Urban innovation policy in the postdevelopmental era: Lessons from Singapore and Seoul

Kris Hartley1 | Jun Jie Woo2 | Sun Kyo Chung3

1 School of Social and Political Sciences, University of Melbourne, Parkville, VIC, Australia
2 School of Humanities and Social Sciences, Nanyang Technological University, Singapore, Singapore
3 Department of City and Regional Planning, Cornell University, Ithaca, New York

Abstract
This article examines the impact of policies for start-up and entrepreneurship on the developmental model that remains a policy legacy in many Asian countries. The main argument is that the influence of central planning is deeply embedded in the institutions of the Four Asian Tigers, but globalisation and economic liberalisation are disrupting the old developmentalism by incentivising innovation and structural adaptability. In practice, although developmentalism once focused on infrastructure and industrial policy, softer strategies such as attracting educated millennials through urban amenities and creative clustering mimic those of the postindustrial West. Either this trend represents the end of developmentalism or top-down industrial policy is being rebranded to embrace knowledge and service industries. This article examines this issue at the urban scale, examining policies used by Singapore and Seoul to encourage start-ups and entrepreneurship in the context of innovation. Government documents are examined and findings compared.

1 | INTRODUCTION

The legacy of industrial planning has been embedded in Asia’s government institutions and state-backed corporate conglomerates since the post-World War II era, when countries...
competitively jostled for global market position. Since the 1980s, an interconnected manifestation of globalisation has shifted the competitive interface from countries to multinational firms, which have utilised national comparative advantages in production to develop global supply chains. Accompanying this trend has been the Washington Consensus-inspired liberalisation of markets, factors of production, and capital. The current environment does not resemble the midcentury context in which East Asian developmentalism emerged, especially regarding industrial policy. The strategy of force-feeding government-backed industrial conglomerates with capital and other policy-related advantages is losing relevance, particularly in a global market where innovation and flexibility are new sources of advantage; for firms, ideas are supplanting location, size, and capital as dimensions of competitiveness. It is against this backdrop that this article explores industrial policy for innovation-based start-ups and entrepreneurship, with a focus on the city scale.

Evidence of the growth of innovation-driven economies is copious. The increasing variety of strategic models includes open innovation, learning organisations, and first-to-market competitive dynamics (Christopherson, Kitson, & Michie, 2008). This trend is salient in the types of knowledge and creative industries that have shaped postindustrial growth in Western cities and are now emerging in Asian cities (Arvidsson & Niessen, 2015; Fahmi, McCann, & Koster, 2017; Gwee, 2009; Irawati, 2013; Kroll & Schiller, 2013; Richardson, 2004; Teeple et al., 2014; Yigitcanlar & Sarimin, 2015). Whereas the “old” Asian-style developmentalism (Huff, 1995; Low, 2001) focused on physical infrastructure, capital-intensive production, corporate-state embeddedness, and industrial policy that anointed champion industries, a new generation of growth strategies is seeking to cultivate creative and knowledge industries in part through urban amenities and firm clustering, which are thought to lure creative professionals (Florida, 2003). This approach serves a crowded and highly competitive market structure where innovation is no longer concentrated within large government-backed corporations but is diffused across an uncoordinated ecosystem of start-ups and entrepreneurial individuals.

This article proceeds on the basis of four premises that progressively constitute a broader argument. First, the decentralised nature of modern innovation is increasingly incompatible with legacy 20th century state-corporate structures, particularly those reflected in the government-backed conglomerates of developmentalist Asia. Second, this new innovative setting occurs increasingly in cities where network and clustering effects are strongest; this phenomenon has been conceptualised by scholars as “entrepreneurial ecologies” or “entrepreneurial ecosystems” (hereafter, EEs). Third, this economic transition comes at a time when many local governments enjoy greater power to design and implement development policies, through decentralisation and devolution reforms now common across East and Southeast Asia. Finally, the creative and knowledge economies driving economic growth include FIRE (finance, insurance, and real estate), technology, other high-value added industries, and entertainment and culture. Manufacturing conglomerates no longer monopolise innovation, and this has implications for how urban growth policy treats firms and individual citizens.

This article’s empirical study focuses on two cases, Singapore and Seoul. Singapore is a global leader in many of the types of knowledge and creative industries that are replacing “hard” industries in growth dynamics. It is well acknowledged that Singapore, as a coterminous city state, is an imperfect case comparison for other national-level studies. However, this research focuses on urban rather than national scale, enhancing the validity of Singapore as a comparator for cities that have increased autonomy to adopt development policies. This study also examines Seoul, whose role in the economic history and current competitiveness of South...
Korea (hereafter “Korea”), in addition to its status as a centre for enterprise and innovation, justifies inclusion in a study focusing on exemplary cases. This article is organised into three parts. First, a literature review explores the concept of clustering for creative industries and innovation and situates the concept within studies about EEs. Second, the case study presents the findings of research into urban-level innovation policies in Singapore and Seoul. The conclusion describes how the findings can be incorporated into urban policies given shifting demographic dynamics and closes with a proposal for further research.

2 | LITERATURE REVIEW

This literature review addresses clustering in creative industries, with a focus on the role of public policy in encouraging EEs in Asia. In examining the influence of marketising activities such as entrepreneurship on the Asian developmental state, this study is rooted in discussions about capital accumulation and neoliberalism in the urban context. This topic has been robustly explored in the Marxist geography literature and other critical readings of global capitalism (e.g., Harvey, 2007), including urban economic development through territorial competitiveness in attracting mobile capital (Brenner & Wachsmuth, 2012; Jessop, 1997; Peck, Theodore, & Brenner, 2013; Peck & Tickell, 2002). Competitiveness, globalisation, and entrepreneurship have also been examined as forces transforming Asian cities (Banerjee-Guha, 2016; Hae, 2017; Jessop & Sum, 2000; Olds & Yeung, 2004; Wu, 2003; Wu, 2004). This review identifies issues most pertinent to the subsequent empirical analysis and is divided into three sections: clustering and innovation, EEs in the urban context, and Asian cases.

2.1 | Clustering and innovation

With the growth of the United States’ technology sector and the emergence of tech clusters in cities and near universities, longstanding agglomeration theory has newfound currency for case types across shifting geographic, industrial, and social settings. Studies of clusters focus often on innovation as a driver of firm competitiveness and within that frame on the facilitation of innovative activity by government policies, corporate culture, and physical settings. A popular case context has been the comparison of Route 128 in Massachusetts and Silicon Valley in California (Bania, Eberts, & Fogarty, 1993; Florida and Kenney, 1988; Fogarty & Sinha, 1999; Herbig & Golden, 1993; Hulsink, Manuel, & Bouwman, 2007; Kenney & Von Burg, 1999; Saxenian, 1996; Torero, 1998; Weiss & Delbecq, 1987). Other U.S.-based studies of innovation and tech clustering have explored firm-level dynamics in North Carolina’s Research Triangle (Aldrich, Elam, & Reese, 1997; Aldrich & Reese, 1994; Gilbert, Audretsch, & McDougall, 2004; Leyden & Link, 2013) and the variously labeled Texas corridor (Florida & Kenney, 1988; Gibson & Butler, 2013; Glickman & Wilson, 1985; Lyons & Luker, 1998; Smilor, Kozmetsky, & Gibson, 1987). Scholars have attempted to understand this phenomenon by studying EEs as environments in which entrepreneurs operate, innovate, and collaborate. With conceptual origins in both the regional development and business strategy literatures (Acs, Stam, Audretsch, & O’Connor, 2017), the EE concept emerges from attempts to develop a coherent unit of analysis and is the topic of a growing body of literature. Studies of entrepreneurial activity are no longer focused exclusively on firm culture but have been rescaled to national-level competitive dynamics and policies and to both formal and informal social space characterised by “a complexity and
diversity of actors, roles, and environmental factors that interact to determine the entrepreneurial performance of a region or locality” (Spilling, 1996, p. 91).

Later work focused on EEs as a process occurring naturally in the course of economic growth. Mason and Brown (2014) define EEs in terms of interconnectedness among actors, organisations, institutions, and processes, and their tendency to “coalesce” in both formal and informal settings (p. 6). Likewise, Neck, Meyer, Cohen, and Corbett (2004) argue in a study of Boulder, Colorado, that the unique relationship between culture, infrastructure, and networks promotes endogenous entrepreneurial activity. The importance of entrepreneurial networks, analogous in the public policy literature to “subsystems” (Howlett, Ramesh, & Perl, 2009) and in the public administration literature to “network governance” (Provan & Kenis, 2008; Yifen, 2007), has a well-developed body of research. Related literature has focused on particular types of actors within EEs. For example, in a study of the longer-term implications of entrepreneurship, Nylund and Cohen (2016) argue that “collision density”—the frequency of interactions that fosters “matchups” among investors, producers, and others—theoretically increases the number, diversity, and extinction (failure and “creative destruction”) of startups. Disaggregating such analysis to network types, Lehmann and Seitz (2016) examine the role of cultures and subcultures in EEs, including pioneering groups sharing a particular value set that distinguishes them from the mainstream as “creative destructors.”

2.2 | EEs in the urban context

Urban EEs have received comparatively less attention than have regional or national EEs (Nylund & Cohen, 2016). This omission is problematic considering the role cities and local governance play in EEs. Florida, Adler, and Mellander (2017) argue that entrepreneurial systems feed from the inherent characteristics of cities, rather than occurring incidentally within them; this justifies the diversion of scholarly attention from firm- or national-level dynamics to cities. Nylund and Cohen (2016) argue that the research on EEs has focused on particular geographic contexts such as suburban tech parks and regional economies. Indeed, Asian governments have embraced the originally American idea of tech parks, which have emerged in cities and near universities in the past two decades (Krishna & Sha, 2015; O’Shea, Fitzgerald, Chugh, & Allen, 2014; Reyes, 2016). However, Isenberg (2010) argues that Asian governments should not simply attempt to replicate the model or characteristics of Silicon Valley or “over-engineer” clusters. Silicon Valley, the Silicon Wadi (Israel’s technology hub), and the Cambridge (U.K.) technology cluster are not the result of overtly top-down policies or government initiatives (Cooke, 2017).

EEs are also receiving scholarly attention in the context of smart city programs, which are emerging across Asia as information and communications technology (ICT) experiences rapid adoption (Carvalho, 2018; Harrington, 2017; Kraus, Richter, Papagiannidis, & Durst, 2015; Ratten, 2017; Vu & Hartley, 2017). Notably, the popularity of tech parks has been superseded by that of tech neighborhoods as urban innovation districts. According to Mulas, Minges, and Applebaum (2016), the recent shift in innovation activities away from suburban tech parks to centre cities underscores the relevance of demographic dynamics such as density, proximity, and diversity; this is reminiscent of Florida’s argument that urban amenities provide a setting for social connections. Mulas et al. view innovative ecosystems not as geographic spaces but as communities, with social connections as the unit of analysis. This overlaps with the cultural, social, and material attributes of Canadian EEs identified by Spigel (2015).
2.3 | Asian cases

Embracing agglomeration theory, Asia’s developmental governments have adopted the strategy of clustering to promote growth. For example, regional clustering continues to be a development strategy in China through the country’s new urbanisation programme (Hu & Chen, 2015), whereas Malaysia uses export hubs to connect local entrepreneurs and global enterprises (Athukorala, 2017). At the same time, the emergence of EEs in Asia is rooted in the region’s development history and offers a context for understanding how government intervention can either cultivate or obstruct entrepreneurship. According to Yun, Cooke, and Park (2017), process innovation in technology, led by the Four Asian Tigers (Korea, Singapore, Taiwan, and Hong Kong), played a role in promoting economic clustering in Asian countries while emphasising the social aspects of enterprise. Nevertheless, in their examination of start-up ecosystems in Tokyo, Seoul, Suzhou, and Chongqing, Hemmert et al. (2016) find that entrepreneurial networks can be weak and segregated, even amidst high population density and innovative activity. According to the authors, the history of Asian start-up hubs differs from that of the West in that the Asian start-up environment operates amidst a number of external facilitative organisations (e.g., research institutions and government agencies), resulting in weaker entrepreneurial network ties. The ineffectiveness of entrepreneurship policy was likewise examined by Zheng (2011) in a study of Shanghai, where the attraction of creative workers to designated clusters was based more on commodified physical characteristics than on policies related to the facilitation of inter-firm linkages. In China, the state continues to be embedded in entrepreneurial activity through funding linked with strategic industrial policies (Kenderdine, 2017). Sociocultural factors have also been found to influence the entrepreneurial ecosystem in Korea, as the pressure to work for chaebols discourages break-out innovation and individual risk taking (Haines, 2015). Kshetri (2014) argues in an examination of EEs in Korea that institutional reforms are needed at both the national and private sector levels, including on immigration policy. One example of a facilitative institution is Korea’s Centre for Creative Economy & Innovation (CCEI), a government-sponsored effort to support start-ups through corporate partnerships. In a study of CCEI, however, Jung, Eun, and Lee (2017) identifies counterproductive bureaucratic and regulatory barriers.

This review has explored three broad concepts, at the intersection of which this article makes its contribution. First, the application of agglomeration and clustering theories to tech parks and now increasingly to urban innovation districts establishes a crucial theoretical underpinning for the examination of EEs and related policies. Second, the presence of entrepreneurial economies in cities reflects a complex environment in which commercial, social, and geographic factors overlap to form an embedded setting that is at once flexible and difficult to engineer through policy. Finally, studies of EEs in urban Asia help to situate innovation and knowledge economies in a policy context that has a deep legacy of state intervention.

3 | CASES: SINGAPORE AND SEOUL

This article adopts the comparative case study approach for examining start-up and entrepreneurship policy. For a detailed description of the relative merits of case studies and comparative studies on efforts to build theory in the field of political sciences, see Eckstein (1975). Due to the embedded and complex nature of the variables in this study, including policy orientation towards developmentalism and entrepreneurship and the interaction of the latter with the network and social aspects of entrepreneurship, the case study method is justified for its ability to capture situational and phenomenological complexity (Yin, 1984). The approach of this article is
sensitive to one of the common misunderstandings of case study research identified by Flyvbjerg (2006): that generalisability is not possible from a single case. The use of a comparative case study in this article should not be interpreted as an effort to address this concern; utilising two cases does not claim to improve the generalisability of findings. Rather, it intends to explore differing contexts in which the theoretical argument can be more deeply explored. Further, the selection of Singapore and Seoul is motivated by a paradigmatic information-oriented methodology based on the anticipated content of the cases, the ability to generate research utility from a small sample, and the value in identifying a “metaphor ... for the domain that [a] case concerns” (Flyvbjerg, 2006, p. 230).

Throughout the 20th century, the economic “miracle” experienced by the Four Asian Tigers, Japan, and China has been characterised by government support of industry, spawning politically connected firms that used facilitative public policies, internal innovative capacities, and reliable access to capital to establish global competitiveness. These initiatives helped these and other successful developing countries integrate into global value chains, not only in manufacturing through finished goods and components but also through services, research and development (R&D), and corporate activities, with a focus on trade in value added and business functions (Gereffi, 2014). Through reduced barriers to foreign direct investment, the Asian Tigers and other Asian “newly industrializing countries” established export-oriented industrial capacity and deepened their integration into the global economy, first through low production costs and later through competitive advantages gained from flexible restructuring (Chiu, Ho, & Lui, 1998). For Singapore in particular, hosting regional headquarters of multinational corporations has contributed to the country’s integration into the global economy as a command-and-control centre (Belderbos, Du, & Goerzen, 2017), with location, quality of business services (Yeung, Poon, & Perry, 2001), and status as network hub in the field of global finance (Meyer, 2015) providing crucial competitive advantages. Seoul’s development has likewise been characterised by the city’s integration with the global economy, with the city’s established industrial champions (chaebols) becoming key players in global production networks (Yeung, 2015) and the market for office space in the central business district reflecting a robust wave of foreign investment (Kim, O’Connor, & Han, 2015).

Crucial to this study, the environment in which high-tech innovation now occurs does not resemble Asia’s developmental epoch; in particular, innovation is more diffuse and entrepreneurial, and thereby less responsive to developmentalist policy or conglomerate structures. The implications of this transformation are prompting governments to revisit legacy growth models that favour intervention in markets and the establishment and survival of large domestic firms. The decentralised nature of innovation and the mechanisms by which innovation is diffused presage a new type of clustering. Rather than “spilling over” among large firms, innovation now resembles a currency traded among entrepreneurial individuals within a constantly shifting environment of startups, failures, and acquisitions. Present in this dynamic environment is a network of subsystems that provide the connective tissue through which entrepreneurs interact, influence policies and markets, and generate economic value. This comparative case study focuses on government interventions that address entrepreneurship through the lens of subsystems in two of Asia’s most dynamic and successful urban economies, Singapore and Seoul.

3.1 | Singapore

Underlying Singapore’s historically rapid economic growth was diligent and targeted industrial policy. The country’s recent shift from export-oriented industrialisation to a similarly export-
oriented knowledge-based economy has prompted a stronger focus on innovation and entrepreneurship (Wong, 2001; Goh, 2005; Parayil, 2005), with a concurrent reorientation of the policy ecosystem and socio-political configurations that had been the cornerstones of the country’s growth strategy. Singapore’s economic policy has been described as being driven by a governing elite of state and industry actors (Hamilton-Hart, 2000, 2002; Tan, 2008). According to Luger (2017, p. 1), “the creative policy implementation process—and its impacts, contestations and resistances—have difficulty moving beyond the ivory tower of elite urban cosmopolitanism.” Luger argues that there exists a policymaking exclusivity that fails to interact with Singapore’s “heartland.” In this vein, policy development can be analysed through internal dynamics among governing elites, through a subsystem or network approach (Woo, 2015, 2016; Woo & Howlett, 2015). Such work includes Barr’s (2014) study of Singapore’s historical development in the context of elite circles of government insiders.

The lingering mechanisms of developmentalism, including socio-political elitism in policymaking, endure even amidst Singapore’s transition to a knowledge-based economy. For example, the government has asserted its strategic vision through the establishment of science research agencies such as ASTAR and SPRING, and the formation of industry-specific creative clusters (Gwee, 2009; Lee & Tee, 2009; Wong, Ho, & Singh, 2010). Aside from the adaptation of developmental-style policy strategies such as industrial favouritism through R&D (Lee & Tee, 2009), Singapore’s priority shift towards innovation and creative clustering has also enabled the emergence of new policy subsystems. Although Singapore’s development policy subsystems have traditionally included representatives from industry firms (Hamilton-Hart, 2002; Woo, 2016), the embrace of innovation has led to inclusion of research institutions, academics, and technology experts in the policy arena (Parayil, 2005; Smart Nation Programme Office, 2017). Despite this growing inclusiveness, Singapore’s policy approach remains primarily state-driven and is rooted in a developmentalist model that crosses functional areas and agencies. This is particularly evident where urban planning complements industrial development through infrastructure provision and land use designations.

Numerous examples of knowledge clustering exhibit Singapore’s continuing statist orientation. The Urban Renewal Authority has established creative clusters and technological test beds throughout the city, with the process of siting clusters remaining centrally planned. The newly established Punggol Creative Cluster and Learning Corridor was planned around a newly formed university (Singapore Institute of Technology) and designed with an emphasis on urban liveability (Urban Redevelopment Authority, 2016). Similarly, Blk71, a start-up hub and entrepreneur ecosystem, was established in conjunction with and close proximity to the National University of Singapore (Blk71 Singapore, 2017), the Jurong Innovation District was formed near Nanyang Technological University (Whang, 2016), and an innovation centre was established through a collaboration between the Singapore University of Technology and Design and JTC Corporation (SUTD, 2014).

These examples reflect a top-down focus on ensuring a mix of firms, start-ups, and research expertise within an engineered innovation ecosystem. A perceived optimum combination of actor types is supported in principle by the proximity of universities and research centres. The physical placement of these districts also serves Singapore’s broader goals to evenly distribute economic activity across the island, with the Jurong Innovation District in the West, Changi Business Park in East, Punggol Creative Cluster in the North, and Blk71 in the South. State intervention is, for example, evident in Punggol, where the Singapore Institute of Technology was formed in 2009 and the cluster’s location confirmed in 2015 (Davie, 2015). Given Singapore’s space constraints, the provision of space where EEs might emerge involves a
balance of economic and land-use considerations, supported by broad government power over rezoning and redevelopment.

The key finding is that Singapore’s efforts to nurture EEs reflect an economic instrumentalisation of what has been a largely endogenous process elsewhere. The theoretical implication is whether the developmentalist model and its offshoots remain relevant and effective amidst shifting global economic forces, particularly as innovation becomes more social and organic than corporate and planned. In practical policy terms, the needs of entrepreneurs and start-ups may be better served through greater participation by research and knowledge constituencies. As subsystems, these groups already benefit from infrastructure and facilitative programs; the declining need for equivalent intervention at advanced development stages will test Singapore’s policy flexibility and loyalty to developmentalist logic.

3.2 | Seoul

Within the past few decades, Korea has achieved rapid economic growth through government intervention and industrial planning. The country has now emerged as a leader in the global knowledge economy, transforming from a beneficiary of United Nations aid to a donor country. Korea is also known for the success of its chaebols, large industrial conglomerates that have historically enjoyed government backing while amassing large and highly diversified global business portfolios (examples are Hyundai, Samsung, and LG). They are also the historic centres of innovation in Korea’s economy, whereas SMEs account for only a small portion of innovation due to their historic role only as suppliers and subcontractors to chaebols (Connell, 2014).

Throughout the later stages of Korea’s period of rapid development, the government has continued to make economic growth a priority and appears to acknowledge the importance of creativity and innovation. One example is the recently introduced Creative Economy initiative, which aims to create jobs, strengthen firm-level competitiveness, and advance creativity. A creative economy action plan introduced in 2013 and the formation of the Ministry of Science, ICT and Future Planning are other examples of the government’s efforts to strengthen innovation.

Long the hub of Korea’s industrial innovation, Seoul has priority within the Creative Economy initiative and serves as its primary driver. Further, Seoul Metropolitan Government (SMG) is now targeting entrepreneurship as a developmental priority. By fostering EEs, SMG seeks not only to accelerate growth but also to address emerging issues such as the “baby boomer” generation’s rising unemployment rate and a general economic slowdown (GDP growth is approaching a 50-year low). SMG’s policy strategy to support start-ups focuses on engaging younger generations in an entrepreneurial landscape animated by talent, population density, and ICT connectivity. For example, in 2016, SMG introduced the Seoul Global Startup Center, which provides free co-working space for foreign entrepreneurs working in Korea. Other efforts include firm incubators (e.g., Google’s first Asian campus) and institutes to match entrepreneurs and companies. An example of the latter is “Digital Media City (디지털 미디어 시티),” which has hosted over 400 companies in media, entertainment, and IT, and functions as a one-stop community connecting researchers, venture capital firms, and enterprises for digital media industries. SMG also sponsors a programme centered on arts incubation, the Seoul Arts Space programme, which has several incubator spaces throughout the city and represents an effort to

1Website: http://policy.creativekorea.or.kr/eng/ (Accessed June 6, 2017)
2Website: http://seoulgsc.com/about-us/seoul-gsc/ (Accessed November 14, 2017)
3Website: http://seouldmc.kr/index.do (Accessed November 14, 2017)
foster tighter community connections among artists. Nevertheless, start-up spaces to accommodate new entrepreneurial projects and promote interaction and exchange are limited and costly in Seoul, due in part to the city’s dense built environment and high property values.

The development of creative clusters is not as evident in Seoul as in Singapore. Likewise, university technology transfer has not been as much a cornerstone of Seoul’s innovation growth as it has been in Singapore. According to a report for the Korean Economic Institute of America, in 2009, Korean universities accounted for only 0.9% of the nation’s overall R&D funding and 1.1% of its activity (Connell, 2014). Despite these weak numbers, recent efforts such as the INNOPOLIS programme are evidence that the Korean government is working to facilitate university-led innovation clustering. Rather than anchoring innovative clusters, Seoul’s universities are found to be more instrumental in city’s innovation system by providing trained graduates (Sohn & Kenney, 2007). Although Seoul has a large supply of highly educated young workers, Korea’s youth unemployment has recently been increasing, with over 11% of workers aged 15–29 out of work. The high number of overseas educated and college graduates, along with a population of foreign students and graduates residing in Seoul needing jobs, is arguably helping to generate an entrepreneurial climate around education.

SMG has partnered with universities in Seoul to implement mentoring and networking programmes between CEOs and students and has also built satellite institutes to offer technical support, certification programs, and workshops for ideation and commercialisation. For example, Seoul’s CCEI, in affiliation with CJ, a Korean chaebol, is a resource for nurturing local entrepreneurs, accelerating firm and innovative capacity building, and supporting global market penetration. CJ also incubates start-ups’ services and products, enabling them to develop businesses directly with firms working with CJ; this often leads to the early successes so crucial for start-ups. Regarding further support for start-ups, the Seoul Entrepreneurship Hub (서울 창업허브), opened in 2017, provides financial aid to start-ups during their initial launch and postlaunch phases through grants and loans, work spaces, legal and accounting advice, and investor matching services at little or no cost.

Despite the aggressiveness of SMG’s proentrepreneurship initiatives, Seoul’s approach through direct funding does not necessarily satisfy the need to facilitate softer dimensions related to social connections, networks, and innovative collaboration. A stronger emphasis on incubator spaces and related programming may help, but must avoid the top-down mentality that lingers from Korea’s developmentalist era. From a policy subsystem perspective, serving the needs of new actors—outside the bounds of chaebols that have previously dominated innovation—requires a more dialogue-based policy development process. A model for this type of government-society interaction has been established for the Seoul Arts Space programme and has scope for application to emerging industries. Like Singapore, Seoul has viewed space and government support as crucial building blocks for an innovation economy.

Finally, it is relevant to reflect upon labour supply, which is at the heart of generating EEs and entrepreneurial vitality. Despite a history of pronatalistic policy interventions in both countries, total fertility rates in Singapore and South Korea are 1.2 (i.e., 1.2 children born per child-bearing-age female); this is below the rate at which population stability can be maintained (Gietel-Basten, Sobotka, & Zeman, 2013). As such, both countries face the prospect of labour forces shrinkage as soon as 2020, threatening long-term economic growth (Walmsley, Aguiar,

---

4Website: http://english.sfac.or.kr/ (Accessed November 14, 2017)
5Website: https://www.innopolis.or.kr/eng_sub0201 (Accessed November 14, 2017)
6Website: http://www.index.go.kr/potal/main/EachDtlPageDetail.do?idx_cd=1495 (Accessed November 14, 2017)
This population ageing crisis is unfolding at a time when the global mobility of talented workers is increasing, and cities in the developed world are making a recruitment push to build capacity in high-skill knowledge industries (Docquier & Machado, 2016; Kerr, Kerr, Özden, & Parsons, 2016). According to a Boston Consulting Group survey of over 200,000 expatriate workers, “people become expatriates for a variety of reasons—to escape political strife, improve their economic circumstances, and sometimes, to have a chance for a life-changing experience” (Strack, Von Der Linden, Booker, & Strohmayer, 2014). It is clear that competing on the amenity-based model referenced in Florida’s (2003) “creative class” hypothesis does not necessarily capture the complex array of locational decisions informing talent mobility (“better standard of living” was the #6 reason for taking a foreign work assignment, according to the BCG survey). As such, the governments of Singapore, Seoul, and other cities targeting start-up economies should adopt a multipronged approach that addresses not only liveability and amenities but also the facilitation of connection and collaboration among entrepreneurial individuals and firms.

4 | CONCLUSION

Efforts by Asia’s urban governments to facilitate EEs are shaped often by histories of developmentalism. Tension arises when new industries embody entrepreneurial interests and behaviours that disrupt the old market structures on which developmentalism once based policy vision and tactical interventions. In the 21st century, supporting development is not simply a matter of providing hard infrastructure, tax incentives, and government capital. Knowledge and creative industries differ from traditional industries in how firms operate, interact, compete, and innovate. This necessitates a type of policy intervention that considers the diversity and plurality of actors and subsystems and embraces a robust feedback system that enables a collaborative approach to policymaking. The cases of Seoul and Singapore illustrate how governments have made progress and have progress to make, in such policy adaptations.

Although both cases illustrate how innovation policy struggles to reconcile developmentalist planning with the new circumstantial mandates of start-up economies, it is also relevant in noncity states to consider policy scale. Local policy distinguishes itself from national policy through three conduits: devolution and decentralisation, the relevance of local planning and land use policies to creative clustering, and the primacy of cities as settings for EEs in technology and other high-growth industries. The new generation of innovation will come not necessarily from large conglomerates with which national governments are familiar and embedded, but from the smaller firms, start-ups, and entrepreneurs that have no formal histories with developmentalism and its government agents. Entrepreneurs and their linkages through networks and subsystems should therefore be supported by policies to enhance communication and collaboration. Examples include sponsorship of networking events, provision of listing services, and regulatory apparatus to facilitate new ventures. There are also conditions for collaboration that exist beyond the ambit of public policy, a topic deserving further research. Future research should also investigate the degree to which innovation policy accounts for the looming population crisis in many developed countries, particularly through measures that serve the needs and desires of knowledge workers. In broader measure, this article has addressed the debate between top-down and bottom-up economic development by illustrating that even in cases of rapid growth, there can a balance of both. The key implication is that legacies of ideological purism in developmentalist policies, such as the ecosystems of production and
innovation themselves, are giving way to a more diffuse model that underscores flexibility, collaboration, and opportunistic strategy (Hartley, 2015). Singapore, Seoul, and other ambitious Asian cities have an opportunity to exemplify this model as they continue to restructure their economies for the 21st century. Further, the continued disruption of 20th century developmentalist models will provide opportunities for theoretical development in the fields of economic development, urban studies, and public policy.

**ORCID**

Kris Hartley [http://orcid.org/0000-0001-5349-0427]

Jun Jie Woo [http://orcid.org/0000-0002-2954-6432]

**REFERENCES**

Acs, Z. J., Stam, E., Audretsch, D. B., & O’Connor, A. (2017). The lineages of the entrepreneurial ecosystem approach. *Small Business Economics*, 1–10.

Aldrich, H. E., Elam, A. B., & Reese, P. R. (1997). Strong ties, weak ties, and strangers. *Entrepreneurship in a Global Context*, 1–25.

Aldrich, H. E., & Reese, P. R. (1994). Does networking pay off? A panel study of entrepreneurs in the research triangle. *Frontiers of Entrepreneurship Research*, 325–339.

Arvidsson, A., & Niessen, B. (2015). Creative mass. Consumption, creativity and innovation on Bangkok’s fashion markets. *Consumption Markets & Culture*, 18(2), 111–132.

Athukorala, P. C. (2017). Global productions sharing and local entrepreneurship in developing countries: Evidence from Penang export hub, Malaysia. *Asia & the Pacific Policy Studies*, 4(2), 180–194.

Banerjee-Guha, S. (2016). Contemporary urban policy in India: A critique of neoliberal urbanism. In *Spatial diversity and dynamics in resources and urban development* (pp. 67–79). Netherlands: Springer.

Bania, N., Eberts, R., & Fogarty, M. (1993). Universities and the startup of new companies: Can we generalize from Route 128 and Silicon Valley? *The Review of Economics and Statistics*, 75, 761–766.

Barr, M. (2014). *The ruling elite of Singapore: Networks of power and influence*. London: I. B. Tauris, ISBN-13 978-1780762340, 224 pages.

Belderbos, R., Du, H. S., & Goerzen, A. (2017). Global cities, connectivity, and the location choice of MNC regional headquarters. *Journal of Management Studies*, 54(8), 1271–1302.

Blk71 Singapore (2017). History. [http://www.blk71.com/about-us/history](http://www.blk71.com/about-us/history).

Brenner, N., & Wachsmuth, D. (2012). Territorial competitiveness: Lineages, practices, ideologies. In B. Sanyal, L. J. Vale, & C. D. Rosan (Eds.), *Planning ideas that matter: Livability, territoriality, governance and reflective practice* (pp. 179–204). Cambridge, MA: MIT Press.

Carvalho, L. C. (2018). Entrepreneurial ecosystems: Lisbon as a smart start-up city. In *E-Planning and collaboration: Concepts, methodologies, tools, and applications* (pp. 1120–1138). Hershey, PA: IGI Global.

Chiu, S. W. K., Ho, K. C., & Lui, T. (1998). *City states in the global economy: Industrial restructuring in Hong Kong and Singapore*. London: Routledge.

Christopherson, S., Kitson, M., & Michie, J. (2008). *Innovation*. Networks and Knowledge Exchange: Oxford University Press.

Connell, S. (2014). Building a creative economy in South Korea: Analyzing the plans and possibilities for new economic growth. In, *2014: On Korea*, Volume 7, Korea Economic Institute of America.

Cooke, P. (2017). A ground-up “Quaternary” innovation strategy for South Korea using entrepreneurial ecosystem platforms. *Journal of Open Innovation: Technology, Market, and Complexity*, 3(1), 10.

Electronic copy available at: https://ssrn.com/abstract=3264530
Davie, S. (2015). New Punggol Campus for SIT. Straits Times, August 24. http://www.straitstimes.com/singapore/education/new-punggol-campus-for-sit.

Docquier, F., & Machado, J. (2016). Global competition for attracting talents and the world economy. *The World Economy, 39*(4), 530–542.

Eckstein, H. (1975). Case study and theory in political science. In F. J. Greenstein, & N. W. Polsby (Eds.), *Handbook of political science* (Vol. 7). Reading, MA: Addison-Wesley.

Fahmi, F. Z., McCann, P., & Koster, S. (2017). Creative economy policy in developing countries: The case of Indonesia. *Urban Studies, 54*(6), 1367–1384.

Florida, R. (2003). Cities and the creative class. *City & Community, 2*(1), 3–19.

Florida, R., Adler, P., & Mellander, C. (2017). The city as innovation machine. *Regional Studies, 51*(1), 86–96.

Florida, R., & Kenney, M. (1988). Venture capital and high technology entrepreneurship. *Journal of Business Venturing, 3*(4), 301–319.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry, 12*(2), 219–245.

Fogarty, M. S., & Sinha, A. (1999). *Why older regions can’t generalize from Route 128 and Silicon Valley: University industry relationships and regional innovation systems*. (pp. 473–509). Industrializing Knowledge: University-Industry Linkages in Japan and the United States.

Gereffi, G. (2014). Global value chains in a post-Washington Consensus world. *Review of International Political Economy, 21*(1), 9–37.

Gibson, D. V., & Butler, J. S. (2013). Sustaining the Technopolis: High-technology development in Austin, Texas 1988–2012.

Gietel-Basten, S., Sobotka, T., & Zeman, K. (2013). Future fertility in low fertility countries. Vienna Institute of Demography Working Papers, No. 5/2013.

Gilbert, B., Audretsch, D., & McDougall, P. (2004). The emergence of entrepreneurship policy. *Small Business Economics, 22*(3), 313–323.

Glickman, N., & Wilson, R. (1985). The emerging economic base and local development policy issues in the Austin-San Antonio corridor, PRP 71. LBJ School of Public Affairs.

Goh, A. (2005). Evolution of industrial policy-making in support of innovation: The case of Singapore. *International Journal of Innovation and Learning, 3*(1), 110–125. https://doi.org/10.1504/IJIL.2006.008183

Gwee, J. (2009). Innovation and the creative industries cluster: A case study of Singapore’s creative industries. *Innovations, 11*(2), 240–252. https://doi.org/10.5172/impp.11.2.240

Hae, L. (2017). Traveling policy: Place marketing and the neoliberal turn of urban studies in South Korea. *Critical Sociology, 1–14.

Haines, J. (2015). Accelerating innovation in global contexts. University of California, Irvine. http://escholarship.org/uc/item/3sv830h5.

Hamilton-Hart, N. (2000). The Singapore state revisited. *The Pacific Review, 13*(2), 195–216.

Hamilton-Hart, N. (2002). *Asian states, Asian bankers: Central banking in Southeast Asia*. New York: Cornell University Press.

Harrington, K. (2017). Smart city leaders, champions, and entrepreneurs—The people part of vibrant smart cities. In *Smart Economy in Smart Cities* (pp. 1005–1012). Singapore: Springer.

Hartley, K. (2015). *Can government think?: Flexible economic opportunism and the pursuit of global competitiveness*. London: Routledge.

Harvey, D. (2007). Neoliberalism as creative destruction. *The Annals of the American Academy of Political and Social Science, 610*(1), 21–44.

Hemmert, M., Cheng, Y., Kohlbacher, F., Kotosaka, M., Loh, C-T, & Waldenberger, F. (2016). High-tech start-up ecosystems in East Asian agglomerations: Are they different from the West. Working Paper 16/1, Tokyo: Deutsches Institut für Japanstudien (DIJ).
Herbig, P. A., & Golden, J. E. (1993). The rise of innovative hot spots: Silicon Valley and Route 128. *International Marketing Review, 10*(3).

Howlett, M., Ramesh, M., & Perl, A. (2009). *Studying public policy: Policy cycles and policy subsystems* (Vol. 3). Oxford: Oxford University Press.

Hu, B., & Chen, C. (2015). New urbanisation under globalisation and the social implications in China. *Asia & the Pacific Policy Studies, 2*(1), 34–43.

Huff, W. G. (1995). The developmental state, government, and Singapore’s economic development since 1960. *World Development, 23*(8), 1421–1438.

Hulsink, W., Manuel, D., & Bouwman, H. (2007). Clustering in ICT: From Route 128 to Silicon Valley, from DEC to Google, from hardware to content.

Irawati, D. (2013). The role of local creative entrepreneurs in shaping creative cities in Indonesia. In *Emerging Knowledge Economies in Asia: Current Trends in ASEAN-5* (Vol. 122) (p. 155). New York, NY: Routledge Press.

Isenberg, D. J. (2010). How to start an entrepreneurial revolution. *Harvard Business Review*, 1–11.

Jessop, B. (1997). The entrepreneurial city: Re-imaging localities, redesigning economic governance, or restructuring capital. In N. Jewson, & S. MacGregor (Eds.), *Realising cities: New spatial divisions and social transformation* (pp. 28–41). London: Routledge Press.

Jessop, B., & Sum, N. L. (2000). An entrepreneurial city in action: Hong Kong’s emerging strategies in and for (inter) urban competition. *Urban Studies, 37*(12), 2287–2313.

Jung, K., Eun, J.-H., & Lee, S.-H. (2017). Exploring competing perspectives on government-driven entrepreneurial ecosystems: Lessons from Centres for Creative Economy and Innovation (CCEI) of South Korea. *European Planning Studies, 25*(5), 827–847.

Kenderdine, T. (2017). China’s industrial policy, strategic emerging industries and space law. *Asia & the Pacific Policy Studies, 4*(2), 325–342.

Kenney, M., & Von Burg, U. (1999). Technology, entrepreneurship and path dependence: Industrial clustering in Silicon Valley and Route 128. *Industrial and Corporate Change, 8*(1), 67–103.

Kerr, S. P., Kerr, W., Özden, Ç., & Parsons, C. (2016). Global talent flows. *Journal of Economic Perspectives, 30*(4), 83–106.

Kim, H. M., O’Connor, K. B., & Han, S. S. (2015). The spatial characteristics of global property investment in Seoul: A case study of the office market. *Progress in Planning, 97*, 1–42.

Kraus, S., Richter, C., Papagiannidis, S., & Durst, S. (2015). Innovating and exploiting entrepreneurial opportunities in smart cities: Evidence from Germany. *Creativity and Innovation Management, 24*(4), 601–616.

Krishna, V. V., & Sha, S. P. (2015). Building science community by attracting global talents: The case of Singapore Biopolis. *Science, Technology and Society, 20*(3), 389–413.

Kroll, H., & Schiller, D. (2013). 7 The role of public R&D funding in innovation systems of East Asian and ASEAN catch-up countries. In *Emerging Knowledge Economies in Asia: Current Trends in ASEAN-5* (Vol. 122) (p. 94). New York, NY: Routledge Press.

Kshetri, N. (2014). Developing successful entrepreneurial ecosystems: Lessons from a comparison of an Asian Tiger and a Baltic Tiger. *Baltic Journal of Management, 9*(3), 330–356.

Lee, Y.-S., & Tee, Y.-C. (2009). Reprising the role of the developmental state in cluster development: The biomedical industry in Singapore. *Singapore Journal of Tropical Geography, 30*(1), 86–97. https://doi.org/10.1111/j.1467-9493.2008.00359

Lehmann, E., & Seitz, N. (2016). Creativity and entrepreneurship: Culture, subculture, and new venture creation. SSRN Paper. https://ssrn.com/abstract=2758550.

Leyden, D. P., & Link, A. (2013). *Collective entrepreneurship: The strategic management of Research Triangle Park* (pp. 176–185). Creating Competitiveness: Entrepreneurship and Innovation Policies for Growth.
Low, L. (2001). The Singapore developmental state in the new economy and polity. *The Pacific Review, 14*(3), 411–441.

Luger, J. D. (2017). When the creative class strikes back: State-led creativity and its discontents. *Geoforum*. https://doi.org/10.1016/j.geoforum.2017.04.012

Lyons, D., & Luker, B. (1998). Explaining the contemporary spatial structure of high-technology employment in Texas. *Urban Geography, 19*(5), 431–458.

Mason, C., & Brown, R. (2014). Entrepreneurial ecosystems and growth oriented entrepreneurship. Final Report to OECD, Paris, 1–38.

Meyer, D. R. (2015). The world cities of Hong Kong and Singapore: Network hubs of global finance. *International Journal of Comparative Sociology, 56*(3–4), 198–231.

Mulas, V., Minges, M., & Applebaum, H. (2016). Boosting tech innovation: Ecosystems in cities: A framework for growth and sustainability of urban tech innovation ecosystems. *Innovations, 11*(1–2), 98–125.

Neck, H. M., Meyer, G. D., Cohen, B., & Corbett, A. C. (2004). An entrepreneurial system view of new venture creation. *Journal of Small Business Management, 42*(2), 190–208.

Nylund, P. A., & Cohen, B. (2016). Collision density: Driving growth in urban entrepreneurial ecosystems. *International Entrepreneurship and Management Journal, 1*, 1–20.

Olds, K., & Yeung, H. (2004). Pathways to global city formation: A view from the developmental city-state of Singapore. *Review of International Political Economy, 11*(3), 489–521.

O’Shea, R. P., Fitzgerald, C., Chugh, H., & Allen, T. J. (2014). University-based entrepreneurship: A synthesis of the literature. In *Building technology transfer within research universities: An entrepreneurial approach* (pp. 33–57). Cambridge, UK: Cambridge University Press.

Parayil, G. (2005). From “Silicon Island” to “Biopolis of Asia”: Innovation policy and shifting competitive strategy in Singapore. *California Management Review, 47*(2), 50–73. https://doi.org/10.2307/41166295

Peck, J., Theodore, N., & Brenner, N. (2013). Neoliberal urbanism redux? *International Journal of Urban and Regional Research, 37*(3), 1091–1099.

Peck, J., & Tickell, A. (2002). Neoliberalizing space. *Antipode, 34*(3), 380–404.

Provan, K. G., & Kenis, P. (2008). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory, 18*(2), 229–252.

Ratten, V. (2017). *Entrepreneurship, innovation and smart cities*. London: Routledge.

Reyes, C. N. (2016). Framing the entrepreneurial university: The case of the National University of Singapore. *Journal of Entrepreneurship in Emerging Economies, 8*(2), 134–161.

Richardson, J. (2004). Entrepreneurship and development in Asia. *International Journal of Entrepreneurship and Innovation Management, 4*(5), 469–484.

Saxenian, A. (1996). Inside-out: Regional Networks and Industrial Adaptation in Silicon Valley and Route 128. *Cityscape, 2*(2), 41–60.

Smart Nation Programme Office (2017). Mobility-on-Demand: Real-Time Demand-Driven Transport through Apps. http://www.smartnation.sg/initiatives/Mobility/mobility-on-demand--real-time-demand-driven-transport-through-apps.

Smilor, R. W., Kozmetsky, G., & Gibson, D. (1987). The Austin/San Antonio corridor: The dynamics of a developing technopolis. IC2 Institute Working Papers.

Sohn, D. W., & Kenney, M. (2007). Universities, clusters, and innovation systems: The case of Seoul, Korea. *World Development, 35*(6), 991–1004.

Spigel, B. (2015). The relational organization of entrepreneurial ecosystems. *Entrepreneurship Theory and Practice.*

Spilling, O. (1996). The entrepreneurial system: On entrepreneurship in the context of a mega-event. *Journal of Business Research, 36*(1), 91–103.
Strack, R., Von Der Linden, C., Booker, M., & Strohmayer, A. (2014). Decoding global talent. The Boston Consulting Group and The Network. https://www.bcg.com/en-au/publications/2014/people-organization-human-resources-decoding-global-talent.aspx

SUTD (Singapore University of Technology and Design) (2014). JTC and SUTD launch new research centre to drive industrial infrastructure innovation. Press Release. July 16. https://sutd.edu.sg/About-Us/News-and-Events/Press-Releases/2014/7/JTC-and-SUTD-launch-new-research-centre-to-drive-i.

Tan, K. P. (2008). Meritocracy and elitism in a global city: Ideological shifts in Singapore. *International Political Science Review/Revue Internationale de Science Politique, 29*(1), 7–27.

Teeple, B., Lieu, N., Thomas, A., Vahedi, S., Chen, E., & Gray, E. (2014). Social entrepreneurship in Singapore, India, and Hong Kong. In *Corporate social responsibility and local community in Asia* (pp. 30–63). London: Routledge Press.

Torero, M. (1998). Analyzing the spillover mechanism on the semiconductor industry in the Silicon Valley and Route 128. *Essays on Diffusion of Technical Change*, 6–48.

Urban Redevelopment Authority (2016). Punggol creative cluster and learning corridor. URA Website. July 28. https://www.ura.gov.sg/uol/master-plan/view-master-plan/master-plan-2014/Growth-Area/Punggol-Creative-Cluster/Punggol-Creative-Cluster.

Vu, M. K., & Hartley, K. (2017). Promoting smart cities in developing countries: Policy insights from Vietnam. *Telecommunications Policy*. https://doi.org/10.1016/j.telpol.2017.10.005

Walmsley, T., Aguiar, A., & Ahmed, S. A. (2017). Labour migration and economic growth in East and South-East Asia. *The World Economy*, 40(1), 116–139.

Weiss, J., & Delbecq, A. (1987). High-technology cultures and management Silicon Valley and Route 128. *Group & Organization Management, 12*(1), 39–54.

Whang, R. (2016). Jurong to Be “Industrial Park of the Future.” Straits Times, March 25. http://www.straitstimes.com/business/property/jurong-to-be-industrial-park-of-the-future.

Wong, P. K. (2001). Leveraging multinational corporations, fostering technopreneurship: The changing role of S&T policy in Singapore. *International Journal of Technology Management, 22*(5–6), 539–567. https://doi.org/10.1504/IJTM.2001.002977

Wong, P. K., Ho, Y.-P., & Singh, A. (2010). Industrial cluster development and innovation in Singapore. In *From agglomeration to innovation, edited by Akifumi Kuchiki and Masatsugu Tsuji (JIDE-JETRO Series* (pp. 50–116). UK: Palgrave Macmillan. https://doi.org/10.1057/9780230251014_3

Woo, J. J. (2015). Policy relations and policy subsystems: Financial policy in Hong Kong and Singapore. *International Journal of Public Administration*, 38(8), 553–561.

Woo, J. J. (2016). *Business and politics in Asia’s key financial centres—Hong Kong, Singapore and Shanghai* (1st ed.). Singapore: Springer.

Woo, J. J., & Howlett, M. (2015). Explaining dynamics without change: A critical subsector approach to financial policy making. *Journal of Asian Public Policy, 8*(3), 312–328. https://doi.org/10.1080/17516234.2015.1082689

Wu, F. (2003). The (post-) socialist entrepreneurial city as a state project: Shanghai’s reglobalisation in question. *Urban Studies*, 40(9), 1673–1698.

Wu, F. (2004). Transplanting cityscapes: The use of imagined globalization in housing commodification in Beijing. *Area*, 36(3), 227–234.

Yeung, H. W. C. (2015). Regional development in the global economy: A dynamic perspective of strategic coupling in global production networks. *Regional Science Policy & Practice, 7*(1), 1–23.

Yeung, H. W. C., Poon, J., & Perry, M. (2001). Towards a regional strategy: The role of regional headquarters of foreign firms in Singapore. *Urban Studies*, 38(1), 157–183.

Yifen, Y. (2007). Network governance: A new framework of public administration. *Journal of Public Management, 1*, 89–96.
Yigitcanlar, T., & Sarimin, M. (2015). Multimedia super corridor, Malaysia: Knowledge-based urban development lessons from an emerging economy. *Vine, 45*(1), 126–147.

Yin, R. (1984). *Case study research*. Beverly Hills, CA: Sage Publications.

Yun, J., Cooke, P., & Park, J. (2017). Evolution and variety in complex geographies and enterprise policies. *European Planning Studies, 25*(5), 729–738.

Zheng, J. (2011). “Creative industry clusters” and the “entrepreneurial city” of Shanghai. *Urban Studies, 48*(16), 3561–3582.

**How to cite this article:** Hartley K, Woo JJ, Chung SK. Urban innovation policy in the postdevelopmental era: Lessons from Singapore and Seoul. *Asia Pac Policy Stud.* 2018;5:599–614. [https://doi.org/10.1002/app5.255](https://doi.org/10.1002/app5.255)