The Governance of Complex Systems: The Case of British Railways

Dario PEIRONE

Working Paper 9, 2005

© HERMES
Fondazione Collegio Carlo Alberto
Via Real Collegio, 30
10024 - Moncalieri (TO)
Tel: 011 670 5250
Fax: 011 6705089
info@hermesricerche.it
http://www.hermesricerche.it

I diritti di riproduzione, di memorizzazione e di adattamento totale o parziale
con qualsiasi mezzo (compresi microfilm e copie fotostatiche) sono riservati.

PRESIDENTE
Giovanni Fraquelli

SEGRETARIO
Cristina Piai

SEGRETERIA OPERATIVA
Giovanni Biava

COMITATO DIRETTIVO
Giovanni Fraquelli (*Presidente*)
Cristina Piai (*Segretario*)
Guido Del Mese (ASSTRA)
Carla Ferrari (Compagnia di San Paolo)
Giancarlo Guiati (GTT S.p.A.)
Mario Rey (Università di Torino)

COMITATO SCIENTIFICO
Tiziano Treu (*Presidente*, Università "Cattolica del Sacro Cuore" di Milano e Senato della Repubblica)
Giuseppe Caia (Università di Bologna)
Roberto Cavallo Perin (Università di Torino)
Carlo Corona (CTM S.p.A.)
Graziella Fornengo (Università di Torino)
Giovanni Fraquelli (Università del Piemonte Orientale "A. Avogadro")
Carlo Emanuele Gallo (Università di Torino)
Giovanni Guerra (Politecnico di Torino)
Marc Ivaldi (IDEI, Universitè des Sciences Sociales de Toulouse)
Carla Marchese (Università del Piemonte Orientale "A. Avogadro")
Luigi Prosperetti (Università di Milano "Bicocca")
Alberto Romano (Università di Roma "La Sapienza")
Paolo Tesauro (Università di Napoli "Federico" II)

The Governance of Complex Systems: The Case of British Railways

Dario Peirone

(*Università di Torino*[a])

Giugno 2005

Abstract

The aim of this paper is to add new elements for a better comprehension of the governance problems that can rise from the privatisation of a complex system, like the railway network, using a methodology that shows the connections and the influence of the various technical, economic and political factors at work within large technical systems. It has been used the case-study of the British Railways as a "paradigm" to show all the difficulties and the risks involved in a complex transition. The paper shows that the social costs of the privatisation of British Rail have been very high because the governance of the transition did not fit with the economic, technical and organisational structure of the network. The analysis, dividing this question in the two aspects of finance and regulation, makes evident the necessity of innovative governance schemes, to cooperate with the increased complexity of markets and firms. United Kingdom has been one the first European countries to liberalise the railways, and the problems run into the British experience can be a useful guide for other reforming systems, like the Italian one.

JEL CLASSIFICATION: L 92, G 38, L 33, L 43

[a] Università di Torino, Dipartimento di Economia "S. Cognetti de' Martiis",. Via Po, 53; 10124, Torino. E-mail:dario.peirone@unito.it

I'm grateful to Graziella Fornengo, Andrew Davies and Tim Brady for their helpful comments. This version has been presented at the SIEPI workshop at Bocconi University in Milan, May the 31st 2005

Introduction

During the last twenty years there has been all across Europe a passage from a situation of production and operation of public services by the state, towards the almost complete privatisation of some sectors. In this essay I will focus on the Railways: in Italy, this type of transport services is reforming radically its structure since the early '90s, when the European Union headed the economies of the members' countries for the privatisation of many state-owned utilities.

There are well known reasons why the state production is not efficient: public managers have different objectives from private managers, there are no residual claimants and there is a lack of control by the capital market, the budget constraints are not really binding, and there is the risk of an excessive political influence. All this happens because in a state-owned enterprise the Government, that most of the times is also the buyer and the regulator of the service, will eventually pay all the possible losses: then, the regulatory incentives are not really efficient.

But other problems rise when the production of public services is delegated to the private sector. We can define "transition" every passage from an initial regime A to another regime B, different from A. This passage implies some costs, namely the *transition costs*: they include all the difficulties depending by the passage from an established routine to a new one, that maybe in the future will be much more efficient, but not necessarily it is efficient in the short-term. In the context of privatisation of public services, the transition costs are associated to the change of market regime, and they can be very high, if not carefully evaluated: in complex markets, many challenges are also posed by innovations in production and organisation. So, the delegation to produce some public services to private subjects cannot be justified simply sustaining the major savings for the public sector, but the eventual efficiency with respect to the public production must be accurately organised well in advance.

Italy is reforming the railway system towards the complete liberalisation of the network, as requested by the European Union, so that many trains will be able to run on the same infrastructure. The first passage has been the formal separation of the holding FS in two different companies, one responsible for the infrastructure (RFI) and the other one for the service (Trenitalia). In 2003 the franchising competitions for the passengers local transport have been opened in some Italian regions.

The Italian analysts suggest a strong policy to incentive the Italian Railways (Ferrovie dello Stato) to act as a private company, with no control by the Government. In consequence, a better governance system is required, because the weak budget constraints, given until now by the commitment of the Government to pay all the eventual losses of the railways, have not stimulated the efficiency.
For doing this, it is more and more discussed the possibility to create an independent regulation authority for transports, to regulate the access to the network, so assuring the same treatment for all the operators, and to analyse the outputs for the operation of infrastructure, and for its maintenance and renewal, fixing the price that should be paid for them.

All these measures involve costs and risks of failure, as all the transitions. If the governance system is not well defined ex-ante, it will be impossible to give the right incentives to all the parts in the network, and the advantages of the involvement of private sector will be more than offset by the increase in costs. This can happen simply because the changes in the system of accountability have the risk to take the Government to assume expensive financial obligations to incentive the participation of private companies in offering public services, without retaining a correspondent control power towards them.

Shleifer and Vishny (1997) define corporate governance as having to do with "the ways in which suppliers of finance to corporations assure themselves of getting a return on their investment". The theoretical justification for this context was derived from the "nexus of contracts" view of the firm, that consider all the relationships between the entrepreneur and the suppliers: the ultimate scope of the firm is to minimize the transaction costs between specialised production factors. Linking in this way governance and production structure, this view shows that the appropriate setting of governance structure can motivate the economisation of production costs.

The aim of this paper is to add new elements for a better comprehension of the governance problems that can rise from the privatisation of a complex system, like the railway network, linking the structure of the system (policy, regulation) with the issues regarding production (finance, technology, etc.).
For this purpose I will use the case-study of the British Railways network as a "paradigm" to show all the difficulties and the various risks involved in this complex transition. United

Kingdom has been one the first European countries to liberalise the railways, and the problems run into the British experience can be a useful guide for a reforming system, like the Italian one, either for the failures, either for the recent solutions.
In particular, I will analyse the crucial role that an efficient governance system can play in this context. Considering both the notion of governance as defined above, and the public nature of the service provided, I divide this question in two parts: **finance** and **regulation**. Since this paper is concerned with the development of the railway system, it adopts a methodology that will merge the approach of the so called Large Technical Systems with the notion of Economies of System: I choose this methodology to show the connections and the influence of the technical, economic and political factors at work within large technical systems, shaping its development towards a particular direction.

The paper is structured in three parts: in the first part it will be presented a general overview about the methodology, with a critical analysis about the contribution of the literatures on the Large Technical Systems and the Economies of System, arriving to define their major strengths and weaknesses, then distinguishing some relevant concepts that will guide the analysis of the case-study. In the second part the history of British Railways of the last 15 years will be presented: I will analyse the major problems incurred in the transition process, eventually showing the crucial role played by the inadequate governance structure of the network in the financial distress that has pushed, in the last years, to completely reforming the structure of the British railways. In the third paragraph the new rules for governing the rail industry will be examined, trying to evaluate their possible costs and benefits. The last paragraph will take to conclusion.

I The Large Technical Systems

The *Large Technical Systems* approach pioneered by Thomas P. Hughes, the American historian of innovation (Hughes, 1983, 1987), focuses on the interactions between system components, and their influence on the pattern of evolution of complex systems, providing a useful conceptual framework for examining the technical and political development of systems.
A system is defined as "coherent structures comprised of interacting, interconnected components" ranging from "relatively simple machines to regional electricity supply

networks" (Hughes, 1983, p. ix). This definition differs from the concept of complex systems offered by Miller et al. (1995), where the unit of analysis is the product and nature of its production: that is, the supply of large, complex, customized, engineering-intensive products or systems, in which production is of a one-off kind, usually on a project basis, to meet the requirements of individual customers (Davies, 1996).

Systems, Reverse Salients, Critical Problems and Momentum

Hughes (1983) identifies three main technical features of what in his more recent work are called Large Technical Systems:

1. The system is constituted by a number of parts, or components, as diverse as artefacts (physical or non physical), organisations, scientific knowledge, legislative rules, natural resources and so on, that form different items of capital equipment. Each component has functional attributes to fill the position required by the system. Inventors, industrial scientists, engineers, managers and financiers are components in the system. They have degrees of freedom not possessed by the artefacts, even if modern system builders have tended to routinize, in order to minimize the voluntary role of workers in the system.
2. These components are connected by a structure, or network, to form a complex system, such that changes in the activity or design of one component impact on the other components of the system. The configuration of the network gives the system its own distinctive technical architecture, which may be arranged vertically or horizontally.
3. A crucial function of people in technological systems, besides their obvious role in inventing, designing and developing systems, is to complete the feedback loop between system performance and system goals and in so doing to correct errors in system performance. In particular, one of the components, the *control component*, distinguishes from the others by its role into the system: it is aimed at optimising the system-wide efficiency and directing the system towards the fulfilment of goals.

In the *pattern of evolution* of a complex system, Hughes distinguishes phases that are not simply sequential because they can overlap and backtrack: invention, development, innovation, transfer, growth, competition, consolidation (Hughes, 1987). During this process,

all the components do not develop at the same pace, some of them lagging behind the others and retarding the system development and growth or impeding its evolution. Hughes (1983) compares an expanding technical system with an advancing military front. Referring to concepts taken from military history, a salient is a bulge or projection in an advancing front, and a reverse salient is a part of the front that lags behind. Then, a **reverse salient** is a component or set of components which is out of phase, or lags behind, other components in an expanding system. Reverse salients emerge from the uneven growth of a system because such components are less efficient than others, do not interact harmoniously with more advanced components, eventually retarding the development of the system. The entire system complexity growing with the number of system components can create intense problems of control. The control component then becomes a reverse salient and a *crisis of control* appears that can threaten the entire system itself.

To continue the further advance of the system, a central role is played by innovative activity, which focuses on removing the reverse salient. If the problem is in the organizational rather than technical structure, the professionals who have the task to come up with innovative solutions may be managers or financiers. On the other side, the technical improvements, performed by inventors, designers, engineers or research staff, in the design or operation of backward components, by means of the analysis of a series of critical problems that are believed to be solvable, help to re-establish a technical balance and efficient interaction between interdependent components.

As the system continues its path on the pattern of evolution, it acquires ***momentum***, whose effect in established systems is analogous to an inertia of directed motion which pushes the system along a path-dependent process of technological change, or trajectory (Dosi, 1982), a metaphor similar to momentum (Hughes, 1987, p. 77). The momentum is maintained by solving critical problems that constrain the system growth and is susceptible to be disrupted by contingent events such as wars or crisis. In Hughes framework, momentum, by its deterministic influence, becomes a central explanatory concept providing "an explanation of both the internal dynamics of systems and the influence of external factors or the environment." (Davies, 1996). So doing, even though Hughes recognises that economic principles of *load diversity* and *load factor* could be a major explanation for system growth through the individual selection process of innovation, the structural role of economic factors

tend to be superseded by this of momentum. With this term Hughes summarises the characteristics of *mass*, *rate of growth* and *direction* of the system.

The mass comprises technical and organizational components. Technical components consist of machines, plant, equipment and durable physical artefacts in which considerable capital has been invested. A commitment to recover sunk costs (the original investment in plant and equipment) creates a disincentive to invest in new technology since its adoption may force premature devaluation before components are obsolete or in need of replacement. Organizational components also add to momentum. The involvement of employees and managers whose knowledge, skills and attitudes are closely associated with the system, together with business firms, government agencies, educational institutions, professional societies, trade unions, financiers, regulatory bodies and other institutions with a stake in the system, often share a commitment to its prolongation.

As a system grows in size, it acquires momentum due to the growing number of subsystems and components which have become part of its technically interrelated infrastructure - an aspect of increasing returns to adoption (Arthur, 1988). The larger the system, the greater its advantage over competing technologies, which, if less adopted, may lack the required infrastructure or require a partial dismantling of the more widespread existing system.

The characteristic of interconnectedness exerts a powerful influence over the direction of innovation in systems. As the system expands in size, interdependence and complexity, its efficient operation requires close attention to the criteria of compatibility with existing of future potential technologies.

I.2 The Economies of System: An integrated Approach between Technology, Economics and Politics

Hughes (1987) dismisses the assumption that large technical systems are autonomous, in the sense that technology obeys an internal logic of its own and, in the process, shapes the character of institutions associated with the system. The appearance of autonomy suggests that the final state can be predicted from initial conditions and the inner dynamic of the system. Informed by the sociological and historical approach labelled the social construction of technology, Hughes provides an explanation of both the internal dynamics of systems and the influence of external factors or the environment: Large Technical Systems which appear

to be autonomous have in reality acquired a high level of momentum. Not only does the concept of momentum support the view that technology is shaped and shapes-social institutions; it captures the structural factors and contingent events influencing the development of systems.

The central problem with the Hughesian framework is that in getting rid of the concept of autonomy, it fails to provide an adequate explanation of the economic forces which give the systems their internal dynamic and rate of growth. In focusing on the way in which certain economic principles were applied by individuals, Hughes neglects to provide an analysis of the economic selection, environment (i.e. cost structure, scale of production and profitability) that structures the behaviour of those involved in a search for improved techniques. The cost structure of large-scale, capital-intensive systems creates internal pressures that have a deterministic influence over the direction and rate of innovative activity.

For this reason, Davies (1996) suggests that a deeper understanding of the causes of innovation in large technical systems and their implications for policy can be achieved by combining concepts developed by Hughes with complementary research on the economics of technological change developed elsewhere in the fields of economic history and technology policy (Arthur, 1988; Chandler, 1990; Rosenberg, 1994; Freeman, 1995). Despite difficulties entailed in predicting the future path of technological change in a complex system, the framework of analysis presented by Davies helps to isolate the technical, economic and political processes which shape the rate and direction of innovation in the railway network, in this way improving the understanding of future changes in this large technical system, and making decision-makers more prepared for evaluating the policy options and dilemmas that these changes present.

Davies' central argument is that an explanation of growth in large technical systems has to account for the economic drive to realize cost-saving economies of scale and scope, which, as Chandler (1990) has argued, is the prime cause of technological and organizational change across the whole spectrum of industrial sectors, ranging from manufacturing to transportation and communication. Economies of scale stem from improvements in the capacity to handle large volumes of traffic and connections to a greater number of subscribers at a lower cost.

Economies of scope are derived from using the same plant and equipment to provide a range of transport services at a lower cost than that of providing each service separately.

Explanations using the concepts of economies of scale and scope help to specify important causes driving growth, but they neglect to explain the most essential characteristic of a large technical systems defined by Hughes: the mechanism for controlling a system of interrelated components. Drawing upon previous research, a new concept of economy of system is put forward to explain reductions in costs which flow from improvements made in controlling the routing of traffic and delivery of services through large technical systems. Indeed, many of the cost advantages attributed to economies of scale and scope cannot be realized without accompanying innovations in the system of control. Such economic forces create internal compulsions that, together with innovative efforts to solve technical problems, may direct technical systems along distinct paths of technological development. If technical and economic forces set limits to possible trajectories of system development, the final selection of one path rather than another is dependent on politics; that is, the relative power of institutional interests and their commitments to particular systems of technology.

What is required, therefore, to portrait a case-study about the transition of a network industry like the railways, is an analysis which takes into account the development of the technology system, and the close interdependence, between technology and economics, and technology and politics. In particular, the interdependence, with different rates of evolution, between technology and economics often generates problems of lack of synchronicity, or mismatch: in this context, innovations attempt to restore the harmonious development of the system.

Economic incentives to reduce costs and supply new markets tend to direct innovative activity towards the solution of reverse salients in system growth. In this dynamic process, solutions to particular problems may give rise to imbalances elsewhere in the system, requiring further modifications of components or creating unexploited opportunities for improvements in the efficiency and capacity of the system. Techno-economic pressures operate at the level of the system as a whole, affecting the network architecture and its control. However, while these forces set limits to possible paths of system development, the selection of one path over another is primarily determined by politics; that is, the power of institutional interests to promote and realize their preferred system architecture. In practice, therefore, technology and economic forces do not work in isolation from politics. Institutions which push the system

along a familiar path may come into conflict with other institutional contenders for control of the system as each competes to gain a dominant position in the market. Path dependence in systems is only observable and capable of explanation after the fact, and prediction is difficult since all early change, however small, can direct the system along a radically different path (David, 1985; Arthur, 1988). With this proviso in mind, it is possible to identify *alternative* trajectories of development by isolating the technical, economic, political and other causal forces contributing to momentum and inertia in systems, and by taking account of countervailing forces which might alter that trajectory of development. In this dynamic framework, it is possible to explain how innovation and the adoption of new technologies by different market actors in the network influence trajectories of development in the entire system.

Now it appears evident the crucial role played in complex systems by the governance structure, to whom is delegated the task of linking together technology, finance and regulation, arriving to define an efficient system of apportion of risks and returns. I sustain that, especially in public projects, the growing complexity of the industrial structures has not seen a parallel evolution on the governance side. Surprisingly, the several changes in the organisational architectures and in the productive structures of the advanced firms have not seen a parallel evolution upon financing, for example with the utilisation of more complex financial instruments that are still mainly employed for speculative purposes, instead of supporting strategic projects, neither upon the development of more effective accountability mechanisms. This mismatch creates a great instability, such that even the most competitive firms face high risks to fail in developing strategic projects. To understand the crucial importance of this gap between governance and production, I examine a case-study of a strategic industry of United Kingdom, the railways, that after privatisation faced a *crisis of control*, essentially because of the inability to reconcile the requests (and to share the risks) of the many different subjects involved in the network.

II From Railtrack to Network Rail: the transition of railway system in Britain

The privatisation and liberalisation of British Railways (BR) has been established in 1993 with the Railways Act that transformed a monopoly into vertically separated, competitive markets, distinguishing the ownership of infrastructure from the operation of trains.
"Under the act, the break-up of BR created a decentralised structure of more than 100 companies. The railway infrastructure is a monopoly owned by Railtrack. Twenty-five train-operating companies (TOCs) share the passenger transport sector on the basis of franchise agreements with the Office of Passenger Rail Franchising (OPRAF) and track access agreements with Railtrack. Three rolling stock companies (ROSCOs) own and lease the rolling stock to the TOCs. Five firms operate freight services. For maintenance, Railtrack and the train operators contract services from a wide range of suppliers. The market is regulated by an independent Rail Regulator." (Geyer-Davies, 2000).

The privatisation laid behind the assumption that private sector innovation and discipline would have driven down the railway's public funding requirement, contemporarily driving up quality of service, against an increasingly falling demand. In the first few years after privatisation, most train companies were successful in living within their own budget constraints, thanks to new revenue growth[1]. The policy of introducing "market disciplines" (that is, the search for profits) into the operation of the network, when the privatised Railtrack took over as network operator in 1994, led also to the outsourcing of maintenance to a number of construction companies on the basis of 20 term contracts dispersed geographically around the network. Contractors had to maintain the standards existing at the time of privatisation, by providing track fit for purpose against predetermined standards. However, those standards were already in decline by the time the new companies took over during the mid nineties and, moreover, Railtrack (like British Rail before it) had little idea of the overall condition of the network (Winch, 2004). This poor asset management interacted with rising utilisation of the network following privatisation to create the crisis with came to a head due to the fatal Hatfield derailment in October 2000.

The growing number of accidents revealed that the privatisation of Railtrack, with the contemporary outsourcing of all the engineering work to infrastructure maintenance

[1] For an extensive analysis, see Florio and Manzoni (2004).

companies, had led the company to a very poor knowledge of its asset conditions, and to a rapid deterioration of the track, which eventually obliged Railtrack to give big penalty payments to train companies, consequent also to the new speed restrictions (White Paper on Transports, 2004). The level of maintenance and renewal work was rapidly increased, but with fast rising costs. These substantial cost increases, combined with a decline in performance consequent to the Hatfield accident and a separate loss of control on the West Coast Main Line project, contributed to the company's worsening financial situation, which eventually led to its entry into administration.

The Project of modernisation of the West Coast Main Line (WCML) had been discussed since the late 1980s to remedy the capacity constraints caused by an outdated technology on one of the most important and used lines in United Kingdom. Privatisation and regulation were intended to provide a stimulus to the modernisation of the WCML.

Transport services are in fact unable to sustain an efficient competition because of the existence of irrecoverable technological costs given by the network structure, and so we can define them as natural monopolies[2]: the main problem is that a firm in natural monopoly will not fix a minimum price of the service (namely equal to marginal cost), and so there will be a not tolerable deadweight (social) loss. The only way to avoid this situation is a regulation scheme fixing prices at an acceptable social level and giving subsidies to the natural monopolist: the challenge for a regulator will be to find the right proportion between prices and subsidies in the interest of the consumers.

The competitive franchising policy of this project made by OPRAF, in fact, was based on operational performance and on the amount of subsidies required for services. The winner of the competition, Virgin Trains, accepted in the franchise agreement a sharp decline in subsidies over the l5-year franchise period such that, when the franchise will terminate in 20l2, Virgin will have to pay a considerable premium to OPRAF. Virgin Trains will only be able to satisfy their financial obligation in the future if their market will grow substantially attracting, with the introduction of high-speed services, new passengers who currently prefer to take the plane for their journeys on that route: so it was indispensable to upgrade the WCML to permit to high-speed trains to operate.

[2] Natural monopoly is a condition in which competition is not desirable or realisable, because the economies of scale or of scope determine an increasing of the costs or useless duplications.

But the fragmentation of the UK market, with the conflicting interests and requirements of the various subjects[3] (Geyer-Davies, 2000), made necessary the establishment of a new subject replacing OPRAF, the Strategic Rail Authority (SRA), thought to provide a solution to this problem, ensuring a balance between the individual demands of the operators and the requirements of integrated network development. But, for many reasons that will be deeply analysed forward in the paper, no composition was possible, Virgin Trains retired the offer and Railtrack has been substantially re-nationalised, with the government assuming responsibility for the WCRM project.

Network Rail took over Railtrack's responsibilities for the management and operation of the network in October 2002. Network Rail is a company limited by guarantee, run on a commercial basis but without shareholders: this means that all the profits are reinvested in the railway, rather than paid as dividends. It has access to private finance and to private sector management skills, but the level of income required by Network Rail is independently regulated by the Office of Rail Regulation (ORR). The Strategic Rail Authority has been wound up and its liabilities have been transferred to the Secretary of State for Transports (White Paper on Transports, 2004).

These events show the several difficulties entailed by a process of transition from a system to another. In particular, the proliferation of subjects operating in the railway market with their different productive and technological endowments and perspectives on one side, and the regulatory and financing schemes on the other side, have created a mismatch taking to the instability of the entire system. In typically Schumpeterian terms, the process of introducing radical technological innovation into the system induces a social and political conflict between the established interests, attempting to use their institutional power to influence the pattern of technological change in their favour, and a new innovating sphere, seeking to expose the system to competition (Schumpeter, 1943, p. 87). Competition from new technologies threatens to undermine the power of the traditional monopoly practices that aim

[3] In the case of WCRM, in order to run high-speed trains, it was desirable to develop a so-called TBS system (transmission based, in-cab signalling system). Railtrack and Virgin have an interest in adopting this signalling technology but ROSCOs, the banks who own the trains, had no guarantees, with the introduction of TBS on the WCML, while using an alternative signalling system on other lines, that they could lease their trains to other operators on the WCML after franchise of Virgin expires. The ROSCOs were interested in a standard design for new railway infrastructure as well as for new rolling stock. Under such conditions, the decision-making process in projects becomes increasingly difficult (Geyer-Davies, 2000).

at defending established positions, protecting fixed capital by delaying the introduction of new technologies and setting prices so as to maximize short-run profit.
The control component, in this context, is the governance scheme decided at the political level, and constituted by the two aspects of finance and regulation. An efficient governance structure should have provided an efficient composition between the interests of Virgin Trains (the innovator) and the ROSCOs (the established interests), but it failed.

The out-of-synchronicity problems, as Freeman (1995) calls, may require narrower technical solutions to components which have fallen behind or be on such a scale that they require institutional innovations in the political and regulatory structure of the technical system when, for example, major changes in technology outstrip existing institutional forms, which may be slow or resistant to change. Talking in Hughesian terms, the growing complexity of the system after privatisation, with the increase in the number of components, made the transition costs to raise dramatically, because the governance setting was *the reverse salient* of the railway system.

The rest of the work will be devoted to this question: my point is that the events occurred to the British railways network were depending essentially by governance problems, where governance is in the sense intended by Shleifer and Vishny, and the problems are intended as a harmful intersection between momentum, reverse salient and a scarce capacity utilization of the railway network.
I will divide this problem in two different, but both crucial, aspects: *finance and regulation*.
The financial aspect involves the efficiency of the method of financing a project (in the British case the Private Finance Initiative with the DBFO scheme) in a context of natural monopoly, and the problem of what financial instruments are most suitable for financing innovations in complex systems.
The regulatory aspect concerns instead the mechanisms and the incentives that an efficient regulation scheme should provide, and the competencies of an independent authority in this field.
I will examine them in turn.

FINANCE

A new policy, the Private Finance Initiative (PFI), was introduced in United Kingdom in the autumn of 1992. There are two fundamental requirements for a PFI project. First, value for money must be demonstrated for any expenditure by the public sector. Second, the private sector must assume the big part of the risk, concept involved in the expression DBFO (Design, Build, Finance, Operate). The idea was that PFI should deliver a better value service, defined in terms of price, quality and risk reduction.

The process of privatisation and de-regulation that accompanied PFI made big changes in markets like transports, transforming the manufacturers also in suppliers of services (design, installation, support during the product life-cycle) to the costumers. The competition in the mid 90s changed the traditional relationship between supplier and buyer, stressing the importance of services in the value chain of the products[4].

Owner-equity backed DBFO schemes mean:

1. The designers are the future operators, with quality and capacity levels optimised in a long-term perspective;
2. The designers are the builders and suppliers, bringing into the planning process precise knowledge of state-of-the-technology and having all interest in keeping costs down and completion times short;
3. The builders/suppliers/operators carry out their own financial engineering, and the capital markets will lend not just to a project, but indirectly to the large companies which make up the DBFO consortium;
4. The DBFO actor has control over its budget.

The theory behind the Private Finance Initiative is that risk should be apportioned between the public and private sector according to where it can best be managed. The underlying assumption of PFI is that efficiency gains generated by private sector construction and management will more than offset the extra cost of capital involved.

This was the scheme used for the privatisation of rail industry in the early 90s, but the public sector tends to favour long-life, capital-intensive approaches, while the private sector favours

[4] (see Davies et al. 2001)

shorter-life, lower-capital cost options: in this context, why strategic projects have been assumed to be more efficient if financed by the private sector?

Actually, this scheme seems to have been set up for trying to avoid to put more public money in the rail industry, with the consequence of delegating to private companies also the major railway projects, but justifying this shift sustaining that an efficient apportion of risks and responsibilities between various (specialised) subjects should bring great savings to the public sector.

In the last years, the Labour Government has started instead to consider if there are alternative ways of generating private funds for public purposes that do not involve the PFI or full privatisation: a new rationale for funding public projects, named Public Private Partnership (PPP) was elaborated.

The use of PPP as a central element in the procurement of design, production and operation of public goods has grown tremendously in the late 1990s and early 2000s in the UK (Davies and Salter, 2004) and PPPs now account for close to 15% of all UK Government capital procurement (HM Treasury, 2004). This growth of PPP have been caused by the commitment of the Labour Government, at the election in 1997, to the spending plans defined by the previous administration and, at same time, by the major programme of investment in public services, especially education and health care, that had been elaborated. The consequent adoption of some "golden rules" for public finance perfectly tied up with the idea behind PPP, namely to shift the burden of upfront costs for the creation of new fixed capital assets from public to private sector, ensuring greater levels of investment in public assets that could not be provided by the Government operating alone (Davies and Salter, 2004).

However, I sustain that the British Government has given a strong political signal against the process of externalisation of power with the development of the concept of Public Private Partnership: the PPP has been presented as an evolution and a broader concept than PFI, but in my view the main difference is in the emphasis put on the word "public", asserting a partnership between two subjects, which is more similar to a concession, rather than discharging an activity to "someone who can manage things better", as in the PFI scheme.

The real problem for the efficiency of PFI was in fact in the governance structure: as risk is transferred to the private sector, value for money rises so long as the private subject is taking on risks with which it is familiar and which it is better able to manage than its public

counterparts, until a point where the private sector may be asked to take on risks which it cannot control and which it may be less able to handle than the public sector. Although such levels of risk may be accepted, they will be priced at a level that represents poor value for money for the public sector, because if the government seeks to transfer a risk which the private sector cannot manage, then the private sector will seek to charge a premium for accepting such risks. The goal is therefore to achieve not the maximum but rather the optimum transfer of risk, which allocated individual risks to those best placed to manage them: *that is, an efficient governance scheme*.

The classic Modigliani-Miller theorem emphasises that the cost of financing a project depends, assuming perfect markets, essentially on its risk profile. Unless alternative methods of financing change that risk profile (by affecting the nature of the risks or the way in which their ultimate burden is assigned between shareholders, taxpayers and other shareholder groups; or by improving the information agents have about the nature of the risks they assume) they will not influence the cost of capital. In the case of PFI, if the introduction of private capital does not change either the allocation of risks associated with public projects or the firm or the incentive of their management, it will be likely to increase the costs of these projects. In particular, where that private capital represents pure off-balance-sheet financing - i.e. financing which has no effect on the ultimate distribution of the costs and benefits of public projects - it can only have the effect of substituting state obligations that are not transparent and poorly marketable for debt that is wholly transparent and wholly marketable. This substitution must increase financing costs overall.

My point is that this governance scheme has been the real problem in the transition of British Railways: in United Kingdom also the owner of the infrastructure was required to produce “profits” exactly as a private company, and the immediate consequence was to cut the budget of Railtrack, while the government was “informally” the ultimate responsible for all the eventual losses of private operators. The dramatic increase of the costs was inevitable.
The choice of this governance system entailed two main distortions in the functioning of the network: one was about production, the other was about maintenance. Both have been consequences of the choice of a not appropriate financing scheme.

The most important difference between PFI and traditional capital spending is, in fact, that most of the money goes on service payments for the lifetime of the contract, rather than construction. As purchasers under PFI specify not only an asset requirement, but a service, the adoption of the PPP-PFI method of finance strengthened the trend towards "integrated solutions" provision, which has led many firms to change their strategies, developing a broader range of service capabilities and occupy new positions in the value stream (Davies et al. 2003). From these new positions, firms were creating new forms of vertically-integrated structures by moving forwards in the value stream to offer the broad base of services in operations, business consultancy and financing that are required to provide complete solutions to their customers' needs (Davies et al., 2003).
The use of PPP and the interconnected organisational innovations can be very efficient in many types of projects, as showed by the increased volume of PPP funding in recent years: I sustain that there is an exception, that is the context of a network with multiple users of the same infrastructure. Looking at the WCRM project, it is possible to see that Railtrack and operators were both responsible for financing, but the only repayment scheme was set up for Virgin Trains, who was the real strategic actor of the network, as stated in the PFI scheme.

The link between technology, infrastructure and finance was roughly considered, because of the complex and adversarial relationships between the different parts of the industry. When a project involves only a single natural monopolist who owns and uses the technology, and who bears the risks and gets the returns, the crucial question is to find effective co-ordination mechanisms to overcome the asymmetry of information between the various subjects involved in the technological upgrading to ensure the overall efficiency, so permitting also the exploitation of the innovative potential of project-based activities. When, instead, there are many different users of the same infrastructures (the "common resource" problem), but just one firm is appointed to bring a new technology and to retain the profits, while the returns of all the other actors in the network become dependent from that technology, it is impossible to find an efficient system of apportion of risks and revenues between the various actors in the network: eventually, this will result only in an increase of the overall costs.
The DBFO scheme with its "integrated solutions" approach, can work efficiently in a context like the railways only if the route for which the project has been assigned is substantially out of the network, like in the case of an airport line: no other operator go on that track, and all the phases are on full responsibility of the contractor, that is then a proper "system integrator".

In this case the single operator can choose the technology that fits best his requests, because all costs and benefits will fall on him.

The other distortion given by the inefficient financing scheme has been the outsourcing policy of the activity regarding the maintenance of the network, that took to the absence in the market of any single body that was able to take a balanced view of the costs and benefits (in either financial, performance or safety terms) of new strategic projects or even of the upgrading of existing lines. In particular, there was no possibility to have a complete overview of the various costs of the projects with a medium-term horizon.
Moreover, the maintenance contracting strategy used by Railtrack, based on contractors both specifying and carrying out activity, had few efficiency incentives and led to a lack of transparency about what work was carried out and its costs (White Paper on Transports, 2004; Winch, 2004).

Network Rail started to face the problem by addressing the governance of rail maintenance contracts almost as soon as it took over in October 2002. In a little over a year it had entirely reversed the outsourcing policy, with consistent economies of system, because of the fall in transaction costs. In fact, rail maintenance, as compared to renewal and upgrade, operations are "repetitive, small scale and have high asset specificities due to the requirement for well-located depots and geographically dispersed around the network. Although task uncertainty itself is relatively low, the physical dispersion and constrained "possession" periods combine with the more familiar contingencies to make transaction governance in the absence of high trust very costly" (Winch, 2004). In this context the direct supervision of contractors by the client would be extremely expensive, so the way to perform the operation has to be left to the contractor, with all the consequences on safety standards and productivity described above.

Re-taking in house these operations takes to big economies of transaction costs, and possible advantages because the repetitive nature of transactions presents the possibility of learning.
In a complex project, there is less scope for routinised learning if the undertaking is inherently one-off or unique, like in the case of CoPS (complex products and systems)[5]. The greatest challenge that maintaining capability represents is learning from project to project, because there is a high risk to loose learning to future projects, so repeating the same mistakes. Davies

[5] See, for a review of the literature on this topic, Peirone (2003).

and Brady (2000) argue that there are opportunities for learning when firms undertake similar categories of projects which involve repeated cycles of activity. Bids and projects are referred to as "similar" when the same sets of capabilities and routines are required for their repeated execution (repeatable solutions). While bids and projects may be similar and repeatable, and be assembled from increasingly standardised components and subsystems, the individual complex product provided still has to be tailored to the unique requirements of each customer. In this context, economies can then result more from the repetition of new types of projects than from scale or scope. It is not so much the size, but rather the increases in the volume of projects executed that permits projects to be delivered at lower costs, on time and to the required specifications.

The rationale offered by Network Rail for in-sourcing maintenance contracts was exactly a learning one. It argued that it did not know enough about the cost-drivers of rail maintenance to act as an informed client, and so decided to take in-house one contract in March 2003. This was followed by the announcement some months later that two further contracts would be taken in house. By October 2003, Network Rail sustained to have done its learning and concluded that in-house maintenance was cheaper. It was announced that all rail maintenance contracts would be taken in-house, with implementation over the following 12 months (Winch, 2004). Because of the fragmented nature of the work, the efficiency savings were only a part of the total economies, that came mostly from the knowledge of the cost structure of maintenance contracts, and the consequent drop of transaction costs. These were heavy, linked to the multiple levels of inspection established to control the contractor's ability to perform work to the expected standards and to the high frequency of these transactions. Efficiency benefits resulted instead by administrative structure in a context where many low-level decisions needing to be made, and by the opportunity to generate trust through an employment contract, rather than a commercial contract[6].

It is evident, from the succession of these events, that the eventual choices about the development (the trajectory) of the entire system have been decided by politics, then interacting with the economic characteristics (cost structure and scale of production) of the

[6] That these were lucrative is indicated by **the large falls in the share prices of the contracting companies** which typically derived between 10% and 30% of their turnover from this source *(Financial Times* 25/10/03) when the decision was announced.

network. Some years ago, the British politicians started to consider that PFI could not fit for a network industry like the railways. Because the private sector needs a return on its investment, the contracts should be long, so a change would be very difficult for many years. The concerns from the politics were clear: "Not only current but future generations (*and Parliamentarians*) will find that they are trapped into forms of delivery and behaviour that others decided for them long ago." (IPPR, 2001)

The wariness about the involvement of private sector in process of decision making was high: "There is another danger in relying on the PFI, that is when the private sector starts to determine what projects are carried out, so the investment decision becomes privatised. If the private sector is not interested then the project does not happen. If it is, then the project goes ahead" (IPPR, 2001). In the case of WCRM, both the government and the train companies touched by (but not directly involved in) the project could not accept that most of the power was given only to one private firm for a very long period of time. "Even where this is not quite so extreme, the exact nature of what is provided and how it is provided may become increasingly determined by what the private sector will consider - and how the PPP can realistically be constructed -and not by what we are really trying to deliver. The structure of PPPs begins to drive the objectives and not the other way round." (IPPR, 2001). The conclusion was straightforward: "We might well find that the fifth term Blair government may need to do the move between the public and private sectors all over again...in reverse." (IPPR, 2001).

The White Paper on Transports published in 2004 stress the need of a new role for the Government, in which it will have control on the overall approach and on the level of funds for the railways. But even in this new system the private sector will continue to take a role in the provision of rail services. This increases the need of a more efficient system of regulation of the entire industry by an independent agency. The decision in year 2004 to wind up the SRA transferring its liabilities to the Secretary for Transports, so leaving only one subject, the Office of Rail Regulator (ORR) in charge of all the regulatory questions, goes in this direction. The past regulation scheme of the rail industry, as stated at the time of privatisation, presented many inefficiencies.

The major problems faced by the regulation system in the transition of the railways in United Kingdom will be examined below.

REGULATION

If the private sector is to take an important role in the provision of infrastructure services, it can provide capital, management or both. If it provides either, then the existing structure of relationships within the framework of state management and control will have to be changed to a more explicit system of regulation of private sector bodies by public agencies.
The British Railway industry presents particular challenges for regulation, because of the level of direct Government funding, and the combination of a natural monopoly network with franchised passenger services.

Before the reform, the integrated BR operated as an independent corporation coordinating directly all activities, although under the control of its public owner. The privatised system, with its many competing parties that need coordination, has been highly monitored, through several public agencies. Two agencies played a leading role: the Office of the Rail Regulator (ORR), which regulated the infrastructure; and the Strategic Rail Authority (formerly OPRAF, the Office of Passenger Rail Franchising), which regulated the franchisees. Other agencies involved are the Health and Safety Executive (HSE) and the Office of Fair Trading, that is in charge of implementing competition laws and has monitored with particular attention the Rolling Stock leasing Companies (the ROSCOs) since they are the only part of the system not subject to specific regulations.

In this context, I want to stress a distinction between **regulatory agencies** and **control agencies**. This distinction is clear in theory, less in practice, but it can be very useful for understanding many problems of the British system, in particular the loss of control and the lack of information about the state of the network, complained by the British Government. The control agencies are totally independent bodies with powers of supervision, collecting information and, eventually, giving sanctions. They are set to guarantee transparency in the market, and they act simply according to the laws.
The regulatory agencies, instead, are able to fix themselves the rules upon a specific sector, that has been privatised. Fixing the tariffs, controlling the projects' execution and costs, are their typical activities. They are set for granting the efficiency of the public services, with adequate value for money for the taxpayers. Because they act in the public interests, there

should not be any political influence, but eventually these agencies respond of their decisions in front of the cabinet: so, more than independent, they are autonomous from the government.

In the system created with the privatisation, only the SRA was a proper regulation agency, while all the other bodies were totally independent. So, the entire rail network was basically out of control of the government, even if the cabinet was set up as the real residual claimant of the all system. The political costs of this situation have been a big source of uncertainty to all the industry.

The Strategic Rail Authority (SRA) was set up to link together the different parts of the privatised industry and to provide cross-industry leadership. The Government established the Strategic Rail Authority to tackle the award and the management of the "passenger franchise contracts". The SRA has had some notable successes, but was in a difficult position. As a public sector body, it could not lead the industry from within, and it was not able to set a strategic agenda for the railways (a political responsibility of government). In addition, as it was directly responsible only for a single transport mode, it had no flexibility to make changes within the wider transport budget to reflect changing priorities.

It will be then a right choice to pass the SRA's strategic and financial responsibilities to the Department for Transport, as announced in 2004. The Secretary of State for Transport will take responsibility for setting the national-level strategic outputs for the railway industry, in terms of capacity and performance. Following this change, the Office of the Rail Regulator (ORR) will have responsibility for ensuring the industry maintains a high level of safety, as well as for protecting the legitimate interests of investors in and customers of the rail industry.

Under the current system, the Rail Regulator has had to determine both Network Rail's outputs for the operation of the rail network, and for its maintenance and renewal, and the price that should be paid for them, given its commitments to the passenger and freight companies. But this, combined with the fact that train companies are insulated from the effects of increasing access charges, has led to Government having no option but to foot the bill, regardless of its consequences on other parts of the transport budget, or even for other spending programmes.

Another problematic consequence of this over-fragmented regulation scheme has been the distortion in industrial dynamics. The original franchise contract designed by SRA offered little flexibility to respond to changing priorities, which meant that when some train companies found themselves unable to operate under the constraints set by their own bids, their contracts had to be renegotiated, increasing costs to Government substantially, but also retarding any industrial innovation. In fact, the operators selected through a bidding process had to reduce their production costs in order to face a more competitive environment and to deal with the planned decrease in public subsidies. The best way for the train companies to operate in this environment has been to lease the trains from Rolling Stock leasing Companies, the so-called ROSCOs. The ROSCOs system leaves a lot of freedom to the competitors in the choice of the best trains, but it is necessary to specify accurately what happens at the end of the franchising period. The perspective of having a unusable train at the end of the period will increase costs, and consequently it will be difficult for train companies to do a low bid.

The consequence of this mode of organization made savings possible mostly on rental costs of the rolling stock, but these economies were directly connected with the possible re-utilisation of these equipments and the dependence of Train Operating Companies on rolling stock owners. The discrepancies between the imposed duration of contracts and the existence of highly specific investments significantly amplified this difficulty. The parties responded by adjusting the variable under their control, thus reshaping their assets.

The leases are commercial agreements between private companies. However, it is the Government that ultimately pays for much of this through its funding of the rail industry. When the industry was privatised, it was envisaged that a competitive market for rolling stock would drive cost improvements. In addition, the returns earned from leasing existing rolling stock were based on an assumption that there was a high risk that the ROSCOs would find themselves with rolling stock they could not let once new stock came into use.

The reform imposed that Train Operating Companies (TOCs) sign leasing contracts with the agreed traction and rolling stock owners (the ROSCOs) for obtaining their equipment. Although formerly not regulated, the initial contracts were designed by the Department of Transport. Among other things, the Department determined the duration of the initial contracts allocating rights to Train Operating Companies, and fixed initial leasing prices at a relatively high level in order to make the Rolling Stock leasing Companies attractive for

investors who could expect a high rate of return within a short period of time. The decision to impose short-term contracts on the Train Operating Companies intended to create and maintain competitive pressure through repeated biddings. However, policy makers were aware that this could deter long-term investments by the Rolling Stock leasing Companies. The discrepancies between contract duration and the physical lifetime of equipment exist in many leasing industries, e.g., car and truck rental; but it is no problem as long as equipment has alternative uses. The risk premium guaranteed by the initial clauses imposing high rental prices on passenger-train operators was expected to compensate the inconvenience of the short term contracts, thus attracting investors and allowing the sale of BR fleet to Rolling Stock leasing Companies at a good value.

The more standard the specification of a train is, the more "liquid" it will be in terms of the lessor's ability to re-lease it on a different route to a potentially different operator in the future. Such standardisation is equally important in terms of both stand-alone attributes (such as mechanical design, door positioning, speed, floor height etc.) and the interface with infrastructure (such as current and loading and track gauge etc.). In order to deal with the misalignment resulting from the constraints imposed on them, parties to the transactions adopted a strategy oriented towards reducing the specificity of assets involved. Substantial changes in the design and construction of rolling stock were introduced, all systematically targeting standardization. In doing so, partners clearly intended to reduce their mutual dependence, circumventing the problem generated by the mode of organization imposed on them. The Rolling Stock leasing Companies lead the movement.

This regulation scheme, then, had strong effects on the entire organisation of the market, determining a particular trajectory which took to a crisis of control of the entire system. The complete distortion of the industrial dynamics has been caused by the failure of regulation mechanisms to establish an efficient governance system for the network resulting from privatisation. As described by the approach on the Economies of System, economic and political forces together direct technical systems along distinct paths of technological development, where the cost advantages given by economies of scale and scope cannot be realized without accompanying innovations in the system of control. But the governance system could not work efficiently, because of the absence of clear scheme of responsibility: as said before, pure-control agencies must only guarantee that the existing laws are respected

by the operators in the market, while the only regulation authority (SRA) was unable to reform the strategic lines of the system. The Public Private Partnership, in fact, allows only the two parts involved (government and private companies) to be responsible for the mechanisms of their relationship, but no clear relationship between these two subjects was formally outlined in the governance system of the privatised railways. Eventually, there wasn't a subject able to introduce innovations in the control system, because the governance mechanisms were themselves the "reverse salient" of the network.

III Governing the Transition

The analysis made until now about the privatisation of British Rail, shows that its social costs have been very high because the governance of the transition did not fit with the economic, technical and organisational structure of the system.

As I stressed above, considering the relative costs of public and private capital, significant differences become apparent only if the introduction of capital is associated with a change in the allocation of risks, and such a change is likely to be achieved only if there is also a change in the structure of management responsibility. In the case of British railways, under the transition system the Government has been set as the ultimate major funder of both track and train companies, and so their primary commercial relationships should be with it, as it is also in the rationale of PPP. But the governance system put in place after the privatisation makes it hard for Government to make choices between its support for infrastructure and for operations, and often keeps it at one remove from the consequences of its decisions, which can take years to become apparent. As sustained before, a weakness of the original structure imposed at the time of privatisation was the assumption that Government could entirely delegate its responsibility for the rail industry, and that market forces alone would drive up performance. The consequences of the use of this governance scheme to an industry that, by definition, requires very large amount of capital, can be appalling, also because there is no clear arrangement between Government and Network Rail setting out the outputs it wishes to buy and the price to be paid for them. In fact, there is no real commercial market between the train companies and Network Rail, and no real customer-client relationship as the Government largely funds both: "Although it was assumed at the time that subsidy levels would decline, and that the industry might ultimately become self-supporting, in fact this left

the taxpayer writing blank cheques for an industry that it did not control" (White Paper on Transports, 2004).

The structure of the privatised system as a nexus of contracts has made evident the central question of governance. The core of the privatised railways was formed by three sets of contracts: track access agreements, defining the conditions of access to the infrastructure; franchise contracts attributed to the Train Operating Companies, and rolling stock leasing agreements to give access to the equipment owned by the Rolling Stock leasing Companies. While the first two sets are regulated, the last one, which is central to the functioning of the system, obeys largely to market rules. In addition, the train companies' franchise contracts with Government are set in a way to insulate them against any rise or fall in the access charge. This means that the access charge regime has not effectively encouraged either Network Rail or the train companies to control costs.

Considering the new statements of the White Paper on Transports released in 2004, it is clear that the British Government is to take a more effective role in programming the priorities for the entire network. In the present structure of British railways, the absence of clear industry leadership and joined-up planning has meant that each major project has tended to be developed in a different way, with decisions rarely based upon any strategic analysis across the transport system as a whole.
If the original assumption of PFI and PPP remains valid, and so the value for money should come from a right distribution of risks and rewards between public and private subjects, even in the new system the private sector can play a major role. In particular, maintaining the method of analysis used until now, it is possible to individuate two situations in which the private companies can play an effective role for the efficiency of this Large Technical System: first, the phase of constructing and upgrading the lines; second, the operation of the trains.

In the former case, a different conception of the DBFO scheme would be necessary. I showed that, in the context of the railways, the scheme of DBFO does not work well together with the tendency towards integrated solutions, because the scheme was intended as centred on the procurement of a public service, more than on the project and its maintenance. However, it is possible to merge the two concepts if the same company that is committed to build a line, is

appointed responsible also for the upgrading phases. This is the spirit of the integrated solutions, because it procures a service for the lifetime of the project, and it follows the rationale of PPP, giving a responsibility to the private sector without undermining the political power to determine the priorities of the system.
Then, instead of outsourcing all the activities to many different firms, the "natural monopolist" who owns the infrastructure, namely Network Rail, should rely for each project on only one single subject, chosen with a bid process, and that will be responsible for the construction and the upgrade for the lifetime of the project. It is also worth noting that Network Rail stated to have no plans to take in-house renewal and upgrade work for two reasons:

- frequency levels are much lower in renewal and upgrade transactions than in maintenance contracts, and projects are significantly larger;
- transaction costs as a proportion of total costs are lower than in maintenance activity, because in renewals it is possible to measure performance very clearly, structuring the contracts such that the contractor has a real incentive to show the efficiency improvement.

With this system, the Government will retain the power to choose the strategic priorities, the selection for the best projects will be made with a competitive process, and a single subject will establish a real commercial relation with Network Rail, that will always have the knowledge of the state of its assets. If the construction and upgrading phases are delegated to a system integrator, in line with the strategic decisions stated by the government, there will be a real costumer-client relationship between the contractor and the infrastructure's owner: in this way the apportion of risks and revenues between the parties is set up in the contract since the beginning of the project, avoiding future governance problems.

For what concerns the operation of trains, the British Government has clearly expressed that the system of the franchise contracts will continue to be the organisational scheme of the railways in United Kingdom. As I sustained before, the leasing mechanism of Rolling Stocks can take to distortions in the market if not well governed. The ROSCOs system leaves a lot of freedom to the competitors in the choice of the best trains, but it is necessary to specify accurately what happens at the end of the franchising period. To guarantee for example the purchase of the train at the end of the contract will reduce the amortization costs, but the

public sector has to commit itself to guarantee financially the ROSCOs, about the requirement of their rolling stocks beyond the end of a specific franchise contract, with a consistent public spending. The perspective of having a unusable train at the end of the period has been a big obstacle for innovation and competition, and eventually has the effect to increase costs, making consequently difficult for train companies to do a low bid. In fact, in 1998 the Rail Regulator conducted a review of the rolling stock leasing market, concluding that, whilst there were constraints on the ability of the ROSCOs to exploit their market positions, the share of the leasing market for passenger rolling stock held by each ROSCO was sufficiently substantial to indicate the likelihood of a dominant position, and limits on interchangeability of stock increased that concentration in relation to certain market segments. A voluntary code of practice was suggested as a remedy. The codes of practice were published by the ROSCOs on 10 February 2000.

The scheme outlined in the new statements of British Government in 2004 is simpler and has a clear governance structure, with the advantage that the big strategic projects will be financed (but not decided) by private capitals. This is an advantage because of the greater flexibility of the methods of financing that are allowed by the presence of private sector. The traditional contrast between public sector financing, which characteristically has a lower required rate of return but for which the funds available are typically rationed, and private sector financing, which demands a higher hurdle rate but for which capital is likely to be available for any project that meets the rate-of-return criteria, is the result of institutional factors rather than the nature of the financing systems themselves. The PFI scheme was set up also to eliminate the consequences of this contrast.
PFI and PPP projects are thriving in terms of size and diversity, and are also becoming more sophisticated in their methods of financing, using all the latest products from the capital markets. There is a growing requirement on the part of project sponsors for their banks to be able to provide either a bank loan or a new financial solution. Competition for this business is increasing with new types of funders.

The real problem has always been that most contractors are weakly capitalised and have very limited scope for long-term equity investment. To the extent that they have been obliged to supply risk capital in the absence of alternative investors, it has come at a high cost. This is the reason why the UK PFI market had traditionally been funded by bank loans, but the usual

finance *via* bank loan is not sufficient anymore. As showed above, in fact, the traditional business firm, with stable technology and clear-cut boundaries is facing dramatic changes. The governance structures of firms are in constant flux, and the most dynamic subjects in the market are moving from production towards the provision of services to their clients, including or excluding activities during their economic lives, with a lower importance of the fixed capital inside the firm.

Although loans are still widely used, various forms of financing from the bond markets have become more popular in the last years and are particularly included in the funding of larger projects. The move towards bond funding has occurred as European banks have become more reluctant to lend at low margins. The private placement markets can provide debt of 25 years or more, a crucial benefit to a long-term infrastructure investment, but banks are nervous about tying up capital for such a long time and the private sector has not been willing to put in the large sums originally expected by government ministers because of the long-term nature of transport projects and the frequently slow pay back. This is why the European bond market has grown rapidly in the two years since the launch of the euro. Usually, it is necessary to establish a "credit enhancement" arrangement to provide an additional insurance on the risks. A characteristic of many transport projects is the long period that elapses before there is any revenue to meet financing charges. The use of credit enhancement - a guarantee from an insurer that bond holders will be paid back in the event of bankruptcy – ensured the bonds achieved an AAA rating, the highest level of credit worthiness. But issuing a bond at the outset also locks the construction consortium into a repayment schedule. Private companies investing under the PFI will want to ensure that their investment is viable. To do so, they will press for a guarantee of a stream of income from the state purchasers. They will then have a vested interest in making sure that the income stream that they have been "guaranteed" will remain. If they succeed in pursuing that interest, the purchasers concerned will be locked into a pattern of provision and a set of providers that may not be appropriate in the long run. This is an advantage because the non-commercial risks of strong political insertion are increased by an unstable financial structure of projects. The disadvantage is that renegotiating the terms of bond would be much more complicated than renegotiating loan deals with the banks, and the process involves the generation of powerful pressure groups with vested interests in the *status quo*: as showed above, this happened in the WCRM case, where the *momentum* of the system impeded a radical innovation of the infrastructure.

The rationale of PFI and PPP does not specify clearly that all the major infrastructure projects are inevitably in the public domain and hence vulnerable to public policy risk, such as cancellation by a new government, failure to provide promised access routes or changes in safety and environmental standards. When a project, because of the delays and the innovation requirements, becomes too expensive and there is necessity of new long-term investments, if the governance scheme is not appropriate and does not allow flexibility, the entire system will face a crisis. The financial needs of a complex project change markedly during its lifetime: first, there is the planning and preparation phase where there are high risks of delays and cost overruns, when unpredicted environmental or regulatory problems can occur, which might result in fundamental redesign of the project making it less viable than originally assumed. The second phase of a major transport project is the lengthy construction period, where there is considerable risk of further delay and increasing of costs especially if the project is insufficiently planned and requires major modifications as it develops. Even in the mature operating phase, when cash flow is established and gradually strengthening with increased traffic volume and higher charges, risks can remain.

In every period the risks/returns stream has to be calibrated carefully for every subject, but this can be extremely difficult because of the *momentum* of the system. As the approach on the Economies of Systems has showed, the technological, economic and political factors work together shaping the trajectory of the entire network. I sustain that a possible way to avoid the typical distortions of these projects, in particular the resistance to innovation, could be to calibrate the governance scheme upon the adopted technology. Until now, it has been exactly the contrary: technology was chosen after all the subjects involved in the network agreed about the governance scheme, so that every modification to the initial mechanisms faced a strong opposition and, in the best case, suffered long delays, in the worst case, it was abandoned. To have a single political subject designing the priorities of the system with a medium or long-term horizon, can take to strategic decisions about technology and innovations that are sufficiently clear-cut to induce the operators to set up a governance system with enough flexibility to follow the various phases of the project's lifetime, namely of the technology's life cycle.

In sum, to an industrial innovation should correspond an innovative financing scheme, avoiding that mismatch between complexity of production and roughness of governance

structure, which I indicated as the primary cause for all the instabilities of Large Technical Systems.

Finally, this new system necessitates of a single control body, as defined above. I showed that the presence of a regulatory agency, with the power to set the rules of the market, can create serious conflicts with the political system, and that too many independent control bodies take to a critical lack of information within the system. On the contrary, a unique authority with extensive control powers upon all the external influences (scientific, technological, economic factors, safety standards) to the industrial dynamics, would not create conflicts of power with the government, and has lower political costs than a regulatory agency. The decision to give directly to the Department of Transports the regulatory powers, and delegate the control function to the independent ORR can finally make the supervision on the system effective, because of the presence of a totally independent body that must only guarantee the respect of the laws.

Conclusions

The case of British Railways shows all the crucial issues, technological, economic and political, involved in a transition process. In particular, the analysis of this case makes evident the necessity of innovative governance schemes, to cooperate with the increased complexity of markets and firms. I divided this question in two aspects, finance and regulation, using a methodology that helps to identify the different influences that each factor (technology, innovation, finance, policy) has in the development of a Large Technical System. In particular, the examination of this case-study trough this methodology has stressed the role of the governance scheme set up for the liberalisation of British Railways as the "reverse salient" of the entire system.

The main initial assumption of privatisation was that, if there is an efficient governance structure in place, all the transactions happen out of the market: debt costs are in fact paid for by operating revenues and there is an "upside" to profitability that is the increasing in passenger traffic and little or no "downside" to making debt payments. In this case simply the government is unwilling to take on the risk, and can delegate responsibility to the private sector. However, this case showed that, on the financial side, the crucial interdependencies in

the apportion of risks and returns between the various economic subjects using the same infrastructure have been undervalued, and, for what regulation is concerned, the responsibilities and the functions given to the various authorities were not appropriate (and then ineffective), for a franchising regime that eventually constrained innovation.

The necessity of new benchmarks for innovative governance structures is showed by the high transition costs faced by United Kingdom in this privatisation, and I suggested that a closer interdependence between technological and financial issues, in line with clear and predetermined political strategic priorities, can be an effective way to overcome the serious problems given by the instability of present governance schemes.

It is possible to say that the advantage of this analysis of the British case, is the description of the evolution and development of a strategic public service as Large Technical System, together with the evolution and the changes of the external environment, in this way understanding the complexity of problems in projects that make an extensive use of new technologies and analysing the problems and the solutions adopted during a complex transition.

I claim that new forms of finance as well could be designed drawing upon this literature: the complexity of the new markets and the growing requirements of money for projects are pulling the private sector to find new financing instruments and solutions, because a growing complexity of projects should be accompanied by a major complexity of models of financing.

For all these reasons, the case of British Railways can be helpful guides for changing contexts, like the Italian one, that are reforming towards a liberalised system, and are facing all the issues presented in this analysis.

Bibliography

Abbot J. (2001), *European railways slowly open up* in Modern Railways, October.

Arthur, W.B. (1988), "Competing technologies: an overview", in G. Dosi, C. Freeman, R. Nelson, G. Silverberg and L. Soete (eds), *Technical Change and Economic Theory*. Pinter Publishers: London, pp. 590-607.

Baumol W.J., Panzar J.C., Willig R.D. (1982), *Contestable markets and the theory of industrial structure*, Harcourt Brace Jovanovich, New York.

Bream R. (2001), *Growing range of options available* in Financial Times survey on PPP. Monday December 3.

Brigden A., Mizen P. (1999), *Money, credit and investment in the UK corporate sector* Working Paper n.100, Bank of England.

Castells, M. (1996), *The Rise of the Network Society*. Blackwell, Oxford.

Chandler, A.D. (1990), *Scale and Scope: The Dynamics of Industrial Capitalism*. Belknap Press of Harvard Univ. Press, Cambridge, MA.

Cohen, W.M., Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation". *Administrative Science Quarterly* 35, 128–152.

Corry D., Le Grand J., Radcliffe R. (1997), *PPP: A marriage of convenience or a permanent commitment?* IPPR-Institute for Public Policy Research, London.

Cowie H. (1996), *Private Partnership and public networks in Europe,* Federal trust for education and research, London.

David, P. (1985), "Clio and the economics of QWERTY", *American Economic Review*, 75, pp.332-337.

Davies, A., Brady, T. (2000), "Organisational capabilities and learning in complex product systems: towards repeatable solutions" in *Research Policy*, 29, pp. 931-953

Davies, A. and Salter, A. (2004), "The great experiment: Public-private partnerships and innovation in design, production and operation of capital goods in the UK", *forthcoming*.

Davies, A. (1996), "Innovation in Large Technical Systems: the Case of Telecommunications", *Industrial and Corporate Change*, Vol. 5 no.4, pp. 1143-1180.

Davies A. with: Tang, P.; Brady, T.; Hobday, M.; Rush, H.; Gann, D. (2001), *Integrated solutions: the new economy between manufacturing and services*, SPRU, Brighton.

Economic Commission for Europe – BOT expert group (1998), *Public – Private Partnerships: a new concept for infrastructure development,* United Nation publication.

Florio, M., Manzoni, K. (2004) "Abnormal returns of UK privatisations: from underpricing to outperformance", *Applied Economics*, 36,2,February,119-136.

Freeman, C. (1995), *History, co-evolution and economic growth*. Working Paper, MERIT, University of Limburg and SPRU, University of Sussex.

Galbraith, J. (1973), *Designing Complex Organizations*. Addison-Wesley, Reading, MA.

Gann, D., Salter, A. (1998), "Learning and innovation management in project-based, service-enhanced firms". *International Journal of Innovation Management* 2 4 , 431–454.

Garvin, D. A. (1993) "Building a Learning Organization", *Harvard Business Review*, July-August, pp78-92.

Geyer A., Davies A., (2000), "Managing project-system interfaces: case study of railways projects in restructured UK and German markets" in *Research Policy* 29, pp. 991-1013.

HM Treasury (2004), *PFI/PPP Projects Database*, HM Stationary Office, London.

Hughes, T.P. (1987), "The evolution of large technological systems". In: Bijker, W.E., Hughes, T.P., Pinch, T. Eds., *The Social Construction of Technological Systems*. MIT Press, Cambridge, pp. 51–82.

Hughes, T.P. (1992), "The dynamics of technological change: salients, critical problems, industry". *Research Policy* 25, 1261–1276.

Hughes, T.P. (1998), *Rescuing Prometheus*. Pantheon Books, New York.

IPPR (2001), *Building better partnerships – the final report of the Commission on Public Private Partnership*. IPPR publication, London.

Kay J. (1993), *Efficiency and Private capital in the provision of infrastructure* OECD Infrastructure policies for the 1990s, pp. 55-74.

Kline, S. J. (1990), *A Numerical Measure for the Complexity of Systems: The Concept and some Implications*, Report INN-5, Thermosciences Division, Department of Mechanical Engineering, Stanford University, California.

Laffont J.J., Tirole J. (1986), "Using cost observation to regulate firms"*, Journal of political economy* 94, pagg. 614-641.

Leonard, D. (1995), *Wellsprings of Knowledge. Building and Sustaining the Sources of Innovation*. Harvard Business School Press, Boston.

Miller, R. , Hobday, M., Leroux-Demers and Olleros, X. (1995), "Innovation in Complex Systems Industries: the Case of Flight Simulation", *Industrial and Corporate Change*, Vol. 4, No. 2, pp. 363-400.

Modern Railways special report, *West coast route modernisation* June 2000

Modern Railways special report, *West coast route modernisation* August 2001

National Audit Office, *Examining the value for money of deals under Private Finance Initiative* Report by the Comptroller and the Auditor General, London, Session 1998-1999: 13 August 1999.

National Audit Office, *Innovation in PFI Financing: The Treasury Building Project*
Report by the Comptroller and the Auditor General, London, Session 2001-2002: 9 November 2001.

Morris, P. W. G. (1994), *The Management of Projects*, Thomas Telford, London.

Nooteboom, B. (2000), *Learning and innovation in organizations and economics*, Oxford University Press, Oxford.

Peirone, D. (2003), "Complex Products and Systems (CoPS) e mutamenti dei mercati: una rassegna critica", in *Economia e Politica Industria*le n.120, pp. 85-103.

Rosenberg, N. (1994), *Exploring the Black Box: Technology, Economics and History*. Cambridge Univ. Press, Cambridge.

Schmalensee R., Willig R.D. (1989) *Handbook of industrial organization*, Vol.II, Elsevier Service Publishers B.V.

Shumpeter, J.A. (1943), *Capitalism, Socialism and Democracy*. George Allen & Unwin: London.

Summerton, J. ed. (1995), *Changing Large Technical Systems*, Westview Press, Oxford.

Teece, D., Pisano, G. (1994), "The dynamic capabilities of firms: an introduction". *Industrial and Corporate Change* 33, 537–556.

Walker, W., Graham, M. and Harbor, B. (1988) "From Components to Integrated Systems: Technological Diversity and Integration between the Military and Civilian Sectors", in P. Gummett and J. Reppy (eds.), *The Relations Between Defence and Civil Technologies*, Kluwer Academic Publishers, London.

Williamson, O.E. (1985), *The Economic Institutions of Capitalism*. Firms, Markets, Relation Contracting. The Free Press, New York.

Winch, G.M. (2004), *The governance of projects: Lessons from the construction industry*, forthcoming.