

Adoption of General-purpose Technologies (GPT) in Australia: The Role of Skills

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Abstract

General-purpose technologies (GPT) have the potential to transform how we work, to change the skills we need and to drive productivity growth. It is therefore important to understand the conditions that lead to the successful adoption of GPT. Using a novel database on the adoption of cloud computing and artificial intelligence/machine learning by Australian-listed firms, this article finds that the COVID-19 pandemic led to a short-lived surge in adoption of cloud computing technologies. In addition, there is evidence that profitable adoption is more likely to occur in firms where the Board has members with relevant technological backgrounds, and that firms adopting GPT are more likely to seek staff with related skills. These findings highlight the importance of workers' and managers' skills in technology adoption, and the impact this can have on productivity growth.

Introduction

Productivity growth is the key driver of living standards over the medium term. The discovery of new technologies helps drive productivity growth, by revealing better ways for businesses to operate. A key step in this process is when the technology moves beyond the inventor and firms begin adopting it for themselves. This step is particularly

important for Australia, which tends to be a technology importer – while only a very small share of Australian firms create a 'new-to-the-world' innovation each year, around half incorporate an existing technology (Productivity Commission 2023).

Over recent decades, Australian firms have fallen further and further behind the global productivity

frontier, providing indirect evidence that the pace at which Australian firms adopt new technologies has slowed (Andrews *et al* 2022). Direct evidence on technology adoption is scarce, particularly on the drivers of and barriers to adoption.

This article attempts to fill this gap by developing a new database on technology adoption using references to technologies from Australian-listed firms' earnings calls and annual reports. It combines this database with information on firms' performance, management and hiring to get a clearer picture of the drivers of and barriers to adoption. The focus here is on cloud computing and artificial intelligence/machine learning (AI/ML) – two emerging digital general-purpose technologies (GPT) – though the approach could be extended to other technologies. These technologies have the potential to alter the way firms do business. Use of these technologies also tends to require highly skilled and educated workers, which has the potential to affect demand for skilled labour (Burgess and Connell 2020; Ellis 2021). As a result, particular emphasis is placed on the role of manager and worker skills in the analysis.

GPT adoption over time

In the early and mid-2010s, the share of firms mentioning cloud computing for the first time – a sign of GPT adoption – remained steady at around 1–2 per cent (Graph 1). Towards the end of the 2010s, there was a slight increase in the share of firms adopting cloud computing, though this remained below the share observed in the United States (Bloom *et al* 2021). The share of firms adopting cloud-related technologies jumped sharply during the COVID-19 pandemic. However, the rate quickly reverted, indicating that this was a temporary boost in the adoption rate and a level shift up in the number of firms that had adopted these GPTs, but not a long-term change in the trend. This suggests that some of the optimism around the potential for the pandemic to lead to an ongoing increase in digital adoption and therefore productivity may be somewhat overstated, though the story will become clearer as more data become available. It is also important to highlight that this

analysis only captured listed firms, and patterns for other firms could differ.

Regarding AI/ML, adoption rose steadily from 2015 to 2018 before stabilising at around 3 per cent of firms newly adopting this technology each year, which was slightly below the share in the United States (Bloom *et al* 2021). Overall, the cumulative share of firms that appear to have adopted AI/ML-related technology remains low. However, recent advancements in generative AI like ChatGPT could potentially lead to an increase in future.

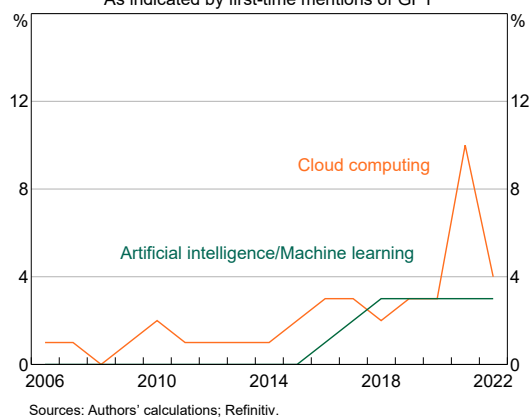
Adoption trends have varied across industries (Graph 2). The IT and communication sectors were early adopters of both technologies, as were the financial and healthcare sectors, particularly of AI/ML. On the other hand, the sharp increase in cloud computing adoption during the pandemic was quite widespread.

Board skills and adoption

Many previous studies have shown that management capabilities are important for firm performance (Bloom *et al* 2019; Alekseeva *et al* 2021; Calvino *et al* 2022). As such, we set out to determine whether having Board members with certain skillsets is associated with greater adoption of GPTs. To do so, we used data from S&P Capital IQ on the Board members at Australian-listed companies – specifically, information on their demographic, educational and professional backgrounds – to identify whether a firm had any Board members

Graph 1

Share of Firms Adopting GPT
As indicated by first-time mentions of GPT



with relevant attributes. The analysis was based on a snapshot of Board members as of March 2023.

Skilled Board members and GPT adoption

We first considered whether firms with certain types of Board members are more likely to adopt these GPTs, focusing on firms outside of the IT sector (see Appendix A for details). We found the following:

- Firms with a Board member *with prior experience in the IT industry* were 30 percentage points more likely to adopt GPT.
- Firms with a Board member *with some experience in GPT* were 8 percentage points more likely to adopt GPT.

There are two potential explanations for these findings. One is that having directors with relevant skills influences the decision to adopt a GPT. Alternatively, firms could hire directors with these skills because they *intend* to adopt a GPT, so the decision to adopt influences the Board composition rather than the other way around. While the data do not allow us to differentiate between these two possibilities, both explanations suggest that having Board members with relevant knowledge is important for GPT adoption.

Skilled Board members and profitability of GPT adoption

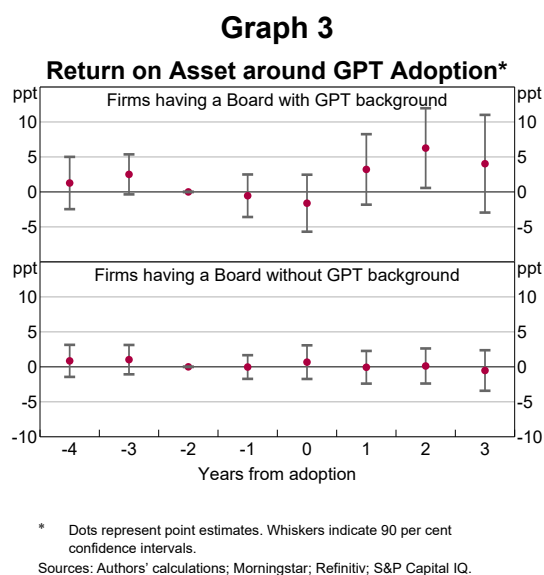
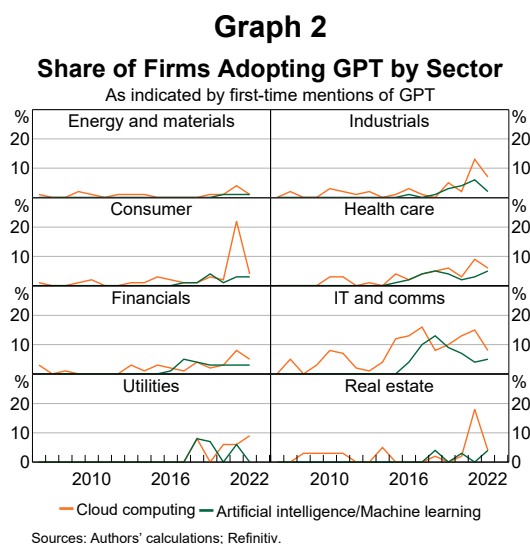
We next considered whether firms with technologically skilled Board members are more likely to experience an increase in profits post-adoption, compared with other firms. To do so, we

split the sample into those that had a Board member with a GPT background and those that did not and traced out the profitability (return on assets) of firms in each group before and after adoption using a panel event study (see Appendix B for details). We found the following:

- Firms with at least one Board member with GPT background saw moderate increases in profitability after GPT adoption (Graph 3 – top panel).
- Firms without any Board members with a GPT background did not see increases in profitability after GPT adoption (Graph 3 – bottom panel).

This suggests that having Board members with relevant technological experience may facilitate profitable GPT adoption. This aligns with previous studies showing that technological skills, including those at management level, are highly valued by firms (Alekseeva *et al* 2021; Calvino *et al* 2022).

That said, we cannot rule out the possibility that there are other factors at play here. For example, it could be that some firms generally have a greater focus on IT transformation, and these firms are both more likely to adopt GPT in a way that increases profitability and to appoint technologically skilled Board members. Although, this would still suggest that the skilled Board member provides some benefit, given the choice to appoint them.



Adoption and demand for workers skilled in GPT

While the skills of Board members were found to be significant for GPT adoption, workers' skills are also likely to be important. Information about the employees at these firms was not available; however, we were able to look at firms' job advertisements to understand what skills they were trying to bring in using the dataset created by Bahar and Lane (2022). The dataset was constructed using online job ads collected by Lightcast (previously known as Emsi Burning Glass) over the period 2012 to 2022 and indicates whether the firm mentioned a GPT in their job advertisements – a sign that the firm was trying to hire people with GPT-related skills. Based on this analysis, we found the following:

- Firms that adopted GPTs at some point were 16 percentage points more likely to advertise for GPT skills compared with other firms, controlling for other factors (see Appendix C for details).
- The likelihood that a firm advertises for GPT skills tends to rise following adoption, especially for firms with Board members experienced in GPT (Graph 4). These firms also showed the most evidence of increased profitability post-adoption, as discussed above.

Taken together, our findings indicate that GPT adoption is linked to a higher demand for skilled workers, and that these skills can play an important role in profitable adoption. However, more comprehensive information on the workforce in these firms could provide a more complete picture and could be explored in future research.

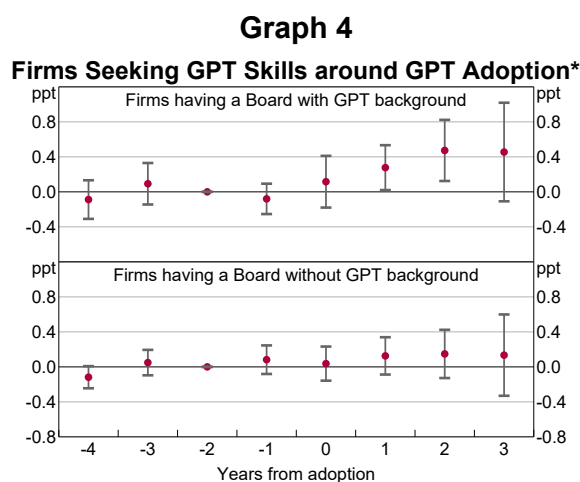
Conclusion

Against the backdrop of slowing productivity growth and technology diffusion, it is crucial to understand the factors that can drive or hinder adoption of emerging digital GPT, as well as how adoption affects firms. This study used a unique dataset derived from annual reports and earnings calls of Australian firms to examine these issues, focusing on cloud computing and ML/AI.

The study revealed that, while the pandemic caused an unprecedented surge in GPT adoption, adoption rates quickly returned to their pre-pandemic levels. This suggests that some of the initial optimism that the pandemic could lead to an ongoing increase in digital adoption and productivity growth may be overstated. That said, more data on the post-pandemic period will be needed to better assess the longer term implications.

The study also found that workers' and managers' skills appear to play an important role in the profitable adoption of GPT. To the extent that GPT-related skills are becoming more prevalent over time, this may make it easier for firms to adopt GPTs, and hence support productivity growth. More generally though, it also underscores the importance of developing a skilled workforce in Australia to foster GPT adoption and support productivity growth moving forward.

This analysis represents a first step in understanding the drivers of, and barriers to, technology adoption. Given the importance of these issues, further work could explore other aspects of adoption, or other technologies, such as green technologies. Further analysis could also look to combine adoption data with administrative data on the workers at these firms to provide a more detailed picture of how skills and training feed into technology adoption. ✎



* Dots represent point estimates. Whiskers indicate 90 per cent confidence intervals.

Sources: Authors' calculations; Bahar and Lane (2022) using Lightcast data; Morningstar; Refinitiv; S&P Capital IQ.

Appendix A

Table A1: Determinants of Adoption – Board Members’ Characteristics

Estimates from linear probability regression, non-IT firms in 2022

	Without size control	With size control
Experience in IT industry	0.249*** (0.0564)	0.313*** (0.0741)
Experience with GPT	0.112** (0.0396)	0.0831** (0.0421)

Note: All explanatory variables are dummies indicating whether the firm has any Board members with these characteristics. *, **, *** indicate significance at the 10, 5 and 1 per cent level, respectively. All regressions control for industry*time effects. Errors clustered at the industry level. Number of observations is roughly 1,250.

Sources: Authors’ calculations; Morningstar; Refinitiv; S&P Capital IQ.

Appendix B

We employed a panel event study framework to estimate the effect of GPT adoption on firm-level outcomes. The framework allowed us to analyse changes in firm outcomes before and after the adoption of GPTs, which can happen at different points in time across different firms. A similar approach has been undertaken by Babina *et al* (2023) for AI adoption.

The variable $Adopt_i$ indicates the period when the technology was first referenced by firm i . The outcome of interest is denoted as y_{it} , and the panel event study specification is as depicted below:

$$y_{it} = \alpha + \sum_{2 \leq j \leq J} \beta_j (Lagj)_{it} + \sum_{1 \leq k \leq K} \beta_k (Leadk)_{it} + X'_{it} \Gamma + \mu_i + \theta_s + \epsilon_{it}$$

Where:

$$(Lagj)_{it} = 1 \{t = Adopt_i - j\} \text{ for } j \in \{1, \dots, J\}$$

$$(Leadk)_{it} = 1 \{t = Adopt_i + k\} \text{ for } k \in \{1, \dots, K\}$$

The adoption event’s lags and leads are defined as binary variables indicating that a specific firm was a given number of periods away from the adoption event. The coefficients of interest are the betas related to the lags and leads. We focused on up to four years before adoption and three years after. While a longer post-adoption window could be appropriate if these investments have very long payoff windows, we were constrained by the sample period available. Control variables included firm size, firm-fixed effects, and industry*time-fixed effects.

Appendix C

Table C1: Regression of Hiring on Technology Adoption

Estimates from linear probability regression, non-IT firms

	With no controls	With industry controls	With industry and size controls
Adopt	0.372***	0.397***	0.162**
(Standard error)	(0.0788)	(0.0834)	(0.0699)

Note: *, **, *** indicate significance at the 10, 5 and 1 per cent level, respectively. Errors clustered at the industry level. Includes 215 firm observations.

Sources: Authors’ calculations; Bahar and Lane (2022) using Lightcast data; Morningstar; Refinitiv.

Endnote

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