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Returns to Scale for Carbon Capture and Storage

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The degree to which carbon capture and storage (CCS) is deployed will be partly determined by the returns to scale of the technological system that captures, transports, and stores carbon dioxide (CO2). This technological system spatially connects the organization of CO2 point sources with the organization of geologic CO2 storage reservoirs. The overall returns to scale for the integrated CCS system are determined as it couples technologies together over space. The SimCCS cost-minimizing geospatial deployment model is used to deploy CCS for a variety of combinations of CO2 sources and injection reservoirs. The returns to scale for the entire CCS system involve the interaction of the cost structures for each link in the CCS chain - capture at the source, transport through the network, and storage at the reservoir - each of which is modeled with cost structures that allow for increasing returns to scale. The returns to scale for CCS deployment are determined by comparing a variety of deployment combinations over a broad range of scales, as well as an econometric generalization of the data generated by SimCCS.

While it is possible that the individual cost structures can reinforce each other, the variability of source and reservoir costs and capacities interact with the spatial organization of sources and reservoirs to limit and ultimately reverse the returns to scale for CCS as the scale of the system expands. A number of lessons are discussed, including those from related work on the spatial distribution of sources relative to reservoirs and technological learning and spillovers in CO2 injection.