Decomposition of Total Factor Productivity and Industry Spillover Effects â€”â€”Based on input-output matrix

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Against the backdrop of a global transition from factor-driven to efficiency-driven growth, Total Factor Productivity (TFP) stands as a pivotal metric for evaluating sustainable development. However, the internal heterogeneous sources driving inter-industry transmission mechanisms have yet to be systematically decomposed. This paper addresses the critical research question of how upstream TFP shocks transmit to downstream sectors through intermediate inputs and seeks to identify the heterogeneous channelsâ€”both technological and factor-basedâ€”that drive this inter-industry spillover. By focusing on forward spillover effects, the study aims to quantify these transmission paths, thereby deepening the theoretical understanding of technology diffusion patterns within complex production networks.

Methodologically, the paper develops an analytical framework that integrates an Input-Output model with a Cobb-Douglas production function incorporating intermediate inputs. By treating intermediate goods as the transmission medium, the framework delineates the TFP spillover paths from upstream to downstream sectors along the industrial chain. Specifically, by mapping downstream intermediate consumption to upstream output, the model embeds upstream TFP and factor expansion into the decomposition of the downstream TFP growth rate. This structural approach identifies structural transmission channels beyond mere correlation analysis, ultimately yielding a decomposition of the downstream TFP growth rate into four distinct, quantifiable sources: (a) indigenous technological progress; (b) scale effects resulting from the sectorâ€™s own factor inputs; (c) inter-industry spillover effects stemming from upstream TFP improvements; and (d) pull effects generated by the expansion of upstream factor inputs.

The empirical analysis employs a balanced panel dataset covering 37 sectors in China over the period 1981â€“2024, with data primarily sourced from the CSMAR database, the National Bureau of Statistics, the national non-competitive input-output tables for 42 sectors in 2020 and 2023 (aggregated into 37 sectors), and time-series input-output tables compiled by Zhang et al. (2021). Based on this dataset, the paper finds that Chinaâ€™s sectoral TFP growth exhibits a significant â€œscale-efficiency divergenceâ€•, characterised by the coexistence of rapid output expansion and TFP stagnation in high-tech manufacturing. Furthermore, while upstream TFP spillovers and indigenous technological progress are identified as primary positive drivers, factor expansionâ€”both indigenous and upstreamâ€”generally acts as a major drag. Moreover, inter-industry spillover intensity displays a gradient attenuation pattern described as â€œbroad upstream, sparse midstream, and near-zero downstreamâ€•, where the cost squeeze from upstream factor expansion severely offsets technology spillover benefits. Additionally, TFP growth volatility is found to be negatively correlated with industrial chain position, with upstream sectors exhibiting severe fluctuations.

A key methodological contribution of the paper is decomposing inter-industry TFP transmission into two heterogeneous channels: â€œpure technology spilloversâ€• and â€œfactor expansion pull.â€• Unlike conventional approaches that rely on R&D stock or patent counts, treating forward spillovers as an aggregate â€œblack boxâ€•, this framework innovatively utilizes fluctuations in intermediate goods value as a transmission medium. By integrating direct and indirect spillovers into a unified accounting system, the model moves beyond correlation to identify causal transmission channels, disentangling the impact of upstream technological progress from the scale effects of upstream factor expansion, effectively overcoming the estimation biases inherent in traditional methods and offering a more refined perspective for understanding productivity transmission mechanisms within production networks.

Based on the empirical findings, this paper proposes targeted policy implications. For upstream sectors with high spillover potential, policy support should prioritise generic technology R&D to extend the spillover chain. For midstream sectors with weak absorption capacities, the focus must shift from capacity expansion to strengthening absorption capabilities. Additionally, digital transformation should be leveraged to embed â€œisolatedâ€• sectors into main industrial chains. Ultimately, optimising factor allocation is essential to inhibit the efficiency squeeze on downstream sectors caused by upstream extensive expansion, thereby fostering sustainable productivity growth.