South Australian Productivity Commission

Research discussion paper no. 4

Demystifying Productivity

Philip Chang

Christopher Findlay

Steve Whetton

January 2023

Government of South Australia

Disclaimer

The views expressed herein are those of the South Australian Productivity Commission and do not purport to represent the position of the Government of South Australia. The content of this research paper is provided for information purposes only. While care has been taken that the material contained in this report is accurate and up-to-date at the time of printing, the information in this research paper is provided on the basis that all persons having access to this research paper will assume responsibility for assessing the relevance, completeness, currency and accuracy of its content. The South Australian Productivity Commission and the Crown in right of the State of South Australia therefore disclaim any liability for any loss or damage arising from reliance on any information contained in it (or any use of such information) which is provided in this research paper or incorporated into it by reference.

South Australian Productivity Commission
GPO Box 2343
Adelaide South Australia 5001
AUSTRALIA

Telephone: 08 8226 7828
Email: sapc@sa.gov.au
Website: www.sapc.sa.gov.au

An appropriate citation for this publication is:

South Australian Productivity Commission 2023, Demystifying Productivity, Research discussion paper no. 4, January (2023)

Contents

Acknowledgements

We would like to express our appreciation to the many people who have reviewed and provided helpful comments and suggestions on this paper. In particular, we would like to thank:

- Professor David N. Weil, James and Merryll Tisch Professor of Economics, Brown University;
- Emeritus Professor Peter J. Lloyd; Department of Economics, University of Melbourne;
- Dr. John L. Nasir, Manager, International Finance Corporation, World Bank Group;
- Dr. Xueli Tang, Senior Lecturer; Department of Economics, Deakin University;
- Dr. Yan Liang, Lecturer; Department of Economics, Deakin University;
- Mr. Jeffrey Hole, Honorary Research Fellow, Department of Economics, Deakin University;
- Dr. Robert Pereira, Senior Manager, Victorian Funds Management Corporation;
- Mr. Matthew Winefield, Director, Department of Treasury and Finance, South Australia; and
- Mr. Talon Deluca, Senior Economist, Department of Treasury and Finance, South Australia.

We would also like to thank Mr. Adrian Tembel, Chair of the South Australia Productivity Commission for his constructive feedback and support for this work.

1. Introduction

Productivity is a concept that is widely reported in the media and commented on by politicians, policy makers, employers, business and trade union associations, and the community.

We often hear that:

> "*Australia's productivity growth had basically stalled.*"
>
> "*Labour productivity … was more or less flatlining.*"[1]
>
> "*Weaker productivity growth reduces people's real incomes and cuts tax revenue, increasing the budget deficits and debt.*"[2]
>
> "*Productivity in Australia is growing at its slowest pace in 60 years, undermining the ability to lift living standards.*"
>
> "*Increasing productivity doesn't mean the spoils are shared evenly.*"[3]
>
> *"Productivity has gained a bit of a bad name after decades of technocratic inquiries and pompous browbeating about how workers are unfocused or even lazy.*
>
> *It is commonly misunderstood as anything that cuts costs, tightens belts or speeds up work. Some employers laughably describe wage cuts as a "productivity initiative" – turning economic theory on its head."*[4]

These quotes illustrate that different commentators have in mind different concepts and understandings when they talk about productivity. Brzustowski (2008) observed that "*Everybody tells us that productivity is very important, but few tell us just what it is.*"

The purpose of this paper is to present the conceptual framework that the South Australian Productivity Commission (the Commission) uses to:

- understand the nature of productivity, including the difference between multifactor productivity (MFP) and labour productivity;
- identify its key drivers and their transmission channels; and
- ensure consistency in language and arguments about productivity growth.

This framework is designed to provide granular insights into the factors influencing productivity and help demystify the concept of productivity.

This paper is the first in a series of three papers that lays the groundwork for the Commission's approach and work program on productivity in South Australia. The paper is organised as follow. Section 2 reviews the concept of productivity. Section 3 discusses the importance of productivity, and its links to living standards. Section 4 examines the key drivers

[1] https://insidestory.org.au/a-progressive-agenda-for-tackling-australias-productivity-crisis/.
[2] https://www.afr.com/politics/federal/chalmers-downgrades-productivity-assumptions-adds-billions-to-deficit-20220803-p5b6ss.
[3] https://www.theguardian.com/australia-news/2022/aug/03/environmental-and-covid-challenges-threaten-australias-productivity-rate-after-slowest-growth-in-60-years.
[4] https://theconversation.com/if-productivity-was-the-magical-fix-some-claim-we-wouldnt-need-a-jobs-summit-188716.

of labour productivity. Section 5 discusses the key measurement issues of productivity. Section 6 concludes the paper

The second paper will analyse South Australia's productivity performance within the context of the framework set out in this paper and highlight the State's productivity challenge.

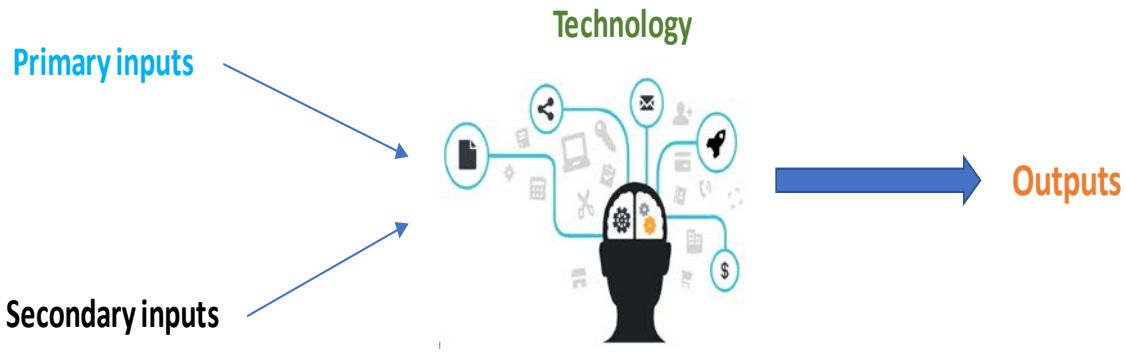
The third paper will discuss the distribution of productivity gains.

2. What is productivity?

Productivity refers to the combined effect of the use of inputs in a production process to produce valuable output. It can be estimated at various levels: industry, economic sector, or the economy. It reflects both the technology (i.e., the available knowledge about how inputs can be used to produce output), and the efficiency (i.e., determined by how inputs and technology are actually used) in producing output.

Inputs into the production process can be categorised into primary inputs and secondary inputs (Korinek (2022)). Primary inputs are inputs that render services but are not (immediately) transformed in the production process, such as human capital; physical capital; and land. Secondary inputs are inputs that used up or transformed in the production process, such as natural resources, energy, and materials. Figure 2.1 illustrates the production process of combining primary and secondary inputs, and technology to produce goods and services.

Figure: 2.1: Production of goods and service



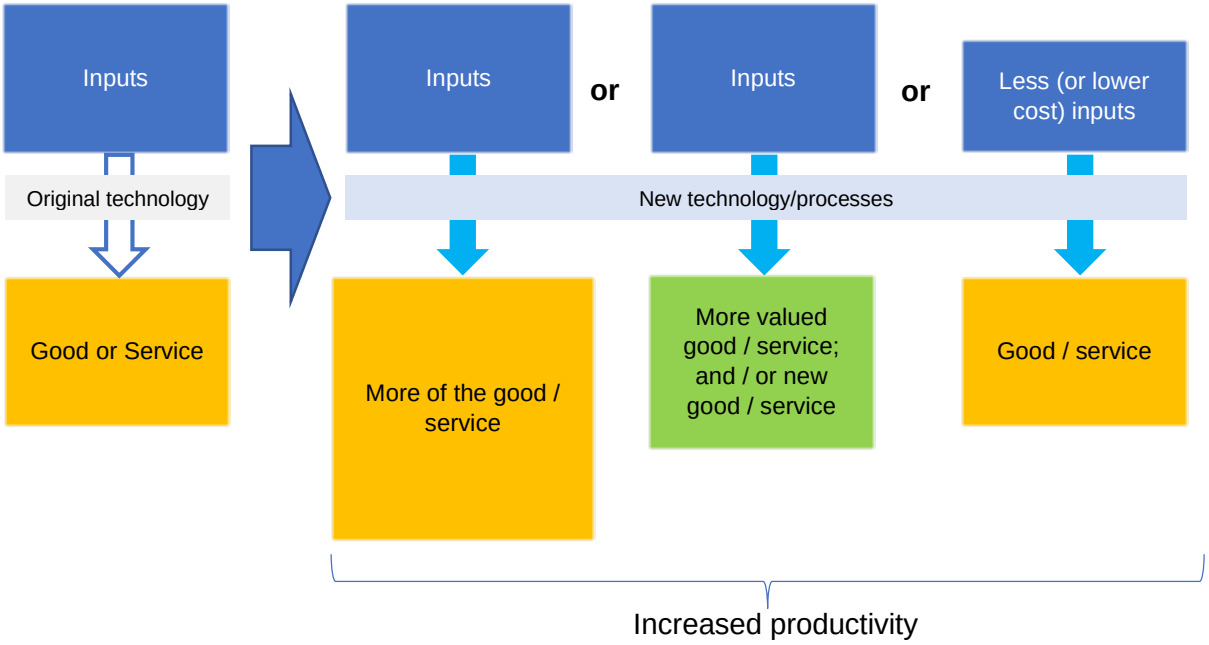
Source: Authors

Productivity increases when a higher amount of existing goods and services are produced from the same level or lower level of inputs, or when more highly valued form of goods and services (whether new or existing) are produced for the same amount of inputs (Figure 2.2).[5]

Where productivity is being measured in terms of all primary inputs (e.g. the amount of output for a given quantity of capital and labour) it is called multi-factor productivity (MFP) or total factor productivity. MFP is calculated as a residual, that is, it is that part of the growth of value added which is not explained by input growth of labour and capital. Some important issues relating to the measurement of MFP and labour productivity are discussed in Section 5.

[5] See Productivity Commission (2022a, Chapter 1) for a discussion on the implications of the introduction of new goods and services.

Figure: 2.2: Ways productivity can increase[6]



Source: Authors.

Alternatively, productivity can be defined in terms of a single factor input, such as labour or capital. Labour productivity (the output per unit of labour) can rise due to an increase in the average human capital of workers, or because of increases in complementary inputs such as capital, or because of an increase in MFP.

Labour productivity is important because it is a major source of increases in real wages and living standards. For instance, when labour productivity increases, it lowers the cost of labour at a given level of real wages. All other things being equal, firms will find it profitable to hire more workers to produce more, increasing the demand for labour. This will raise real wages as firms compete to hire additional workers (Walsh 2004).[7] The links between labour productivity and living standards are discussed in Section 3.

[6] Prices for some of these goods may fall due to the productivity increase (e.g. computers, cars, etc.). Some new goods that are of higher value to customers can command higher prices. New goods could include those with improved quality.

[7] At the macro level, it can be shown that real wage growth depends on both the labour share of income and labour productivity growth for a certain production function. In this case, real wage growth in an economy will grow at a similar rate to labour productivity growth if the labour share of income is relatively stable (Lawrence (2015)).

3. Why productivity is important?

Productivity growth is important because it raises South Australia's material living standards measured in Gross State Product (GSP) per person. Higher living standards is generally associated with higher quality of life, for instance, as measured by the United Nations Human Development Index.

South Australia's living standards refer to outputs/incomes generated in the state, compared to total population. It depends on two factors (Figure 3.1):

i. **labour productivity**, i.e., the value of what the South Australian economy produces per hour worked – *how effectively we work*; and

ii. **labour utilization**, i.e., the average number of hours worked per person in the population in the South Australian economy – *how much we work*.[8,9]

Labour productivity is the only factor that drives increases in South Australia's standard of living in the long run because there is an upper limit on labour utilisation. That is, there is an upper limit on the number of hours that a worker can work in a day, and an upper limit on the share of workers in the population.

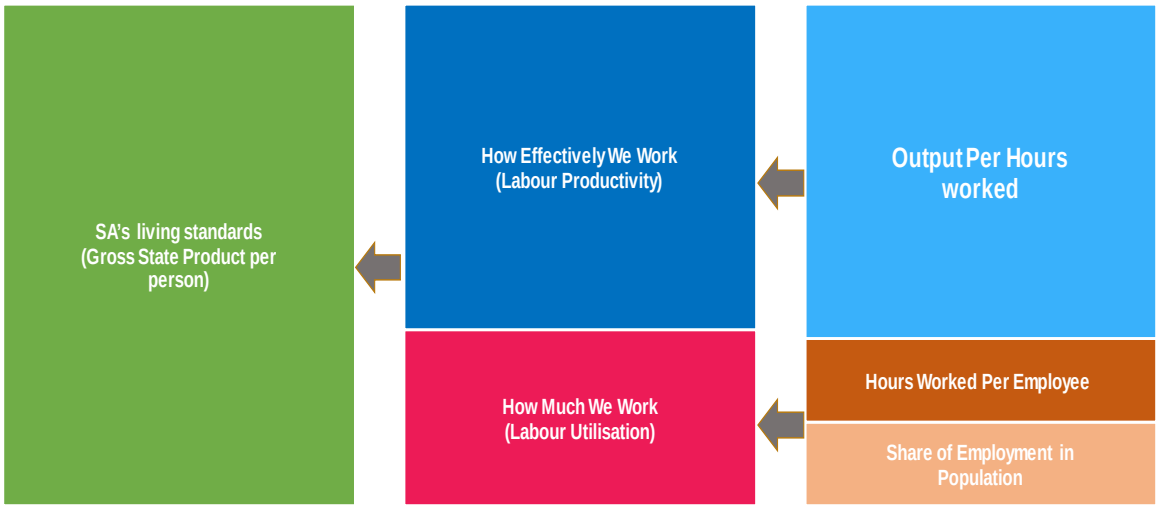
Increasing labour productivity:

- means that living standards can rise without requiring South Australians to work more (via higher wages and/or lower prices increasing real wages);
- provides South Australian families with more capacity to make choices and scope to improve their quality of life;
- increases the competitiveness of local business; and
- increased incomes means higher tax revenues, which adds to the fiscal capacity of the South Australian Government to invest in other drivers of wellbeing such as health, education and training, and decarbonisation industries.

[8] *GSP per person = Labour productivity * labour utilisation; where* $GSP\ per\ person = \frac{GSP}{Population}$; $Labour\ productivity = \frac{GSP}{hours\ worked}$; *and* $Labour\ utilisation = \frac{Hours\ worked}{Workers} * \frac{Workers}{Population}$. Australian Treasury (2007) decomposed real GDP growth into three drivers: population, (labour force) participation and (labour) productivity – known as the "3 Ps". That is, $GDP = population * [\ 1 - unemployment\ rate] * labour\ participation\ rate * averare\ hours\ worked * labour\ productivity$.

[9] Incomes can still rise if the South Australian economy's terms of trade improved, that is, the prices that we receive for goods and services that we export compared those that we import. It is important that resources are shifted to parts of the income where opportunities created by changes in the terms of trade can be captured (Productivity Commission (2013)).

Figure: 3.1: Drivers of South Australia's living standards



Source: Authors

In South Australia and other Australian states and territories, GSP per capita growth is predominantly driven by labour productivity growth (Figure 3.2). That is, growth in GSP per person (the black line) is dominated by the blue bar associated with labour productivity rather than the red bar associated with labour utilisation. Indeed, the latter is negative in many cases. It is also important to note that the contribution of labour productivity has fallen over time in all three states.

Figure: 3.2: Contributions* to growth of *GSP per person

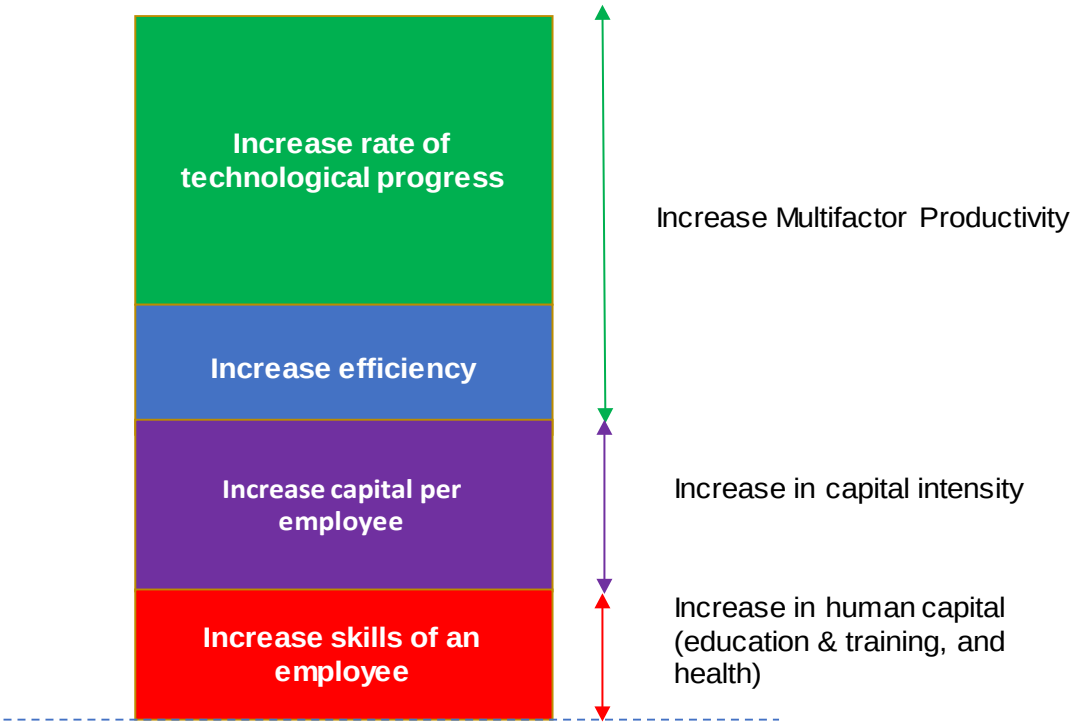
Source: ABS 5220, ABS 3101.0, ABS 6202.0, ABS 6291.0.55.001 - RQ1.

With respect to variations between states, South Australia's rate of labour productivity growth was comparable to that of larger states, such as New South Wales (NSW) and Victoria in the first period in Figure 3.2. In 2000s, labour productivity growth exceeded that of the other two states, and was the major source of growth of GSP per capita in South Australia (i.e., the sum of each of blue and red bars in Figure 3.2). However, South Australia's labour productivity growth fell substantially in 2010s. As a result its contribution to GSP per capita growth was smaller than in 2000s.

4. What are the drivers of labour productivity?

Boosting labour productivity can be achieved through technological and efficiency improvements (which add up to the contribution from changes in multifactor productivity), and use of more skills and capital (Figure 4.1). We now look at these 4 drivers in more detail.

Figure: 4.1: Four drivers of labour productivity growth



Source: Authors

4.1 Technological improvements

The first factor that drives labour productivity is technological improvements (also referred to as technological progress or technological change) (Weil, 2013). Technological progress is defined as changes in the way that factors of production are combined to produce output. It overcomes the limitations imposed by the law of diminishing returns.[10] Importantly, technological progress is not just about advances in science or engineering, it also encompasses new ways of organising work, new ways of distributing goods and services, and new ways of marketing products.

An economy can acquire technology through (i) technology creation (invention), which requires investment in expanding the frontiers of knowledge through research and development (R&D); or (ii) technology diffusion and adoption (imitation), including across borders, which depends on the appropriateness of technology, tacit knowledge, and the level of human capital as well as participation in international trade (Akcigit and Melitz (2022)). In many cases, local R&D to work out how to adopt some already existing technology into an

[10] The law diminishing returns refers to a situation where adding an additional unit of an input of production, with other inputs remaining unchanged, will result in smaller increases in output.

organisation that is not currently using it is necessary for diffusion. The Australian Productivity Commission's Productivity Inquiry found that only between 1 to 2 per cent of Australian businesses introduce innovations that are novel to the world. This suggests that technology adoption and diffusion in both the private and sector sectors will be a critical factor in overall growth of productivity (Productivity Commission (2022b)).

For South Australia, according to a variety of innovation indicators (business spending, patents issued and new business creation), the state lags national averages. A topic for further work by the Commission is to deepen our understanding of the drivers of innovation in the state, which will help identify ways to promote the creation and adoption of new technology. There are also interesting questions about how innovations in the production of goods differs from that in services.

4.2 Efficiency improvements

The second factor that drives labour productivity growth is efficiency improvements.[11] Efficiency refers to how inputs and technology are combined to produce valuable output. The difference between efficiency improvements and technological progress is illustrated in Box 4.1.

In general, there are many factors that can affect the efficiency of an economy, some relating to organisational practices, some relating to government intervention and some relating to social norms. Examples are presented in Table 4.1.

Box: 4.1: Efficiency improvements versus technological progress

Technological progress

- A new variety of apple that is suited to local conditions is developed through local research and development.
- It increases the *potential* yield from 100t per ha to 120t per ha in the Adelaide Hills.

Efficiency improvements

- Farm 1 and 2 use same technology (same new variety of apple).
- Farm 1: actual yield is 110t per ha.
- Farm 2: actual yield is 120t per ha.
- Farm 2 more efficient than Farm 1.
- Possible sources of higher efficiency of Farm 2 in this case include better use of irrigation, better land management, and better processes e.g. watering/fertilising schedule to produce higher yields from new technology.

Source: Filsell's Apples Orchard Visit – Adelaide Hills – PickALocalPickSA

[11] Jones (2021) refers to efficiency improvements as reduction of misallocation.

Table 4.1: Sources of inefficiency

Sources of inefficiency	Examples
Misallocation of resources within firms: inefficiency arises when resources are diverted from productive to unproductive activities within organisations. Misallocation also occurs when productive human and physical capital are unemployed or underemployed.	Rent seeking (e.g. apple growers spend time away from their farms lobbying for a licensing scheme), managers focussed on securing promotion through networking rather than on performance, corruption, cost of compliance with regulation. Unemployment, underemployment (more workers than needed), a factory that is unused, a factory running below full capacity.
Misallocation of factors of production among firms: inefficiency arises from misallocation of resources among firms due to barriers constraining the reallocation of resources from less productive firms to more productive firms.	Subsidies, preferential contracts, trade protection, monopoly power; government policies that favour smaller firm size (where large firms are on average more productive than smaller firms).
Misallocation of factors of production among sectors: inefficiency arises from misallocation of resources among sectors due to barriers constraining the reallocation of resources from less productive to more productive sectors.	Entry restrictions into some markets for goods and services, due to barriers to trade, restrictions on access to factors of production (e.g. land, capital and labour), ethnic or gender discrimination may prevent productive sectors from growing.
Technology blocking: inefficiency arises when technology could feasibly be used but someone deliberately prevents its use.	Incumbent firms with market power can use that position to block new technologies from entering the market, or use its pricing power to deter a switch to a better product. For example, Weil (2013) notes a US court finding that Microsoft tried to suppress various new computer technologies that threatened its Window's monopoly.
Inadequate infrastructure and connectivity: inefficiency arises from inadequate and inefficient provision of infrastructure (e.g. transportation, energy, water, digital) and connectivity, which constrains economic activities and raises costs to producers and consumers.	Insufficient water supply constrains agricultural sector growth, and the development of the hydrogen energy sector. Infrastructure bottlenecks. Inadequate transport connectivity increases the transportation costs.
Inefficient and inadequate institutions (rules of the game): inefficiency arises from inefficient institutions and institutional bottlenecks.	Inefficient provision of public services, bureaucracy, regulations, policies, and the tax system.
Inadequate scale: firms are unable to grow to an efficient scale or an industry is unable to procure specialised inputs because of the lack of its scale.	Small scale of local markets for non-tradeable goods and services, or restrictions to market access for tradeables. Barriers to growth of existing firms (e.g. access to finance, land, markets, etc.).

Source: Weil (2013), Section 10.3

For South Australia, the relative significance of the different sources of inefficiency are topics for further work in the Commission.

4.3 Physical capital deepening

Physical capital includes machinery and equipment, buildings, infrastructure (e.g., roads and ports, telecommunications, electricity, and water supply networks), vehicles, computers, software and other forms of embodied knowledge. Producing most outputs requires the use of physical capital of some form. For most jobs, a worker with access to more or better capital will be able to produce more output.

Physical capital has the following characteristics (Weil, 2013, ch. 3):

- It is productive i.e., the amount of output a worker can produce increases when he/she has more capital to work with.
- It needs to be produced. The process of producing capital is called investment.
- Its use is restricted i.e., only a number of people can use a given capital at one time.
- It can earn a return.
- It depreciates over time.
- It can embody research and development undertaken elsewhere.

Capital accumulation or investment raises capital per worker (also referred to as capital deepening) and increases labour productivity but at a diminishing marginal rate due to the law of diminishing returns.

For South Australia, labour productivity growth had been driven mainly by higher capital inputs (the purple box in Figure 4.1): it was more important that the combined contribution of changes in efficiency and adoption of new technology (i.e., of MFP growth) since the turn of the century (Parham 2020).

4.4 Human capital improvements

Human capital, or the quality of labour, is the third factor that drives labour productivity. The OECD defines human capital as “the stock of knowledge, skills and other personal characteristics embodied in people that helps them to be productive” (Botev, J., et al. (2019, p.5). Health and education & training are key factors that affect the quality of labour and its productivity.

Human capital, like physical capital, is an important input into the production process of goods and services. Human capital shares several characteristics with physical capital (Weil, 2013, ch. 6):

- It is productive. It refers to the qualities that people possess to enable them to produce valuable output.
- It needs to be acquired. People are not born with knowledge and skills. They are acquired through investment, such as education and training or better health,[12] that will equip them with the necessary skills to perform tasks successfully.

[12] Categories of education include formal education (early childhood, formal school system, adult training programs) and informal education, as well as on-the-job learning and work experience.

- It earns a return in terms of an increased wage.
- It can also depreciate due to lack of use, ageing, deteriorating health due to illness, or changes in production technology and consumer demand which render some existing skills obsolete.

Additionally, improved human capital contributes to technological progress because it facilitates the development and the adoption of new technology, and to economic efficiency improvements by raising the efficiency of labour.

For South Australia, various indicators of skill levels find a lower performance in the state compared to other states in Australia. According to the Commission's analysis, based on available data (2019), South Australia had the lowest proportion of 25 years and 44 years, with a bachelor's degree or higher (22 per cent compared to a national average of 28 per cent), and the second highest proportion (below only Tasmania) with a highest level of education of year 11 or lower.

4.5 Three observations

We make three observations on the drivers of labour productivity growth.

1. **In the long run, technological change is what matters**

In the long run, an economy cannot maintain its labour productivity growth by simply accumulating more human capital or physical capital because both suffer from the law of diminishing returns. Opportunities for efficiency improvements can also eventually be exhausted, as the economy reaches its most efficient allocation. MFP growth from technological change will therefore be the main driver of long-term growth of labour productivity.

In a small open economy like South Australia, almost all of the technology used is developed elsewhere and adopted locally. Therefore, the local skills and technological capacity which facilitate the adoption and application of new technology in the production of goods and services are very important.

2. **Boundaries are blurred**

The boundaries between the four drivers of labour productivity growth are not always clear. For instance,

- the process of capital deepening may be a vehicle for the installation of new technology, which is embodied in a new investment;
- human capital can contribute to both technological progress (through development and application of new technology) and to efficiency improvements;
- new capital goods can require additional or different skills to use successfully, requiring a joint investment;
- the line between technological change and improved efficiency may be blurred, for example, in the service sector; and
- MFP may drive investment and capital deepening, which in turn is a vehicle for technological change.

3. Trade and factor flows matter

Trade and factor flows matter because they can amplify the impact of the four drivers on productivity growth by

- raising efficiency through increased competition and economies of scale; and
- promoting technology transfer and innovation; and
- enhancing human capital through movements of labour and/or migration and facilitating the importation and adoption of new physical capital.[13]

There is a virtuous circle from productivity to trade. The presence of sunk costs in setting up for export has a key influence on which firms become involved. This leads to a bias towards those which are already more productive in MFP terms who can cover those costs.

Participation in trade can also foster higher MFP through market size and learning effects, competition; improved product quality (especially via access to imported inputs); and innovation. Access to imported inputs is also important. Two-way traders are the most productive group of firms, followed by importers and then exporters, while firms selling or buying on the national market only are the least productive (Wagner, 2019).

The links between trade and MFP also lead to changes in the mix of firms at the sectoral level, with a greater share of more productive firms. This process is an important contribution to the longer run performance of the economy.

[13] For further discussion of the effects of participation in trade see Shu and Steinwender (2019).

5. Issues in measuring productivity

The Australian Bureau of Statistics (ABS) calculates MFP for 16 industries in the market sector, which comprises about 70 per cent of the economy, and labour productivity for the market sector and the economy as a whole (including non-market sector, i.e., Public Administration & Safety, Education and Training, and Health Care and Social Assistance). The ABS also releases annual estimates of productivity at the state level.

Despite its economic importance, productivity is difficult to measure and there are significant differences of opinion on how it should be defined. Specific issues to do with its measurement include the following (Gordon, Zhao and Gretton, 2015).

1. **Measurement focussed on the volume of inputs and outputs**

MFP estimates calculated by the ABS only take into account the market sector of the economy. However, these estimates can be affected by the choice of price deflator used to convert value to volume data, as in line with the main measures from the national accounts such as GDP, productivity is calculated on a volume basis. As a result, MFP estimates are unlikely to take into account all improvements in quality of inputs and outputs (and in utilisation of inputs).

Additionally, there are often statistical errors in measurement of inputs and outputs which affect productivity estimates, particularly for the service sectors.

2. **Some inputs are not measured**

MFP estimates will be distorted as some inputs are not purchased in the market (e.g. some natural resources inputs) and human capital are not always included in the measure of inputs. The ABS does seek to estimate changes in the 'quality' of labour, however such adjustments are difficult to make accurately (however for policy purposes it is also useful to separate the contribution to output growth of human capital changes from those related to labour time). No official Australian data accounts fully for degradation of natural endowments (such as top-soil erosion on farmland or extraction of minerals deposits) in calculating output and productivity.

3. **Impact of business cycles**

During a downturn, many firms will reduce output volumes, but cannot easily reduce capital and labour inputs as they need these inputs ready for when demand recovers. Hence, firms are likely to underutilise capital and labour inputs in a downturn and MFP will be lower. Conversely in a recovery, firms can often deliver initial increases in output through increasing the utilisation of underused capital and labour, leading to an apparently substantial increase in productivity.

4. **Lags between investment and when it is utilised in production**

Large infrastructure projects can take several years between investment and utilisation. Hence, growth in measured capital services in the investment year(s) can be higher than the *actual* growth in capital service, which will overestimate input growth and underestimate MFP growth. Once the new capital begins to be fully utilised this data error can appear in the reverse form (this issue is common in the mining industry).

5. Special measurement issues in service sector

Services account for about 80 per cent of production in Australia, and 90 per cent of employment. This concentration of economic activity in services is common across higher income per capita economies. There has been a concern that service sector growth is a drag on national productivity performance because it is seen as harder to increase the productivity of services delivery than of goods production.

Services are diverse, for some services, there is slow or zero productivity growth, especially face-to-face activities, such as haircut, psychotherapy and aged care. Therefore, if the economy shifts to these sectors, then there will be slower productivity growth in the aggregate.

Conversely, some services have shown higher productivity growth than in goods, such as financial services, ICT, business services, and transport. Moreover, service sector growth can be productivity promoting because it might be more profitable to contract out certain functions to specialists.

It can also be the case that productivity growth is more difficult to measure in services because it is harder to measure changes in output. This is due to the nature of services and the range of dimensions involved, the participation of the consumer in the process, and the difficulty of separating quality differences from price differences.

6. Conclusion

We present the framework that the Commission uses to examine and analyse the factors that drive productivity growth in South Australia. A key feature of this framework is the decomposition of MFP into two components: technological improvements and efficiency improvements. In particular, it provides a systematic way to categorise the factors that influence productivity. Some economies may be getting more “bang for the buck” in extracting productivity gains from efficiency improvements than from technological progress in the short term to medium term. But in the long run, it is technological progress and the adoption of new technology that counts.

This framework also provides the basis for further work in the Commission to develop a research program to identify the drivers and the barriers that affect the four drivers of labour productivity growth, to analyse their impact, while considering a number of measurement challenges, and then to propose policies and interventions to lead to better performance.

References

Akcigit, U. and M. Melitz (2022), International trade and innovation, ch. 6 in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, Handbook of International Economics, Elsevier, Volume 5, pp. 377-404.

Australian Bureau of Statistics, (2021), Australian System of National Accounts: Concepts, Sources and Methods, https://www.abs.gov.au/statistics/detailed-methodology-information/concepts-sources-methods/australian-system-national-accounts-concepts-sources-and-methods/2020-21.

Australian Treasury, (2007), Intergenerational Report 2007, Commonwealth of Australian, Canberra.

Botev, J., Egert, B., Smidova, Z., and Turner, D., (2019), "A new macroeconomic measure of human capital with strong empirical links to productivity", OECD Economics Department Working Papers, No. 1575, OECD Publishing, Paris, https://doi.org/10.1787/d12d7305-en.

Brzustowski, T., (2008), The Way Ahead: Meeting Canada's Productivity Challenge, The University of Ottawa Press, Ottawa.

Gordon, J., Zhao, S. and Gretton, P.,(2015), On productivity: concepts and measurement, Productivity Commission Staff Research Note, Canberra, February.

Jones, I. J., (2022), The Past and Future of Economic Growth: A Semi-Endogenous Perspective, Annual Review of Economics, 14, pp. 125–52. https://web.stanford.edu/~chadj/annualreview.pdf

Korinek, A., (2022), The Economics of AI – Modeling Technological Change, University of Virginia, https://www.coursera.org/learn/economics-of-ai#syllabus

Parham, D., (2020), A data-driven investigation of South Australia's productivity performance, Research Discussion Paper No. 1, SA Productivity Commission.

Productivity Commission, (2013), 'On efficiency and effectiveness: some definitions', Productivity Staff Research Note, May, Canberra.

Productivity Commission, (2021), Productivity Insights: Things you can't drop on your feet – an overview of Australia's service sector productivity, April. https://www.pc.gov.au/ongoing/productivity-insights/services/productivity-insights-2021-services.pdf

Productivity Commission, (2022a), 5-year Productivity Inquiry: Key to Prosperity, Interim report No.1, July.

Productivity Commission, (2022b), 5-year Productivity Inquiry: Innovation for the 98%, Interim report no.3, September.

Shu, P. and Steinwender, C (2019). The impact of trade liberalization on firm productivity and innovation. Innovation Policy and the Economy, 19(1), pp.39-68.

Walsh, E. C., (2004), The Productivity and Jobs Connection: The Long and the Short Run of It, Federal Reserve Bank of San Francisco Economic Letter, No. 2004-18, July 16. https://www.frbsf.org/economic-research/publications/economic-letter/2004/July/the-productivity-and-jobs-connection-the-long-and-the-short-run-of-it/

Wagner, J., (2019), Effect of international activity on firm performance. IZA World of Labor. https://wol.iza.org/uploads/articles/509/pdfs/effect-of-international-activity-on-firm-performance.pdf

Weil, D., (2013), Economic Growth, Third Edition. Pearson Education Limited.