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DOCTORAL PROGRAM IN MANAGEMENT, ECONOMICS AND INDUSTRIAL ENGINEERING

The Doctoral Program in Management, Economics and Industrial Engineering (DRIG) provides students with advanced education and the opportunity to do research activity in these scientific fields. The program allows students to build a solid methodological background, and it fosters the development of multi-disciplinary knowledge, an open minded approach to research activities, and the ability to address problems in an innovative way, while combining different perspectives and approaches.

The program is taught in English. It is composed of three different types of training activities.

Main courses include:
· methodological courses relating to aspects relevant to research in management, economics and industrial engineering;
· thematic courses whose aim is to introduce students in state-of-the-art research in specific fields relating to the above mentioned disciplines: Business strategy, Organization & human resources, Finance, Economics and management of innovation, Industrial Organization, International economics, Regional and urban economics, Supply chain management, Operations, Facility management, Logistics and others.

Elective courses and training in specific themes
These activities are customized according to the specific research interests of students. Their aim is to extend the scientific knowledge of students in specific topics and to introduce them to the international research community through the presentation of research work in international conferences.

Thesis
This is the core of the program. Students are expected to develop state-of-the-art research competencies on an issue relevant to the scientific debate and to produce an original contribution that extends the available scientific knowledge on this issue.

The doctoral program covers three years. Students are required to spend at least one semester in a foreign research institution. The Department of Management, Economics and Industrial Engineering is qualified as hosting institution of the PRIME Network of Excellence established by the European Commission within the 6th Framework program. Hence students have access to the mobility support measures aimed at promoting international collaboration between the doctoral programs in the network. In addition, students are encouraged to attend doctoral schools and workshops organized by other institutions and to participate in international scientific conferences. Presentation of an original research work in an international conference is mandatory for admission to the final exam.

In previous years, students have been hosted by well known foreign academic institutions such as CRIC-University of Manchester, SPRU-University of Sussex, University of Reading, University of Nottingham, London Business School, Trinity College Dublin, Université Henri Poincaré Nancy, IESE Barcelona, Chalmers University Göteborg, ETH Zurich, Harvard Business School, Columbia, MIT, UCLA and others.

The Faculty of DRIG includes, in addition to professors of the Department of Management, Economics and Industrial Engineering of Politecnico di Milano, several foreign professors: Adolfo Arata, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile; Neil Gandall, Tel Aviv University, Israel; Benoit Iung, Université Henri Poincaré, Nancy, France; Tom Svantesson, CEN, Sweden; Tereza Tykvova, Zew, Germany; Mike Wright, University of Nottingham,UK; Frank Rothaermel, Georgia Institute of Technology, Atlanta; Bruno Cassiman, IESE Business School; Alan MacCormack, Harward Business School; Dirk Czamitzky, University of Leuven; Erik Hultink, Delft University of Technology; Christopher Lettl, Aarhus School of Business; Joseph Sarkis, Clark University, MA, USA; Jaco Huisman, TU Delft .

The program has developed several research collaborations with private manufacturing and service firms, regulatory bodies, and other public research institutions: Value Partners, TXT e-solutions, D'Appolonia, Consorzio MIP, Fondazione Rosselli, Consorzio Politecnico Innovazione, IRER, Società Banknord GE.PA.FI. SIM, Siemens, Fondazione CEUR, Fondazione Politecnico, ANIMP-OICE-FONDAZIONE LUIGI DE JANUARIO, PIRELLI & C., EUROCONTROL, C.T.G. Italcementi Group.

Typical career opportunities opened up by the doctoral program include the following ones:
· researchers and lecturers in Italian and foreign universities;
· officials of research and training bodies operating as a link between universities and private sector companies;
· researchers in economics and management working in the research departments of private corporations, financial institutions and public bodies;
· consultants in leading management and strategy consulting companies;
· managers and entrepreneurs of innovative companies.

The research projects that are presented in the following section are typical examples of the research work carried out by DRIG students.

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INNOVATION IN INVESTMENT MANAGEMENT

Marco Jean Aboav

This thesis presents three works on innovation in investment management, each of them corresponds to a chapter of the manuscript. The common theme among the chapters is to provide new insights and practical tools for investors to cope with the financial market environment of the last 20 years characterized by boom-bust financial cycles, liquidity and financial crises.

In **Chapter 1** the goal is to understand whether funding liquidity risk could affect the future distribution of hedge fund strategy returns and the implication for strategy allocation. Using regime switching models, I show that several hedge fund strategies from a basket of the 9 most famous strategies are statistically exposed to a switch from a calm distribution (i.e. high return, low standard deviation) to a turbulent distribution (i.e. low return, high standard deviation). Moreover, following a recent theoretical model proposed in the literature on funding liquidity and market liquidity by Brunnermeier and Pedersen [2009], I study whether funding and market liquidity risk factors trigger turbulent regimes among the strategies considered. I am interested in the prediction of the strategy future distributions, for this reason I use a time-varying transition probability Markov switching model to identify predictors

of the turbulent distributions. I show that most of strategy turbulent distributions could be predicted by funding liquidity variables (BAA-10Y, BAA-AAA, proxy of carry trade). Looking at the results from a mean-variance perspective, during a turbulent funding regime (in general very similar to the economic cycle) there's no place to hide in the hedge fund industry because the risk adjusted return profile during these extreme economic periods is lower than the calm funding regime one for each strategy considered.

In **Chapter 2** the goal is to apply the Adaptive Market Hypothesis proposed by Lo [2004] in equity predictability. In particular I first show that, using a time-varying regression model based on the kalman filter, predictive power of economic variables in US equity sectors predictability varies over time because the market tries to arbitrage away opportunities. Using a pseudo-bayesian model averaging based on the dynamic search of the best model compared to the classical static search for convergence to the "true" model in the literature, I put models in competition in order to extract at each point in time the probability of being the true model for each single model. For each sector index I run 16 models in parallel to understand which model should be used to predict the index. Using different

forecast combination, I evaluate predictability based on the recent concept of local predictability suggested by Timmermann [2008]. I am able to beat the S&P 500 index in terms of risk adjusted return and several extreme risk measures. My results are also robust to transaction costs.

In **Chapter 3** I study what are commonalities during the over- and under-valuation of US stock market. I apply a recent quantitative tool proposed by Taboga [2011] to evaluate over/under-valuation of stock market based on earnings per share ratio. It seems that the fundamental valuation technique anticipates the bubble of several years. This is reasonable because market could not realize that there is a bubble for years. However I add a new market sentiment indicator based on a regime switching model approach to extract from the market the probability of being in high risk averse regime. Matching information from fundamental valuation and market sentiment I am able to construct an indicator that provides the probability of being in a "overheated" US equity regime. It fits the data over the last two decades very well and it shows the stylized facts about the recent main peaks of the US equity market. Because the US equity market is the biggest equity market in

the world and US investor in a broad sense is probably the most relevant investor globally, it could be interesting to study what are the commonalities across asset classes during the "expensive" or "cheap" regime of the equity market.

The economic implications of my approach are twofold: first I can see whether the cheapness or the expensiveness of US equity market could affect investments decisions on other asset classes globally (e.g. one might expect that when the equity market is bullish after a crisis like in 2008 also other risky assets as high yield bonds or emerging markets equities are bullish), second I am able to study what is the optimal global portfolio for an US investor over the two main market conditions (cheap regime and expensive regime) and not over time.

THE ROLE OF PERFORMANCE MEASUREMENT SYSTEMS (PMSs) IN PUBLIC SERVICE NETWORKS

Deborah Agostino

MANAGEMENT, ECONOMICS AND INDUSTRIAL ENGINEERING

1.1 Research context and objective

The context in which public services are delivered has dramatically changed in the last 20 years.

Public administrations are increasingly moving towards collaborative arrangements (McGuire, 2002) for addressing valuable services for the entire community, such as health care programmes, transportation systems, urban development or mobility projects. In this context, public network have emerged as a powerful collaborative solution. They involve more than two organisations working together to deliver a common outcome, whose achievement require the joint effort of all the organisations involved. Public networks are characterised by some distinctive characteristics (Provan et al., 2007):

· The existence of a common objective that cannot be achieved by the single organisation alone (Koppenjian and Klijn, 2004);
· The presence of multiple actors, ranging from private companies, public administrations and associations of citizens (Provan and Milward, 2001);
· The existence of inter-organisational activities that allow to achieve the common objective. These inter-organisational relationships

can be either managerial relationships between service providers aimed at jointly working for delivering the service, or policy relationships, aimed at making decisions about how to plan, manage or control the service itself. Networks are recognised, not only as an opportunity for improving public service delivery, but also as complex organisational arrangements (Chisholm, 2008) that pose several challenges for both managers and policy makers. Network challenges can be organised around three main aspects:

· Decision making problems. This issue is associated with the recognition of the network objective that generates problems in the identification of the objective itself and in the alignment between the network objective and the single organisational objective;
· Motivational problems. This aspect is related to the requirement of aligning actors' strategies and increasing the willingness of each single actor being part of the network. Accordingly, the main challenge is related to the alignment of network actions. Joint working is required in order to achieve the common objective.
· Measurement problems. This challenge is related to both the definition of how to measure

networks of multiple actors and accountability problems about the identification of the actor who is responsible for both policy implementation and service delivery.

Public sector and accounting scholars have started investigating managerial approaches and control mechanisms to deal with these network challenges. Yet, the role of the Performance Measurement System (PMS) has been only partially explored despite its recognised importance (Provan and Milward, 2001; Kenis and Provan, 2009; Barretta and Busco, 2011; McGuire and Agranoff, 2011).

Given this background, this thesis has the objective to investigate how the PMS supports network managerial problems- decision making, motivational issues and measurement problems. Specifically, the research objective is organised around three main questions:

· What are the technical characteristics of the PMS adopted by network actors, in terms of Key Performance Indicators (KPI), target and reporting?
· How is the PMS used by network actors?
· How do support processes, Information Technologies and Auditing, influence the PMS technical characteristics and uses?

1.2 Research approach

The three research questions are addressed through a single longitudinal case study aimed at investigating a specific network of service delivery. The local public transport system in an Italian Region, Lombardy Region. Within the Italian transport service, the focus has been on the Lombardy Region because it started a reorganisation process in 2008 with the specific purpose to integrate transportation services between Provinces and City Councils, and finally at the overall Regional level. This reorganisation process activated a complex network of managerial and policy relationships between service regulators, service operators and associations of users. This network has been investigated from the end of 2008 until November 2011. The sources of data included: regulation at the European, National and Regional level; archival from the network as a whole and from each single network actors; media commentaries; participant observations; semi-structured interviews with key informants involved in the Regional transportation network. They include politicians, public administrators, service providers as well as representatives of citizens.

The empirical data were analysed adopting a qualitative approach which meant textual analysis, sorting data into themes and cross-referencing them with theory in order to increase the internal validity of the case study material (Denzin, 1978).

1.3 Main findings

Results provided evidence about the roles of the PMS in

supporting both policy and managerial relationships in public networks.

Managerial relationships are supported by the introduction of new KPIs that measure network relationships; targets to ensure the achievement of certain quality levels on the service provided (defined by the service regulator); new reports to provide information about the network as a whole. The PMS is used by network actors in a different way, ranging from decision making, formal compliance, external accountability or knowledge development. The analysis of the PMS support processes provide evidence of the lack of a formal auditing procedure, which is informally exerted by users; lack of a network IT system to share real time data about the provided service.

Policy relationships are supported by the introduction of new KPIs about the network as a whole. Unlike managerial relationships, they are not enough to support decision making activities; rather, additional data from European cities are adopted. Targets, in this case, are set by the region only and no additional network reports support policy discussions. With respect to the PMS use in policy relationships, the empirical evidence differentiates between two uses. Service administrator (the Region) that uses the PMS to develop knowledge of the network, identify network problems and propose solutions. The other network actors that use the PMS to persuade other actors about the validity of their strategy. Finally, with respect to the PMS support processes, I found technical problems in the use of the regional network

database and a lack of auditing procedures. The importance of having reliable data was pointed out by users, who finally have their auditing role formally recognized.

The finding contributes, at the academic level, to five open areas of research:

· accounting in public networks, by identifying technical problems for implementing a network PMS and how they are used and useful for different actors in the network;
· theory on network managerial behaviours and leadership by adding further dimensions to the portfolio of network managerial competences;
· literature about coordination in integrating public service delivery. Specifically, it highlights how different types of PMSs influence the organisation motivation to be part of the network, finally having contrasting effects on action coordination;
· literature about the distribution of power in public networks recognising the relational and constitutive role of PMS in empowering receivers of the public service;
· literature on the relationship between trust and PMS, highlighting the duality between trust and PMS.

STRATEGIC AND OPERATIONAL DESIGN OF PMS FOR SOCIAL ENTERPRISE

Irene Bengo

This thesis aims to develop a strategic and operational performance measurement system (PMS) design for social enterprises (SEs).

Social Enterprise definition

Founding principle of a SE is the idea of transforming the maximization of profit and wealth creation in the means by which the "social entrepreneur" fulfils unmet social needs. There are different SE definitions, however, we pinpoint two specificities that can be used to characterize the essence. SEs are: (1) multi-objective organizations – i.e. SEs achieve with equal priority the economic objectives, social objectives and environmental objectives. (2) With a multi-stakeholder governance.

The research problems

This specific configuration makes crucial to SE survival the possibility of demonstrating their contribution to socio-economic development and improving their efficiency and their ability of competing on the market and to be transparent and accountable to internal and external stakeholders.This is at least partly due to the lack of a consistent PMS.

The research objectives

The thesis investigates how a PMS for social enterprise can be developed. The proposed approach aims to provide operational guidance to identify SE's relevant stakeholders and their informative needs; to identify the dimensions against which SEs performances should be assessed, considering the stakeholders expectations.

Research development

First step: survey

The exploratory survey aiming at the definition of the Italian SEs' information needs. Based on the survey results we define the characteristics to which the PMS for SEs has to respond (Table1).

Second step: literature analysis

We analyze the strengths and weaknesses of the existing tools to measure SE value. We report the synthetic results in Table 2.

Considering that these methods don't respond completely to the PMS characteristics defined, we relied upon three different streams of literature for the creation of PMS for SEs:
Third sector literature, from which we derived the tools to involve the stakeholder.
Public sector literature on performance measurement:

1. COMPLETE	to represent the different aspects of the business: Multi-purpose, multi-stakeholder, strong consistency with the social mission
2. SELECTIVE	in particular has to capture the relevant aspects: economic, social, environmental
3. ABLE TO IDENTIFY THE SPECIFIC RESPONSIBILITIES	it measures the performance indicators for each organizational unit through which the units can influence with their actions, for areas and projects
4. MEASURABLE	it has to associate to each performance one indicator that must be objectively detectable
5. DYNAMIC	to be constructed that it follows the dynamics of the organization, has to follow all evolution: evolution and rapid changes of SE to respond to social needs
6. RELIABLE AND ACCURATE	to be able to correctly assess the impact of performance monitored with respect to the overall objectives: measurable and credible data
7. SIMPLE	easy to use, comprehensibility
8. TIMELY	the ability to quickly provide the information requested

Table 1. PMS characteristics for SES.

the three Es framework - i.e. Economy, Efficiency and Effectiveness.
Literature on sustainability reporting within the for profit sector: from here we highlighted the need of standard indicators and protocols.

Third step: the proposed approach

We defined a guide to the development of a PMS for SEs. We first defined the overall model: the performance dimensions for measuring performances in a SE (Fig. 1). Second, we defined the steps to enact the framework and development of a PMS.

Fourth step: conceptual validation

We test the model compliance, from a theoretical point of view. We interviewed two groups:
· Experts of the field coming from the academic world and in particular from EMES.
· Practitioners, potential users of the model proposed.

We validate the model's effectiveness in answering the SEs PMS specifics and the performance dimensions are confirmed by the examined potential users.
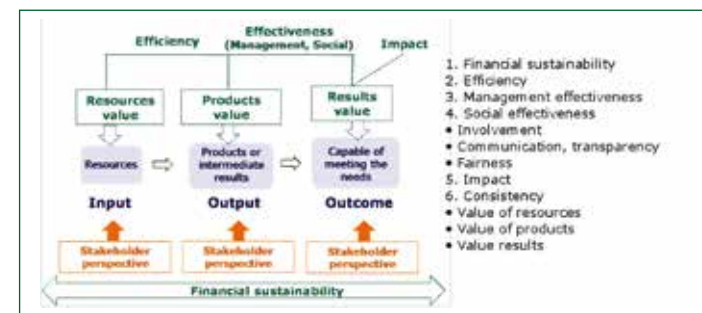
Final step: Pms Implementation in 5 cases of Italian social enterprises

The proposed model is applied to five SEs to verify its applicability to real cases (*Cedis, Cantieri del Sole, La Fabbrica di Olinda, Di Mano in Mano, Efrem*). For each cases we identified the specific characteristics, the information needs and we associated to each stakeholder the performance dimensions, we built the PMS defining a set of indicators coherent with the specific context of SE.

The thesis contribution

From an academic perspective, this thesis can extend the current literature on SEs and the final set of indicators covers the performance dimensions. Finally compared to existing models, the proposed approach captures SE specificities. From a practitioner perspective, this work provides a concrete guidance to build a PMS that answer to SE characteristics. Limitations and future research The quality of conceptual approach is directly dependent from the quality of the actors involved in building the PMS. This process ensures the completeness of the model but at the same time involves lengthy time for the information collection. Therefore future research could make an attempt to standardize the information needs and related indicators.

PMS	1	2	3	4	5	6	7	8
SROI	O	\	O	X	O	O	O	\
BSC BULL	\	\	\	\	O	X	\	X
SEBSC OF SOMERS	\	O	\	\	O	\	O	O
BSC ADAPTED	X	\	-	O	\	\	X	X
SIMMONS MODEL	X	\	-	O	\	\	X	X
SIMPLE METHOD	X	X	-	\	\	\	O	\
BAGNOLI- MEGALI MULTI-DIMENSIONAL CONTROL SYSTEM	\	\	\	\	\	\	X	\

1. Complete
2. Selective
3. Able to identify the specific responsibilities
4. Measurable
5. Dynamic
6. Reliable and accurate
7. Simple
8. Timely
O = Low
\ = Medium
X = High
- = feature not defined

Table 2. Limits of existing tools.

1. The model proposed and the related dimensions.

STRATEGIC CORPORATE SOCIAL RESPONSIBILITY: THE INTEGRATION OF CSR INTO STRATEGY THROUGH INNOVATION

Anna Maria Contri

This thesis essentially presents three works, one for each chapter, whose common denominator is the focus on strategic Corporate Social Responsibility (CSR). The concept of strategic CSR refers to the possibility to generate socio-environmental benefits while at the same time contributing to the improvement of firms' competitiveness. The creation of shared value for the company and the society becomes possible if CSR is integrated in the company's strategy. In particular, if CSR commitment drives the innovation of the company's products or processes (generating the so-called CSR-driven innovations), this can result in the acquisition of new market areas or customers' segments, or in an improvement of the company's cost leadership or differentiation strategy.Thus, the thesis aims to contribute to the literature debate on the integration of CSR into corporate strategy, with a focus on the role that innovation can play in this perspective. Starting from a review of existing literature two main gaps have been found: i) the role played by formal tools related to the implementation of CSR in fostering its integration into corporate strategy is controversial; ii) no research explored the managerial and organizational factors that may

support companies in translating their CSR commitment in product, service, or process innovations. The thesis aims to fill these two open issues, and therefore has a twofold objective: i) to investigate the relation between the integration of CSR into strategy and the formalization of CSR, in order to understand the role played by formal tools in this integration; ii) to explore the main managerial and organizational aspects of CSR implementation that can favor the generation and development of CSR driven innovation. The first chapter is dedicated to answer the first research objective. It investigates the CSR strategy of eleven companies in order to analyze the role they attribute to CSR formal tools. The results of the analysis put in evidence the existence of a group of companies (addressed as innovators) whose CSR strategy is mainly centered in the innovation of their core products and processes in response to social and environmental issues. The empirical analysis conducted in the first part of the thesis drove the choice of the single case study where to explore the organizational and managerial enablers of CSR-driven innovations. The results of this second part of the thesis underlined the importance of partnering with the nonprofit

sector in an open innovation perspective. This result informed the last part of the investigation, that has deepened the topic of profit-nonprofit partnerships as sources of innovation, analyzing in particular the business and social outcomes they could generate.

The structure of the thesis is as following.

The first chapter contributes to the literature debate on the role that formal tools related to CSR implementation can play in integrating CSR into corporate strategy. Previous research stated that the majority of companies have a 'cosmetic' approach to CSR. This is based on the adoption of formal tools such as sustainability reports and ethical ratings, used only with cosmetic purposes, and in the implementation of several sporadic CSR initiatives not related to the companies' core business. A different approach to CSR is suggested, which consists in a higher integration between CSR and the strategy of the firm, and could create relevant strategic advantages. However, The role that formal tools can play in supporting such increased integration appears not clear: existing literature contributions provide controversial positions on this issue. Therefore, the aim of the first chapter is to contribute to the debate on the topic, with

a twofold objective. Firstly, to investigate if it is possible to reach an high level of integration of CSR into corporate strategy, without a comparable level of formalization. Secondly, to investigate which roles, beside the cosmetic one, companies attribute to formal tools related to CSR. Based on a theoretical framework made up of the main theories used in literature to explain companies' CSR commitment (institutional theory, resource dependence theory and resource based view), the chapter analyses and compares eleven case studies of large Italian companies. The research points out that integration and formalization levels may be not aligned, but this may happen only under specific circumstances. In general, companies depending on their different features and approach to CSR, may use formal tools to integrate CSR in their strategy and mission. In particular, these tools may facilitate the creation of a shared culture and vision of sustainability, the management and reduction of reputational risks, and the improvement of the innovation strategy of the firm.

The second chapter is focused on CSR - driven innovations, defined as product, process or market innovations that address social or environmental concerns and in turn create new business opportunities and competitive advantage. Considering the strategic relevance of these innovations in mediating the relation between CSR commitment and business advantages, this chapter studies what a firm can do, from a managerial and organizational

point of view, to foster and improve the development of CSR-driven innovations. Based on a single, explorative case study regarding IntesaSanpaolo, the largest bank in Italy, whose CSR strategy is largely based on the development of such innovations, the research identifies and discusses those aspects that seem to facilitate the development and launch of CSR-driven innovations. These aspects are discussed and interpreted by drawing upon established theories in the field of CSR and innovation. The creation of an ambidextrous organization, a systematic process of stakeholder engagement, and the involvement of nonprofit actors in an open approach to innovation emerged as fundamental factors affecting the development and success of CSR driven innovations. Maintaining the focus on innovation, and considering the results of the previous phase of the research, the third chapter has been aimed to investigate the outcome, in terms of business and social value, of profit-nonprofit partnerships leading to four different innovation typologies: product, process, market and organizational. The research shows that the collaborations actually led to a business value, deriving from the exploitation of the innovation, and to an immediate social value for the direct beneficiaries of the NPO. These direct benefits were predictable and implicit in the realization of the partnership. However, from a business perspective, the analysis shows that the results achieved by the companies go beyond the direct

benefit deriving from innovation. The collaborations had relevant business benefits, unexpected at the beginning of the project, that contribute to the realization of the corporate strategy. In parallel, from the social perspective, the partnerships originated a learning process in the NPOs that may lead to a further future spread of the social value. The four cases used for the multiple case study analysis can be interpreted as best practices in implementing the renewed EU strategy on CSR presented by the European Commission in 2011, which encourages companies to "explore the opportunities for developing innovative products, services and business models that contribute to social wellbeing and lead to higher quality and more productive jobs". This perspective enlightens the managerial implications of the analysis, as it shows the high business potential of these collaborations. Moreover it provides evidence to policy makers of the importance to encourage this kind of practices.

MANAGING ICT-DRIVEN INNOVATIONS TO SOLVE THE EXPLORATION-EXPLOITATION DILEMMA IN HEALTH CARE: A COLLABORATIVE RESEARCH PROGRAMME

Luca Gastaldi

MANAGEMENT, ECONOMICS AND INDUSTRIAL ENGINEERING

Research Context

The main challenge that the health care sector faces today is that of finding a synergistic combination of the rationalisation of health care costs, and the increase in the quality of health care processes. The problem is that these two objectives have a binary nature, and are tremendously difficult to be reached at the same time. Starting from the idea that the difficulties in attaining this dual goal lie in the dichotomy between the activities underlining the two contradictory objectives, it is possible to review the trade-off between cost rationalisation and quality improvement as the dilemma between exploratory and exploitatory activities performed on the health care processes.

Increasingly scholars are recognising the importance of process coordination as a critical element to develop an organisational capability to ambidextrously balance exploratory and exploitatory activities. Moreover, most of the problems in health care are actually related to the absence of coordination among the health care processes.

From this viewpoint, Information and Communication Technologies (ICTs) can play a strategic role. In health care organisations ICTs have become indispensables, not only due to their increasing pervasiveness, but also to their ability to respond to the aforementioned sector challenges, as well as to process coordination issues. Despite the crucial strategic role ICTs can play, most health care organisations continue to barely give them a second thought as an innovation source, and do not adequately analyse the strategic implications required to concretise their impact on both exploratory and exploitatory activities as well as on the organisational performances (cost reduction and quality improvement). Moreover, even if many authors see them as an important driver to underpin ambidexterity, the role of ICTs in the exploitation-exploration dilemma has not been clearly defined.

Research Process

This work aims to start filling these empirical and theoretical gaps. The dissertation is organized around two interrelated, complementary research questions:
Is ICT a lever that health care organisations can use in order to solve the exploration-exploitation dilemma?
How can a health care organisation manage ICT in order to solve the exploration-exploitation dilemma?
Every year, the research weaves two main streams of collaborative research. The first stream is a research-driven Semi-Qualitative Research (SQR) process enriched with the involvement of the practitioners in the gathering and analysis of the data pertaining to the research problem. The SQR process is focused on formally inserting the tackled issues in the global academic discourse, with the aim of gradually switching from an exploratory to an explanatory perspective. Every year, the SQR process uses a combination of:
A panel of 4 electronic surveys delivered to the Chief Information Officers (CIOs), Chief Executive Officers (CEOs), Chief Financial Officers (CFOs) and Chief Medical Officers (CMOs) of all the Italian health care organisations;
Several qualitative case studies on how the most interesting Italian health care organisations and regions generated ICT-driven innovations;
A series of meetings called Advisory Boards, as well as an online community to continue the discussions.

In the second research stream, the health care organisations themselves are the change agent, and—in the process of seeking help—they engage in a reflective Clinical Inquiry Research (CIR) process. This practitioner-driven stream is more focused on effectiveness during the
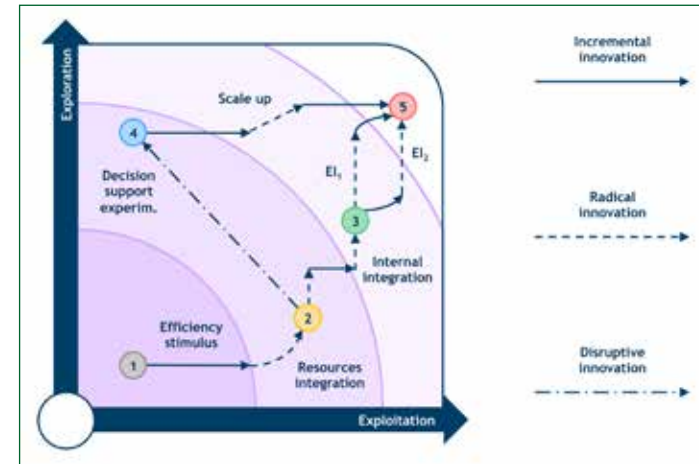
1.

practical implementation of the developing models, and aims to progressively expand its focus from problem-solving to change management. Clinical refers to the role that researcher must play in helping the organisation to: emphasise in-depth observations of learning and change processes, emphasise the effects of change interventions, benchmark the findings, and build theory and empirical knowledge through developing concepts that capture the real dynamics of the system. In order to attain a more affordable research, the CIR stream is framed into annual projects (CIR_1, CIR_2, CIR_3).

Research Results

The answer to RQ_1 has been provided through a progressive inquiry mainly based on the surveys delivered in the first and the second year of the research. There are four interesting findings that have been achieved: The opinion of C-levels regarding the impact of ICT on the capability of their health care organisations to solve the exploration-exploitation dilemma is biased;

In most of the Italian health care organisations ICT does not solve the exploration-exploitation dilemma;
The context in which the health care organisations operate affects their capability to solve the exploration-exploitation dilemma;
The are not only external but also internal barriers to the effectiveness of ICT as a lever to solve the exploration-exploitation dilemma; the strongest internal barrier is related to the changes brought into the health care routines and processes after ICT adoption.

The answer to RQ_2 has been provided through a progressive inquiry mainly based on the case studies performed during all the three annual researches. The cross-analysis of these cases shows the presence of three ICT-driven innovation macro-paths that foster and maintain a positive correlation between exploratory and exploitatory activities:
The digitalization of the data utilized within the health care processes (from ① to ②);

The progressive integration among health care stakeholders (from ② to ③, and then to ⑤);
The disruption of health care processes through the use of analytics, and the relative decision-making support (from ② to ④, and then to ⑤).

The findings provide contributions to both academics and practitioners. Academics will find a detailed analysis regarding a new lever (ICT) that is not only complementary to the organisational levers used by most of the literature studying the exploration-exploitation dilemma, but also applied in an industry where the ambidexterity capability is considered as critical. From a practitioner viewpoint, according to the power, the legitimacy and the urgency in managing ICT issues within health care organisations, the expected results will be of interest to the following main actors of a typical health care organisation:
The CIOs who need models to increase the exploratory and the exploitatory impact of the ICT-based solutions adopted in their health care organisations;
The CEOs who aim to learn more about how to encourage the successful adoption of emerging ICT within their health care organisations;
The CFOs who wish not only to use ICTs as a driver of costs reduction but also as a tool to control the financial situation of their health care organisations;
The CMOs who are committed to exploit ICTs in order to increase the quality of health care services in their organisations—safeguarding clinicians needs.

SOVEREIGN WEALTH FUNDS AND STATE CAPITALISM

Stefano Lugo

With the beginning, in 2007, of the deepest financial crisis in the post-WWII era, Governments have come back to the fore as active players in firms and financial markets in almost all industrialized countries. The number of investments made by Governments and Government-Owned Entities (GOE) in national and foreign companies in the last few years has increased exponentially. Along with public interventions, by both Governments and central banks, another type of Government-linked entity has come to the rescue of distressed firms, especially in the financial sector: Sovereign Wealth Funds (SWFs). SWFs are funds owned or directly controlled by Governments investing in any kind of financial asset, both domestically and abroad. While they share some features of other financial actors, they also have some unique characteristics which make them different from any other investor. Most notably, the main driver of interest on these actors is their connection with Governments often perceived as hostile by American and European observers; the identity of their shareholders could in fact entail they pursue political - rather than financial - targets. Eventually, the distinctive features of SWFs suggest that their impact at a micro (i.e. on firms) and macro

(i.e. on financial) level are ambiguous from a theoretical perspective. On the one hand, SWFs could play a beneficial role in financial markets, by providing a long-term perspective which other investors lack, especially in periods of financial turmoil. But, at the same time, other factors suggest that their investments could be driven by political objectives which could lead to distortions in capital allocation. This work aims at assessing this fundamental issue from two perspectives.

First of all, in order to judge whether SWFs investments follow a financially sound logic, it is necessary to define what would be a rational portfolio allocation for a SWF. Once a reasonable allocation is defined, a sound empirical strategy to verify if the actual allocation is in line with what suggested by the theory is required. Focusing on SWFs whose wealth derives from natural resources revenues(in particular oil), I argue that if they invest on a purely financial basis they should take into account their need for hedging oil revenues into their investment strategy. Modern Portfolio Theory is a well suited framework in the sense that it easily allows to take into account the SWF need for hedging a non-shortable position like its country natural resources endowment. While the optimal

portfolio can be estimated only with scarce precision, I show that studying portfolios in terms of relative deviations from a neutral benchmark instead of looking at absolute assets weights allows to implement some parsimonious tests for the SWF allocation optimality which are more robust to parameters uncertainty. To confirm the goodness of this empirical strategy, I show that the Norwegian Government Pension Fund - Global (one of the few oil-based SWFs which investment strategy can be fairly considered as purely financially driven) exhibits an asset allocation which deviate both in static and dynamic terms from the neutral benchmark in the same way as predicted by the theory. The proposed empirical strategy could be thus used in the future to evaluate the Strategic Asset Allocation of other SWFs, as increasing transparency and private data collection allow to reconstruct with a good degree of precision their portfolio composition.

Taking a micro-perspective, assessing whether SWFs can be considered as beneficial or detrimental means to study which kind of firms receive a direct investment from a SWF and what (if any) is their impact on targeted firms. Previous literature on SWFs

portfolio allocation from a micro perspective have found that they have a particular appetite for big, levered and more likely to experience financial distress firms. SWFs also appear to invest in poorly performing firms and to experience insignificant or even negative abnormal returns on their direct investments on a medium term basis. Some authors have suggested these results are a sign of SWFs being either mismanaged or pursuing political targets, and anyway to be considered detrimental for their portfolio firms. Using different models specification I find that SWFs appetite for poorly performing firms can be cast in doubt, while I also find further evidence of the positive impact of firms proxies for financial and cost of distress on their likelihood to be targeted by SWFs. The results on medium-term financial performances are in stark contrast with the evidence of significant positive short-term abnormal returns verified in all empirical studies on SWF, including this one. All in all, theories proposed so far to justify the performances of firms invested by SWFs seems to be unable to reconcile all the verified empirical results: pessimistic views of SWFs cannot explain their positive short-term effect; optimistic views cannot explain their often negative or insignificant medium-term

effect on financial performances. Moreover, most previous theories seems to have a tough time when tested empirically with an analysis of determinants of abnormal performances. Focusing on empirical results on the relevance of firms financial conditions for both SWFs investments likelihood and impact, I propose an alternative theoretical framework to explain why SWFs are positively hailed by markets in the short-term, and especially so for financially distressed firms. I argue that SWFs - given their financial capacity and lack of short-term liabilities - can have a comparative advantage in providing their portfolio firms with fresh capital in case of need. SWFs would thus be more likely than other shareholders to act as "investor of last resort", thus certifying firms financial viability. In order to test this hypothesis, I look at SWFs impact on firms credit risk (measured using CDS spread), finding an abnormal reduction. Even more importantly, I find this reduction to be moderate by SWFs, deal and firms characteristics in a highly coherent fashion: SWFs more able to keep their long-term view have a stronger impact on credit risk; smaller firms which credit risk is relatively concentrated in the short-term are those experiencing the

greatest abnormal CDS spread reduction in the aftermath of SWFs investments.
All in all, I reckon that SWFs bring some economic and political issues that must be carefully addressed by policy makers; to this extent, I provide in this book a simple empirical strategy to test how much their portfolio allocation can be considered as financially sound. Nonetheless, this work also show that Sovereign Wealth Funds can be considered a positive force in financial markets, helping reducing credit risk at least at the micro level.

LOCAL GOVERNMENTS AND PUBLIC SERVICES RESTRUCTURING THROUGH COMPETITIVE BIDDING

Riccardo Marzano

The thesis is aimed at investigating competition for the market in local monopolies. Liberalization processes, during the last decade, have provided a chance to study how municipalities react to competition for the market. The research means to enhance our understanding of factors driving local governments' decisions on control and restructuring of local public services. The analysis is remarkable for the complexity due to interplay of several motivation/objectives conveyed by municipalities. Indeed, each municipality could play in turn the role of shareholder, regulator, franchisor and customer and be accordingly interested in profits, efficiency, budget and service attributes. In particular, I take gas distribution sector as empirical setting, because of the maturity of its liberalization process in the Italian context.

The thesis includes an introduction, a description of gas distribution sector and regulation and three papers. In the first paper, I study decisions about timing and modes of restructuring public enterprises once competition for the market at municipality level has been introduced. In the second paper, I analyze factors explaining local governments' resistance to organize competitive procedures in newly liberalized public services. Finally in the third paper, I examine possible distortions that may arise when local governments design competitive procedures in order to assess to what extent competitive bidding is a valid tool to select public service providers.

The paper develops an empirical model aimed at identifying factors explaining local government's decisions about timing and modes of restructuring gas distribution service, after competition for the market at municipality level has been introduced. In this way, the analysis takes advantage of a dataset accounting for the entire population of Lombard municipalities directly controlling a gas distributor.

A competing risk model – i.e. a survival model in which failure events are more than one - is adopted, by considering two distinct restructuring measures: contracting-out and inter-municipal cooperation. The occurrence of the two events is modeled in an unified framework. The empirical model has considered variables related to ex-ante governance structure, productive efficiency, fiscal stress and political and ideological factors. To the best of my knowledge, this is the first time in which a competing risk model is applied in the context of restructuring decision in local

public services. In doing so, I take advantage of the duration model developed by Gonzalez-Gomez and Guardiola (2009) and Miralles (2009). Productive efficiency gains are not found to be a factor explaining restructuring measures. Municipalities controlling smallest operators delay restructuring measures, whereas those controlling largest ones choose merger operations and move rapidly. The attempt to reduce actual competition at franchise bidding stage could explain the result. In this case, anticipating the merger would be a rational strategy, because of the possibility to exploit higher market concentration as soon as possible. Modes of governance play an important role in driving municipalities among restructuring decisions. Municipalities formerly operating the gas distribution service directly – economy management – undertake restructuring measures rapidly and are biased towards contracting-out. On the contrary, municipalities controlling partially privatized gas distributors seem to delay restructuring measures, mainly when merger operations are considered. This is consistent with the literature claiming that most of the efficiency gains occur during the partial privatization stage (Aivazian *et al.*, 2005; Bilodeau *et al.*, 2007).

As a result, further restructuring measures are not considered pressing. Finally, local finance restrictions are not found to have an effect on restructuring measure (Dijkgraaf et al., 2003; Hebdon and Jalette, 2008). By enlarging the sample to include municipalities that don't control gas distributors, a stylized picture of resistance to competition for the market could be achieved; this extension has been carried out in the second paper.

The paper empirically analyzes local governments' decisions about complying with competition for the market in Italian gas distribution sector. The analysis is carried out on a sample of Italian municipalities whose gas distribution franchises have been expiring before 2009. The empirical model has considered variables related to transaction costs, municipal ownership, political factors, purchaser's familiarity with the rules, incumbent characteristics and fiscal stress. Estimates are obtained through binary models. The empirical findings indicate that both purchaser's familiarity with the rules and expected degree of competition have a positive, statistically significant impact on compliance. Neither the alleged inefficiency of the directives in terms of incurred transaction costs, nor the expected supplier resistance stemming from shareholder position occupied by municipalities seem to influence the compliance with the directives. Rational choice argument - in terms of expected efficiency gains coming from competitive bidding - and public choice argument - enabled by

interest groups' pressures – have not been disentangled, making impossible any inference.
If there are factors explaining local governments' resistance to comply with competition for the market, it couldn't ruled out that even when competitive procedures are organized the same factors are in place in explaining their designs. The third paper takes into account that issue.

The paper is an empirical analysis of calls for tenders that Italian municipalities have issued in the gas distribution sector over the 2001-2008 period. The attention is drawn on analysis of franchisee's objectives and conducts. In particular, I test the taxation by regulation effect (Posner, 1971), which occurs when contracting authorities pursue objectives that are not directly related to their regulatory stance, the influence of transaction costs, political turnover and administrative capabilities. The potentially relevant selection criteria have been classified according to five dimensions: franchise fee, terms for infrastructure asset transfer, prices, new infrastructure assets, service quality. Indicators describing the city characteristics concern financial distress of the local coffer, municipal population, infrastructure ownership, political turnover, experience of bureaucrats in organizing competitive procedures, composition of residents (e.g. poverty), need for infrastructure and locations. The relationship between the municipality characteristics and the selection criteria has been studied using a SUR model, by estimating five equations, each

for one of the dimensions along which bids are evaluated. Results seem to reject the taxation by regulation story, but by contrast some parallel hypotheses are found to explain the design of competitive procedure. Firstly, transaction costs related to asset specificity hazard are very relevant in shaping tenders assessment. Contracting authorities try to protect themselves against hold-up risk by overweighting the criteria that specify modes and conditions for the transfer of networks and plants to the municipality at the end of the franchise period. Secondly, local governments behave opportunistically and overweight the franchise fee dimension when they are expected to occupy the local administration for a longer period of time. Thirdly, experience of public servants in organizing competitive procedures explains the weight attached to the service quality dimension in the competitive procedure design – i.e. the most difficult to evaluate and control during the contract period.

IMPROVING THE PREDICTION PERFORMANCE
OF SUPPORT VECTOR MACHINES

Alessandro Perolini

Performance improvement is one of the leading topics in recent Machine Learning Literature. Since nowadays new data and new machines are available several new methods and modified versions of existing ones are suggested to reduce the prediction error. The problem has been investigated with regard to the two main elements that influence the predictions: the former is that of the Learning Methods, whilst the latter is that of the complementary factors. The first point concerns the development of specific frameworks aiming at carrying out the analyses. The second point is about the "external factors" that influence the prediction performance of Machine Learning approaches. Among these two points, the research is mainly focused on the "external factors" that have recently assumed an increasing importance because of their positive effects on predictios. Starting from this remark, four main external factors are investigated: the features, the method parameters, the incomplete data and the relations among features and method parameters. The guideline of the research is the improvement of predictions and, within the Learning Methods, it is focused on the Support Vector Machines (SVM), a supervised classification approach. The

research has a methodological perspective and proposes three new methods to improve the prediction accuracy of Learning approaches: the Kernel Matrix Genetic Algorithm (KMGA), the Reduction by Differences (RbD) and the missVal.
The KMGA and the RbD have a common research context. The phase prior to the learning is based on the feature and the model selection. Both topics are non-trivial and may have a negative impact on the prediction performance of classifiers. Those issues are usually investigated separately and the relations among the features and the method parameters are not considered. Recently, a new research area founded on the concept of a joined selection has been developed proposing combined Evolutionary Algorithms-Learning methods approaches to handle features and method parameters selection.
The first method proposed is the Kernel Matrix Genetic Algorithm. The KMGA is suggested for small-medium size datasets and designed for SVM classifiers. Since the prediction performance of SVM classifiers depends on the features, the SVM parameters and the relations between them, the KMGA is based on a Genetic Algorithm (GA) framework that performs a simultaneous search

for the subset of features and the parameters values. The KMGA is developed both to improve the prediction ability of SVM classifiers and to reduce the computational efforts of the expensive GA-SVM approaches by means of approximated kernel matrix estimation measures. The evolutionary search of the KMGA is performed in accordance to a kernel matrix measure that is used as a proxy of the prediction accuracy of the SVM classifier. The KMGA has been assessed on several publicly available real-world datasets using both the linear and the non-linear classifications through four kernels. The experiments show that the KMGA provides reliable information about the features to select and the parameters to use in a classification process through SVM and a reduction of computational time.
The second method proposed is the Reduction by Differences. It is developed for large datasets and, although it is discussed with respect to the SVM classifiers, it is designed for any Learning Method. As described before, to overcome the negative effects of separate features and method parameters selections, joined GA-SVM approaches are considered. These methods are able to perform both selections simultaneously, but, when large

datasets are taken into account, their application is not feasible because of the computational effort required. To make the exploration feasible the number of dataset features has to be reduced from thousands to a few hundreds or even less causing a loss of relations. Moreover, some large datasets, like microarrays, suffer from the presence of many irrelevant and redundant features and from the Curse of Dimensionality because the number of features is greater than the number of observations. To solve the previous problems, the RbD is proposed. Unlike the *state-of-the-art* methods, the RbD deals with thousands of features without requiring any filtering step and performs a simultaneous search for the features and the method parameters on the whole set of features preserving the relations among features and parameters. To assess the RbD several artificial and real-world microarray datasets have been considered and the experiments have been discussed with respect to the error on test set, the relevance of selected features, the similarity between solutions and the classifiers comparison. Statistical tests confirm that the RbD performs better than *state-of-the-art* methods reaching a low prediction error.

The context in which the missVal method is developed is that of the classification under uncertainty. In Machine Learning Literature classification under uncertainty is a challenging issue that has deep roots. The main reason is related to the inability of methods to handle incomplete data. To solve this problem researchers suggest either to fill with appropriate values the incomplete points or to create Learning Methods that avoid a direct imputation of unknown values. In both cases a bias is introduced and the learning process is influenced by the choices made a priori. In fact, the imputation may distort and reduce the variation of the data while the creation of too conservative methods may reduce the prediction accuracy. The research starts from the field defined by the first topics and sheds light on the role of replaced missing values and, in particular, on their influence on the classification process that may alter the predictions of Learning Methods.
The third new method proposed is the missVal. It is developed to improve the prediction performance of SVM classifiers applied to incomplete datasets. In order to perform the learning, the missing values have to be replaced and so an imputation method is required. The imputation method fills

the incomplete elements but introduces a bias that may impair the learning process. The missVal is an iterative approach based on the concept of the updating strategies and designed to take advantage from the Learning Method used. Following the principle of Occam Razor, the missVal searches for the simplest classifier reducing both the bias and the contribution of replaced missing values in the learning phase. The experiments have been performed on artificial and real-world datasets of different sizes and classification difficulty comparing the six variants of the missVal to *state-of-the-art* techniques. The missVal method has been assessed with respect to the parameters of the classification method and the prediction error on test set. The experiments confirm that the missVal is able to achieve good prediction performance and that the variants of the missVal are suitable in different contexts.

AN ANALYSIS OF THE STRUCTURE OF EUROPEAN R&D NETWORKS AND NETWORKING INSTITUTIONS

Lorenzo Pirelli

R&D network-based models of cooperation have emerged as key instruments to support Innovation Systems competitiveness (Georghiou and Roessner, 2000). Their recent growth is linked with the increasing need for complex and multidisciplinary skills to develop innovation (Laredo, 1998; Gassmann, 2006), resulting in the rise of the Open Innovation Paradigm (Chesbrough, 2003). Despite their increasing popularity and relevance, networks' complexity derived from their systemic nature and variability along several dimensions makes it challenging for scholars to reach a univocal definition and theoretical framework (Ottani, 2009). Moreover, there is a paucity of empirical studies indicating the key variables to consider in designing and managing them (Verganti, 2011).
This thesis tackled these gaps by:
1) developing a conceptual framework to guide the analysis, design and management of R&D networks;
2) carrying out two empirical analyses on EU-funded networks investigating the importance of the network characteristics affecting their governance and, thus, their capacity to 'achieve unity by integrating diversity', which has been identified as the key managerial challenge to ensure network effectiveness.

First, drawing on an extensive review of the main definitions, taxonomies, theories, barriers, determinants and existing models of academia-industry R&D cooperation, this thesis provided a systematization of the key network characteristics. These are highly interrelated, giving rise to critical trade-offs. The fundamental trade-off takes form in the "paradox of openness", consisting in the need for network members to be simultaneously open to absorb external knowledge and closed in order to appropriate its value, implying networks members "want complementarity but with friends" (Saz Carranza, 2008). This thesis developed a conceptual framework (Figure 1) that synthesized the various interrelations in terms of their effect on the network governance.
The first empirical research explored the key network characteristics for the design of the European Institute of Innovation and Technology (EIT), a new institution based on networks of universities, research centres and firms.
A wide-ranging survey among researchers working for Italian public research institutions (313 answers, 30% response rate) was conducted to identify the most critical and most controversial characteristics, which showed to be: the level of involvement of the

partners, their selection criteria and the role of the firms. Econometric analyses highlighted the main respondents' attributes – the basicness of their research activities, their work experience in the business sector and their managerial experience, especially in coordinating EU networks – explaining their different outlooks towards the several possible EIT configurations.
These findings confirmed the relevance of the basic trade-off between the need for diversity, as respondents showed great consideration for the EIT design options favouring rather open and heterogeneous networks, and the need for consistency to manage the deriving complexity as they showed some concern for ensuring manageable compromises in respect to the basicness of the research activities, the role of the firms, the partners' selection criteria and the funding and resources' ownership model.

The second empirical research consisted in investigating the structural characteristics of 1,736 R&D networks supported by the various EU RTD Framework Programmes involving 700 high-tech start-ups (as well as other 24,073 partners), with a special attention to the governance issues, considered crucial by the literature for ensuring an active involvement of these firms in such networks, often declared

1. Conceptual framework highlighting the relations and trade-offs among the various network characteristics and their effect on the network governance

as a primary EU research and innovation policy objective (Small Business Act for Europe, EC, 2008).
The dataset resulted from the merge of the CORDIS (the EC database containing data on the duration, coordinator, number/nationality of partners, funding amount of the supported networks) and the VICO-project (containing accounting, investment and performance data on 8,370 high-tech start-ups operating in 7 EU countries) databases.
The statistical analyses highlighted remarkable differences in the network size, duration and geographical heterogeneity when a high-tech start-up is the network coordinator. These characteristics were proven – through the econometric analyses – to have a negative influence on the likelihood for a high-tech start-up to be the network coordinator, while the age of the firm and its previous participation in EU networks to have a positive impact. These findings confirmed the theoretical argument that the network characteristics increasing

the diversity and, in the end, the complexity of the network increase the coordination costs and demand for more centralized and formalized governance structures that a start-up can hardly ensure.

This thesis provided a significant contribution to the academic debate in the field systematizing the key network characteristics identified by the literature into a single conceptual framework. The two analyses substantiated the relevance of the basic trade-off between the need for diversity of network partners and resources and the need for ensuring some consistency to manage the deriving complexity. The analyses showed that the most critical network characteristics – the role of the firms or the partners' selection criteria – relate to who should be the network partners. They also showed the network and partners' characteristics, such as their previous experience in networks or in the business sector or their geographical diversity, having the greatest influence on the network governance.

The research on the EU networks provided specific indications to policy makers willing to favour the active role of start-ups in R&D networks, showing that networks having more than 10 partners or nearly less than 30% of network partners from the same country or lasting more than 3 years are very unlikely to be coordinated by a start-up.
The future developments include:
· considering other network variables (e.g. the relative size of partners, the strength of the relationships);
· extending the perspectives of analyses to the participant-level (assessing the cost/benefit of network membership) and to the community-level (assessing the impacts on society);
· investigating the degree of complementarity/substitution between EU/national/venture capital funding on network partners.

ENERGY EFFICIENT TECHNOLOGIES AND BARRIERS TO ENERGY EFFICIENCY IN MANUFACTURING SMEs

Andrea Trianni

Emerging economies are driving the impressive growth of energy consumption and, due to their heavy reliance on coal, also of greenhouse gases (GHG) emissions. Moreover, it is possible to observe the primary role played by the industrial sector, responsible of more than 50% of the total energy "delivered". Recent analyses of the "20-20-20" European Council Directive revealed that, despite the strong efforts, only two objectives will be reached: those related to the increase of renewable energy sources and the reduction of GHG emissions.Therefore, in the last 10 years it seems apparent that strong efforts will be needed on energy efficiency, with particular attention to the world of small and medium-sized enterprises (SMEs), far more inefficient than large enterprises (LEs), but that constitute the core of the industrial structure for number of enterprises and employees, cover a consistent share of energy consumption, and are strategic for the domestic economies.

Therefore, in order to develop the most effective policies to promote energy efficiency within industrial SMEs, it is crucial on the one side to understand the most profitable areas for energy efficiency, putting also in evidence the possible solutions in terms of Best Available Technologies and Practices (BAT/Ps); on the other side to develop a novel taxonomy to classify and evaluate the difficulties for which those solutions, since now, have not been implemented. Those two pillars constitute the research objectives of this PhD thesis. The thesis has tried to cope with the first research objective dividing it into two concurrent activities: the first is the development of an energy audit methodology able to point out the possible critical areas for energy efficiency and the opportunities of improvement. The secondis to highlight the possible solutions that should be adopted by manufacturing SMEs and thus should be suggested and promoted.

Starting from a literature review on energy audit methodologies and SMEs characteristics, the new developed assessment methodology is based on a quantitative economic model, to provide an immediate monetary estimation of savings and implementation costs. Secondly, it is based on the BAT/Ps, focusing highly the needed actions. Thirdly, it is modular and scalable, with one checklist for each process, in order to match the wide variety of processes and activities of the SMEs and reduce the disturbance. And also integrates economic and environmental aspects.

The methodology strongly relies on the suggestion of the BAT/Ps. Therefore a specific section of the thesis has been devoted to the identification, characterization and evaluation of the energy-efficient BAT/Ps for manufacturing SMEs. To do that, different wide datasets from Western countries, have been analysed and compared, proving the consistence with an Italian database in terms both of suggested interventions and parameters for the estimation, e.g. frequency of implementation, energy savings, direct implementation costs. The analysis has been performed for several subsets, by looking both at main activity and firm's size, and according to several criteria. Starting from the available data about the production and the expenses, the methodology calculates a profile of the energy consumption of the enterprises, divided by homogeneous functional units (FUs, either by energy source or activity within the production process). Coupling the energy consumption profile with the importance for the enterprise of environmental issues and the energy price by fuel source, it is possible to draw a criticality index, that represents the relative importance of the given FU with respect to the total. The second index highlights the enhancement opportunities, according to the estimated BAT/Ps.Coupling the criticality and the enhancement indexes it is possible to obtain a priority index, that immediately points out the functional units in which would be more profitableto act. The methodology has allowed to reduce the time to perform the energy audit (needing about 16 working hours from gathering off-line data to delivering the report), with consequent reduction of costs related to the execution of the energy audit, as emerged from 38 applications in Northern Italy. Moreover the energy audit in this case is surely far more objective, not depending very much on expertise and skills of the assessor, but rather on close answers checklists.Furthermore, it has effectively highlighted the suggested actions for the SMEs, since several of them have proceeded in undertaking the investments.

Nonetheless, without a thorough analyses of the obstacles that limit the adoption of energy-efficient technologies, any policy would be abruptly ineffective. As a consequence, a large part of the thesis has been devoted to the development of a new taxonomy for barriers to energy efficiency particularly suited for SMEs.

A preliminary investigation, coupled with a vast analysis of the literature, allowed to obtain a clearer picture of the issues that needed to be addressed. Firstly, a complete taxonomy (encompassing the most relevant contributions), classifying the barriers according to the actors, and avoiding overlaps or implicit interactions. The new taxonomy has been structured, putting in evidence the external actors (with respect to the firm) and their possible barriers, and a classification of the internal barriers dividing them accordingly to what found in the literature among economic, organizational and behavioral barriers.

The second arisen issue was the adaptation of the new taxonomy for empirical investigation, thus requiring a detailed analysis of the perspective of the enterprise with respect to the perception of external barriers, and thus needing to explicitly assess the difference between perceived and real barriers, and evaluate theirspectrum of influence. A strong importance for the empirical investigation is the effect of each barrier on the decision-making process, thus looking, for each barrier, if it affects the generation of interest, the knowledge of inefficiencies and opportunities, or the analysis of the investment. In doing that, the thesis has explored the relationships between barriers, identifying three possible relationships: *causal relationship*, i.e. the enterprises presents a barrier that has its roots in another barrier; *composite effect*, i.e. an enterprise might have a barrier, but the perceived and real values are related to other barriers; and *hidden effect*, which is the case when an enterprises perceives a barrier, but, by the fact, it is affected by another one.

The third issue was to adapt the new taxonomy for empirical investigation in SMEs according to their characteristics, that seemed almost ignored by the literature. Therefore, the taxonomy has been accordingly conceived to be modular and scalable.

The empirical investigation of the new taxonomy among 48 SMEs within Northern Italy has revealed that the taxonomy is complete and able to categorize all operational difficulties to a single barrier, and avoided of overlaps and implicit interactions, with low correlation coefficients between barriers. Moreover, an innovative approach to the dynamics of the barriers and their effect on the decision-making process has been proposed, highlighting several differences between manufacturing SMEs according to some relevant factors as the size, the energy expenditures, and some elements of the market in which the enterprises operate, e.g. complexity of the production, demand variability, and strength of competitors. Future research opened by the PhD thesis are the determination and evaluation of the barriers to specific energy-efficient technologies, and the exploration of the links between energy efficiency processes and other important processes within SMEs, e.g. innovation. Moreover, the PhD thesis has opened the investigation of the so-called indirect benefits and the drivers to promote energy efficiency in SMEs.

REGULATORY REFORMS AND INVESTMENTS IN THE TELECOMMUNICATIONS INDUSTRY

Michele Zaccagnino

The past decades have witnessed a radical change in the role of State in network industries. While until late Eighties network industries were regarded as natural monopolies upon which State exercised directly a political control through ownership, nowadays most markets have been opened to competition, most State-owned incumbents have been privatized and, overall, State has been defined as industry regulator.

The thesis means to investigate the relationship between reforms and investment in the telecommunications industry. The focus of the thesis on the telecommunications industry is explained by two main reasons. First, the telecommunications industry is a very interesting case to study, among network industries, because it has experienced the earliest and widest program of industry restructuring. Second, modernization investments in telecommunications industry contribute significantly to countries' economic growth; more particularly delayed investment in broadband networks is of concern to policy-makers. Broadband connectivity is a key component for wide and differentiated development, adoption and use of information and communication technologies (ICT) in the economy and

society. Broadband is of strategic importance because of its ability to accelerate the contribution of ICTs to growth and innovation in all sectors of the economy and to the diffusion of services that have a great value for citizens. The research is motivated by the need to enhance our understanding of conditions which foster the development of advanced communications systems. More particularly, in my research, I have empirically attempted to identify which factors in the new regulatory and market environment have increased or rather inhibited investment incentives for incumbents and entrants. In addition, the thesis explores why and how several countries are currently considering and designing new forms of public sector involvement in broadband markets as a remedy to investment needs.

The thesis includes an introduction, a description of markets and regulations for broadband networks, and three papers.

The first paper means to add to empirical research on the relationship between competition and incumbents' investment. In addition, I have explored the moderating action of two measures that can accompany market competition, i.e. privatization and unbundling policy. The empirical analysis

is carried out on a sample of incumbents from 27 OECD countries (1993-2008 period). Using data on incumbents' financial and economic indicators, an investment model is specified according to the micro-econometric literature on investment. Estimates are obtained through dynamic panel estimators. Findings can be summarized as follows. Competition in isolation does not play a significant role. Unbundling policy has been found to be a relevant moderating factor: it is likely to reduce the incumbent's incentives to invest, unless a certain degree of rivalry emerges in the markets. Privatization does not seem to have a significant effect on incumbent's investment. My results can be sketched against the extant empirical analyses. Similarly to Hausman and Sidak (2005), Wallsten and Hausland (2009) and Grajek and Röller (2011), I have found that service-based competition through mandatory unbundling may depress the incumbent's incentives to invest, by granting a 'free option' to new entrants. However, the inhibiting effect fades away when competitors have already gained not negligible market shares. At the same time, I have confirmed the results, improving the methodology and the sample

used, obtained by Bortolotti et al. (2002) on privatization: State-owned enterprises are not found to invest more intensively than private counterparts, irrespectively from market structure. An analysis of new entrants' investments is required to fully explore the interplay between competition, unbundling policy and penetration of advanced communications networks, an effort that I have carried out with the second paper.

The paper addresses the impact of LLU on new entrants' investments in broadband networks. I have tested two propositions, which have been formulated according to the ladder of investment theory. First, service-based entry, which relies on LLU, paves the way to new entrants' subsequent investment in broadband systems. Second, under a LLU regime, the price charged for local loop should increase over time in order to have a significant investment in alternative platforms. The empirical analysis is carried out on a sample of 27 European countries (2002-2009 period). The main originality of the paper is related to methodologies, which are expected to confer some robustness to empirical evidence. After having verified the stationarity of variables, I have estimated dynamic

panel models through GMM-difference and Least Squares Dummy Variables corrected (LSDVc) estimators. The preliminary results suggest that service-based entry does not lead entrants to a subsequent facility-based entry. At the same time, an increasing price of local loop is not found to stimulate entrants' investment. My empirical findings cast some doubts on the ladder of investment theory, similarly to other empirical papers (Hazlett and Bazelon, 2005; Bacache et al., 2011). Moreover, in opposition to previously results (Crandall et al., 2004; Waverman et al., 2007), my empirical evidence seems to suggest that local loop price are negatively, rather than positively, related to facility-based entry. The last paper reviews the literature on the new role of public sector in the ultra-broadband market. The development of broadband networks, and next generation networks (NGNs) particularly, is attracting the attention of economists and policy makers, who assume widespread benefits for countries' economic activity and society. At the same time, empirical analyses illustrated by the first two papers leave us with a disappointing picture of the ability of market competition and access regulation to create the right

incentives for incumbents and entrants to develop a nation-wide advanced communication networks. My results help in explaining why governments are re-considering the role of public sector in this sector.

In the last years, several governments, both at national and at local level, have launched public programs in broadband markets, e.g. through private-public partnerships, ad-hoc state-owned enterprises and public subsidies. The heterogeneity of measures, combined with their novelty, implies that we still have a fragmented knowledge about supply-side policies in broadband markets. A synthesis of most recent results obtained by economists and policy scholars can contribute to overcome the gap. This paper wants to systematically review the recent research on this topic. Firstly, I discuss main motivations for public intervention in the deployment of broadband networks and I analyze approaches followed by different countries worldwide. Secondly, I focus on policy studies which have examined broadband plans and policies adopted by some European countries, in order to grasp the main objectives, characteristics and critical elements of public investment in broadband market.

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