Setting Occupational Target Demand

The impetus for agents to act within our model relies on non-static target demand across occupations. In other words, occupational demand for workers needs to fluctuate during the simulation. We define such movements at the occupational level by drawing on the share of occupations employed across various US industries and interact these shares with the real value added of each industry. As such, we arrive at occupational target demand profiles that fluctuate in line with real-world target demand over the simulated time period. Important future work should aim to accommodate shifts in labor productivity of different industries and/or shifting industry-specific occupational shares to account for additional sources of structural transformation beyond those explored in this work.

First, using reported occupational shares of industry employment from the Bureau of Labor Statistics' Occupational Employment and Wages dataset and the industry Value Added (quarterly data available from 2005 and annual data available from 1999), we calculate the occupational employment composition across 19 US industries at NAICS 2-digit code level.

First, assume that the baseline de-trended demand for occupation i in the economy D_i is:

$$D_i = \sum_{j=1}^{n} \bar{d}_{ij} = 1$$

where the de-trended fluctuating demand (i.e., demand at time t for occupation i) is:

$$D_{it} = \sum_{j=1}^{n} \hat{d}_{ijt}$$

$$\hat{d}_{ijt} = \sum_{j=1}^{n} \bar{d}_{ij}\theta_{jt}$$

in which $\bar{d}_{ij}$ is the average share of occupation i in industry j and θ_{jt} is the de-trended value-added of industry j at time t. Thus, we obtain occupation-specific fluctuations in demand dependent on their "exposure" or the share of a specific occupation in industry j. We de-trend the value added using a Hodrick-Prescott filter to obtain occupational target demand as a fluctuation around a mean. This allows for an interpretation of demand fluctuations as either an upward or downward pressure on occupational employment levels.

In the following sections, we describe the data used, provide visualizations of the series as well as the imputed occupational target demand series.

Value Added by Industry

We use industry value added data from the US Bureau of Economic Analysis (using annual data from 2000-2004 and quarterly data available from 2005) to define θ_{jt} to create these occupation-specific target demand trajectories. We de-trend the value added using a Hodrick-Prescott filter. Below, we present the industry real value added and demonstrate that these disagreggated series closely follow the national real GDP series.
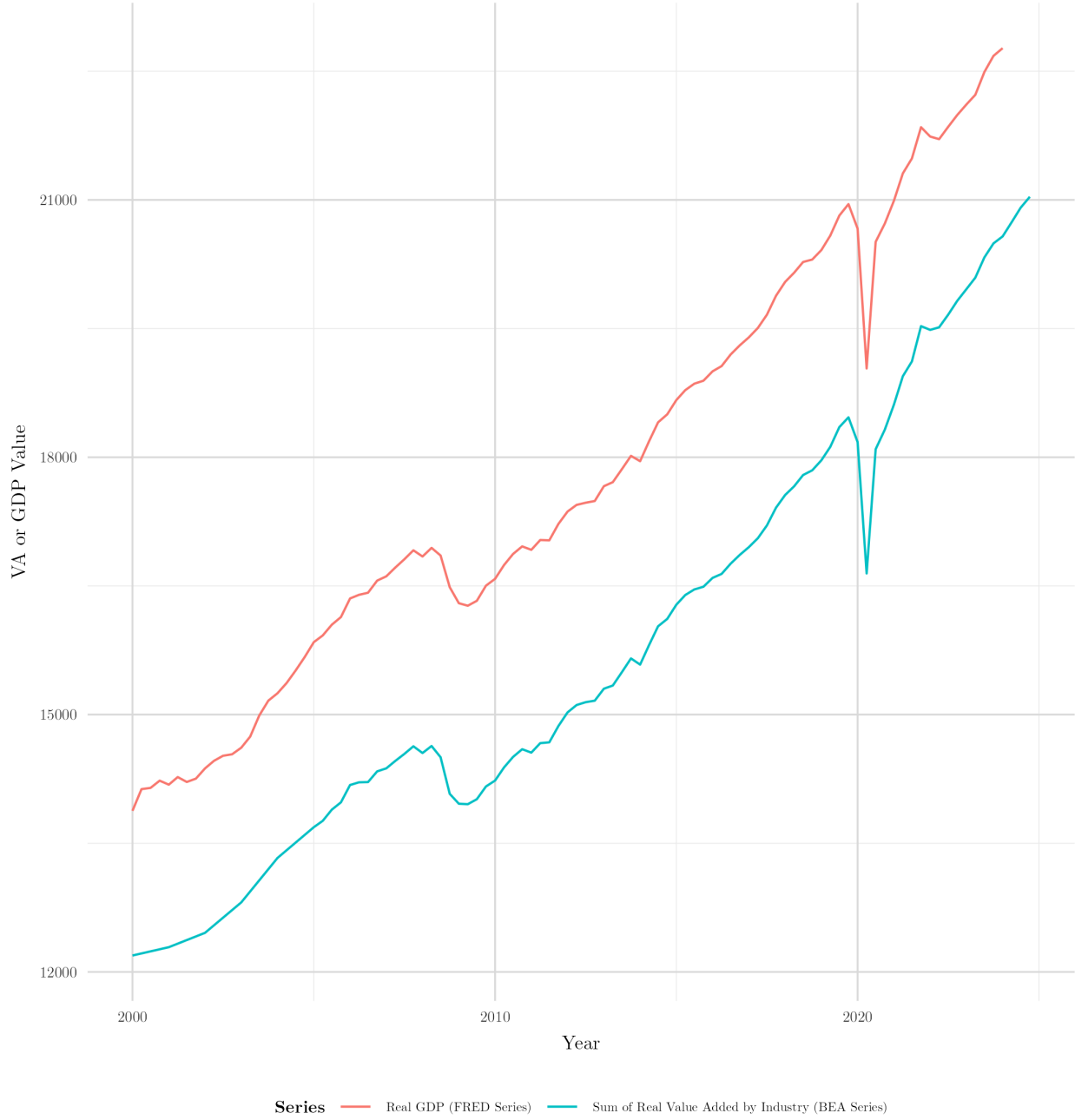
Quarterly Real VA by Industry 2005-2024

Data from Bureau of Economic Analysis Economic Accounts

Real Value Added in 2017-chained USD

Year-Quarter
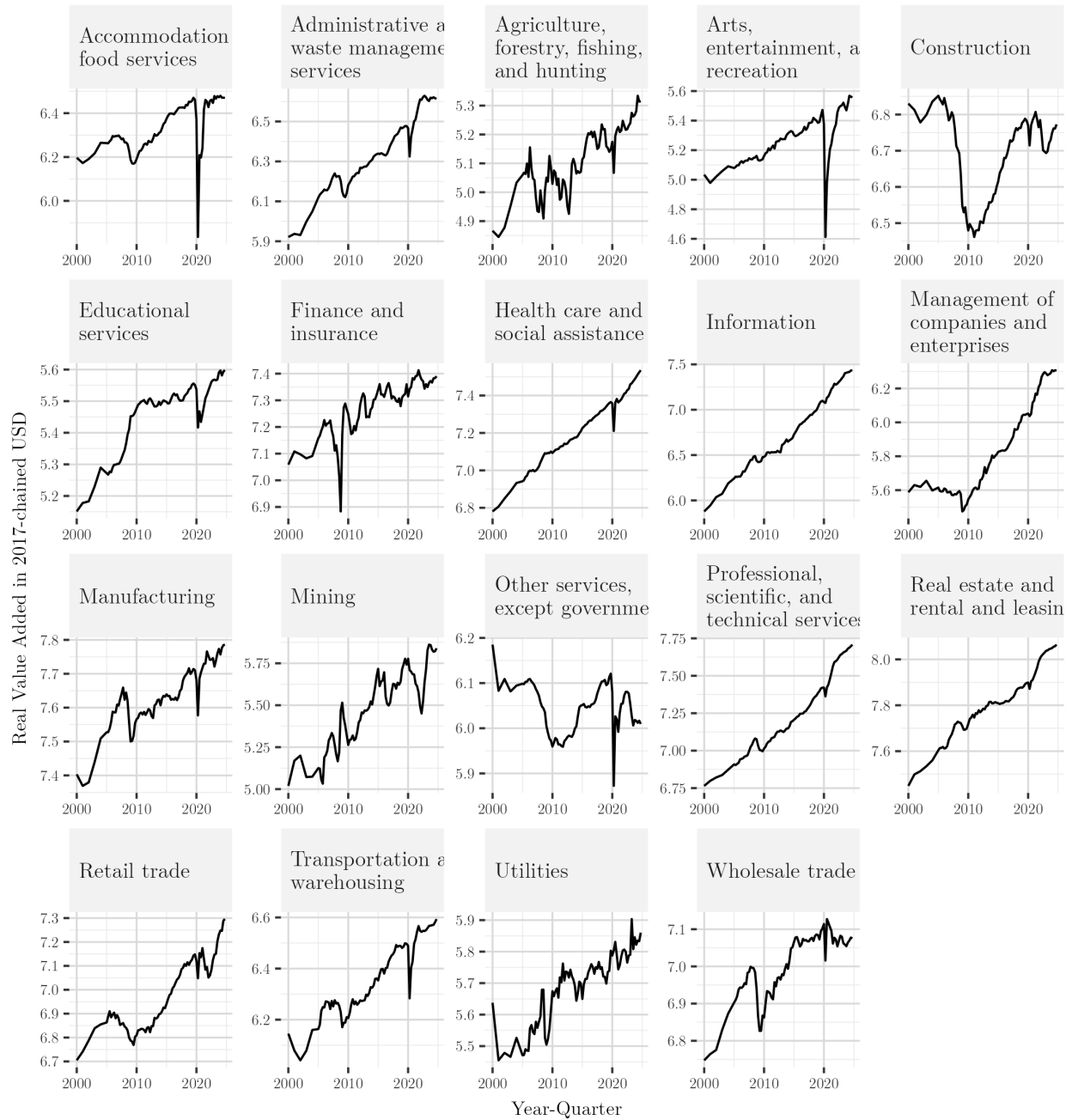
Annual data prior to 2005 is linearly interpolated to achieve a quarterly frequency matching the later portion of each time series.

**Comparison of Quarterly GDP
Series and Real Value Added
as Reported by Industry**

Occupational shares of industry-level emloyment

We use annual occupational shares of employment from the Occupational Employment and Wage Statistics database from the US Bureau of Labor Statistics to derive our $\bar{d}_{ij}$. The first figure shows the share of occupations within each industry, drawn from the OEWS data. The gaps in the figure is due to a reshuffling of occupational codes in 2010 and 2018. To deal with this challenge, we take the mean industry-share of occupational employment reported in the years where majority (>97%) of our occupational codes are present (2012-2018 - after and before SOC reorganization of 2010 and 2018). We display the occupation-industry

employment shares in a gridded format as well.

Note that the procedure we employ to arrive at consistent occupational shares of industry-level employment results in 6 occupational categories that have a sum of their mean shares greater than 1.1.

Occupational Employment Shares by 2-digit NAICS

Occupation–Industry Employment Shares

The colors display the share of total occupational employment in each industry.
Industries are ordered by the total number of occupations they employ in ascending order.
We display only those occupations whose industrial-level employment share is at least 5%.

Industry (NAICS title)
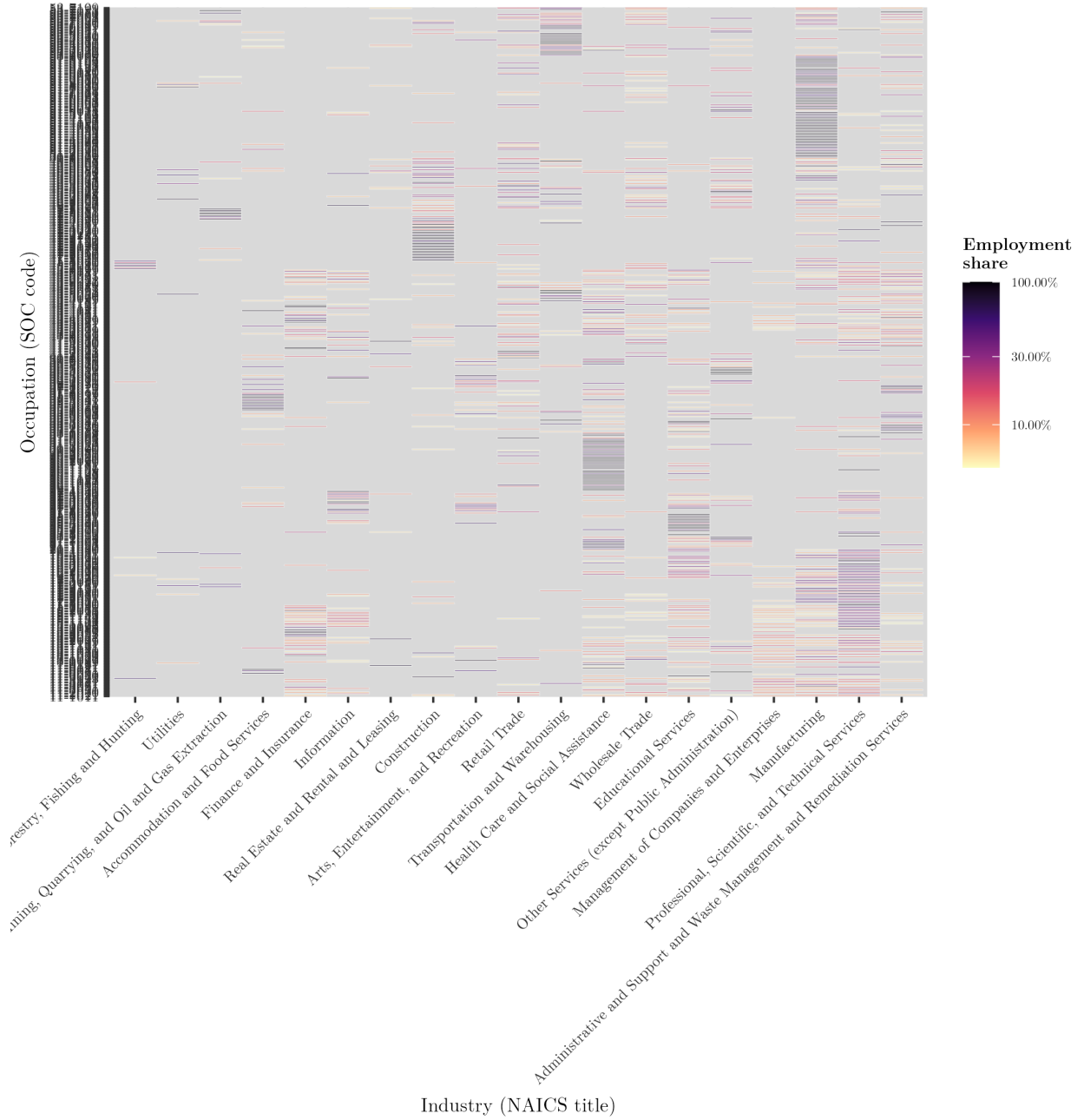
[1] "6 occupational categories have a sum of mean shares > 1.1:"

SOC2010 Occupational Code	Occupational Label	Sum of Mean Shares
53-4041	Subway, streetcar, and other rail transportation workers	1.374194
49-9093	Other installation, maintenance, and repair workers	1.254556
43-2099	Communications equipment operators, all other	1.180072
37-2021	Pest control workers	1.135526
53-6011	Bridge and lock tenders	1.132450
53-6041	Other transportation workers	1.121672

Bringing them together

We bring these values together by adding the product of industry-level real-value added and the fixed occupational employment shares across all industries as in the formulation above, repeated here for ease: $\hat{d}_{ijt} = \sum_{j=1}^{n} \bar{d}_{ij} \theta_{jt}$. This yields occupation-specific target demand profiles that respond to disaggregated industrial productivity movements.

Industry-level Value Added Shocks

Normalization of HP Filter Method: Raw HP Filter vs. Percent Deviation
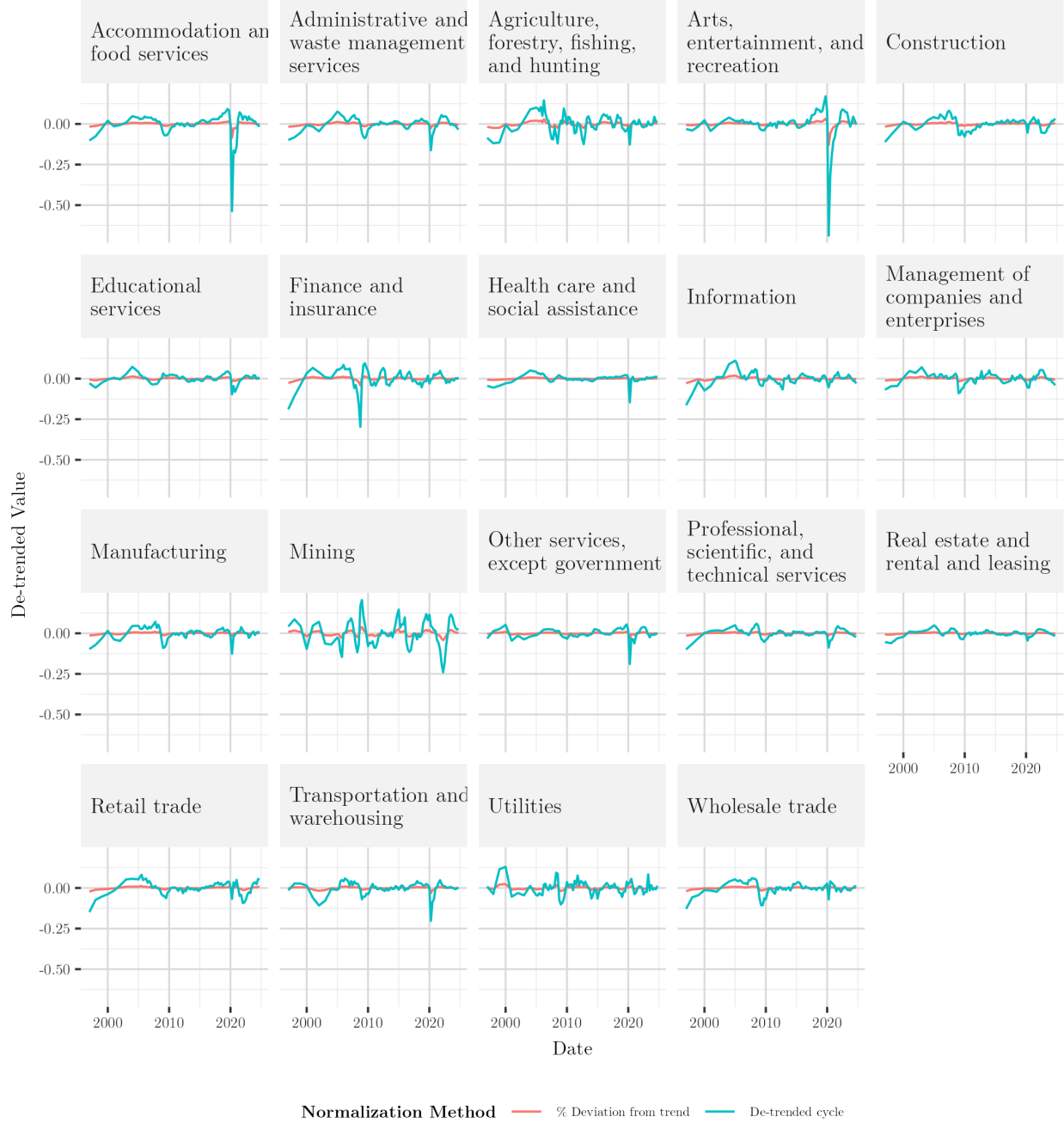
Note that we are missing information on occupation code 13-2081 (Tax examiners and collectors, and revenue agents) which are present in our occupational network but not in our VA data as they are only employed in

public administration. VA information does not exist for public administration. For now, we use the shocks to 13-2082 as the shocks to 13-2081 though this could potentially be adjusted such that public administration fluctuations depend on overall GDP fluctuations.

Furthermore, in the case of the full OMN we are missing both 13-2081 and 33-3031 (Fish and Game Wardens). We assign the fish and game wardens the same occupational shocks as 33-9011 (Animal Control Workers) within the same broad category grouping of SOC codes.

Finally, in the case of the O*NET Related Occupations Network both of the above are missing in addition to 45-3021 (hunters and trappers). We assign hunters and trappers the same occupational shocks as the only other occupation in the same Minor SOC Group (45-3011 - Fishers and Related Fishing Workers). They are both categorized within the same "Fishing and Hunting Workers" Minor SOC Group (45-3000).

Occupation Specific Value Added Shock

Composite of Industry VA shocks x Industry Occupational Shares