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THE PUBLIC-PRIVATE PARTNERSHIP IN THE ITALIAN SATELLITE TELECOMMUNICATION SYSTEM DESIGN: SIRIO AND ITALSAT (1969-1996)

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The Public-Private partnership in the Italian satellite telecommunication system design: SIRIO and Italsat (1969-1996).

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ABSTRACT

In the last decades of the XX Century the expansion in telecommunications urged the development of an innovative satellite network infrastructure. Satellite telecommunication-a network technology-presents public-good characteristic and high-cost and technological-risks. The case of the design of the Italian satellite telecommunication system consists in a peculiar case of public-private partnership (PPP).

This paper compares the Sirio and Italsat satellites systems to highlight the differences in the partnership agreements between the public buyer and the firms involved. In both cases the government provided clear signals of market demand to spur innovative activity, however, contractual obligation proved decisive. In the latter case, the public financial support took the form of a purchase agreement of a service with specific requirements at a specific time in the future, creating incentives for innovation and on-time and on-budget implementation. A public agency then was created to coordinate the research efforts of different firms reducing cost and opportunistic threats.

Keywords: Procurement, Public-private partnership, research and development agreement, space industry.

JEL Classification: N44, N74, 031, 038

Introduction[1]

Among the technical infrastructures that support a society, telecommunications are increasingly important. In the last two decades of the past Century the introduction of digital services techniques and the progressive reduction of transmission costs led to an increase in telecommunication demand, and consequently pushed for an expansion of the telecommunication infrastructures. Also, telecommunications became vital for business in the context of globalization in the post cold-war era and a main source of economic activity.

This paper explores the evolution of the form of partnership between public and privates that aims to deliver innovative types of telecommunication infrastructure. Satellite telecommunication was an emerging, high-cost, and high-risk technology that introduced a relevant technological change in the way people communicate. Such an infrastructure is clearly a public-good, often only a State can afford it. However, it is not just a matter of financial supply that guarantees the development of a complex technology. To obtain the best result, the public side of the partnership should explore the market for the proper capabilities available, design a feasible project, manage incentives for its realization and share the risk of the innovative process. In a process of "trial and error" arrangements, the Italian government was able to launch two satellite system successfully between 1969 and 1996, creating an effective institutional framework for the investment in research and development of firms with the support of public finance and governmental coordination.

Methods and motivation

The research here presented aims to investigate the peculiar effect of public-private agreement to develop a new technology on the base of the manifested public demand. Furthermore, it proposes an evaluation of process of technological procurement that may result beneficial to policy-makers.

A public-private partnership can be established to introduce a relevant novelty in the pursuing of a solution to a new or unsolved need. The State can cover all the cost connected to the research process in the case of a risky technology. Despite the financial coverage, the formulation of the agreement with a private company is far from delivering the outcome in the proper way. It may leave room for an innovative mode of linking the availability of financial resources with the development of a new technology. In stand of financing research and

[1] This paper is based on a previous presentation held at the XI Milan European Economy Workshop "The History of European Infrastructure Finance", 22 June 2012, University of Milan.

development indiscriminately or subsidized the installation of an infrastructure in exchange of exclusive rights, a government may use public procurement to trigger the development of a new technology. While the mechanism of standard public procurement is not connected with technological innovation, technological public procurement sets specific requirements to be developed by the private contractor. Then, public financial resources are used to fulfill the purchase agreement once the product is finished by date and respect the requirements. However, the risk avoided by such a mechanism of procurement is the achievement of a minimum market demand for the newly developed product, while the entire risk of product development and its technological feasibility is still handled completely by the private contractor. Then, the public buyer has a potential great role in providing technological trajectories to the private contractors in order to reduce uncertainty about the feasibility of the demanded solution.

Exploring the pattern of negotiation and specification of the technological requirements would allow to better understand which conditions permit the most convenient mechanism of public funding of private technological development of an innovative infrastructure. For those reasons the methods selected is the analysis of the procurement of a infrastructure with high cost of research and development as a telecommunication satellite system is. Two sequential procurement agreement are explored longitudinally to compare benefits and pitfalls of the two experiences, putting in light the “trial and error” effort made to improve the partnership.

The most suitable method that might help to observe and describe a phenomenon is an in-depth cases study (Stuart *et al.* 2002, Browning and Heath 2009), as well as to increase the understanding of it (McCutcheon and Meredith 1993; Handfield and Melnyk 1998; Meredith 1998). A case-study research methodology is then particularly fitted to provide insights for further empirical research (Yin 2003). Even a single case-study can inspire new ideas and show how the conceptual argument might actually be applied to reality (Flynn et al. 1990; March *et al.* 1991; Siggelkow 2007).

The case selected regards the design of a satellite telecommunication system in Italy between 1971 and 1996. The satellite infrastructure was public and committed by the national government to private companies to fit technical requirements which forced them to pursuit incremental innovations in the satellite system design. The public purchase was motivated by a perceived future need - the increase of traffic demand - and therefore it can be considered the public procurement of a not yet existing technology. Two different satellite system are observed: *Sirio*, started in 1969 and launched in 1977; and *Italsat*, developed between 1981 and 1991, with a further satellite within the same program launched in 1996. The comparison of two cases

allows to test the independent variable correspondent to the different financial and technical agreement that formed the public-private partnership.

Theoretical framework

When a government acts as a buyer of a product to be developed in order to forestall a future need and for doing so sets requirements to be fulfilled, that government is using a demand-tool of innovation policy.

Demand-driven innovation policies are measures that induce or speed up the production of knowledge and innovations through public demand or by supporting private demand. Edler (2009) has defined demand based innovation policies "a set of public measures to increase the demand for innovations, to improve the conditions for the uptake of innovations and/or to improve the articulation of demand in order to spur innovations and the diffusion of innovations".

Research on the impact of demand on new product development strategies has investigated the influence of consumer needs on technology development at the level of technology projects (von Hippel 1988; Lynn, Morone, and Paulson 1996), business strategy (Kim and Mauborgne 1997; Day 1990, MacMillan and McGrath 2000) emerging competition (Adner 2002) and the broader evolution of technological trajectories (Abernathy and Clark 1985; Malerba 1985; Christensen 1997; Sutton 1998; Malerba *et al.* 1999; Adner and Levinthal 2001; Tripsas 2001).

In the case of a infrastructure network, public demand is often essential to reach a minimum scale effect needed to overcome the high entry cost of a new developed product, service, or process, creating the market conditions for its diffusion. Then, when demand is sufficiently strong and clear, the market can provide influences on innovative activities (Porter 1990).

However, not every demand policy focuses on innovation. For instance, standard public procurement is the purchase of an existing product or service by a public authority that does not explicitly imply any innovation. Conversely, public procurement to effectively foster innovation demands for something, either product or service, that need to be developed. Edquist and Hommen (2000) defined public technology procurement the purchase "of a not-yet-existing product or system whose design and production will require further, if not completely novel, technological development work". The functional requirements of the product are predefined by the government, but the realization and development are not (Rothwell and Zegveld 1981; Geroski 1990; Aschhoff & Sofka 2009). The positive impact of public procurement on

innovation activities is related to the nature of many research-intensive industries such as aviation and military related, where public administrations are the main source of demand and act as lead users for innovations.

Governments use innovation policies to strengthen the link between knowledge production and the final high-tech product (Borrás 2001). In the case of complex technologies, governments may set up dedicated institutions in order to better design requirements and feasibility in the form of technical agency. As prescribed by institutional theory, institutions exist to reduce constraints in the transfer of knowledge; according to this view, public agency deals with procurement of innovation as intermediaries of demand and technological supply which can easily evaluate concepts and their feasibility (Schoormans *et al*. 1995; Veryzer 1998). The expertise of the agency then combined with the big market share available to the public buyer mixed the relevant product development information with a clear market sign to buy the new product beyond the minimum share needed to overcome the cost of production, making more informed assessments (Ozer 2009). Especially in the case of high performance products, governments may play a relevant role, quite often in the very early phase of the product cycle (Dalpé *et al.* 1992) as it was proved in the case of defense-related demand (Stoneman 1987; Lichtenberg 1989; James 2004). Innovative infrastructure with dominant design should be considered a natural area for innovation made through public-private partnership.

Satellite telecommunication infrastructure in Italy, 1969-1996

Since the beginning of the satellite era (USSR launched the Sputnik in 1956) space has been used for human purpose, including every-day activities such as communications. Progressively, the satellite bandwidth allocated to telecommunication services reached saturation. Yet in the Sixties, when the 4-6 GHz band was close to its maximum traffic capacity, the search of frequency bands around 12 and 18 GHz started.

At the 1971 World Administrative Radio Conference (WARC) in Geneve[2], the frequency slots above 10 GHz were formally defined and assigned to the satellite telecommunication services. The new frequency increased the capacity of international commercial satellite communication and made possible the competitive advent of domestic satellite systems[3].

[2] http://www.itu.int/en/history/radioconferences/Pages/1979-WARC.aspx

[3] G. Perrotta, "Historical Perspective: The SIRIO-1 Satellite, a Precursor of the Commercial Ku-Ka_band Satellite Communications". 15th KA and Broadband Communications, Navigation and Earth Observation Conference, September 23, 2009, Cagliari, Italy; p. 1.

Only two years before, in 1969, the "Sirio Project" started as an Italian offspring of the European Eldo-PAS program. This satellite aimed to do propagation experiments in the 12 and 18 GHz band intended for telephony and television transmission. The experiments made by the Sirio satellite would have been relevant to the European countries for the acquisition of data valid for systems operating in the Ku_band and in Ka_band. Indeed, from 1981 to 1985, Sirio-1 was the only spacecraft emitting signals available in Europe[4].

The Sirio experiment served well the needs of communication system designer for the realization of the first European commercial satellites in the second half of the Eighties. The European Space Agency (ESA) launched Olympus in 1989, but it had to be withdrawn from service in 1993 due to malfunctions. It was again Italy that launched in 1991 the Italsat F-1 satellite, followed in 1996 by the Italsat F-2, for the continuation and expansion of the Q band and propagation of experiments in wider bands. Again, the main purpose was to enlarge the telecommunication traffic capacity of the satellite infrastructure, this time not exclusively for phone communication but aiming the emerging satellite television market.

Public contract and private development

Despite its scientific and technical success, Sirio satellites suffered several difficulties during its development, mainly due to a lack of contractual guarantees. The Sirio project started in 1969 was managed by the Italian National Research Council (*Consiglio Nazionale delle Ricerche*, CNR), it lasted until 1974 with the industrial contractors participating at the study and development phases. Prime contractor was the *Compagnia Aerospaziale Italiana* (CIA) -a company participated by *Selenia Industrie*- NASA (for the launcher, the ground infrastructure and the launch itself), Fiar for the subsystem and SNIA for the propulsion system. However, during the first 5 years period there were not contractual obligations for CNR to financially take risk in the project development; hence, since the whole risk in the realization of the Sirio satellite was fully taken by the companies, the lack of incentives caused a slow down in the activities.

Only in 1974 a contract was signed by the two sides, the public costumer CNR and private and State-owned companies, speeding up the activities that concluded within less than three years. The shift from an open, informal agreement to a *public-private partnership* (PPP) was not only an improvement of the financial and operational conditions of the project, but also a major change in the way the work was managed. The agreement overcame the old way of

[4] Ivi, p. 2.

scientific effort careless of timing and results towards a more enterprise-oriented way of measurement of cost, coherence and schedule of the results on time.

The experience of Sirio made clear the existence of an insufficient contractual framework to incentive the development of risky innovation in public infrastructure. Firstly, the complexity of the technology has kept the private companies far from doing the research by themselves due to the high cost and uncertainty. Secondly, the different competences needed hardly are embodied in an unique firm. Many companies are called to work in team, as in the Sirio case, increasing the risk connected to opportunistic behavior in information sharing. Other than market uncertainty, government may help to overcome opportunistic behavior among collaborating firms operating as a genuine knowledge broker in the innovation process. Indeed, for the second satellite system, the Italian government tried to find a solution to the first problem by creating a public funds for space activities as part of the research and industrial policies, the National Space Plan.

The first National Space Plan (*Piano Spaziale Nazionale*, PSN) started in Italy in 1979 for the financing and management of the space activities, either within the European framework of ESA and at the national level with the aim of helping the consolidation of an high technological domestic industry. The PSN was financed with public funds attributed every year by the government on the basis of a five year plan. As the previous public space activities of Italy it was managed by CNR on behalf of the Minister of scientific and technological research.

The Italsat satellite telecommunication system was developed in the context of the PSN to avoid uncertainty about the willing of the public to conclude the deal. The whole project was split in different phases, each ones assigned to a specific company pursuing a specific task. In the first step ("phase A") Telespazio –controlled by the telecommunication state-holding STET– was in charge of the evaluation of the technological development. The development of the industrial prototype ("phase B") was assigned to the space division of Selenia and concluded in January 1984. The "phase C1" ("bridge") for the realization of the satellite was again assigned to Selenia in March 1984, which in the meanwhile made a spin-off of its space division in an independent company controlled by the state-holding STET, *Selenia Spazio*. For the realization of the "bridge" step, the government signed an agreement for 26.429 million of Italian Lire[5].

While the Italian National Research Council (CNR) was responsible for the development of the space segment and the ground segment major elements to demonstrate the technology

[5] 26.429 million of Italian Lire in 1984 are equal to 66336.79 million in 2011, converted in 34275.86 Euro. Archival Source: ASI (Agenzia Spaziale Italiana, Rome. I am grateful to Eng. Delfina Bertolotto for granting me the consultation of archives)

readiness and the system capabilities, Selenia Spazio was prime contractor of the industrial development alongside other private companies[6]. Beside the partnership agreement, Selenia received in 1985 a loan from IMI (Istituto Mobiliare Italiano) of 3.2 billion of Italian Lire in funding for the telecommunication satellite project and another loan of the same amount from the "Fondo speciale per la ricerca applicata" ("*special fund for applied research"*) directly granted by the Italian Government[7]. Selenia has collaborated at the satellite platform alongside Aeritalia, SNIA BPD, Galileo (for sensors), Fiar, Laben (for telemetry) and other international groups. Siemens Telecommunications has contributed for the payload of the satellite, i.e. the various "packages" of communications, and FIAR for TDMA modulators on board the satellite, and FIAR. Siemens Telecommunications, and Telettra Fiat participated at the ground stations realizations[8].

The estimated date for the lunch of the satellite was 1988. After the spacecraft would be in orbit, the first eight months period have been dedicated to test the telecommunication system about performances related to traffic, atmospheric effects, and voice, data, video-conference and TV broadcasting. CNR would have transferred the system operations responsibility after the experimental stage to Telespazio on behalf of the Italian telecommunication company SIP.

Italsat: technological design

The Italsat project has consisted of two telecommunication satellites (named *F1* and *F2*) launched respectively in 1991 and 1996 from the space centre of the European Space Agency in French Guyana. According to what stated by the ASI president at that time, prof. Luciano Guerriero, it was "not intended to be a communications satellite similar to those already existing on the international market: it was a program which foresaw a wide range of technological innovations, as well as a breakthrough in the field of space telecommunication systems integrated in a ground network"[9]. Indeed, the Italsat F1 provided 30 GHz (uplink) and 20 GHz (downlink) to the Italian domestic coverage using six spot beams and a "global" national beam. The global beam provided three transparent transponders each of which has a 36 MHz RF

[6] Dinaro, M.; Marconicchio, F.; Saitto, A.; Saggese, E.; Morris, A., Italsat - The first preoperational SS-TDMA system. In: GLOBECOM '88 - IEEE Global Telecommunications Conference and Exhibition, Hollywood, FL, Nov. 28-Dec. 1, 1988, Conference Record. Volume 3 (A89-26753 10-32). New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 1774-1778.

[7] Archival Source: ASI. 3.2 billion Italian Lire in 1985 equal to 3.8 million Euro.

[8] Marconicchio, F., De Padova, S., Valdoni, F., The Communications Mission. Rivista Tecnica Selenia, III(4), 1990, pp. 27-39.

[9] *Ibidem.*

bandwidth. These were intended to carry 24.576 Mbits/sec QPSK or analog frequency modulation (FM) television. The adoption of the Ka_band (20-30 GHz) aimed to overcome the imminent saturation of the lower frequencies. The adoption of the Ka_band resulted in a significant space saving both of on board and ground antennas. The transponders and the demodulators were particularly innovative and a considerable step forward of the state of the art[10].

The Italsat F1 was intended to be experimental, while the F2 was supposed to be the operational one on the basis of the results achieved by the test carried on the F1. When Italsat F1 was launched it was among the more sophisticated communications satellites and it was used for the further design of the European satellites Artemis and DRS, and for the Korean homologous Koreasat.

The operational life of the Italsat project lasted for a little more than a decade (1991-2002). The satellite telecommunications faced in the Nineties the challenge brought in by fiber optic evolution and diffusion, a technological competitor. Nevertheless the satellites flexibilities allowed the application of telecommunication technologies other than civil use, as it was the coverage of military communication in Bosnia. The Italsat F2 included military payloads supporting the military program SICRAL, and providing the first European implementation of on-board processing.

The Italsat F2 did not carry any propagation experiment, it only used a 20-30 GHz communication advanced transponder. Nevertheless, Italsat-2 was withdrawn from service by mid-2002, without any substitute able to the gathering of propagation data in the MMW bands[11].

Satellite	*Launch date*	*PPP* (Public buyer - Prime private contractor)	*Experimental freq. bands (GHz)*	*Geographical availability*
SIRIO	August 1977	CNR - CIA	11.5 and 18 GHz	Europe. For 7 years
Italsat F1	January 1991	CNR/PSN - Selenia	20-30 GHz (18.7 / 39.6 / 49.5 experimental)	Europe. For 10 years
Italsat F2	August 1996	ASI - Selenia Spazio	20-30 GHz	Europe. Till July 2002

[10] *Ibidem.*
[11] Perrotta, The SIRIO-1 Satellite, op. cit.

Public-private partnership (PPP): Sirio and Italsat

The case of the *public-private partnership* (PPP) for the development of satellite telecommunication in Italy is of particular interest; other than for the technological implications of such infrastructure, it is interesting for the different actors involved. The terms public–private partnership generally refer to forms of cooperation between public authorities and private firms in order to ensure the funding, construction, renovation, management or maintenance of an infrastructure or service[12]. A particular form of PPP that combines the advantages of competitive tender and flexible negotiation is the *private finance initiative* (PFI). PFI transfers risks away from the public sector to the contractor, responsible for both the construction of the asset and the provision of related services. In the Italsat case, only the technological risk was transferred to private. Indeed, funds were mainly public and provided by government to finance industrial research and development.

A main focus of PFI is the shift of the perspective from the procurement of assets to the purchase of services. Governments makes a contract with the private sector to provide the services. Because payments are made only when the service meet governmental requirements, there is a strong incentive for the partner to deliver the service properly and on time. This mix of mechanisms and incentives means that, once a contract is signed, it leaves no space for additional payments.

Various PPP deals are increasingly being considered by public bodies to finance civil and military space project. Examples of space program around the world under a PPP scheme: the Galileo program (concession), the British Skynet 5 (PFI contract), two German Earth Observation projects (*TerraSar* and *RapidEye*), the SpainSat military communications satellite and the Japanese Quasi-Zenith mobile/navigation program. These are also original type of PPP procurement, which has to co-exist with a publicly funded design and validation program.

In the space sector public procurement is heavily affected by demand from national governments due to defense and security reasons. Then, the space sector activities are characterized by high-risk with a fragile economic viability, even though commercial value of applications is growing.

In the case of the design of the satellite telecommunication system in Italy, the government entered into contracts to acquire not only the final product –the satellite system–, but the research and development of the technological solution first. The National Research Council had specified the requirements on the basis of the output needed. The Sirio and Italsat satellites

[12] Green paper on public–private partnerships and Community Law on Public Contracts and Concessions, Brussels, April 2004, COM(2004)327 final.

were both committed to enlarge traffic availability of satellite telecommunication and overcome saturation.

The Sirio project suffered a lack of contractual arrangements that did not share risk between the contractor and the companies, with the result of a slow down in timing. The Italsat project tried to share the risk connected with the technological development of an innovative solution between the public actor and the privates. The PSN divided the overall process in technological phases (evaluation, development, assembly, test) and signed a contract assuring the purchase of each service. That way of proceeding also helped the company to respect deadlines while traditional public procurements are often characterized by significant construction delays and cost overruns. Nevertheless, a contract for buying something to be developed at a specific time in the future ensures that the private partner has incentives for timely delivery.

The most clear and stable legal framework of the Italsat development project compare to the SIRIO experience achieved a better allocation of the risk. However, even in the Italsat case some delay happened, mainly due to an evolving institutional framework in the space sector.

Institutional framework of PPP in satellite telecommunication.

A first change happened after the Sirio satellite was launched, when the National Space Plan (PSN) started its five years program in 1979. Before the success of the Sirio project the Italian space policy was relegated to the European initiatives or the collaboration with NASA. But, also because of the good results achieved by the Sirio satellite and the prior experimental satellite San Marco, Italy started its own space plan with the aim of sustaining the development of a domestic high-tech industry in the technologies related to the space sector (telecommunication, aviation, propulsion, innovative materials, earth observation).

The first responsible institution for the PSN was CNR for the time needed to create an apposite center that would have managed the plan. Originally planned to start within a few years, the Italian Space Agency (ASI) took ten years to be fully operative.

In the case of the Sirio satellite, the basic research was undertaken by a public research institution (Polytechnic of Milan) while the technical development was assigned to a team made of firms; nevertheless, the risk connected to the uncertain contents of the technology requirements inhibits firms to operate efficiently –as proved by the delay in manufacturing operations– until the CNR signed an arrangement to buy the new product. In the case of Italsat, the National Space Plan provided the financial requirements needed to cover the risk and to

stimulate the firms to explore innovative solutions with the guarantee of government purchase. The role of the public demand was determinant to incentive the firms to bear the risk of a complex technology and its market potentiality[13].

The development service acquired for the Sirio satellite strongly suffered from the asymmetrical risk allocation. Only when CNR signed an agreement to buy the new technology the firms actively developed the innovative solution. In the Italsat case, Italy has had ownership of the civil satellite telecommunications infrastructures, based on the principle "Build Own and Operate" (BOO), centered on a vehicle company established as a Public Private Partnership (Sciortino 2011, p. 16).

The funding of the PSN in the firms perspective overcame the financial constraints in the market for innovation. In the case of Italsat, the certain commitment of the public buyer to buy the technology strongly reduced firms uncertainty. The Ministry of research has made the funds available for the Space Plan. Since 1988 the Italian Space Agency has been in charge of the PSN. Alongside the public funds, ASI "integrates" financial resources, also in kind, with partners on cooperative projects. The Agency aggregates resources under different patterns: tendered direct finance, market revenues, equity in purpose companies and consortia (Sciortino 2011, p. 15).

At the time of the Italsat F1 launch, ASI became owner of the vast majority of commercially available Ku-band and Ka-band space capacity required to fulfill national demand. The availability of a national telecommunication system avoided the need to buy the service from other regional providers, resulting in a net reduction of the disbursement on the international accounts.

With the Italsat project, the Italian Space Agency was among the forerunners of PPP project financing without a "vehicle company", in the meaning of a NewCo (new company) created within the partnership agreement. Italsat, the first telecommunication program managed directly by the Italian Agency had a business model calling for a tight cooperation between the Agency (the public party) and Telecom Italia (the private party). In the Italsat programme ASI was responsible for the space segment, while Telecom Italia was responsible for the launch of one of the two satellites, of the ground segment, and of the service provision. Fundamental aspects of project financing centered on PPP was a long-lasting relationship between public and private parties establishing a balance between State interests and commercial viability, wider outlook for financing, and diversified allocation of risks while maintaining clear identity and responsibilities. Premise for the success of the operation was a tested level of commercial self

[13] For an historical analysis of the effect of public demand upon innovation see the classic essay by Schmookler (1962).

sustainability for the project. Institutional users strongly affects space sector demand with national defense and research budgets, while space is a high-risk sector. Therefore a coordination of public demand would increase market efficiency taking into account social, economic and political goals[14].

Financial allocation to Italsat in the National Space Plan (in million)[15].

ITALSAT	expense	commitments	1984	1985	1986	1987	1988	TOTAL
Italian £ 1981	29.680	38.060	50.000	76.000	76.000	106.000	150.000	390.740
Italian £ 2011	110.400	141.580	186.000	282.720	282.720	394.920	558.000	1.453.470
€	57	73	98	146	146	203	288	750

Propositions

On the basis of the observation made upon the two cases, it is possible to derive some propositions useful for further research.

Concerning the investments in knowledge production useful for industrial innovation, Arrow (1962) has noted either technical and market uncertainty. Institutions are then called to reduce uncertainty and transaction costs (North 1984), and for this reason governments have historically had an important partnership role with private firms in fostering innovation (Link 2006, p. 23).

To face market risk related to innovation, a government might help society needs to turn into clear market demand. Thus, when future demand is quite clear because of the signaling action of the government, firms can more easily recognize new segment of market demand. Here, a public buyer can ensure the right will to pay for a product developed in a future time to trigger innovation activity.

Proposition 1 – A public buyer may help firms to understand emerging market segments and spur innovation by creating clear signs of future demand

[14] Pisano, Marco; Moving Europe towards a more effective procurement of space-based assets; Space Policy, 2006, 22(3), pp. 176–184

[15] Archival Source: ASI.

However, market demand may be not enough stringent to trigger firms in technological innovation. Complex technologies may take several years to pay off and require a consistent minimum market share to justify such risky investment. High technical risk may cause market failure even when a firm is successful if the private returns fall short of the social returns (Link 2006, p. 29). The broader market environment in which a new technology will be sold can significantly reduce incentives to invest in its development and commercialization because of technological lock-in (Arthur 1989) and path dependency (Arthur 1994). Hence agreements must cover for the technological risk and bring in enough financial resources to persuade firms to explore high-cost innovation.

Proposition 2 – Contractual agreements supported by an adequate public financial framework may open markets for high-cost, high-risk technologies to the firm

A major difficulty in the pursuit of an innovative product may be the need to collect multiple capabilities among several firms to respond to complex technological demand. Big scale projects often require the conduction of R&D in teams. A unique research facility is not generally available within individual companies; responding to complex demand may imply the combination of technologies from what were heretofore separate, non-interacting parties. Finding the technologies required and coordinating multiple players in a timely and efficient manner is cumbersome and costly. Agencies play then the unique role of exploring technologies available in the firms and coordinating the required effort in the most suitable way. Because of their expertise, agency promotes the generation of knowledge, and increase competencies and researchers' output (Edler et al. 2005; Edler 2010).

Proposition 3 – Supporting institutions are able to coordinate different firms competences and to promote knowledge generation in a timely and efficient manner at an affordable cost

Sharing R&D information is not just difficult, it can also be perceived risky due to the possibility for opportunistic behavior. The exchange of the information needed for the development of the technology can make the transaction between firms prohibitively costly if the incentives for opportunistic behavior are not to be reduced to a reasonable level with obligational contracts (Teece 1980). Because of the public interest embodied in the agency acting as an intermediary, private firms perceive it as an honest broker in the innovation process (Leyden and

Link 1999).

Proposition 4 – The public nature of the supporting institution decrease the risk of opportunistic behavior and then facilitate the exchange of complementary knowledge between different firms

Discussion and concluding remarks

The two cases show how risk allocation is fundamental in the design of a public-private partnership. Indeed, a weak element of the Sirio project was the absence of contractual obligation to force the public costumer to buy the new product, resulting in great uncertainty for the companies. In the case of Italsat, the PSN funds have ensured an optimal harmonization of public procurement rules and market commercial value for the private firms. In both cases eventually the team of firms came out with an innovative telecommunication system thanks to the partnership ensure by the public that opened a market for a risky technology. In the Sirio case is evident how a clear obligational contract has provided incentives to the firms first in collaborating and, secondly, in speeding up the activities in order to respect on time development. For the Italsat project the financial framework was upgraded with a national, long-lasting plan for funding space technology.

Risk allocation regards program risk whether the mission will succeed or be on schedule to be transferred to the private suppliers; market risk about the commercial value of the new product that remains with the publicly funded users; and the technological risk that has to be shared between the parts[16]. For the last reason, the service has to be valued by the public buyer before the procurement to optimize cost-effectiveness. Governments need to attribute realistic value to the service being purchased, hence publicly funded users must be demanding customers, setting priorities and expressing their requirements quantitatively[17].

The project management by governmental institutions has adopted a functional strategy of splitting the different stages by technological requirements and assigned them to different firms, coordinating the whole projects. Doing so has allowed firms to contribute to the project in an efficient way avoiding the risk of opportunism in other firm while sharing information.

Essentials in space-related PPPs are cost saving mechanism as primary goal, to exploit the market potentiality of the government buyer, and to adopt clear technical and demand

[16] Elliot, Chris; Funding for space – Private finance for public space missions?; Space Policy, 1997, 13(2), pp 315-322.
[17] *Ibidem*.

forecasts. Alongside telecommunication, space PPPs is potential suitable for Earth observation and meteorological monitoring for governmental use that can benefit from the implications derived from the observations here presented.

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