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Southeast Asia Working Paper Series

Paper no.11

June 2024



SOUTHEAST ASIA
Research at LSE ■

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Published by

Saw Swee Hock Southeast Asia Centre
London School of Economics and Political Science
Houghton Street
London WC2A
2AE
seac.admin@lse.ac.uk
www.lse.ac.uk/seac

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The scale-up state: Singapore's industrial policy for the digital economy

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Abstract

The Singaporean state has played a crucial role in the country's economic development. This led to concerns that a state-steered economy would be unable to develop fast-changing, disruptive sectors that are reliant on individual entrepreneurship, such as digital technology. Yet Singapore has become a world leader in the scaling of digital technology firms. In this paper, we consider how this happened. We show that advances in ICT opened a window of locational opportunity in digital tech, which was spotted by Singaporean policymakers open to experimentation. A distinctive 'Singapore model' developed to take advantage of this opportunity, exploiting Singapore's geographical position, open economy, and business environment but combining this with active state intervention. To address coordination problems in the creation of an entrepreneurial ecosystem, Singaporean policymakers worked through a process we term 'network coordination' across the whole of government. While overall rates of entrepreneurship remain low, the country has been successful at scaling firms in the digital technology sector. These primarily focused on consumer applications and non-Singaporean markets, but there has been little development in frontier 'deep tech'.

Keywords: Digital Technology; Singapore; Developmental States; Industrial Policy; Entrepreneurial Ecosystems

Acknowledgements: We would like to thank the LSE Saw Swee Hock Southeast Asia Centre (SEAC) for generously funding this project and Kester Low for excellent research assistance at an early stage. We received valuable feedback at a SEAC seminar and the Utrecht School of Economics and help from Julian Seng, Hyun Bang Shin, Lee Mager, Robin Klingler-Vidra, and Henry Yeung.

1. Introduction

Singapore has long been seen as a model for successful economic development. One feature of this development has been the role played by the Singaporean state in shaping the country's economic system (WIPO, 2022). As Klingler-Vidra (2018: 93) argues, the “omnipresence of the government's supportive tentacles cannot be overstated”. This state-directed economic model has clearly been successful in some sectors such as pharmaceuticals, as Singapore has attracted Research and Development (R&D) intensive multinationals to the country (Wang, 2018). But others have suggested that state-led development is problematic, as it prevents success in rapidly changing sectors such as digital technology, where radical entrepreneurship matters more than long-term funding of rapidly obsolete lab facilities (e.g. Mok, 2005; Cheang, 2022; Audretsch & Fiedler, 2023). A decade ago, this argument seemed to be supported by observable developments and trends. Between 2000 and 2012 the Singaporean government focused considerable resources on developing a technology sector, but Reuters was reporting on Singapore's failure to do so (Ananthalakshmi, 2012).

Yet, a decade later, Singapore is seen as one of the world's leading locations for digital technology (Zalizan, 2022). One world ranking of start-up hubs placed it second only to Silicon Valley (Heo, 2021), and Singapore was cited as one of the world's most successful economies for the creation of high-value ‘unicorn’ firms (Vogelaar and Stam, 2024). Singapore's digital technology sector, understood as firms which use digital technology as part of their growth and which includes cyber security, data, fintech, games, global business, services, and software, includes firms such as Trax (computer vision), Patsnap (internet software), Hyalroute (fibre), and Matrixport (Fintech). The ride-hailing company Grab had the largest NASDAQ IPO of any Southeast Asian company. Given that many suggested the Singaporean state would be unable to adapt to fast-changing sectors such as digital technology, this change from a large-firm-focused developmental state to a successful scale-up entrepreneurial state is a puzzle.

How did Singapore develop this strength in digital technology firms? In this paper we investigate the growth of Singapore's digital sector, an example of economic and industrial policy which has pushed the country from a relatively weak position to one where it is a regional, if not world, leader. To investigate this transformation, we use an empirical

research strategy based on the synthesis and triangulation of three different methodological approaches. First, we conducted a policy mapping exercise by identifying key policy actors, policy documents, and key institutions. Second, we conducted a mapping exercise at the firm level, using databases to identify major firms, their characteristics, and trajectories. Using these two approaches, we built a framework to structure a set of interviews with key stakeholders in Singapore.¹ We drew this together and developed a new framework for understanding the Singaporean state's role in digital technology.

The development of new hubs of entrepreneurship and innovation is a coordination challenge: it is hard for policymakers to artificially produce the structure of networks and supporting organisations which are crucial to these ecosystems (Spigel, 2020). Innovation and entrepreneurship can be seen as part of localised systems which rely on interconnected actors. As a result, policymakers trying to stimulate growth face a Catch-22, as it is hard to develop new networks without connections between actors already in place. This lack of coordination is one reason why so many industrial policy efforts fail. Policymakers in Singapore solved this problem through what we term a network coordination approach. Taking advantage of the window of technological opportunity, the rise of smartphones, and a window of locational opportunity, Singapore's position in the regional economy, they focused policy on the attraction and creation of digital technology firms through a "whole-of-government" approach.

The policy toolkit for exploiting these opportunities was often very different to the standard approaches to developing a digital technology sector. In addition to 'standard' policy tools such as STEM skills, university-business links, innovation parks, and incubators, the Singaporean government used the provision of specialist finance to seed a funding ecosystem for digital technology start-ups in Singapore, offered residency rights, regulatory test-bedding, and a broader "whole-of-government" approach which encouraged key firms to base activities there. Singaporean development in digital technology can, therefore, be seen as due to a combination of technological opportunity, locational opportunity, the fundamentals of the business environment and deliberate policy action. Essentially, the

¹ We conducted 14 interviews with government policymakers, venture capitalists, entrepreneurs, and business representatives.

Singaporean state coordinated to overcome coordination problems in the development of new ecosystems.

The result is a Singaporean entrepreneurial ecosystem which excels at the production and attraction of scale-up firms in digital technology, rather than more general measures of entrepreneurship. This may help to explain why some are sceptical of the Singaporean state's ability to foster entrepreneurship generally. But our results challenge the view that strong state intervention restricts the development of radically innovative firms (Mok, 2005), and pushes countries such as Singapore to an innovation system dominated by large external firms (Wang, 2018).

We contribute to a developing literature on the digital technology sector in Asia. An important literature considers the development of the hardware sector, and chipmaking in particular (for example, Yeung, 2022), and there is a wider literature on the 'Silicon Valley model' of entrepreneurship more generally (e.g. Breznitz, 2021). Our focus is on digital technology firms working in software more generally and Singapore specifically. Hon's (1992) paper argued that Singapore's IT industry was the result of a proactive government strategy, although much has changed in the 30 years since its publication. More recent work includes Klingler-Vidra's (2018) book in which a chapter is dedicated to the Singaporean model, but with a focus on the adaptation of the Silicon Valley model to the Singaporean case, and Lai's (2018) study of Singaporean Fintech.

The remainder of the paper is structured as follows. The second section builds up our key theoretical framework for understanding digital tech, the classic 'policy models' of Silicon Valley, and the dominant explanations for the growth of the sector. The third section provides an outline of Singapore's existing digital technology sector and how it has grown over the last decade. The fourth section presents a new framework to help understand the conditions for these digital technology firms and develops this for the Singaporean case. The fifth section concludes by considering the implications of the 'Singaporean model' for theory and practice elsewhere, and its limitations as a policy approach.

2. Conceptual framework

We base our conceptual framework on three approaches, each relating to the development of new industries. First, we use the developmental state literature, which describes a specific policy approach used in East Asia during their ‘catch-up’ growth. This helps to explain how the Singaporean state has managed the economy. Next, we use windows of opportunity theory to explain how technological discontinuities create spaces for new industries to emerge. Finally, we argue that approaches based on networks, systems, and ecosystems are useful in helping understand the dynamics of frontier industrial sectors like digital technology and the challenges faced by policy in stimulating their growth.

The developmental state

This idea of the developmental state comes from the work of Chalmers Johnson (1982), who noted that the rapid economic growth of some East Asian economies - notably South Korea, Japan, Taiwan, and Singapore - was underpinned by strong state intervention.

Developmental states took a middle way between central state planning, as in communist countries, and the form of semi-free market capitalism practised in the developed West. Instead, the state played a key role in governing the market and had a highly integrated relationship with the private sector (Leftwich, 1995; Wade, 2004). Key characteristics of the developmental state model were strong government control of the economy, elites unified by their desire for economic growth, collaboration between the state and industry, investment in infrastructure, education, and other factors of production (with consumption suppressed), and a strong focus on export-oriented growth.

Singapore’s developmental state was focused on ‘niche creation’ where potential growth areas were identified and developed (Woo, 2018). Most of the time, these niches were in profitable tradeable manufacturing industries, famously semiconductors. This was initially the focus of the Singaporean technology sector, and the country remains a large but not advanced producer of semiconductors (Yeung, 2022). But these sectors were relatively easy for the state to steer, as they relied on sunk-cost investments made over a long-time horizon, and involved large firms, often multinationals, in existing sectors. The political stability which came from being a near one-party state allowed the government to follow long-term

plans, develop key sectors, and coordinate policy (Woo, 2018). In contrast, digital technology firms often require shorter technology cycles, meaning states need to be quicker to act and are initially less capital intensive, meaning that long-term state finance is less important. Instead, firms in these sectors may achieve success through scale economies achieved through rapid scaling of new business models.

One critique of Singapore's developmental state model is that, while successful in some industries, it would restrict entrepreneurship and, by extension, the development of new firms in fast-changing sectors such as digital technology (Cheang, 2022; Audretsch and Fiedler, 2023). For example, Audretsch and Fiedler (2023: 574) argue that the importance of the Singaporean state in the economy helps explain low levels of individual entrepreneurship. In making this argument, they critique the Entrepreneurial State argument of Mazzucato (2013), who suggests that the US' success in fast-changing digital technology sectors is actually underpinned by strong state intervention, notably in the de-risking of early-stage research which contributed scientific discoveries which were later commercialised by non-state actors. Audretsch and Fiedler (2023) argue that the developmental state model and low levels of entrepreneurship in Singapore are closely linked. They argue that the role of the state in Singapore has meant considerable success, but that "[t]he other side of the coin is that while shifting the locus of opportunity discovery, recognition, and commercialization to the entrepreneurial state can fuel entrepreneurial activity in certain industries and sectors, it also imposes a societal knowledge filter that ultimately can crowd out entrepreneurship." (2023: 575).

Such a view assumes that the developmental state has not adapted over time. Yet other scholars have shown considerable adaptation away from the historic model. In particular, as the global economy shifted from vertically integrated lead firms to a web of complex interrelationships between technologically advanced roles, states found that their role in economic development needed to change. As Hamilton-Hart and Yeung (2021: 29) explain, this meant that:

“Developmental states may be less authoritative and centralised as a whole, but this tendency may in fact enhance the capacities of specific agencies and bureaucracies for development tasks that require flexibility and public-private collaboration. In

today's highly interdependent global economy, it is now much harder for almost any national economy to develop fully vertically integrated industries that are internationally competitive.”

The developmental state model has adapted considerably over time, but there are still concerns that it may hinder entrepreneurship and be better suited to the attraction and development of multinationals than the creation of new firms in newly emerging sectors.

Windows of opportunity

A second important concept in understanding Singapore's development is the idea that windows of opportunity develop in which new market opportunities arise. The development of new industries is characterised by technological discontinuities, which provide opportunities for entrepreneurs and firms to enter new markets and displace incumbents (Boschma, 1998). A window of technological opportunity develops when technological discontinuities create opportunities for new entrepreneurs or firms to overcome the advantages of incumbents. Incumbents may be reliant on early technology and approaches, while later entrants can survey the market, face fewer initial R&D costs, and leapfrog incumbents by using more up-to-date technology (Eggers, 2014). This is particularly the case if early entrants build up products and management structures focused on older technology. Incumbent firms can face a competency trap as they find it hard to adapt structures based on old technologies to the use of new ones (Giachetti and Mensah, 2023). Thus, in fast-changing sectors or newly developing sectors, there is an opportunity for new firms to enter markets and thrive.

While windows of technological opportunity help to explain which firms and industries develop, the concept of windows of *locational* opportunity helps to explain *where* they do (Boschma, 1998). This concept also builds on the idea that there may be technological discontinuities and that these may create opportunities (Boschma, 1998). Boschma and Van der Knaap (1998) develop this concept, suggesting that while generic conditions in particular regional economies may matter, the development of new industries in those locations cannot be simply explained by these conditions as they do not explain why the industry develops in one location relative to another with the same generic conditions. However, the windows of

locational opportunity concept stresses the importance of chance events and downplays specific factors in regional or local economies which can create opportunities.

'Systemic' approaches to entrepreneurship and innovation

Our third conceptual building block is the idea that firms in new industries form part of wider systems of entrepreneurship or innovation. This idea is clearest in the canonical case study of new industry creation, Silicon Valley. Studies of the Bay Area highlight the importance of key institutions, such as Stanford University, in the success and endurance of the cluster. But explanations based solely on the existence of leading firms or universities are not sufficient in explaining why Silicon Valley developed ahead of other places which had similarly strong institutions, nor can it explain the persistence of Silicon Valley for almost ninety years.

Instead, studies have shown that it is the strength of the networks in the area which have helped to ensure innovation-based entrepreneurship. Ferrary and Granovetter (2009: 328) argue that innovation is the result of “inter-firm interactions supported by social networks.” They point to the history of friendships becoming business relationships and the interdependence of these firms. Tracing the agents who may be involved in a successful start-up (from university, law firm, large firm, to recruitment consultant and marketing firms), they argue that start-ups are more likely to be successful in places where there is such a supportive firm-level infrastructure and firms have strong networks to access such resources. They also highlight the importance that venture capitalists play a crucial role in supporting these networks. This core argument is developed in a comparison with Los Angeles by Storper et al. (2015) who show that it is not simply the existence of networks which matters, but their openness. San Francisco’s networks have developed in a more open fashion than those of Los Angeles, where businesses were more likely to be linked to only a smaller number of local firms.

The success of Silicon Valley was not simply a story of local networks. Three forms of international linkages have been important. First, the small set of indigenous start-ups was accompanied by a number of larger, non-local firms (Adams, 2011). These outside firms were attracted by major research universities and helped the area to achieve the critical mass needed to sustain skilled labour markets and for networks to develop. Second, there has been

considerable circulation of skilled workers from the area to elsewhere. As Saxenian (2006) outlines, this process of brain circulation centred in the Bay Area meant that new information and knowledge coming into Silicon Valley moved elsewhere simultaneously. Finally, and more recently, as documented by Yeung (2021), firms in Silicon Valley overcame weaknesses in the 1990s by integrating themselves into wider global production networks, often working with firms in East Asia. In this way, Silicon Valley moved from being a local centre of production and innovation to being a global hub which served as a central node in these production networks.

This basic case study is reflected in a set of concepts, including entrepreneurial ecosystems, clusters, and regional innovation systems, which share an ‘obvious harmony’ (Spigel, 2017: 51). These approaches are unified in that they are in some sense ‘systemic’ or that they emphasise the importance of interpersonal and inter-firm networks. But they also share an important implication for policy: ‘network’ approaches suggest that for self-sustaining systems to develop requires a set of linked actors to be operating together, but that, as the success of one actor requires other actors to be in existence, it is hard to achieve this artificially. While there are strong examples of the organic development of these systems, it is hard for policymakers to create them anew.

Synthesis: State-sponsored network building

These three literatures – on the developmental state, windows of opportunity, and the organic development of new ecosystems, clusters, and networks – appear at first sight to suggest quite different models of innovation and entrepreneurship. Developmental state theory suggests that strong state intervention in the economy can guide sectoral upgrading. However, it is focused on the attraction and development of large multinationals rather than the growth of firms in new industries. Approaches based on ‘opportunity’ suggest that there are moments when new technologies present developmental opportunities. And systems approaches suggest that networks of firms and supporting organisations are vital, but that there is a ‘chicken and egg’ problem as these networks or systems cannot be successful if half-built. As we will show, all three ideas are useful in helping to explain the development of Singapore’s digital technology sector.

3. Singapore's digital technology sector

Motivation: Singapore's economic evolution

Our focus for this study is Singapore, a city-state of almost six million people in Southeast Asia. It is seen as one of the world's most important cases of successful economic development. Since independence from the United Kingdom in 1959, the country followed a developmental state model driven by a growth-focused and tight-knit elite, the guiding principle of pragmatism, rather than ideology, and an open orientation which reflected the country's small size (Woo, 2018).

Singapore's small size had two important implications. It meant that the government was better able to control the economy than in large countries (Woo, 2020). But it also meant that policymakers had no option but to work with international partners. Under Lee Kuan Yew, the first Singaporean Prime Minister, the country had a deliberate strategy of maintaining an open economy (Lee, 2000). An early industrialisation drive involved strong government intervention, focused on the attraction of foreign multinationals, alongside a set of complementary interventions such as ensuring a stable macroeconomic environment, the progressive lowering of taxes, and efforts to improve population skills (Yue, 2002). The country grew first on exports sourced by locally based multinationals, and later by becoming an advanced service centre. Despite a small population, the country grew in economic and cultural significance as the headquarters location for many firms' Asian bases, becoming a highly internationalised global city (Woo, 2018). This approach, which prioritised the attraction of foreign direct investment rather than indigenous entrepreneurship, worked as firms moved slowly up the value chain with new industries developing, for example, in electronics. An important part of this growth strategy was the need to compensate for the small domestic market by providing access to wider regional ones.

This strategy led to Singapore becoming one of the world's richest and most innovative economies. The country scores highly on measures of the ease of doing business and international innovation rankings: it comes fifth globally and first in East Asia and Oceania in

the World Intellectual Property Organisation's Global Innovation Index (WIPO, 2023). There are strong industrial sectors including banking, oil, advanced manufacturing. It also serves as the local base for many global multinationals including Microsoft, Rolls Royce, and FedEx as well as domestic multinationals.

The innovation system is still strongly state-directed. As one author working for A*STAR, the Singaporean science and technology agency, argues: "Singapore's R&D push was predominantly a directed, government-led effort to upgrade and strengthen the competitiveness of the domestic economy" (Poh, 2016: 134). R&D has historically been largely conducted by foreign multinationals, which undertake an unusual amount of R&D in Singapore relative to other economies such as Taiwan or South Korea, in part because of strong government incentives for this to happen (Amsden et al., 2001).

One key question about the Singaporean model is the extent to which it can adapt to new sectors as they develop, particularly where they are fast-changing and reliant on entrepreneurship rather than existing firms (Audretsch, 2003). This line of argument suggests that the state would be unable to spot opportunities, align incentives, and support rapid growth in the way that highly entrepreneurial economies would do organically. The archetypal case in point for Singapore was efforts to stimulate the creation of new firms in digital technology, something which was firmly established in government rhetoric. For example, then Prime Minister Lee Hsien Loong, in his National Day Rally of 2006, suggested that:

"we are determined to take full advantage of all the digital opportunities which are opening up. We are building the infrastructure in Singapore. The Infocomm Development Authority plans to wire up the whole country so that it's wired and wireless. We will be fully into the cyber world."

Yet it did not, at first, appear to be successful. In 2012, Reuters reported on the failure of the country to produce many new tech start-ups, complaining that the venture capital system was largely focused on the wider region. The government was seen as providing grants which supported nascent firms, but without providing enough funding for growth (Anthony, 2011). A

fear of failure, more commonly known as *kiasi* colloquially, was preventing entrepreneurship, (PWC, 2015) while potential entrepreneurs had few incentives to take risks given the availability of well-paid jobs in multinationals (Audretsch and Fieldler, 2023). These problems were particularly acute in digital technology, a sector which was fast-moving, changing rapidly, and reliant on a wider system of support - from venture capital funding and connectivity to skilled workers and university links.

The evolution of Singapore's digital technology sector

Singapore's digital technology sector has seen rapid growth since around 2010. There has been growth in the number of start-ups in the tech sector, defined as services. Wong (2022) defines start-ups as firms which are five years old or younger, and 'tech' as those with above average R&D intensity, showing that there were 1,539 tech start-ups in services in 2004 but 3,931 in 2015 (a slight decrease on 2014, but a general upward trend). Between 2010 and 2015, the number of tech services start-ups grew by around 11% per year. Using the OECD sectoral definition, the Singaporean Infocomm Media Development Authority (IMDA) and Lee Kuan Yew School of Public Policy (LKYSPP) estimate that the digital economy accounted for around 13% of Singaporean GDP in 2017 but increased to around 17.3% by 2022 (IMDA & LKYSPP, 2023).

This growth can be seen in the increasing number of digital technology unicorns - start-ups valued at US\$1bn or more - in Singapore (see Table 1). Unicorn data needs to be considered with great care: it is an indicator of valuations and thus may reflect asset bubbles rather than profitability. Nonetheless, the composition of Singapore's digital technology unicorns provides some useful information about the nature of large, rapidly growing digital technology firms in the city-state. The archetypal Singaporean unicorn, Grab, is a good example of how the state has played an important role. Grab is a super-app which provides services including ride-hailing, food delivery, digital payments, and financial services including loans and insurance. It is not an indigenously developed firm, but one which was co-founded in Malaysia in 2012 by Anthony Tan, a Malaysian entrepreneur. In 2014, Vertex Venture Holdings - the venture capital arm of Temasek and the largest VC firm in Singapore - made a Series A investment in Grab, which

became a unicorn that year. This, alongside Singaporean residency for Tan, persuaded the Malaysian firm to move to Singapore (Finance Asia, 2017).² Grab's engagement with the Singaporean state extends beyond this. Other nearby countries banned ride-hailing, but Singapore adopted a 'wait and see' approach which meant Grab could test its products. Through its FinTech Sandbox, Singapore's financial regulator, the Monetary Authority of Singapore, allowed experimentation to develop Grab's FinTech arm and Grab was given a digital bank license and allowed to connect to instant payment platforms.

Grab illustrates three common features of the Singaporean model of digital technology development. The founder was encouraged to move to Singapore rather than indigenously Singaporean, and the state played an active role in Grab's growth by providing partnerships with the public sector through finance and supportive regulation. However, Grab was innovative only in the sense that it introduced new business models and moved into new markets. The functions of Grab, such as ride-hailing or grocery delivery, were already common in the US.

A second example is PatSnap, which offers an Artificial Intelligence (AI) platform which gives information on patenting with the aim of providing founders and investors with the information they need to view and access intellectual property. Two of the founders of PatSnap attended the National University of Singapore, giving them close ties to others in the local innovation system. The firm was incubated in the NUS Enterprise and received a small (SG\$ 55,000) grant for their start-up and later received Series A and D investments from Temasek and Vertex Ventures. They launched a US\$15.6 million R&D centre and linked closely to local AI skills. In short, PatSnap has been a success story of local entrepreneurship and there have been multiple rounds of state support.

Two additional points are also worth noting. There is an extremely skewed distribution in the valuations of these firms, with the two highest – Sea (US\$132 billion, although this has since dropped precipitously) and Grab (US\$40 billion) – being many multiples higher in value

² <https://www.financeasia.com/article/how-vertex-lured-grab-to-singapore/436929>

than the next highest (Acronis, US\$3.5 billion). Second, of the top ten digital technology unicorns in Singapore, only two had a founder who was born in Singapore. Perhaps supporting the Audretch and Fielder (2023) view, the Singaporean tech scene does not seem to be developing from business models put forward by local Singaporeans. Instead, Singaporean unicorns seem to be largely specialised in applications of tech for consumers, with only two of these firms developing ‘deep tech’ and these generally specialised applications rather than more general uses. While we need to be careful about generalising from a small set of unicorn firms, this accords with other academic evidence on this point. Wong (2022) has also shown that growth in Singaporean digital technology has been “primarily in internet / mobile / e-commerce services, with relatively few indigenous deep technology-based “scale-ups” emerging”. This is clear from the list of Singaporean unicorns. Only PatSnap could be considered as ‘deep tech’, but while this is more than simply a commercial application of existing technology, as with Grab, it is not a general-purpose AI firm.

Table 1. Overview of Singapore-based digital technology unicorns

Company	Year founded	Founders	Business model	Valuation / year (US\$)	State investment
Sea Group	2009	Forest Li (Chinese-born Singaporean)	Tech conglomerate	\$132bn (2022)	Seed funding from GIC-Government of Singapore Investment Corporation (新加坡政府投资公司), Toivo Annus
Grab	2012	Anthony Tan (Malaysian-born Singaporean); Tan Hooi Ling (Malaysian)	Consumer tech, including ride-hailing, grocery delivery, and payment	\$40 bn (2021)	Series A, B and C rounds included Vertex Ventures (2014),
Acronis	2003	Serguei Belousov (Russian-born Singaporean); Ilya Zubarev (Cypriot)		\$3.5 bn (2022)	N/A
Razer	2005	Tan Ming Liang (Singaporean); Robert Krakoff (American)		\$3.2 bn (2021)	N/A
Lazada	2012	Rocket Internet / Maximilian Bittner (German)		\$3.15 bn (2017)	Late-stage funding round led by Temasek Holdings
Advance.ai	2015	Jefferson Chen (Chinese-born Singaporean)		\$2 bn (2021)	
Trax	2010	Joel Bar-El (Israeli); Dror Feldheim (Israeli)		\$2 bn (2021)	
TDCX	1995	Laurent Junique (French)		\$1.5 bn (2022)	
Hyalroute	2015	Xinglong Huang (no records, but likely Chinese or Chinese-born Singaporean)		\$1.3 bn (2019)	

Carousell	2012	Queuk Siu Rui (Singaporean); Marcus Tan (Singaporean); Lucas Ngoo (Singaporean)		\$1.1 bn (2021)	
Patsnap	2007	Jeffrey Tiong (Malaysia)		\$1 bn (2021)	Start-up grant from Media Development Authority (2007), Seed includes NUS enterprise (2010), series A includes Vertex (2014), series E includes Vertex (2021)
Matrixport	2011	Daniel Yan (no records, but likely Hong Kong); Jihan Wu (Chinese); Yuesheng Ge (No records, but likely Chinese)		\$1 bn (2021)	
Livspace	2014	Anuj Srivastava (Indian); Ramakant Sharma (Indian) (Original HQ in Bangalore, India)		\$1 bn (2022)	
Darwinbox	2015	Chaitanya Peddi (Indian); Jayant Paleti (Indian); Rohit Chennamaneni (Indian). (Original HQ in Hyderabad, India)		\$1 bn (2022)	

Note: Acronis has a dual HQ in Switzerland; Razer has a dual HQ in Irvine, USA.

4. The ‘Singapore model’ - A framework

We have argued that Singapore has developed a successful digital technology sector, despite the predictions of some authors who argued that the state would hinder entry into this fast-changing sector. But how? To put our argument in simple terms, Singapore’s success in digital technology stems from a combination of related factors:

Fundamentals + Opportunity + Policy → Development of digital technology sector

Essentially, the sector’s development can first be seen as a combination of pre-existing factors such as a skilled population, a supportive business culture, the advantages of its location, and strong infrastructure. A window of technological opportunity opened up, as smartphones became dominant, and Singaporean policymakers identified a window of locational opportunity through which it could become a regional hub for Southeast Asia. All three of these factors were necessary: policy would have failed without strong fundamentals and an opportunity, and the existence of strong fundamentals or opportunity alone would have been insufficient for the sector to grow.

Singaporean policymakers faced a second challenge, however. As the literature on ‘systems’ of innovation and entrepreneurship shows, there is a coordination problem in the development of new digital technology sectors. As interconnections between economic actors matter, it is hard to develop new sectors in the way which might be possible with, for example, a standardised manufacturing plant. Two key features of the policy mix helped them achieve this. First, actors across government worked towards a central goal through a process we call ‘networked coordination’. Second, while the policy mix included some ‘standard’ policies for digital technology development, such as science parks, it had some unusual features such as the whole-of-government approach, the use of the sovereign wealth fund to jump-start investment markets, and policy learning from elsewhere. We set out the key characteristics of this model below.

5.1 Fundamentals

The success of any industrial or innovation policy needs to reflect the foundational conditions of the economy in which it works. Singapore's position and economic role as a central node in Southeast Asia's regional economy was already well established, and the city-state had a strong critical mass of headquarters functions. The country scored highly on the World Bank's ease of doing business rankings, reflecting a private sector-friendly outlook. Past interview-based studies of parts of the tech economy have shown the importance of these 'hygiene' factors in setting up businesses, even where the eventual market of those businesses is not Singapore (Pangarkar & Vandenberg 2022). In 2021, 97% of Singaporeans used the internet, more than in the United States (92%) or the European Union (87%) (World Bank, 2024a). Singapore experienced a rapid and early rise in smartphone use, with East Asia and the Pacific region following (World Bank, 2024b).

However, there have long been some concerns raised about the problems of establishing new firms in Singapore. Pangarkar and Vandenberg (2022) outline five issues, based on interviews with Singaporean tech firms. High salaries raise costs, particularly for start-ups. Generous grants can lead some firms into a cycle of applications for the sake of it, leading them to focus on applications for (and the bureaucracy associated with) grants rather than market imperatives – a concern which was also expressed by our interviewees. While the system of finance has generally worked well, too much is loaded towards early stages rather than growth capital. Working with the government was also seen as hard, as procurement processes were sometimes lengthy. Finally, it was necessary to have Singaporeans on the management team to secure funding, which made it harder for some foreign-run firms to access government capital.

There were other important aspects of Singapore's general business environment which helped develop the digital economy sector. Singapore has well policed intellectual property rights, particularly relative to the regional average. This strong business environment attracts foreign start-ups and MNE. Corporate taxes were also very low (although not as low as in Hong Kong) with no capital gains tax (Pangarkar and Vandenberg, 2022). The country was also extremely open to foreign investment, firms, and entrepreneurs. World Bank figures for 2022 show that Singapore has the fifth highest trade-to-GDP ratio in the world, at 337% of GDP, and the fourth highest FDI-to-GDP ratio, at 30%. The country is open to other foreign workers and expatriates:

around 37% of the population are non-Singaporean born (United Nations, 2019). Its position as an entrepôt in Southeast Asia and cultural similarities with China, India and East Asia were both important.

The significance of digital connectivity is also clear, particularly for digital economy firms. The historic advantages of geographical location and trust in government also helped Singapore to assume a central position as a nodal point for submarine fibre optic cable networks, with the result that the country had some of the fastest internet speeds in the region (Speidel, 2022).

5.2 Opportunity and identification

In this case, the specific nature of the Southeast Asian regional economies was one factor which may have increased the competitiveness of Singaporean firms. They could learn from American technological innovations adopted in the United States (Klingler-Vidra, 2018), adapt business models to regional markets, and build scale rapidly in Southeast Asia, benefiting from network effects which prevented US incumbents from outcompeting them.

The widespread use of smartphones across Southeast Asia represented a technological discontinuity, which provided firms with an opportunity to develop new business models which outcompeted those of existing firms. Smartphone penetration in Southeast Asia rose rapidly from 2010, and there was already strong interest in the use of digital technologies and high levels of Internet penetration.

Moreover, there was also a more specific policy mix which was strategically oriented towards a regional 'technological window of opportunity': the explosion in Southeast Asian internet access through cheap smartphones. Southeast Asia's internet economy has been growing rapidly, and is estimated to grow to over US\$300 billion by 2025 in some projections (Google and Temasek, 2020). There are parallels here with how early film adoption in LA allowed it to overshadow New York's theatre scene and become the leading entertainment cluster (Storper et al., 2013). But in the Singaporean case, this reflected a clear strategic policy emphasis which was stressed in official documents such as the Committee for the Future Economy (CFE, 2017). The firm

executives we interviewed saw Singapore as an open place to develop businesses before scaling them externally.

Singaporean policy was predicated on picking the ‘next big thing’ (Klingler-Vidra, 2018), with the government identifying and investing in areas of growth potential (Poh, 2016). A*STAR, a statutory board, has also been producing 5-year plans on science and technology policy since 1991, when it was formerly known as The National Science and Technology Board (NSTB) (Seng, 2023). On an industry level, the Future Economy Council designs industry transformation maps (ITMs) across 23 industries to address sector issues and encourage multi-stakeholder collaboration within each industry, of which the ITMs are updated regularly. Currently, Singapore’s Ministry of Trade and Industry has a Futures Group that looks at emerging future trends and translates those insights to actionable policy implemented by EDB. Similarly, the MTI Futures Group works closely with the Centre for Strategic Futures, a strategy group under the Prime Minister’s Office, to ensure forward-looking initiatives and considerations are embedded in the national strategy.

5.3 Coordinated policy

While the importance of locational fundamentals and the identification of an opportunity cannot be overstated, it would still have been hard for Singapore to develop a functioning system without a specific form of policy which helped them move into this sector. We can outline a set of key features of this policy making strategy, which forms a specific ‘Singaporean model’ - a policy mix well suited to digital economy firms:

Clear medium-term policy goals. The Economic Development Board (EDB) is the crucial agency governing economic policy outcomes (Woo, 2018). Through its corporate investment arm, EDB Investments (EDBI) Strategic Growth Programme has made investments in targeted sectors, which have historically included the innovation-intensive parts of the Information and Communication Technology sector (Woo, 2018). Digital Industry Singapore (DISG) is the key body integrating the EDB, Enterprise SG, IMDA, and linked regulation with strategy for the development of domestic start-ups and foreign firms.

Specialist Finance. Singapore faced a coordination problem in building up a self-sustaining local system of entrepreneurial finance in a small local market. Singapore had chosen to work with foreign capital and rely on foreign investment and technology transfers to build up the Singapore financial system. The top Singaporean companies, however, were State-Owned Enterprises (SOEs) and it was not until the 1980s, which coincided with Singapore's shift towards mass computerisation, that Temasek Holdings was brought into corporatise large SOEs to Government-Linked Corporations (GLCs), which in turn publicly listed them on the Singapore Exchange (Yeung, 2016), fuelling a wave of divestment from 1985 to 2010. The strong foothold of Temasek Holdings and the GLCs gave the government a firm grip on Singapore's economic development. The benefits were twofold: Singapore's economy continues to be balanced between private sector firms and state-mediated corporate vehicles; world-class GLCs also enjoy an opportunity to compete globally and expand their market share.

The provision of specialist finance for start-ups and scale-ups is crucial to the Singaporean model, and one of Singapore's two Sovereign Wealth Funds - Temasek - has played a key role. It provides patient capital and long-term funding, at multiple stages of the funding cycle, largely without intrusive management oversight. Stakes in European firms but with support accessing partners and customers in Asia and China, guidance in growth, (Temasek, 2021).

Temasek's most significant role has been to help address the coordination problem of the development of an early-stage finance ecosystem. Its venture capital arm, Vertex Ventures, has been a prominent investor. Through this channel, the state championed an anchor tenant (Grab) to address the lack of VC confidence in the young local ecosystem. The Singaporean state has put pressure on Grab and Sea Group to list on the Singaporean stock exchange (Telling, 2022). In doing so, they helped to break the coordination problem of the development of ecosystems. They also focused policy on the long-term, by adopting an approach based on 'building' and 'partnerships'.

These efforts helped to catalyse a rapidly emerging digital economy start-up financing ecosystem and were complemented by policies aimed at increasing both the number and diversity of funding sources. In a situation where there was little specialist venture capital, most venture

capital firms were set up in Singapore with some form of state funding (Wonglimpiyarat, 2013). Table 2 gives information on the share of venture capital funding across advanced economies. Singapore, while in absolute terms a much smaller market than countries such as the United States or the United Kingdom, has a much higher share of venture capital funding per capita than any other country. Funding seems to be strong at the early stages, but more limited afterwards with a lack of growth stage capital (a claim made by PWC, 2015 in Pangarkar & Vandenberg 2022, later supported by an interview). Nonetheless, some private-sector interviewees closely involved in digital economy finance indicated that these financing ecosystem gaps are rapidly being filled, and there is increasingly abundant specialist financing available for digital economy firms at all stages of the high-tech start-up life cycle. In their view, the crucial ecosystem bottleneck is no longer the ability to raise capital, but rather the relative scarcity of innovative business plans being pitched that have a strong potential to scale internationally.

Table 2. Venture capital funding per capita

Rank	Country	Total funding, year to November 2021 (US\$)	Funding Per Capita (US\$)
1	Singapore	\$8.25B	\$1,398
2	Israel	\$8.44B	\$959
3	Estonia	\$1.19B	\$915
4	US	\$269B	\$808
5	Sweden	\$7.15B	\$700
6	UK	\$32.1B	\$472
7	The Netherlands	\$6.15B	\$358
8	Denmark	\$1.97B	\$340
9	Switzerland	\$2.75B	\$316
10	Finland	\$1.70B	\$303

Data from Glasner (2021) using Crunchbase data. Data for countries with \$+1bn in venture funding.

Network building. The government envisioned Singapore as a leading innovation and start-up hub within a global network of connected ecosystems and planned to rapidly scale up the local start-up ecosystem and grow more high-quality innovation-driven tech start-ups for the global stage (CFE, 2017). To achieve this, network building initiatives have been a cornerstone of Singapore's digital economy transformation policy. Singapore was already deeply embedded within the global economy, and the goal was to strategically leverage and strengthen its regional and global connectivity to accelerate access to innovative ideas, talent, and market intelligence beyond the city-state's borders.

The Singaporean state pushed hard to build networks with top hubs in the US, Europe, China and India. This was, as Klingler-Vidra (2018) shows, partly a process of policy learning with models from elsewhere adapted to the Singaporean context. But it was also a process of network building: ensuring Singaporean policymakers and entrepreneurs were well linked to what was happening in these other hubs. The state positioned itself as a nodal point in these networks and fostered knowledge flows to Singapore from leading innovation clusters worldwide. Key nodes in the form of new and expanded overseas branches helped state agencies gain valuable market intelligence by tapping into place-based knowledge networks in leading innovation clusters. For instance, the Financial Times reported in 2019 that "Temasek possesses dense information networks in the US, China, India and elsewhere that enable it to discover promising companies before others do and revise its portfolio quickly." and suggests that Temasek believed that "the digital economy will continue to grow through areas such as e-commerce, ride-hailing and online travel bookings" (Nakano, 2019).

The state also brokered a range of channels for Singapore-based firms to build global connections and plug into leading tech start-up ecosystems. These transnational networking channels included entrepreneurship-focused study abroad programmes in Singaporean universities; establishing new physical convening spaces, such as the Block71 San Francisco incubator; and promoting high-potential Singapore-based start-ups at prominent international trade conventions. These outward-directed relational infrastructure-building channels complemented government efforts to attract high-tech MNCs to set up Singapore subsidiaries, and broker collaboration between them and locally-based entrepreneurs.

These initiatives helped to drive the acceleration of a global outlook among Singapore-based firms and a tacit understanding of entrepreneurial opportunities. They also supported the Singapore government's goal of establishing Singapore as a launchpad for scale-ups to the regional digital economy. As Singapore's digital start-up ecosystem rapidly takes root and cements its regional leadership, more government support policies to accelerate the scaling-up of locally-based start-ups to regional business opportunities have been rolled out, such as the Scale-up SG programme launched in 2019 by the MTI. Existing policies, such as the IMDA's start-up accreditation program, have also increasingly emphasised innovative business plans that have a high potential to scale up to the region and beyond. State-supported network building initiatives, such as the Global Innovation Alliance and the Global Start-up Exchange programme, have also expanded their reach to help promising start-ups understand business opportunities in key regional demand markets.

Policy coordination. This policy stability means that the state gave unusually clear signals in the notoriously noisy and uncertain tech start-up setting. For example, official messaging seems to have promoted Singapore as a place for the commercialization and application of existing digital skills and technologies, as well as a launchpad for regional upscaling, rather than to specialising in disruptive frontier innovation (as seen in the three areas of official strategic focus in the CFE report: cybersecurity, data science and digital platforms).

State interventions were often directed towards solving bottlenecks. For example, Grab's VC funding from Temasek allowed Grab to upscale and become a unicorn, which in turn created private VC confidence in the fledgling local tech ecosystem. Also, the longstanding and continued commitment to world-class ICT infrastructure, as well as the comprehensive suite of smart nation/digital economy policies being rolled out, signalled a high and sustained level of policy support for the tech industry. But they also gave state agencies greater control over problem definition.

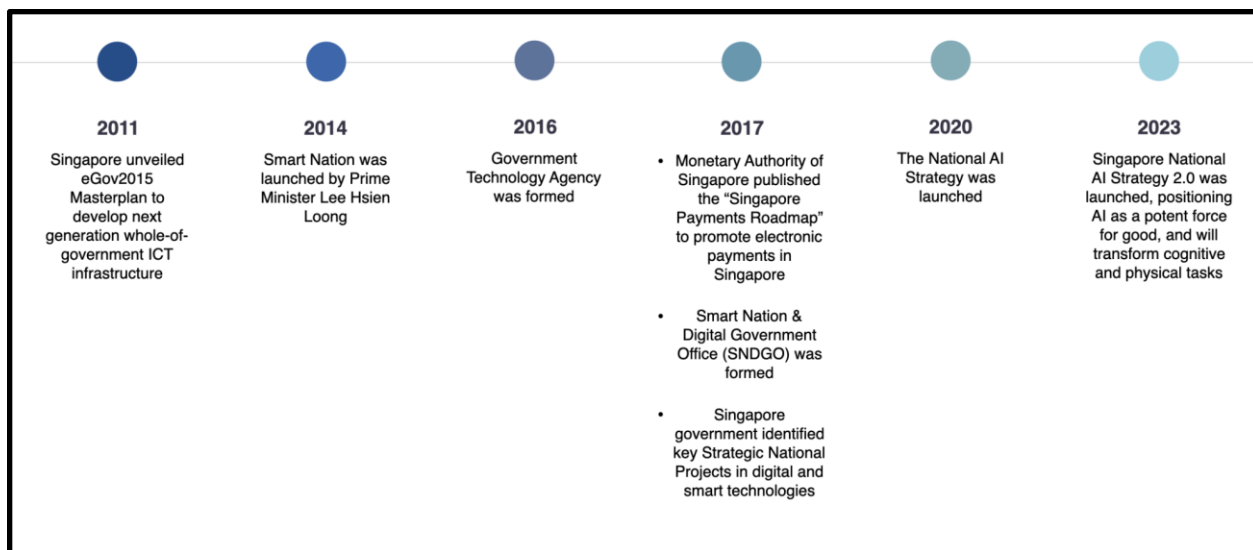
Whole-of-government policy. The development of the digital technology sector has also been supported by a 'whole-of-government' focus in policy, with new state agencies developed to enact policy and high-level coordinating bodies founded to focus policy efforts. There have been

multiple programs to foster university-industry knowledge spillovers and co-innovation. The MCI has had multiple policies to improve the use of digital technology amongst Singaporeans, providing a use case for digital economy firms. Digital skills were emphasised in an ongoing multi-billion initiative for lifelong learning. Singapore took on a regulatory sandbox approach in some crucial sectors, helping firms which need changed regulation (Pangarkar and Vandenberg, 2022). Although private sector interviewees were sceptical about the impact of this specific policy, they acknowledged that the Singaporean government was open to experimentation and new business models. The state showed a clear commitment to digital transformation, emphasising this commitment in state communications, and interviews suggested that the government was always keen to gain the first-mover advantage in new sectors.

As Seng (2023) argues, based on interviews with Singaporean policymakers, the Singaporean government has actively tried to promote entrepreneurship to the population, including by ensuring that national media outlets such as *The Straits Times* feature entrepreneurs as role models. In addition, he also shows that schools are increasingly including tech entrepreneurship as part of education. This trend implies that Singapore's policy for entrepreneurship is broader than just entrepreneurship policy, and that there is some coordination of policy around a central aim.

Woo (2020) suggests that when policymakers have multiple but coherent goals, policy instruments can be integrated rather than inconsistent. He focuses on Singapore's Smart Nation policy (see Figure 1), an attempt to address city management problems through the use of technology, but he suggests that this use of technology was seen by policymakers in economic development terms. This relationship was clear in our interviews; the smart nation strategy, while not exclusively about entrepreneurship, merges city functions with the economic potential of artificial intelligence. Much of this - for example, efforts to increase digital payments - both make Singapore more efficient as a city and open up major market opportunities. Because these multiple policy aims are consistent, they can still be achieved.

Figure 1. Recent Development Timeline of Smart Nation Singapore



Source: Author's adaptation from Smart Nation (2024).

In summary, the Singaporean model included some elements of a 'standard' economic development package - incubators, university-business links and so on. But it also had some special features which are unique to Singapore. Perhaps because of its small size, Singapore is able to coordinate economic activity in a way which allows it to focus on long-term goals. Our interviews also suggested that state actors are increasingly unsure about their strategies as they approach the technological frontier. Singapore's first-mover regional advantages are steadily being eroded as neighbouring countries rapidly develop digital economy capabilities. There is a growing impetus for digital transformation to stay ahead of rapid technological change. The Singapore government has been working to stay ahead and accelerate new growth engines, and there is a growing policy turn towards developing ecosystemic capabilities in emerging digital economy frontiers, particularly in cloud network infrastructure, cybersecurity, AI & data science, and immersive media (IMDA, 2024).

5. Conclusion

This paper set out to address a key question in economic development: how can a post-developmental state succeed in a rapidly changing, frontier sector? It focused on Singapore, an archetypal state-managed innovation system which has developed a thriving set of digital

technology start-ups. We trace a ‘Singapore model’, a form of technology and industrial policy which aimed to shift the structure of the economy (Bailey et al., 2019), which we contrast with the organic development of digital tech sectors. While Singaporean levels of entrepreneurship are still relatively low, the model allows the successful growth of firms in Singapore. Because of this focus on the growth of high quality existing firms, it is more appropriate to term Singapore as a ‘scale up state’ rather than a ‘start-up state’. In studying a rare and contextualised model of industrial policy success, we hope to illuminate the ways in which states can build new industries although, we would note, there are many examples of similar policies which have been less successful (Breznitz, 2021).

Our core argument is that the spread of digital technology such as smartphones opened up a window of locational opportunity for Singapore which its geographical position and strong business environment meant it was well placed to seize. But along with the ‘standard’ toolkit of innovation policy measures, a more strategic and active state allowed it to address the opportunity and network failures which arise in frontier sectors. As Mazzucato (2013) has argued, new technology-based industries will often only develop when there is an identified opportunity and the state can address network or coordination failures which hinder its development. For example, it has seeded a domestic venture capital market with state capital and allowed quick changes to regulation. In this respect, Singapore shows that the flexible bureaucracy and ‘public-private collaboration’ that Yeung (2022) discusses can play a role.

What distinguishes Singapore from the classic Silicon Valley model? There are important differences. As a second mover, Singapore has undertaken consistent network building efforts with hubs in the US, Europe, China and India. State communications do not position Singapore as a rival to leading hubs elsewhere, but instead emphasise fostering strong networks to them. While US tech hubs have tended to evolve from business networks, Singapore’s digital economy sector has tended to involve state stewardship – through championing of an anchor tenant, in this case, Grab, and, to a lesser extent, Sea Group, and building up confidence within investor communities by using state finance to stimulate a venture capital market. State actors have served as central players in the development of Singapore’s tech ecosystem, through

certifications.³ The state acts as the lead user for entrepreneurship, and the IMDA (and other partnering state bodies) also works closely with these entrepreneurs and gatekeeps access to funding and mentoring networks. In doing so, the state helps entrepreneurs avoid the major bottlenecks in the start-up process. The state's championing of anchor tenants (i.e. Grab, Sea Group) to address the lack of VC confidence in the young local ecosystem also helped catalyse the emergence of virtuous innovation and entrepreneurship dynamics by creating a key local source of localised knowledge spillovers and digital economy entrepreneurship.

There are some important caveats to the success of Singapore in digital technology. The first is that while many of the firms developed in Singapore are innovative, they are often taking US technologies and applying them to Southeast Asian markets, using Singapore as a base. The basic research happening in Singapore is not yet producing the same success in radical clusters as that in the US. As such, a critic might argue that Singapore's tech ecosystem model is not really innovative because of its limited success in fostering 'deep tech' start-ups (WIPO, 2022). As a high-cost economy, this limitation raises concerns that Singapore will need to move towards 'frontier' technology if it is to sustain growth and high living standards (WIPO, 2022). Otherwise, there is a danger that its small domestic market could, with improvements in the business environments of other Southeast Asian economies, erode its competitive position.

Yet this doesn't make Singapore's model unsuccessful. As Storper (2013) notes, the places where frontier technologies are developed are not always those where it is successfully applied. Second-mover clusters are often those which benefit economically. Indeed, this fast-follower approach may be a deliberate result of policy. Singaporean digital economy industry policy appears to emphasise the latter type of cluster development: The CFE report indicates that Singapore's industrial development policy is strategically oriented towards becoming a tech exploitation and regionalization hub and is seemingly deliberately positioned as 'second-order' versus Silicon Valley's cutting-edge tech innovations. It is also wrong to say that these firms are not innovating technologically. Although they are clearly not as innovative as US firms in the technology-first, Silicon Valley sense; but might nonetheless be seen to be innovative in the user-oriented, context-adaptive sense, which is

³ See [OIN](#) and [IMDA Certification](#)

especially relevant considering the diversity, turbulence, and developing nature of the broader Southeast Asian region. There is also a chance that the local ecosystem is still maturing and might yet produce ‘the next big thing’.

A second major concern is that the Singaporean model has yet to create many indigenous unicorns, with a focus on attraction and scale up of promising firms from elsewhere. Singaporean policymakers seem relaxed about this, so long as good jobs are created for Singaporeans. They questioned the extent to which firms in Silicon Valley were founded by people with strong roots in California, particularly given the importance of immigrant founders to innovation in the United States (Saxenian, 2006). Indeed, there was some hope that indigenous firms would develop from the staff of these firms with foreign founders. But there was general recognition that the success of Singapore in creating good jobs for Singaporeans was Janus-faced: the strong economy raises the opportunity cost of setting up a new business, reducing the incentives for locals to create new firms. The problem of low levels of entrepreneurship has been noted in the literature (Audretsch and Fieldler, 2023), but Singapore’s success has been in creating quality firms, not quantity. Moreover, it is confusing means with ends: entrepreneurship is a means to an end, economic success, not a policy goal for its own sake.

Singapore is an outlier case, both in terms of its small size and geographical position, and its economic success. As we have argued, it is the interaction between Singapore’s fundamentals of geography and business environment, and Singapore’s strategy for this window of technological opportunity which makes it interesting. But Singapore’s status as an outlier case also means that studies of other economies which have faced the same window of opportunity with less success are also necessary. It also raises an important question about the next phase of technological change. As AI and other forms of deep tech become more important, other governments will be trying to take advantage of the windows of technological opportunity which open. The question remains as to what the role of the state should be to stimulate success in these very different technologies, and if they will be as open as commercial digital technology.

References

Adams, S. B. 2011. Growing where you are planted: Exogenous firms and the seeding of Silicon Valley. *Research Policy*, 40(3), 368-379.

Amsden, A. H., Tschang, T., & Goto, A. 2001. Do foreign companies conduct R&D in developing countries? (No. 14). *ADB Research Paper Series*.

Ananthalakshmi, 2012. Failure to launch: Singapore start-ups struggle to woo investors. *Reuters*, December 20, 2012. <https://www.reuters.com/article/idUSBRE8BJ19J/>

Anthony, S. D. 2011. In Singapore a Failure to Fail. *Harvard Business Review*, March 24th 2011. Available from: <https://hbr.org/2011/03/the-failure-of-failure>

Audretsch, D. B. 2003. Entrepreneurship, innovation, and globalization: does Singapore need a new policy approach In *Sustaining Competitiveness in the New Global Economy: The Experience of Singapore*, 205-225.

Audretsch, D. B., & Fiedler, A. 2023. Does the entrepreneurial state crowd out entrepreneurship?. *Small Business Economics*, 60(2), 573-589.

Bailey, D., Glasmeier, A., Tomlinson, P. R., & Tyler, P. 2019. Industrial policy: new technologies and transformative innovation policies?. *Cambridge Journal of Regions, Economy and Society*, 12(2), 169-177.

Boschma, R. 1996. *The window of locational opportunity-concept* (No. 260). Quaderni-Working Paper DSE.

Boschma, R. A., & Van der Knaap, G. A. 1999. New high-tech industries and windows of locational opportunity: the role of labour markets and knowledge institutions during the industrial era. *Geografiska Annaler: Series B, Human Geography*, 81(2), 73-89.

Breznitz, D. 2021. *Innovation in real places: Strategies for prosperity in an unforgiving world*. Oxford University Press

Cheang, B. 2022. What can industrial policy do? Evidence from Singapore. *The Review of Austrian Economics*, <https://doi.org/10.1007/s11138-022-00589-6>

CFE. 2017. Report on the Committee on the Future Economy. Available from:

<https://www.mti.gov.sg/Resources/publications/Report-of-the-Committee-on-the-Future-Economy> [Accessed 23rd May 2024]

Eggers, J. P. 2014. Competing technologies and industry evolution: The benefits of making mistakes in the flat panel display industry. *Strategic Management Journal*, 35(2), 159-178.

Ferrary, M., & Granovetter, M. 2009. The role of venture capital firms in Silicon Valley's complex innovation network. *Economy and Society*, 38(2), 326-359.

Giachetti, C., & Mensah, D. T. 2023. Catching-up during technological windows of opportunity: An industry product categories perspective. *Research Policy*, 52(2), 104677.

Hamilton-Hart, N., & Wai-chung Yeung, H. 2021. Institutions under pressure: East Asian states, global markets and national firms. *Review of International Political Economy*, 28(1), 11-35.

Heo, S. 2021. Singapore still first in tech innovation hub global ranking: KPMG survey. The Business Times, <https://www.businesstimes.com.sg/startups-tech/technology/singapore-still-first-tech-innovation-hub-global-ranking-kpmg-survey>

Hon, W. S. 1992. Exploiting information technology: A case study of Singapore. *World Development*, 20(12), 1817-1828.

Infocomm Media Development Authority [IMDA] and Lee Kuan Yew School of Public Policy [LKYSPP] 2023. Singapore Digital Economy Report 2023, Available from: <https://www.imda.gov.sg/-/media/imda/files/infocomm-media-landscape/research-and-statistics/sgde-report/singapore-digital-economy-report-2023.pdf>

Infocomm Media Development Authority [IMDA]. 2024. *Singapore Digital Economy Framework for Action*. Available from: <https://www.imda.gov.sg/about-imda/research-and-statistics/sgdigital/digital-economy-framework-for-action#:~:text=Our%20goal%20as%20a%20nation,Iswaran%20on%202021%20May%202018>. [Accessed 23rd May 2024]

Johnson, C. 1982. *MITI and the Japanese miracle: the growth of industrial policy, 1925-1975*. Stanford university press.

Klingler-Vidra, R. 2018. *The venture capital state: the Silicon Valley model in East Asia*. Cornell University Press.

Lai, K. P. 2018. Singapore: Connecting Asian markets with global finance. In, Cassis, Y. and Wojcik, D. eds. *International Financial Centres after the Global Financial Crisis and Brexit*. Oxford University Press.

Lee, K. Y. 2000. *From Third World to First*. Harper Collins, London.

Leftwich, A. 1995. Bringing politics back in: Towards a model of the developmental state, *The Journal of Development Studies*, 31:3, 400-427, DOI: 10.1080/00220389508422370

Lundvall, B. Å. 2007. National innovation systems—analytical concept and development tool. *Industry and Innovation*, 14(1), 95-119.

Mazzucato, M. 2013. *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*. Anthem Press, London.

Mok, K. H. 2005. Pro-competition policy tools and state capacity: Corporatisation of public universities in Hong Kong and Singapore. *Policy and Society*, 24(3), 1-26.

Pangarkar, N., & Vandenberg, P. 2022. Singapore's ecosystem for technology startups and lessons for its neighbors. *Asian Development Bank*.

Poh, L. C. 2016. From research to innovation to enterprise: The case of Singapore. Cornell University, INSEAD, and WIPO, *The Global Innovation Index*, 133-139.

Saxenian, A. 2006. *The New Argonauts: Regional advantage in a global economy*. Cambridge, MA: Harvard University Press.

Seng, J. Y. 2023. *Essays on the Political Economy of Innovative Startups*. Copenhagen Business School [Phd]. PhD Series No. 42.2023 <https://doi.org/10.22439/phd.42.2023>

Smart Nation. 2024. Milestone's of Singapore's Smart Nation Journey. Available from: <https://www.smartnation.gov.sg/about-smart-nation/our-journey/milestones/> [Accessed 20th May 2024]

Speidel, U. 2022. A short history of Singapore's role in the cable world. Available from: <https://blog.apnic.net/2022/09/12/a-short-history-of-singapores-role-in-the-cable-world/>

Spigel, B. 2017. The relational organization of entrepreneurial ecosystems. *Entrepreneurship theory and practice*, 41(1), 49-72.

- Spigel, B. 2020. *Entrepreneurial ecosystems: Theory, practice and futures*. Edward Elgar Publishing.
- Storper, M. 2013. *Keys to the City: How Economics, Institutions, Social Interaction, and Politics Shape Development*. Princeton University Press.
- Storper, M., Kemeny, T., Makarem, N., & Osman, T. 2015. *The rise and fall of urban economies: Lessons from San Francisco and Los Angeles*. Stanford University Press.
- Telling, O. 2022. Singapore courts local tech giants over ‘national duty’ to relist. *Financial Times*, July 24th 2022. <https://www.ft.com/content/4723e543-5219-4122-b838-f91646865820>
- United Nations. 2019. International migrant stock, 2019. Available from: https://www.un.org/en/development/desa/population/migration/data/estimates2/docs/MigrationStockDocumentation_2019.pdf
- Vogelaar, J. J., & Stam, E. 2024. *Unicorns: from Silicon Valley to a global phenomenon?*.
- Wade, R. 2004. *Governing the market: Economic theory and the role of government in East Asian industrialization*. Princeton University Press.
- Wang, J. 2018. Innovation and government intervention: A comparison of Singapore and Hong Kong. *Research Policy*, 47(2), 399-412.
- WIPO. 2022. Global Innovation Hotspots: Singapore’s innovation and entrepreneurship ecosystem. Geneva: World Intellectual Property Organization.
- WIPO. 2023. Global Innovation Index, 2023. Geneva: World Intellectual Property Organization.
- Wong, J. 2004. The adaptive developmental state in East Asia. *Journal of East Asian Studies*, 4(3), 345-362.
- Wong, P. K. 2022. An Evolutionary Analysis of the Development of the One North Innovation District in Singapore. *Journal of Evolutionary Studies in Business*, 7(2), 70-99.
- Wonglimpiyarat, J. 2013. Innovation financing policies for entrepreneurial development—Cases of Singapore and Taiwan as newly industrializing economies in Asia. *The Journal of High Technology Management Research*, 24(2), 109-117.

Woo, J. J. 2018. *The evolution of the Asian developmental state: Hong Kong and Singapore*. Routledge.

Woo, J. J. 2020. The smart city as layered policy design: Singapore's Smart Nation initiative. In *Governing Cities* (pp. 32-45). Routledge.

World Bank. 2024a. Individuals using the internet, % of population. Available from: https://data.worldbank.org/indicator/IT.NET.USER.ZS?end=2021&locations=SG-Z4-EU-US-GB&most_recent_value_desc=false&start=2021&view=bar [Accessed 26th April 2024]

World Bank. 2024b.. Mobile cellular subscriptions. Available from: https://data.worldbank.org/indicator/IT.CEL.SETS.P2?end=2021&locations=SG-Z4-EU-US-GB&most_recent_value_desc=false&start=1960 [Accessed 26th April 2024]

Yeung, H. W. C. 2016. *Strategic coupling: East Asian industrial transformation in the new global economy*. Cornell University Press.

Yeung, H. W. C. 2022. *Interconnected worlds: Global electronics and production networks in East Asia*. Stanford University Press.

Zalizan, T. 2022. The Big Read: Defying doubters, Singapore built a flourishing start-up scene within a decade. Can it take the next step up?. *CNA Asia*, Available from: <https://www.channelnewsasia.com/business/big-read-singapore-startup-scene-decade-next-step-3032171>