InFoMM
Industrially Focused
Mathematical Modelling

UNIVERSITY OF
OXFORD

Labour market impacts of the post-carbon transition in the US: A networks perspective

Anna
Berryman

The United Nations believes that 'climate change is the defining issue of our time' and if we are to achieve many of the net-zero carbon goals set out by countries across the globe, we need to understand how a rapid transition to a net-zero economy will affect every aspect of society. There is a significant concern about the possible impact on employment, particularly for workers currently employed in emissions-intensive jobs.

The UK Government Department for Business, Energy and Industrial Strategy (BEIS) are interested in understanding all aspects of the economy and in particular the labour market. We aim to provide new insights into the effect of a post-carbon transition demand shock on the United States labour market.

Previous studies aiming to quantify the employment impact of environmental policies often rely on models that assume labour to be unrealistically flexible. There is also little regard for the geographical concentration of employment in emissions-intensive industries, the challenges that these workers may face in transitioning into other lines of work, or how this transition may exacerbate inequality.

Our aim is to address a number of these shortcomings by extending a network model of the labour market developed in Oxford to understand the labour market impacts of automation. In addition to the overall effects that the post-carbon transition will have on employment, many jobs that will be greatly affected are highly geographically concentrated. We are interested in using this labour market network model to explain this geographical concentration at the state and metropolitan and nonmetropolitan area levels.

In order to gain insights into the impacts that the post-carbon transition will have on the United States' labour market, we incorporate employment, unemployment, and vacancies open for each job into the model. We use a list of 464 jobs including 'cashiers', 'physicians and surgeons', and 'first-line supervisors of production and operating workers'. We model the behaviour of workers by describing the flow of workers between jobs using random processes for how vacancies open, how workers are fired from their positions, and how workers apply for jobs.

The unique aspect of our model is that we represent the jobs of interest as nodes in a network. We consider two different jobs networks. In the *occupational mobility network*, directed edges are drawn from one job to another if a worker made this transition between January 2010 and January 2017 in the United States. In the other, the *jobspace network*, jobs are connected with an edge if they share common work activities. We use 332 work activities described by the O*NET database including general activities such as 'assign work to others' as well as specialised activities including 'evaluate patient or client condition or treatment options'.

Many previous models assume that workers can freely transition between any jobs, regardless of their skills; this is not the case in reality. A network-based approach creates a more realistic model of job transitions made by workers. Our network model also makes it simple to detect secondary effects from a demand shock. For example, jobs not directly affected by the post-carbon transition will be indirectly affected by supply and demand changes felt by their neighbours.

UKRI Engineering and Physical Sciences Research Council

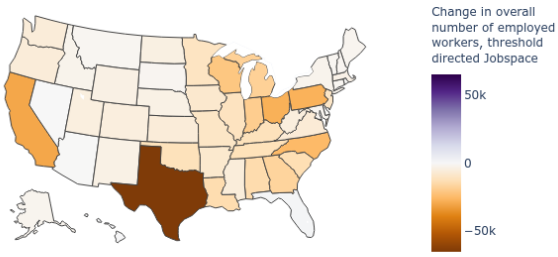

Figure 1 – Change in employment during demand shock by state, threshold directed Jobspace network

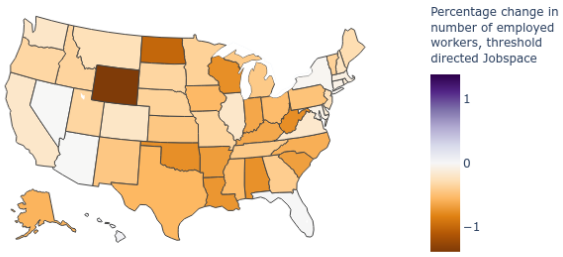

Figure 2 – Percentage change in employment during demand shock by state, threshold directed Jobspace network

We then quantify how much disruption each job is likely to experience during the post-carbon transition. We draw on a previous study which classifies occupations as emissions-intensive if they are more likely to be employed in emissions-intensive industries. We assume that the demand shock felt by each emissions-intensive occupation will be equivalent to reducing the demand proportional to the number of workers in emissions-intensive industries within that occupation.

Combining the labour market model, the jobspace network, and a demand shock, we are able to gain novel insight into the impact that the post-carbon transition might have on the United States. In Figure 1, we see that, during the demand shock, Texas is predicted to see the greatest fall in employment (losing 57,000 jobs), as well as California (22,000) and states in the east, including Ohio (25,600), Pennsylvania (24,500) and North Carolina (25,000). When looking as a percentage of the total state workforce however, as shown in Figure 2, Wyoming stands out with a decrease in employment of 1.4% during the demand shock. Other states worthy of note with a high percentage decrease in employment include North Dakota (1.0%), West Virginia (0.77%), and Wisconsin (0.77%).

We also carry out the analysis on metropolitan and nonmetropolitan areas. This reveals large decreases in employment in oil and gas related emissions-intensive jobs in the cities of Houston and Dallas in Texas; as well as suggesting a high percentage of the jobs lost in Alabama will be in textile-related emissions-intensive roles. The results indicate that climate policies aimed at mitigating the labour market effects of the post-carbon transition need to reflect the geographical concentration of different emissions-intensive jobs.

Summary

Our results give insight into how individual occupations might be affected by the post-carbon transition. We also show that the heterogeneity of the labour market across the United States, in different states and different metropolitan and nonmetropolitan areas, results in differences in the effects that the post-carbon transition might have. Our work will provide a new lens for BEIS to analyse the future of labour markets as we transition to a net-zero economy.

James Foster and Alice Lazzati from BEIS said:

> *Anna has worked with two analytical teams in International and Domestic Climate Strategy at BEIS. She has been an extremely helpful and effective collaborator, laying out the basis of a methodology that we can use to address an emerging evidence gap in our policy area. By starting to develop a network model to assess labour market impacts in high carbon sectors associated with climate transitions (which can later be adapted to understand broader transition patterns to growing low carbon sectors), this research has, and will, contribute significantly to our understanding of the risks arising from shifts in major economies as they transform to meet their climate targets. Anna has quickly understood how to integrate the bigger policy picture into her research, delivering value for BEIS and other partners involved in the process.*