

Beyond Output per Hour: Productivity Measurement in an AI-Driven Economy

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This submission is a shortened version of the research briefing note, Duncan, AS (2025), [Reframing Productivity Measurement in the AI-Driven Economy: the KLEMICAS Framework](#). BCEC Policy Brief 25/3, July 2025.

Background

The Economic Reform Roundtable provides an important opportunity to reflect on the need for an authentic, inclusive, and future-proofed productivity framework that better captures the real drivers of long-term prosperity for Australia and its population.

The global productivity landscape is shifting rapidly, driven by technological disruption, the rise of data and AI, and the growing economic value of care and human services. The way goods and services are produced, and the nature of inputs into value creation, has changed fundamentally. To remain competitive and build a resilient, inclusive economy, Australia must modernise its productivity frameworks to reflect these transformations.

Limitations of current productivity metrics

Australia's productivity narrative remains tied to output per unit of input, with a default approach that is optimised for goods-producing sectors and market-priced outputs. Existing metrics, including labour productivity (GDP or gross value added per hour worked), or multi-factor productivity (output per combined input bundle), are definitionally myopic, biased towards market outputs, influenced by transitory price effects and sectoral volatility.

These existing productivity metrics:

- undervalue social infrastructure and care and human services contributions with long-lag, non-market benefits, despite their evident contribution to long term productivity.
- misrepresent transitory price-led changes in output value as productivity growth, especially in mining and resource sectors where commodity price cycles dominate company performance.
- exclude the full value of service sector outputs (e.g. health, education, or aged care) that create or enhance Australia's human capital assets over the long term but are difficult to quantify using conventional value-added approaches.
- fail to accommodate data, information capital and artificial intelligence (AI) as distinct and increasingly vital productive assets whose influence on production will grow exponentially into the years ahead.

The KLEMICAS Framework: motivation, structure and innovation

Conventional productivity measurement frameworks such as KLEMS (Capital, Labour, Energy, Materials, Services) have provided a structured method to account for input contributions to output growth (O'Mahony and Timmer, 2009). However, such frameworks increasingly fall short in recognising emergent drivers of productivity - especially the role of artificial intelligence (AI), the strategic use of proprietary and open-source data, and the societal contributions of care and human services.

This submission puts forward an enhanced productivity measurement framework that extends the conventional KLEMS system by incorporating extra inputs that are both distinct and essential to current and future productivity growth - Information and data, Care and human services, and Artificial Intelligence – the KLEMICAS framework.

The KLEMICAS productivity framework		
	Input	Description
K	Capital	Physical capital (buildings, plant & machinery)
L	Labour	Workforce & skills (quantity and quality)
E	Energy	Renewable & non-renewable energy
M	Materials	Intermediate goods & raw materials
I	Information & data	Proprietary & open-sourced information and data assets
C	Care & human services	Paid/unpaid care, community services, relational work
A	Artificial Intelligence	AI systems, automation, GenAI and NextGenAI
S	Services	Embedded services and platform-based inputs

By reframing Australia's approach to productivity measurement in this way, the KLEMICAS approach provides a more authentic and future-focused representation of the drivers of economic growth.

- This expansion aligns with contemporary shifts in firm behaviour, where digital infrastructure, data accumulation, and algorithmic decision-making are rapidly enhancing productivity, especially in knowledge-intensive or service-oriented sectors.
- The KLEMICAS approach retains the empirical practicality of KLEMS (decomposability, alignment with national accounting frameworks, and global comparability) while enhancing its conceptual relevance for a digital economy.

- KLEMICAS provides a platform for policymakers, researchers, and statistical agencies to track productivity more meaningfully and to evaluate innovation and investment strategies that centre on intangible capital and automation.
- It can be used to facilitate policy-relevant evaluations of productivity in both market and non-market domains.

Practical considerations for implementation

Options such as these for enhanced productivity measurement would provide more authentic and comprehensive metrics, but to embed such approaches within the economic reform agenda requires practical, sustainable implementation pathways based on secure, consistent data infrastructure. The following data implementation solutions are recommended for consideration:

- K. **Physical capital: buildings, plant & machinery**
ABS national accounts, BLADE asset registry
- L. **Workforce & skills: quantity and quality**
ABS labour force surveys, PLIDA, ABS Census
- E. **Renewable & non-renewable energy**
ABS Energy Account Australia (EEA), firm-level energy data; national energy reporting (NGER).
- M. **Intermediate goods & raw materials**
Input-output tables, BLADE, supply chain data, BITRE freight line data.
- I. **Proprietary & open-sourced information/data**
Digital investment reports, PLIDA linkages.
- C. **Paid & unpaid care, community services**
ABS Time Use, NDIS/DSS admin datasets, HILDA, AIHW sources, Health records, Medicare MBS.
- A. **AI systems, automation, GenAI and NextGenAI**
Firm R&D surveys, BLADE technology adoption data, Business Expenditure on R&D (BERD)
- S. **Embedded services and platform-based inputs**
BLADE, Administrative records, community sectoral service delivery data.

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Satellite accounts for AI, data and information inputs could serve to operationalise KLEMICAS, using linked firm-level data (BLADE) and individual outcomes (PLIDA) to estimate the marginal productivity of AI, information and data. Outcome measures (health improvements, educational attainment, reduced care needs) may be used to estimate human services productivity.

International alignment

The KLEMICAS framework aligns with emerging international efforts to modernise productivity analysis by recognising intangible, digital, and human-centred inputs:

- The EU' Beyond GDP and ESSNet initiatives have advanced methods to integrate data, AI, and public value into national accounting systems.
- The United States Bureau of Economic Analysis (BEA) has expanded its treatment of intangible assets and is actively exploring the role of data and digital services in productivity growth.
- The United Kingdom's Office for National Statistics (ONS) has launched initiatives to measure public service productivity (WELLBYs) and enhancements to the Public Service Productivity Estimates program.

These developments reinforce the global momentum toward frameworks like KLEMICAS that reflect the rapid evolution of production systems.

Summary

The Economic Reform Roundtable presents an opportunity to modernise Australia's productivity framework. As technology, data, and human services reshape value creation, the KLEMICAS approach offers a future-focused, internationally aligned model that better reflects real economic drivers, supports inclusive growth, investment, and sustained national prosperity in a changing world.

Selected references

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