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Economic statecraft at the frontier: Korea's drive for intelligent robotics

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ABSTRACT

East Asian countries come most to mind when considering the role of governmental institutions in the contemporary economy. Specifically, it is widely assumed that the openness of economies, the maturation of companies, and their participation in global production chains have created extraordinary pressures that erode opportunities and incentives for government-business collaboration. We test this assumption in the South Korean context, with a focus on the case of robotics. This case is fruitful because it highlights the multiple challenges that face South Korean policymakers. These include the capacity to deliver cutting-edge technologies, to create new industry, to address potential downsides with novel solutions, and to engage the private sector in a relationship of 'governed interdependence'. In examining Korean strategies for grappling with the pressures they face, we seek to illuminate a pattern of state activity that existing concepts fail to capture. By refocusing the concept of geo-economic statecraft to encompass domestically deployed initiatives at the techno frontier, we intend to breach the impasse in the developmental/post developmental state debate and to open up a new research agenda. That agenda should probe the conditions that might motivate states to craft techno-economy building initiatives, and the relationships of governed interdependence which they must forge to achieve them.

KEYWORDS

Technological frontier; developmental state; geoeconomics; economic statecraft; South Korea; robotics

Introduction

For decades, the South Korean state – as one of East Asia's classical developmental states – captured the scholarly imagination for its outstanding ability to lead the industrial transformation of the nation. While other less developed countries often struggled to overcome predatory rulers or deeply entrenched rent-seeking elites, South Korea stood out for its ability to bring the private sector on board with its projects and deliver socially productive outcomes.[1] In this sense, the Korean state

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was the quintessential change agent, scanning the horizon for emerging challenges and mobilizing and coordinating the resources to meet them.[2]

Today, a new understanding has emerged in which the state centered on Seoul is perceived to be overwhelmed and outwitted by pressures originating both at home and abroad. The stresses are by no means trivial. They center on the need to maintain economic growth under heightened competition while dealing with its potentially adverse consequences – not least, increasing inequality and rising environmental damage. In addition to these stresses, the government–business relationships that in the past helped to solve problems of coordination and harness profit-seeking motives in socially productive ways now show signs of maladaptation. Moreover, it is commonly assumed that as large firms mature and globalize they have little need of state resources and are thereby unlikely partners in developmental projects. Following from this logic, one influential view proposes that we have entered an era of the 'post-developmental state' (Yeung, 2016; see also Introduction to this issue).

Yet while the pressures are real, their impacts on the state and its transformative capacities are neither clear nor well established. Existing studies leave little doubt that policymakers remain resolute in their developmental ambitions, including Wong on biotech (2011), Kim and Thurbon (2015), and Kim (2019) on renewable energies, Thurbon (2016) on the developmental mindset more broadly, and Pacheco Pardo and Klingler-Vidra (2019) on venture capital initiatives. While the outcomes in biotech and renewables remain mixed, it is fair to ask whether these are the critical test cases. Many if not most advanced countries have struggled with the biotech challenge, and Korea was starting with no competencies at all in this frontier technology. In the case of renewables, the presence of entrenched domestic opposition from the nuclear industry has deeply complicated industry-building efforts at home. Yet its export-oriented initiatives are proving more fruitful (Kim, 2019; Kim & Mathews, 2016). In light of the particularities of these sectors, it would seem premature to conclude that the state is neither able nor willing to pursue transformative projects for economic and social payoffs – and that economic actors no longer see the gains of collaboration.

A comprehensive treatment of the stresses that confront the Korean state and its coping mechanisms would need to broaden the lens to encompass several policy arenas and industry sectors. This is why we focus on the case of intelligent robotics. We understand intelligent robotics as a subfield of artificial intelligence (AI), one that brings together AI, information technology, and mechanical engineering.[3] As a product, a process, or a system that can be deployed across the entire economy, producing broad spill-over effects, it is also a general purpose technology[4] with key applications in industrial, personal, and professional service spheres.[5] With this transformative effect in mind, intelligent robotics was one of the Korean government's nine 'new growth-engine' initiatives introduced in 2003.

Intelligent robotics (hereafter 'robotics') is of interest to us for at least three reasons that touch directly on several influential claims that we wish to evaluate. First, as a frontier technology, it allows us to appraise the influential idea that as East Asian states approach the technology frontier, they succumb to multiple political and economic pressures, retreat from their earlier leadership role, and opt for a more hands-off approach. The underlying assumption is that promotion of frontier technologies is fraught with uncertainty and failure, which puts it beyond the

state's capacity or willingness to be involved (Wong, 2011). Robotics is one of several *frontier technologies* that Korea is currently promoting, and it has done so continuously since 2003. Indeed Korean strategizing over robotics has now encompassed four administrations – from President Roh Moo-hyun to Lee Myung-bak, Park Gyun-hye and now Moon Jae-in.

Second, since Korea's robotics policies are aimed at Korean companies, both large and small, they allow us to examine the changing dynamics of government-business relations in the Korean setting. Here we evaluate the widely accepted view that as Korea's chaebol have globalized and grown economically powerful, they have become unlikely collaborators and least willing partners in the state's developmental projects. Indeed as the Introduction to this Special Issue suggests, the chaebol have become 'strategically disembedded from their home states'. There is a strong kernel of truth to this idea, as we show below. However, it is limited in so far as it assumes that 'powerful chaebol' have nothing to gain from collaboration with the state.

Our analysis reveals a different, more subtle dynamic at work. As we show, at the outset the chaebol were reluctant to collaborate with government's intelligent robotics project. So in its first incarnation of the strategy, government turned to non-chaebol firms; but as competitive pressures intensified over time, it changed the chaebol's strategic calculations, bringing them into alignment with the ambitions of government. Since then, we find the emergence of new modes of government–business collaboration that are also evident in other high-tech arenas (e.g. on smart micro-grids, see Kim, 2019).

Third, insofar as robotics promotion is explicitly bound up with concerns over technological autonomy and competitiveness, a study of this case allows us to probe the strategic considerations that inform persistent efforts at the technology frontier. To the extent that these strategic considerations are geo-economic in nature (often difficult to disentangle from geopolitics), we find it fruitful to conceptualize Korean actions at the techno frontier as a variety of economic statecraft. In this respect, we seek to extend the concept to encompass a range of domestic economy-building initiatives that respond to external pressures.

Marketcraft versus statecraft at the frontier?

To highlight the shared limitations of each perspective, we begin by revisiting both the prevailing view of the state's role in advanced industrial settings, and the mainstream understanding of economic statecraft. This allows us to pinpoint their shortcomings and advance our own argument. Our case study develops that argument in detail.

It has become a commonplace view that only in developing countries can industry benefit from some form of state guidance. When countries become more integrated (Majone, 1994, 1997) or graduate to industrial maturity, the state ostensibly becomes both less able and less willing to provide directional thrust. The literature on East Asia is exemplary in this regard, positing a grand shift that leads from developmental state to the post-developmental cum-regulatory state (see Jayasuriya, 2005; Hsueh, 2011; Painter, Mok, & Ramesh, 2019; Yeung, 2016). Observing this shift in the literature, David Levi-Faur (2013, p. 239) writes:

> The age of the rise of the regulatory state, so the argument goes, is therefore the age of the decline of the positive-developmental state. The rise of the first and the decline of the second, it is now widely held, are in turn causally associated with the rise of neoliberalism and the belief in the superiority of markets as mechanisms for maximising the public good.

A variant of this understanding has the technology frontier in view. As economies approach or reach the leading edge of technology, governing the market becomes too complex and states are soon compelled to take a back seat on matters of industrial transformation. Early iterations of this argument focused on the electronics sector. Scott Callon (1995), writing about Japan in the mid-nineties, advanced the claim that it was the rapid pace of technological change that rendered long-term planning increasingly futile, and the capacities of agencies like MITI increasingly ineffective. In a more recent rendition, it is South Korea's efforts in biotech that have elicited a similar conclusion: innovation at the frontier frustrates strategic endeavors and dooms the state to failure and retreat (Wong, 2011). In each case, the uncertainty associated with high-tech development takes different forms, depending on the nature of the sector. In electronics, for example, the uncertainty might center on which new technologies (and standards) will prevail. In biotech, it is more a case of which research projects are most likely to bear fruit, as the costs of backing the wrong horse can rebound on the confidence and ambitions of policymakers and, not least, the goodwill of the electorate.[6]

Uncertainty does not, however, diminish the state's economic importance. In the most recent understanding the state simply shifts gear to focus on regulation. Creating and refining a regulatory architecture for existing markets becomes the major activity, for which Vogel (2018) coins the term 'marketcraft'. In revisiting the well-understood idea that markets require rules, Vogel's target is the liberal view of market reform that casts it as a destructive exercise of de-regulation rather than a constructive enterprise of carefully crafted re-regulation. His important critique of the market-liberal perspective is that it 'underestimates the scale and scope of regulation necessary to make modern markets work…' (2018, p. 5). In Vogel's account, effective economic governance demands *marketcraft,* defined in purely *regulatory* terms.

But how do we conceptualize a pattern of economic governance that is *not* purely regulatory – indeed, one that is aimed at shaping the industrial structure? We know that in the case of Korea there is far more than marketcraft occurring. The problem is that our classical conceptual tool – the development state – is now so fiercely disputed that it threatens debate derailment, rather than enjoining more productive enquiry.

Notwithstanding a rich literature on the evolution of the Asian DS,[7] the prevailing view is that activities of the classical DS are confined to the catch-up phase of development when ostensibly business is 'weak' and the state is 'strong'. Beyond that phase, it is alleged that the region has entered a 'post-developmental state' era (see the introduction to this volume). By contrast – and ironically – as discussed below, the misapplication of the DS concept to countries outside the region has further muddled understanding of the state's role in diverse settings (on its misapplication to the United States, see especially Weiss, 2014).

To circumvent this impasse, we propose a fresh way of thinking about the state's economic activities in advanced industrial settings. Our approach captures the

strategic pattern of behavior that we observe in South Korea and fills the void created by both concepts of 'post-developmental state' and 'marketcraft'.

This brings us to the idea of statecraft, which we repurpose for our analytical objectives. Our starting point is Vogel's pairing of marketcraft with economic statecraft as core functions of government. But neither Vogel's brief discussion of the latter nor the economic statecraft literature itself is able to accommodate the kinds of activities in which the Korean state (and possibly others) is currently involved, a point we return to shortly. The existing statecraft literature is overwhelmingly focused on *foreign* economic policy tools such as trade, investment and financial sanctions aimed at advancing *offensive geopolitical* objectives (e.g. Andrews, 2006; Baldwin, 1985; Cohen, 2018; Drezner, 1999, 2015).[8] The Korean case, however, aligns with neither image. Here we find *domestic* policy tools being deployed for primarily *geoeconomic* purposes.

For these reasons, we argue that neither marketcraft nor statecraft (as currently understood) offer an adequate framework for conceptualizing Korea's domestic economy building initiatives. By positing marketcraft and (outwardly oriented) economic statecraft, as the state's only arenas of economic activity, Vogel's classification throws open a space in which certain *non*-regulatory, domestically focused state activities are currently invisible.

This brings us to our argument. While we can easily agree with the notion that markets require rules to function effectively, we contend that it takes more than regulation, however well designed, to ensure that in a world of competing nation states, a developed economy can at least maintain, if not increase, its standard of living. In this context, it is well established that technological innovation is key to growth, productivity, and wealth creation. If these are the desirable goals, then it takes little effort to recognize that even for the most developed economies, there can be no standing still. Climbing the technology ladder is a *never-ending* process, one that involves more than regulatory input from the state. This statement, which seems obvious from the historical record, is nonetheless far from widely understood or acknowledged. More typical, as we have seen, is the assumption that as a country achieves advanced industrial status, the state's role switches from market development to market reform (so-called 'marketcraft'). Twinned with this notion is the thesis that we now inhabit a world of post-developmental and/or 'regulatory states'.

The argument

This brings us to the four main strands in our argument. First, in the classical sense, 'development' is a never-ending process. In this process, it is more fruitful to see the state taking on different tasks, rather than assuming a hands-off (or exclusively regulatory) approach.

Second, at the technological frontier where risk (which is calculable) shades into uncertainty (which is not), the state's supportive (and sometimes catalytic) role becomes more, not less important. At the high-tech frontier, as we will see, economic governance includes fostering technological breakthroughs with patient capital, supporting, and expanding firm capabilities through network coordination, as well as helping to grow new markets through public procurement. All this involves a good deal more than implied by the concept of marketcraft. In prioritizing

rulemaking, Vogel's marketcraft toolbox excludes what it takes to create and sustain markets at the frontier of technology. Most tellingly, it falls short because it completely misconstrues how the United States (one of his two key cases) has come to dominate high-technology markets.

To elaborate, Vogel overlooks the vital statecraft (much more than marketcraft) that went into the making of Silicon Valley's first modern venture capital industry (Lerner, 1999; Weiss, 2014, Ch.3). Moreover, his rendering of the rise of Silicon Valley itself draws on the Hall and Soskice idea of market-led initiative as the source of radical innovation. His only corrective to this story is to emphasize the critical *regulatory* role of government. This marketcraft was indeed important and should not be downplayed. Yet it is very far from the whole story, which when properly told reveals the massive (though often overlooked) use of economic statecraft that lay behind Silicon Valley's rise. (We return below to a discussion of economic statecraft.) It is no surprise, then, that all foreign efforts to replicate the US phenomenon, by way of crafting a regulatory architecture, have fallen on stony ground.[9] Indeed, when we examine how since 1945, the United States has become a high-tech hegemon, we find that the federal government has been massively involved in economic statecraft – devising, investing in, co-developing, and procuring breakthrough technologies for *security*-driven imperatives (Weiss, 2014, pp.8-9ff).

This links directly to the third strand of our argument. The task of growing and creating markets at the technology frontier sits uneasily between the 'marketcraft' view of regulation and the geopolitically oriented 'statecraft' view of foreign economic policy. 'Economic statecraft' is used largely in discussions of international economic conflicts involving tariffs, sanctions, and protection of economic security. Existing accounts invariably portray the tools of economic statecraft as only outward oriented – typically deploying trade, aid, foreign investment, and currency-related instruments.[10] Added to this portfolio is the ability of political leaders to act through state-connected enterprises in foreign jurisdictions. William Norris's study of Chinese economic statecraft is exemplary of this approach, defining (China's) economic statecraft as 'state manipulation of *international* economic activities for strategic purposes … [requiring the ability] to control the behaviour of commercial actors that conduct the vast majority of *international* economic activity'. (Norris, 2016, p. 3, emphasis added).

Moreover, it is almost always a large country that is seen to be exercising statecraft, rewarding or penalizing those it seeks to influence.[11] This large-country/foreign-policy focus has led to a general neglect of the ways in which both geopolitical and geo-economic goals can shape *domestic* economic policy (and institutional) settings, notably in the high-technology arena. This neglect is curious for two quite different reasons. First, we have the exemplary case of the United States. In the US experience during the Cold War, a significant part of America's economic statecraft was focused *domestically* on creating superior technological (and institutional) capabilities that would ensure its military primacy.[12] In this case the goals were indeed preponderantly geopolitical, the means nationally based. In other cases, however, the goals of state action may be primarily geo-economic – as when a country mobilizes national resources in a bid to fend off economic rivals and defend its position in export markets. Post-World War II Japan is the classical case

of a country that has traded in its geopolitical ambitions for security through intensive economic development (see Katzenstein, 1996).

To capture this experience – completely obscured by existing concepts – we develop an argument that builds on and broadens the existing understanding of economic statecraft in two main ways. First, we contend that the *tools* of economic statecraft are not exclusively internationally focused (even if in some cases, such as the United States, they may have power-projection objectives). Second, we observe that the drivers of state action are not exclusively geopolitical. In a world of competitive states, geo-economic concerns can become important catalysts of domestically-oriented economic state activity, even in the absence of overwhelming strategic security priorities. The United States and South Korea, each in its own way, provide instructive illustrations of these differences. The United States engages in economic statecraft not only abroad, but especially at home to project power (Weiss, 2014). By contrast, Korea practises economic statecraft for geoeconomic reasons that do not necessarily feed into geopolitical goals (this paper).

We, thus, arrive at our fourth and final proposition: a government may exercise economic statecraft in its own territorial domain primarily for geoeconomic objectives – designed to defend its international position by bolstering its domestic economic strength. In this case, its decision-makers will turn to policy tools that involve domestic economy/technology-building initiatives.

In view of the existing conceptual vacuum highlighted earlier, we propose to draw on the concept of economic statecraft to incorporate the making and growing of markets at the techno-industrial frontier for geoeconomic objectives. We, thus, extend the concept of economic statecraft to embrace government initiatives that reach for or seek to push the technology frontier to fend off, outflank, or move in step with rival economic powers. This refocus on *domestic* policy tools is not such a stretch because we already have ample evidence of a world power – the United States – which has exercised extraordinary economic statecraft at home, albeit in response to geopolitical pressures. It is now well established that in pursuit of its strategic objectives, the US poured massive resources into high-risk initiatives, building a 'national innovation engine' that could secure its ability to project superior military power by dominating the technology space (see Weiss, 2014). In the Korean context, examined next, we see a considerably smaller, but nonetheless technologically focused effort, in this case designed to defend against economic encroachment by international rivals.

Statecraft versus industrial policy

It is important to clarify how the statecraft we observe in Korea differs from 'industrial policy' per se. 'Statecraft' implies an acute awareness of the geo-economic challenges facing the nation and a set of strategic actions designed to meet those challenges head on. Economic statecraft is thus trained on a clearly identified set of foreign economic rivals and involves the setting (and monitoring) of concrete targets for improving the techno-industrial and export competitiveness of local firms *vis-a-vis* its rivals. In the developmental state literature, such activities are often labeled 'strategic industrial policy'. But 'industrial policy' (strategic or otherwise) does little to convey the geo-economic imperatives that may drive these activities. This becomes particularly problematic when we consider that almost all

Table 1. Differentiating marketcraft, industry policy, and economic statecraft.

Marketcraft	Industry policy	Economic statecraft
Setting the rules for market governance (e.g. protection of IPRs; financial regulation; governance of the digital economy)	Any kind of state support aimed at economic activity, regardless of objectives, drivers, or motivation (e.g. job creation, company bailouts, tariff protection, tax incentives, etc.)	Strategic initiatives for industrial development which are motivated by an external impetus and focused on the domestic arena - Where the external driver is geoeconomic in nature (competitive threat perception), we use the term economic statecraft - We thereby differentiate economic statecraft (as in South Korea) from its geopolitically motivated counterpart (as in the US) where national security objectives – rather than commercial ones – are paramount

Source: Authors' own.

countries are now said to practise 'industrial policy' in some form or another. This is because the term 'industrial policy' has become an umbrella term for almost every kind of support delivered by the state to economic actors – and without regard to the drivers or ambitions that underpin it.[13] This blanket usage obscures qualitative differences in the objectives and approaches of state actors.

Beyond Korea (and its Northeast Asian neighbors), for example, what passes for 'industrial policy' is often domestically rather than externally driven. That is, governments are motivated to support particular industries to protect jobs or to advance other domestic political–economic objectives such as regional re-balancing and electoral gains. And where it has an external referent, 'industrial policy' is often framed as a response to diffuse challenges such as 'globalization' or 'climate change' or designed to emulate lead-nation policies. In these contexts and in contrast to Korea, 'industrial policy' is most certainly *not* aimed at countering the challenge posed by a clearly identified foreign economic rival, or at building the capabilities of local firms that might outcompete such a rival. Rather, while such initiatives may seek to support certain industries within the national territory, they typically do so without serious regard to the participation or relative competitiveness of *local firms* within those industries (Table 1).

We are not claiming that statecraft is unique to Korea. Indeed, we believe that it applies more broadly. There is, for instance, a rich literature on the role of government in high-technology in response to international competition (see e.g. Busch, 1999; Ostry & Nelson, 1994; NRC, 1995; Zachary Taylor, 2016; Scherer, 1992). However, whether such cases qualify as statecraft or industrial policy remains an issue for empirical analysis. Our contribution is to provide a language through which to capture and differentiate such activities. The payoff is to fill the void created by the marketcraft idea of governance and to breach the impasse in the developmental state/post-developmental state debate.

We now turn to the case of intelligent robotics, first discussing the geoeconomic drivers behind the pursuit of this frontier technology, then outlining the main

features of statecraft in action. Among the most important features, we find the strategic positioning of Korea in the global technology race; understanding and maneuvering around the obstacles to be overcome; and turning threats into opportunities when China's new strategy nudges the chaebol toward partnership with the government. Importantly, as we shall see, Korea's economic statecraft entails innovation in both institutions and policies.

Geoeconomic drivers

Korea's embrace of robotics (among several other 'growth engine' initiatives) can be directly traced to the emergence of a new threat perception in the early 2000s. At that time, the pervasive view took hold that Korea was facing a stark new threat to its national economic security. This was swiftly labeled 'the sandwich effect' in business, political and media circles. In this view, Korea's manufacturing sector – the backbone of its economy and symbol of national advancement and pride – was being squeezed between an increasingly technologically competitive China and a technologically superior and highly cost-competitive Japan. Evidence of the effect was Korea's deteriorating terms of trade, driven by the loss of technology-intensive export markets to Chinese firms and a widening trade deficit in advanced technology products with Japan.[14] As the 2003 Presidential election loomed, the so-called sandwich effect was routinely raised in national media debates and widely depicted by business and political leaders and academic and media commentators as a serious threat to the nation. In the words of one striking editorial, which appeared in a national daily:

> Korea is vanishing, sandwiched between two economic juggernauts – technology-armed Japan and huge-market-potential China. If we do not wake up quickly … Koreans will fade away in history just like many of those minorities that dwelled on the periphery of China. ('Wake up call from China rings Aloud', *Korea Times*. 10 September 2001)

For many Koreans, the growing economic squeeze between China and Japan was reminiscent of the geopolitical encroachment suffered by Korea over many centuries. As voters prepared for the polls in 2003, the media and think tanks earnestly warned that Korea had only a narrow window of opportunity to fend off the China threat and achieve its long-held ambition of catching-up with Japan. The so-called sandwich effect had an impact on newly elected Roh Moo-hyun, who assumed the Presidency in February 2003. As one of the most technologically literate leaders, Roh clearly recognized the seriousness of the challenges and in his inauguration speech emphasized the need to respond with a new national development strategy centered on future growth engines:

> The international economic situation is also deteriorating. Developed nations are continuously exploring new frontiers and new markets while developing countries are rapidly closing the gap. Our nation, therefore, is in urgent need of a new economic growth engine and viable development strategies.[15]

Within just two days of coming to power, Roh reached out to his advisors to ask who would best be placed to develop a strategy that would thrust Korea into the ranks of advanced nations. Their answer was Chin Daeje. At that time, Chin was President of Samsung Electronics. Chin's earlier public statements about the sandwich threat had brought him to the attention of the President. Two days after his inauguration, Roh personally telephoned Chin to ask him to join his

government as Minister of the newly created Ministry of Information and Communication (MIC). Upon his immediate acceptance and resignation from Samsung, Chin began work on a strategy that would address the squeeze. That strategy was the so-called IT-839 initiative, which he described as a 'project for national development' (Chin, 2004, p. 1). The new Minister's preface to that initiative reflects his perception of the competitive threats facing the nation, and the need for Korea to become a technological leader to survive:

> … we cannot afford to be complacent with the past achievement of the Korean IT industry, since today's winner-takes-all society allows only a company or a country with world's best technologies to survive the fierce competition across international borders … (Chin, 2004, p. 1).

To meet that challenge and become a global leader, the MIC's new Minister insisted that Korea take 'a road untraveled by its competitors'. The IT-839 initiative, as executed, promoted the development of eight new services (including wireless broadband) and three new networks (including a broadband convergence network). Together, these provided the platforms to support nine 'New Growth Engine' (NGE) industries – the most significant of which for our purposes is intelligent service robots.

In this story, institutional rivalry played an important role. Although typically viewed as dysfunctional for state capacity, competition between state agencies can also be productive (see e.g. Kim, 2019). In the case of intelligent robotics, MIC's role in leading industry development was by no means a *fait accompli*. Institutional rivalry raised its head in the form of MOCIE which pre-existed MIC and already had a conventional robotics program. In an enlightened move, President Roh asked both ministries to prepare and pitch their respective visions for developing new growth industries, including intelligent robots, in Korea. At the conclusion of their pitch, President Roh raised the hand of the victorious MIC minister.[16] This escalated institutional rivalry and deepened each ministry's commitment to winning, which ultimately bore fruit for Korea, as we shall see.

Korea's decision to enter the intelligent service robot industry in the early 2000s was ambitious to say the least. Korea had very limited technological capability in this arena and lagged seriously behind pioneers Japan and the United States. Nevertheless, in typical Korean style, MIC's Minister declared aggressive national goals from the outset, including thrusting Korea into the ranks of the world's leading robot producing nations in record time: '(W)e are jockeying to become one of (sic) global top three robot producers by 2010. In 2020, every Korean household will have a robot'.[17] As an ambitious vision of Korea's future, pursuit of the goal demanded more than marketcraft (*aka* regulation); indeed it required a degree of strategizing that sets it apart and demands a concept that enhances our understanding of state action. We turn to this task next.

Economic statecraft in action

As we have proposed, Korea's robot strategy is an exemplary case of what we call domestically-oriented economic statecraft. To reiterate, domestically-oriented economic statecraft involves initiatives to make and grow markets at the techno-industrial frontier to fend off, outflank, or move in step with rival economic powers. So

while its external impetus is geoeconomic, its policy focus is domestic and its primary impulse is at least initially defensive.

Strategic positioning

Having decided on a plan to pursue a high-tech strategy at the frontier, the challenge lay in carving out a path as a latecomer. Strategists in the MIC understood that the path chosen would have to leverage existing competencies and avoid direct competition with existing players. The robotics promotion team at MIC thus came up with a novel strategy that would build on Korea's world-class strengths in ICT and broadband infrastructure.[18] Where the United States and Japan focused on industrial robots, Korea would concentrate on a different kind of intelligent robot: the *service* robot which encompassed both professional and personal services.[19] This market was immature but expected to grow rapidly, especially with an aging population. As the Team Leader of the MIC's Robot Division, Oh Sang-Rok, explained:

> The market size of industrial robots is almost saturated worldwide … but the market of service robots [in education, entertainment, home security and household chores] is only now opening … Social and economic needs for intelligent service robots to support people's daily lives are increasing with the advance of an aging society.[20]

A focus on intelligent service robotics would demand an emphasis on the development of humanoid robots, a technology arena long dominated by Japan. Japan had a lead of almost 30 years on Korea, whose researchers only began their humanoid research projects in the early 2000s. As a result, Korea was far less advanced than its Japanese counterparts, especially in the mechanics arena (such as bi-pedal automation, required for walking). Oh and his team were convinced that if Korea were to swiftly enter and dominate the service robots market, they would need to take a different route. Japan produced robots that combined all three functions (sensing, processing, and action) in one unit. This made Japan's humanoid robots very expensive. Under the Korean plan, firms would focus initially on developing robots that were comparatively simple on the mechanical front (for example, relying on wheels to move instead of bipedal motion). 'Intelligence' would then be delivered to these robots via high-speed Internet pipeline, rather than being incorporated into each individual machine.

State strategists anticipated that this finely tuned approach would enable Korea to rapidly drive down the cost of service robots, dramatically increasing demand and enabling rapid market penetration. Program manager Oh explained the strategy, thus:

> Think of downloading a variety of software to your computer via high-speed Internet network … Like that, you will be able to download sensing and processing powers from the network, which will reduce the price of robots … In the early stages, we will use wheeled models in light of its higher commercial viability. But in the long run, we will be likely to adopt more and more bi-pedal models.[21]

By this reasoning, in spite of lagging behind by several years in core robotics technologies, program leaders envisaged that Korea could overcome this hurdle and 'lead the service-robot market'.... if it 'could show some killer applications with favorable business models'.[22]

Maneuvering around the obstacles

It was of course one thing to conceive this strategy, and quite another to execute it. Statecraft is also evident in the way states cope with the constraints they encounter. As we shall show, Korean decision makers faced several obstacles to the implementation of their vision. Each of these demanded a creative response, beginning with the need to build new relationships with the private sector.

Enlisting willing private partners

The first challenge was to find private firms willing to jump into the fledgling field of intelligent service robotics. After all, as a frontier technology, this was an arena where uncertainty abounded: no real market demand currently existed and payoffs were far from guaranteed. Initially, MIC strategists entertained the hope that large companies like Samsung would lead the charge. Yet despite direct appeals from government officials to make large investments, the chaebol remained reluctant (see Thurbon, 2016, p. 105). Indeed, wounded by the Asian financial crisis, the chaebol were playing it safe with their tried and tested fast-follower strategy. To the extent that they were investing, they were doing so by offshoring production, chiefly to China, as the WTO's new entrant.

In light of chaebol reluctance to take the frontier route, it was left to the robotics program manager and his team to envision an alternative route to growing the market. In the first instance, this involved the government bypassing the chaebol and working with smaller (non-chaebol) firms. This approach leant heavily on the development of collaborative arrangements between government and business, which has been fruitfully described as a form of 'governed interdependence' (Weiss, 1995).

As an approach well developed in the Korean setting (albeit between government and chaebol), governed interdependence can be seen wherever '… a government body works with or through private actors and entities to achieve its own objectives, but at the same time maintains control over the goals to be pursued and the rules of participation' (Weiss, 2014, p. 15, 200–201). More specifically, GI draws attention to a relationship that involves the state in considerable collaboration, negotiation and partnering with private actors for mutual benefit, but which is ultimately governed by public objectives. Building relationships with the private sector is as intrinsic to the institution of GI as is the deployment of disciplinary mechanisms to direct these relationships towards desired outcomes. Such mechanisms are not simply 'sticks' but also 'carrots'. These may take the form of cost-sharing (giving business skin in the game) or time-limited incentives tied to performance outcomes.

As should be evident, the concept of GI differs significantly from that of 'embedded autonomy' (Evans, 1995). Reminiscent of Marx's 'grave-digger' thesis, embedded autonomy has a use-by date built into it: state success achieved via its embeddedness in society creates a powerful business sector, which ultimately sidelines the state's own role and diminishes its capacity for economic governance. By contrast, GI has no such timeline because the relationship it represents depends to some extent on an international environment that is dynamic and evolving. This was certainly the case in the East Asian setting. By contrast, the embedded autonomy argument invokes a closed system in which the state's role centers on

nurturing new or immature market players and helping them grow to maturity, after which its role is done. That may indeed be the limit of a state's role in a relatively static or closed environment. The reality, however, is a globalized economy that produces relentless pressures to upgrade firms in existing industries and to bring on new players in emerging sectors. It is within these pressures that we find the 'enabling' dynamic of globalization where state support of various kinds continues to be sought, if not always delivered (Weiss, 2003). In this dynamic world, we contend that governed interdependence offers a more fruitful entry point to the question of how and under what conditions governments can continue to be effective in an open-economy environment – *if they so choose*. Indeed, we propose that GI is fundamental to the effective execution of economic statecraft, and that GI evolves over time. In the Korean setting, that evolution has drawn SMEs into the state's strategic orbit, and ultimately involved a network of firms small and large.

In making its choice to join the frontier race, and in forging new relationships, the Korean state attracted new players in the business sector by creating the market in a four-step process.

First, it established and funded consortia with local firms and publicly-funded research institutes. The consortia were challenged to develop robot prototypes across a range of potential service applications, especially government services. Second, the government established test-beds to trial these technologies in public bodies, including schools, post offices, the police force, and the military. Third, once a product had been tested and proven viable in the public market, the government helped to find new public and private markets at home and abroad. Finally, while waiting for the markets to emerge, the government helped these fledgling firms access finance to keep them afloat (Thurbon, 2016, p. 107). The added benefit of this approach was that it complied with new WTO constraints. As a WTO member, the government was limited in the extent to which it could subsidize firms in existing industries. But activities related to the co-creation and commercialization of new technologies through government procurement was all within WTO guidelines (Weiss, 2005).

As companies joined forces with the MIC, the robot division launched a series of pilot projects between 2005 and 2006, across the education, security and medical rehabilitation spheres. In 2006, for example, the government invested $33.9 million to catalyze the development and deployment of police and military robots, based on the networked robot model explained above. As the robot program manager explained:

> The robots will be directed by a remote-control system or move autonomously via their own artificial intelligence systems … The two sophisticated robots will be empowered by the country's state-of-the-art mobile network, thus enabling mass production at an affordable price.[23]

The MIC also began to deploy robots in test-beds in post offices and private homes, with a view to competing with world-leader Japan in a short period of time on the home services front. As the then Director General of MIC, Hyung Tae-gun, commented: 'Recently Japan unveiled household service robots priced at up to 10 million won, almost 10 times as expensive as ours. So you can guess the competitiveness of our network robots.'[24]

By 2006, there were 1000 researchers and over 30 companies working on the test-bed scheme. Nevertheless, despite these efforts, as President Roh's tenure

progressed, Korea continued to lose market share in high-tech industries to China and Japan, intensifying the threat perception among the business and policy elite.

Managing the politics and institutionalizing the commitment

Into this intensifying geoeconomic environment, a new domestic pressure loomed on the horizon: the 2008 Presidential election. As the robotics strategists in both ministries knew from earlier experience, competitive politics could disrupt the continuity of their initiatives. Whatever the outcome of the election, they wanted to ensure that the emphasis on intelligent robotics would remain. One way to get around the change of administration was to enshrine in law those initiatives deemed too important to expose to the whims of electoral fortunes. Thus, emerged the MOCIE plan for the Robot Act. In proposing the Act, MOCIE also saw an opportunity to seize the leader's mantle and present themselves to the incoming President as the best team for the job.

Controversially, the proposed Act subsumed the rival MIC's most innovative initiatives (such as the test-bed initiative), putting them under MOCIE's control. Not surprisingly, MIC vigorously opposed the introduction of the Act in that form. The conflict was only resolved when the President elect, during the transition period, announced the design of his new bureaucratic structure. In the new architecture, the MIC was dissolved by the President's new advisor – a former MOCIE official – leaving MOCIE (renamed MOTIE) to lead the robotics strategy. While MIC officials were absorbed into the newly created Ministry of Knowledge Economy, MIC's programs would live on, forming the centerpiece of the first Master Plan for Robotics Industry Development developed by MOTIE under the Act (discussed below). The Act was passed just days before the inauguration of the new President. As remarked in the press: 'The passage laid the foundation for the intelligent robot industry to maintain the growth even in the new government'.[25]

By enshrining its promotion in law, the Robot Act was a turning point in the industry's development. In particular, Article 5 requires the Government to provide a Master Plan for robotics industry development every 5 years. This requirement has provided an important safeguard against distraction on the part of policy-makers, especially with the eruption of the GFC, which hit Korea almost as soon as President Lee Myung-bak came to power in 2008. Despite the swirling crisis, the government was compelled to forge ahead with its responsibilities under the Act, releasing on schedule in 2009 its first Master Plan for Robotics Industry Development. As we shall see, the Act provided the institutional foundations required for the robust growth of the Korean robotics industry.

The Intelligent Robots Development and Distribution Promotion Act of 28 March 2008 outlined a comprehensive range of measures that would institutionalize the government's long-term commitment to robotics industry development.[26] As well as the mandatory 5-year Master Plans under Article 5, the 2008 Act required governments at all levels to allocate part of their budget to the development and distribution of intelligent robots (Article 3). Perhaps the most significant institutional innovation was the creation of an entity (KIRIA, discussed below) that would be solely responsible for promoting the industry in addition to facilitating inter-ministerial cooperation and overseeing the regulatory framework required to support the industry's development.[27]

Korea's first Master Plan was released in 2009. It preserved earlier initiatives to promote service robotics, and set ambitious targets for technological upgrading, export expansion, and firm growth. The Plan's primary objective was to close the technological gap with Japan (and the United States) through 'infrastructure building' initiatives and market creation programs. In practical terms, this meant creating the institution mandated by the Act, known as the Korea Institute for Robot Industry Advancement (KIRIA). Where MOCIE would devise the policies, KIRIA would be responsible for coordination and implementation. Planning for the organization's establishment was completed in 2010, and KIRIA officially opened its doors in 2011. Its significance lay in facilitating a coordinated and streamlined approach to industry promotion, establishing clear lines of responsibility and thereby reducing the likelihood of inter-agency conflict. KIRIA was also granted a substantial annual budget to fulfill its role.[28] Underlining the government's seriousness of purpose, KIRIA was also tasked with the collection of industry statistics, which had been mandated under the Act (Article 7). Data collection would, thus, form an important part of the government's ability to monitor progress towards its goals. Since 2011, KIRIA has been releasing its annual analysis of the industry's development entitled *Research on the Actual Condition of the Robot Industry* (ACRI).[29]

This institutional innovation was matched by significant policy evolution in the form of the Pilot Programs for Market Creation initiative of 2011; this initiative involved an expansion of the MIC's test-bed program discussed above.[30] Some US$90 million was allocated to a 2-year pan-governmental pilot program, in which ten ministries committed to work with private firms to develop and utilize robots in areas from firefighting to medical care. Government also undertook to help collaborating firms find overseas markets for verified technologies. In devising this strategic approach to export market development, government was keenly aware that demand for certain kinds of services was likely to vary between economies. As one Ministry of Knowledge Economy official explained:

> The robotics market will shift its focus from today's mass-production models to service models down the road. We must strive to pre-empt the trend … with tailor-made strategies in tapping into the international market.[31]

In a deftly targeted, clearly diversified marketing strategy, Korea would thereby seek to export to the advanced markets (EU and US) service robots for the aged and for surgical procedures. African markets by contrast would supply demand for surveillance robots, whereas Asian buyers would be most attracted to robots for education and household chores. This program has continued to run since its 2011 inception, providing support for both government-led and private sector-driven projects.[32]

In arriving at a positive evaluation of this initiative (and of the effect of the Robot Act more broadly) in 2016, Korean analysts drew attention to a number of positive outcomes. These include the successful commercialization of government-supported technologies, produced in collaboration with emergent high-tech champions working at the cutting edge (Cho et al., 2016). Some graduates of the program include P&S Mechanics' walk rehabilitation robot ('walkbot'), developed with the Korea Institute of Science and Technology (KIST, 2016), as well as Future Robot, Robotis, and ISAN Solution – all of which have managed to leverage the program for export opportunities.

Seizing victory from the jaws of defeat?

Effective as the government's smaller firm strategies had been, its efforts to entice the chaebol into partnership initially failed to bear fruit. As Korea entered the second decade of the new century, however, new pressures from the international arena that threatened their competitiveness would begin to nudge the chaebol towards a more collaborative relationship with state actors. Most significant have been rising labor costs in China and not least, China's new strategic focus on high-technology, notably intelligent robotics.

China's decision to start aggressively promoting its own robot industry in 2011 was a particularly decisive nudge factor.[33] Seeing the writing on the wall, the chaebol faced a strategic choice: either take the low road by chasing cheap labor all the way to India (as some non-Korean companies were doing), or else choose the high road, by bringing some production back home and investing in intelligent industrial robot technologies that it could both deploy in its own manufacturing operations and develop as an export industry.

The high road choice opened the door to a rekindled government-business partnership to advance the high-tech frontier. Here we find market shifts triggering lead economic actors to recognize the benefits that collaboration with government could deliver. The newly formed partnership began with the ambition to develop so-called 'cobots'. Unlike their traditional industrial counterparts, cobots are designed to operate alongside, and interact with, human workers. They are also smaller, safer and less expensive than traditional industrial robots. Creating and deploying Korean-made cobots would both enhance the competitiveness of Korean manufacturers through lower production costs, and give a big boost to the capabilities of domestic producers who would develop and sell the cobots.

By choosing the high road however, Korea has had to deal with its technologically much weaker suppliers of parts and components, mainly smaller firms. With these constraints in mind, Korea's policy approach also included a major emphasis on the localization of robotic parts and components. This was the focus of Korea's second Robot Master Plan, issued in 2014.[34] However, no sooner had the Korean Master plan been issued than China and Japan released their own aggressive national development plans for robots, further intensifying the innovation race among the 'three kingpins' of the region. As the business press announced at the time, the fact that China, Japan and Korea were simultaneously launching 'massive government programs for robot-driven automation' was 'wholly without precedent anywhere in the world'.[35] Moreover, the competition between them was more than just economic. As one commentator observed, 'In a place where losing face is tantamount to becoming a non-person, each of these Asian behemoths is putting billions of dollars and its national prestige behind these programs'.[36] Not surprisingly, the announcement of the Chinese and Japanese programs amplified the competitive pressures and sparked a flurry of further policy activity on the part of Korean policymakers, who set about crafting a new suite of industry development initiatives – this time in close collaboration with the chaebol (Table 2).

The Smart Factory initiative (SFI) provides the centerpiece of this new collaboration. It is also the most recent manifestation of GI. By 2015, ten chaebol had joined the smart factory initiative, including Hyundai Motor, LG, Dusan, Hyosung, and Posco. The 2015 smart factory agreement between Samsung and the Korean government exemplifies the new three-way mode of collaboration in which

Table 2. Key policy initiatives in intelligent robotics industry development.

2003	IT839 – Intelligent Robotics first identified as a strategic industry
2005	MIC launches Intelligent Robotics test-bed initiative
2006	Already 1000 researchers and over 30 companies working on MIC's test-bed scheme
2008	Government passes *The Intelligent Robots Development and Distribution Promotion Act* which: –identifies MOTIE as the lead Ministry responsible for intelligent robotics industry promotion; –requires government to have a 5-year Master Plan for Robotics Industry Development (Article 5) –mandates the creation of KIRIA to implement robot industry promotion plans and to facilitate inter-ministerial cooperation – requires governments at all levels to devote a proportion of their budgets to the development and distribution of Intelligent Robots (Article 3)
2009	First Master Plan for Robotics Industry Development
2011	*China announces robotics as a new strategic industry and establishes an initial 3-year plan to kick-start local development*
2011	KIRIA established
2011	Government announces Pilot Programs for Market Creation Initiative (expansion of MIC's 2005 test-bed initiative) (USD90 million over two years)
2013	*China establishes China Robot Industry Alliance*
2014	Second Master Plan for Robotics Industry Development – MOTIE launches Smart Factory Initiative
2015	*China and Japan launch major National Plans for Robotics Industry Development*
2016	Robot Act revised – government agencies must submit annual purchasing plans for intelligent robotics and report on procurement performance
2018	MOTIE announces Intelligent Robot Industry Development Acceleration Strategy

Source: Authors' own.

government and chaebol co-invest to improve the capabilities of small firms. In this instance, the two parties – Samsung and MOCIE – committed some $25 million to help more than 600 smaller Korean manufacturers construct digitized–robotized factories. Samsung further committed 150 engineers for placement with participating firms.[37] Having skin in the game would thereby more likely ensure a commitment to the goals of the initiative and act as a kind of disciplinary mechanism as embodied in the notion of governed interdependence.[38]

A related measure seeks to boost business demand for automated and robotic solutions through a public-private partnership under the auspices of the Korea Smart Factory Foundation. Under this partnership some 2,800 SMEs are given support to begin digitizing and robotizing their factories. Government projects that this number will expand to 10,000 by the end of this decade (and most recently, to 30,000 by 2025).[39] To drive localization of the production of key parts and components (where Korean firms lag behind their competitors), MOTIE allocated an additional budget of $310 million. In the words of KIRIA's Director, 'MOTIE aims to build up high-quality components of reducers, sensors, controllers and motors by reducing reliance on global robot parts suppliers'.[40] The impetus to drive localization continues at the time of writing.[41]

Ambitious goals are one thing; meeting them is quite another. Where the SFI is concerned, in the eyes of many, the factories involved are inadequate in number and have not become smart enough. Improvements have tended to concentrate at the most basic level of automation. Nonetheless, the comparative record tells us that quick wins are not the norm in this arena and that Korea is not alone in falling short of its stated objectives.[42] Shortcomings aside, analysts have also reported significant progress. As of 2016, the 2,800 SMEs, mentioned above as part of the

SFI, had apparently improved their productivity by 25%, reduced defective product ratios by 46% and cut costs by 16%.[43]

Beyond the smart factory initiative, Korea's focus on intelligent industrial robots continues alongside the longer-standing service robot initiative. Government agencies are funding new pilot projects to drive demand for innovative service robots in strategic areas based on future projections.[44] In a significant new development, the Korean government has revised the Robot Act in an effort to ensure that anticipated public demand will be forthcoming: MOTIE now requires relevant public agencies to submit annual robot purchasing plans, along with annual reports on their procurement performance.[45]

More generally, we find little surprising in the rekindling of government–chaebol relations of the kind discussed here. As we have already indicated, in a dynamic international environment rather than a closed system, states and firms alike face relentless, ever-changing pressures that provide the impetus for collaborative action. If there is anything new about that action in Korea, it is the concerted effort to bring new players (smaller firms) into the partnership.[46] This partnership forms an integral ingredient of geo-economic statecraft (Table 2).

How effectively then has Korea exercised statecraft in this arena? For some experts involved in technology policy, there is frustration at the apparent lack of progress. For them, 15 years of dedicated government support should have already repaid with blockbuster products and significant market demand.[47] Nevertheless, the historical record suggests that success or failure may not be apparent within a 15-year timeframe (witness electricity, the Internet, virtual reality, etc.). Because of their many different applications and degree of coordination required for their uptake, the mass adoption of general-purpose technologies [like AI/intelligent robotics] is often a slow process (Weiss, 2014, p. 190). As one astute analyst observes, 'It took more than two decades for electricity [for example] to surpass steam (in terms of share of total horsepower in manufacturing) … and almost four decades to become the undisputed source of power generation. That makes sense: To make use of electricity, governments had to invest in nationwide electric grids; entrepreneurs had to invent complimentary technologies like light bulbs, cables, and switches; bureaucrats had to agree on standards such as the voltage of the current and the shape of the plug; and ultimately, businesses had to create saleable products compatible with the new source of power' (Campanella, 2018: np). These political–economic (and more socially complex) considerations apply to AI broadly and intelligent robotics in particular. For our purposes, however, 15 years has been a sufficient amount of time for us to track Korea's progress through this snakes and ladders game, and not least to better grasp the state's commitment and capacity to ensure the nation is a player.

Conclusion

A focus on the nature or extent of government's economic involvement often takes a back seat to an exclusive concentration on policy outcomes. Although too soon to pronounce success or failure (or somewhere in between) at the technology frontier, we have already seen some indicators of progress along that route. There have also been failures, yet these have not diminished the ambition. More to the point, an absence of failure would mean not taking risks and without risk there can be

no techno-economic progress.[48] It is fair to say that we still have much to learn about the remaining milestones and whether they will be met. This will undoubtedly repay further research.

More broadly, the fact that the Korean endeavor is a work in progress and has not been failure free does not detract from our central argument. We have proposed that there is something significant in the government's overall approach and that the pattern of activities identified is not at all well captured by the prevailing regulatory view of the state's economic involvement. The Korean state is involved in much more than marketcraft.

We have argued that statecraft more accurately conveys the long-term strategic thinking that informs the government's approach to techno-economic decision making. Economic statecraft draws attention to a pattern of activity which is of a different order, not just from that of marketcraft, but also from industrial policy. As we have emphasized, unlike the concept of industrial policy (however 'strategic'), statecraft offers a more accurate and nuanced understanding of the state's strategic positioning vis-à-vis its international competitors. In particular, it reflects an acute awareness of the geo-economic challenges facing the nation. By contrast, industrial policy need not be driven by external pressures. While its impetus might be a generalized or diffuse set of pressures stemming from international competition, it could just as well be motivated chiefly by domestic political concerns.[49]

Our aim has been to illuminate the changing role of the state in Korea that is obscured or ignored altogether when viewed through the lens of existing concepts. By developing the concept of geo-economic statecraft to embrace domestically deployed initiatives at the techno frontier, we have sought to bypass debates that emphasize development, and thereby open up a new research agenda. That agenda should probe the conditions that might motivate states to craft techno-economy building initiatives and the relationships of governed interdependence they must forge to achieve them.

Notes

1. This is not to say that Korea was ever free of rent-seeking business elites; but rent-seeking has been found to be pervasive in all economies and the issue is whether rents are directed at productive ends (Khan in Khan and Jomo, 2000). In South Korea, rent-seeking rarely reached development-hindering proportions, and indeed was often used in a pro-developmental context. For an attempt to reconcile Korea's rapid growth with money politics, see Kang (2002).
2. For pioneering works on the developmental states of East Asia, see Johnson (1982), Amsden (1989), Wade (1990), Woo (1991), and Weiss and Hobson (1995).
3. It is helpful to distinguish between 'narrow' and 'general' AI: Narrow AI is 'the programmed ability of a machine to create its own courses of action and to choose among them to perform an assigned task'. By contrast, '… general AI is the programmed ability of a machine to set its own goals, learn from them, and change them' (think Skynet and the Terminator). Most existing AI applications fit the narrow category, including the case we discuss in this paper (Work, 2019).
4. On the radical economy-wide impacts of general purpose technologies in the postwar era, see Ruttan (2006).
5. Industrial applications include collaborative robots, or 'cobots' (see below) which can work safely alongside humans; intelligent service applications cover both personal and professional tasks. A non-exhaustive list includes home assistance, security, and disaster management (e.g. drones) and medical devices (e.g. rehab and surgical).

6. In the context of debates about the shrinking developmental state for example, scholars have argued along similar lines, deeming the innovation-based economy too challenging for "state bureaucrats [who] may not have sufficient frontier knowledge in making adequate decisions to lead the economy (e.g. Breznitz, 2007; Wang, 2007; Wang, Chen, & Tsai, 2012; Wong, 2004, 2005)" (Wang, 2014, p. 1).
7. For recent studies see Thurbon and Weiss (2016), Thurbon (2016, 2019), Chu (2015), Wade (2018), Dent (2018), Pacheco Pardo and Klinger-Vidra (2019), and Kim (2019).
8. Aid programs, while not strictly 'offensive', are typically aimed at furthering a state's foreign policy agenda.
9. See for example Breznitz (2017) and O'Mara (2010).
10. See e.g. Baldwin (1985), Drezner (2015), Andrews (2006), and Cohen (2018).
11. For one exception focused on emerging powers, see Armijo and Katada (2015).
12. We are grateful to Peter Trubowitz for suggesting some years ago, in private correspondence, that the domestic-based strategy for technological dominance detailed in Weiss (2014), can be seen as an exercise in economic statecraft. See also his analysis of how the cross-pressures of international and domestic politics shape the diverging grand strategies of U.S. leaders (Trubowitz 2011).
13. For a representative sample of this expansive and contentious application of the 'industrial policy' and 'developmental state' label to the US see Wade (2018), Mazzucato (2018), and Block (2008).
14. On the dimensions of Korea's growing technology deficit with Japan (and the US) from the late 1990s onwards, see OECD (2009: 94–100).
15. Roh cited in Thurbon (2016, p. 101). The following paragraph also draws on Thurbon (2016, p. 102).
16. Authors' interviews with Korean officials who wish to remain anonymous (Seoul, June 2018).
17. Chin Daeje, cited in 'Robots at Service for $1,000 Per Pop', *Korea Times*. 27 October 2005.
18. In the early 2000s, over 70% of Koreans had broadband Internet.
19. To use the words of Korea's Ministry of Science, ICT and Future Planning (MSIFP), an intelligent robot is 'a mechanical device by which exterior environment is perceived, cognized on its own, and autonomously activated and manipulated' (MSIFP, 2014, p. 92). The three main types of intelligent robots, according to purpose, include robots for manufacturing (component handling, welding, etc.), for professional services (medicine, education, national defense); and for personal service.
20. Oh cited in *National Geographic*, 6 September 2006. This rationale was echoed by Shim Hak-bong, Head of the Ministry of Commerce, Industry and Energy's Robot Team: 'Korea might lag behind Japan and the U.S. in terms of robot technology, but those countries still do not have markets for household or service robots. So we still have a chance if we create a solid market for robots ahead of our competitors.' Cited in 'Robot Industry, Core Pivot for Korean Growth Engine' *KBS World Radio*, 20 March 2007.
21. Cited in 'KAIST to Unveil Self-Regulated 2-Legged Robot This Year', theautochannel.com, 24 November 2004.
22. Oh, cited in *National Geographic,* 2006.
23. Cited in 'Police, Army Robots to Debut in 5 years', *Korea Times,* 16 January 2006.
24. ibid.
25. 'Robot Act Passed in National Assembly', *The Electronic Times,* 27 February 2008.
26. *The Intelligent Robots Development and Distribution Promotion Act* can be accessed at: http://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=17399&type=part&key=18)
27. Article 41 of the Act mandated the establishment of a 'Robot Promotion Institute' charged with 'advanc(ing) projects for the promotion of the intelligent robot industry and support(ing) the development of policies on the intelligent robot industry', specifying a number of business activities to be undertaken for that purpose.
28. Approximately US$50 million per annum in 2018.
29. ACRI provides a snapshot of the current status of Korean robot manufacturers and related companies, as well as statistics pertaining to manpower issues and R&D investments and outcomes for the industry as a whole (Cho et. al., 2016: 35).

30. The aim of the program, in the words of KIRIA's then Director of Policy Planning, Bong-Hyeon Baek, is 'to develop a test bed for verifying developed robot products for commercialization to create and expand the service robot market, which is still in its infancy worldwide' (Baek, 2014, p. 5).
31. MKE official cited in 'Korea eyes robotics industry', *Korea Times*. 9 December 2010.
32. In the former case, government agencies direct investment to create demand in public sectors. Private-sector projects are initially planned by private firms then proposed to the government for potential procurement (Cho et al., 2016, p. 30). Government-led projects have included ETRI's drone-based delivery system, and KEPCO's autonomous flying robots for the aerial diagnosis of power facilities (KIRIA, 2016).
33. For example, in 2011, for the first time, China's five-year national development plan identifies Robotics as a strategic industry for national promotion. That same year, the Chinese government allocated US$700 million for a new three-year project to build robotics capabilities to rival America's in some areas. Then in 2012, China's Ministry of Industry and Information Technology sets up annual industry exhibition at the China International Robot Show. In 2013, the Government established the China Robot Industry Alliance 'to help the country develop an internationally competitive domestic industry' (Austin, 2018, p. 280). By 2015, China's local capabilities had developed to the extent that it was able to participate alongside Korea in DARPA's robot challenge. By 2018, the number of robot and component manufacturers had grown from less than 10 to more than 700. The number of companies using robots in their manufacturing and material handling process had also grown by a similar factor. See 'What's all the Fuss about AI, Robotics and China? *Robohub*. 11 April 2018. Accessed at: http://robohub.org/whats-all-the-fuss-about-ai-robotics-and-china/
34. The Korean government committed US $2.5 billion in order to grow the robot market from $2.2 billion to $7 billion; to achieve $2.5 billion in exports; to increase the number of Korean robot companies by a third (to 600); and to virtually double average company sales to $11.7 million, all by 2018 (Baek, 2014).
35. 'New Factory Asia' *Robotics Business Review,* 9 October 2015. Accessed at: https://aws.roboticsbusinessreview.com/manufacturing/new_factory_asia_2025/
36. ibid.
37. 'Samsung, Govt . to Inject 30 Billion Won to Build Smart Plants'. Business Korea. 1 September 2015. Accessed at: http://www.businesskorea.co.kr/news/articlePrint.html?idxno=11878
38. On the smart factory initiative as applied to the renewable energy and smart-grid sector, see Kim (2019).
39. MOTIE will also build up to 15 advanced robot commercialization research centers – AI/ICT convergence centers and humanoid robot research centers – to ensure the supply of intelligent robots for the industrial sector. 'New and Emerging Trends in Korea's Robot Industry'. *Kotra Express*. October 2017. Accessed at: http://www.investkorea.org/kotraexpress/2017/10/Industry.html
40. Reported by KIRIA Director Johnny Kim in ibid.
41. In 2018, MOTIE announced the 'Intelligent Robot Industry Development Acceleration Strategy. The plan establishes ambitious localization goals, seeking to raise the localization ratio of key robotic parts from 41.1 percent in 2016 to 60% in 2022. It further seeks to increase the number of robotics SMEs posting over 50 billion won (approx $45 million) in sales from 16 to 25 by 2022, and to expand the number of employees in the domestic industry from 29,000 to 36,000. 'S. Korea to Promote Collaborative Robots for Manufacturing Field. *Business Korea*. 8 February 2018. Accessed at: http://www.businesskorea.co.kr/english/news/industry/20497-expanding-local-robot-market-s-korea-promote-collaborative-robotics
42. See for example, Capgemini (2018).
43. Reported by Han Seokhee (presentation at Aarhus University, 3 November 2016).
44. For example, rehabilitation, unmanned transport, public works, and security. *MOTIE Press Release*. 15 November 2016. Accessed at: http://www.motie.go.kr/motie/ne/presse/press2/bbs/bbsView.do?bbs_seq_n=158818&bbs_cd_n=81)
45. ibid.

46. Thurbon (2016) identifies the wider shift from chaebol-centered government-business relations to tripartite partnerships bringing in smaller firms as part of a fundamental shift in the developmental strategy of the Korean state.
47. Personal communications with former high-ranking policymaker in the field of robotics, February 2019.
48. As various corporate leaders have attested, and famously encapsulated in Thomas Watson, founder of IBM, 'If you want to succeed, raise your error rate.'
49. It is also important to be aware that, as a concept, strategic industrial policy was designed with a view to debunking the neoclassical economic tenet stipulating that markets develop under their own steam and operate best when left to their own devices (Johnson, 1982). Consequently, strategic industrial policy is not necessarily understood as a response to external pressures, or conducted with an eye to coping with one's preeminent economic challengers. That is the domain of domestically-oriented economic statecraft. To reiterate, this involves government initiatives that reach for or seek to push the technology frontier in order to fend off, outflank, or move in step with rival economic powers.

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