C16

CHAPTER 16

THE STATE AS A FACILITATOR OF INNOVATION

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C16.S1

Introduction

C16.P1 Innovation and technology upgrading play a central part in a country's economic growth. Nevertheless, the economic literature shows that knowledge production and technology innovation are very risky and costly (Nelson, 1959; Solow, 1994). Incomplete capability of appropriation due to the nature of knowledge externality significantly weakens the incentives of conducting innovation by private business as well (Romer, 1986, 1990). In addition, information asymmetries between external financiers and companies make it even more difficult for innovating companies to raise enough external finance for their expensive research and development (R&D) investments (Meuleman and Maeseneire, 2012; Chen et al., 2018). Furthermore, technology innovation in any specific industry often requires adequate supply of well-trained workers and technicians with appropriate expertise and coordinated development of both upstream and downstream industries, which are beyond the capability of individual firms or private sectors. Thus state support can be vital for corporate innovation, in particular in emerging economies (Brown et al. 2012; Stiglitz and Lin, 2013; Zhou et al., 2017; Wang, 2018).

C16.P2 The theoretical and empirical literature on government support for innovation and technology upgrading is voluminous but still burgeoning (Lerner, 1999; Guo et al., 2016; Howell, 2016; Howell, 2017; Zhou et al., 2017; Lazzarini, et al., 2020; Sun et al., 2020). Government support for innovation takes a variety of forms including state ownership, provision of tax allowances, loans, grants, education and training, special organizations, information supply, government procurement, registration, and regulation (Guan and Yam, 2015; Zhou et al., 2017). Moreover, the roles of the state vary greatly in different countries and range from directive government intervention by actively formulating and coordinating industrial and innovation policies and selectively investing in strategic industries, to facilitative government

activities by transforming infrastructure and institutions, creating positive market environment, encouraging entrepreneurship, and providing public goods for industry and companies (Lin and Monga, 2010).

C16.P3 However, empirical findings on the effects of government policies on innovation are rather mixed and often even conflicting. In fact, all three likely outcomes are well reported in the literature: 1) government supports are found to promote private innovation; 2) to have no impact at all; 3) or even to crowd out private R&D investment (Dimos and Pugh, 2016). Some studies suggest that government support has a positive impact on corporate investments and R&D expenditures, such as Lerner (1999), Carboni (2017), and Wu (2017). This is because it eases financial constraints, increases the likelihood of raising external finance, and thus mitigates the potential underinvestment risks in technology innovations. Besides, states in emerging economies such as China and Brazil are usually committed to developing indigenous technological capabilities by collaborating with foreign companies, or by fostering their own champion state-owned enterprises (SOEs) to close technology gaps with the rest of the world (Lazzarini et al., 2020; Sun et al., 2020). Sun et al. (2020) find that the preferential resources provided by SOEs' partners help promote more R&D investments to be undertaken within foreign host-state international joint ventures (IJV) than foreign-private peers.

C16.P4 In contrast, other papers exploring the impacts of governmental programs supporting innovation and technology upgrading (e.g., Klette et al., 2000; Marino et al., 2016) find few significant differences between the nonsupported firms and the supported firms, despite the large amounts of R&D support provided. Wallsten (2000) even provides evidence that government support such as the Small Business Innovation Research (hereafter, SBIR) Program in the US crowds out private investment in innovation, and thus impacts the corporate R&D investment negatively. Sun et al. (2020) even identified a negative association between host-country state ownership and innovation output, which is measured by patent activities in emerging market-based IJVs, due to the prominent agency problems rooted in SOEs.

C16.P5 To summarize, while it is generally agreed that a strong and capable state is important in promoting innovation and technology upgrading, in particular in emerging economies, how government functions and whether the government intervention is effective are still debatable in the academia and in the policy community. The debate about innovations under state capitalism has been ongoing for many decades (Li et al., 2015; Bardhan, 2016; Zhou et al., 2017; Lazzarini et al., 2020; Sun et al., 2020), and there is no consensus in sight yet, particularly in those countries with strong government interventions such as Japan, Singapore, and China. This chapter aims to shed light on the implication of government involvements in innovation by exploring how the state works as a facilitator of innovation and technology upgrading. It provides a summary of the recent theoretical and empirical studies on how the state capitalism exerts its influence on firms' innovation behaviors.

C16.P6 The remainder of the chapter is structured as follows. The next section reviews theoretical research on the effects of government policy on innovation and technology upgrading. The following section discusses both strengths and weaknesses with regards to state intervention activities. Our next section then addresses the facilitating role of the state in cultivating emerging industries and promoting corporate innovation activities in both developed and emerging economies. In the penultimate section, an in-depth discussion is made of industrial and innovation policies in China from a historical and dynamic perspective. Grounded in our discussions, we conclude and offer implications for theory and practice.

C16.S2

A Brief Review of Theoretical Research

C16.P7 A large volume of studies have explored the theoretical justifications and policy effects of government tools to promote R&D investment, including innovation input additionality, namely increasing corporate investments in innovative activities, behavioral additionality, encouraging behaviors in a desirable direction favoring innovation, such as innovation collaboration, and output additionality, namely increasing innovation outputs (David et al., 2000; Klette et al., 2000; Dimos and Pugh, 2016; Wu, 2017; Chen et al., 2018). In general, the prior literature documents two sets of theoretical rationales for governments to support high-tech firms and/or industries that need technology upgrading.

C16.P8 The first rationale is to rectify market failures in the production process of innovation knowledge, arising from the problems of "incomplete private appropriability." Support for this argument in the form of economic modeling dates back to Schumpeter (1942) and has been further developed by Nelson (1959); Nelson and Phelps (1966); Romer (1990); Aghion and Howitt (1992), among others. One crucial feature of innovation activities is the high uncertainty of success, so it is rather difficult for successful research projects to yield an adequate financial return to offset the many failures arising from R&D investments. Griliches (1992) argues that the social rate of return from the firms' R&D expenditures exceeds the private rate by a considerable amount. In particular, small and medium-sized companies count on innovation to an even greater extent than large firms, but are much less capable of appropriating benefits associated with innovation (Radas et al., 2015). Thus, firms usually invest below the socially optimal level of R&D and have fewer incentives for knowledge creation and technology innovation (Lerner, 1999). Government programs that support commercial innovation activities are justified on the theoretical assumption that profit-driven firms often underinvest in R&D (Wallsten, 2000). In particular, market failure in the financing of young and high-tech entrepreneurial companies may lead to active state interventions (Guerini and Quas, 2016). By investigating and summarizing 52 micro-level empirical evaluation studies, Dimos and Pugh (2016) conclude that the employment of government subsidy as part of innovation policy contributes to correcting market failures by increasing both R&D inputs and outputs in subsidized firms in comparison to the unsubsidized firms.

C16.P9 The second rationale is to address the "informational asymmetries" problem. As innovative firms are subject to the liability of originality and tend to disclose little information to the public, external investors may have difficulty assessing the prospects and risks of the firms (Stuart et al., 1999). This gives rise to a situation of information asymmetries between the innovative firms and external financiers, and makes raising external finance very difficult for innovative firms (Lerner, 1999; Zhang and Wiersema, 2009; Chen et al., 2018). To enhance information flow and to attract more external financing, innovative firms need to signal their technological competence, quality, and prospects to external financiers (DeCarolis and Deeds, 1999; Hsu and Ziedonis, 2013; Liu et al., 2019; Moon and Bretschneider, 1997; Zhang and Wiersema, 2009). As such, government support can play a key role in signaling the quality of the firms to external investors and thus create innovation input additionality, namely resource-effects (Feldman and Kelley, 2006; Guo et al., 2018; Meuleman and Maeseneire, 2012; Takalo and Tanayama, 2010; Wu, 2017; Chen et al., 2018). For example,

Feldman and Kelley (2006) state that when a government agency's assessment is linked with the potential of commercialization, private investors consider the grant-winning project more valuable than other high-risk research projects. Takalo and Tanayama (2010) also propose a theoretical model in which government R&D grants convey a positive signal to market-oriented investors. Wu (2017) argues that receiving government support acts as a noticeable indicator of the unobservable applicant's quality, and government officials are able to certify firms worth investing by granting subsidies or other forms of support.

C16.P10 Influenced by these theoretical arguments, policy makers adopt a portfolio of policy instruments to promote private innovation by incentivizing them to conduct R&D and enhance innovation output (Dimos and Pugh, 2016). Thus, in many countries, many industry and innovation policies become an important tool to support development and technology innovation. The elements of innovation policy typically include: 1) innovation subsidies; 2) tariff policy and other forms of protection; 3) direct government investment on innovative companies; 4) economic planning at the national level; 5) manpower policy broadly defined; 6) regional innovation policy; 7) government procurement policy; and 8) other policies regarding research, development, and technical training (Carlsson, 1983; David et al., 2000; Czarnitzki and Lopes-Bento, 2013). Some studies, such as Amsden (1989) and Rodrik (1995, 2004), argue that rapid industrial development and innovation in the history are often backed by governmental interventions such as subsidies, public venture capital, and protective tariffs, which deliberately shape markets to incentivize entrepreneurship and innovation investment.

C16.S3

Strengths and Weaknesses of State Interventions

C16.P11 Public sectors of industrialized countries spend massive amounts of their budget on supporting commercial R&D in manufacturing firms (González et al., 2005), and several strengths can be identified through their practices in the arena of innovation. First, the key strength of state intervention is to help conquer the low appropriability of many innovation investments that have good public characteristics, namely non-excludability and nonrivalry (Dimos and Pugh, 2016). By designing and enhancing legal and economic institutions relating to innovation, policy makers help strike a better balance between inefficiency in the process of creation and distribution of knowledge, and more appropriability that encourages R&D activities. Thus, state actions are able to contribute to achieving a better appropriability trade off, such as constructing a more robust system of intellectual property rights (IPR) protection (Sun et al., 2018). Besides, government officials and SOE managers, especially in the emerging economies, are more motivated to invest in new inventions and to develop pioneering technologies, which has a larger potential for knowledge spillover than managers of private firms who prefer direct value and low volatility (Lazzarini, et al., 2020).

C16.P12 Second, state interventions are capable of enhancing information efficiency. Because government does not compete directly with innovative companies, companies are more willing to provide relevant information on innovation activities to government than to external investors (Wu, 2017). Government officials thus are able to certify firms to private financiers

by offering R&D grants to alleviate funding gaps for small firms' innovation projects (Meuleman and Maeseneire, 2012). Lerner (1999) finds that R&D grants provide a positive signal about enterprise quality and technological merits of the firms' projects, and thus help alleviate capital market imperfections and facilitate attracting venture capital: firms with SBIR subsidies, in comparison to those without, are more likely to attract venture capital, and this relationship is even stronger in high-tech industries. Takalo and Tanayama (2010) confirm the signal effect of R&D subsidies and find that the receipt of government R&D subsidies helps attract funding from other sources. Employing a Belgian dataset, Meuleman and Maeseneire (2012) come to the same conclusion by identifying a positive certification impact of obtaining a public R&D grant.

C16.P13 Third, state interventions also help release the financial constraints faced by innovative firms. It is widely recognized that R&D activities are difficult to finance due to collateral constraints in a competitive market, with the link between financial constraints and innovation well established in the literature (Rodrik, 2008a; Guariglia and Liu, 2014). Colombo et al. (2013) analyze the effect of government subsidies on corporate investment in a longitudinal sample of Italian unlisted non-venture capital backed high-tech firms, and report indications of reduced financial constraints after receipt of the first government subsidy. Meuleman and Maeseneire (2012) examine the effects of subsidies on small firms' access to external equity, short-term and long-term debt financing, and show that obtaining an R&D subsidy sends a positive signal about firm quality and results in better access to long-term loans. Zhou et al. (2017) argue that state ownership help enable firms to gain more financial resources to invest in R&D activities.

C16.P14 Finally, the state is able to reduce uncertainty and contributes to risk control. When a company performs innovation activities, it faces various forms of risks from the technology, product, and financial markets (Pierrakis and Saridakis, 2017). Various forms of government involvement in the innovation and diffusion-facilitating processes, such as enhancing two-way information flows and providing financial support and legal facilitation, are very likely to increase the probability of adoption and diffusion of technological innovation (Moon and Bretschneider, 1997). The state can be capable of coordinating the development of a set of microeconomic capabilities and incentive structures, adopting well-structured innovation policies, creating a level playing field, facilitating the entry of firms into new markets, and thus reduce the uncertainty in the commercialization of new technologies (Koh, 2006). Besides, the state has strength in ensuring sufficient intellectual property protection that plays an important role in creating incentives for innovation and technology upgrading. Liu et al. (2019) also report that government interventions influence enterprise innovation behavior through the channel of risk control.

C16.P15 However, state interventions have notable weaknesses too. Potential shortcomings related to resource inefficiencies in association with state interventions in innovation and technology upgrading have long been recognized in the literature (Dixit, 1997; Lazzarini, 2015). Critics of market failure theory state that there are no clear-cut standards to identify market failures and to assess when the state should intervene (Demsetz, 1969; Wang, 2018). A theoretically optimal and appropriate government response to activities that generate positive externalities does not mean that government is capable of rectifying the market failure in practice. Public programs to correct market failures are possible to generate incentives that lead the private sector to undo many of the programs' intended benefits (Wallsten, 2000). Government supports usually do not rely on the ex-post measures like

achieved performance, but are fixed ex-ante, based on some selection criteria (Nishimura and Okamuro, 2018). Pack and Saggi (2006) state that there is little empirical support for an activist government policy that can justify the use of state interventions even though market failures are present.

C16.P16 Bureaucrats are admittedly less capable of identifying opportunities and picking winners if they are not familiar with the industry, and several distortions related to government intervention may manifest themselves (Lerner, 1999). One possible distortion is corruption. It is suggested that government involvement can be distorted by the desire of interest groups, or of the politicians themselves, to maximize their own private benefits rather than the public welfare (Lerner, 1999). Firms are likely to seek transfer payments that directly increase their profits, and politicians are possible to acquiesce to such transfers to politically connected companies (Eisinger, 1988). Some critics state that excessive governmental involvement in the private sector can lead to rent-seeking (Ades and Tella, 1997; Pack and Saggi, 2006; Sun et al., 2018), and large-scale corruption in the context of pervasive government involvement in the economic activities has already been pointed out by Krueger (1990). Zhou et al. (2017) propose that, due to lack of appropriate capabilities or skills to run companies efficiently, the SOE managers may misuse the R&D input to achieve their personal goals and diminish the efficiency of producing innovation output. By manupulating the rules of the game of business and directing financial resources to politically favored firms, government intervention may have the potential of innovation rent creation (Sun et al., 2018). Based on the empirical context of China's pharmaceutical sector, Sun et al. (2018) find that the lower the degree of state intervention in the subnational economy of China where a focal firm is located in, the higher the intensity of the firm's R&D investment.

C16.P17 The second distortion leads to a crowding out effect. Government officials may select firms based on their likely future success rate, but pay no regard to whether the government funds are needed. In such situations, they are able to claim credit for the firms' ultimate success, even if the marginal contributions of the government support are very low (Cohen and Noll, 1991; Wallsten, 2000). To fund the most commercially viable projects is a typical incentive that government agencies face. Taking the American government program that aims to "increase private sector commercialization of innovations derived from federal research" as an example, Wallsten (2000) describes the rationales for government program managers to pick winners and support commercially attractive projects, which made receiving awards endogenous to a firm's R&D activities. Taking this endogeneity into account, government supports in the form of subsidies simply crowd out firm-financed R&D expenditures, and thus have little impact on innovation activities (Wallsten, 2000).

C16.P18 The third distortion is the suboptimal allocation of resources among industries, firms and within organizations. Channeling resources to certain industries and firms may put other industries and firms at a disadvantage (Joseph and Johnston 1985; Wang, 2018). Because firms receive funding from the state through nonmarket-based mechanisms, resource allocation distortions may occur as well. In comparison to other financing sources, government funds are a relatively cheap way to finance innovation projects. Some firms may hide private information from public agencies and divert government grants to projects that would have been conducted in any case (Dimos and Pugh, 2016). Consequently, the underlying incentives and the efficiency of the receiver firm may be affected (Dixit, 1997). To obtain more public resources, firms may use loose criteria when assessing innovation projects and

carry out projects with weak potential (Zhou et al., 2020). As mentioned in Rodrik (2008a), all policies and state interventions have shortcomings and difficulties in reality, no matter how strong their theoretical supports are.

C16.P19 Nevertheless, innovation and industrial policies with the potential of generating rent-seeking opportunities as well as other forms of market distortions may help the establishment of second-best institutions, in particular in developing countries where first-best institutional rules are not available/feasible (Rodrik, 2008b; Bardhan, 2016). Thus, state involvement in spurring innovation and coordinating exploration into new technology that the private sector is not willing/able to develop inevitably has a higher failure rate, which implies many trial-and-errors of state capitalists in the innovation arsenal (Mazzucato, 2013; Bardhan, 2016).

C16.S4

The Facilitating Role of the State in Corporate Innovation across the World

C16.P20 The OECD countries have spent significant amounts of public money on government programs to stimulate innovative activities over several decades (Klette et al., 2000). In the US, federal government support for private R&D dated back to the nineteenth century. Before the start of the twenty-first century, most federally funded industrial R&D had been directed at satisfying government needs, such as large weapon systems (Wallsten, 2000). Among various government interventions, government-industry R&D programs have become more popular in recent years; many of them aim at assisting firms to commercialize innovations by subsidizing their R&D (Cohen and Noll, 1991; Nelson and Romer, 1996; Wallsten, 2000). The rapid industrial development in the US owed very much not only to temporary protection against industrialized products from Britain in the nineteenth century but government-sponsored R&D and targeted initiatives such as those in computing, health, and agriculture sectors (Lazzarini, 2015; Mazzucato, 2013).

C16.P21 Lerner (1999) evaluates the performance of the firms receiving SBIR program awards in the US from 1983–1985. His paper shows that SBIR awardees grew significantly faster than similar and non-supported firms, both in terms of sales and employment. Although he also finds some empirical evidence of distortions in the award process, especially the geographical diversity, in general the state has played an important role in certifying American firms' quality as well as the technological merits of the projects.

C16.P22 Recent growth in high-tech industries in Asia has been attributed to government initiatives and interventions (Branstetter and Sakakibara, 1998; Choi and Lee, 2017). Many countries have managed to catch up with developed economies through active industry and innovation policies (Lazzarini, 2015). In Japan, government support for R&D projects has focused on large private firms in the same or related industries since the early 1960s (Nishimura and Okamuro, 2018). Branstetter and Sakakibara (1998) examine the performance of the Japanese research consortia in innovative industries such as the semiconductor and other high-tech industries that were heavily subsidized. On average, two thirds of the research costs for the R&D projects carried out within the consortia were covered by government grants. They find that government grants do not crowd out private R&D spending, but

tend to increase the firms' own R&D expenditures by raising the learning opportunities and thereby stimulating more innovation activities.

C16.P23 Implementing the science and technology basic plan, the Japanese government had initiated and provided government grants for R&D consortia over 1997–2007. It was one of the first and major government support programs for R&D consortia in Japan targeting small- and medium-sized enterprises (SMEs). Based on a sample of SMEs that participated in publicly funded R&D consortia in Japan, Nishimura, and Okamuro (2018) examine the impact of project monitoring by the government and reveal that strict government monitoring in the form of progress checks and mid-term evaluations enhance firms' innovation performance in R&D consortia. Japanese government provides loans or tax credits to foster private sector R&D; Kobayashi (2014) explores whether tax credits affect corporate R&D investment. The author finds that R&D tax credits produce an increase in Japanese SMEs' R&D investment and the impact is even larger for liquidity constrained companies.

C16.P24 The state of South Korea has given a large amount of public money to SMEs to promote innovation. Doh and Kim (2014) examine the impacts of government policies on corporate innovation, measured by utility model, patent, trademark, and new design registrations, in the regional strategic industries. Results show a positive relationship between the assistance provided by the Korean government and the patent acquisitions as well as new design registrations in regional SMEs. Focusing on Korean pharmaceutical industry, Choi and Lee (2017) explore the impact that public R&D subsidy exerts on the composition of private R&D investments. Their empirical finding indicates that the public R&D subsidy stimulates rather than crowds out private R&D expenditures in SMEs. Thus, government support can reduce market failures in private innovation investment, though public subsidy has limited capabilities in stimulating the SMEs to expand new product R&D activities.

C16.P25 Singapore is widely known for its strong state interventions in various aspects of society and the economy, while Hong Kong favors a free market economy and minimizes the power of state in influencing the market (Mok, 2005). Hence, these two cities represent polar cases regarding the different roles of the state in shaping innovation activities and are worthy of comparative studies.

C16.P26 Koh (2006) provides the details of how Singapore has taken on several policy initiatives to promote entrepreneurship and innovation since 1998. These initiatives consist of plans to promote skills upgrading, attract foreign talents, and nurture high-tech start-ups. To stimulate technology transfer from public to private sector and to nurture indigenous innovations in local industry, the Singapore government has launched a multi-agency initiative named "growing enterprises with technology upgrade" since January 2003 (Ho et al., 2016). To foster entrepreneurship and cultivate a risk-taking business culture, the Singapore government has been operating a Start-up Enterprise Development Scheme to provide matching funding for young companies, and launched a new scheme that provides loans to SMEs in 2005 (Koh, 2006). To nurture domestic firms to become world-class companies, the Singapore government established a US$1 billion venture capital fund in 1999 to encourage American venture capital companies to locate regional operations in Singapore (Koh, 2006). To create a strong base of innovation capability, the Singapore state has invested heavily in public research institutes with a concentration on key industrial clusters. These public research institutes have produced substantial intellectual properties and developed a large quantity of research scientists and technology engineers (Ho et al., 2016; Wang, 2018).

C16.P27 In contrast, Hong Kong is well-known for its laissez-faire capitalism. Its government keeps a low public budget and has played a very limited role in shaping the market. Much less active industrial and innovation policies have been seen in Hong Kong. After 1997 when the sovereignty change occurred, the government has become more proactive in advancing innovation development and technology commercialization (Cheung, 2000; Yam et al., 2011). However, public investment in R&D remains modest with the majority of government funding being allocated to universities and research institutes, while the private business sector largely counts on itself to finance innovation and technology upgrading (Wang, 2018). Wang (2018) compares Singapore and Hong Kong to probe the relationship between state intervention and innovation performance (in the form of patents). The author concludes that government intervention is effective in improving technological upgrading and innovation scope, since the Singapore government, a representative of state capitalism, has successfully directed the transition from an investment-based to an innovation-based economy.

C16.P28 In the extent literature, European countries' experiences are more ambiguous, though so far little evidence has confirmed the corruption-induced or crowding-out effects. Klette et al. (2000) assess public programs that aim at cultivating and promoting commercial R&D projects on information technology in Norwegian manufacturing industries. Intending to stimulate complementary R&D activities, especially in high-tech manufacturing, the state effort peaked in the 4-year time period from 1987–1990. Nevertheless, the empirical evidence of Klette et al. (2000) suggests relatively few significant differences between the non-supported firms and the supported firms in the same industries.

C16.P29 Italian experience is well studied in the literature as well. Bronzini and Piselli (2016) explore the impact of a R&D grant program implemented in northern Italy on innovation by beneficiary firms in the early 2000s. They focus on the potential influence of the grants on the number of patent applications. Results show that the R&D subsidy program increases the number of patent applications and the likelihood of smaller firms' application for a patent. In addition, a certain amount of grants, approximately €206,000–€310,000 are needed for one additional patent application made by the firms. Caloffi et al. (2018) analyze whether public subsidies, supporting collaborative R&D projects in SMEs, are able to encourage persistent R&D investment and interorganizational networking more than subsidies supporting individual R&D projects. They suggest that if their objective is to induce SMEs to network with external organization, subsidies for collaborative R&D projects need be preferred to those for individual R&D projects. Colombo et al. (2011) analyze 247 new and high-tech firms in Italy and find that only subsidies proffered on a competitive basis have significant positive impacts on corporate productivity growth.

C16.P30 In Belgium, Agency for Innovation by Science and Technology (IWT) in Flanders was established by the Flemish Government in 1991 to create new competences in the development of science and technology. It was later transferred from the federal to the regional government and its funding scope is rather broad, such as industrial R&D projects, feasibility studies and innovation projects for SMEs, and support to industrial networks and universities. Czarnitzki and Lopes-Bento (2013) examine the influence of direct subsidies by analyzing this specific government-supported commercial R&D program over time. Results show that the government policies are not subject to full crowding out; receiving subsidies from other sources does not impede the estimated treatment effect; receiving grants repeatedly does not reduce the magnitude of the treatment effects, and on average five R&D jobs are created per supported project.

C16.P31 Radas et al. (2015) investigate the impacts of direct government grants and indirect tax incentives on recipient SMEs by analyzing the data collected in Croatia. Their empirical evidence indicates that direct government subsidies used alone or with indirect tax incentives are capable of strengthening the R&D orientation of the SMEs and certain aspects of innovation outputs and absorptive capacity. This implies that government interventions may affect the recipient firms at a deeper and more enduring level, such as assisting a firm to develop crucial absorptive capability to create competitive advantages.

C16.P32 Szczygielski et al. (2017) analyze the effectiveness of government supports in Turkey and Poland, which represent a similar level of economic development and face similar challenges of innovation and technological upgrading. This study assesses the relative importance of government supports granted by various levels of public programs, namely their national governments and the EU, as well as specific kinds of innovation-related grants from other government agencies and foundations. It concludes that government assistance to R&D activities contribute to better corporate innovation performance in both countries, while grants for physical and human capital upgrading funded by the EU are rather inefficient in fostering, and actually impede, innovation in Poland.

C16.P33 Government policy makers can also address the market failures in financing entrepreneurial companies in high-tech industries by providing government venture capital (GVC) funding rather than direct subsidies (Guerini and Quas, 2016). Using a sample of European entrepreneurial companies, Guerini and Quas (2016) show that GVC funding increases the likelihood that companies will receive private venture capital in the future. In addition, GVC-funded companies that have received a first round of private venture capital (PVC) are at least as likely as other PVC-backed companies to receive a second round of PVC or to be listed or acquired. This is indicative of GVC's capabilities in selecting promising portfolio companies, and at the same time certifying them to PVC investors.

C16.S5 The Impacts of Industrial and Innovation Policies in China

C16.P34 Since the economic reform starting in 1978, China has undergone more than four decades of rapid growth, which is partially based on the exploitation of low-wage and demographic advantages. However, it now confronts challenges such as higher wages and a shrinking workforce. Thus, China needs to move to a growth model that is based more on innovation and embrace a shift to a more innovative economy (Wei et al., 2017b). At present, China is seeking effective policy tools to enhance its corporate innovation activities. Implementation of China's industrial and innovation policies and their impacts have received much attention from the rest of world. Academic evidence generally shows that a large portion of firm R&D and innovation in China has been driven by the Chinese government (Guan and Yam, 2015; Guo et al., 2016). Thus, we devote this section to research on the impacts of China's government support on innovation.

C16.P35 Chinese companies once played a secondary role in the global innovation arena as low-cost producers and suppliers. During the 1960s and 1970s, almost all of China's R&D investment and innovation activities had been carried out by government-supported research

organizations, and research products were mostly manufactured by SOEs (Guan and Yam, 2015). Only after its reform in 1978 has China pursued its innovation policy development and made successive adjustments. China's central government issued 287 innovation-related policies between 1980 and 2005 (Guan and Yam, 2015). It mainly aimed at realizing technological catch-up by adopting the market-oriented reform of its innovation system. Later it shifted innovation policies from accelerating the speed of technology transfer from laboratories to production to encouraging mass entrepreneurship and innovation activities (Fang, 2010; Sun and Cao, 2018).

C16.P36 Guan and Yam (2015) focus on China's initial economic transition period in the mid-1990s. Based on a large-scale empirical survey of Chinese manufacturing firms, they show that the major government financial incentives positively affect innovative performance of firms, whereas direct earmarks had no effect, and sometimes even has a negative effect on firms' innovative economic performance, which is measured by the ratios of innovation sales and profits. More surprisingly, all government financial incentives do not enhance patent performance of either high-tech or general firms and direct earmarks even negatively affect the patents. Overall their study suggests that the centrally planned funding system of the 1990s was not effective for improving technological development in Chinese manufacturing firms, which in turn encourages the Chinese government to adopt a more market-driven model.

C16.P37 Since the mid-1990s, to upgrade Chinese firms' technological capabilities and push them to catch up with firms from industrialized countries, the Chinese government has learned the importance of focusing industrial and innovation policies on the creation of new knowledge through cutting-edge research. In May 1999, China's State Council approved the establishment of the Innovation Fund for Small and Medium Technology-based Firms (Innofund) program. Examining a panel data set on Chinese firms in the manufacturing industries from 1998 to 2007, Guo et al. (2016) find that, in comparison with their non-Innofund-backed counterparts and the same firms before obtaining the public grants, Innofund-backed firms create greater technological and commercialized innovation outputs. But the positive evidence does not always hold. Boeing (2016) investigates the allocation and effectiveness of Chinese government subsidies over 2001–2006 and finds that subsidies instantaneously crowd out business R&D investment, though this crowd-out impact turns to be neutral in later periods.

C16.P38 In 2005, China's central government decided to shift Innofund from a centralized project screening system to a more decentralized one. Decentralization of governance is associated with more pronounced effects of R&D subsidies. The effects of Innofund on technological innovation outputs become stronger after the governance of Innofund was decentralized (Guo et al., 2016). Guo et al. (2018) explore the influence of government R&D subsidies provided by Innofund program on firm productivity and show that public R&D subsidies tend to support firms with higher productivity. More interestingly, the productivity of the government-backed firms can be further improved after they are awarded government grants.

C16.P39 Between 2006 and 2008, the Chinese government introduced at least 79 innovation-related policies (Guan and Yam, 2015). The "Medium and Long Term Program of Science and Technology (2006–2020)" (hereafter MLP) was launched in 2006, and the general policy was transformed into numerous specific initiatives (Chen and Naughton, 2016). Since the implementation of the MLP, both China's technological innovation and industrial

development have changed in a number of ways. Boeing (2016) points out that there are dramatic changes of China's innovation system after 2006. Before the late 1990s, most of China's R&D programs had been managed and monitored by the Ministry of Science and Technology (MOST), such as the National Science-Tech Support Plan. Since the launch of the MLP, in order to increase the transparency of activity screening and decentralized decision making in project selection (Springut et al., 2011), provincial governments have been given more power and have acted as influential regulators of firms' innovation activities under their jurisdictions.

C16.P40 The MLP has been a blueprint for turning China into a technological powerhouse by 2020, emphasizing "indigenous innovation" and providing funding for 16 Megaprojects (Chen and Naughton, 2016). Since then, China has been seeking to make the transition from imitation to innovation so as to avoid the middle-income trap and catch up with advanced economies (Fu, 2015). The Chinese government has paid increasing attention to scientific and technological activities, and the R&D expenditures continue to increase (Wu, 2017). In the study by Boeing (2016), only 10% of the sample firms received R&D subsidies before the launch of the MLP, whereas in 2014 this number rose to 85%, with over 83% of government subsidies going to R&D-related projects.

C16.P41 Due to the considerable changes in the governance of the Chinese government's R&D subsidies, the capital supply for innovation has increased substantially. Positive impact of government support has been documented by several studies. Wu (2017) examines R&D intensity and government R&D subsidies of Chinese listed companies over 2009–2013, and finds that winning R&D subsidies increases the likelihood that Chinese firms raise external finance. Zhao et al. (2018) assess both direct spillover and indirect crowd-out impacts of government R&D subsidy by analyzing data collected by a provincial government. They reveal that although both significant direct and indirect effects are identified, there is a positive net effect when the subsidy amount is large. In addition, firm characteristics do not serve as major factors in determining whether R&D subsidy is awarded by the provincial government, but they are critical in determining the subsidy amount awarded.

C16.P42 Hong et al. (2016) investigate the function of public grants in innovation activities by using a panel data set of 17 high-tech industries in China over 2001–2011. They suggest that excessive government grants exert a significantly negative impact on innovation efficiency of high-tech industries. On the other hand, the influence of private R&D funding is significantly positive. Furthermore, when the high-tech industries are grouped into five subindustries, the evidence indicates that government grants have uneven effects on the innovation in each subindustry, with positive influence on some but negative impact on others. As such, they state that the Chinese government shall explore how to improve the structure of government grant allocation, and provide grants to some specific sectors such as the medicine and aircraft/spacecraft subindustries that react to state support positively, while decreasing the support to those with negative reactions.

C16.P43 Moreover, a nonlinear relationship between government support and corporate innovation has been identified in some empirical studies. Dai and Cheng (2015) use a large sample of Chinese manufacturing firms to explore whether an optimal interval of subsidy exists. The findings suggest that public subsidies have an S-shaped relationship with the firm's total R&D expenditures and an inverted U relationship with the firms' private R&D investments. In other words, beyond a certain point, further increase in public subsidies can no longer boost a firm's total R&D expenditures, with a possibility of crowding out a firm's private R&D

investment. This suggests that a minimum threshold value of public subsidies is required to induce the firm's private R&D spending.

C16.P44 Zhou et al. (2020) assess how effectively government-funded research projects (GFPs) can facilitate corporate innovation in the cultural and creative industries. They differentiate two types of GFPs—central and local GFPs—to explore their potential effects on two types of innovation—radical and incremental innovation. They argue that GFPs have an inverted U-shaped relationship with corporate innovation and also expect central GFPs to be more effective in promoting firms' radical innovation than local GFPs. Their results show that an inverted U-shaped impact on both firms' radical and incremental innovation for central GFPs, while the inverted U-shaped effect only appears on incremental innovation for local GFPs.

C16.P45 Liu et al. (2019) focus on three main channels—resource allocation, information efficiency, and risk control—through which the Chinese government supports innovation activities in the electronic manufacturing industry. They identify a nonlinear relationship between public supports and private innovation, and suggest that government subsidies promote corporate technology innovation but will inhibit innovation when there are too many subsidies. They also conclude that the optimal amount of government subsidies for a manufacturing firm in a developed region is larger than that in a less developed region, since subsidies are more likely to be complemented by the developed region's greater resources in talent and finance. Similarly, employing data from 269 firms in the information technology industry, Chen et al. (2018) find that R&D subsidy has exhibited an inverted U-shape impact on IPO performance, while non-R&D subsidy has displayed a significant, positive influence on IPO performance. In line with studies such as Dai and Cheng (2015); Zhou et al. (2018); and Liu et al (2019), this study also suggests the existence of an optimal level/structure of public subsidy to motivate corporate R&D endeavors.

C16.P46 Studies also explore some other forms/aspects of government support. In general, the roles of different forms of government interventions, such as subsidy, tax credit, and other institutional support, are shown to be different in China. Zhang and Guan (2018) find that direct government subsidies only promote corporate innovation performance in the short run, but hinder them in the long run. Nevertheless, tax credit incentives always contribute to enhancing innovation performance in both the short and long runs. Shu et al. (2015) define government institutional support (GIS) as the extent to which administrative institutions provide support to firms in a region to promote corporate innovation activities, and investigate the moderating role that GIS may play in the relationship between patenting activities and corporate innovation. The empirical results suggest that while GIS can enhance the impacts of protective patenting motives on patenting behaviors, it can also mitigate the impacts of strategic patenting behaviors on product innovations. Thus firm patenting and innovations are distinct activities, and GIS acts as a double-edged sword in patenting and innovation.

C16.S6 Conclusion

C16.P47 Different public instruments, such as subsidies, tax incentives, and government venture capital, have been used to correct market failures, thus facilitating corporate innovation and

technology upgrading worldwide. Assessing the theoretical and empirical effects of government interventions on innovation inputs and outputs is crucial for future research and practices. Given the extensive efforts in this direction, this chapter is by no means a comprehensive review of this large and complex literature. However, it helps advance our understanding of the role of the state in facilitating innovation and upgrading activities around the world.

C16.P48 As summarized by this chapter, many studies have identified positive influences of government support on innovation such as R&D intensity and patent activity (Czarnitzki and Lopes-Bento, 2013). And government policies, in combination with proper institutional arrangements and government effectiveness, are able to correct market failures, cultivate a fertile environment to enhance innovation networks, and improve corporate innovation capacity (Sun and Cao, 2018; Lazzarini et al., 2020). On the other hand, some studies indicate that, in some circumstances, government policy has no impact on firms' R&D activities, or even crowd out private investment (Boeing, 2016). Thus, the presence of a theoretically optimal government response does not guarantee that government can effectively rectify the market failure in practice (Wallsten, 2000).

C16.P49 Despite the uncertainty in policy impacts, many governments in the world have worked as a facilitator of innovation and used many policy measures to change the nature, path, and structure of innovation investments. This chapter reveals that the state plays an important role of coordinating between various industrial and innovation policies, and ensuring that various economic and financial policies are well-structured and properly aligned. Misallocation of innovation resources by governments may not be unusual (Wei et al., 2017a), so sensible policy design is very important to guarantee the success of government initiatives in this regard.

C16.P50 A country's transition from an investment-based growth strategy to an innovation-driven growth strategy is by no means an easy one. The state in emerging economies like China or Brazil is supposed to play a crucial facilitating role in promoting innovation. It not only needs to work on overcoming market failures, but also to help shape markets in newly emerged and innovative industries. We designate this type of state the "facilitating state." Specifically, the facilitating state not only leads the country to specialize in activities for which they have a comparative advantage, such as low-cost labor and abundant land, but also fosters dynamic advantages by creating a range of institutional arrangements and mechanisms through which firms upgrade their innovation capabilities and exploit new technological trajectories (Lazzarini, 2015; Lazzarini et al., 2020).

C16.P51 Of course, despite a large amount of research indicating the positive roles of the facilitating state, measuring the public and social returns and risks of government supported R&D projects is still rather difficult. It should also be noted that government intervention involves nontrivial costs, and the provision of public resources may be distorted in the prevailing market and organizational structures. The costs of remedying improper or market-distorting government actions are possibly higher than the potential gains. Therefore, the facilitating state needs to evaluate potential benefits and costs of different policy measures, and assess both the extent and quality of interventions.

C16.P52 Our chapter also suggests areas for further research. First, there is a need to explore the effectiveness of government instruments at different stages of economic development. This will require access to more historical information about industrial and innovation policies on a global scale. Second, future research can check the robustness of our findings on the

facilitating policy impacts on innovation and productivity in emerging countries like China by exploring heterogeneous influences of formal and informal institutions.

C16.S7

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