Using data and networks to unravel the forces of urban agglomeration

Project 1

Cities are naturally constrained by their current resources, and the proximity of their current capabilities to new opportunities [3, 5]. This simple fact gives rise to a notion of path dependence that may be described using a network where nodes represent industries and edges represent capability overlap. This network can be seen as modelling the opportunity landscape of cities: where a particular city is located in this network (i.e., its industries) will determine its future diversification potential [5, 15, 16]. A city located in a central well-connected region has many options, but one with only few peripheral industries has limited opportunities. Such models are informative about a range of economic processes, particularly in a developing country context, concerning the growth of formal employment and industrial diversification of cities [16].

These networks can be built using a variety of data-sources to assign the edge weights (the 'relatedness' between industries) including geographic co-location or inter-industry job switches, see project 2 for examples and citations. Mathematically, we can think about a diffusion process on the network describing the diversification of a city: the current industry presences in the city correspond to the initial condition for dynamics governed by the network structure [5]. Yet, while the language of path dependence, complex systems and network dynamics is ubiquitous in this literature, most studies do not fully embrace a global approach to network analysis in a mathematical sense.

Here we will build on previous work [1] that adapts existing metrics to account for the network structure via the detection of 'industry clusters' in the network, and further develop and apply this approach to a range of models to predict city-industry employment growth and diversification in variety of countries.

Project 2

Firms or industries tend to cluster in cities for several reasons depending on their needs, but typically to reduce costs such as shipping costs, searching and matching costs via labour market pooling, and promote knowledge sharing. These are the so-called Marshallian channels [10]. While it has long been understood that it is these 'externalities' that lie at the root of the success of cities, measuring their impact, and modelling their behaviour and dynamics, remains a challenge. In particular their has been little success in estimating the relative importance of each Marshallian channel to firms' decisions - a key question for city planners and policy-makers.

While it is difficult to directly measure or model these externalities for individual industries, recent approaches have sought to estimate instead the similarity of industry pairs in terms of their reliance on each channel [11]. For example, chemical and pharmaceutical companies might rely on access to a similar labour pool, and hence they would be deemed similar in terms of the labour pooling channel. We use geographic co-location of industries as a general metric for capability overlap or agglomeration [5], production-input similarity as a proxy for input-sharing [12], the transitions of workers between industries as a proxy for labour sharing [13], and the appearance of industry pairs on patents as a proxy for knowledge sharing [11]. Each of these industry similarity metrics gives rise to a distinct network, where nodes are industries, and the edges connecting industries are governed by distinct agglomeration channels. Note: These networks correspond to variations the industry networks mentioned in project 1, and each capture a different type of 'relatedness' or similarity between industries. The Marshallian perspective provides a framework in which to study the relationship between these networks.

Previous work has sought to disentangle the relationship between the co-agglomeration and labour sharing/input-output networks at both a whole network [11], industry-level [14] and modular (industry-cluster) [2] scale, the latter two studies demonstrating distinct heterogeneity in the strength of Marshallian channels across the network. Here we will build on this work to explore the role of this variation in the prediction of urban diversification patterns. In other words, we ask to what extent identifying the type of linkages present and possible in a city enables us to better predict urban growth patterns.

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