10ISSN 1183-1057

SIMON FRASER UNIVERSITY

Department of Economics

Working Papers

11-01

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June, 2011

SFU Economics

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Vancouver, Mannheim, June 2011

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Abstract

In environmental policy first mover advantages for environmental technologies are often taken for granted. It is a popular view to see the state as a political entrepreneur who introduces a certain environmental policy instrument, e.g. feed-in tariffs for renewable energies, and thus becomes the world market leader or the lead market for the respective technology. Against this background, this paper wants to find out if the idea of first mover advantages can be justified by theories and empirical evidence from industrial organization and business management studies. After a review of theoretical and empirical papers we see that first mover advantages are not confirmed by empirical evidence. Thereby the successful innovator is not necessarily the first but very often one of the early movers within the competition of different innovation designs. We show that the success of a timing strategy depends on country-specific lead market potentials, on market and technology characteristics and on the regime of the country-specific regulation.

On this basis we derive options for environmental innovation strategies for firms under different circumstances of markets, technologies and regulations. We will see different implications for practical innovation management and innovation policy.

Keywords: Lead markets, environmental innovation, first mover advantages, innovation strategies

JEL classification: Q55, L60, O33

Index of contents

Index of tables:

Index of figures:

1 Introduction

The term “first mover advantage” is often cited in documents of environmental policy. For example, in the justification of the Renewable Energy Act the German government states that it will realize first mover advantages due to the use of renewable energy with modern technology (Bundesregierung, 2007). Another example from the German Ministry of Environment (2008) is the report “Investments for a climate friendly Germany” which mentions these technology investments will create “first mover advantages” for the domestic industry. At the European level the President of the European Commission, Jose Manuel Barroso (2008), argues that the European energy and climate change package should be seen as an opportunity to Europe in economic terms: “It will encourage innovation and it will increase competitiveness. It is a mistake to oppose the fight against climate change to the competitiveness of European industries. The Union should lead the global efforts to tackle climate change. And European industries should continue to be world leaders. At the same time, we will also create new markets and new jobs, and make sure that we have the "first mover advantage" in many sectors.”

It seems that in the political arena first mover advantages for environmental technologies are taken for granted. It is a popular view to see the state as a political entrepreneur who introduces a certain environmental policy instrument such as feed-in tariffs for renewable energies, and thus creates a profitable market for the respective technology. There would also be an alternative strategy for government strategies in environmental technology markets: to wait and catch up quickly later, being a second mover or a late follower, with likely giants steps in catching up (Hilton, 2001).

Against this background, this paper wants to find out if first mover advantages for pioneering firms are confirmed by theories and empirical evidence from the relevant literature of industrial organization and business management. We focus on an analysis of market-oriented innovation strategies of eco-innovating companies. These firms produce goods and services that include cleaner technologies as well as products and services that reduce environmental risk and minimize pollution and resource use. This may include new energy efficient products such as dishwashers, pellet ovens or better insulation material.

After a review of theoretical and empirical papers in section 2 we will see that first mover advantages for innovative (not necessarily eco-innovative) firms are not confirmed by empirical evidence. Thereby the successful innovator is not necessarily the first but very often one of the early movers within the competition of different innovation designs. The success of a timing strategy depends on lead market potentials, market and technology characteristics. While section 3 introduces the concept of lead-markets, section 4 will discuss the role of

regulation as a peculiarity for environmental innovations, and develop implications for lead market strategies. Since the success of a timing strategy depends on lead market potentials, market and technology characteristics, section 5 derives options for environmental innovation strategies for firms under different circumstances of markets, technologies and regulations. We will see different implications for practical innovation management and innovation policy.

2 Innovation Timing Advantage

2.1 Sources of First- and Second Mover Advantages

The “first mover” in theory is the very first firm to bring an innovative product or service to market, but in practice it means one of the first to do. Therefore, Gilbert/Birnbaum-More (1996) recommend to use the term “early mover” since it might be a more accurate description of most situations, which are discussed as first mover. “Second mover” or “Late Movers” mean all firms entering the market after the first mover(s). They typically imitate the innovation design. Only the profits for innovation with well specified and protected intellectual property rights (IPR) are limited to a single first user. Where do the first mover advantages result from and why don’t they come up in specific situations? Three basic sources of first mover advantages and another three of second mover advantages are often described in literature of business strategies (cf. e.g. Gilbert and Birnbaum-More, 1996; Lieberman/Montgomery, 1988).

The first source of a first mover advantage is technological leadership due to a quick fall of costs down, the learning or experience curve (Lieberman, 1987) or a success in R&D or patent races (Mansfield, 1986). When IPRs are well-specified and protected a firm gains competitive advantage through patenting or copyright, or as a trade secret. Mansfield (1985) however, has found that successful protection of IPRs against imitation by other firms is a rare case.

Secondly, a source of first mover advantages can be the preemption of physical or spatial assets such as skilled workers, unique channels of distribution or manufacturing facilities. It is seldom the case however that those assets are completely appropriated by a single firm (Lieberman/Montgomery, 1988). It can thus be argued that pre-emption of assets is a kind of timing advantage available to several first movers, i.e. first movers securing anchor locations in a new shopping mall in a desirable area gain advantage over latecomers.

The third category of advantages is buyer switching costs. Switching costs develop due to initial transaction costs or investments when a user has to adapt to the new product. First of all, the user must be convinced of learning another system. This step demands for non-superior products specific marketing skills and

additional costs of the followers. Additionally, there arise user-related qualification costs, which must be covered by the supplier or the user. All these costs have to be raised by the follower in order to drive out the first mover from the market. In case the first mover is able to convince the buyer of the uncertainty of the follower`s product quality, then the user will seldom turn away from the first brand, which has already proven its quality. Switching costs may also arise through the users' contractual restraints with the first mover (Lieberman/Montgomery, 1988).

It can be summarized that out of the three sources of first mover advantages, only technological leadership – if at all - is restricted to a single firm. And in the case of technological leadership it depends on the existence and protection of IPRs, and on the time potential imitators need to find ways around the restriction. Also, second movers have a competitive advantage in specific situations, which are based on three theoretical arguments. There is no indication in literature that second mover advantages may be limited to a single firm:

The competitive advantage for second movers is simply to free-ride on first mover investments. This is possible due to the positive spill-over of the first mover, especially when IPRs are not well-defined and specified. Many products and services can be easily and inexpensively imitated. In many cases also second movers can profit from improvements of the first mover regarding the learning and experience curve (Lieberman 1987).

A second source of advantages is technological developments or customer needs, which arise after the introduction made by the first mover. They may be overlooked by the first mover due to incumbent inertia. This argument is taken up by Markides/Geroski (2005) who argue that a first mover is colonizing the product and typically has a different – in most cases technology-driven - mindset, while a fast second firm focuses on consolidation from niche to mass markets.

The third main advantage for second movers is leapfrogging (Fudenberg et al., 1983), i.e. catching up to the first mover in fast, big or even giant steps. While the developer of the new product or service had to experiment with a lot of different variations of the original innovation design, and thus had to pay a large amount of development costs, which are now sunk costs, the second mover has the advantage of reduced market, technological and regulatory uncertainty.

The summary of considerations brings up reasons for and against first mover advantages, which have been analyzed broadly and empirically based in the last decades. An analysis of studies shows that until the mid 1980`s the opinion prevailed that only the market pioneer can secure a long-lived market share advantage (cf. e.g. Yip 1982, Urban et. al 1986, Robinson/Fornell 1985). Biggadike (1979) was convinced of having proved in his study that even after 5 to 8 years later entrants were not able to catch up the disadvantage.

Not until later studies this apparently natural symbiosis between the first mover and the innovation success was questioned. Studies conducted by Tellis/Golder (1996), Lellien/Yoon (1990) and Lambkin/Day (1989) confirm a higher failure

rate of market pioneers. Golder/Tellis (1993) ask rightly whether the pioneer advantages are a "Marketing Logic or Marketing Legend". Olleros (1986, p. 8) even states that „we see industries emerge over the dead bodies of their early pioneers". Markides/Geroski (2005, p. 2) give a great number of anecdotic examples for unsuccessful pioneers. However, it is not the case that these results speak against a first mover advantage. Robinson/Min (2002) observe a 66% survival rate during the same time for market pioneers, whereas early followers only have a 48% chance. The results could not be more diverging, so that Min/ Kalwani/Robinson (2006, p. 15) come to the correct statement that the first mover advantages depend on the respective environmental circumstances.

In the following we want to present the results of some empirical studies that have analyzed, which factors influence the innovation success of market pioneers/ of a follower in dependency on different environmental factors.

2.2 Empirical evidence from the business management literature

One of the first studies that has have dealt with the environmental circumstances of the market is the study conducted by Urban/ Carter/Mucha (1983). Data basis were the sales of 38 and in a later analysis 44 brands of frequently purchased consumer goods in connection with information from media audits and interviews. On the basis of regression analyses the authors analyzed the influence of the order of entry, the years between the entry, the product positioning, the preference of a brand of interviewees, and the advertising intensity on the market share of first movers. The authors assess that a later entrance has less market share on average than the market pioneer, but pioneer`s share decreases with each new firm entering the market. This decline is higher if other brands can achieve superior price and product positioning. In order to avoid this market pioneer should occupy and defend the preferred product positioning.

Another regression-analyses approach was chosen by Robinson (1988). On the data basis of 1.209 companies from mature industrial goods manufacturing businesses he confirms that market pioneers gain a sustainable market share advantage. In addition, their products have a better quality and show a broader product line. While the product quality advantage decreases over the time, the advantage of the breadth of product line remains. Robinson (1988, p. 93) differentiates the results with regards to the different velocities of the technological development on markets. The market share of the pioneer decreases when the technological competition increases on the market. Only if the value added of an industry is high, the market pioneer is able to resist the technological competition and to extend the market share.

Some years later Gilbert/Birnbaum-More (1996) take up the findings of the influence of dynamics in technology and on the market in the framework of a meta study, in which they bring together the empirical results of different surveys. On

the basis of different sources of competitive advantages, they propose the important influencing factors on the industry and technology level as well as on the product/service level (cf. Table 1). With increasing fragmentation of the industry and increasing velocity of the innovation the first mover advantage rises. This effect is being emphasized when switching costs are high and technological infrastructure is sufficiently available. The implementation of a first mover strategy is successful under these circumstances only by taking-over technological leadership and the herewith connected R&D expenditures. The diffusion rate, the degree of novelty and the complexity of the product however, have negative effects on the first mover advantage. The second mover has the advantage that the pioneer has already found technological solutions and has developed these for the market preference. There are no costs for the followers, so that a cost leadership strategy is promising.

Table 1: Correlation directions between actors and timing advantages

Level	**Factor**	**Correlation with**	
		1st Mover Advantage	2nd Mover Advantage
Industry/ Technology	Degree of fragmentation	+	-
	Velocity of innovation	+	-
	Rate of innovation diffusion	-	+
Product/ Service	Connection to technological infrastructure	+	+
	Degree of novelty	-	+
	Difficulty of production/complexity of technology	-	+
	Customer resources invested (lock in)/switching costs	+	-
Firm Strategy	Cost leadership	-	+
	Differentiation	+	-
	Core Competence	+	+

Source: According to Gilbert and Birnbaum-More (1996).

An important contribution to the discussion of first mover advantages for radical innovation comes from Markides/Geroski (2005). The authors show anecdotically that the process for radical innovations is mainly driven from small firms or startups, very often without an established brand name. They develop a technology pushed innovation over a long period in niche markets and they feel less risk to pioneer a radical innovation. The innovation design is being developed in an elaborate exploration process, during which different variations have to be

checked with regard to the market preference. The major role of the pioneer is the Colonization of the new market Markides/Geroski (2005). The established firms free-ride on the technological and market experience of the brave pioneer. They make use of the developing mass market and the dominant designs, by trying to drive out the first mover with rival variants of the dominant design, and to consolidate the market into a mass market.

This can also be seen in the area of eco-innovations, e.g. in the case of E-Mobility. Up to now it is not decided, which engine technology – if at all - will win the race for a sustainable transport technology, if it will be e.g. hybrid, fuel cell or battery cars? Thus, following Markides/Geroski, big firms should aim at a strategy of consolidating markets, i.e. taking up a radical innovation early enough to be able to develop it from niche to mass markets.

Table 2: First and Second Mover Strategies for radical innovations

	First Mover	**Fast Second**
Focus of activity	Exploration and Creation of product on Niche Market	Creation of Mass Market
Firm characterization	Young, small	Established, big
Major role	Colonization (creation of product)	Consolidation (of market)
Innovation drivers	Technology push	Market pull
Object of competition	Rival innovation designs	Rival variants of dominant design
Dominant innovation design	Variation, Exploration	Selection
Market structure	Large firm population	Concentration, Shakeout

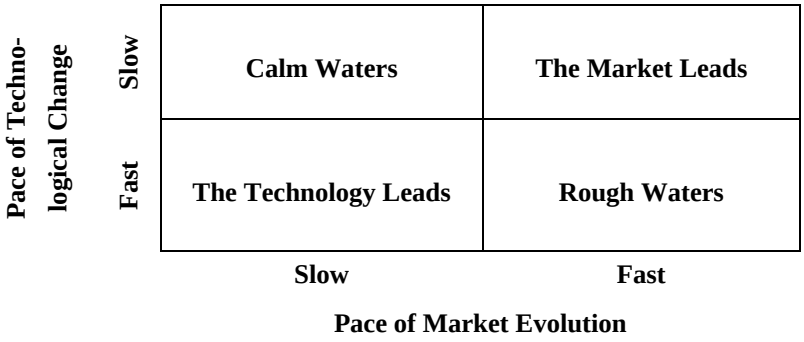
Source: Own overview according to Markides/Geroski (2005).

Min/Kalwani/Robinson (2006) look at radical and incremental innovation. The latter is „designed to satisfy a felt market need and uses an existing technology or refinement of it" (Min/Kalwani/Robinson 2006, p. 16). Using the Thomas' Register of American Manufacturers they identified 264 new industrial markets and they analyzed the influence of different factors on the survival rate of first movers. Indeed, the multivariate hazard rate analysis shows that market pioneers have a greater survival risk for radical than for incremental innovation. This context is not significant for early followers. For radical innovations the market pioneers show a significantly higher survival risk than the early follower. For

incremental innovation it is vice-versa. „In conclusion, market pioneers are often the first to fail in really new product-markets. However, this is not true in incremental new markets, in which market pioneers have consistently lower survival risks than early follower" (Min/Kalwani/Robinson 2006, p. 30).

Suarez/Lanzolla (2005) come to similar results: in their study as well, it seems empirically proven that the pace of technological evolution – that means radical or incremental innovation – and the pace of the market evolution play a decisive role for the first mover advantage. Therefore, the authors propose the Portfolio of contained effects of market and technological change in Figure 1 as a basis of strategic orientation of innovation strategy.

Figure 1: Portfolio of Combined Effects of Market and Technological Change



Source: Suarez/Lanzolla (2005, p. 124)

The best prerequisite for a long-lived first mover advantage is when technology and market develop slowly ("Calm Waters"). Followers are not able to gain a market share of the pioneer through technological or product differentiation. Their market growth is too small to realize economies of scale. The slow market pace enables the first mover to build up step by step new market segments. R&D, skills, marketing and other capabilities of the First Move are less stressed than in other situations. Durable first mover advantages are very likely.

In case "Technology Leads" short-lived and durable first mover advantages are very unlikely. Radical changing technology brings in again and again new competitors with new developed innovation designs. This is more or less the case for all market actors on the market, so as well for later entrants. Only strong R&D and high expenditures for product development capabilities (technological leadership) are able to gain and to maintain a long-lasting position as market pioneer and to stand on the forefront of the technological development. Only if the technological dynamic slows down and market takes off with pioneer's innovation as global design, the first mover is able to collect the rewards on his investment.

The most difficult situation is “Rough Waters”, because durable first mover advantages are very unlikely. Product technology changes radically and innovation designs becomes rapidly obsolete. In fast progression new technological solutions develop, which enable later entrants to push out older technology of the pioneer. “Leapfrogging” through later entrants is very likely. This is made possible because at the same time customer preferences follow the rapid development of new technologies and because the market demands technological changes. Only in case of strong R&D and technological leadership with simultaneous large-scale marketing, distribution and production capabilities a successful first mover strategy is possible, however, it stays risky at the same time. Only a quick-in quick-out market strategy makes sense to realize short-lived first mover advantages.

Within “The Market Leads” situation, durable and short-lived first mover advantages are very likely. The technology develops only slowly and the dominant design developed by the first mover holds a great market share. Sales are growing because of the enormous expansion rate of the market demand. The first mover has to assure that he addresses all kind of emerging market niches. Only then, followers have no chance to enter the entire market through a niche. In order to satisfy the entire market the pioneer must possess large-scale production, marketing and distribution capabilities (Suarez/Lanzolla 2005, pp. 125).

It can be ascertained, that the successful innovator is not necessarily the first but very often one of the early movers within the competition of different innovation designs. Diverse theoretical approaches of this phenomenon are being used to explain first or early mover advantages. Apart from the diverse – at this point not presented - timing game approaches (cf. e.g. Hoppe 2000 or Hoppe/Lehmann-Grube 2001) there are mainly empirical studies based on correlation or regression analysis. However, these are inconsistent in the choice of factors, which are finally responsible for the development of successful global designs. The results of the empirical studies range from

1. „Luck“, to
2. technological leadership, preemption of assets and buyer switching costs (Lieberman/Montgomery, 1988) to
3. industry, technology, firm and product-specific factors (Gilbert/Birnbaum-More 1996) and
4. leading time, market dynamic, and type of innovation (Min/Kalwani/Robinson 2006, Suarez/Lanzolla 2005).

Characteristics of different national country markets for the global success of an innovation design have hardly gained importance in the discussion. However, Suarez/Lanzolla (2005) mention the pace of market evolution as one of two important influencing factors for successful innovation. But here as well, the different conditions on different national markets are not being more differentiated in their importance for the development of global designs. Although from an ex-

post analysis of successful global innovation designs there are always similar patterns. We can consider "successful" global designs to be those which

- firstly enjoy early national success,
- are then successfully commercialized worldwide and
- force other innovation designs out of the market in the medium term, to become the global design or the world standard respectively.

There are many examples of global design emerging from the adoption in one country, e.g. the cellular mobile telephony in the Scandinavian countries, the personal computer in the USA, the industrial robot or the fax machine in Japan, the airbag in Germany and the smart card in France (see e.g. Beise 2001, Beise 2006 and Beise/Cleff 2003). All these examples show that the first country that adopts a specific design becoming the global dominant design is often not the country where the innovation was invented or the technology used for it mostly developed. On the contrary it is often another country that is leading the worldwide adoption of an innovation: This country can be called the Lead Market.

3 The Lead Market Approach

The Lead Market approach suggests focusing customer interaction on those regions, which are likely to be ahead in international demand trends and show demand preferences that are later adopted in other regions, too. It was first suggested in the 1980s by Porter (1986) and Bartlett and Ghoshal (1990) and is receiving increasing attention worldwide during the last years (cf. e.g. Johansson 2000, Commission of the European Communities 2006, Cleff/Grimpe/Rammer 2009). Bartlett and Ghoshal (1990, p. 243) consider Lead Markets as "markets that provide the stimuli for most global products and processes of a multinational company. […] [Local] "innovation in such markets become useful elsewhere as the environmental characteristics that stimulated such innovations diffuse to other locations".

A Lead Market can be defined as a country where users prefer and demand a specific innovation design that not only appeals to domestic users, but can subsequently be commercialised successfully in other countries as well. The technical design preferred by the Lead Market squeezes out other designs initially preferred in other countries and becomes the globally dominant design. The innovation designs adopted in the Lead Market have an advantage over other country-specific innovation designs competing globally to set the international standard. This advantage makes consumers from other countries follow the technological standard of the Lead Market and adopt the design preferred by users there. In some cases this means abandoning a design that was previously preferred on the national market (Beise et al., 2002). Where the scientific and technical knowledge for this purpose was actually generated is mostly not relevant, as companies in the Lead Market are able to appropriate this knowledge. More

important for competitiveness is the ability to learn on the Lead Market about the applications and production of innovations (Meyer-Krahmer, 1997).

Therefore, Lead Markets have specific properties (Lead Market factors) that increase the probability of a wide take-up of the same innovation design in other countries (Commission of the European Communities, 2006). A theoretical lead market model has to provide these lead market factors and has to give an answer to the question under which market circumstances country's market characteristics are appropriate to the adoption of technological innovations that will succeed internationally and mark out the technological path to be followed worldwide.

At the moment there is no consistent and stringent lead market theory. However, Beise (2001 and 2006) and Cleff/Grimpe/Rammer (2007) were able to develop an eclectic approach of a lead market model. They have been investigating lead markets on the basis of detailed ex-post case studies focusing on the mechanisms at a national level and how these mechanisms are leading to global designs. Beise himself (2001) has been derived a system of five particular country-specific attributes - the so called Lead Market factors. These factors are influencing the international competitiveness of innovations and a good performance of these factors on national level increases the probability of the market becoming a lead market. The five factors are:

- price advantage,
- demand advantage,
- transfer advantage,
- export advantage and
- market structure advantage.

A price advantage arises from national conditions that result either in relative reductions in the price of a nationally preferred innovation design compared with designs preferred in other countries or in anticipation of international factor price changes. Countries can gain a price advantage if the relative price of the nationally preferred innovation design decreases, thus compensating for differences in demand preference to foreign countries. This price mechanism is the centerpiece of Levitt's (1983) globalization hypothesis, according to which consumers in foreign markets "capitulate" to the attraction of lower prices and abandon their initial endowment of goods. Price reductions are mainly due to cost reductions based on static and dynamic economies of scale (learning-by-doing). Market size and growth are examples of country-specific factors creating economies of scale. Another price advantage emerges from anticipatory factor prices in the lead market. Factor price changes can induce innovation. If the new relative prices occur worldwide, the same innovations are adopted worldwide as well.

Demand advantages originate from national conditions which result in the anticipation of the benefits of an innovation design emerging at a global level. A good example is provided by off-grid solutions in the energy and

telecommunication sector. Such innovations are more beneficial and thus more likely to be adopted first in industrialized, geographically large countries with a low population density, such as in Scandinavia (Beise and Rennings, 2005). When other countries catch up, they demand the same innovation that has already been used in the country at the forefront of the trend. Another example is provided by trends related to environmental problems such as climate change. Some countries are more exposed to the risks of rising temperatures (e.g. countries with above-average risks of flooding like the Netherlands) than others and will thus anticipate these trends earlier.

Transfer advantages are national conditions that increase the perceived benefit of a nationally preferred innovation design for users in other countries or by which national demand conditions are actively transferred abroad. The perceived benefit increases when information on the usability of the innovation design is made available. The initial adoption of an innovation of unknown merit reduces the uncertainty and therefore the risk for subsequent adopters and kicks off a bandwagon effect - also referred to as the demonstration effect of adoption (Mansfield, 1968).

The market structure effect focuses mainly on the degree of competition. Competition and entrepreneurial effort have been described as two of the main determinants of international patterns of innovations by researchers such as Posner (1961) and Dosi et al. (1990). The lead market is usually highly competitive. This is due to the fact that faster development and more market-oriented innovations are supported by competitive market structures. Firstly, companies engaged in fierce competition will demand more innovations from suppliers because they are able to reap greater competitive rewards from using innovative parts than monopolies (Porter 1990). Secondly, competing firms are under more pressure to emulate firms which have already adopted a new technology (Mansfield 1968). Thirdly, and possibly most importantly, more innovation designs are tested in a competitive market than in a monopoly market.

It is assumed that a Lead Market is always present when demand in a country provides innovating companies with a considerable quantitative impulse to innovate and, at the same time, the companies generate a large proportion of their turnover abroad. If quantities of product innovations exported are high and the impulse to innovate came from customers in the home market, this shows that demand at home prefers an innovation design that has the potential to succeed internationally. Three national export advantage factors can be identified: domestic demand that is sensitive to the problems and needs of foreign countries, the established export experience of national firms, and the similarity of local market conditions to foreign market conditions. Dekimpe et al. (1998) support the hypothesis already proposed by Vernon (1979) that the greater the cultural, social and economic similarities are between two countries, the greater is the likelihood that an innovation design adopted by one of the two countries will be adopted by the other country as well.

Conversely, it is a sign of an idiosyncratic market

1. when companies only export a small share of their goods because they respond too much to the "eccentric" customers' wishes at the home market. In this case, customers appear to prefer product solutions that cannot be marketed internationally (idiosyncratic demand), or
2. when innovators concentrate on technology specific product innovations based on their own or external sources of knowledge, but which do not provide solutions suitable for export (idiosyncratic technology).

Exportable innovations may also originate from sources other than the home market. Innovating companies that are highly export-oriented but do not, to any great extent, rely on home demand as a source of innovation. These markets can be categorised into three different types. In the first type, the drive behind innovations that are suited to the world market comes from the company's own R&D, or from technological know-how purchased externally. The second possibility is to base new products on the imitation of innovations of foreign competitors. The third category comprises firms that are driven to innovate by demand from abroad. This could indicate that the home market is a Lag Market. In this case, home companies may not be leaders in launching product innovations at the home market, but they are good at quickly picking up on new trends from abroad then converting these into export success. We denote all of these effects as "technological impulses to export".

4 The Lead Market, Eco-Innovation and Regulation

In this paper we define environmental innovation (or eco-innovation) as innovation of new or modified processes, techniques, practices, systems and products (Kemp/Arundel 1998 and Rennings/Zwick 2002).[1] Two different types of eco-innovation can be differentiated:

1. Environmental innovations can have a typical business objective with the aim to reduce the costs in the production process or the product characteristics, to raise the product quality and thus to improve the competitive situation – with a reduction of environmental impact at the same time. This type of eco-innovation does not differ in its primary focus from other product or process innovations, which also have as target the increase of process- or market efficiency. Porter/van der Linde (1995) see this form of eco-innovation especially there, where resources are privately owned or possess a regular market price and savings of respective resources are immediately cost-effective. Several eco-innovations have this "triple-benefit" for the environment, the firm and the user. Examples for such eco-innovations are innovation in energy and material efficiency (Rennings and Rammer, 2009). When the state interferes into the innovation process in such a situation through regulations it has two possibilities: It can (1) support the technology path already taken by the firm and accelerate the technological development, e.g. by setting standards on the basis of BAT (Best Available Technology). From the point of view of the lead market approach the legislator must assume that the technology path taken will create the lead market design or follow the respective design developed on other markets. The state can (2) correct the effectiveness of unfavorable combinations of the lead market factors by taking influence in a regulatory way on individual lead market factors, so that the technology path will have a new direction. In doing so in Germany the price of produced solar electricity was relatively reduced through the German Renewable Energy Act (EEG), so that this technology gained a relative price advantage (Bundesregierung 2007). This procedure is only advisable when the regulations are "anticipatory". Regulatory policy has to be of such manner that (1) its implementation is so "attractive" that it is adopted by other countries and that (2) future trends of the lead market factors are anticipated. Otherwise the risk of developing an idiosyncratic market is very high.

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[1] Innovation in the organization of firms as it is described in the OECD (2005) guidelines on the collection and interpretation of innovation data is not within the scope of this paper.

2. On the other hand eco-innovations can have the exclusive focus on the reduction of environmental impacts. This is the case when policy regulations interfere in the economy and thus cause innovations. The prohibitions to use certain harmful products, resources or end-of pipe technologies are examples for this. This type of regulation can improve the international competitive situation for the home industry when the regulation policy is adopted by other countries so that the innovation design established on the home market can develop into a global design. One can speak – in terms of the lead market language – of an anticipation of existing regulatory trends by a national government. It is not very difficult to observe such long term regulation trends if we look at the issues of international agreements: low carbon economy, energy and material savings are for example megatrends of the current and future decades. Regulation can pick up such regulatory trends and lead to the development of new markets, for example for energy efficient refrigerators, dishwashers or washing machines. These new markets however, must orient themselves along the Lead Market factors and allow the development of a global design on the home market. However, there is the risk that other countries will not follow the regulation process or that they will choose another form of regulation and that there develops an idiosyncratic innovation design on the home market. However, the rapid worldwide diffusion of energy efficiency labels shows that there is a quick adoption of innovative regulation in the area of eco-innovations.

Beise and Rennings (2005) have shown that lead markets exist for environmental innovations, with demand advantages being especially relevant e.g. for eco-efficient cars. However, for other eco-innovations such as renewable energies innovations were strongly driven by regulation. They added regulation advantages of a country as a sixth lead market factor specifically for eco-innovations. It is evident that regulation will have an important influence on the innovation process and therefore on the lead market position. How should a company react to regulation?

The answer to this question can only be given in dependency on the Lead Market potentials on the home market. In the following **Figure 2** the strategic options are summarized.

Firstly, we will have a look at a market with distinctive lead market characteristics. In case A there is a regulation supporting the existing technology path on this market, then the development of an innovation towards a global design will be accelerated. An example of case A is the national renewables policy in several countries. If the relative prices (e.g. of the factor costs) develop at the same time on a decreasing trend and the absolute prices are below the comparable substitute, then the lead market may have led the development toward a global design also without regulation. Regulatory intervention accelerates this process by emphasizing the effect of lead market characteristics through anticipatory regulation. This increases not only the short-term development of a global design

but also the realization of first mover advantages. In such cases companies should build on first mover strategies.

Figure 2: Regulation and Lead Market Innovation Strategies

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">Probability that Home Market is the Lead Market</th></tr>
<tr><th>Probability is LOW</th><th>Probability is HIGH</th></tr>
<tr><td colspan="2">Case A:
Regulation supports the respective national technology path</td><td>Type of Regulation:
• Non-anticipatory
• danger of idiosyncratic innovations!
Innovation Strategies:
• focus on needs of users in the lead market;
• dual-use innovation;
• follower strategies appropriate in most cases;
• co-operation with firms in lead markets.</td><td>Type of Regulation:
• Anticipatory or regulation trend
Innovation Strategies:
• short-term and especially long-term first mover advantages are likely.</td></tr>
<tr><td rowspan="2">Case B:
Regulation does not support the existing technology path and demands a move to a new technology path</td><td>Regulation will be adopted by other countries</td><td>Type of Regulation:
• Anticipatory
• Regulation creates new markets
Innovation Strategies:
• short-term first mover advantage;
• long-term first mover advantage only if regulations lead to relative Lead Market advantages.</td><td>Type of Regulation:
• Anticipatory
• Regulation creates new markets
Innovation Strategies:
• long-term first mover advantages are likely .</td></tr>
<tr><td>Regulation will not be adopted by other countries</td><td>Type of Regulation:
• Non-anticipatory
• danger of idiosyncratic innovations!
Innovation Strategies:
• focus on needs of users in the lead market;
• dual-use innovation;
• follower strategies appropriate in most cases;
• co-operation with firms in lead markets.</td><td>Type of Regulation:
• Non-anticipatory
• danger of idiosyncratic innovations!
Innovation Strategies:
• look for new Lead Markets;
• dual-use innovation;
• follower strategies appropriate.</td></tr>
</table>

Source: Own figure.

If the relative prices (of factor costs) in a market with distinctive lead market characteristics are on an increasing trend, then there may be the case that the developing innovation on the lead market cannot develop to the global design on short-term. This is then the case when the increasing price development is still not developed or is developing only slowly on other markets. The new innovation design developed with regard to relatively higher prices will not be able to establish itself against relatively cheaper innovation designs in short term. Economies of scale effects cannot develop at first so that the companies have to bridge this period of time at high costs and have to accept the risk of plagiarism. Only when the increasing relative price will unfold on other markets too, the lead market innovation will develop into a global design in the long term. The chance that first mover advantages will develop in this situation is rather small. Fast follower strategies in dependency on time of the price development on other markets makes more sense in this situation.

When in the case of low lead market potentials (lag market) a regulation supports the existing technology path on a market, then the creation of an idiosyncratic innovation is pushed forward, which can be successful locally and for a short time, but which may not be exportable or successful against the lead market design. Therefore, the companies should resist, if possible, the regulatory incentives and target their innovations on the technology path of the lead market to fit the preferences of users there. Targeting the lead market can take on varying degrees of intensity. These range from simply making use of listening posts in the lead market to analyzing competitor`s innovation and to testing or launching own new products there. All too often, companies lack the capacity to conduct such activities. From this point of view a first mover strategy does not seem to make sense. In fact a fast follower strategy adapted to the lead market should be chosen. Firms that are “fast followers” can often attain a high share of the world market, because they are able to learn from the pioneers (in the lead market) but not bear the same development costs. However, any lag-market strategy of being a “fast follower” should also be lead market oriented. Thus, even companies from markets with lead market disadvantages can be internationally successful. A possible way would be to develop an innovation at home but taking account of information about the specific conditions on the lag market. Dual-use innovations, which satisfy demand and the regulation both on the lead market and at home, can be a useful strategy option. In any case, companies should avoid technological designs that would be atypical on the lead market when developing an innovation for the home market. A good way for a company to establish links with a lead market is via cooperation partners, particularly when the company has not yet built up any resources or accumulated any experience on the market. Compared to establishing a subsidiary in a potential lead market, cooperation with an existing company has the advantage that such a company already has longstanding relationships with customers and, as such, can offer considerable insight into conditions on the lead market. This is of particular significance during the market launch, since that is when the most important information for the further

development of the product comes to light. Furthermore, cooperation costs less than building up a subsidiary and thus involves less entrepreneurial risk.

In case B the regulations intervene in the Lead Market by forcing a change of direction toward a new technology path. A recent example of case B is the nuclear phase out in Germany. In this case the companies find themselves in a dilemma. The lead market advantage remains only on the long run when the regulations are adopted in other countries in similar way. Only then the market keeps its lead market position with useful – above mentioned – lead market strategies and first mover options. If this is not the case regulations change the lead market characteristics, so that factor prices and other lead market advantages develop unfavorably for the former lead market in the long run. The risk of idiosyncratic designs is great and first mover advantages cannot be realized anymore. Companies have to fall back on lag-market strategies. In the same situation are the companies that had to act in lag-markets before regulation, and which see their lag-market situation sharpened through a non-anticipatory regulation. If the regulations are anticipatory on a lag-market – the regulations are adopted willingly by other countries – new products and markets can develop. For companies acting on this market short term first mover advantages develop. If lead market factors change into relative advantages through regulation (e.g. factor costs etc.), then a lead market can develop, in which a first mover advantage can remain on the long run. If the lead market disadvantages stay even after regulation, then the pioneer innovations on this market will be pushed out by the lead market design.

5 Conclusions and Management Implications

In the previous paragraphs the sources of first mover advantages were presented. There is unanimous opinion in the literature that first mover advantages depend on the respective environmental circumstances. The described and decisive requirements are especially velocity of the technical development and pace of the market dynamics. We learned that first mover advantages are very unlikely and sometimes even risky if technology changes abruptly. A high market dynamic however increases the potential for first mover advantages, but does not guarantee it. Requirement for first mover advantages is definitely the ability to develop a global dominant design – at least temporarily – which is generated in the lead market. For that reason the innovator should orient align the innovation activities very close to the circumstances on the lead market. The following question has to be answered:

- Under which circumstances and
- under which regulatory conditions
- with which timing-to-market strategy
- and with which lead market strategy

can a common efficient innovation strategy be created? We use the “portfolio of combined effects of market and technological change” introduced by Suarez/Lanzolla (2005) in order to answer the question.

In the situation "**Rough Waters**" first mover advantages are very unlikely and risky. Only technological leadership (for long-lived advantages) or quick-in quick-out (for short lived advantages) combined with large-scale marketing capabilities could support a successful first mover strategy. Especially in the lead market new innovation designs spread quickly and may assure technological leadership and high competitiveness through the fast diffusion of new technological designs. Therefore, the lead market approach is very important under these circumstances. For companies acting on these markets the government intervention is only then a problem if “non-anticipatory” regulations demand a move to a new technology path which is not transferable to other markets. The market loses its lead market character in this situation. In order to avoid the creation of an idiosyncratic innovation companies should take into account dual-use innovations and follower strategies as possible options. The product development should orient itself along potential new lead markets. Firms acting on a lag market with technological impulses to export may not be leaders, but they are good at quickly picking up on new trends from abroad then converting these into export success. Leapfrogging through rival variants of the dominant design, or imitations are relevant options in order to realize short-lived advantages. „Consolidation strategies“ are only

successful on a short-term basis. If lag markets develop only through an idiosyncratic technology and/or idiosyncratic demand then companies are likely to implement only late follower strategies. In some cases a non-anticipatory regulation for these idiosyncratic markets can be responsible. Only a change toward an anticipatory policy would improve the situation. In the meantime the company has to satisfy the niches on the home market and has to achieve exporting success with other designs by imitating or co operating with firms on lead markets with other designs.

Also in "**Technology Leads**" situation durable and short-lived first mover advantages are very unlikely. A first or early mover strategy can only be a useful but risky strategy if technology leadership and sufficient capital is given. In contrast to the situation "Rough Waters" the market is characterized by stagnation, which makes it more difficult to build up quickly economies of scale effects. The radical changing technology brings in new competitors, which push onto the lead market one after the other. The companies are exposed to an enormous price- and technology competition. This is also relevant for later entrants. Here as well the lead market is the decisive market to be observed, on which the global design will establish so that for companies from lead or lag markets there are the same strategic options like in the situation „Rough Waters". The same accounts for the consequences of a "non-anticipatory" regulation policy.

With decreasing velocity of the technological development the probability of success of first mover advantages increases. Great market dynamics and market potential combined with mature technology („**Market Leads**") durable first mover advantages are very likely. The global dominant design developed and incrementally improved on the lead market holds a great market share with enormous market potentials. The market growth however attracts new competitors so that the pioneer should prevent this entry through strategic measures. This can be achieved by occupying immediately niches through variations of the global design by the pioneer. Due to the high market dynamic this is a cost-intensive strategy because the pioneer must possess large-scale production, marketing and distribution capabilities. On the other hand the first or early mover should use cost reduction potentials or build these up, in order to be competitive against new entrants. On the lag market new technological solutions hardly develop, thus firms have to use typical follower strategies, like for e.g. the adaptation of the global dominant design, the development of a rival variant of the dominant design or the imitation of a product. Due to the market dynamics there frequently come up options for the entry into a niche.

Under „**Calm Waters**" circumstances pioneer's timing-to-market advantages achieved through incremental technological changes can hardly be reached by the competitor. In most cases the long-lasting global design was developed on the lead market. Due to the slackness of the market and the technological development there hardly emerge new competitive designs. In case these develop then surely on the lead market itself, because there arise the necessary price advantages due to the relative higher propensity to consume. This makes the observation of the lead

market relevant also under “calm water” circumstances. Strategically this means that the lead market pioneer should occupy all emerging market niches in order to avoid economies of scale effects of followers. A slowly developing market supports such a strategic orientation because the costs related to the occupation of niches do not develop to such a great extent and in such fast sequence. On the lag market new technological solutions develop even more hesitantly than on the lead market. Lacking absolute market growth hamper the competitiveness in addition. Lag market firms should focus on typical follower strategies, which provide them with a price advantage by adopting rival variants of the dominant design at simultaneous low production- and infrastructure costs. This is not an easy task because potentials for cost reduction are often higher or equal on the lead markets. Lag Market firms should align their product development along the lead market and give up possible lag market designs in case they do not fulfill the lead market needs.

Regulation Policy is to be applied anticipatory in the situation of a mature technique and a mature market. It offers the chance of new products and new markets. “Calm Waters” circumstances can convert - pushed by diverse new innovation designs – into a “Rough Water”, “Technology Leads” or “Market Leads” environment, in which the Lead Market plays an important role as long as there are no non-anticipatory regulations taken. Figure 3 summarizes the relevance of timing-to-market strategies and the relevance of the Lead Market approach under different environmental circumstances. Figure 4 derives the possible innovation strategies for firms acting under different circumstances of markets, technologies and regimes of regulation.

Figure 3: Timing-to-market and Lead Market Strategies under different environmental circumstances

Situation	"Rough Waters"	"The Market Leads"	"Technology Leads"	"Calm Waters"
Market	fast growing expansion rate and enormous new market potentials	fast growing expansion rate and enormous new market potentials	low market growth or even market decrease; low acceptance of new products	low market growth or even market decrease; low acceptance of new products
Technology	technology changes abruptly; R&D costly	only a gradual change of a mature technology;	technology changes abruptly; R&D costly	only a gradual change of a mature technology;
Relevance of Timing to Market				
1st/Early Mover Advantage	First mover adv. are very unlikely. Innovation designs become rapidly obsolete. Leapfrogging is very likely. Only technological leadership (for long-lived advantages) or quick-in quick-out (for short lived advantages) combined with large-scale marketing capabilities could support a successful first mover strategy.	Durable first mover adv. are very likely. The dominant design developed by the first mover holds a great market share with enormous market potentials. Emerging market niches should be covered by the pioneer to hamper market entrants. Pioneer must possess large-scale production, marketing and distribution capabilities.	Durable first mover adv. are very unlikely, because of high costs for technological leadership. The radical changing technology brings in new competitors/ global designs. This is also relevant for later entrants. Only if the technological dynamic slows down and market takes off with pioneer's innovation as global design.	Very likely (for both: short-lived/durable). Followers are not able to gain a high market share through technological leadership. The slow market pace enables the first mover to build up step by step new market segments. R&D, skills, marketing and other capabilities of the first move are less stressed.
Relevance of the Lead Market approach for different types of markets (Lead/Lag Markets)				
Firms acting on the Lead Market	Low relative price level and a high propensity to consume. New innovation designs spread quickly and may assure technological leadership and high competitiveness. Fast diffusion of new technological designs in the Lead Market.	Low relative price level and a high propensity to consume. Innovation designs spread quickly and make use of the market size advantages to increase their ability to compete on price. Long-lasting global design developed in the Lead Market.	Because of the high propensity to consume a new innovation design spread quickly and may assure technological leadership. Fast diffusion of new technological designs in the Lead Market but only slow increase in other markets.	The long-lasting global design was developed in the Lead Market. Due to the slackness of the market/ technology pace there hardly develop new designs. If these develop then only due to the high propensity to consume on the Lead Market.
Firms acting on the Lag Market: Technological impulses to export	Low demand but firms are highly export-oriented. Products are developed by own R&D or imitations. Firms are good at imitating new trends from abroad then converting these into exports	New technological solutions develop only hesitatingly while the demand on the Lag Market increases very slowly and does not support the development of a global design.	New technological solutions develop in fast sequences. R&D is oriented along the customer in the Lead Market, because the demand on the home-market grows too slowly.	New technological solutions develop even slower than on the Lead Market. Compared to the Lead Market the Lag Market is not in the centre of attention of innovations.
Firms acting on the Lag Market: Idiosyncratic Technology and/or Idiosyncratic Demand	Firms are not able to follow the fast technological change with adequate products and cannot profit from the (intern.) market growth because the preferences of international customers are not satisfied.	Firms are not able to react to the dynamic market growth with adequate technological solutions, although the technology develops slowly.	Firms are not able to follow the fast sequence of technological solutions with adequate products. Lacking market growth excludes a niche existence.	Firms are in an inferior position in the technological competition and the lacking market growth impedes the competitiveness in addition.

Source: Own figure.

Figure 4: Options for Innovation Strategies under different environmental circumstances

Situation	"Rough Waters"	"The Market Leads"	"Technology Leads"	"Calm Waters"
Market	fast growing expansion rate and enormous new market potentials	fast growing expansion rate and enormous new market potentials	low market growth or even market decrease; low acceptance of new products	low market growth or even market decrease; low acceptance of new products
Technology	technology changes abruptly; R&D costly	only a gradual change of a mature technology;	technology changes abruptly; R&D costly	only a gradual change of a mature technology;
Strategy options				
Strategies for Lead Markets	• Early mover • Technology Leadership • R&D oriented to the needs of the own Market	• First Mover Strategy • Decreasing-Price strategy • Prevention that followers can occupy market niches • R&D oriented to the needs of the Lead Market	• Early mover • Technology Leadership • R&D oriented to the needs of the Lead Market • Low-Price strategy	• First Mover Strategy • Decreasing-Price strategy • Prevention that followers can occupy market niches • Product development and differentiation oriented to the needs of the Lead Market
	In case of non-anticipatory regulation: • dual-use innovation; • follower strategies; • look for new Lead Markets			
Strategies for Lag Markets	• Follower/leapfrog strategy • Lead Market-oriented R&D • Abandon Lag Market technology • Rival variants of dominant design or imitation	• Consolidation strategy • Low-Price strategy • Abandon Lag Market technology • Rival variants of dominant design or imitation	• Follower/leapfrog strategy • Lead Market-oriented R&D • Abandon Lag Market technology • Rival variants of dominant design or imitation	• Low-Price strategy • Abandon Lag Market technology • Rival variants of dominant design or imitation
	In case of non-anticipatory regulation: • dual-use innovation; Lead Market oriented R&D			

Source: Own figure.

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