METHODOLOGICAL NOTE FOR CASE STUDIES ON ECO-INNOVATION AND PUBLIC PRIVATE PARTNERSHIPS

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NOTE FROM THE SECRETARIAT

This note was commissioned by the OECD Environment Directorate and prepared by Dr. Gilles Leblanc, of Ecole des Mines de Paris / CERNA, France. The note was commissioned in the context of the preparation of the OECD Global Forum on Environment focused on eco-innovation, held on 4-5 November, 2009, at the OECD Conference Centre in Paris (for more information, visit www.oecd.org/environment/innovation/globalforum). It will provide guidance for the development of case studies on selected environment-related innovations and public-private-partnerships.

The note is posted on the above-mentioned website and will be presented at the Global Forum on Environment. Comments are welcome and should be sent, before the end of November 2009, to gfsd.eco-innovation@oecd.org. A revised draft will be made available after that date. The opinions expressed in this paper are the sole responsibility of the author and do not necessarily reflect those of the OECD or the governments of its member countries.

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This note aims at defining a common framework for the case studies on eco-innovation which will be developed jointly by the OECD and the European Commission. The case studies are focused on the role of associated public policies. The methodology developed here builds on three key elements: 1) the specific economic patterns of eco-innovation with respect to standard innovation, 2) a review of the major determinants considered in the literature, 3) a refined framework setting the technological competitive environment based on the submarkets approach. The final section derives the implications for empirical research and interviews in the context of the case studies.

SPECIFYING THE ECONOMIC NATURE OF ECO-INNOVATION

Eco-innovation exhibits a number of distinctive economic features, which a comprehensive and insightful case study must consider. Fieldwork research and academic literature have identified the following key elements:

- Contrary to innovative products based on the creation of a new utility or quality improvement, there is no clear, undisputed, instantly valued by the customer, and widely shared evaluation of superior utility for green products or services. Most of them exhibit higher prices with no superior performances, quality improvement, nor satisfaction of a previously uncovered need. They usually actually offer a replacement alternative for existing solutions, with improved environmental impact, but at a higher price.

- Economic evaluation of eco-innovative products requires a life-cycle analysis to take into account savings over a long period of time. Even direct customer benefits such as energy saving must be aggregated on a life-cycle basis to compensate the purchase premium price.

- Some (not all) green technologies involve network externalities (either knowledge spillovers or facilitating infrastructure networks).

- They combine traditional product innovation valid in a specific market or sector with transversal enabling innovation, potentially valid for any sector.

- Very often, they involve several independent technological trajectories (i.e. limited demand substitution or R&D scope economies), raising irreversibility issues for public support or firm's R&D effort.

DETERMINANTS OF ECO-INNOVATION AND ROLE OF POLICY INSTRUMENTS

Academic research on environmental innovation usually considers three types of explanatory variables: regulation, market and firm-internal conditions (ZEW, 2001; Bernauer et al., 2007). The vast empirical literature then builds an ad hoc framework to test relations between environmental innovation and a set of factors aimed at capturing the various forces at work in each field. To illustrate that strain of research, consider for example three recent papers. Cleff et al. (2008) examine five factors that can potentially act as driving forces stimulating innovation, or as barriers hampering innovation activities: 1) Financing of innovation, 2) Taxation, 3) Competition in product markets, 4) Demand, 5) Regulation. Horbach (2005, 2008) suggests determinants of eco-innovation should be grouped in three distinct fields: supply side, demand side, institutional and political influences. Technopolis (2008) lists the following elements: 1) Cost and demand, 2) Regulation and standards, 3) Taxation, 4) Competition, 5) Socio-cultural factors.

However, empirical (sector, country) studies on the relative influence of each factor brings so far inconclusive results. This is well illustrated by Mickwitz et al. (2008) testing some "popular claims" (such as regulation providing no additional incentive to innovate, the superiority of taxes to other policy instruments, or the inefficiency of R&D subsidies) on two industries in Finland, and demonstrating that any generalization of the role of policy instruments for environmental innovation is unfounded and dangerous. Despite these limitations, several methodological insights from the literature are worth considering to organize the case studies. We suggest grouping them in three categories: the technological innovation system and its "failures", the dynamic view of markets and public intervention, the diversity of policy instruments and goals.

The first approach uses the concept of technological innovation system (TIS) to pin down some "system failures" hampering innovation. The systemic picture sees technological innovation as arising out of interplay between different actors and involving both knowledge flows and market interactions. In this richer picture of innovation process and diffusion, seven main functions of the TIS are identified and characterized (Bergek et al., 2008; Hekkert et al., 2007 among many references): knowledge creation and diffusion, entrepreneurial experimentation, definition of the directions of search, market formation, exchange of information, legitimation, and resource mobilization. This framework allows a more accurate analysis of barriers and incentives to innovate and the potential room for public policy, as the underlying view is that the overall system efficiency relies on the performance of each of those functions (see Hekkert et al., 2007 on the success case of cogeneration in the Netherlands, or Foxon, Pearson, 2008 on the identification of system failures in the UK associated with the lock-in of existing carbon-based technologies).

A second line of research insists on the dynamics of markets (product life-cycle) and public policy (timing, accumulation, and consistency of public instruments). Specific attention is here paid to the time process of innovation diffusion. Egmond et al. (2006) distinguishes between three stages of market development: the early market (innovators and early adopters), followed by the mainstream market (the early and late majority), and ending with the laggards. The interesting point is that the rationality to adopt innovation differs between these categories. While early adopters expect a radical discontinuity, bet on a change in the competition to build temporary monopolies through innovation and are prepared to bear with the associated risks and costs, mainstream players are careful decision-makers with routines and habits, consider innovation as an application to solve current problems, and seek gradual continuous change. This has important consequences on the relevance and efficiency of each potential policy instrument. Another similar time segmentation can be found in Foxon et al. (2005) based on five technological maturity stages: R&D, Demonstration, Pre-commercial, Supported commercial, Fully commercial. But public policy also has its own time frame and dynamics. Chappin et al. (2009) note that most studies on the effects of environmental policy on environmental innovation neglect policy accumulation, or only focus on short time periods. They suggest to investigate the policy accumulation, i.e. the implementation of "a mixture of policy instruments with a variety of underlying mechanisms to enable the achievement of policy goals". Attention should then be paid to the growing variety of instruments, the (in)consistencies between the associated mechanisms, and the temporal aspect (continuity or change, potential clustering of instruments in a short period of time). Their empirical application to the case of CHP adoption in the Dutch paper and board industry over a 40-year period demonstrates the differentiated role of policies in the different time periods. The results reveal different effects: some instruments reinforcing each other, new instruments disturbing situations originating from earlier policy instruments, negative risk-adverse firm behavior triggered by several instruments implemented in a short time span.

Finally, several papers emphasize the variety of policy instruments used (fiscal incentives, direct subsidies, norms design, public procurement…) and argue that this diversity should be comprehensively reviewed to evaluate the impact of public policies on innovation creation and diffusion. Actually, instruments are not substitutes as they differ significantly across several dimensions. An efficient policy cannot solely rely on a single one and will mix a set of tools over time. As Egmond et al. (2006) claim, "one size does not fit all!" and the final outcome crucially depends on the composition, relevance and coherence of the policy mix implemented in each case. To conduct such an analysis, an interesting comparative frame is developed by Aschhoff and Sofka (2009). To assess the role of public procurement on innovation policy, they compare it to other major policy instruments such as regulation, R&D subsidies, basic research at universities, along a set of key features: selection decision, selectivity, government objectives, input for the firm, incentives for the firm, effects on the firm, time horizon, and risk.

Reconciling these three different approaches in a comprehensive (and potentially formal) model would be a huge and ambitious task, well beyond this study. While several attempts are worth noting in this direction (notably Foxon, Pearson, 2008 and Bergek et al., 2008), we suggest a rather pragmatic and empirical use of their results for the case studies. The various dimensions and descriptive variables introduced to specify the TIS functions, the market dynamics, the variety and time accumulation of policy instruments will be assessed for each eco innovation considered. This will indeed allow a richer and more accurate picture of the institutional and market features as well as the nature of public policy. However, the competitive environment and market structure also deserve more attention. The following section suggests a framework based on industrial organization research to capture their key features relevant for eco innovation.

CONCEPTUAL FRAMEWORK OF ECO-INNOVATION DIVERSITY AND COMPETITION

The technological landscape of eco-innovation is quite complex and often rests, as mentioned in section one, on a large variety of distinct technical solutions. Using the global R&D effort on a given market to evaluate the competitive impact can then be misleading and irrelevant. This calls for a finer and more accurate description of the technological environment. Recent works in the industrial organization literature may prove to be very useful in this respect.

The starting point is that most of competition models rest on the definition of a market as comprising a set of goods, all of which are substitutes. However in highly innovative and R&D intensive industries, we have to define a market broadly enough to incorporate all substitute goods, which may lead us to include various sets of products, each of them requiring some distinct technical knowledge, know-how or investment. For example, when electronic device aims at replacing mechanical equipment, both mother industries should be jointly considered to define the relevant and comprehensive competitive and technological landscape. In this case, the firm or the public institutions must choose not only the level of R&D spending, but also the way in which this R&D effort must be divided among the various product groups. Those R&D programs may or may not contain common elements, raising small or large economies of scope in R&D across different submarkets. At the same time, on the demand side, the level of product substitution may significantly vary across submarkets, defining closely interlinked subgroups and more isolated ones. As public policy or firms's actions in one submarket will have effects on the competition, profits and strategic choices of firms in the other submarkets, one cannot dismiss this problem by working at a lower level of aggregation and simply moving the analysis of competition and market structure at the level of the submarket.

Actually, the pattern of linkages across submarkets on the demand (substitution) and technological (R&D scope economies) sides is often quite complex. Sutton (1998) suggested a response to these problems by introducing the notion of distinct technological trajectories, each of them associated with a distinct submarket. When products in submarkets are close substitutes, one firm advancing along one trajectory with a large R&D effort will manage to win market shares from firms operating on other trajectories and submarkets. On the other hand, when products in different submarkets are poor substitutes, the market becomes separable in a number of independent submarkets, where a superior R&D effort in one of them will have little impact on the others.

In this setting, two polar patterns may emerge in high tech and innovative industries. The first one is a pattern of R&D escalation along a single technical trajectory, leading to a high level of concentration. The second one is a pattern of proliferation of technical trajectories and their associated submarkets. Sutton illustrates the two cases with the aircraft industry (escalation in the 1920-30s along the technical trajectory defined by the DC3 design from a very diverse landscape of plane types) and the flowmeter industry (specific applications to particular types of buyers limit the scope of demand substitution and, despite a high-level of R&D intensity, allows for a large number of submarkets, of specialized firms, and fragmentation of the industry).

This framework could bring insightful results in the case of eco-innovation, allowing a distinction between markets where escalation mechanism prevails and those marked by a continuous proliferation of technological trajectories. This context will have significant implications for the analysis of the respective role of market forces (demand, supply) and public policies. This line of reasoning requires a definition of the overall utility in the market considered, a comprehensive identification of the various technical solutions available to answer this need, including the environmental ones, and a careful examination of the substitution and scope for R&D economies between them.

IMPLICATIONS FOR THE EMPIRICAL WORK

The discussion carried out in the three above sections suggests several methodological points for a rigorous empirical research along case studies of eco-innovation. All of them aim at defining a finer and more relevant framework taking into account the different economic dimensions of the eco-innovation considered. Four key elements can be successively underlined: overall utility definition, innovation patterns, demand characteristics, competition.

Definition of the overall benefit served and the associated market

The diversity of environmental issues must be clarified. Regulations usually do not target the overall environmental performance of products but consider specific issues such as toxic emissions, recyclability or energy consumption. Equally, innovation improves one, sometimes a few environmental attributes of products. Also firms do not face the same regulatory stringency for each environmental issue. Product innovation, regulatory stringency and potential for customer benefit vary over the different environmental issues[1].

To define the market where the eco-innovation will compete, a comprehensive review of all existing or planned solutions fulfilling the same overall benefit must be carried out. This will help defining the different submarkets at stake.

Specification of the eco-innovation

The eco-innovation can be detailed with the classical distinction between product, process and organization innovation. Actually, organizational innovation in the field of eco-innovation is rarely examined and taken into consideration, while this factor could play a crucial role in the adoption and diffusion rate.

It is also worth examining, depending on the technology and the market considered, the scope and composition of the double externality in eco-innovation (Renning, 2000): environmental quality improvement in addition to traditional R&D spillover.

Finally, the definition of an environmental product innovation could be enriched by characterizing its extent (i.e. the proportion of products for which green innovations have been implemented) as well as its degree of novelty (for the firm or for the market respectively).

Demand

The potential direct benefits for the customer (green marketing literature) should be carefully examined and specified. Products which besides public benefits also bring direct private environmental gains for the customer will generate stronger demand. The potential sources are multiple: cost and energy savings, improved durability, better repair, upgrade and disposal possibilities, reduced health impacts…

A distinction between individual and firms' demand will be introduced, as this defines quite distinct market and competitive environment.

Competition

Following the approach presented in section 3, the extent and nature of demand substitution and R&D scope economies between the different technologies and submarkets will be carried out. On this basis, a definition of the technological context in terms of escalation or proliferation can be suggested.

A specific attention will be given to the dynamic effects. While most of the studies have a static view focusing on the innovation R&D, conception, the final outcome is clearly determined by the

[1] For an empirical illustration, see Kammerer, 2009 on the case of the German appliances industry.

adoption, diffusion and deployment process. This is particularly true in markets with technological proliferation (multiple distinct trajectories).

In conclusion, let's note that the set of cases (electric car, CSS, CHP, fuel cell, biopackaging) considered in this study covers the differentiating variables suggested. For instance, it includes product innovation (electric car) as well as transversal enabling technologies (CSS, CHP). The electric car environment is marked by technology proliferation while CSS and CHP are based on a limited number of technological options. Markets for electric cars and CHP systems already exist though rather small, while CSS is still at a development and experimental stage.

Scope and of content planned interviews for the case studies

The methodological approach developed below also has important implications for the interviews to be carried out for the case studies. First, it suggests an enlarged scope of relevant targets for fieldwork research. To assess the competition between distinct technological trajectories as well as the potential for product substitution and R&D scope economies, one should not limit the analysis to the eco-innovation per se, but also consider the other alternatives and the associated industries. This will allow a practical evaluation of network externalities, market structures, diversity of technological trajectories, crucial for the successful adoption of an eco-innovation in its specific technological and competitive environment. Secondly, the customer side should be carefully examined, to evaluate the potential direct benefits brought by an eco-innovation, according to existing substitutes and the nature of market competition (price, product differentiation, quality, brand…). Finally, the analysis of public policies in terms of instruments' scope and coordination will be enriched by the specification of market structure, technological environment, customer potential direct benefits, as well as the timing and variety of public tools.

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