

THE ECONOMIC INTERDEPENDENCE OF INDUSTRIES: A NETWORK SCIENCE APPROACH

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BACKGROUND

Economic input-output (EIO) models represent, in mathematical form, the monetary transactions between industry sectors. They specify what goods and services (output) are consumed by other industries (input) and can be transformed into **production networks**.



OBJECTIVE

This study focuses on the interdependence of different industries and wishes to examine how sectors support each other in growth by modelling production networks from EIO models. The research questions include whether the production networks have a **defined topology**, whether it changes in time, and which top industries stay the same.



METHODOLOGY

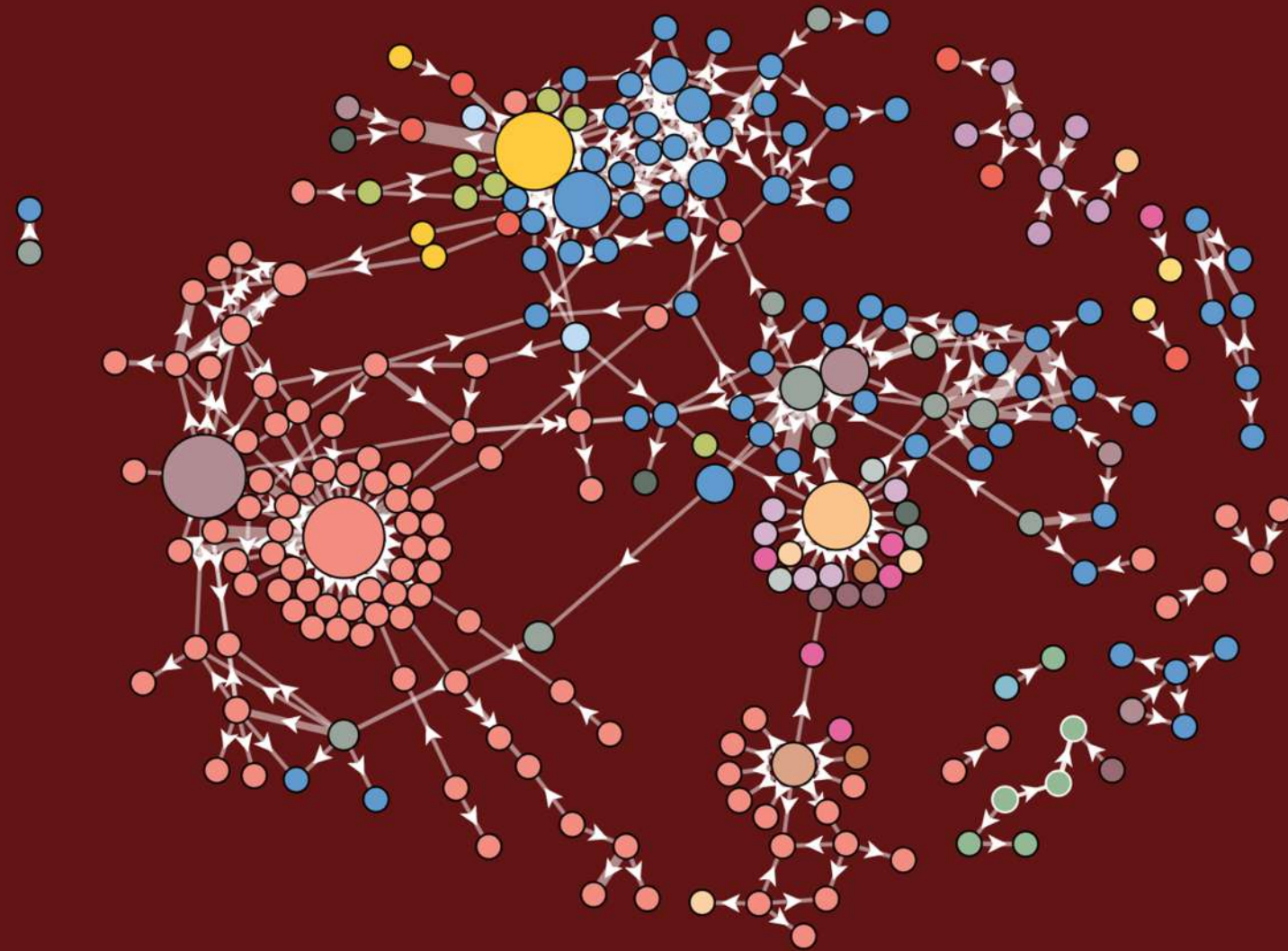
We develop and explore the detail-level network of 405 sectors. For data sources, we use the newest **US Input-Output Accounts Data** from 2007 and 2012. We examine their **topology** and **centrality metrics** under various thresholds for what represents a supporting link between two industries.



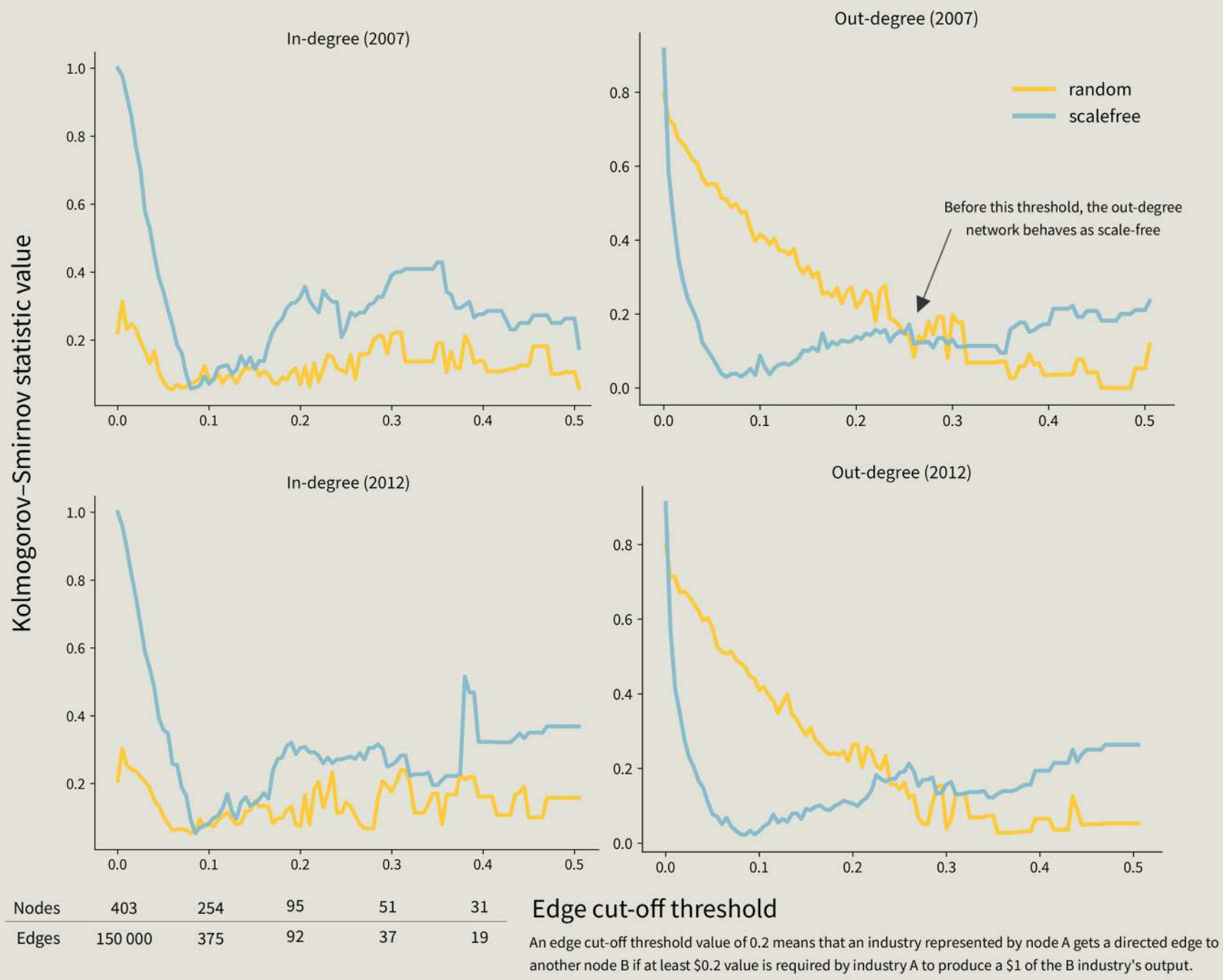
FINDINGS

Our research argues that we must analyse detail-level models with a high number of sub-sectors to understand the most accurate structure of the network of industries. We find that the production network is susceptible to a defined **threshold** and that the field of sectors is **asymmetric**.

Production network (2012 | threshold > 0.1)

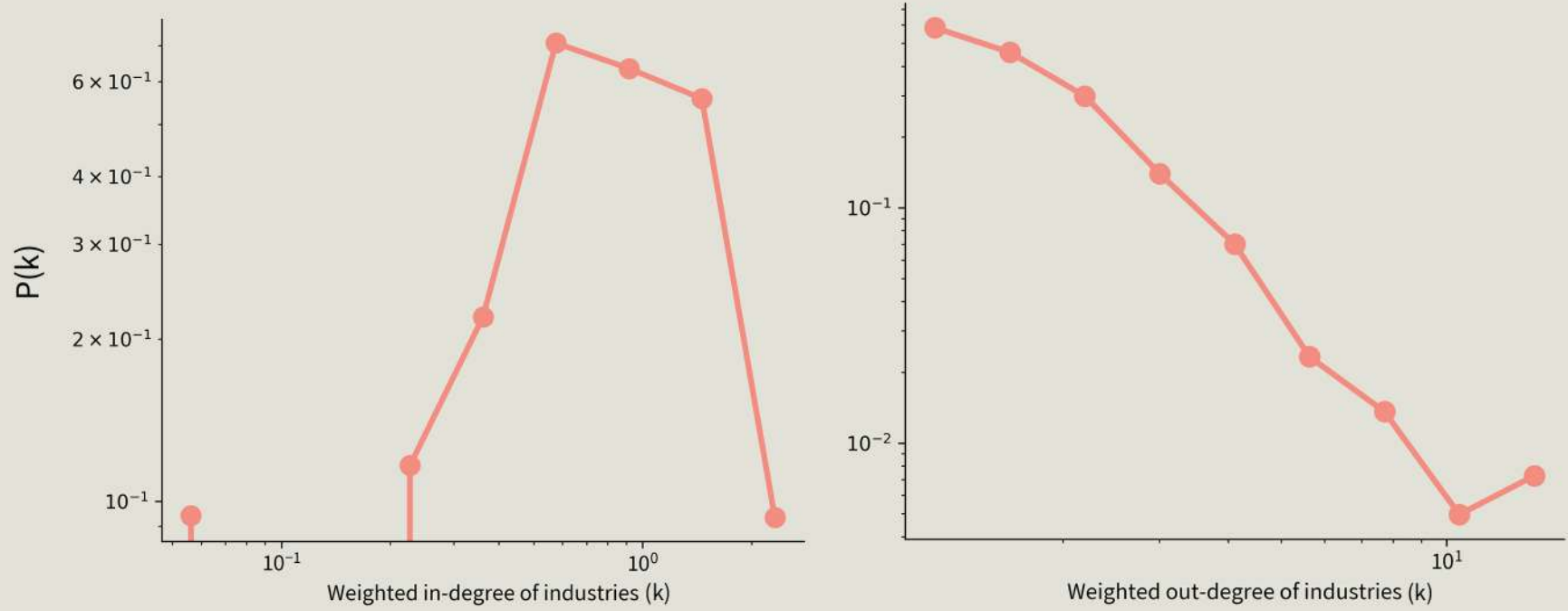


TOPOLOGICAL SHIFT



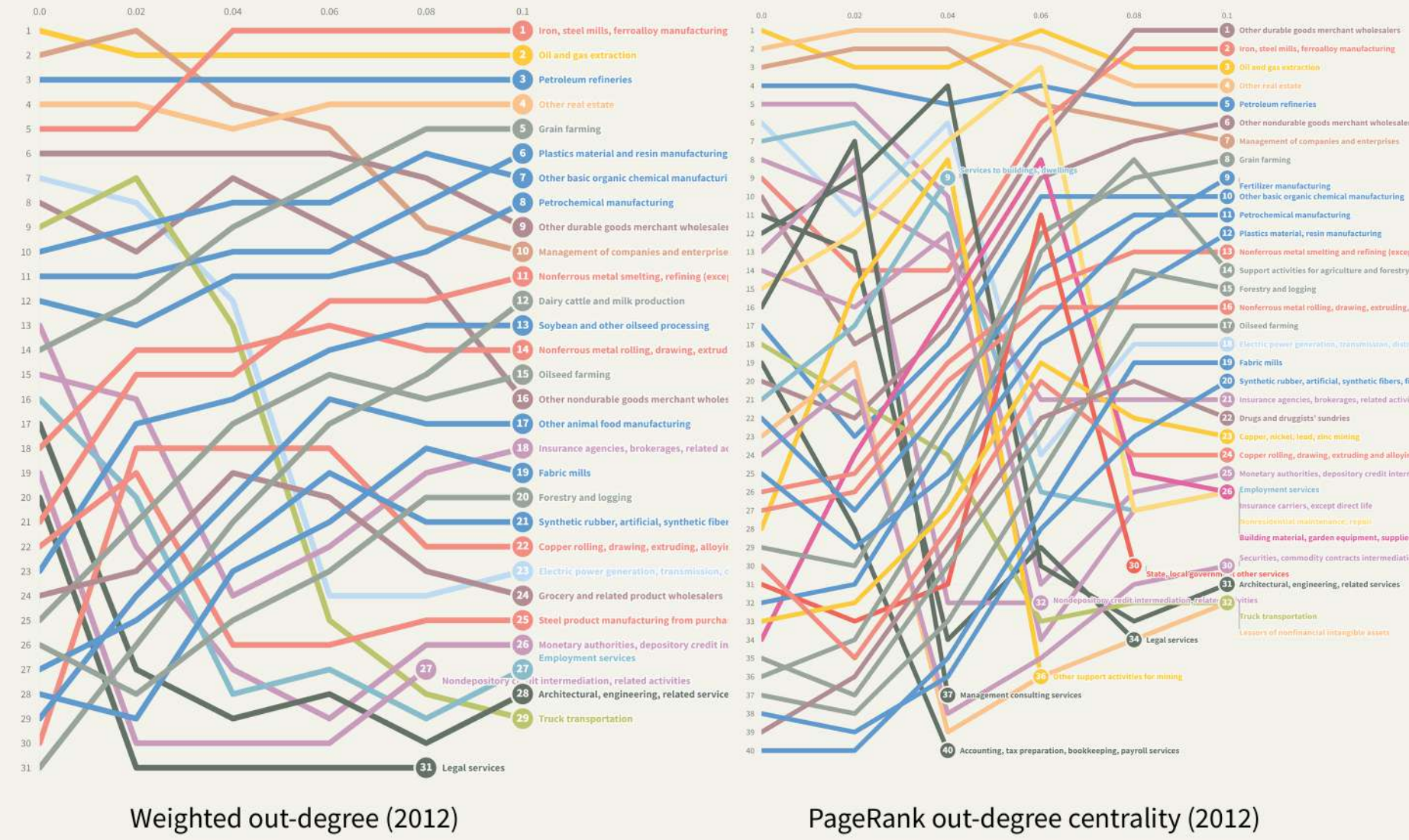
The **threshold** is associated with the value of the links, representing inter-industry trade in monetary expression. We define 100 thresholds with equal intervals and cut the graph. We generate a **scale-free and random graph** with the same parameters as our production network at each cut-off point. With the help of the **Kolmogorov-Smirnov test**, we compare the two distributions at each threshold (the generated graph's to our production network's). We find that the industry inter-dependence network topology is **highly sensitive to the threshold value** and goes through a 'scale-free - random' **topology shift** as we increase the cut-off point. The in-degree network has a topology more similar to a random network than that of a scale-free network, regardless of its edge cut-off threshold.

ASYMMETRY IN IN-DEGREE AND OUT-DEGREE DISTRIBUTION



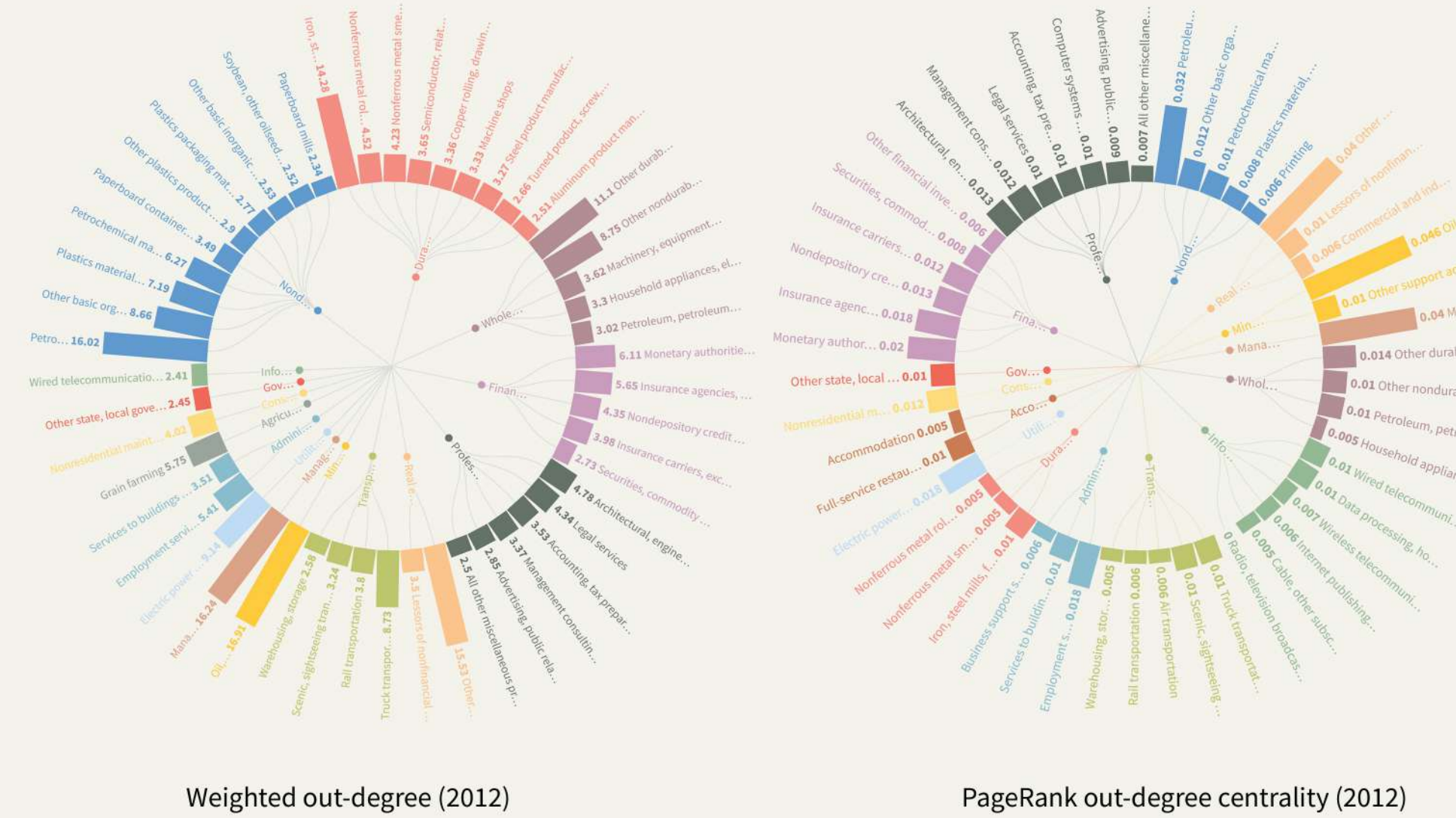
We find an apparent **asymmetry in topology** from the in-degree and out-degree dimensions. It is noticeable when considering the weights of the links and when comparing the two distributions at cut-off points without taking into account the scale of the transactions.

NODE-LEVEL THRESHOLD SENSITIVITY



When analysing the top industries according to **weighted out-degree** and **centrality** at each threshold value, we find that the top 3 industries tend to remain the same. Although there are big falls, some industries support others with minor value transactions, and the **threshold change** cuts these off. Therefore, we can conclude that threshold matters at node-level too.

DETAIL-LEVEL ANALYSIS FOR THE MOST ACCURATE STRUCTURE



Most research in production networks looks at **aggregate-level data**. We argue that the aggregate-level doesn't give the most relevant picture. Some aggregate categories have only one sub-category in the top lists (mining, management of companies and enterprises), while others have multiple (nondurable goods, wholesale trade). This **distorts the analysis of production networks**. On the other hand, industries grouped in categories are quite arbitrary; therefore, it can be questionable when analysing 'super-industries'. Here we showed top industries at detail-level and sector-level according to weighted out-degree representing how big an industry is in **monetary terms** in the production network and according to PageRank centrality representing how key an industry is in **terms of location** in the network.