061 | Hastings |
| E30000064 | Hexham | E30000070 | Isle of Wight |
| E30000076 | Lancaster and Morecambe | E30000093 | Middlesbrough and Stockton |
| E30000095 | Minehead | E30000106 | Penrith |
| E30000108 | Peterborough | E30000110 | Poole |
| E30000124 | Spalding | E30000135 | Thetford and Mildenhall |
| E30000147 | Whitby | E30000159 | Andover |
| E30000160 | Ashford | E30000161 | Banbury |
| E30000162 | Barnstaple | E30000163 | Barrow-in-Furness |
| E30000164 | Basingstoke | E30000165 | Bath |
| E30000166 | Bedford | E30000167 | Bideford |
| E30000168 | Birkenhead | E30000169 | Birmingham |
| E30000170 | Blackburn | E30000171 | Blackpool |
| E30000172 | Blandford Forum and Gillingham | E30000173 | Blyth and Ashington |
| E30000174 | Boston | E30000175 | Bournemouth |
| E30000176 | Bridgwater | E30000177 | Bridlington |
| E30000178 | Bridport | E30000179 | Brighton |
| E30000180 | Bristol | E30000181 | Bude |
| E30000182 | Burnley | E30000183 | Burton upon Trent |
| E30000184 | Bury St Edmunds | E30000185 | Buxton |
| E30000186 | Cambridge | E30000187 | Canterbury |
| E30000188 | Chelmsford | E30000189 | Cheltenham |
| E30000190 | Chesterfield | E30000191 | Chichester and Bognor Regis |
| E30000192 | Clacton | E30000193 | Colchester |
| E30000194 | Corby | E30000195 | Coventry |
| E30000196 | Crawley | E30000197 | Crewe |
| E30000198 | Cromer and Sheringham | E30000199 | Darlington |
| E30000200 | Derby | E30000201 | Doncaster |
| E30000202 | Dudley | E30000203 | Durham and Bishop Auckland |

| TTWA | Area | TTWA | Area |
|---|---|---|---|
| E30000204 | Eastbourne | E30000205 | Evesham |
| E30000206 | Exeter | E30000208 | Folkestone and Dover |
| E30000209 | Gloucester | E30000210 | Great Yarmouth |
| E30000211 | Grimsby | E30000212 | Guildford and Aldershot |
| E30000214 | Harrogate | E30000215 | Hartlepool |
| E30000216 | Hereford | E30000218 | High Wycombe and Aylesbury |
| E30000219 | Huddersfield | E30000220 | Hull |
| E30000221 | Huntingdon | E30000222 | Ipswich |
| E30000223 | Kendal | E30000224 | Kettering and Wellingborough |
| E30000225 | King's Lynn | E30000226 | Kingsbridge and Dartmouth |
| E30000227 | Launceston | E30000228 | Leamington Spa |
| E30000229 | Leeds | E30000230 | Leicester |
| E30000231 | Lincoln | E30000232 | Liskeard |
| E30000233 | Liverpool | E30000234 | London |
| E30000235 | Lowestoft | E30000236 | Ludlow |
| E30000237 | Luton | E30000238 | Malton |
| E30000239 | Manchester | E30000240 | Mansfield |
| E30000241 | Margate and Ramsgate | E30000242 | Medway |
| E30000243 | Milton Keynes | E30000244 | Newbury |
| E30000245 | Newcastle | E30000246 | Northallerton |
| E30000247 | Northampton | E30000248 | Norwich |
| E30000249 | Nottingham | E30000250 | Oxford |
| E30000252 | Penzance | E30000253 | Plymouth |
| E30000254 | Portsmouth | E30000255 | Preston |
| E30000256 | Reading | E30000257 | Redruth and Truro |
| E30000258 | Salisbury | E30000259 | Scarborough |
| E30000260 | Scunthorpe | E30000261 | Sheffield |
| E30000262 | Shrewsbury | E30000263 | Sidmouth |
| E30000264 | Skegness and Louth | E30000266 | Slough and Heathrow |
| E30000267 | Southampton | E30000268 | Southend |
| E30000270 | St Austell and Newquay | E30000271 | Stafford |
| E30000272 | Stevenage and Welwyn Garden City | E30000273 | Stoke-on-Trent |
| E30000274 | Street and Wells | E30000275 | Sunderland |
| E30000276 | Swindon | E30000277 | Taunton |

| TTWA | Area | TTWA | Area |
|---|---|---|---|
| E30000278 | Telford | E30000279 | Torquay and Paignton |
| E30000280 | Trowbridge | E30000281 | Tunbridge Wells |
| E30000282 | Wadebridge | E30000283 | Wakefield and Castleford |
| E30000284 | Warrington and Wigan | E30000285 | Weston-super-Mare |
| E30000286 | Whitehaven | E30000287 | Wisbech |
| E30000288 | Wolverhampton and Walsall | E30000289 | Worcester and Kidderminster |
| E30000290 | Workington | E30000291 | Worksop and Retford |
| E30000292 | Worthing | E30000293 | Yeovil |
| E30000294 | York | K01000005 | Cinderford and Ross-on-Wye |
| K01000009 | Berwick | K01000010 | Carlisle |
| K01000011 | Chester | K01000013 | Newport |
| K01000014 | Oswestry | N12000001 | Ballymena |
| N12000002 | Belfast | N12000003 | Coleraine |
| N12000004 | Cookstown and Magherafelt | N12000005 | Craigavon |
| N12000006 | Derry | N12000007 | Dungannon |
| N12000008 | Enniskillen | N12000009 | Newry and Banbridge |
| N12000010 | Omagh and Strabane | S22000005 | Campbeltown |
| S22000013 | Western Isles | S22000032 | Mull and Islay |
| S22000035 | Orkney Islands | S22000039 | Shetland Islands |
| S22000047 | Aberdeen | S22000048 | Alness and Invergordon |
| S22000049 | Arbroath and Montrose | S22000050 | Aviemore and Grantown-on-Spey |
| S22000051 | Ayr | S22000052 | Broadford and Kyle of Lochalsh |
| S22000053 | Dalbeattie and Castle Douglas | S22000054 | Dumbarton and Helensburgh |
| S22000055 | Dumfries | S22000056 | Dundee |
| S22000057 | Dunfermline and Kirkcaldy | S22000058 | Dunoon and Rothesay |
| S22000059 | Edinburgh | S22000060 | Elgin |
| S22000061 | Falkirk and Stirling | S22000062 | Fort William |
| S22000063 | Galashiels and Peebles | S22000064 | Girvan |
| S22000065 | Glasgow | S22000066 | Golspie and Brora |
| S22000067 | Hawick and Kelso | S22000068 | Inverness |
| S22000069 | Kilmarnock and Irvine | S22000070 | Livingston |

| TTWA | Area | TTWA | Area |
|---|---|---|---|
| S22000071 | Motherwell and Airdrie | S22000072 | Newton Stewart |
| S22000073 | Oban | S22000074 | Perth |
| S22000075 | Peterhead | S22000076 | Pitlochry and Aberfeldy |
| S22000077 | Portree | S22000078 | St Andrews and Cupar |
| S22000079 | Stranraer | S22000080 | Thurso |
| S22000081 | Turriff and Banff | S22000082 | Ullapool |
| S22000083 | Wick | S22000084 | Fraserburgh |
| S22000085 | Greenock | S22000086 | Lochgilphead |
| W22000003 | Bridgend | W22000009 | Haverfordwest and Milford Haven |
| W22000011 | Llandrindod Wells and Builth Wells | W22000015 | Newtown and Welshpool |
| W22000016 | Pembroke and Tenby | W22000021 | Aberystwyth |
| W22000022 | Bangor and Holyhead | W22000023 | Brecon |
| W22000024 | Cardiff | W22000025 | Cardigan |
| W22000026 | Colwyn Bay | W22000028 | Llanelli |
| W22000029 | Merthyr Tydfil | W22000030 | Pwllheli and Porthmadog |
| W22000031 | Rhyl | W22000032 | Swansea |
| W22000033 | Tywyn and Dolgellau | W22000034 | Wrexham |