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- Emerging Risk Assessment & Underwriting
- Human Rights & Development Practice
- Consumers in Society
- Psychological Science in Business
- Privatisation & PPP
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- Economics of Innovation and Policy

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Modular structure in labour networks reveals skill basins

Neave O'Clery, Stephen Kinsella

Synopsis

Ideas are the currency of a knowledge economy. Positive spillovers usually take the form of people moving, taking their ideas and know-how with them, from company to company. Multinational companies have excellent managerial skills and lots of ideas, and if we saw multinational employees leaving to set up startups or join indigenous tech companies, that would suggest a deeper embedding of capabilities in the indigenous sector, which would be good for long term economic growth.

In our paper, we detect skill-based industrial clusters via the inter-industry labour flow network. We use these clusters to measure the skilled workforce available to an industry. We then show that this metric is predictive of industry-city employment growth in the UK, and we finally exploit this multiscale structure to find an 'optimal' cluster size for labour pooling.

Introduction and Background

There is an emerging consensus in the literature that locally embedded capabilities and industrial know-how are key determinants of growth and diversification processes. In order to model these dynamics as a branching process, whereby industries grow as a function of the availability of related or relevant skills, industry networks are typically employed. These networks, sometimes referred to as industry spaces, describe the complex structure of the capability or skill overlap between industry pairs, measured here via inter-industry labour flows.

Existing models typically deploy a local or 'nearest neighbour' approach to capture the size of the labour pool available to an industry in related sectors. This approach, however, ignores higher order interactions in the network, and the presence of industry clusters or groups of industries which exhibit high internal skill overlap.

We argue that these clusters represent skill basins in which workers circulate and diffuse knowledge, and delineate the size of the skilled labour force available to an industry. By applying a multi-scale community detection algorithm to this network of flows, we identify industry clusters on a range of scales, from many small clusters to few large groupings.

We construct a new variable, cluster employment, which captures the workforce available to an industry within its own cluster. Using UK data we show that this variable is predictive of industry-city employment growth and, exploiting the multi-scale nature of the industrial clusters detected, propose a methodology to uncover the optimal scale at which labour pooling operates.

Issues and Questions Considered

Regions are dependent on what they know. This is the fundamental tenet on which a large literature is based originating in the pioneering ideas of evolutionary economists *Nelson and Winter (1982)*. Much of this literature speaks of evolutionary 'branching' of economic activities, whereby regions accumulate capabilities as workers learn on the job and then use this know-how to diversify into new economic activities in a path dependent manner.

In order to model development paths for a region, it has been common to predict the entry of new industries or the growth of industry-specific employment using metrics based on the size or concentration of local employment in 'related industries'. This type of metric captures the level of available relevant capabilities in the local economy. This 'related diversification' literature has probed a wide range of questions around local growth paths, including employment and export growth, firm and sector entry, and technological change.

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Methodology

Our aim is to detect groups of industries that exhibit high internal worker mobility in the form of network communities. There are a wide array of algorithms and techniques to perform this task as outlined above. Most community detection algorithms are composed of two components: an optimization criteria which is minimized (or maximized) by a particular partition of the nodes, and a searching algorithm which looks for the best node partition to satisfy the optimization criteria.

We develop a new community detection method based on network mathematics.

We use the UK Annual Survey of Hours and Earnings dataset (ASHE) in order to construct the inter-industry flow matrix. This dataset enables us to track the industry code of a large cohort of UK employees over the period 2009 to 2018. Specifically, it contains anonymised demographic and employment information of 1% of the total employee jobs in the HM Revenue & Customs (HMRC) Pay As You Earn (PAYE) records.

Outcomes and Findings

In this paper we extend the literature on defining industrial clusters and develop the conceptual and modelling toolbox of evolutionary economic geography by connecting commonly used metrics for 'related employment' to skill-based industrial clusters. In particular, we develop a methodology based on multi-scale community detection to uncover the statistically optimal scale at which inter-industry labour pooling operates in terms of supporting industry employment growth. Applying our model to data from the UK, we find that key sectors merge to form integrated labour pools.

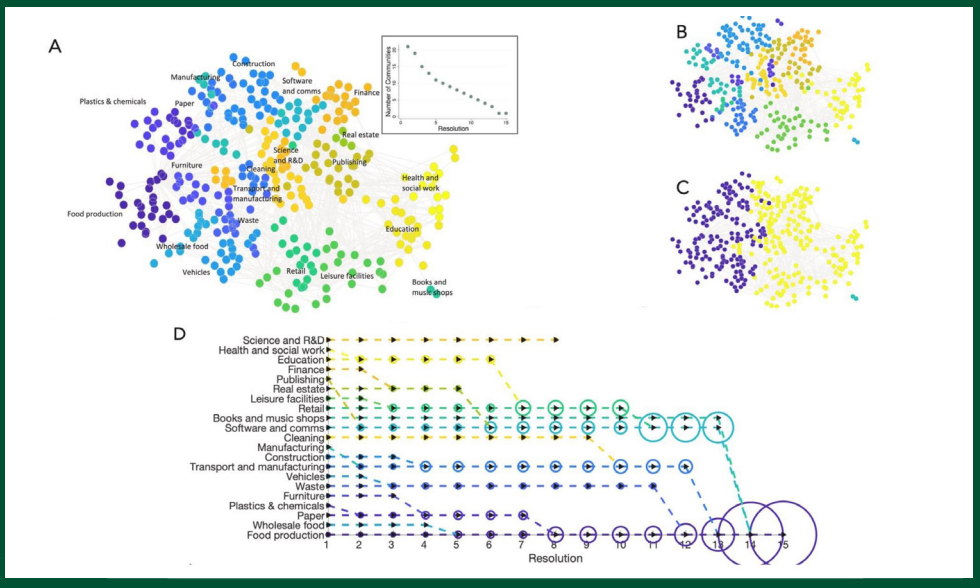
We contribute to a current push to exploit tools from network and data science to probe the complex dynamics underlying the labour market. Specifically, we link the topological structure of the labour mobility network to industry employment growth dynamics in a way that is both novel and founded in economic theory. A graphical summary of our results is shown below.

Fig. 1A shows a visualisation of the labour flow network for the UK. The node layout is based on a spring algorithm called 'Force Atlas' in Gephi.2 Edges are shown over a threshold . We observe a large degree of clustering of related industries, with public services broadly located on the far right-hand side, retail leisure on the bottom right and finance and professional activities on the top right. Manufacturing and related industries appear slightly less clustered and dominate the left, with construction on the top left and food and farming on the bottom left. In order to systematically extract industry groupings corresponding to labour mobility and skill sharing patterns, we apply a community detection algorithm as introduced above. A key feature of this algorithm is that it produces not one, but several node partitions corresponding to industry clusters at different scales.

The inset of Fig. 1A shows the number of communities as the resolution parameter increases. As the parameter increases, the community detection algorithm finds increasingly larger industry clusters, effectively merging smaller clusters into large industry groupings3 Fig. 1B and C shows the communities at resolutions , and 13.

A couple of features are evident at first glance. For example, by services including the public sector and finance have merged with business and software activities (yellow cluster), but remain distinct from retail, farming, manufacturing and construction (blue cluster). This highlights a clear segmentation of the economy, whereby workers and skills rarely transition from services to manufacturing and vice versa. This is a particularly striking finding which is consistent with the well established view that large swathes of traditional 'blue collar' workers are being left behind in the 'knowledge economy'.

This analysis highlights the heterogeneous nature of industry clusters based skill-sharing. As opposed to official sectoral groupings, some industries cluster into tightly knit groups of very similar activities, rarely exchanging workers with other sectors. Other industries are connected to a diverse set of other industries, exhibiting a large number of connections and flows. These groupings ebb and flow as the resolution parameter changes, implicitly tuning the degree of connectivity required for cluster formation. This motivates us to consider a bespoke 'neighbourhood' for each node when estimating the size of its labour pool, with neighbourhood size dependent on the resolution selected, as captured by our cluster employment variable.



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Forthcoming Research Bulletin

Title: The Fundamental Review of the Trading Book: Implications for portfolio and risk management in the banking sector.

Authors:
McCullagh, O., Cummins, M. and Killian, S.

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