Robots Reshaping Firm Dynamics: The Quantitative Effects of Automation Supply Shock and Policy Tools

Topic: Input-output Modelling and Supply Chain Resilience (II)
Author: Yun Ge
Co-Authors: Zheang Chen

This abstract is submitted to the Special Session â€˜Input-output Modelling and Supply Chain Resilienceâ€™.

We study how automation supply shocks reshape the spatial distribution of manufacture firms in China, as well as the productivity development of each province. As artificial intelligence and automation technologies serve as major drivers of new organizational forms, novel application scenarios and economic growth, secure and reliable access to automation inputs has become central to strengthening supply-chain resilience. We investigate in three questions. Firstly, how do automation supply shocks affect macroeconomic outcomes and the spatial distribution of industrial activity? Secondly, what roles firm dynamics and supply chains play in shaping these effects? Thirdly, will Chinaâ€™s strategy of building domestic unified market mitigate adverse impacts of automation supply shocks and help stabilize the resilience of supply chains?
To address these questions, we develop a dynamic quantitative spatial general-equilibrium model incorporating householdsâ€™ optimal consumption and migration decisions, value-added production with automation inputs, and firmâ€™s spatial dynamics. The model features a Melitz selection mechanism in which, within each province, firms with relatively low local productivity are endogenously eliminated. The surviving firms may relocate across regions or voluntarily exit the market, while the eliminated firms may migrate to other provinces characterized by lower productivity thresholds. Building on this framework, we quantify the effect of automation supply constraints induced by automation shocks, including raising costs, reducing capacity, and generating network spillovers along supply chains. We use the dynamic quantitative spatial equilibrium model to evaluate the macroeconomic equilibrium effects of automation supply shocks on value added and welfare, as well as the spatial equilibrium effects on firm dynamics. We further assess whether China's strategy of developing domestic unified market will serve as buffers against external automation supply shocks, especially the policy effect of promoting the usage of robots in China's hinterlands.
To map the data into our modelâ€™s equilibrium conditions, we use the Multi-regional Inputâ€“output table to calibrate the initial inter-regional trade structure within China. We also use the International Inputâ€“output tables compiled by OECD to calibrate the initial international trade structure. With respect to the spatial distribution of firms, we use firm-level registration data for the base year 2017 from Chinaâ€™s comprehensive industrial and commercial registration database. Firm entry and exit rates outside China are from the OECD Structural and Demographic Business Statistics database. In addition, we use Chinese firm-level tax survey data to calibrate the initial distribution of firm productivity across regions.
Compared with the existing literature, we make three main contributions. Firstly, in terms of research perspective, the shock design is grounded in the real challenges that developing countries currently faces. Unlike prior studies that rely on general shocks like generic TFP shocks and capital shocks, we provide a more targeted and realistic characterization of external supply-side disruptions. In analyzing the effects of the shock, we build more comprehensive framework with general-equilibrium, spatial, and supply chain effects, thereby capturing macro-level adjustments that are difficult to identify cleanly in empirical works. We also explain how automation supply shocks affect macroeconomic indicators through spatial general equilibrium, firm location choices, productivity competition and supply chain linkages. Secondly, in terms of methodology, we contribute to quantitative spatial general equilibrium modeling by eliminating firms with relatively low

local productivity in a Melitz channel. We also allow quitting firms to choose their new production location. This enables the model to trace dynamic patterns of TFP evolution and scale adjustment, providing a feasible framework for studying industrial relocation, regional coordination, and firm dynamics. Finally, in terms of transmission patterns, our model moves beyond static approaches and fully characterizes the dynamic processes of automation accumulation, productivity growth, welfare changes, production-network adjustments, and firm flows. In modeling supply chain transmission channels, we incorporate production-network effects into the quantitative spatial general-equilibrium model, thereby capturing higher-order indirect effects.