STATE OWNED ENTERPRISES AS KNOWLEDGE EXPLORER AGENTS

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Abstract

This paper deals with the role of the State Owned enterprises (SOEs) in innovation processes. Only a few studies focus on the contribution SOEs as companies might give to produce new knowledge and technological innovation. We argue, however, that SOEs are a pillar of the innovation process and we explore conditions that can make SOEs very effective.

Through two in-depth case studies in two different industries (STMicroelectronics in the semiconductor and Thales Alenia Space in the space industry) we illustrate how SOEs can contribute to innovation by exploring new opportunities and recombining different sources of knowledge. We highlight the conditions that can make exploration and recombination possible. We also highlight the ability of the two companies to change their boundaries through a continuous wave of agreements, mergers and acquisitions. This way, they were able to expand beyond their domains in a way that matched the evolution of their original industries.

Keywords: State Owned enterprises; knowledge recombination; technology management; innovation strategy; entrepreneurial state.

JEL codes: L32, O32, O38

1. Introduction

State Owned enterprises (henceforth SOEs) were and still are a pillar of several economies and, at the same time, a key issue in the debate among scholars, as well as practitioners and politicians. Their role is well documented both in mature and developing countries (Christiansen, 2011; Kowalski, 2013). For instance, SOEs contributed to the post-war development in Western economies, accounting for a large share of GDP. Similarly, SOEs are crucial in developing countries, as in the case of Russia and China, among others (Girma et al., 2009; Gershman et al., 2016). The presence of SOEs in mature and developing economies varies over time. SOEs reached their peaks at the end of '70s, when they accounted for around 7% of GDP in developed countries, 12% in developing non-socialist countries, and around 90% in planned economies (Bernier, 2014; Musacchio and Lazzarini, 2014).

Despite the wave of privatization that occurred afterwards, they still have a considerable impact. SOEs account for a large share of market capitalization, investment and employment (Clò et al., 2016). Their role has been and still is particularly relevant in key industries as utilities and infrastructures, although open competition has replaced natural monopolies in several countries. Not surprisingly, SOEs have been a key issue in the debate among scholars, on one hand, and among practitioners and politicians, on the other. The debate was strictly interwoven until the beginning of the '90, when the collapse of walls between Western and Easter Europe cut SOEs off the political agenda. Still, several scholars, practitioners and politicians argue that have been and still are relevant, especially with regard to emerging countries like China, whereas others maintain that should progressively leave the scene to private companies.

In this paper, we explore the function of SOEs in technology development and innovation activities. Our thesis is that SOEs have been playing, and still do play, a complex role. In a sentence, SOEs are knowledge explorer agents for a State acting as a knowledge recombinator. The argument is that SOEs often go beyond their specific value chains, search and access new technologies, acquire technical capabilities, and implement innovation in products and processes precisely because their assignment is to a large extent wide and their mission challenging. This requires a high degree of autonomy, considerable resources, and a general setting that makes possible for SOEs to do their job. SOEs are exploring agents launched in an unknown space but equipped with good parachutes. They are entitled to explore in different directions, possibly working with other public and private organizations. Some linkages and interdependencies with other organizations may be designed in advance. Others may emerge over time. SOEs are, therefore, decision-makers that do not depend on the State's say on which direction to take. SOEs explore paths that seem to lead nowhere, and that turn out to be fundamental for innovation. On the same token, SOEs investigate routes that, at the beginning, seem relevant and then become unsuccessful. SOEs select alternatives, shedding lights on dark areas where private companies cannot enter. SOEs reject technological alternatives that lead nowhere, sort knowledge that looks promising, and makes it available to others. This way, knowledge gets recombined without relying on a top-down, planned approach.

To back-up our position, we rely on the case of two industries: aerospace and semiconductor. Two French-Italian companies, namely STMicroelectronics in the semiconductor industry and Thales Alenia Space in space technologies, emerged from a long and complex process. They both explored new, on the edge technologies. They both combined different internal and external capabilities and were able to cope with severe environmental jolts. They both succeeded in modifying their ownership structures through a

wave of mergers and acquisitionsthat allowed them to emerge. They started from narrow, specific domains and were able to reach a relevant position in new technologies and new industries. Both companies show two peculiar features: a superior exploratory capability, that allowed them to investigate new frontiers, and a combinatorial capability, that made the combination of different structures and practices possible. STMicroelectronics and Thales Alenia Space are a good example of the role SOEs can play.

The main implication of our paper is that the contribution of SOEs to innovation processes is largely underestimated. In the so-called debate on the 'entrepreneurial State' SOEs are barely considered. Supporters of the 'entrepreneurial State' argue that the state guides the 'technoeconomic process' (Mazzucato, 2014, 8). According to this view, most of the radical innovations that 'have fuelled the dynamics of capitalism—from railroads to the Internet, to modern-day nanotechnology and pharmaceuticals—depend upon capital-intensive, 'entrepreneurial' investments pioneered by the State' (Mazzucato 2013, 3). On the other hand, critics dispute the role of the State, arguing that it is detrimental to innovation and progress. According to this perspective, the State picks winners instead of promoting free competition. Therefore, market incentives get reduced and the overall economic performance decreases (McClosky, 2010). This way, the State impairs the dynamic nature of the market that provides fertile ground to entrepreneurial action and innovation (Kirzner, 2000).

We argue that SOEs' are an important vehicle for innovation. They also support the view of the State as a knowledge recombinator through decentralized structures 'in which the organizations involved are nimble, innovative and dynamic' (Breznitz and Ornston, 2013). We acknowledge the role of the State, but we argue that SOEs are specific mechanisms that deserve in-depth investigation. SOEs are a special vehicle used to explore new possible recombinations of knowledge.

Our paper has several limits. First, is that it is largely based on two case-studies. Although they cover two relevant industries in Italy and France, they mainly provide anecdotal evidence. A longitudinal, in-depth analysis could offer a better understanding of the role played by SOEs in these two industries. Second, we have scattered evidence about the effects both companies have produced at a system level, as we had limited access to data and information. Third, we could not do a micro investigation to assess which specific components of the two companies were crucial in their development.

The remainder of this paper is organized as follows: in the next section, we review the relevant literature of SOEs and discuss how they operate in innovation activities. In the third section, we present the case of the aerospace and semiconductor industries. Finally, we draw main conclusions and offer possible insights and suggestions for future research.

2. Literature review

2.1 State Owned enterprises

Both in centrally planned and market economies, SOEs represent a key element of the economic and social landscape. OECD (2015: p. 14) defines State Owned enterprises as 'any corporate entity recognised by national law as an enterprise, and in which the state exercises ownership'. Musacchio and Lazzarini (2014) distinguish three different models: the Leviathan as entrepreneur, where the State has full control; the Leviathan as major investor, where private shareholders have a minority share; and the Leviathan as a minority investor, that regulates the dominant operators through ad hoc directives.

Liberalization and political pressures decreased the number of SOEs in developed economies since the 1980s (Guriev and Megginson, 2007). Nevertheless, SOEs are still relevant nowadays for the world economy. Before the 2008 crisis, SOEs produced between

one fourth and one fifth of industrial output and accounted for a large part of the total assets in advanced economies (OECD, 2005; Tõnurist and Karo, 2016). After the crisis, their presence and economic weight have increased. For instance, the share of SOEs among the Fortune Global 500 has increased from 9% in 2005 to 23% in 2014 (PWC, 2015), despite the fact that listed SOEs are just a limited subset of the total (OECD, 2014). Today, SOEs account for around 10% of global GDP and represent around 20% of global market capitalization (Bruton et al., 2015).

SOEs are particularly relevant in new developing countries (Ralston et al., 2006; Musacchio and Lazzarini, 2014; Stan, Peng, and Bruton, 2014). Most of the SOEs in the world are Chinese. They produce 29% of China's GDP (Lee, 2009), control the national economy, and are dominant in the strategic industries (Chan and Rosenbloom 2010; Nolan and Xiaoqiang, 1999; Girma et al., 2009). Besides China, SOEs are highly significant in transitional economies like Brazil (Trebat 1983, Musacchio and Lazzarini 2014), India (Baliga and Santalainen, 2006), and Russia (Gershman et al., 2016).

SOEs are also largely present in high developed countries like Finland, Sweden (Clifton et al., 2006; Tõnurist and Karo, 2016), France (Levy, 1999) and Italy. In Italy, SOEs were the main instrument to nurture economic development and to support economic growth (Antonelli et al., 2014; Clò et al., 2016) A pivotal element of the SOE model in Italy was IRI (Amatori and Toninelli, 2011), a public holding established in 1933 and dismantled in 2002. IRI invested heavily in steel and in the transport, machinery, and electrical equipment industries (Toninelli and Vasta, 2011). However, the industrial specialization of IRI went far beyond the supply of capital goods, particularly in the form of intermediary inputs. Instead, IRI had a central role in the technological advancement of multiple industries, including ICT, power generation, aerospace, and electronics (Antonelli et al., 2014).

Scholars agree in considering SOEs a specific stream of research (Peng et al., 2016). Broadly speaking, the debate around SOEs has mainly focussed on two issues. First, and most common issue concerns reasons that drive States' attitude to guide economic development by designing and implementing general and industrial policies. In this framework, SOEs exist to achieve a mix of economic and social interests' goals. Three specific reasons explain why SOEs exist. First, is the case in which the market mechanism fails to achieve an efficient allocation of resources because of market failure (Arrow, 1969). When market failures occur, SOEs can support governments in producing positive externalities, usually in public goods. Typically, SOEs deal with utilities and network industries like energy and telecommunications. Utilities are frequently characterized by monopolistic or highly concentrated markets, large-scale operations, and huge investments. Second, SOEs make social objectives possible when economic incentives do not exist. SOEs can make basic services available to the whole population even through economic incentives do not exist or are negative, as in the case of wired telephone connections. Third, SOEs are crucial in supporting the development of particular areas or specific industries. This was the case for instance, of Southern Italy, where SOEs have heavily invested in the hope of igniting autonomous growth (Christiansen, 2011; Del Bo and Florio, 2012; Tõnurist and Karo, 2016). A combination of economic and social goals would characterize SOEs as organizations that pursue stability in lieu of change (Mintzberg, 1979) in the interest of the general public (OECD, 2015, 19).

Second, a more recent issue deals with the performance of SOEs vis-a-vis private companies. The general assumption is that SOEs would be *ceteris paribus*, less efficient than private companies in allocating resources for two reasons. First and foremost, SOEs often enjoy a monopoly status and are not designed to face competitive conditions, especially when new, disruptive business models emerge. This is, for instance, the case of the airline industry

in Europe, where national champions–once enjoying monopolistic status and recording huge profits–have experienced severe problems and often exited the industry once competitive conditions emerged through liberalization (Williams, 1994). Second, SOEs are normally designed to simultaneously achieve social and economic goals. Although in principle social and economic goals are not necessarily in conflict, managers would be constrained in their capacity to extract value from current operations as they must comply with political guidelines. Managers of SOEs would lack incentives to pursue efficiency (Ramamurti, 2000; Freund, 2001) due to administrative and political reasons (Shleifer and Vishny, 1994; Shleifer, 1998; Ramaswamy, 2001). However, despite SOEs being associated with scant economic efficiency, there is actually no full support of the hypothesis that firms' performance depends upon their ownership control–be it private, public, or privatized (Boardman and Vining, 1989; Dewenter and Malatesta, 2001). More recently, however, scholars found management culture, legislation, political goals, and competition to negatively impact SOEs efficiency much more than state ownership (Victor et al., 2011; Belloc, 2014).

Reasons why SOEs exist and performance issues are still central in the political and research agenda, but other–less clear-cut, evident but, perhaps, more fruitful matters have emerged recently. First, is the comparative political economic perspective of SOEs, as suggested by Millward (2011), who explores at large the relationship between States and companies (including SOEs). He found that for a long period, public policies in Western Europe aimed at ensuring national cohesion and external protection, more than economic growth and welfare. Second, is the government-firms interaction. The hypothesis is that the effectiveness of specific policies (e.g. those supporting the creation of global players) depends upon appropriate co-ordination mechanisms and proper incentives (Colli, Mariotti and Piscitello, 2014). Governments act not only as a rule-setter but also as a strategist with long-term goals. The key element is the alignment of interests between states and companies

with the emergence of coalitions that are relatively stable over time. These coalitions would make policies effective. Third, has to do with the role played by the State in innovation processes as discussed below.

2.2 SOEs and innovation

Since Arrow's seminal contribution, there are good theoretical reasons to acknowledge that to a considerable extent research and invention ought to be financed by governments or 'some other agency not governed by profit-and-loss-criteria' (Arrow, 1962, 623). It is no surprise that 'this has always happened to a certain extent' thanks to efforts made by research centres, universities, and individuals. The role played by the government goes beyond basic research and covers several stages of the innovation process. For example, the state supports entrepreneurs in the U.S. through the Small Business Administration (SBA); it encourages start-ups through incubators publicly funded, as in Israel; it directly invests in innovative companies through specific funds, as in the case of Finland (Mazzucato, 2016); and so on.

That States and governments are key actors in the innovation process should be indisputable, not only for their investments and for the resources they allocate, but also because they are often involved in adopting new technologies and processes (OECD, 2015). Although the available evidence is mostly anecdotal, there is the proof that breakthrough innovation can also occur in the public sector (Sahni et al., 2013). Paradoxically, successful innovations in the public sectors often occur in the presence of financial constraints and budget cuts, suggesting that the public sector is a major source of innovation and a possible catalyst for new solutions.

Literature on the role played by governments in innovation processes is extensive, but this is not the case of the role specifically played by SOEs. Empirical research on the link

between SOEs and innovation is scant and mostly centred around the role played by government-linked companies in newly developed countries. At a more micro level, scholars have investigated specific issues like knowledge spillovers from SOEs' activity (Molas-Galart and Tang, 2006, Munari et al., 2010, Musacchio and Staykov, 2011), inquired about the roadmapping abilities of SOEs to implement technological forecasting (Gershman et al., 2016; Vishnevskiy et al., 2015), and explored their absorptive capacity (Li, 2011).

Recent literature has re-evaluated the role played by SOEs, suggesting that their impact is much more relevant than previously assessed. According to this view, SOEs are a powerful mechanism of knowledge governance (Antonelli et al., 2014). The assumption is that knowledge spillovers are not all alike, and that necessary, complementary conditions must be in place to leverage their full potential. More specifically, knowledge spillovers' effects depend upon the characteristics of the source, the perspective user and the context in which knowledge spillovers occur (Antonelli et al., 2014). In the second wave of Italian industrialization that occurred in the second part of the 20th century, SOEs would have been excellent sources of knowledge spillovers, therefore playing a central role in generating and spreading new knowledge. More precisely, SOEs 'were able to feed the fast rates of total factor productivity (TFP) growth of the system with the provision of strong and far reaching spillovers carrying high quality knowledge externalities' (Antonelli et al., 2014, 44). Several factors explain the overall contribution of SOEs in producing and spreading new knowledge. First and foremost, SOEs are characterized by an institutional mix of property rights (shares controlled by IRI, a public holding company, but traded on the Stock Exchange), where public property paralleled the style of private entrepreneurship. Second, SOEs were given high managerial autonomy and long-term R&D projects were encouraged; this way, a national research system with labs in different domains was established, favouring the dissemination of high quality knowledge. Third, and more important, SOEs acted in Italy as

an open R&D system, performing in-house research commissioned from outside and commissioning projects performed externally. They operated as the interface between scientific research, through hundreds of projects with external structures, and the generation of new technological knowledge, that was accomplished through licenses, technology agreements, and joint-ventures with foreign multinationals. In the Italian case, SOEs were a powerful instrument of innovation policy, not only because they accounted for a large share of investments in R&D, but because they were central in producing and spreading new knowledge to the industrial system.

Other scholars highlight the role of SOEs as instruments of innovation policy, suggesting that the analysis at firm level ought to be accompanied with a macro level governance perspective. Tõnurist and Karo (2016) argue that SOEs provide an institutional setting where private incentives and risk taking behaviour, on one side, and public incentives and long-term orientation, on the other side, cohabit. Their double-faced nature and the ability to combine into a single organization a public and private role would make SOEs good candidates not only for producing and disseminating new knowledge, but also for coordinating and directing other actors that are needed for nurturing a national innovation system. This way, SOEs are conceived both as independent innovators, they pursue specific long-term innovation strategies in a specific domain, and as a policy instrument within a larger policy mix that can vary according to broader factors.

The rationale of SOEs in innovation activities is justified by more immediate feedbacks they can transfer to innovation policy makers as well as their risk-taking/experimentation capabilities (Tõnurist and Karo, 2016), within a framework that emphasises the co-evolution of micro-level managerial capabilities and macro-level policy capacities.

We argue that this co-evolution plays a key role in affecting the development of a national innovation system. This co-evolution, however, needs to be explored and examined in depth, as it requires an evaluation of several factors. First, coordination mechanisms put in place between SOEs and government/State agencies can have a relevant impact on innovation processes (Colli, Mariotti and Piscitello, 2016). Effective coordination mechanisms can facilitate transmission of information from companies to policy makers. They can also produce faster, more appropriate decisions at both levels. Second, alignment of several actors–as managers of SOEs, institutional committees and government–is crucial. Alignment emerges over time, producing stable coalitions. Alignment is not a static equilibrium, as it encompasses possible disagreements among key actors, who might have different preferences about critical issues. However, this alignment occurs thanks to a common vision and shared values.

The role played by SOEs in innovation processes depends upon two interdependent variables: decisions made at the company's level and policy guidelines set at the central level by a dominant coalition. If the dominant coalition is stable for an appropriate time and actors are aligned, SOEs can be successful in promoting and sustaining innovation processes thanks to their combinatorial capability. Combinatorial capability is the outcome of two different, intertwined, activities.

The first activity is the acquisition of knowledge. Acquisition of knowledge is essentially a process of search, screening, and recognition of existing pieces of knowledge, both from internal sources, either tacit or formal, and external knowledge by interaction with users and owners (Cassiman and Veugelers, 2006; Metcalfe, 2007; Arthur, 2009). Acquisition of knowledge in the case of SOEs has occurred to a large extent through both internal and external sources, as in the case of IRI (Antonelli et al., 2014). Managers of IRI operative companies enjoyed a significant degree of autonomy. Autonomy and managerial

skills made a broad search for new knowledge possible both from internal and external sources. These features supported the exchange of both codified and tacit knowledge from technological domains that in principle, were quite distant from each other. Such an exchange requires absorptive capacity and learning abilities (Nooteboom, 2000; Gilsing et al., 2008) between SOEs and private companies

The second activity is the recombination of knowledge. Recombination of knowledge, occurs when an organization has access to the internal and external knowledge repository of other organizations and is able to interact with them on a continuous basis. This recombination depends upon the quality and variety of knowledge sources (Graf and Krüger, 2011; Arikan and Knoben 2014).

The cquisition and recombination of knowledge is possible to the extent organizations are entitled to explore unfamiliar and possibly unknown domains. At the same time, permission to explore does not necessarily mean to be able to discover new valuable knowledge and to extract value from it. In the next section, we report the case studies of two SOEs that succeeded in exploring and discovering new knowledge, thus complying with the call for 'more detailed case studies of the few success stories of SOEs as innovation entrepreneurs' (Tõnurist and Karo, 2016, 641).

3. SOEs as knowledge explorer agents

3.1 Methods and case selection

Our analysis focuses on two different industries across two countries. We have chosen France and Italy because SOEs have always played a key role. We have triangulated anecdotal information, first-hand data, and secondary data to retrieve the formation and the evolution of Thales Alenia Spazio in the aerospace industry and STMicroelectronics in the

semiconductor industry. In their present state, both companies are the outcome of several mergers and acquisition processes that occurred at various stages. STMicroelectronics and Thales Alenia Space are illustrative of exploration processes undertaken in different high-tech industries and of a recombinant capability that allowed they to emerge as leading companies.

3.2 STMicroelectronics

STMicroelectronics (or ST) is nowadays a French-Italian multinational company based in Genève and the leading European firm in the semiconductor industry. STMicroelectronics is the world's sixth semiconductor producer in terms of earnings, with revenues of 6.2 billion € in 2015. It employs around 44.000 people, of which around 11.500 are in 16 R&D centres around the globe, from Milan and Catania in Italy, to Grenoble and Rousset in France, and others around the world including Singapore (STMicroelectronics corporate website), and owns more than 16 thousands patents (Cinici, 2013).

ST was formed in 1987 after the merge of French Thomson's semiconductor branch and Italian SGS (*Società Italiana Semiconduttori*). The decision of the merger resulted in a commercial success and was one of the most remarkable in the industry and in Europe (Coriat and Lucchini, 1995). More relevant, the company still is largely state-owned. The company has been the leading global supplier of analog circuits for telecommunications and the second largest for SRAM memories since 1992. At the time of the merger, the company's main shareholders were the French and Italian governments with 45% each. The key players in the ownership structure were respectively France Telecomm and Thomson on the French side, and IRI on the Italian side. It became partially public in 1994, with an initial public offering on the Paris and New York stock exchanges, and then in 1998, in Milan. The capital injection was useful for acquisitions, including the semiconductor divisions of Nortel in

Canada, Alcatel in France, and Genesis Microchip in the US. In the meantime, the original name SGS-Thomson changed to STMicroelectronics in 1997. In 2002, ST reached an alliance with Motorola, Philips, and Taiwan Semiconductor Manufacturing Company. In 2007, it created a joint venture with Intel in memory applications. By that time, ST was the first producer in Europe and the sixth in the world. Today, around 27.5% of its shares are equally controlled by French and Italian public bodies, i.e. *Cassa Depositi e Prestiti* and *Bpifrance Banque Publique d'Investissement* (STMicroelectronics, 2016, 73).

The older firm of the STMicroelectronics merger is SGS Microelettronica, which was the result of a merger, too. SGS, originally founded by Adriano Olivetti in 1957, and vacuum tube maker ATES (Aquila Tubi e Semiconduttori), a State Owned enterprise, merged in 1972. The second firm, Thomson Semiconducteurs, combined, in 1982, the State Owned Thomson's electronic division, evolved from the *Compagnie Generale de Telegraphie San Fil*s, with a handful of small electronic firms, and a few years later, with US integrated circuit manufacturer Mostek. SGS-Thomson formed to overcome the limits of small markets in France and Italy and to contrast the power of American, i.e. Intel and Motorola, and Japanese, i.e. NEC, semiconductor producers.

The two original companies were already a combination of spare technological capabilities, from telecommunications to electronics. The later merger further expanded the technological boundaries of the firm and overcame national borders. The challenge was in the control of existing resources and capabilities and the accumulation of new knowledge in a context of uncertain dominant design (Cabanes et al. 2016). However, keeping control over internal knowledge is not sufficient to sustain innovation. Large firms often expand beyond their own assets and capacities in search of complementary resources to reach full innovative capacity (Teece, 1986; Christensen, 2006). STMicroelectronics was successful in the application of a 'comprehensive up-front strategy' involving combinations, alliances, and

acquisitions in an open-innovation fashion (Christensen et al 2005, 1546); for examples, ST engaged with Apogee–an American specialist in amplifier technology–to form a partnership aiming at 'an interactive and evolving learning process based on a mutual recognition of the opportunities for innovative synergies between the two parties' (Christensen, 2006). An empirical analysis of 52 R&D projects conducted in an ST subsidiary over the period 1998-2003, shows a large use of co-operative partnership agreements either with universities (19), research centres (11), or firms (22), while the contracting of single activity is much higher with universities (21) than with other firms (4), leaving to research centres the supply of special services (Cassiman, Di Guardo, Valentini, 2009). The competitive advantage of ST is in discovering, accessing, mobilizing, and leveraging knowledge from a global network of localized sources (Doz, Santos, Williamson, 2001). The control of different sources of knowledge diversity, i.e. alliances, is then strategically important. In this respect, the autonomy granted to the management has been essential. The experience of Pasquale Pistorio as Ceo of ST between 1987 and 2005 is illustrative. He managed ST looking at both the interest of the State-ownership, and of the overall stakeholders, for example, by being one of the first companies to invest seriously in sustainability. However, his major contribution was in the organization of a worldwide company. He was able to manage an internal network of geographically dislocated 'micro' units, each with a distinct culture, devoted to targets coherent with the overall corporate vision (Pistorio, 2011, 207-208).

The ability to generate the power of diversity into a steam of innovation is at the base of ST's governance. Serendipity and coordination of knowledge boosted the enterprise's innovation (Santos, Doz, Williamson, 2004). Nevertheless, the organization of capabilities and knowledge diversity is a determinant for the adoption of the proper governance form. Governance of alliances through co-operative agreements seems insufficient to assure control compared to contracts (Cassiman et al., 2009). Conversely, however, an equity-based alliance

that spans across different activities is more suitable to transfer tacit knowledge and allows greater exchange and value creation than contracting for knowledge transfer performance (Chen, 2004).

The STMicroelectronics case highlights new innovation management issues. Scholars examined the innovative process in the ST case to present a balance of co-operative and competitive forces in R&D projects based on knowledge attributes, governance structure, and partner selection (Cassiman et al., 2009). ST shows an organizational evolution to deal with new and existing knowledge, internal and external expertise, and new instruments to organize and coordinate knowledge sources and the relative learning processes (Bigliardi, Galati, Petroni, 2011; Cabanas et al, 2016). The firm combined a strategy of specialization with organizational changes, 'aiming at taking advantage from the most up-to-date experiences about present sources and criteria of innovation and competitivity' (Coriat and Lucchini, 1995, 151).

The key to ST's success is its organization of knowledge for competences integration and its role as a hub of collaborations, co-operations, and partnership in the industry. In fact, organizing for competences integration goes beyond particular areas of technological knowledge; instead, it includes screening and acquisition of knowledge (Kogut and Zander, 1992). STMicroelectronics oriented its strategy around a strong external network. Within this network, ST has the role of system integrator, innovation architect, and knowledge coordinator of increasingly distributed and vertically disintegrated competences (Christiensen, 2006). Then, STMicroelectronics built a strategy of alliances to pool and combine complementary technologies. Strategic alliances allowed overcoming industrial boundaries. Around half of ST's sales comes from partnerships with 12 actors in four key industries: automotive, computer hardware, electronics goods, and telecommunications (Steve, 2004).

ST's network of collaboration goes beyond industrial partnerships. For example, in Italy it signed agreements with University of Catania and Sant'Anna School of Advanced Studies in Pisa (SSSUP). In Catania, the partnership with the local university aimed to educate personnel for its facility in Sicily (Cassar, 2002). The partnership with Sant'Anna looks at common research in bio-robotics, smart systems, and microelectronics (SSSUP, 2011).

Figure 1: **HERE**

3.3 Thales Alenia Space

20 years ago (in 1997) the mission Cassini-Huygens started its journey to the planet Saturn. The orbiter Cassini concluded its exploration of Saturn in April 2017, and it is currently expected to dive into the planet and be destroyed in its atmosphere. The probe Huygens landed on Saturn's moon Titan in January 2005, and since then has been sending data back to Earth including 350 pictures of the moon's surface. The mission took over 25 years and is now close to conclusion. It has been one of the major space scientific programs in decades. Many countries are participating in the mission, with a greater effort from the space agencies of the USA (NASA), Europe (ESA), and Italy (ASI). Enterprises from France and Italy have been particularly involved in the development of the spacecraft. French Aérospatiale was the prime contractor for assembling the probe and the scientific equipment, while the Italian Space Agency was in charge of the radio antenna, the Visible and Infrared Mapping Spectrometer (VIMS), and the radio-science subsystem for Cassini (Asi, Cassini-Huygens, 2017), for which Italian State-holding Finmeccanica was the main supplier. Nowadays, the companies originally involved in the project development of the mission merged in a leading European space company, Thales Alenia Space.

Thales Alenia Space formed in 2005 as a joint-venture between French telecommunication company Alcatel-Lucent and Italian aerospace and electronics company Leonardo (formerly Finmeccanica). The original name of the company was Alcatel Alenia Space before rebranding to the present name in 2006, following the acquisition of Alcatel's space activities by the French defence group Thales. The joint-venture is not equal; Thales owns 67% of the share, while Leonardo owns the remaining 33%. Both companies are State controlled. The French government is the first shareholder of Thales with around 25% of total shares (Thales, 2015); similarly, the Italian Ministry of Economy holds around 30% of Leonardo.

Theles Alenia Space operates in several business lines. It is among the world leaders in the design and production of satellites and payloads for telecommunications and navigation, and is the world leader in radar altimeters for operational space oceanography. It also operates in Earth observation, scientific exploration of space, and produces Orbital infrastructure and space transport. Thales Alenia Space is one of the major contractors of the International Space Station (ISS), having delivered over half of its pressurized volume. It posted revenues of 2.4 billion euros in 2016 and around 8.000 employees (Thales company website).

Today's company is a combination of technologies inherited from enterprises hardly related to space. It took a long way to reach full and systemic capabilities in space technologies. The origins can be traced into distant and yet complementary businesses. What is peculiar in this case is that, despite both companies and states pursuing a long-term strategy, there was not a clear understanding of space technologies as the ultimate goal of that strategy at its inception. The effort was instead in the continuous attempt to keep pace with the technological frontier that, at the time–in the second half of the 20th Century–was a matter of 'race' between superpowers. France traditionally pushes State Owned companies to

protect the independence of the nation from foreign technologies, even at the cost of inefficient techno-nationalism. Such fetishism toward national technological capacity explains the position of France in up-front technologies such as nuclear power, but even more unproductive efforts in industries like information-technologies (Nohara and Verdier, 2001). On the contrary, Italian enterprises were able to take part in many innovative industries, from nuclear power to informatics, yet a lack of government strategy, and especially of industrial policies, has cost the country's companies exit from many promising businesses. To see an Italian company in the space business today might seem a paradox. Instead, it is the result of an open-strategy to sustain not a particular business or picking a singular company, but rather to let technological competences cumulate in State Owned enterprises and recombine among them and/or with others, whether private or foreign.

The company had–at its creation–a large experience in several lines of business, from electronics to aeronautics, which turn out to be instrumental to the design, assembly, and operation of integrated space system (Tornincasa et al., 2008). On the French side, Alcatel Space merged the space activities of the mother company Alcatel–a world leader in telecommunications and network equipment founded in 1876–with the satellite's business of aerospace company Aérospatiale in 1998. Then, Alcatel Space reached a cooperation agreement with Thompson-CSF, an electronic company predecessor of Thales group. Both Aérosaptiale and Thomson-CSF were State Owned companies. Just a few years later, in 2001, Alcatel bought Thales' stake for €795 million (Thales, 2016,: 177). The Space division of Alcatel was transferred again to Thales in 2006, which assumed the actual name Thales Alenia Space. Thales followed the partial privatization of Thomson in 1998 and today operates mainly in the three areas of aerospace, defence, and electronics. It is a world leader in traveling wave tube technology, fundamental to telecommunications satellites.

On the Italian side, Finmeccanica–recently rebranded as Leonardo–was the holding company for the mechanical industries of the State Owned IRI group. Finmeccanica have operated in several industries since 1948, including automotive through Alfa Romeo; energy, transportation, and engineering through Ansaldo; and Aerospace through Aerospazio. Finmeccanica organized its business around aerospace and defence during the 1980s with the sale of Alfa Romeo and the acquisition of the electronic company Selenia, itself owned by IRI. Finmeccanica merged the space subsidiary of Selenia in Aeritalia in 1990, which later became Alenia. The merger consolidated a wide range of technological capabilities. Indeed, Aeritalia was the pursuance of IRI's aeronautic business Aerfer integrated in 1969 with private Fiat-Aviazione, a firm created to consolidate the national capabilities in the industry. On the other hand, Selenia started in Naples in 1961 as a partnership between Italian Edison and Finmeccanica with American Raytheon. Selenia was built around the competences in radar production and the operator of three small companies aggregated by IRI as part of Finmeccanica, which then attributed their capabilities to the partnership (Zamagni, 2009). It became alongside Aeritalia the main contractor of the Italian space program and among the firsts in the European Space Agency (Landoni, 2016). The consequences are two. First, Selenia spun off its space activities in 1982 with the formation of Selenia Spazio, Second, IRI arranged a further consolidation of the industry, this time aiming exactly at the space technologies, through the merge of Aeritalia and Selenia in 1990. Alenia Spazio operated in the satellite production and operations and in the space infrastructure manufacturing businesses, and was in active partner in many international partnerships, including the International Space Station.

Figure 2: **HERE**

4. Discussion

The two cases shed light on a pattern of technological (and industrial) evolution based on the active role of SOEs in exploring and organizing knowledge sources. Relevant to our discussion is that, despite the sources of knowledge being distant and apparently non matchable, their combination led to the emergence of new technologies and a novel industry (i.e. space) as result of an SOE assisted process of knowledge exploration. Because this SOEs provided the means of creation of the new technology.

SOEs in our case studies do not repeat the 'national champion' model, based on the three issues that deal with the government-business relation. First, they operate as multinationals in competitive markets without national protectionism. Second, although the companies are no longer 'national champions' in a strict sense, both the French and Italian states own relevant stakes, so that SOEs remain strategically connected to governments. Third, it follows that State-ownership is not detrimental to integration with foreign companies, and conversely one can speculate about possible advantages because of the limited case of comparable success of private multinationals in high-technologies in both countries.

Both our cases overcame national protectionism by merging with foreign firms. Economies of scale and industrial dynamics are surely mainsprings of internationalization; yet, the role of the SOE is still not neglected. Indeed, SOEs have been government-backed for years in the two countries, but our cases show greater liberty to evolve autonomously. Such evolution happened not just because the state picked a direction, but for the conditions it provided, a decentralized structure effective at learning and innovation, coordinated with policy expertise and intelligence, which resulted in SOEs as organizations that embrace the private autonomy of management and public mission. The first allows exploring and learning

with an entrepreneurial attitude, the second to avoid top-down decision and still assuring long-term commitment and strategic coordination with governments (Mazzucato, 2016).

STMicroelectronics is an example of an organization free to explore industrial solutions beyond its firm and national boundaries centred on a public mission of nurturing a semiconductor industry in Europe. Semiconductor technologies have been at the core of the development of ST since its origin. Since the general purpose of this technology allows for its application in multiple fields, from telecommunication to computers, different competences are required. The Italian side of the company was formed by the merger of computer manufacturer Olivetti's subsidiary with a vacuum tube producer. Around the same time, the French side resulted from the aggregation of electronic and telecommunication competences of various French companies, e.g. Compagnie Generale de Telegraphie San Fils, with the State Owned Thomson; yet the spectrum of capabilities was not enough to fulfil the production of advanced components like semiconductors. Thus, Thomson Semiconducteurs explored the most developed market for the industry, the US market, in search of the missing specialist capability. Eventually, Thomson acquired the chip maker Mostek from United Technologies in 1985 (von Tunzelmann, 1999, 144). Due to distance between a large French company and a small US firm caused the integration of Mostek in Thomson was not fully successful (Doz, 1987), it is still relevant for two reasons. First, it shows the will of a State Owned enterprise to look beyond its familiar domain and its effort to explore a technology-seeking acquisition; this provides more evidence from the increasing studies on the international merger and acquisition (M&A) activities of SOEs other than Chinese (Chen and Young, 2010). Second, it confirms how SOEs are important to innovation through the acquisition of foreign technology (Li, 2011).

ST overcame the cultural distance when the management was able to benefit from great autonomy, as stated by Pasquale Pistorio, first Ceo of ST (Pistorio, 201). Whether the

acquisition of US Mostek was not successful due to the cultural differences with a French SOE, ST later based its growth on a globalized network of research centres. The management of diversity is essential to innovative companies, the real key in explaining success and failure. On one hand, the independence of activities has been a boost for innovation; on the other hand, management has leveraged diversity as part of its corporate strategy, not subjugated to political-oriented, short-term goals, e.g. electoral support.

The activity of exploration of distant knowledge sources is even more evident in the case of Thales Alenia Space. First of all, space technologies simply did not exist in their present definition. Then, the few aerospace capabilities available were an insufficient base to start the space industry both in Italy and France. The industry emerged from a novel combination of aerospace, electronics, and telecommunications technologies. In France, Alcatel and Aérospatiale were respectively SOEs in the telecommunication and aerospace industries. They later merged in Alcatel-Space. Similarly in Italy, Aeritalia and Selenia were SOEs in aerospace and electronics. The latter enjoyed the collaboration with US based Raytheon for developing its radar activity. The two Italian SOEs formed Alenia in 1990.

The assembly of technological capabilities took several stages. Around 1990 two SOEs, Alcatel-Space in France and Alenia Spazio in Italy, were operating in the space industry. Market dimension and particularly the search for a greater synergy of activities prompted a further merger. Again, as in the case of ST, State ownership did not prevent the exploration of technological complementarities neither in foreigner nor different industries. Furthermore, the governance structure changed to adapt to the expansion toward international markets.

The two cases together highlight the ability of SOEs to explore and combine new knowledge despite differences in industry, market, and national identity. The process of technological combination has proved to be effective in the case of ST, which compete in a

global market of components for consumer electronics goods, as well as Thales Alenia Space, which conversely depends on demand strongly oriented to public buyers due to the minimum scale needed and the national interest linked to a defence-oriented industry. Both ST and Thales Alenia Space are expanding beyond their main area of activities. For example, ST has also been producing since the 90s SRAM memories and other memory devices in collaboration with Intel other than semiconductors, and it is collaborating with other industries, e.g. automotive. They were and are able to keep innovating on the basis of a firm's governance that continuously adapts the boundaries of the frim. Our observations show how ST and Thales Alenia Space growth has been based on the internal organization of externally acquired capabilities (Cassiman et al., 2009). This growth occurred through numerous acquisitions. As a result, the two companies are now leaders in Europe in their innovative domain and among the world leaders. Significantly, acquisitions did not follow a simple vertical integration strategy, but instead used a network that goes beyond their specific value chain both horizontally and vertically to access new technologies.

In this regard, the need for collecting and combining capabilities explains the choice of governance and organization (Argyres et al., 2012). Heterogeneity of capabilities is found in and across industries; however the need to capitalize on their recombination gives rise to a centralized governance mode. The centrality of the SOE model works as a hub that produces a vision shared between management and government, leaving autonomy to corporate management in the organization of the sources of knowledge. Such an organizational form appears extremely relevant. It allows changing the boundaries of the firm continuously over time; it has been able to overcome and learn from setbacks as happened in the Thomson case; it kept the dynamic process of exploration and acquisition of capabilities active and efficient in the long run. Indeed, these two cases show companies continuously dealing with protean redefinition of their industry, mainly due to multiple M&As. This ability to redefine one's

own industry by technological combination is not at all granted. Many are the stories of M&A failures in the private sector; take, for example, Daimler-Chrysler in the automotive industry and the failed merger Telit between telecommunication companies Italtel and Telectra in Italy.

The control of different sources of knowledge diversity as reported by ST's Pistorio is again significant. Lastly, one must note that the two SOEs are competing in industries not favorable to private companies from the same countries, e.g. computers' components manufacturer in France, and more broadly capital-intensive, high-technologies in Italy. Whether it is not the aim of this research to prove a supposed greater efficiency of this model with respect to private sector, it certainly is to suggest SOEs as mechanism with a great potential to start the engine of innovation.

5. Conclusion

SOEs were established in different times to reach a variety of objectives. Historical analysis and the economic literature offer a solid framework to understand their rationale and the role they have been played (Millward, 2010). From an empirical perspective, SOEs still do represent a key component of modern economies. This holds true both in newly developed countries–where SOEs continue to cover the lion's share in State managed economies–as well as in several Western economies, despite the privatization wave that occurred in the '80s.

SOEs have been investigated from several angles, mainly in reference to the traditional rationales that support their existence and their performances A few exceptions notwithstanding (e.g. Tõnurist and Karo, 2016), the vast majority of studies has not focussed

on the role of SOEs in innovation systems and technological development. This is quite surprising due to the increasing popularity of the 'entrepreneurial state' approach that highlights the centrality of governments and public policies in sustaining and implementing innovation processes (Mazzucato et al., 2013). According to this approach, governments and public policies bear most of the risk. They invest in long-term, basic research, whose results are available to private companies. Without the generous efforts of public institutions, private companies would not have been able to introduce breakthrough products. The case study of iPhone is purposely used to demonstrate the high indebtedness of private companies to public research.

The 'entrepreneurial State approach, with the exception of public banks, does not consider SOEs as a key component of the innovation processes. In a significant number of countries, data tell a different story (OECD, 2005). Our study suggests to analyse the role of the State from a more analytical perspective: the state can act as an entrepreneur–following the above mentioned approach–in different ways. Setting up SOEs is not the same as building research centres or other public initiatives. SOEs are companies. They can set up proper routines and organizational practices that are crucial for producing new knowledge and for innovation.

To shed full light on the role of State as entrepreneur, we need a thorough investigation of SOEs constituencies–compared to available alternatives–and outcome. In a large number of newly developed and mature countries, SOEs remain central both from an input and output perspective as far as the innovation process is concerned.

From an input perspective, SOEs not only account for a large share of R&D investments, but their researchers represents a significant proportion of the human capital committed to innovation. From an output perspective, available evidence–largely based on case studies–supports the view that SOEs contributed both to long-term research and

commercially oriented research. This is, for instance, the case of STMicroelectronics, who succeeded in a very competitive, technology intensive industry. Thales Alenia Space, on the other hand, emerged in an industry characterized by long-tem, public projects. As any organization, SOEs have tried to comply with external environment, in order to reduce their dependence. The two cases we have presented bear evidence of varieties of external conditions SOEs have met. SOEs have been facing not only favourable market conditions, as in the case of heavy regulated industries, but also very severe and competitive ones. Although evidence on this matter is largely anecdotal and based on case studies (Antonelli at al., 2014), it is not too much of a leap to argue that SOEs–as a specific form of public support–have been able to play a pivotal role as far as research and innovation are concerned. Still, SOEs are represented as 'second best': a large part of the existing literature argues that SOEs are comparatively less efficient than private owned enterprises (POE) both when governments are benevolent and malevolent (Belloc, 2014). Understanding under which conditions SOEs were able to perform successfully–as in the cases we have examined–could be highly beneficial, as we need to go beyond pure statements of intent.

There are good reasons to conclude that the 'pure effect of state ownership on innovation should be positive' (Belloc, 2014, 834). However, existing support of the positive effects of State intervention (not SOEs, as they are treated as interchangeable forms) is normally based on general properties such as the ability to deal with risks. More recently, scholars have pointed out that public companies might have a superior ability in exchanging knowledge through interindustry and intercompany relationships. We share the view that SOEs might be comparatively better equipped in setting up an effective set of interorganizational relations to support innovation. We suggest that this advantage might be due not only to the common ownership of several cooperating companies, as in the case of IRI (Antonelli et al., 2014) but also to a higher level of managerial autonomy compared to

private companies. Under specific conditions, and in the presence of a good alignment between managers and political economic decision-makers, SOEs can have more degrees of freedom in also establishing relationships with private companies.

Summing up, the two case studies presented here suggest to replicate and extend the investigation about SOEs and innovation. We suggest looking for invariants that can explain success and failure of SOEs. We have proposed that one of the successful invariants is the combinatorial capability of SOEs in knowledge creation. Scholars have acknowledged that innovative projects are by nature interdisciplinary, thus requiring companies to combine pieces of knowledge that can be far away from their mainstream. However, combinatorial capabilities leverage and require adequate organizational practices, as well as a sustainable organizational design. We posit that these two aspects play a key role in the evolution of SOEs and in their capacity to produce valuable knowledge over time. SOEs are not an homogeneous set of companies, whose only hallmark is public ownership. Some of them were able to produce not only technological, but also organizational, innovation. This organizational innovation–that as in the case of ST was accomplished through several waves of agreements and mergers–was crucial in making the survival and growth of the company possible. Future research will tell whether the components of this organizational innovation were exclusively internal or whether they were highly dependent upon a strong alignment between the company managers and the government.

Finally, our research warns about the complexity of the innovation landscape. The innovation landscape cannot be reduced to a simple dichotomy based on public intervention on one hand and private firms on another hand. Public intervention and private firms have different constituencies as far as basic knowledge and innovation is concerned. However, they are not homogeneous: public intervention occurs in different organizational ways that still need to be deeply examined. States support basic knowledge generation by financing

Universities, public research centres, and public-private long-term projects. SOEs are therefore a case in point that needs to be comparatively examined.

References

Amatori, F. and P. A. Toninelli. 2011. "Does an Italian model of State Owned enterprise exist?" In *Reappraising State Owned Enterprise: A Comparison of the UK and Italy*, edited by F. Amatori, R. Millward, and P. A. Toninelli, 31-49, Abingdon: Routledge.

Antonelli, C., F. B. Amidei, and C. Fassio. 2014. "The mechanisms of knowledge governance: State owned enterprises and Italian economic growth, 1950–1994". *Structural Change and Economic Dynamics*, 31: 43-63.

Argyres, N. S., T. Felin, N., Foss, and T. Zenger. 2012. "Organizational economics of capability and heterogeneity". *Organization Science*, 23(5): 1213-1226.

Arikan, A. T. and J. Knoben. 2014. "Sources of inter-firm heterogeneity in accessing knowledge-creation benefits within technology clusters." *Industry and Innovation*, 21(6): 476-493.

Arrow, K. J. 1962. "Economic welfare and the allocation of resources for invention". In *The rate and direction of inventive activity: Economic and social factors*, 609-626. Princeton University Press.

Arrow, K. J. 1969. "The organization of economic activity: issues pertinent to the choice of market versus nonmarket allocation". *The analysis and evaluation of public expenditure: the PPB system*, 1: 59-73.

Arthur, W.B. 2009. *The nature of technology: What it is and how it evolves*. New York: The Free Press.

Baliga, B. R., and T. J. Santalainen. 2006. "Transformation of State Owned enterprises in Estonia and India: an examination of the relative influences of cultural variations". *Journal of International Management*, 12(2): 140-157.

Battistella, C. and A. F. De Toni. 2011. "A methodology of technological foresight: A proposal and field study". *Technological Forecasting and Social Change*, 78(6): 1029-1048.

Belloc, F., 2014. "Innovation in State Owned enterprises: reconsidering the conventional wisdom". *Journal of Economic Issues*, 48(3): 821-848.

Bernier, L. 2014. "Public enterprises as policy instruments: the importance of public entrepreneurship". *Journal of Economic Policy Reform*, 17(3): 253-266.

Bernier, L. ed. 2014. *Public enterprises today: missions, performance and governance. Learning from fifteen cases*. Brussels: P.I.E. Peter Lang S.A.

Bigliardi, B., F. Galati, and G. Petroni. 2011. "Collaborative modes of R&D: the new challenges for personnel management". *International Journal of Business, Management and Social Sciences*, *2*(3): 66-74.

Boardman, A. E. and A. R. Vining. 1989. "Ownership and performance in competitive environments: A comparison of the performance of private, mixed, and State Owned enterprises". *the Journal of Law and Economics*, 32(1): 1-33.

Breznitz, D. and D. Ornston. 2013. "The revolutionary power of peripheral agencies: Explaining radical policy innovation in Finland and Israel". *Comparative Political Studies*, 46(10): 1219-1245.

Bruton, G. D., M. W. Peng, D. Ahlstrom, C. Stan, and K. Xu. (2015). "State Owned enterprises around the world as hybrid organizations". *The Academy of Management Perspectives*, 29(1): 92-114.

Cabanes, B., P. Galy, P. Le Masson and B. Weil. 2016. "Technical staff management for radical innovation in science-based organizations: a new framework based on design theory". In *R&D Management Conference*, 3-6 July 2016, Cambridge, UK: 1-14.

Cassar, S. 2002. “Sviluppo delle competenze e dell’occupazione nel settore della microelettronica in Sicilia (1963-2000)”. In *Il lavoro come fattore produttivo e come risorsa nella storia economica italiana*, edited by Zaninelli, S., and M. Taccolini, Milan: Vita e Pensiero: 435-444

Cassiman, B., M. C. Di Guardo, and G. Valentini. 2009. “Organising R&D projects to profit from innovation: Insights from co-opetition”. *Long Range Planning*, 42(2):. 216-233.

Cassiman, B., and R. Veugelers. 2006. “In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition.” *Management science*, 52(1). 68-82.

Chan, H. S., and D. H. Rosenbloom. 2010. “Four challenges to accountability in contemporary public administration: Lessons from the United States and China”. *Administration & Society*, 42(1s): 11S–33S.

Chen, C. J. 2004. “The effects of knowledge attribute, alliance characteristics, and absorptive capacity on knowledge transfer performance”. *R&D Management*, 34(3): 311-321.

Chen, Y. Y. and M. N. Young. 2010. “Cross-border mergers and acquisitions by Chinese listed companies: A principal–principal perspective”. *Asia Pacific Journal of Management*, 27(3): 523-539.

Christiansen, H. 2011. “The Size and Composition of the SOE Sector in OECD Countries”. *OECD Corporate Governance Working Papers*, 5, OECD Publishing.

Christensen, J. F., 2006. “Wither core competency for the large corporation in an open innovation world”. *Open innovation: Researching a new paradigm*: 35-61.

Christensen, J. F., M. H. Olesen, and J. S. Kjær. 2005. "The industrial dynamics of Open Innovation—Evidence from the transformation of consumer electronics". *Research Policy*, 34(10): 1533-1549.

Cinici, M. C. 2013. "Innovazione e network di conoscenza. Uno studio esplorativo del ruolo svolto dagli inventori centrali". *Atti del XXV Convegno annuale di Sinergie*, Università Politecnica delle Marche, Ancona.

Clifton, J., F. Comín, and D. Díaz Fuentes. 2006. "Privatizing public enterprises in the European Union 1960–2002: ideological, pragmatic, inevitable?" *Journal of European Public Policy*, 13(5): 736-756.

Clò, S., M. Di Giulio, M. T. Galanti, and M. Sorrentino. 2016. "Italian State Owned enterprises after decades of reforms: Still public?" *Economia Pubblica*, 3: 11-49.

Colli, A., S. Mariotti, and L. Piscitello. 2014. "Governments as strategists in designing global players: the case of European utilities". *Journal of European Public Policy*, 21(4), 487-508.

Coriat, N. and N. Lucchini. 1995. "Integrating R&D with manufacturing to build world-wide competitiveness: SGS-Thomson integrated circuits". In *Europe's next step: organisational innovation, competition and employment*, edited by Andreasen, L.E., B. Coriat, H. den Hertog, and R. Kaplinsky. Abingdon: Frank Cass and Company Limited: 151-166.

Del Bo, C. and Florio, M., (2012), "Public enterprises, planning and policy adoption: three welfare propositions". *Journal of Economic Policy Reform*, 15(4): 263–279.

Dewenter, K. L. and P. H. Malatesta. 2001. “State Owned and privately owned firms: An empirical analysis of profitability, leverage, and labor intensity”. *The American Economic Review*, 91(1): 320-334.

Doz, Y. L., 1987. “Technology partnerships between larger and smaller firms: Some critical issues”. *International Studies of Management & Organization*, 17(4): 31-57.

Doz, Y. L., J. Santos, and P. J. Williamson. 2001. *From global to metanational: How companies win in the knowledge economy*. Cambridge: Harvard Business Press.

Doz, Y. L., J. Santos, and P. J. Williamson. 2004. “Is your innovation process global?” *MIT Sloan Management Review*, 45(4): 31.

Freund, E. M. 2001. “Fizz, froth, flat: The challenge of converting China’s SOEs into shareholding corporations.” *Policy Studies Review*, 18: 96-111.

Gershman, M., S. Bredikhin, and K. Vishnevskiy. 2016. “The role of corporate foresight and technology roadmapping in companies' innovation development: The case of Russian State Owned enterprises”. *Technological Forecasting and Social Change*, 110: 187-195.

Gilsing, V., B. Nooteboom, W: Vanhaverbeke, G. Duysters, and A. van den Oord. 2008. “Network embeddedness and the exploration of novel technologies: Technological distance, betweenness centrality and density”. *Research Policy*, 37(10): 1717-1731.

Girma, S., Y. Gong, and H. Görg. 2009. “What determines innovation activity in Chinese State Owned enterprises? The role of foreign direct investment”. *World Development*, 37(4): 866-873.

Graf, H., and J. J. Krüger. 2011. “The performance of gatekeepers in innovator networks”. *Industry and Innovation*, 18(1): 69-88.

Guriev, S., and W. Megginson. 2007. “Privatization: What have we learned?” In Annual World Bank Conference on Development Economics—Regional 2007: Beyond Transition, edited by Bourguignon, F., and B. Pleskovic: 249-96. Washington, DC: World Bank

Kirzner, I. M. 2000. *The Driving Force of the Market: Essays in Austrian Economics*. Abingdon: Routledge.

Kogut, B. and Zander, U., 1992. “Knowledge of the firm, combinative capabilities, and the replication of technology”. *Organization science*, 3(3): 383-397.

Kowalski, P., M. Büge, M. Egeland, and M. Sztajerowska. 2013. “State Owned Enterprises: Trade Effects and Policy Implications”, *OECD Trade Policy Papers*, No. 147, OECD Publishing.

Landoni, M., 2016. “The Public Private Partnership in the Italian Satellite Telecommunication System Design”. In *Infrastructure Finance in Europe: Insights Into the History of Water, Transport, and Telecommunications*, edited by Cassis, Y., De Luca, G., Florio, M.: 297-311. Oxford: Oxford University Press.

Lee, J. 2009. “State Owned Enterprises in China: Reviewing the Evidence”. *OECD Occasional Paper*: 6-7.

Levy, J. D. 1999. *Tocqueville's revenge: state, society, and economy in contemporary France*. Harvard University Press.

Li, X. 2011. “Sources of external technology, absorptive capacity, and innovation capability in Chinese State Owned high-tech enterprises”. *World Development*, 39(7): 1240-1248.

Mazzucato, M. 2013. *The Entrepreneurial State: Debunking Public vs. Private Myths in Risk and Innovation*. London: Anthem Press.

Mazzucato, M. 2014. "A Mission-Oriented Approach to Building the Entrepreneurial State". *Innovate UK* (November). Available at http://marianamazzucato.com/innovate-UK.pdf

Mazzucato, M. 2016. "From market fixing to market-creating: a new framework for innovation policy". *Industry and Innovation*, 23(2): 140-156.

McCloskey, D. N. 2010. "A Kirznerian Economic History of the Modern World". *Annual Proceedings of the Wealth and Well-Being of Nations* 3: 45–64.

Metcalfe, J. S. 2007. "Alfred Marshall's Mecca: Reconciling the theories of value and development". *Economic Record* 83 (S1): S1-22.

Millward, R., 2011. "Public enterprise in the modern western world: an historical analysis". *Annals of Public and Cooperative Economics*, 82(4): 375-398.

Mintzberg, H. 1979. *Structuring of Organizations*. Englewood-Cliffs, NJ: Prentice-Hall.

Molas-Gallart, J., and P. Tang. 2006. "Ownership matters: Intellectual Property, privatization and innovation". *Research Policy*, 35(2): 200-212.

Munari, F., R. Oriani, and M. Sobrero. 2010. "The effects of owner identity and external governance systems on R&D investments: A study of Western European firms". *Research Policy*, 39(8): 1093-1104.

Musacchio, A., and S. G. Lazzarini. 2014. *Reinventing State Capitalism: Leviathan in Business, Brazil and Beyond*. Cambridge: Harvard University Press.

Musacchio, A., and E. Staykov. 2011. "Sovereign wealth funds: barbarians at the gate or white knights of globalization?" Harvard Business School Case: 712–022.

Nohara, H., and E. Verdier. 2001. “Sources of resilience in the computer and software industries in France”. *Industry and Innovation*, 8(2): 201-220.

Nolan, P. and Xiaoqiang, W., 1999. “Beyond privatization: Institutional innovation and growth in China's large State Owned enterprises”. *World Development*, 27(1): 169-200.

Nooteboom, B. 2000. “Learning by interaction: absorptive capacity, cognitive distance and governance”. *Journal of Management and Governance*, 4(1-2): 69-92.

OECD, 2005. *Governance of Innovation systems*. Paris: OECD Publishing.

OECD, 2014. *The Size and Sectoral Distribution of SOEs in OECD and Partner Countries*. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264215610-en

OECD, 2015. *Guidelines on Corporate Governance of State-Owned*. *Enterprises*. Paris: OECD Publishing. https://www.oecd.org/daf/ca/OECD-Guidelines-Corporate-Governance-SOEs.

Pistorio, P., 2011. “Proprietà, management e governo dell’impresa”. *Sinergie rivista di studi e ricerche*, 73-74(7): 205-208.

PWC, 2015. *State Owned enterprises: Catalysts for public value creation*? https://www.pwc.com/gx/en/psrc/publications/assets/pwc-state-owned-enterprise-psrc.pdf

Ralston, D. A., J. Terpstra-Tong, R. H. Terpstra, X. Wang, and C. Egri. 2006. “Today’s State Owned enterprises of China: Are they dying dinosaurs or dynamic dynamos?” *Strategic Management Journal*, 27: 825–843.

Ramamurti, R. 2000. “A multilevel model of privatization in emerging economies”. *Academy of Management Review*, 25: 525–550.

Ramaswamy, K., 2001. “Organizational ownership, competitive intensity, and firm performance: An empirical study of the Indian manufacturing sector”. *Strategic Management Journal*, 22(10): 989-998.

Sahni N., M. Wessel, and C. Christensen. 2013. “Unleashing Breakthrough Innovation in Government”. *Stanford Social Innovation Review*, Summer.

Shleifer, A. 1998 ‘‘State versus private ownership.’’ *Journal of Economic Perspectives*, 12: 133–150.

Shleifer, A., and R. W. Vishny 1994 ‘‘Politicians and firms.’’ *Quarterly Journal of Economics*, 109: 995–1025.

SSSUP. 2011. *STMicroelectronics e l'Istituto di Biorobotica della Scuola* http://www.sssup.it/UploadDocs/11821_Comunicato_ST_santanna.pdf

Stan, C. V., M. W. Peng, and G. D. Bruton. 2014. “Slack and the performance of State Owned enterprises”. *Asia Pacific Journal of Management*, 31: 473–495.

Steve, B., 2004. “Il successo di un'azienda nata nel posto sbagliato”. *L'industria*, *25*(1), pp.83-98.

STMicroelectronics, 2016. “2015 Annual Report”. Washington DC: Securities and Exchange Commission.

Teece, D. J., 1986. “Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy”. *Research Policy*, 15(6): 285-305.

Toninelli, P. A., and M. Vasta. 2011. “Size, Boundaries, and Distribution of Italian State Owned Enterprise (1939-1983)”. Reappraising State Owned Enterprise. A comparison of the UK and Italy, edited by Amatori, F., R. Millward, and P. A. Toninelli: 68-99. Abingdon: Routledge.

Tõnurist, P., and E. Karo. 2016. “State owned enterprises as instruments of innovation policy”. *Annals of Public and Cooperative Economics*. 87(4): 623-648.

Tornincasa, S., M. Alemanni, G., Alessia, and E. Vezzetti. 2008. “Key performance indicators for PLM benefits evaluation: The Alcatel Alenia Space case study”. *Computers in Industry*, 59(8): 833-841.

Trebat, T. J. 1983. *Brazil's State Owned enterprises: a case study of the state as entrepreneur*. Cambridge University Press.

Victor, D. G., D. R. Hults, and M. C. Thurber ed. 2011. *Oil and governance: State Owned enterprises and the world energy supply*. Cambridge University Press.

Vishnevskiy, K., D. Meissner, and O. Karasev. 2015. “Strategic foresight: state-of-the-art and prospects for Russian corporations”. *Foresight*, 17(5): 460-474.

Von Tunzelmann, N. 1999. “‘Convergence’ and corporate change in the electronics industry”. In *The organization of economic innovation in Europe*, edited by Gambardella, A., and F. Malerba: 125-157. Cambridge University Press.

Williams, G. 1994. *The airline industry and the impact of deregulation*. Burlington: Ashgate.

Zamagni, V., 2009. *Finmeccanica: competenze che vengono da lontano*. Bologna: Il Mulino.

Figure 1: **STMicroelectronics**

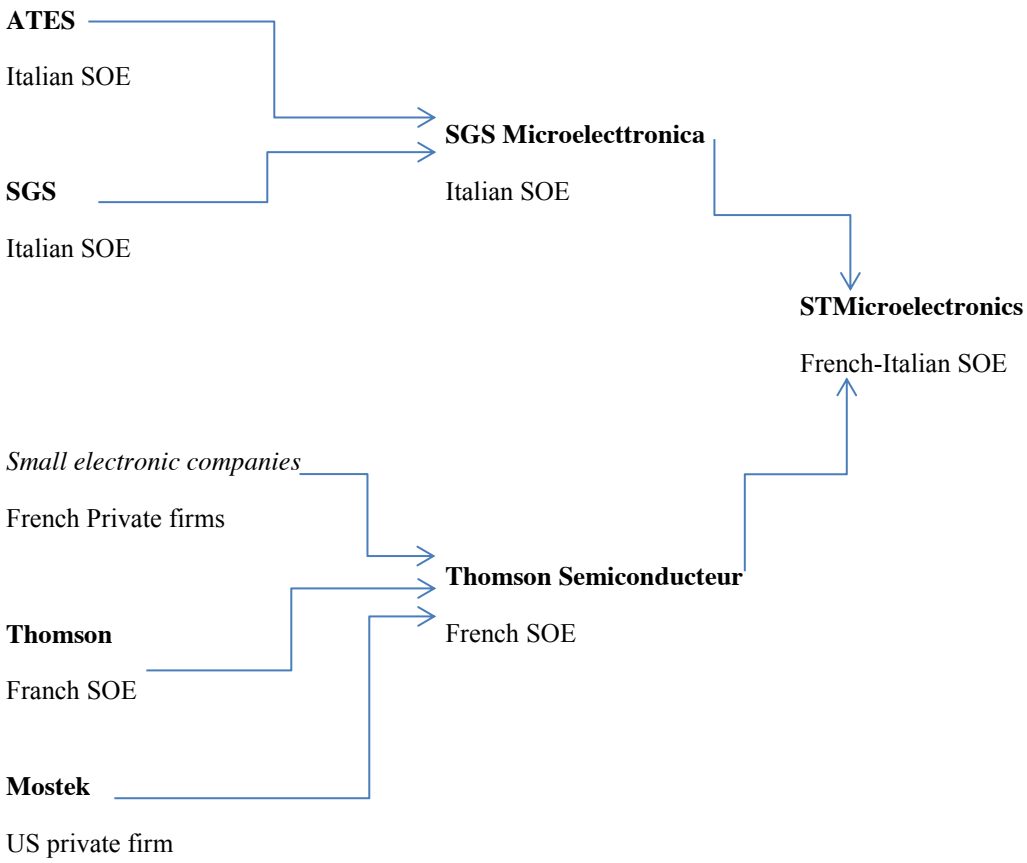

Figure 2: **Thales Alenia Space**