PRODUCTIVITY RESEARCH NOTES 2615

Broad Gains, Flat Aggregate

Industrial Structure and Japan's Energy Productivity to 2040

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KEY MESSAGE

Under a technology-and-societal-implementation (TSI) scenario for Japan to 2040, energy productivity improves across most industries, yet the economy-wide measure changes little. This is not a sign of weak efficiency gains. It reflects a shift in industrial structure toward more energy-intensive activity as manufacturing returns home under TSI, which offsets broad-based industry-level improvement in the aggregate.

WHY THIS MATTERS

Aggregate energy productivity is widely read as a gauge of efficiency, but it is a composite of three things: genuine efficiency gains within industries, changes in energy quality such as electrification, and changes in industrial structure. Even when no industry becomes more efficient, the aggregate can rise simply because the economy shifts toward less energy-intensive activity—or fall as it shifts toward more energy-intensive activity. Japan's postwar record illustrates this: the relative shrinkage of energy-intensive heavy industry inflated the apparent improvement after the oil shock, while structure-adjusted "true" energy productivity peaked earlier, during the high-growth years from the mid-1950s to the early 1970s, when those industries were expanding (Nomura 2023, Chap. 2). Read without separating these components, the aggregate can mistake structural change for efficiency.

EVIDENCE FROM THE SBI-FERI BIP MODEL

Using the SBI-FERI BIP model, a high-resolution sectoral general equilibrium model of Japan's 828-activity economy, we compare two 2040 scenarios: Business-as-Usual (BaU) and TSI, in which structural impediments are removed under a stable and affordable electricity supply. PRN2602 examined the TFP gains from AI adoption; this note turns to their energy counterpart. Figure 1 shows energy productivity growth for both scenarios. Under TSI, the implemented technologies also contribute to energy savings, and most industries show broad improvement. Yet at the level of the whole economy, the gain is slight—from 0.9% per year under BaU to 1.0%—far less than the breadth of industry-level improvement would suggest.

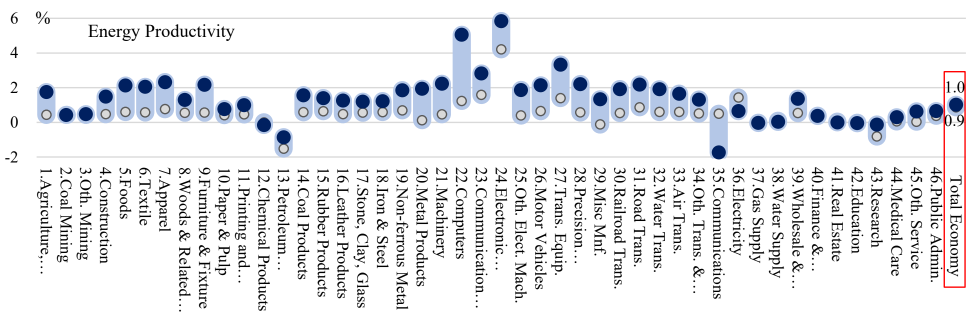

Figure 1. Energy productivity at the industry and aggregate levels

Source: Nomura (2026). Unit: Percentage (annual average growth rate, 2020–40). Output is gross output by industry and real value added for the total economy; energy input excludes non-energy uses such as naphtha and, for the total economy, includes household energy use. See Measurement Considerations for the treatment of energy quality.

INTERPRETATION

The explanation lies in industrial structure. Under TSI, the restored competitiveness of Japan's industrial base brings manufacturing production home, shifting the economy toward a more energy-intensive composition. This is why the broad industry-level improvement in Figure 1 does not carry through to the aggregate. It is the same configuration as Japan's high-growth era, when the rapid expansion of energy-intensive heavy industry held the aggregate down even as true efficiency reached its postwar peak—and the reverse of recent decades, when the relative shrinkage of that industry, including the offshoring of production, flattered the aggregate and made measured energy productivity look better than underlying efficiency warranted.

The same logic applies to emissions. Under TSI, domestic energy-related CO_2 emissions are higher than under BaU, where deep reductions are achieved. But part of that BaU improvement reflects the relocation of energy-intensive output overseas, not its elimination—a reduction in domestic emissions that does not lower global emissions. Seen this way, the higher domestic emissions under TSI are the counterpart to keeping production at home and need not imply higher global emissions (see also PRN2609).

MEASUREMENT CONSIDERATIONS

Energy productivity here is output per unit of energy. Fuels are aggregated to control for quality differences across fuel types, unlike the simple energy totals underlying standard measures; because primary and final energy are not separately identified, however, gains in thermal efficiency are not controlled for and instead appear in the energy-conversion sector. The economy-wide figure is value-added–based, as in real GDP, and thus reflects the effects of shifts in industrial composition: a relative shift toward energy-intensive activity lowers the aggregate even when every industry improves. Weighting by energy use would control for this; the value-added basis does not, but it is retained here because real value added is the output concept used for energy productivity in national and international statistics.

IMPLICATIONS

01

Economy-wide energy productivity is a composite of efficiency, energy quality, and industrial structure; aggregate movements should not be read as changes in efficiency without separating these components.

02

Broad industry-level gains coexist with a near-flat aggregate because the return of manufacturing shifts the economy toward a more energy-intensive structure—the reverse of the offshoring that once flattered the headline.

03

Higher domestic emissions need not imply higher global emissions; conversely, lower domestic emissions may reflect production—and emissions—relocated abroad.

REFERENCES

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This note is part of the Productivity Research Notes series, examining key issues in productivity and economic performance in Asia. The views expressed are those of the author(s). Inquiries may be directed to sankenoffice@info.keio.ac.jp.

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