Tracing Carbon-Intensive Upstream Paths in the Global Textile Supply Chain: A Unit Structure Analysis of Japanese Final Demand

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In recent years, the textile industry has been estimated to account for roughly 10% of global greenhouse gas (GHG) emissions, imposing a severe and growing environmental burden on the planet. In Japan, the industry faces a critical environmental problem that about 90% of clothing is discarded within a single year, and two-thirds of those items end up as waste. This fact reflects a chronic oversupply that far exceeds actual consumer demand. Within the life cycle of clothing, emissions are primarily concentrated in â€œupstream processesâ€• --extending from raw material extraction to manufacturing and distribution. Notably, the raw material procurement stage alone accounts for approximately 70% of total emissions. Against this background, a global textile supply chain analysis at the production stage is necessary.

We used the ADB Multi-Regional Inputâ€“Output (MRIO) Table covering 63 countries/regions and 35 industrial sectors for the period 2007â€“2021, expressed in constant prices. The results show that, in terms of clothing production value induced by Japanese textile final demand, China accounted for a dominant 67% in 2021, followed by Japan (12%) and Vietnam (6%). These results confirm that the production supporting Japanese clothing consumption remain heavily dependent on Asian nations, particularly China.

Furthermore, when calculating the COâ„‚ emissions associated with this production, the concentration becomes even more pronounced. Over the period 2007â€“2021, Chinaâ€™s share of emissions rises to 77% and Vietnamâ€™s to 7%, while Japanâ€™s share declines to 5%. This disparity suggests that production in China and Vietnam is characterized by an extremely high â€œcarbon intensityâ€• compared to other regions. To further clarify the specific emission structure of Chinaâ€”the largest source of emissionsâ€”this study applied a â€œUnit Structure Modelâ€• to extract the pure economic ripples and CO2 emission paths. We identified the structural paths through which Japanese final demand drives emissions across various Chinese sectors and cross-border transactions.

The top 10 largest identified paths in 2021 quantitatively demonstrate how Japanese final demand drives CO2ã€€through multi-layered processes within China, specifically originating from high-intensity utility sectors. The most significant pathway is â€œChina Electricity, gas, and water supplyâ€• â†’ â€œChina Textiles and textile products,â€• which accounts for 23% of the induced emissions. This indicates that huge amounts of electricity are consumed during direct manufacturing stages, such as sewing and dyeing.

The second-largest path was the energy sectorâ€™s self-input chain â€œChina Electricity, gas, and water supplyâ€• â†’ â€œChina Electricity, gas, and water supplyâ€•â€”which accounts for 17% of induced emissions. This underscores the high carbon intensity of Chinaâ€™s power system: a substantial amount of energy is required not only for downstream production but also for electricity generation and distribution itself. Moreover, energy-related inputs are embedded far upstream in the supply chain, appearing in routes that ultimately connect to primary sectors such as agriculture, basic metals, and mining.

Material-related paths in China were also significant. Of the total embodied CO2 emissions induced by Japanese final demand for textile products, the utilities-to-chemicals path (8%) and the

subsequent chemicals-to-textiles path (4%) indicate that the production of synthetic fibers, such as polyester, is highly CO2-intensive -- a pattern further reinforced by intra-chemical processing (2%). Furthermore, the agriculture-to-textiles path (2%) suggests that even natural-fiber inputs impose a non-negligible carbon burden when induced by final demand.

The results reveal that the massive CO2 emissions induced by Japanese textile demand in China are driven by structural issues that go beyond simple production volume. The fact that most emission pathways originate in the energy sector underscores that Chinese textile production relies heavily on a high-carbon power infrastructure centered on coal-fired power plants. This implies that the act of a Japanese consumer selecting and purchasing a garment indirectly but powerfully drives fossil fuel consumption in China.

Therefore, to achieve effective global emission reductions, it is essential to advance the decarbonization of energy-intensive upstream sectors, such as chemicals and agriculture, rather than focusing solely on energy-saving efforts within the textile sector itself. Accordingly, from a policy perspective, we argue that the textile industry should combine incentives for clean power in upstream production hubs with demand-side measures that curb overproduction and promote circular strategies, such as extending the lifespan of clothing products.