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Governance, Regulation and Innovation: Introducing New Studies

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ABSTRACT

We introduce new studies that argue in favour of: (i) according a central role to governance and regulation as potential determinants of innovation; and (ii) analysing the effects of governance and regulation on innovation in conjunction with the effects of the market structure. These studies were presented at an international conference at the University of Greenwich in September 2011 and will be published as an edited book titled *Governance, Regulation and Innovation: Theory and Evidence on Firms and Countries* (Edward-Elgar, 2013). The studies explore the relationship between governance and regulation widely defined and innovation, taking into account the interactions between governance and market structure as well as between different dimensions of governance. They contribute to existing literature by providing new empirical evidence and by pointing out to *complementary* and *offsetting* innovation effects that may result from interactions between economic governance institutions, corporate governance rules, regulation on the one hand and the market structure on the other.

Key words: Governance, corporate governance, regulation, innovation

JEL classification: E02, G3, L5, 03

INTRODUCTION

For a long time, determinants of innovation had been studied with an exclusive focus on market structure, industry characteristics, technology choice, and appropriability of the innovation profits. This institution-free approach can be traced back to Schumpeter's (1934, 1942) seminal work, which argued that large firms and concentrated market structures promote innovation. Arrow (1962) takes issue with the Schumpeterian hypothesis and demonstrates that a monopoly shielded against competition has less incentive to innovate compared to firms within a perfectly competitive market. According to Gilbert (2006), we are still far from a general theory of the relationship between innovation and market structure as industry characteristics, the nature of technological competition and the distinction between product and process innovation emerge as confounding factors. Yet, recent empirical work informed by Aghion et al (2002a, 2005) demonstrate that the relationship between market structure and innovation is likely to be non-linear, with competition fostering innovation at low levels of competition but reducing innovation when the initial level of competition is already high (Peneder, 2012).

Although the quality of governance institutions does not feature in this debate, protection of intellectual property does. Indeed, together with product-market competition, protection of intellectual property determines the extent to which innovators can appropriate the returns on innovation. Hence, the relationship between institutional factors and innovation is implicit in the debate, but the latter has unfolded without due attention to the ways in which the wider institutional framework (including economic and corporate governance institutions) interact with market structure and other factors to affect innovation incentives and outcomes.

Two strands in the literature represent a departure from this institution-free view of innovation: the national innovation systems (NIS) approach and the work on the relationship between corporate governance and firm performance. In the pioneering work on NIS (Freeman, 1987; Lundvall, 1988; Dosi, et. al., 1988; and Nelson, 1993), innovation is analyzed within a national environment that consists of government incentives for innovation, intellectual property protection, support for education, trade policies, competition and industrial policies, and economic culture. Although it lacks a fully-fledged institutional

perspective, the NIS literature has been influential in shifting the attention towards the relationship between innovation and the national environment, which is an amalgam of policy and institutional factors that affect the costs and incentives faced by economic actors.

However, the NIS literature has been criticized on two grounds. First, the work has remained mainly normative, indeed practical (see, Erickson's contribution in chapter 10). Secondly, its normative quality has led to a strong policy uptake of its research outcomes, but its focus on the 'right' environmental factors that make countries or regions more innovative has created taxonomies rather than specific hypotheses that can be tested rigorously. This weakness is evident in the ways in which the 'optimal' NIS examples pointed out by this literature have changed over time, from the Japanese model in the 1990s to more varied models associated with emerging innovators such as China, India or Brazil.

In contrast, the literature on the relationship between corporate governance draws on the agency theory or the theory of contracting to derive and test hypotheses about how corporate governance dimensions affect firm performance, including innovation. This literature tends to take the level of product-market competition as given and investigates the ways in which corporate governance rules may encourage or hinder innovation by resolving/minimizing the agency problem or facilitating contracting. Pioneering works include Hill and Snell (1988), Baysinger and Hoskisson (1990) and Baysinger *et al.* (1991 on the relationship between board independence and innovation; Jensen (1988), Shleifer and Summers (1988) and Stein (1988) on the relationship between anti-takeover defences and innovation; and Graves (1988) and Hill *et al.* (1988) on institutional ownership and innovation. Extensive reviews of this literature are provided in Belloc (2012) and Sapa *et al.* (2009), with further reviews in chapters 3 and 4 of this volume by Engelen and van Essen and Hashem and Ugur, respectively.

Most of the corporate governance literature tends to overlook the effects of market structure on innovation and how the latter may interact with governance with complementary or offsetting effects. Notable exceptions include Aghion *et al.* (1999, 2002b) who examine the interactions between CG dimensions and innovation, and some recent work by Sapa *et al.* (2009) and Atanassov (2012) who include market structure as a control variable.

The few studies on the relationship between macro-level governance institutions and innovation also tend to overlook the interaction between market structure and governance. For example, Keefer and Knack (1997: 591) reports that firms tend to invest less in new technologies if the rule of law is weak and the risk of ‘expropriation’ is high. This finding is supported by Clarke (2001), Lundvall et al. (2002), Dakhli and de Clercq (2004), and Giménez and Sanaú (2007) who report that innovation performance tends to be lower in countries where the risk of expropriation is higher and the rule of law is weaker. More recently, Tebaldi and Elmslie (2013) demonstrate that institutional quality in general encourage innovation by facilitating patent registration, diffusion of ideas, enforcement of property rights and by reducing the uncertainty of new projects. Yet, none of these studies investigates the interactions between economic governance institutions and market structure.

The key rationale for this book (and for the conference that preceded it in September 2011 at the University of Greenwich) has been to develop the case for: (i) according a central role to governance as a potential determinant of innovation; and (ii) analysing the effects of governance dimensions on innovation in conjunction with the effects of the market structure. This rationale can be justified easily. Investment in innovation is costly and associated with uncertain returns. Furthermore, investment in innovation projects is characterized by indivisibilities and economies of scale. Third, it is difficult to ascertain the quality of the innovation projects due asymmetric information between innovators on the one hand and creditors or shareholders on the other. Finally, innovation projects may have spill-over effects and/or the results of innovation may be subject to partial non-excludability (Jones and Williams, 1998; Aghion and Howitt, 1992; Mansfield, 1985; Jaffe, 1986; Acs et al., 1994).

Hence, at a given level of product-market competition, innovation performance at the firm or national levels would depend on the extent to which governance institutions are effective in fostering innovation as a result of encouraging risk taking, resolving or minimizing collective action problems, mitigating market failures, and aligning the interests of different actors such as managers, shareholders, employees, and policy makers. Similarly, at a given level of governance quality, innovation performance also depends on the degree of competition, which determines the levels of pre- and post-innovations profits that can be appropriated by innovators. Given these dynamics, it is necessary to investigate not only the partial effects of governance and market structure on innovation but also the ways in which both dimensions interact and with what consequences for innovation.

ECONOMIC GOVERNANCE, CORPORATE GOVERNANCE AND INNOVATION

Our contribution in this book is empirical, but informed by seminal work on the economics of innovation and recent developments in the economics of governance institutions. According to North (1990, 1994), a country's institutional environment constrain actor's choices and behaviour, and as such hinder or support economic performance in general and innovation in particular. Governance institutions can be considered as the 'rules of the game' and consist of both formal and informal institutions. Formal institutions include written rules, regulations, laws and contracts; whereas informal institutions consist of norms, values and trust that a society has developed and internalized over time.

As Dixit (2009) has indicated, governance institutions affect economic outcomes in general because good governance is necessary for securing three essential prerequisites for market economies: (i) security of property rights; (ii) enforcement of contracts; and (iii) resolution of collective action problems. The relevance of these prerequisites for innovation is evident. Institutions that secure property rights foster innovation by enabling innovators to appropriate post-innovation profits (Acemoglu, 2006). In addition, governance institutions that secure contract enforceability reduces transaction costs and foster innovation by enabling firms to choose advanced technologies that tends to prevail in contract-intensive sectors (Acemoglu et al., 2007). Finally, institutions that minimize or resolve collective action problems also foster innovation because they facilitate internalization of the externalities associated with innovation, hence enabling countries or firms to avoid prisoners' dilemmas in the management of common pool resources such as knowledge.

Given these relationships between governance institutions and innovation, what remains to be explained is the combination of economic governance institutions, corporate governance rules and regulation within a single project. The normative explanation is the following: we aim to make a case for analysing innovation in the light formal and informal governance institutions that affect the costs and incentives faced economic actors. Therefore, we have cast the net wide and included both country-level economic governance and firm-level corporate governance dimensions. The country-level governance dimension, in turn, is defined widely to include both general institutional indicators such as rule of law,

accountability, control of corruption and bureaucratic efficiency; and more specific rules codified in product-market or industry regulations.

Yet, we have not let our normative preferences dominate the choice of governance dimensions in our analyses. In his address to the one hundred and twenty-first meeting of the American Economic Association in San Francisco, Avinash Dixit (2009) has indicated that ‘good economic governance underpins the whole Smithian process whereby individuals specialize in different tasks and then transact with one another to achieve the full economic potential of the society’. Furthermore, governance is not a disciplinary field per se, but ‘an organizing concept for many fields’ in social sciences and as such ‘offers a unique opportunity for the social sciences to have a meeting point ... after their separation over a century ago.’ This perspective clearly indicates that regulation is a subset of economic governance as it also ‘underpins the Smithian process’ and affects the cost and incentive structures faced by economic agents.

What about corporate governance? Is it justified to include the latter within a book that aims to make the case for more systematic analysis of the relationship between governance and innovation? Again, we draw on Dixit (2009), who considers corporate governance as the ‘more popular cousin’ of economic governance and provides useful insights into the relationship between the two. Dixit (2009: 8, 11, 12) distinguishes between formal and informal governance institutions. Whereas the former include constitutions, the legislature, the judiciary and regulatory agencies; the latter include private and social institutions that reduce transaction costs. Corporate governance rules adopted by firms (with or without a macro-level governance framework) can be considered as a subset of the informal governance institutions that internalize contracts and hence convert contract enforcement into an agency problem in corporate governance. Therefore, our inclusion of corporate governance as a subset of the governance framework is justified.

GOVERNANCE, REGULATION AND INNOVATION: NEW PERSPECTIVES

Given the rationale indicated above, contributors to this book endeavour to address the following questions: does governance affect innovation effort at country or firm levels? How does governance and market structure interact and affect innovation? Stated more specifically, do market structure and governance dimensions have complementary or

offsetting effects on innovation? Do these interaction effects differ between economic/corporate governance and regulation? If good governance fosters innovation, how does the innovation effort affect policy reform aiming to enhance governance? Similarly, if regulation affects innovation, how does investment in innovation affect regulatory outcomes?

Although the contributions in this book are embedded within relevant theoretical frameworks, their answers to these questions are essentially empirical. In other words, we let the data ‘speak’, making sure that our data analysis methods are appropriate and our models are informed by relevant theoretical perspectives on innovation, governance institutions, agency and contracting problems, regulation, competition, and policy reform. Seven of the eight main chapters are based on unique datasets that allow for investigating not only the relationship between governance widely defined and innovation, but also the interactions between the two. Two of the empirical chapters also examine the effects of investment in innovation on the probability of policy reform in 27 members of the European Union (EU) and on regulatory outcomes in public-private partnerships in the French water industry. Finally, one chapter takes a normative approach to develop the case for enhanced governance of intellectual capital – an emerging but less-easy-to-govern process of innovation compared to processes analysed in intellectual property or national innovation systems literature.

The book is organized in three parts. In Part I, we present four chapters that investigate the relationship between innovation and governance, including country-level economic governance and firm-level corporate governance dimensions. Part II also includes four chapters, which focus on the relationship between regulation and innovation. Finally, we devote Part III to one chapter on governance of intellectual capital and a concluding chapter that summarizes the main findings and discusses their research and policy implications.

In Chapter 2, Ugur begins with the observation that the existing literature tends to investigate two potential determinants of innovation (market structure and governance institutions) separately. In addition, the policy discourse tends to be based on the assumption that competition and innovation go hand in hand, with little or no attention to whether the competition-innovation relationship could be non-linear or how market structures and governance may interact and produce complementary or offsetting effects on innovation. Given this observation, Ugur argues that it is necessary to verify if product-market competition is conducive to innovation or whether innovation entails deadweight losses

associated with market power as a driver of innovation. He also argues that it is necessary to pay attention not only to the partial effects of governance and market structure, but also to the interactions between the two to see if such interactions produce complementary or offsetting effects.

The chapter by Ugur is based on a panel dataset on patenting activity in 24 OECD countries from 1988-2007. Following an extensive literature review, the chapter proposes a model in which the relationship between market power and innovation is non-linear and governance affects innovation both directly and indirectly through interactions with market power. The case for the model is based on theoretical and empirical insights from institutional economics (Acemoglu, 2006; Acemoglu et al., 2007; Dixit, 2009) and economics of innovation (Aghion et al., 1999, 2002a, 2002b and 2005). Ugur utilizes a generalized least-squares (GLS) estimator with panel-corrected standard errors (PCEs), which allows for error structures that are heteroskedastic and contemporaneously correlated across panels (Beck and Katz, 1995; Egger, 2002). This method is reported to be efficient when the number of time periods is close to the number of cases (countries) (Chen et al, 2009) – and this property matches the structure of the dataset used, which contains observations for 24 countries over 20 years.

One finding reported by Ugur is that the non-linear relationship between market power and innovation that is established at the firm level also holds at the national level. Another finding is that the non-linear relationship is *U-shaped* in the full sample, but it has an *inverted-U* shape in countries with higher-than-average levels of per-capita GDP, economic openness and governance quality scores. Ugur explains the difference by arguing that markets in the latter countries are contested more heavily (i.e., market power in these countries is usually lower than the sample average) and therefore the Schumpeterian hypothesis tends to hold – i.e., innovation is driven by increased market power when the initial level of the latter is relatively low.

Ugur also provides novel evidence on the relationship between governance and innovation. He reports that the governance score (a composite index derived from 5 governance indicators that include bureaucracy quality, control of corruption, investment profile, law and order, and government stability) is related positively to patenting activity in the full sample and in the split samples. Although similar findings are already reported in the

literature, Ugur argues that the existing findings may suffer from model misspecification bias. He demonstrates market power interacts with governance and has an offsetting effect on the relationship between governance and innovation, leading to smaller marginal effects overall. In addition, the interaction between governance and market power also modifies the marginal effects of market power on innovation, having a complementary effect until the turning point of the *U-shaped* curve but an offsetting effect thereafter. Hence, Ugur establishes that both partial and the marginal effects (i.e., the sum of partial and interactive effects) of governance or market power on innovation may be biased if both variables and the interaction between them are not included in the model

Ugur also reports a range of significant relationships between innovation and other country characteristics. For example, income inequality and economic openness are related negatively to patenting activity. On the other hand, per-capita GDP, depth of the stock market and military expenditures as percentage of GDP are related positively to patenting activity. The relationship between labour share in national income and patenting activity is also positive but it is significant only in some estimations. These findings are robust to sample selection and standardization of the standard errors.

Chapter 3 by Peter-Jan Engelen and Marc van Essen focuses on the recent financial crisis and address a highly topical question: how do country-level economic governance institutions and corporate governance characteristics of the firms affect the rate of curtailment in research and development (R&D) expenditures by European firms during the financial crisis of 2007-2009? To address this question, Engelen and van Essen assemble a dataset for 411 firms from 16 European countries from 2006 to 2009. They estimate a model in which economic and corporate governance influences the management's R&D investment decisions directly and indirectly as a result of interaction between the two dimensions of governance. The model is derived from a number of hypotheses that authors distil from existing theoretical and empirical work.

Engelen and van Essen make three contributions to the evidence in this volume and the wider literature, two of which are novel. First, they provide evidence on the relationship between two governance dimensions and R&D effort during the crisis by taking into account both country- and firm-level data. Earlier studies have focused only on firm-level factors (Munari et al., 2010) or combined only industry-level data with country-level data (Barbosa

& Faria, 2011). Secondly, they provide evidence on both partial and combined effects of different governance dimensions, taking into account the interactions between the two. Although the interaction between country-level economic governance and firm-level corporate governance has been investigated in other studies on firm performance, the study by Engelen and van Essen is the first that investigates the interaction in the context of innovation performance. Finally, the authors focus on the recent financial crisis and complement the literature that investigates the relationship between governance and innovation in European firms during normal times (Honoré et al., 2011; Munari et al., 2010).

Engelen and van Essen report that firms with large institutional owners or under government ownership tend to curtail R&D investment more than other firms during the crisis. This finding is interpreted as evidence of institutional investors' short time horizons, which induce preference for short-term gains as opposed to long-term commitment. This finding is in line with the wider corporate governance literature, which report that institutional investors they engage in high trading volumes around the announcements of quarterly earnings (Kim et al., 1997; Lang and McNichols, 1997; and Potter, 1992). Firms under government ownership may be induced to curtail R&D investment as a result of fiscal deterioration. Neither board size nor CEO duality or board independence has a significant effect on R&D curtailment during crisis times.

With respect to country-level governance institutions, Engelen and van Essen report that firms in countries that rely mainly on equity finance tend to curtail R&D spending more than others in countries that rely mainly on bank finance. The authors explain this finding by indicating that banks in Europe have opted for coordination with distressed firms rather than shutting down the credit lines. This finding is also supported by findings on the interaction effects, which indicate that market-based financial systems tends to augment the adverse effect of institutional ownership on R&D effort whereas the interaction between bank-based regimes and creditor rights is associated with higher R&D effort (i.e., less R&D curtailment).

In chapter 4, Hashem and Ugur focus on the relationship between corporate governance and R&D expenditures by US-listed firms. Utilizing a panel dataset for more than 1,500 firms from 2004-2010, the authors investigate the partial and interactive effects of corporate governance on R&D intensity (R&D/sales ratio) by controlling for non-linear effects from market concentration. The joint analysis is justified on the grounds that both corporate

governance and market structure affect R&D effort by influencing the incentives of the managers to invest in risky innovation projects. Corporate governance may enhance the R&D effort if it exerts discipline on managers and/or mitigates the agency problem by aligning managerial and shareholder interests. Similarly, market concentration also affects the R&D effort depending on the extent to which it causes managerial slack and/or affects the levels of pre- and post-innovation profits. Therefore, one needs to take account of interactions between the two. Paying attention to interactions between corporate governance and market structure is also necessary from an empirical perspective: partial effects from estimations that exclude the interaction term would be inaccurate due to model misspecification bias.

The authors utilize a two-way cluster-robust estimation method that yields standard errors that are robust to cross-sectional and time-series dependence between the error terms and the independent variables. They control for non-linear relationship between market concentration and R&D intensity by utilizing an industry-based Herfindahl-Hirschman Index and its square. Their corporate governance indicators capture four dimensions: board independence and board diversity; ownership structure (insider and institutional ownership); anti-merger defences; and shareholders' rights.

They report that board independence is related positively to R&D intensity and that market concentration acts as a *complement* that strengthens the positive relationship. All other CG indicators (number of women directors on the board, percentage of shares owned by insiders and institutional investors, and percentage of vote required to approve mergers or amend company charters) are related negatively to R&D intensity. In addition, market concentration tends to have a *substitution* effect when it is interacted with these CG indicators. They also report that the relationship between market concentration and innovation has a *U-shape*, implying that an increase in market concentration is associated with lower R&D intensity when the initial level of concentration is low; but the change is positive when the initial level of concentration is high. These results are robust to other measures of R&D effort (R&D expenditures and R&D expenditures per employee) and to inclusion of firm-characteristics such as firm size, age, returns on assets, Tobin's Q, and the ratio of long-term debt to capital as control variables.

Hashem and Ugur's findings confirm the non-linear relationship between competition and innovation analysed by Aghion et al (1999, 2002a, 2002b and 2005). They also provide

novel evidence on the significance of interactions between market concentration and corporate governance indicators, after controlling for a wide range of firm characteristics. Their findings indicate that the effect of corporate governance rules is mediated through market concentration and the effect of market concentration is mediated through corporate governance rules.

The last chapter in Part I is by Andrea Conte, who addresses the relationship between governance and innovation from a different angle. Conte is interested in the determinants of policy reforms that are likely to enhance a country's innovation performance. In other words, his dependent variable is not innovation effort *per se*, but the extent of policy reforms that the European Union (EU) and its member states consider as necessary for better governance of the knowledge economy and better performance in terms of innovation. The policy reforms are placed within five policy areas related to innovation: allocation of public resources for innovation, support for private-sector R&D, supply of researchers, protection of intellectual property rights and technology transfer

Conte's research is highly topical and policy-relevant as it provides new evidence on what factors tend to increase the probability of policy reforms by EU member states in the context of the Lisbon Agenda and the Europe 2020 strategy. The analysis is based on a rich panel dataset from the European Commission's *Database on Microeconomic Reforms (MICREF)* and estimates a Probit model, in which the dependent variable is the reform performance of 27 EU member states in the five policy areas from 2004-2008. The time frame is determined by data availability for 27 member states. In the model, the probability of reform depends on two clusters of variables: (i) Innovation and education-related performance indicators (which include business and government R&D expenditures as percentage of GDP, patenting activity, human resources in science and technology sectors, and public expenditure on education); and (ii) a set of macroeconomic variables that include per-capita GDP, government debt, tax burden and a measure of the business cycle.

The findings by Conte indicate that there are both convergence and divergence between EU member states with respect to the relationship between past innovation performance and undertaking of policy reforms that would encourage innovation in the future. Convergence is evident in policy areas related to governance of *innovation inputs* such as government and business R&D expenditures and expenditures on education. In these policy areas, countries

with lower performance in the preceding year tends to have a higher probability of introducing reforms in the current year in order to enhance future performance. These findings indicate that the Lisbon Strategy, through its targets and monitoring mechanisms, have been effective in closing the gap between low- and high-performing member states in terms of building the governance structures necessary to support innovation.

However, the evidence also indicates that the Lisbon Strategy is also associated with divergence between EU Member States in policy areas related to governance of the 'inventive stock' reflected in the number of patents per-capita, technology trade and protection of intellectual property rights. In these areas, the current reform effort is positively related to past performance, indicating that the governance gap between high- and low-performing Member States is widening. Hence, the findings by Conte indicate that the type of past innovation performance is an important predictor of policy reforms that would eventually affect the quality of the governance structures closely related to both innovation inputs such as R&D and education expenditures and innovation outcomes such as technology transfer and intellectual property.

In Part II, we have four chapters on the relationship between regulation and innovation. In chapter 6, Demirel and Kesidou utilize a dataset of 289 UK firms that responded to a survey conducted by the UK's Department for Environment, Food and Rural Affairs (DEFRA) in 2005 and 2006. The survey provides a valuable source of information on eco-innovation expenditures by UK firms, with good coverage across manufacturing industries. It also allows for exploring the determinants of different types of eco-innovation investments in: (i) end-of-pipeline pollution control technologies (EOP); (ii) integrated cleaner production technologies (INT); and (iii) eco-innovation research and development activities (ECORD). The authors provide a review of the related literature and articulate a conceptual framework that relates eco-innovation investments to two sets of factors: the environmental regulation framework and the internal firm-specific motivations. The environmental regulation framework is depicted along two regulatory instruments: *prescriptive regulations* that require compliance with environmental protection standards and *incentive-based regulations* that entail environmental taxes and subsidies. So far as the internal firm-specific motivations are concerned, Demirel and Kesidou investigate the effects of organisational capabilities, efficiency considerations and corporate social responsibility (CSR) considerations.

One novelty in this chapter is that the authors also distinguish between three types of environmental innovation expenditures. The distinction is based on the extent to which the innovation type affects the range of products produced and processes used by innovating firms. Expenditures on end-of-pipeline pollution control technologies (EOP) are considered at the lower end of the impact spectrum as manufacturing firms apply EOP solutions mainly to treat, handle, measure or dispose emissions and wastes from production. On the high end of the impact spectrum, we have eco-innovation R&D expenditures (ECORD) that enable firms to improve products and processes by devising solutions for cleaner production and consumption. Environmental R&D has a higher technological impact because (a) it enhances absorptive capacity and (b) the scope of environmental R&D is not limited only to process innovations but also covers product innovations. Finally, integrated cleaner production technologies (INT) are considered to have a medium innovation impact as they help modifying production processes but fall short of inducing significant product innovation.

Demirel and Kesidou utilize a Tobit regression methodology and report a rich set of findings. Their estimation results enable the reader to find out not only about the marginal effect of environmental regulation on the probability of a firm being an innovator, but also about decomposed effects on: (i) the probability that regulation induces the firm to undertake investments in eco-innovations; and (ii) the conditional mean level of eco-innovation expenditures that the firm undertakes.

With regards to environmental regulation frameworks, their results indicate that prescriptive regulatory instruments are effective in driving two types of eco-innovation: EOP innovation at the lower end of the impact spectrum and ECORD innovation at the higher end of the impact spectrum. In contrast, incentive-based regulatory instruments such as environmental taxes fail to motivate any of the three eco-innovations considered, with the exception of marginal effect on the probability of innovation by existing innovators in the middle of the impact spectrum. In addition, Demirel and Kesidou report that prescriptive regulations increases the probability of eco-innovation not only by existing innovators but also by firms that are new to eco-innovation. This is in contrast to incentive-based regulation that only induces existing innovators to innovate (i.e., picks up winners) – and only in the case of medium-impact innovation investments in integrated technologies.

These findings expand the existing evidence base not only by providing evidence on the relationship between regulation and different types of eco-innovation, but also by distinguishing the marginal effects on non-innovators as well as existing innovators. Hence, the authors report not only a *U-type* relationship between prescriptive regulations and eco-innovations, whereby prescriptive regulatory rules tend to have significant effects on the low and high ends the eco-innovation spectrum. They also report that prescriptive regulation tends to have *stronger effects* on the probability of non-innovators taking a decision to innovate compared to their effects on the innovation efforts of firms that are already innovators.

Demirel and Kesidou also report interesting findings on other determinants of eco-innovation. For example, efficiency considerations tend to be significant in driving eco-innovation expenditures whereas CSR considerations are insignificant. The impact of environmental management systems (for example the effect of subscribing to ISO 14001) is reported to be positive and significant with respect to EOP and ECORD innovations. The decomposed marginal effects suggest that subscription to ISO 14001 standards is effective in motivating firms to start investing in EOP and has a significant but smaller effect on increasing the EOP investments of those firms that already invest in EOP. In the case of ECORD, ISO 14001 is only effective for persuading firms to invest in ECORD but does not motivate increased ECORD investments by firms with existing ECORD activities.

Chapter 7 by Simon Porcher addresses the relationship between regulation and investment in information and communications technology (ICT) in a sample of 11 manufacturing industries in 10 OECD countries over 26 years from 1980-2005. Porcher tries to establish whether different measures of regulatory stringency on its own or in interaction with closeness to the technology frontier can explain ICT intensity (i.e., the ratio of ICT investments to value added) at the industry-country level. To do this, he assembles data for a range of regulatory measures and other control variables that are used in the literature.

Porcher utilizes four proxies for regulation, all of which are taken from OECD data. These include: (i) a regulatory environment indicator (*REGREF*) for network industries (telecoms, electricity, gas, post, rail, air passenger transport, road freight), the output of which is heavily used by manufacturing firms in the sample; (ii) an indicator that measures the extent to which industries are constrained by administrative burdens, entry regulation and

other market barriers in key non-manufacturing sectors such as network services, retail distribution, financial services and professional business services (*REGIMP*); (iii) an indicator of product-market regulation (*PMR*) that provides information about barriers to entry in each country; and (iv) an indicator public sector presence in product markets (*PMRP*).

Closeness to the frontier (*FRONT*) is calculated using productivity levels for each industry in each country from 1980 until 2005. Closeness to the productivity frontier is measured as the ratio between the productivity in industry *i* in country *j* at time *t* and the highest productivity level in the same industry *i* at the same time *t*. The range of control variables captures different factors that influence ICT intensity and includes: the capital/labor ratio (*KL*), externalities (*EXT*) that captures the international intensity of the ICT capital input; and import penetration (*MPEN*) as a measure of the extent to which the market is open to external competition.

Estimation results indicate that closeness to the frontier has a negative effect on ICT investment intensity across all estimations. This is to be expected because industries closer to the frontier needs to invest less in ICT to remain competitive. Secondly, regulation also tends to have a negative partial effect on ICT intensity. This is in line with the received wisdom, which expects a negative relationship between regulation and innovation. However, this partial effect does not tell the whole story as regulation interacts with closeness to the frontier and the interaction term (*REG*FRONT*) has a positive and significant effect in three out of four estimations. This means that an increase in regulation mitigates the negative effect of the closeness to the frontier and drives industries close to the frontier to increase their investment in ICT technology. It also indicates that regulation reduces the innovation effort in laggard industries that are distant from the frontier.

Porcher tests if the marginal effect of regulation (i.e., the combined effects of regulation and the interaction term) is significant at different levels of closeness to the frontier. The test results indicate that the marginal effect is positive and significant when industries are at the technology frontier and negative and significant when closeness to the frontier is minimum. In between, the marginal effect is insignificant. Hence, regulation is more likely to slow down innovation when industries are far from the technology frontier, but it is not likely to slow down the innovation effort of the industries that are close to the frontier. Porcher

proposes two explanations for these results. First, regulation may induce firms to remain competitive by investing in ICT as a means of improving quality standards and product variety rather than cutting costs. Secondly, regulation may encourage firms to undertake drastic rather than piecemeal innovation. Hence, the product market deregulation prescription of the Lisbon Agenda may be counterproductive. The Lisbon Agenda may be effective in securing innovation convergence between European industries by encouraging the laggards to invest in cost-cutting innovation; but it may remain ineffective in securing its declared aim of achieving convergence between EU and USA levels of innovation.

The relationship between regulation and innovation is also an issue that Eshref Trushin investigates in chapter 8. Trushin utilizes a panel dataset for more than 1,000 pharmaceutical firms in 11 countries for the period 1997-2007. The data is compiled from financial statements of the sample firms in the *Orbis* database. The analysis in this chapter is conducted in three steps. In step 1, Trushin conducts Pearson Chi-square and likelihood ratio independence tests to establish if R&D intensity (R&D/sale and R&D/assets ratios) is related to the stringency of price regulation and market concentration in the pharmaceutical industry. Then, he estimates average technical efficiency levels for firms within each country, using stochastic frontier modelling and a production function with three inputs: intangible assets, tangible assets, and labour. In the third step, he conducts independence tests to verify if the average technical inefficiency at the country level is related to the stringency of price regulation and market concentration.

Trushin reports that there is no evidence indicating that the stringency of drug price regulations is systematically associated with R&D intensities or technical production inefficiency. The same result is obtained with respect to the relationship between market concentration and R&D intensities or technical production inefficiency. There is partial evidence indicating that the most liberal pharmaceutical price regimes in the UK and the US have the lowest inefficiency in the truncated normal time invariant random effect panel specification, but this result is not robust across other specifications for the inefficiency term. The policy implication of this result is that price regulations do not seem to prevent firms from achieving the highest level of output given factor inputs.

A major limitation of the findings is that the small sample of only eleven countries reduces the power of the tests. Another major problem is the difficulty involved in accounting

for the quality of intangible assets. Time discounting of patents and quality of patent portfolios can be major confounding factors, which must be taken into account in further research.

The last chapter in Part II is Freddy Huet and Simon Porcher, who investigate how investment in innovation affects the balance between reputational and opportunistic behavior of private water companies in the French public-private partnership contracts (PPPs). Drawing on the relevant literature, Huet and Porcher demonstrate that water supply firms engaged in PPPs can be expected to increase their chances of winning the contract at the renewal stage by following two strategies: opportunistic behaviour aimed at reducing the probability of rivals' market entry or by building a good reputation that would increase their probability of winning the contract. Although a rich literature exists on the determinants of opportunistic behaviour or reputational concerns in a principal-agent setting, the effects of investment in innovation on corporate behaviour in regulated industries are not investigated. Huet and Porcher set to address this issue.

The authors utilize a dataset on the French water industry, compiled by the French Environment Institute (IFEN), the French Health Ministry (DGS) and the National Statistics Institute (INSEE). The dataset contains information on more than 4,000 French municipalities with water services under private management in 2004 and 2008. They argue that network update information transmitted by private suppliers to municipalities can be considered as a measure of reputational behaviour because such information reduces information asymmetries. Then, they set to investigate whether investment in geo-referring information systems (*GIS*) for leak detection is related to the probability of providing network information updates in 2008, taking into the account the effects of competition and a range of control variables.

Investment in innovative leak detection systems is expected to have two effects on the probability of disclosing information to the municipality. On the one hand, GIS investment may induce incumbents to withhold network update information in order to strengthen the "lock-in" situation that makes the incumbent more likely to win the contract at the renewal stage. In this case, the incumbent is acting opportunistically. On the other hand, large investments made by an operator can be a signal of reputational concerns. In this case,

investments in *GIS* leak detection systems will be associated with higher probability of transmitting information.

The authors test these hypotheses by estimating a Probit model, in which they control for a range of variables that relate to the competition environment, the contractual characteristics and some control variables. Their findings indicate that investment in specific innovation capital input (*GIS*) has a positive and significant effect on the probability of reputational behaviour, which is measured as the probability of disclosing network information to the municipality. They explain this result by the fact that innovative investment in itself is a signal for reputational concerns and that information disclosure follows in tandem to reinforce the reputational signals. Furthermore, operators with *GIS* leak detection systems are able provide more timely and detailed information at lower variable cost compared to rivals with older systems.

Huet and Porcher also report that competition from public-sector suppliers of water services and closeness to the end of the contract tends to increase the probability of opportunistic behaviour. Furthermore, when interacted with innovation, competition from public-sector providers has a substitution effect on reputational behaviour. In other words, as the number of public-sector providers increase the probability of reputational behaviour decreases among incumbents that invest in *GIS*. Hence, they conclude that incumbents that invest in *GIS* tends to disclose less information when faced with competition from public-sector providers compared to other incumbents with the same level of investment in *GIS* but lower level of competition from public providers.

Huet and Porcher argue that their findings showed that firms involved in PPP contracts in the water sector may strategically react to the competitive environment by concealing network information in order to raise rivals' entry costs. Therefore, some policies that aim to foster competition in this industry may fail if they don't take into account the strategic behaviours that firms could adopt to protect their rents. Hence, they suggest that regulatory policies that reinforce the obligation for incumbents to invest in innovative capital may reduce the probability of opportunistic behaviour by incumbents.

In the last chapter, Erickson revisits the theme of corporate governance and innovation, but asks a different question: does the emergence of intellectual capital as a wider concept of

innovation require a re-think on corporate governance? His answer is positive and depends on growing evidence that softer knowledge assets, i.e., the class of assets that are less amenable to be defined by structured innovation mechanisms, are additional sources of competitive advantage for the firm. Hence, Erickson makes the case for: (i) adding knowledge asset development and use to the remit of national innovation systems; and (ii) devising new corporate governance mechanisms that would induce managers to manage, report and protect these assets more effectively.

According to Erickson, the national innovation system (NIS) approach has proved valuable during the past decades. It has provided a guide to the right national governance approach that would support innovation. However, the concept has remained practical and taxonomic; and does not lend itself to addressing the new type of knowledge assets that he describes as intellectual capital. Although intellectual capital is considered critical to firm performance, it is not protected by traditional intellectual property legislation. Hence, it is necessary to devise national innovation system approaches that would encourage the development and application of softer forms of knowledge by creating government programs to grow knowledge (education, infrastructure, etc.), by encouraging the establishment of common metrics and reporting standards, by creating protection mechanisms, and by forming procedures that would make government use of such assets predictable.

However, effective governance in this realm may not be easy to develop and implement, as returns on intellectual capital are often not accruing until some years in the future. Therefore, corporate governance rules should be developed to facilitate the management, reporting and protection of intellectual capital. Corporate managers should be able to show that they have procedures and rules to protect such valuable proprietary assets, both from prying competitors and from sloppy collaborators, including government. In short, effective corporate governance faces a number of new concerns that were not even on the radar two decades ago.

CONCLUDING REMARKS

As indicated above, this volume is based on papers presented to an international conference on governance and innovation held at the University of Greenwich in June 2011. At the time, the call for papers indicated that the relationship between innovation and governance is a

relatively under-studied area of research. This has been the case despite extensive work on the relationship between governance quality and other performance indicators such as growth, firm value, investment, and income distribution. In addition, potential synergies that may result from combining economic governance, market structure, corporate governance and regulation remain to be explored. The conference aimed to bring together innovative research papers that explore the relationship between governance widely defined and innovation, taking into account the interactions between governance and market structure as well as between different dimensions of governance.

The contributors to the conference and to this edited volume have risen to this challenge very well by undertaking innovative and empirically-rich studies. The summary above does reflect these qualities to some extent, but it is far from doing justice either to the effort of the contributors or to the richness of their analysis. Hence, I would like to conclude this introductory chapter by thanking the contributors again and inviting the reader to explore the perspectives and evidence they provide on governance and innovation outcomes at firms, industry and country levels.

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