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Published in:
National Systems of Innovation

DOI (link to publication from Publisher):
10.7135/UPO9781843318903.008

Publication date:
2010

Document Version
Accepted author manuscript, peer reviewed version

Link to publication from Aalborg University

Citation for published version (APA):
Gregersen, B. (2010). The public sector as a pacer in national systems of innovation. In *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning* (pp. 133-150). Anthem Press. https://doi.org/10.7135/UPO9781843318903.008

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Chapter 7

THE PUBLIC SECTOR AS A PACER IN NATIONAL SYSTEMS OF INNOVATION

by

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2010 (First published 1992)[1]

7.1. Introduction

In a period characterized by increasing internationalisation and transnational political regulation the traditional role of *national* government in relation to industrial policy and technology policy is challenged. In this context it becomes important to understand which role the public sector has played in the past and can play in the future in relation to innovation and technical change within nations.

In many ways, the central role of the public sector in creating, maintaining and developing modern national systems of innovation is comparable with the one played by a pacer in a bicycle race. If public sector demand in both qualitative and quantitative terms races ahead it loses contact with the innovative capability of national suppliers. On the other hand, if public sector demand slows down too much, national suppliers may slow down their process of renewal and stick to pure routinising. As optimal pacing in a bicycle race requires a mutual understanding between the racing cyclist and the pacer, optimal pacing leading to an upgrading of national systems of innovation requires a mutual understanding between the public and private participants in interactive learning and searching processes.

In many countries the public sector actually tries to play the role of a pacer via technology programmes, public procurement policies, and so on. Sometimes it succeeds, and sometimes it

[1] Full reference: Gregersen, B. (2010), The Public Sector as a Pacer in National Systems of Innovation. In: Lundvall, B.Å. (ed.) (2010), *National Systems of Innovation – Towards a Theory of Innovation*, Anthem Press, pp. 133-150.
[This 2010 version was first published as: Gregersen, B. (1992), The Public Sector as a Pacer in National Systems of Innovation. In: Lundvall, B.Å. (ed.) (1992), *National Systems of Innovation – Towards a Theory of Innovation*, Pinter Publishers, pp. 129-145.]

fails or comes out with only modest success. In this chapter we will try to specify circumstances under which the public sector participates in innovation processes as a competent pacer stimulating long term positive learning effects, internal as well as external to the public sector, and circumstances where public sector activities seem to have inhibited innovativeness in both the public and the private sectors.

The direct and indirect participative roles of the public sector in creating, maintaining and developing modern national systems of innovation are very complex and many-sided and can, of course, not be fairly portrayed in a single chapter. The main emphasis here is put on the public sector as a pacer through its role as a *user* and *regulator* paying less attention to the public sector as a *producer* of crucial R&D and human resources. This is taken up in Chapter 9 of this book, where Freeman analyses the role of R&D in national systems of innovations. The general discussion of the pacer role will be illustrated by some exemplary case material drawn mainly from Denmark and the other Nordic countries.

In most countries technology policy programmes have hitherto been dominated by a technology push strategy. The purpose has been primarily to support high-tech producers directly, paying less attention to the user side. However, innovation studies (e.g. Rothwell & Zegveld, 1981; von Hippel, 1988; Porter, 1990) have shown that an effective supplementary national strategy might be to strengthen the demand side in quantitative and qualitative terms. 'Competent users' being able to communicate their needs in a form, which makes it possible for producers to adapt and develop high-quality products reflecting such user needs is an essential basis for dynamic interactive learning (Lundvall, 1985). The public sector itself is a very large and important user of various products necessary to support production and fundamental human needs, and especially in a period where a combination of technical uncertainty and market uncertainty tends to restrain the development of new products and processes the potential effects of an innovation oriented procurement policy reflecting competent user needs appear to be great.

Despite the fact, that the public sector is one of the most important users of many innovations, this sector has in general not attracted much attention in the literature on technical change and economic theory. This also holds for analyses studying user-producer interrelationships and interactive learning. Two important and interrelated exceptions from this analytical obscurity are the many interesting studies of public procurement and regulation in relation to domestic military and telecommunications industries.

These studies of the innovative effect of public procurement and R&D spending in relation to the military area and its 'set-off' on civilian industries seem to show great variations concerning the potential positive effects over time both among nations, among the national industries, and among the individual military programmes (e.g. Kaldor, 1981; Braun & Macdonald, 1978; Rothwell & Zegveld, 1981; Reppy, 1990). For instance did the US semiconductor industry benefit to a much higher degree than the UK semiconductor industry in the 1950s and early 60s from a relatively huge, sophisticated and lucrative military market. However, since the mid 60s the civilian market for electronics in the US as elsewhere has increased its relative share and has now far outstripped the quantitative and qualitative importance of the military demand except within very specific areas with no or very limited potential civil application.

It is indisputable that public military procurement and military R&D spending - be it relatively large as in the US and UK or relatively small as in Japan and most small welfare states including Denmark - should be an important part of our understanding of the role of the public sector in various national systems of innovations, although it is still controversial to what degree it is a benefit for the economy as a whole. While this the *national* part of the 'national system of innovation' concept is especially strong and important in relation to the military area, we will not discuss this special case further in this chapter. Our case material is mainly collected from various non-military welfare fields including environment protection.

Most theoretical and empirical analyses of incentives to innovate or adopt new products and processes stress the drive for profit and growing market share and thereby exclude the public non-profit activities from the dynamic dyads of innovative users and producers. From many of these innovation studies we know that the ability to innovate and adopt new technology within a given techno-economic paradigm differs between industries and firms depending on the technology in question, firm size, the capital, time and human resources required as well as the environment in which the firms are operating such as market conditions and relations to suppliers and users. To grasp and analyse such similarities and dissimilarities in ability to innovate and adopt new technologies Pavitt (1984) among others has employed useful categories for firms and industries within the *private* sector, but we still lack a counterpart covering the *public* sector based on innovation studies within this part of the economy. Or in other words, we cannot be sure that the mainly private sector-based innovation theories and studies hold for the public sector too. In section 7.2 we discuss such possible differences between the private and public sector in the ability to innovate and adopt new technology.

In section 7.3 we stress the interaction between the public and the private sector based on two different main pacer roles played by the public sector in relation to learning and searching processes: interactions based on the public sector as a user of innovations and interactions based on the public sector as a regulator. Although these and other roles often occupy the stage simultaneously they are here treated separately.

7.2. Public and Private Stereotypes

Public sector organisations are often portrayed as bureaucratic, ineffective, parasitic monsters in contrast to flexible, effective, productive private firms. One of the key words has been 'system defects' as an explanation of an assumed ineffectiveness of the public sector. Murray (1987) mentions various examples of such claimed 'system defects' in the public sector. First, *economists* have focused on the absence of free market forces which may have several negative implications: The 'real' demand is unknown, which either leads to over-production or rationing. The fixing of prices is uncertain, and without the drive for profit there is no motivation for adjustment and rationalisation of the production. There is a lack of dynamic efficiency in the Schumpeterian sense, and a lack of innovative capability. Second, *public choice theorists* have stressed that decisions taken in the public sector are not 'pareto optimum', since the majority can control the minority. Third, contributions from *organisation theorists* have pointed to elements such as ineffective organisation and management, rigid wage contracts, inadequate cost awareness and obscure and blurred goals. According to Murray, there is one important common characteristic of these statements: They are all *hypotheses* due to a striking lack of empirical analysis, and they compare *assumptions* about the public sector to an *ideal abstraction* of 'perfect markets' and a presumed economic rationality prevailing in the private sector (Murray, 1987, p. 16).

As described in Chapter 3 by Lundvall and Chapter 4 by Andersen, one of the fundamental assumptions behind the interactive learning concept is the interrelationship between production, use and innovation. If such an interrelationship is assumed to be present also where public sector institutions participate as users, producers or suppliers, the distinctive characteristics of the underlying goal orientation or rationalities of this participation may influence both the innovative capability and the orientation of the learning processes. In other words, public sector demand dominated by social, political, strategic or military goals or rationalities may stimulate or restrain innovation, and perhaps even pull or push innovation processes in certain directions.

Studies of public performance oriented procurement in connection with the military area especially have demonstrated how offensive or defensive national military considerations may outstrip any economic rationality in the sense that product quality in terms of performance, reliability and accuracy clearly exceed cost considerations in importance. In other parts of the public sector innovation diffusion may be facilitated due to the relatively high degree of openness of procedures where detailed product and process information are less strategic or proprietary.

Following this line of argument that different rationalities or goal orientations may influence the pace and direction of interactive learning and searching processes, one important question is, which types of rationality are then to be found when the public sector participates and how do they affect the innovative capability of this sector?

One interesting attempt to answer this question is made by van de Donk & Snellen (1989). They pictured government policy as situated between four rationalities. *Political rationality* implies that government actions and decisions (for instance in relation to public procurement and regulation) reflect the - at any time - dominating political and economic interest groups or coalitions. *Legal rationality* means that government policy must have its foundations in law ensuring equality before the law and legal security due to the independent position of the legal establishment with respect to politics. *Scientific rationality* (or 'paradigmatic rationality') is to a certain degree sector specific and related to individual professions or social-scientific disciplines. In public sectors dominated by technical disciplines as within the technical infrastructure areas (e.g. electricity, communication, railway systems, water-supply) we can expect agents to give their highest priority to technical security and quality, while medical, human and social professionalism and rationalities are expected to prevail in public welfare institutions like hospitals, institutions for old age- and child care. *Economical rationality* implies that budgetary cycles place restrictions on government policy. Since the mid-1970s the economic restrictions on many public sector activities have been severe as compared to the 'happy 60s'.

The four rationalities are presented above without interdependency. However, in real public institutions and government policy formulation these archetypes often interrelate and concrete policy outcomes will mostly reflect a mix of the various rationalities. The mix of the cocktail may of course differ from sector to sector, from case to case, and from period to period. For instance in a study of the introduction of new computer technologies in American local government it was political rationality in the shape of reinforcement politics that was found to

be the crucial component rather than economic or technical rationality (Danziger et.al., 1982). Strategies developed and implemented by the central edp-departments came up with technical solutions reinforcing the technical and organisational structure and power of the central edp-departments. Contrariwise, in those (rare) cases where the user departments (e.g. social services department, revenue department) were the project originators, the technical and organisational solutions promoted, reinforced the computer capacity of the user departments at the expense of the central edp-department. In another study of the diffusion of computer-based systems (including WP) in Danish local government during the late 1970s and the beginning of the 80s, budget restriction was found to be the prime restraining factor (Brændgaard et.al., 1984). Often computer-based systems, legislation and administration proceed hand in hand. Complex and changing legislation within, for instance, the social and fiscal area demands large computer-based systems for their administration at both the local and central administrative level. On the other hand, the use of computer-based systems may be restricted by legislative ties as is the case in relation to the composition and physical placement of central computer files. In other cases, as for instance in relation to environment protection, short-term economic rationalities may more frequently today than previously take the back seat thanks to increasing environmental awareness and consciousness among producers, consumers and politicians.

According to van de Donk & Snellen the four-rationalities distinguishes public administration from private enterprise. This distinction, however, is based on the assumption that private enterprises in principle may limit themselves to economic rationalities and to a certain degree scientific rationalities. As discussed previously in this book (see Part I) and in other institutionalist and evolutionary approaches (e.g. Nelson & Winter, 1982) this assumption may be an unrealistic simplification. Few would argue that legislation of various kind does not affect the strategies of private firms. Also the concept ‘political rationality’ may, in the broad sense as we have used it above, be relevant for our understanding of activities going on in and between private enterprises. The distinction between public and private organisations may then be rather a question of finding significant patterns in the way these various rationalities are interrelated, than a question of one, two or four rationalities being relevant. Arguments for this statement may be found in Lane (1988), who, in a way, is less ‘categorical’ in his distinction between public and private organizations.

From a comparative analysis of public and private management Lane argues, that in a mixed economy it may be difficult to distinguish, clearly, between public and private leadership, because “each appears to work with a multiplicity of goals, facing a complex environment

where several interests look for participation and many rules restrict behaviour" (Lane, 1988, p. 61). However, he concludes, that in a mixed economy there are still fundamental differences between public and private management especially along two dimensions as illustrated in Table 7.1 below. The one dimension is the well-known classical one concerning *goal orientation*. The second dimension is the *environment*, within which the two types of organisations operate. The traditional image of public organisations is type I, whereas that of private is type IV.

Table 7.1. Public and Private Leadership

	Environment	
Orientation	Stable	Unstable
Public interest	I	II
Private interest	III	IV

Source: Lane, 1998, p. 61.

According to this image, public organisations tend to work in a more stable or less unstable environment than private organisations. The 'market conditions' or the relation to the consumers or clients differs among the two types of organisations. The relations to consumers or clients of the public organisations are often authoritative without possible exit whereas the relation of private organisations to their consumers is dependent upon market demand where exit for both the producer and the consumer is a possibility.

Private organisations attempt to maximise or satisfy a private goal function, whereas public organisations have to respond to the public interest defined by a political body being the government or the electorate. As previously indicated, public interest may often consist of a multiplicity of conflicting goals or rationalities, qualitative in nature which may be more difficult to quantify or evaluate than a dominating profit orientation in private organizations.

If we then substitute the goal orientation dimension in Table 7.1 with a dimension capturing the orientation towards innovation, which is the prime focus in this book, we can illustrate the traditional image of innovativeness of public and private organizations as follows:

According to this traditional image public organisations tend to be of type I, whereas private organisations mainly belong to type IV. Lack of competition (e.g. stable environment) together

with bureaucracy in the Weberian sense (e.g. functional specialisation, rules and procedures to ensure uniformity and continuity, impersonality of interpersonal relations, hierarchy of authority, and technical qualifications forming the basis of employment and promotion) is assumed to put a brake on the innovativeness of public organisations and stimulate conformity and standardised routine solutions. Contrariwise, the spirit of entrepreneurship in the Schumpeterian sense (e.g. personal growth, creativity and initiative) together with competition (e.g. unstable environment) force private organisations toward continuous innovation.

Table 7.2. Public and Private Innovativeness

	Environment	
Orientation	Stable	Unstable
Routine	I	II
Renewal	III	IV

The framework developed by Daft (1982) may help to introduce some light in this gloomy picture of innovative capability in public bureaucracies. The point of departure is that all organisations, be they public or private, organic or mechanistic, or hybrids, have to handle the stability-change dilemma (as described in Chapter 5 by Gjerding) by facilitating both routinisation and novelty but they solve this dilemma in different ways depending upon the type of innovation typically needed and the environmental context.

> *The question of bureaucracy versus nonbureaucracy should not be answered upon our biases for nonbureaucratic forms of organization, but on the needs of the organization for stability versus change and on the ability of the structure to meet those needs (Daft, 1982, p.160).*

With a minor transcription we may conclude that the question of public versus private innovative capability should not be answered with reference to our biases for competitive forms of organisation, but on the needs of the organisation for stability versus change and on the ability of the structure to meet those needs.

Many traditional public welfare institutions related to personal services like old age homes, kindergartens and schools, but also public administrative institutions like tax authorities and

social services departments have during the 1980s found themselves in a very unstable environment with frequently changing laws and severe financial cuts. Also public hospitals have in recent years faced increasing uncertainty in both the technical and the administrative environment creating an urgent need for special organisational changes. Some of these institutions, especially the administrative parts, have tried to respond to the changing environment by introducing new information technologies. However, many of these public administrations have run into problems due to both a lack of internal 'computer-knowledge' and a lack of organisational change towards a more organic type of bureaucracy which seems more suited to take advantage of new information technology.

It is important to stress that the degree of uncertainty of environment may shift over time. Since the micro-electronic revolution and the shift in techno-economic paradigm, the pressure for both technical and administrative innovations has been increased in private as well as public organisations, but without comparative studies we have no particular reason to believe a priori that public institutions may do worse than private ones in the long run.

7.3. Public-Private Interactions

In this section we will switch our focus from a discussion of possible distinctive characteristics between public and private organisations in relation to innovative capability to a discussion of how *interactions* between the two sectors may stimulate (or restrain) innovation. We thus turn our attention from a discussion of stability versus change or routine versus renewal *inside* public institutions or private firms to a discussion of how *interaction* based on stability, standardisation and routinising inside public institutions under certain circumstances may stimulate and under other circumstances inhibit change, renewal and innovativeness in private firms. We will also discuss the opposite situation where change, instability and renewal of public sector activities under certain circumstances inhibits and under other circumstances promotes innovativeness in private firms. In other words, we will try to locate situations or circumstances where the public sector has acted either as a professional or as a more amateurish pacer for the private sector using public demand and regulation as political tools.

We start the discussion in section 7.3.1 with four examples sketching how the public sector may perform as a pacer under various circumstances. Section 7.3.2 discusses more generally the regulation tool in relation to innovation, and section 7.3.3 focuses on public sector demand.

7.3.1. Four Illustrations of the Pacer role

Table 7.3 illustrates four different outcomes of interactions between public users and private producers.

Table 7.3. Public-Private Interactions

	Innovativeness Among Private Producers	
Demand from Public Users	Routine	Renewal
Routine	I	II
Renewal	III	IV

Type I illustrates a situation where a high degree of stability in both the technical and administrative environment combined with a routinised behaviour among public users tends to lull the private suppliers to sleep. The public market is secure and stable and the suppliers set the pace. Examples can be found within traditional public procurement areas where a monopolistic or monopsonistic domestic or local supplier structure typically prevails as for instance public transportation, or municipal standard wastewater treatment plants.

Type IV illustrates the opposite type of interaction between public users and private producers. A high degree of instability in the technical and administrative environment forces public users to be innovative pacing innovativeness among private suppliers. Illustrative examples are the wide diffusion of new public waste-handling routines based on recycling and eventually combined with restrictive regulations on packaging as in Germany. The growing need for sustainable solutions to the escalating waste-handling problems all over has initiated re-thinking and a renewal process among technicians, administrators, lawyers (and even economists) in public sector institutions (especially at the local level) in Denmark, Sweden, Netherlands, Germany and other high-income countries. More and more private producers respond with new low- and non-waste products with greater recycling possibilities and more environmentally compatible products and production processes. Another encouraging kindred example of progressive public sector pacing is the rise of the Danish windmill industry despite an originally strong resistance from the established power stations. However, using old instru-

ments such as taxes, rates, and dues on the conventional energy sources together with public R&D funding and subsidising the development and use of 'alternative' energy sources, the Danish Energy Ministry has converted the concessionary energy companies to a more conciliatory attitude towards windmills and other 'alternative' energy sources.

As indicated by Type II, it is not necessarily the case that the classical virtues of public bureaucracies in the form of market stability, technical standardisation and administrative routinising lull the domestic suppliers to sleep. In fact, if demand is characterised by long term stability, technical standards are set at a high level, and work-procedures are routinised and widely spread among public users, the innovative 'inclination' and capability among domestic private producers may be stimulated. The Danish hearing-aid industry obtained international strongholds (today about 2/3 of the world market) as a result of optimal pacing combining high level technical standards and knowledge within the electro-acoustics area with a solid home market based on public subsidising (Jørgensen, 1986). Another well-known example of this type of interaction between public (or semi-public) users and private producers is the development of national telecommunications industries as convincingly described by Grandstrand & Sigurdson, 1985. In their study of the Swedish telecommunication industry they show how public 'routinising' in the form of technical standardisation, price setting, procurement and market regulations combined with R&D subsidising made the foundations for not only a strong *domestic* tele-industry - as has been the case in most developed countries - but also an industry with international strongholds. Thus, routinising (to a certain degree) among the public users may sometimes be a precondition for renewal among private producers.

Public-private interactions of Type III illustrate situations where a high degree of market uncertainty combined with a forced process of renewal of administrative routines among public users may inhibit long term innovativeness among private suppliers. The Danish public demand for wastewater treatment plants contains an illustrative example on Type III-relations (Gregersen, 1988). Since the early 1970s Danish municipal investments in wastewater treatment plants have been rather unstable and fluctuating. In the first half of the 1970s investments accelerated. Then investments declined rapidly in the period of the late half of the 1970s to the late 1980s when once more investments accelerated. This stop-and-go policy made long-term planning of the suppliers' R&D activities very difficult. During the period of cuts in the late 1970s and early 1980s many engineers and experienced marketing experts in established firms had to reorient their efforts and ambitions from advanced wastewater technology for the home market to technically less advanced water treatment plants for less-

developed countries. Another consequence was debilitation of the users. Due to the cuts in the public sector since the late 1970s local government have been unable to maintain their technical expertise in administrative departments and on the operational plant level. Local government is now forced to rely entirely on the suppliers and the private consulting engineers. The base for future dynamic interactive learning has thus been clearly weakened.

Despite the stop-and-go policy, some Danish suppliers actually developed international strongholds within biological wastewater treatment technology in the late 1970s and the first half of the 1980s. The explanation of this has however more to do with the 'Type II interaction'. These innovation processes started in a period when increasing environmental awareness among politicians and their voters caused stricter environmental regulation and, no less important, caused an expectation among the suppliers of a more or less stable tendency towards stricter future legislation on both domestic and international markets. This combination of sticks and carrots in the form of a stable tendency for stricter future regulation and possible first mover advantages stimulated research activities among some of the central domestic suppliers. The patented advanced methods for biological removal of nitrogen and phosphorus from wastewater, BIO-DENITRO and BIO-DENIPHO, were developed in that period by Akvadan in cooperation with the Department of Environmental Engineering at the Technical University of Denmark. Also the development of the oxygen meter by Danfoss, improvements of the active sludge treatment process by Krüger and several other technical improvements within wastewater treatment technology belong to this period when strict public regulation paced the domestic suppliers ahead of their international competitors.

One general conclusion from these examples is that *maintaining* the successful pacing of domestic suppliers over time is a difficult task. It seems to require that both quantitative and qualitative demand change under stable conditions, and that user qualifications and technical standards are maintained at a high level. However, even if these conditions are fulfilled there is, of course, no guarantee of interactive learning leading to fruitful innovation.

7.3.2. Pacing Private Firms Using Regulation as a Stick

One important difference between the public and the private sector is the ability of public authorities to define the 'room of innovative manoeuvre' for both private and public sector organisations by setting up standards, Patents Acts and various other regulatory procedures to protect and control innovation and diffusion of new products and processes. The instrument of

regulation has many strings, but one may roughly distinguish between one category mainly aiming at economic efficiency and another focussing at other goals. In the first category we find regulations in the form of standardisation and Patents Acts. In the second category we find regulations aimed at environmental protection, consumer and worker safety. The main focus in this section is on regulation of the second category.

Since the 1950s and 1960s, various national and international regulations covering nearly all kinds of products and processes have emerged. Environmental regulation acts with quantitatively defined emission rates, regulations on time of rest for truck drivers, restrictions on the introduction of new drugs and pharmaceuticals and several consumer goods, rules for the mesh size of fishing nets, standardisation of communication equipment, just to mention a few examples. Regulation in this strict sense of making rules and procedures for innovation and diffusion may serve either the producer or innovator (as for instance the patent system), the user (as for instance regulation concerning drugs and pharmaceuticals) or the environment and natural resources (as for instance emission rates or fishing quotas).

Most of the academic literature on regulation and innovation has seen this interplay as a kind of input-output process, where regulation either stimulates or restrains the rate of innovation and diffusion. One may find several case studies supporting each statement, depending on the sort of regulation, the type of innovation and the kind of industry in question. (For an overview of the literature on regulation and innovation see for instance Rothwell and Zegfeld, 1981). By counting the number of new products introduced and the time delay from invention to marketing due to approval restrictions, studies on the effects of the growing regulation within for instance the drug and pharmaceutical areas have pointed out the restraining facets of the interrelationship. By similar studies, the stimulating facets have been shown especially within military, health and environment protection areas.

One may of course question the methodological base for many of these case studies on the interaction between regulation and innovation. One fundamental problem concerns the difficulties in isolating the effects of regulation from all the other firm internal and external factors effecting learning and searching processes. Another methodological problem is related to the analytical level, which has typically been the single innovation or the single firm. When the analytical level is the single innovation, it is of course difficult to draw more general conclusions for other kinds of innovations taking place in another period or at another location. When the analytical level is the single firm, the effects of a specific regulation on the overall

economy, consumer behaviour or long term knowledge accumulation in the national system of innovation are excluded. A third kind of problem, similar to that of adding apples and pears, arises when different types of innovations are put together and measured along the same time axis.

In short, most of the studies done within this area hitherto, have focused on how regulation affects the *rate* of innovation and diffusion.

> *"Regulation has rarely been considered as a positive means of technical control e.g. through stimulating new forms of technological response rather than simply restricting the operation of the market-place. The whole issue of regulation, therefore, has been conceptualized as a post-innovation check on undesired side-effects rather than as a tool for directing technology towards socially desirable ends"* (Irwin & Vergragt 1989, p. 58).

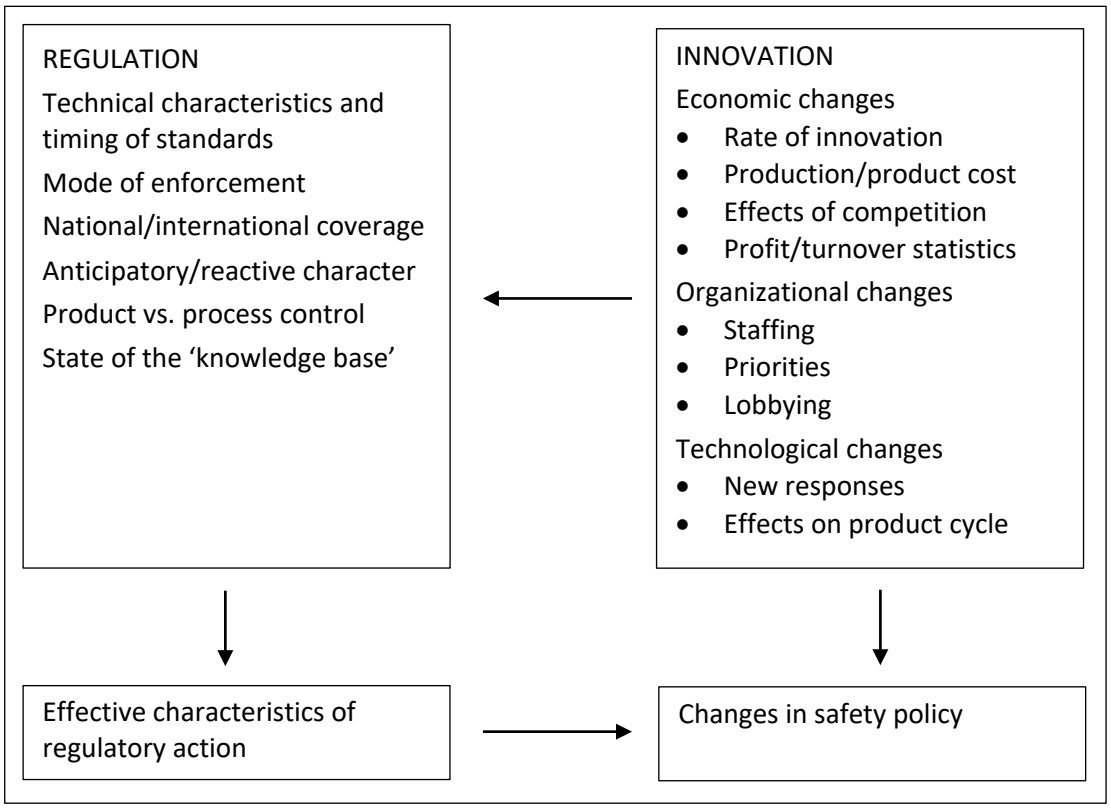
Irwin & Vergragt (1989) introduce an approach to study the *inter-relationships* between regulation and innovation based on a more complex socio-technical perspective. Innovation, regulation, and their interaction have to be seen as a product of 'social and institutional negotiations' at every level (1989, p. 63). In their 'interactive model of regulation-innovation' the form of regulation affects the corporate response, and the character of that response will affect future regulation. Thus, innovation and regulation are part of the same social and technical process.

As the model indicates, the form of regulative intervention can be manifold, and so can the corporate response. The extent of necessary organisational, technical or economical changes and responses may be dependent on both the technical characteristics and the timing of standards and vice versa. For instance emission limits for nitrogen and phosphorus may correspond to existing or dominating best practise techniques or they may within a certain time span require the development of radical new products or processes as in the case of the 'Montreal-protocol' from 1987 demanding a total stop in year 2000 for the use of CFC (freon) in industrial processes and products like home freezers, refrigerators, sprays and several others.

The mode of enforcement, for instance to what degree the combination of regulative sticks (taxes, rates and dues) and regulative carrots (subsidies and development contracts) is open to objection, will influence the outcome of the regulation-innovation interaction too. Many exceptions to specific emission dues or repeating exemptions to passed respites - as for instance has been the case in relation to the realisation of the Danish 'water-environment action plan'

from 1987 - may of course influence the search intensity towards new technical solutions negatively.

Figure 7.1. The Interactive Model of Regulation-Innovation



Source: Based on Irwin and Vergragt (1989, p. 62)

National or international coverage of the regulation may also influence competitiveness of the firms concerned. In the short run, international competitiveness of some individual firms may decline as a result of strict national environmental regulation. In the long run, such regulation may give international comparative first mover advantages to the same firms concurrently with environmental regulative tightening in other countries. This is, for instance, clearly the philosophy behind the Danish regulative initiatives on CFCs, which put a deadline for the use of CFC a couple of years before the 'Montreal-agreement'. To support the Danish development of new CFC-free products and processes the Government has set up a specific R&D programme on CFC-free production, indirectly financed by a CFC-tax.

Regulation may be reactive or proactive in character. Hitherto environmental regulation has in most countries mainly been reactive in character in the sense that the dominating environmental

protection activities have been leaning against an 'end-of-line' philosophy as for instance municipal wastewater treatment plants or high chimneys with smoke filters. A more, but not fully alternative proactive strategy is pre-treatment at the source of pollution, for instance industrial wastewater treatment. Proactive regulation stimulating low- and non-waste technologies are still only dawning in most countries despite their ecological superiority.

Regulations may refer to individual products or entire manufacturing processes. Regulations and standards may be formulated in terms of products or process specifications or they may be formulated in functional terms (for instance strength, durability, speed, or compatibility). It is important to notice that the type of regulation and standardisation will influence the direction of future search activities. If for instance standards are formulated in functional terms rather than in terms of product or process specifications, the search activities may be more open-ended and less bounded within existing trajectories.

If there is a widespread disagreement about the environmental assessment results of a specific regulation among experts (e.g. the state of the 'knowledge base' is unstable) - the strategic behaviour of the organisations affected by the regulation may be influenced too. The affected firms may see their chance to loosen the regulations and the following control activities may be less consistent.

Two general propositions are put forward in the interactive model of regulation-innovation above. The *first* is, that the type of regulation affects the potential innovative outcome and the *second* is, that success, where regulation paces private firms to innovate, depends on social and institutional negotiations among qualified agents and experts within both the public and the private organisations involved. We may expect to find the most positive and encouraging successful illustrations of regulation-innovation interaction when the regulation instrument is used with a certain professional 'fingerspitzengefühl' in areas where competent public demand prevails.

7.3.3. Pacing Based on the Public Sector as a User of Innovation

Public sector demand affects innovativeness in the private sector directly through its size and quality. In modern national systems of production and innovation public demand is considerable. According to Dalpé, government markets represent between 10-15% of total production in most industrial countries (Dalpé, 1989). An European Commission study of

public sector procurement has estimated total public purchasing (government and public enterprises) to about 15% of GDP in 1984 for the EC as a whole, but with important country variations ranging from 12% in Germany to 22% in the UK of which government purchasing contributed half (WS Atkins Management Consultants, 1988).

There are of course variations in the share of government markets between different product areas. In areas such as food products, consumer electronics and miscellaneous metal products, government markets account for only a minor percentage of the total market. Within areas, such as transport equipment and computers, the public sector market is large and growing. In other areas, such as environmental protection, medical equipment and infrastructure products and services, government markets in most countries account for the major part. In relation to a long-term upgrading of national systems of innovation it is important to stress this variation between product areas, because the market share of public sector demand seems to be dominating and increasing especially in the growing markets for high-tech products based on new information technology or biotechnology.

The *quantitative* side of the demand is a very central ingredient in an analysis of how the public sector as a user explicitly or implicitly may stimulate, inhibit or orient innovativeness among private producers. Firstly, a certain quantitative demand is a necessary precondition for private firms investing in R&D-activities. Within many product areas, the public sector is the first user of innovations, patents and products (Dalpé & Debresson, 1989). As indicated above stable government home-markets may be essential not only from an infant industry perspective, but also in relation to the long-term maintenance of obtained international strongholds. Secondly, the market position of the public sector is important for the ability of the public sector to play the card of demand pressure. Such potential public demand pressure may not always be fully exploited due to possible shortcomings in the coordination of time and demand specification among the many small and scattered users operating on the local government level. The solution to such coordination problems is of course the establishment of various types of institutionalised co-operation as for instance state discount on public purchases, common advisory committees or specific public owned suppliers like the Danish Municipal Software House (Kommunedata) providing administrative information systems for local government. However, while a lack of coordination and exchange of experience among users may reduce the demand pressure and thus weaken potential interactive learning processes between public users and their suppliers, extended institutionalised co-operation may on the other hand contain a risk of lock-in of

technical and organisational solutions. As indicated in section 7.3.1, balancing routinising and renewal processes certainly is a difficult task.

The importance of the *qualitative* side of demand has in the recent years obtained increasing attention in innovation theory and empirical analyses. There are two interrelated aspects of qualitative demand reflecting the degree of user-participation. The one is concerned with user-lead innovations where users innovate or where users participate directly in the innovation process. It is well documented that competent users play such direct participative roles in some innovation processes (von Hippel, 1976 and 1988; Lundvall, 1985). The other aspect is concerned with user-lead innovations, where competent users formulate user needs or demands, but leave the 'enterprise' to the suppliers. Along this line, as mentioned earlier in this chapter and in Chapter 3, studies of processes of innovation and diffusion of new products and processes have indicated, that a lack of competence amongst users may weaken long-term innovativeness among suppliers and/or inhibit optimal or efficient use of new technological opportunities (e.g. Lundvall, 1985; Gregersen, 1988; Gjerding et.al. 1990).

While most of the innovation theory and studies with economic roots have hitherto mainly emphasized innovation processes in the private sector, several of the case studies of competent user-involvement in innovation processes actually deal with professional users within the public or semi-public sector, as for instance does the classic study by von Hippel of user-dominance in the development of scientific instruments for hospital and university labs, and the studies of government procurement in relation to areas such as defence, hospitals, telecommunications and environmental protection. The conclusion, that qualified users are important in innovation processes based on dynamic interactive learning, is general in the sense that it holds for all user types, be they private or public. However, as indicated in section 7.2, the specific goal orientation towards public interests, where other than 'simple' private monetary profit and cost rationalities dominate, distinguishes public sector institutions from private firms in relation to possible user-pacing of suppliers. When public sector demand is primarily driven by military, political or social goals and secondarily by cost considerations, 'quality and performance oriented procurement' tends to favour innovation (Dalpé, 1989). The development of for instance the Swedish telecommunications industry (especially Ericsson) illustrates how standardisation combined with public procurement may form an innovative platform for world-wide competitiveness. The development of the Danish hearing aid industry, the Danish wind-mill industry, and the Danish environment industry are other illustrative examples of how standardisation, regulation, welfare schemes and public subsidising under certain

circumstances (e.g. a qualified and stable home market) may pace socially-desirable innovations from the private sector.

7.4. Conclusion

In many industrial policy recommendations the distinguished role of the public sector and governments is to create a 'dynamic industrial environment' in which private domestic firms may flourish. The practical content of this support or dynamic industrial policy is manifold. It range from taxes, direct subsidies, public education and training facilities, public R&D institutions, infrastructure facilities, financial support, regulation, standards, to public procurement. In general, these policies have hitherto mainly been a question of domestic concern, but along with the on-going transition of the national based systems of production and innovation towards international and transnational based systems of production and innovation follows a corresponding transition on the political stage, where transnational political regulation increasingly narrows the scope of national politics. These subjects are the main focus in Part III.

The internationalisation process surely challenges the traditional role of the national public sector, but it does not render it superfluous. As indicated in this chapter, the public sector can play an important role as a stabilising and stimulating pacer in a situation where the private sector is confronted with extremely unstable environments.

First, successful public sector pacing requires both maintenance and renewal of learning processes *inside* the public sector. It implies that resources inside the public sector must be channelled continuously to maintain and develop user qualifications at a high level. The direct effects of the ongoing privatisation and cuts in traditional public welfare activities as health care, social security, education and environmental protection are in the first hand reduced level of services, but a more indirect threat may be a debilitated capacity for renewal of central parts of the national system of production and innovation in the long run due to lack of competent demand from users in the public sector.

Second, successful public pacing requires both maintenance and renewal of interactive learning *between* the public sector and the private. The case-material presented in this chapter supports the conclusion that such positive learning processes are facilitated if both the quantitative and the qualitative public demand change under stable conditions, and technical standards are

maintained at a high level. Despite the on-going 'deregulation debate', our case-material indicates that the regulation instrument may be a rather effective means to pace socially desirable innovations from the private sector if the preceding social and institutional negotiations are taken place among qualified agents and experts within both the public and the private organizations.

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