The Changing Input-Output Network Structure of the U.S. Economy

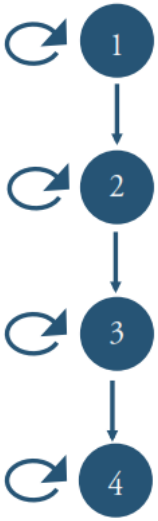
By Andrew Foerster and Jason Choi

Network Structures of Four Example Economies

Economy A

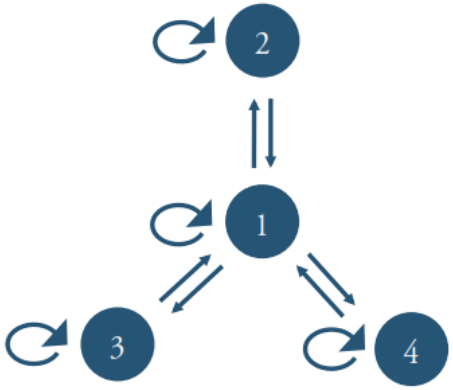
Network density = 0.25
Centrality of industry 1 = 0.25
Centrality of industry 2 = 0.25
Centrality of industry 3 = 0.25
Centrality of industry 4 = 0.25

Economy B



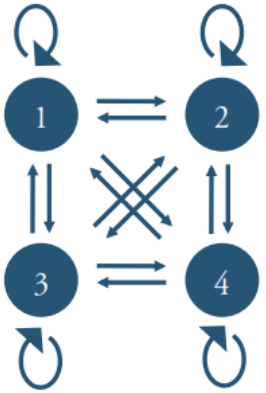
Network density = 0.4375
Centrality of industry 1 = 0.37
Centrality of industry 2 = 0.24
Centrality of industry 3 = 0.22
Centrality of industry 4 = 0.17

Economy C



Network density = 0.625
Centrality of industry 1 = 0.4
Centrality of industry 2 = 0.2
Centrality of industry 3 = 0.2
Centrality of industry 4 = 0.2

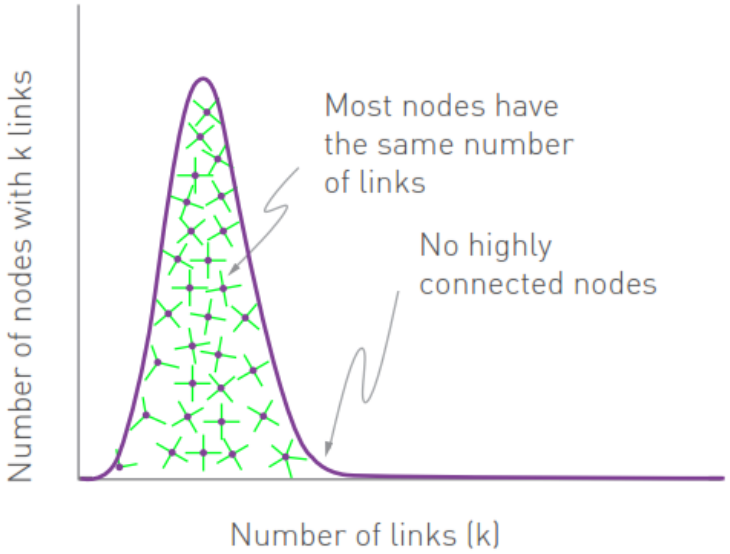
Economy D



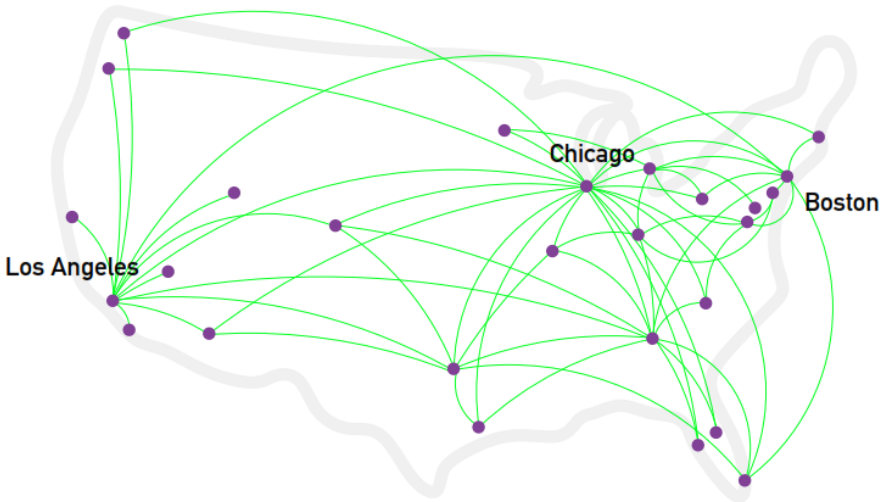
Network density = 1.0
Centrality of industry 1 = 0.25
Centrality of industry 2 = 0.25
Centrality of industry 3 = 0.25
Centrality of industry 4 = 0.25

Highway network

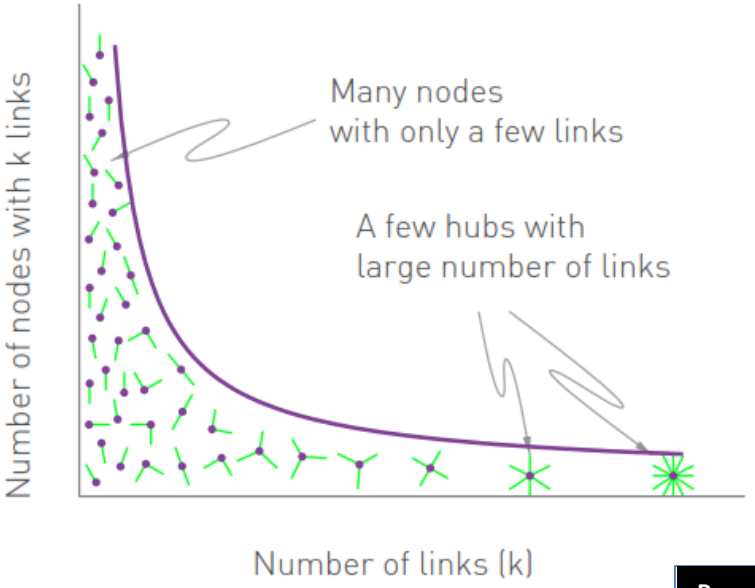
POISSON



Air-traffic network

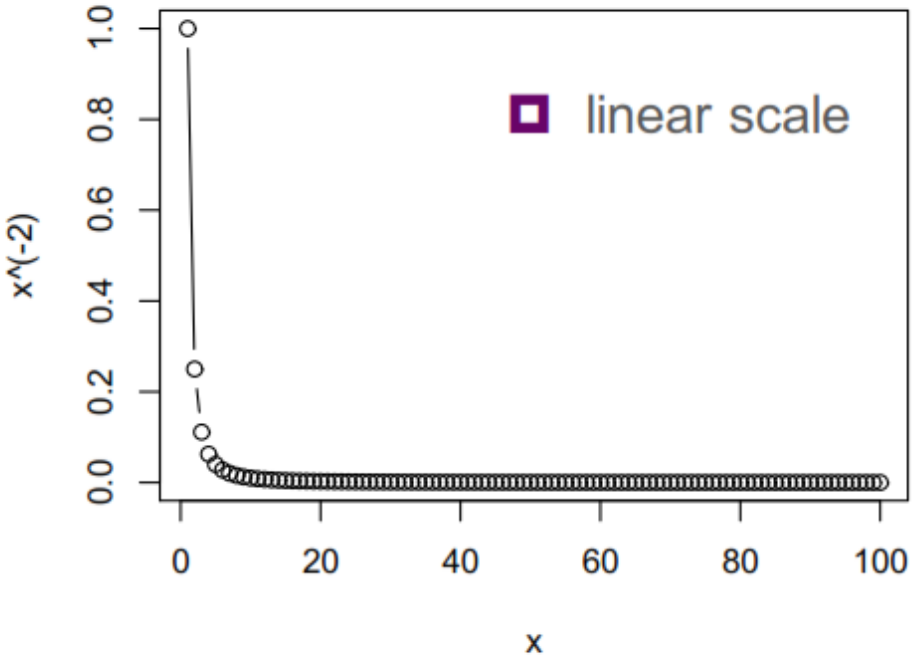


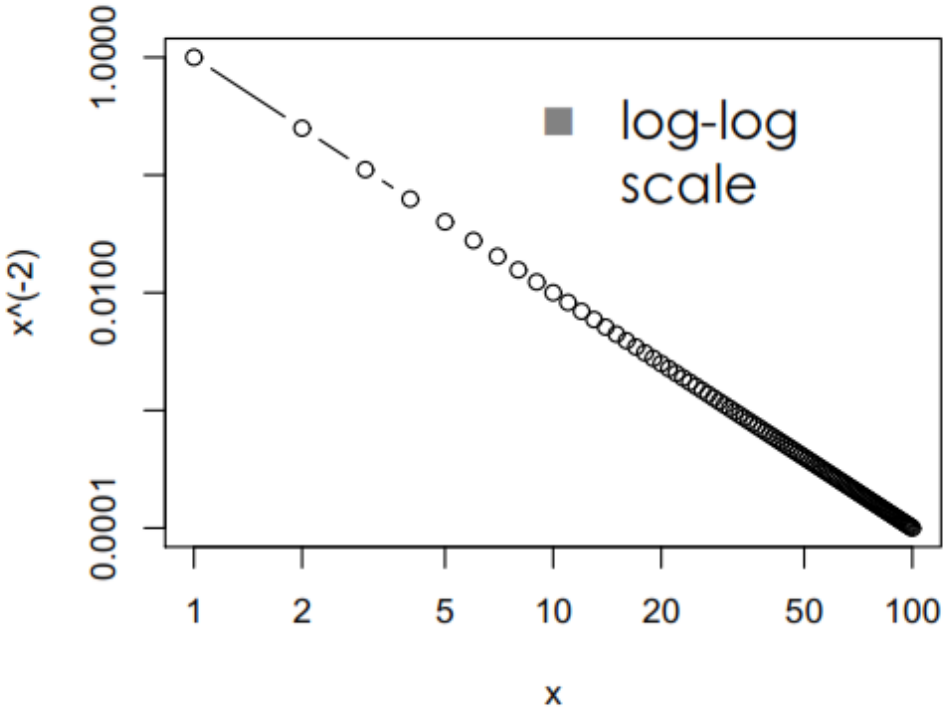
POWER LAW



Source: Barabási (2016)

Power-law distribution

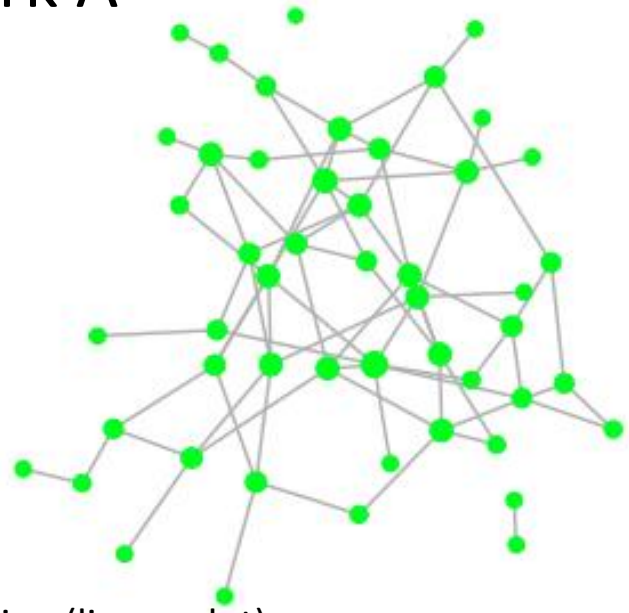




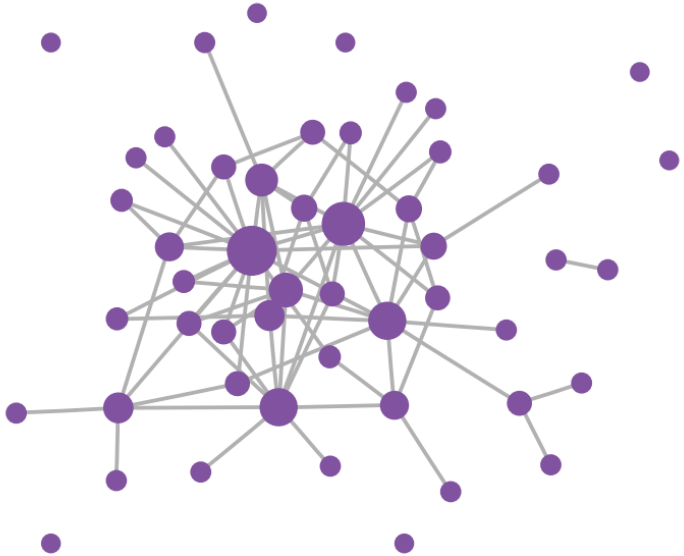
- High skew (asymmetry)
- Straight line on a log-log plot

Source: http://snap.stanford.edu/class/cs224w-2015/slides/04-powerlaws.pdf

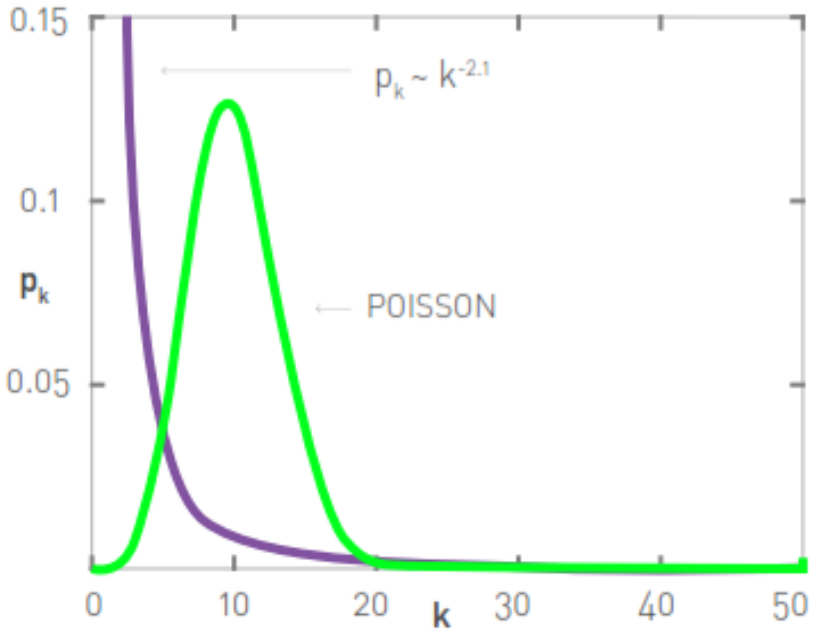
Network A



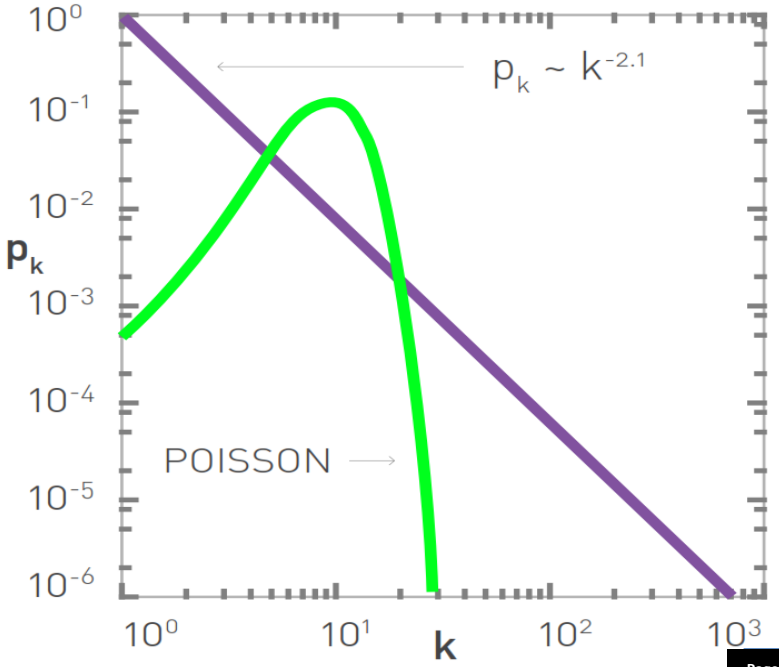
Network B



Distribution (linear plot)

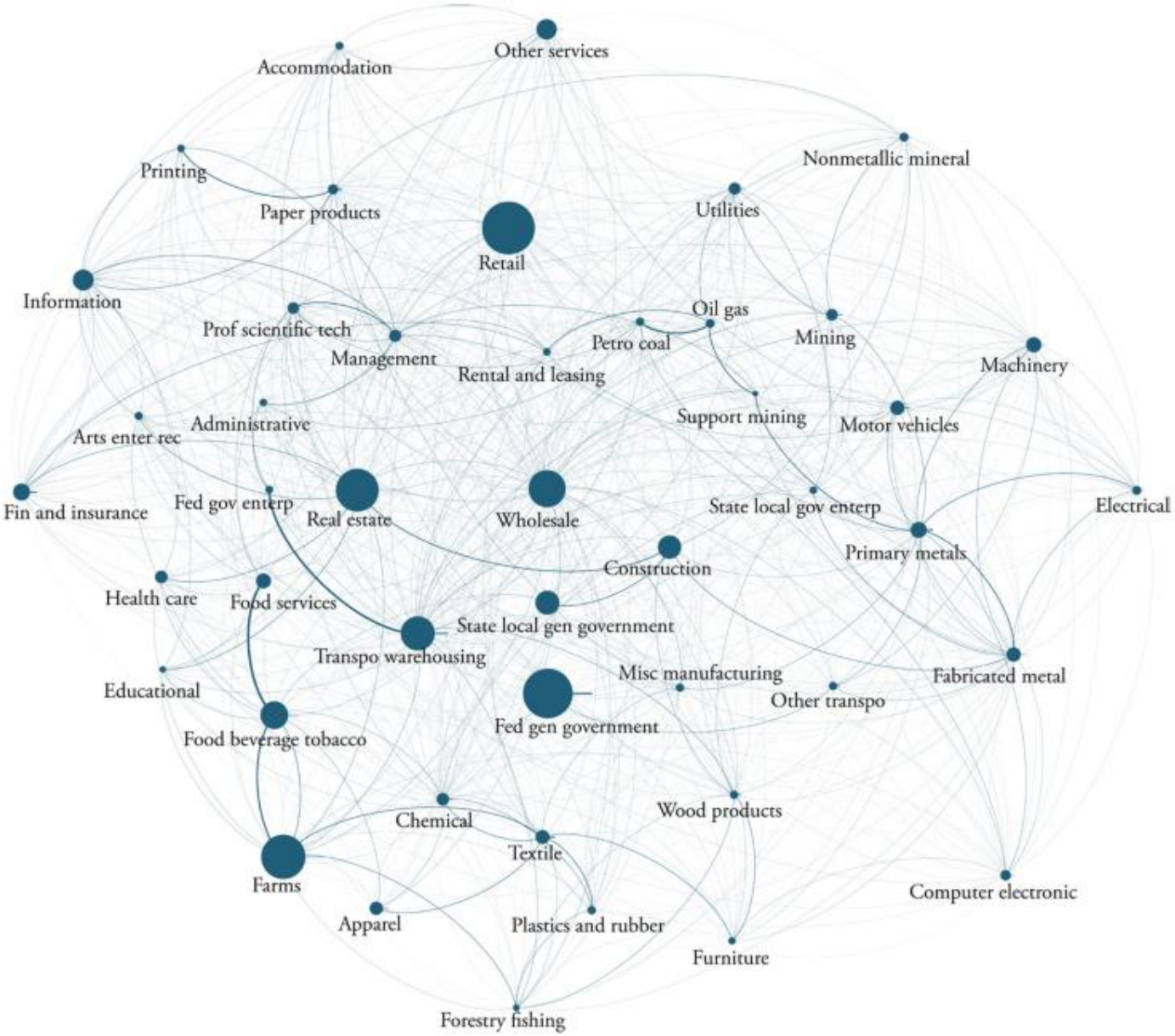


Distribution (log-log plot)



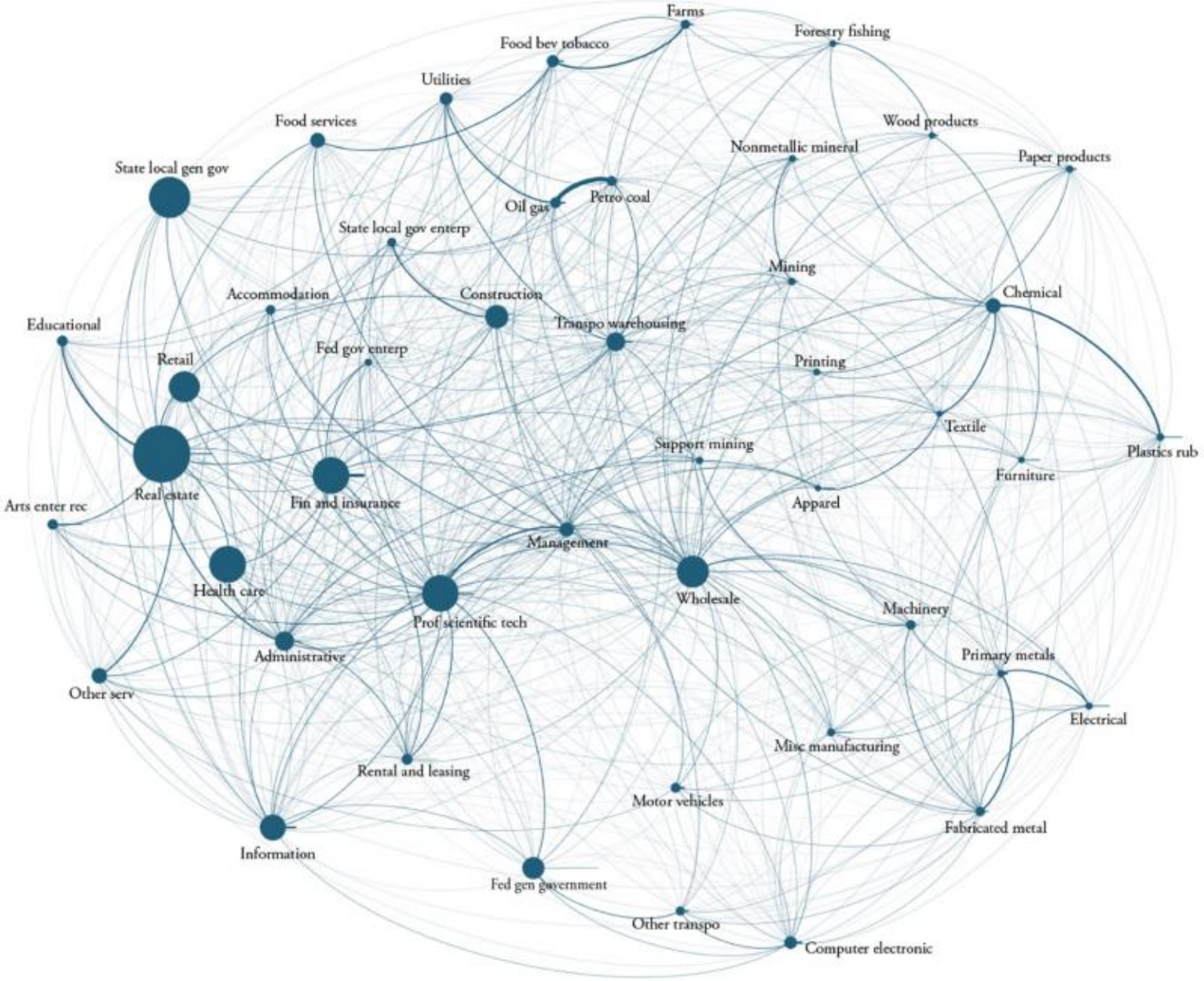
Source: Barabási (2016)

The U.S. Input-Output Network in 1947



Sources: Bureau of Economic Analysis and authors' calculations.

The U.S. Input-Output Network in 2015



Sources: Bureau of Economic Analysis and authors' calculations.

Chart 1

Changing Network Density

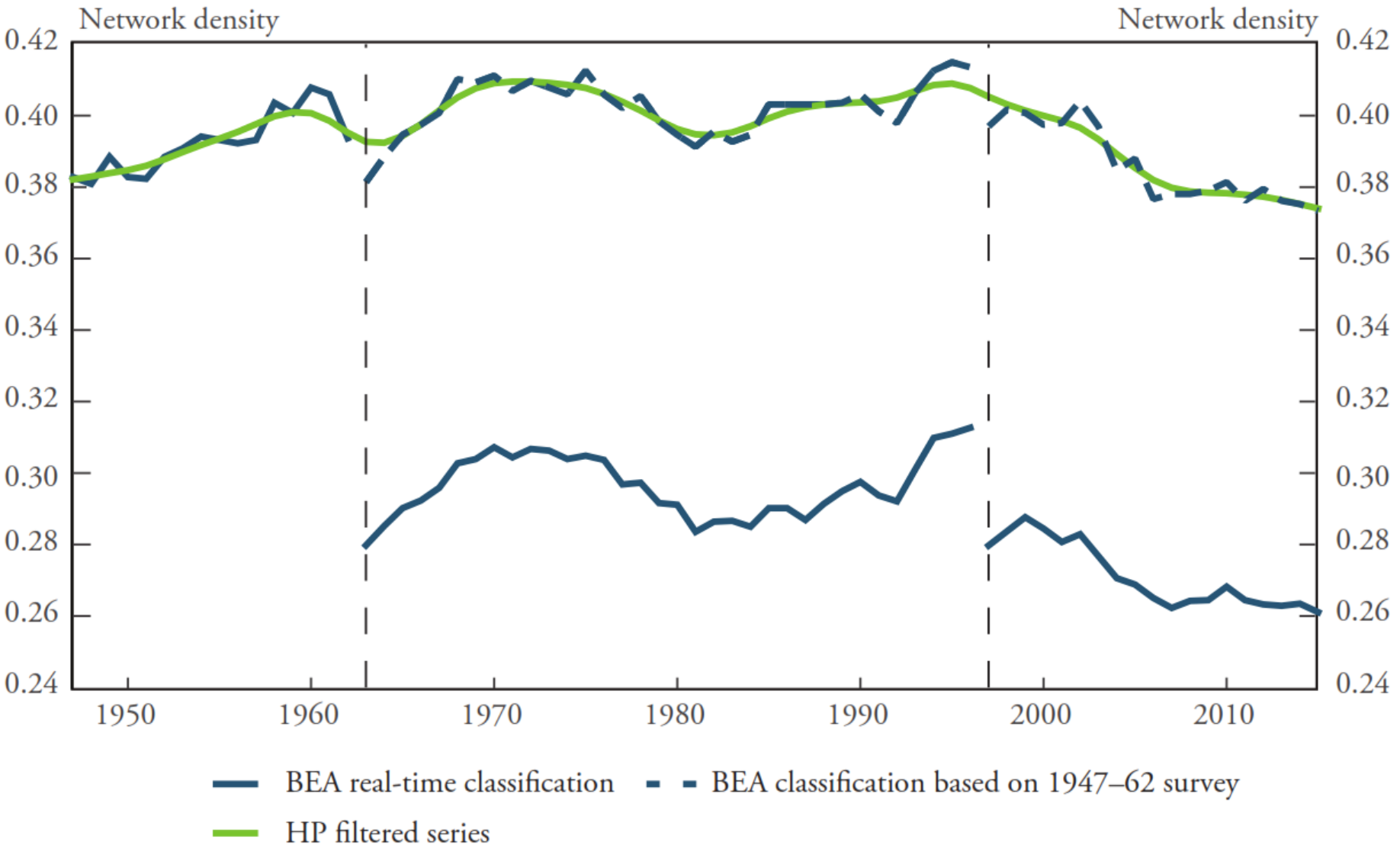
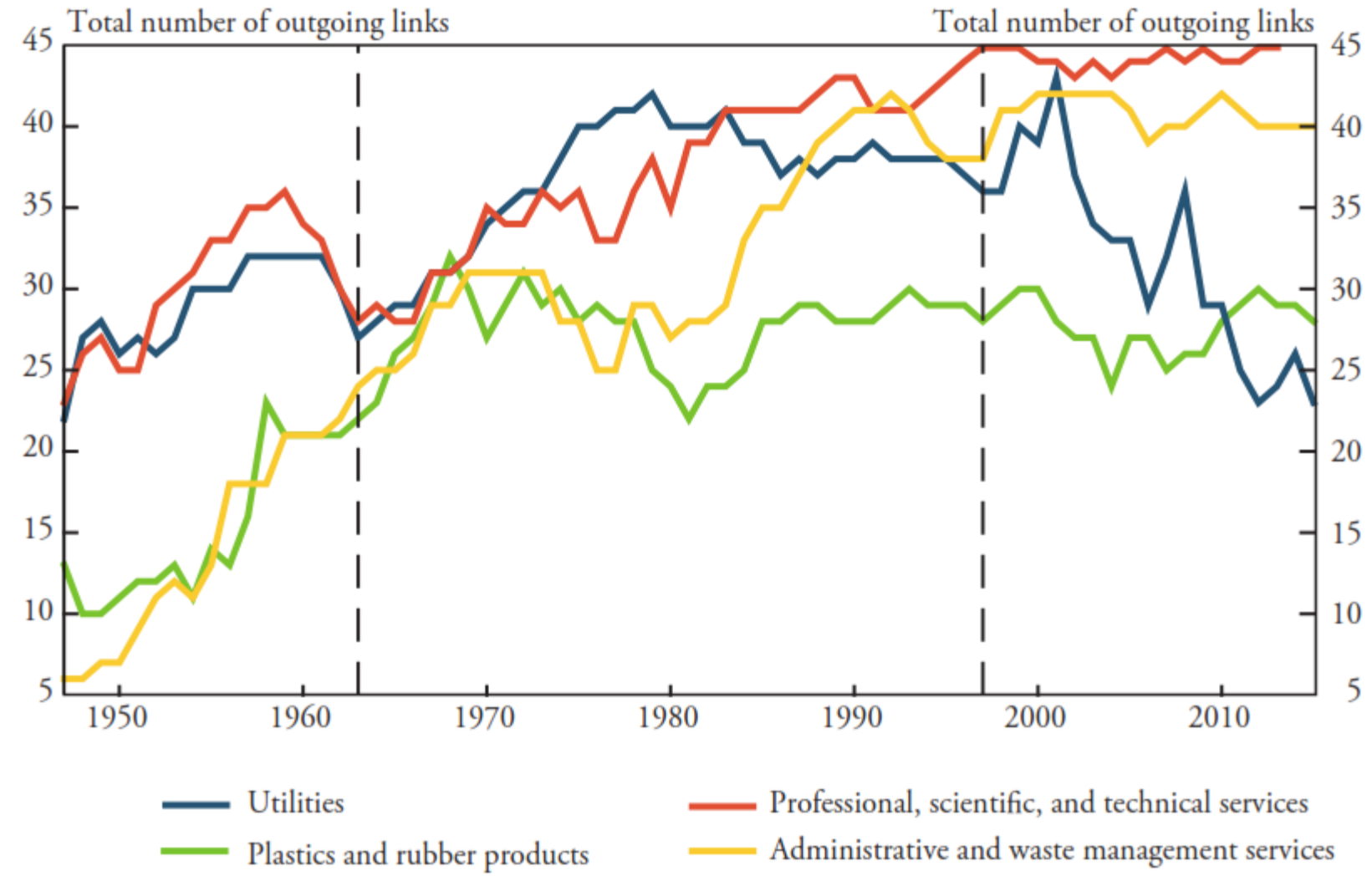


Chart 2

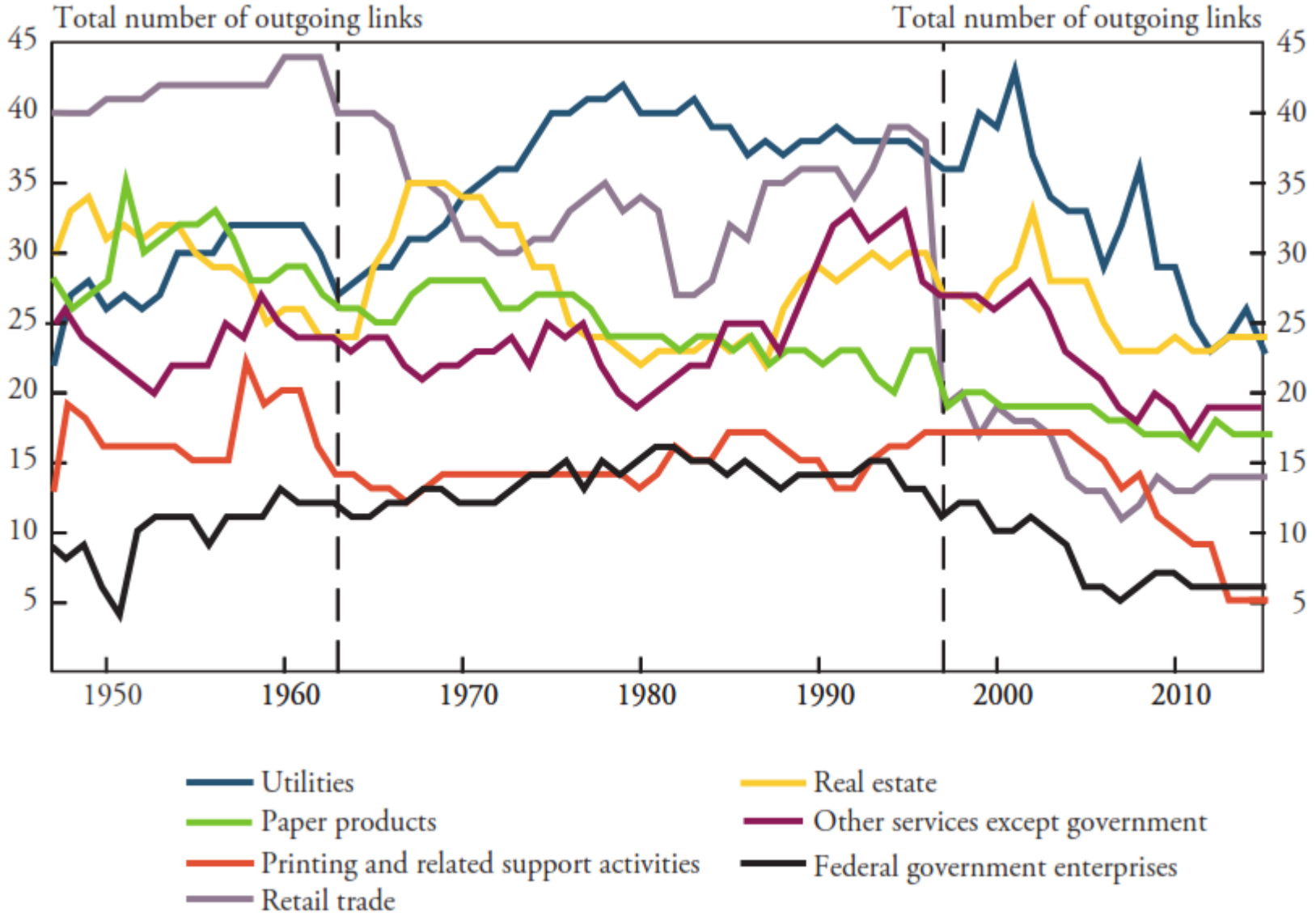
Change in Number of Links for Select Industries: Explaining the Rise in Network Density from 1947 to 1962



Sources: Bureau of Economic Analysis and authors' calculations.

Chart 3

Change in Number of Links for Select Industries: Explaining the Fall in Network Density from 1997 to 2015



Sources: Bureau of Economic Analysis and authors' calculations

Table 2

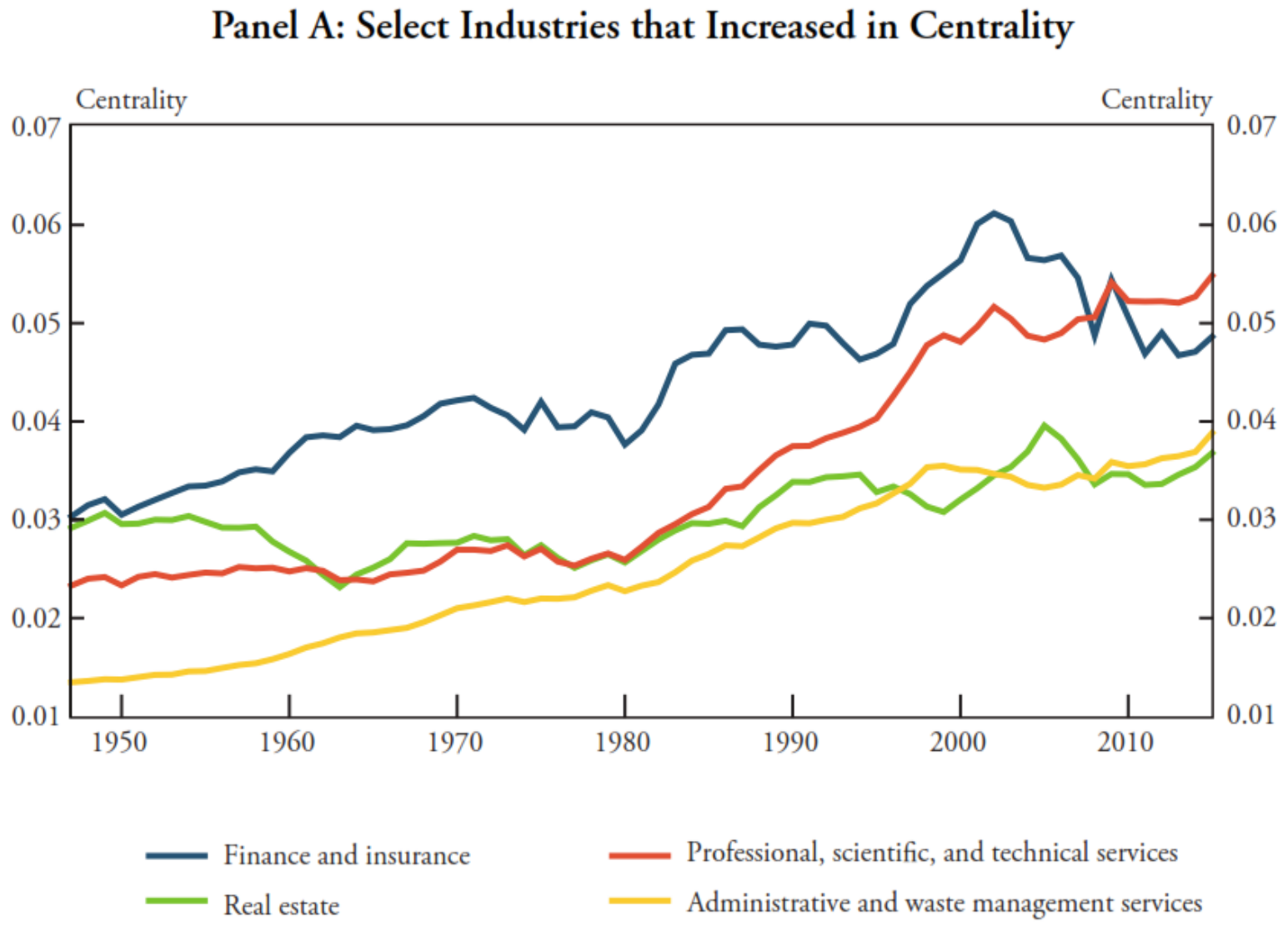
Industry Centrality and Changes in Centrality from 1947 to 2015

Top 5 central industries in 1947	Top 5 central industries in 2015
Transportation and warehousing	Professional, scientific, and technical services
Primary metals	Finance and insurance
Wholesale trade	Administrative and waste management services
Food and beverage and tobacco products	Wholesale trade
Farms	Transportation and warehousing
Bottom 5 central industries in 1947	**Bottom 5 central industries in 2015**
State and local government enterprises	Educational services
Furniture and related products	Furniture and related products
State and local general government	Apparel and leather and allied products
Health care and social assistance	Support activities for mining
Educational services	Health care and social assistance
Top 5 rank improvements from 1947–2015	**Top 5 rank decline from 1947–2015**
Administrative and waste management services	Textile mills and textile product mills
Computer and electronic products	Farms
Rental and leasing services and lessors of intangible assets	Paper products
Plastics and rubber products	Food and beverage and tobacco products
Professional, scientific, and technical services	Miscellaneous manufacturing

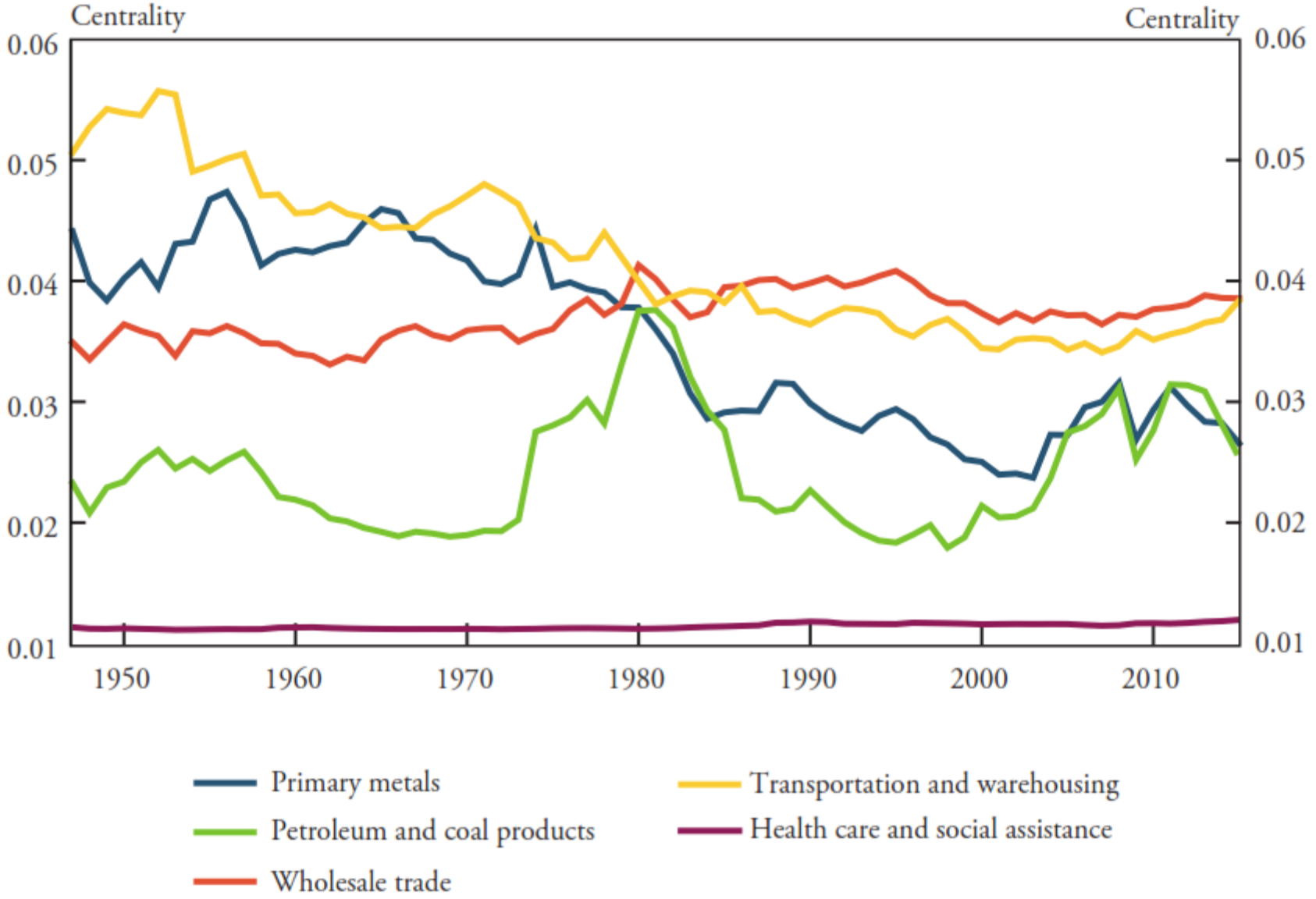
Sources: Bureau of Economic Analysis and authors' calculations.

Chart 4

Changing Centrality of Select Industries



Panel B: Select Industries that Did Not Increase in Centrality



Sources: Bureau of Economic Analysis and authors' calculations.

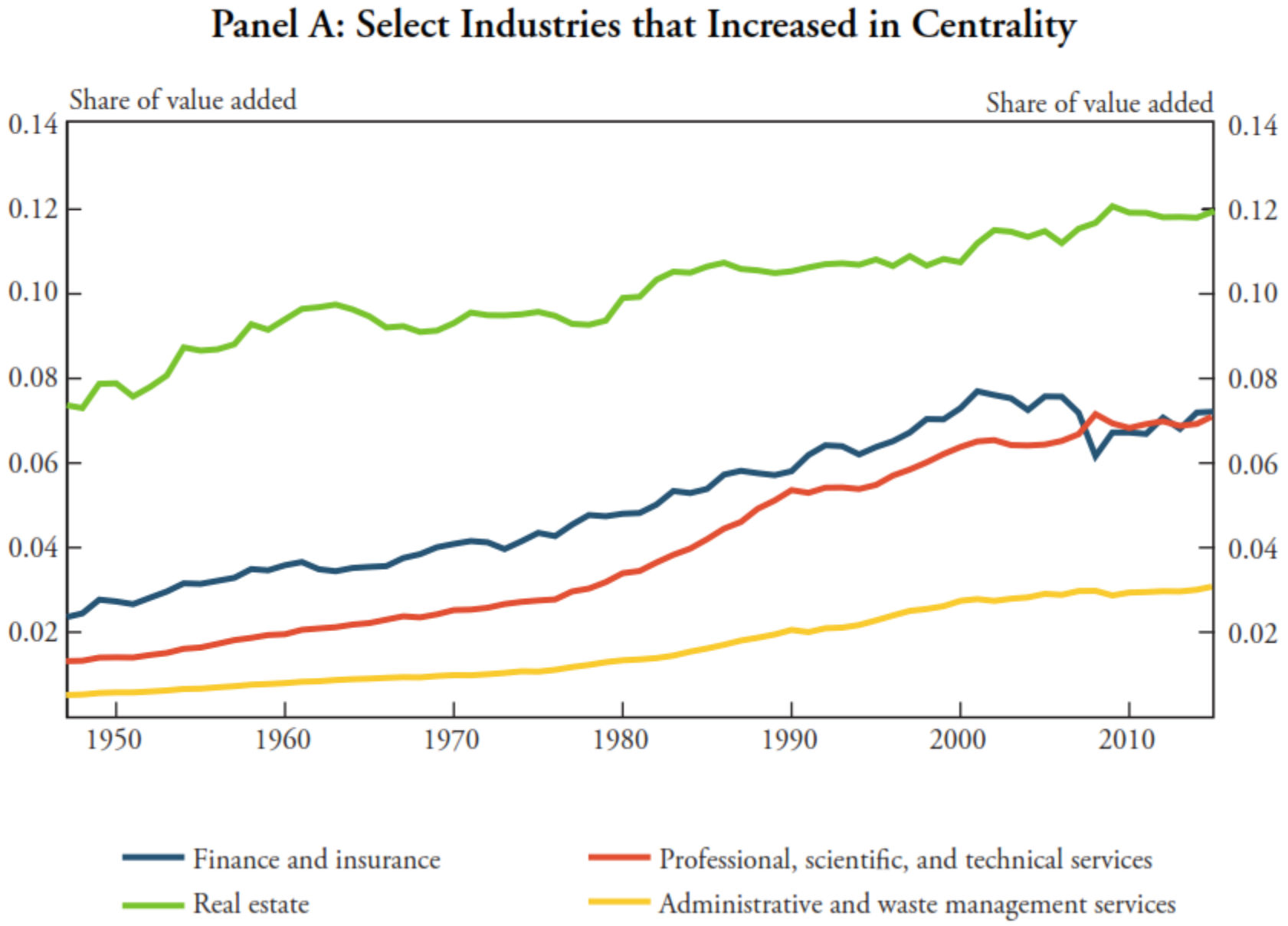
- Only **two of the top five** most central industries in 1947 **remained** in the top five in 2015: "transportation and warehousing" and "wholesale trade".
- The three other most central industries in 1947—"farms," "food and beverage and tobacco products," and "primary metals"—were replaced with "professional, scientific, and technical services," "finance and insurance," and "administrative and waste management services."
- The industries with the biggest rank declines were **food or manufacturing related**, while those with the biggest rank increases were **services based or computer or plastics products**.
- These changes all point to a **shift in the importance of certain industries**—not from a final product perspective, but in terms of input-output relationships.

- **“Finance and insurance”** also became much more central over the sample period, specially around the early 2000s.
- **“Real estate”** became very central during the late 2000s.

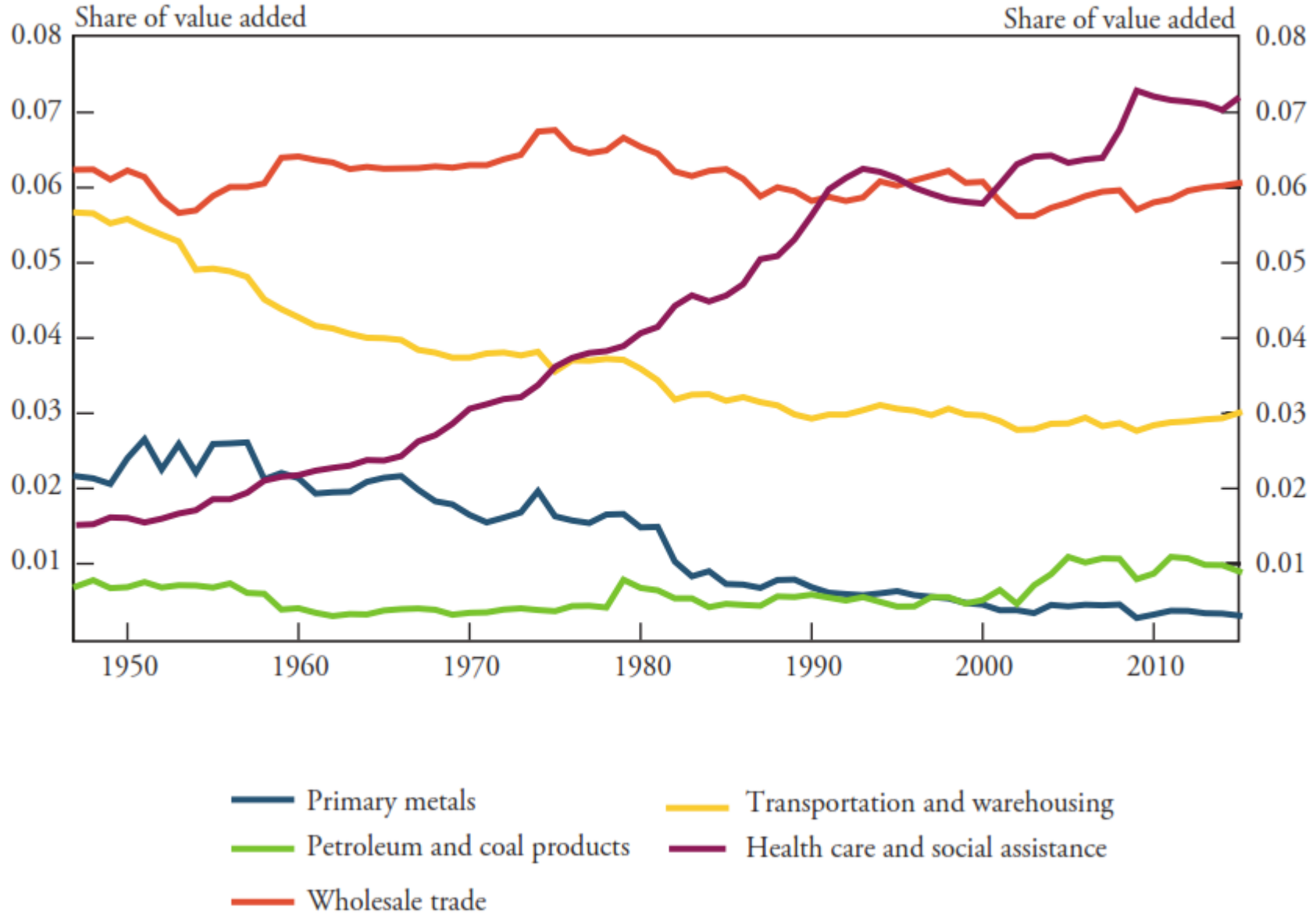
- The centrality of **“wholesale trade”** has **remained consistent** throughout the sample period, while the centrality of **“petroleum and coal products”** spiked during the 1980s but had a relatively similar level at the beginning and end of the sample.
- Other industries, such as **“primary metals”** and **“transportation and warehousing”** have slowly become **less central** in the economy.
- Lastly, **“health care and social assistance”** saw **little change** in its already low centrality over the sample.

Chart 5

Changing Value Added of Select Industries

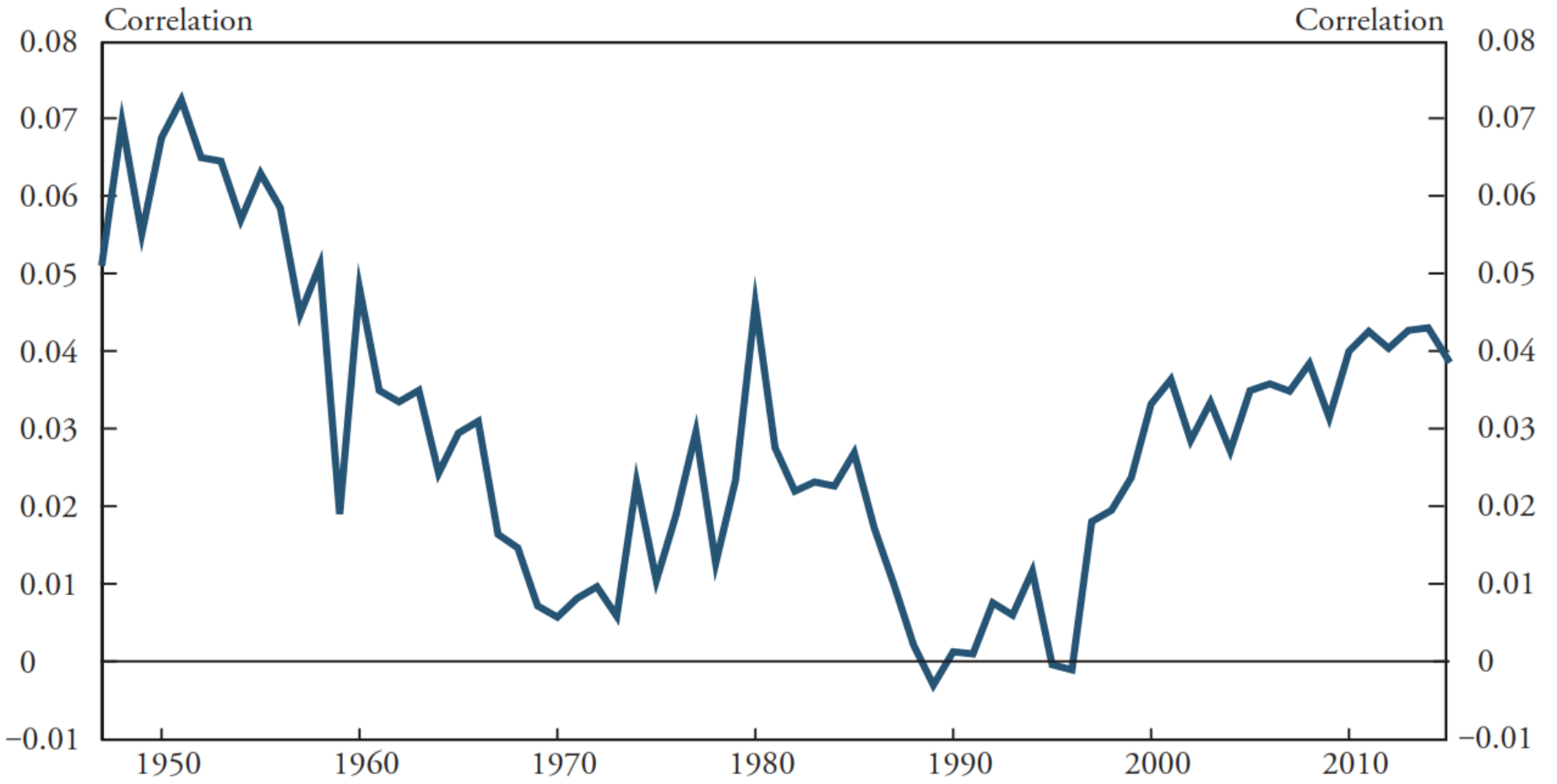


Panel B: Select Industries that Did Not Increase in Centrality



Sources: Bureau of Economic Analysis and authors' calculations.

Correlation between the Centrality of Linked Industries



- Our analysis of centrality shows that the **most central industries** tend to be **spread across the network rather than clustered** and that this feature has held **over time**.
- The **changing network** may have implications for interpreting **movements in the macroeconomy**.
- However, an important caveat in deriving policy implications from our analysis is that we have only illustrated **how interconnectivity and centrality have changed over time**.
- Stronger policy conclusions might depend on several issues beyond the scope of our analysis such as the **quantitative importance of the network in generating fluctuations**, **how economic inefficiencies interact**.

- Nonetheless, establishing **how the input-output network** of the U.S. economy **changed overtime** is **an important step** in addressing these and similar issues.