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Environmental innovations and profitability: how does it pay to be green? An empirical analysis on the German innovation survey

Claudia Ghisetti [a], Klaus Rennings [b,*]

[a] Department of Economics, University of Bologna, Italy
[b] Center for European Economic Research (ZEW), L7, 1, 68161 Mannheim, Germany

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A B S T R A C T

Much of the empirical literature analysing the relation between environmental innovation and competitiveness has focused on the question whether "it pays to be green". We differentiate between different types of environmental innovations, which will be disentangled in those aiming at reducing the negative externalities and those allowing for efficiency increases and cost savings. What we analyse is at first the extent to which these two typologies have impacts on firms' profitability with opposite signs, and, secondly, whether the motivations driving the adoption of those innovations make the difference in terms of economic gains. We find empirical evidence that both the typology of Environmental Innovation and the driver of their adoption affect the sign of the relationship between competitiveness and environmental performance. Innovations leading to a reduction in the use of energy or materials per unit of output positively affect firms' competitiveness. Contrarily, externality reducing innovations hamper firms' competitiveness. The empirical strategy is based on a sample of German firms and makes use of a merge of two waves of the Mannheim Innovation Panel in 2011 and 2009 that allow overcoming some endogeneity issues which may arise in a cross-section setting.

1. Introduction

The broad 10-year growth strategy "Europe 2020" of the European Commission, aiming at a smart, sustainable and more inclusive economy by 2020 (EC, 2010), is depending upon improvements towards a greener production that may lead to a "decoupling" of environmental pressure and economic growth. The generation and adoption of Environmental Innovations (from now on EI[1]) by firms are consequently keys to improve the sustainability of the production processes. This holds either when innovations are integrated in the production process (*Cleaner Production measures*) or when innovations are add-on measures that allow to reduce the negative externalities of the production in the last stage of the production process, for example by including specific filters to reduce pollution (*end-of-pipe technologies*). Previous literature has highlighted the peculiar nature of EI (e.g. Horbach, 2008; Rennings, 1998, 2000) and, suggesting the need of a multidisciplinary approach (e.g. Kemp, 2010), has recently contributed to a better understanding and identification of the determinants that are beyond the generation and the adoption of EI within firms.

Whereas a consensus on the determinants of EI[2] seems to be growing, the economic implications of their adoption are still

* Corresponding author. Tel.: +49 (0)6211235207; fax: +49 (0)621123522.
E-mail addresses: claudia.ghisetti@unibo.it (C. Ghisetti), rennings@zew.de (K. Rennings).

[1] Multiple and exhaustive definitions of EI have been provided by the literature (e.g. Kemp and Pearson, 2007; Kemp, 2010; Rennings, 1998, 2000). Among them, the one we will be referring to is the following: "the production, assimilation or exploitation of a product, production process, service or management or business methods that is novel to the firm [or organization] and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives" (Kemp and Pontoglio, 2007, p. 10).

[2] The extant ecological economics literature has mainly agreed on the relevance of a cluster of EI determinants (e.g. Horbach, 2008; Horbach et al., 2012) mainly *Market-pull* (e.g. Kammerer, 2009; Rehfeld et al., 2007), *Technology-push* (e.g. Horbach, 2008), *Firm specific factors* (e.g. Horbach et al., 2012) and *Regulation* (e.g. Brunnermeier and Cohen, 2003; Costantini and Crespi, 2008; Del Río González, 2009; Ghisetti and Quatraro, 2013; Popp, 2002; Rennings and Rexhäuser, 2011; Rennings and Rammer, 2011)with a relevant role attributed to the adoption of management schemes to improve environmental performance (e.g. Theyel, 2000; Wagner et al., 2002, 2008; Ziegler and Nogareda, 2009) The access to knowledge sources coming from outside the firms' boundaries is also found to be relevant (De Marchi, 2012; Cainelli et al., 2011; Mazzanti and Zoboli, 2005, 2009): relying on external knowledge sources is indeed positively influencing the adoption of EI and the enlargement of an EI portfolio within firms (Ghisetti et al., 2013) Furthermore, the investigation of what determines firms' attitude towards cleaning behaviours has provided evidences of an important role of social pressure, cognitive and attitudinal factors as well as of technological factors and opportunities and organizational capabilities, all of them moderated by the perceived risks and the overall attitude towards the development of clean technologies (Montalvo, 2002, 2003, 2008).

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widely debated, to understand whether firms are missing (getting) economic opportunities in improving (not improving) their environmental performances. We contribute to this debate on whether it pays or not to "be green" by proposing a differentiation between different typologies of EI. Our main argument is that it depends on how to be green, i.e. the "box" of EI has to be opened to disentangle the competitiveness effect of their adoption. Some neutral or even negative profitability effects might be associated with EI that are only aiming at reducing negative production externalities, while some positive economic benefits are indeed expected when EI are cost saving and/or efficiency improving innovations. Our corollary argument is that what drives the adoption of EI can influence the competitive outcome of the EI itself. Section 2 discusses the theoretical framework our research is based upon. The empirical analysis is carried out on the Mannheim Innovation Panel dataset for the years 2011 and 2009 and will be made clear in Section 3. Section 4 provides a discussion of our results and highlights a set of robustness checks we implemented to reinforce our estimates. Section 5 concludes.

2. Theoretical framework

A deep research effort has been devoted to the analysis of the economic performance effects of improvements in the environmental performances at various levels of analysis, where economic performance has been conceived through short-term measures, such as profitability or even longer term measures that capture firms' competitiveness. While still no clear answer has been provided, the research question whether it pays or not to be green has existed for a long time.

According to the natural-resource-based view[3] (NRBV) of the firm, it is expected that firms' profitability is positively influenced by the competitive advantages generated by the accounting of the natural environment as this pro-active behaviour favours the development of strategic resources that are engendering positive economic returns (Hart, 1995). Ecosystem degradation and resources depletion engender a threat to firms' resources (Hart and Dowell, 2011), and as a reaction, firms can pro-actively adopt an environmental strategy (Hart, 1995), which can be read as the development of a dynamic capability[4] (Aragon-Correa and Sharma, 2003; Hart and Milstein, 2003). To this respect, firms facing higher risks associated to climate change are those subject to greater incentives to develop green strategies (Hoffman, 2005). Moreover, the idea that *it pays to be green* became even more attractive when it was linked to the NRBV as "it is a theory of how an individual firm might gain a competitive advantage by going green" (Berchicci and King, 2007: 516). The economic benefits deriving from pollution reduction are, however, usually underestimated by managers (e.g. Hart, 1995; Berchicci and King, 2007 for a discussion) and this might lead to sub-optimal levels of environmental efforts if it is acknowledged that innovations might more than offset the cost of compliance to stringent environmental standards (Porter and Van der Linde, 1995). This underestimation can be driven by the costs associated to collecting proper information about the values and returns of different pollution reduction factors as firms can be unwilling to bear the search costs and thus can underexploit or abuse certain "greener" production techniques (King and Lenox, 2002). Waste prevention processes, for instance, have proved to be underexploited because of their not-directly-observable benefits (e.g. King and Lenox, 2002; Russo and Fouts, 1997). Lastly, the literature on Corporate Social Responsibility (CSR) (e.g. Porter and Kramer, 2002, 2006), which is centered on environmental responsibility (e.g. Hart, 1997; Orlitzky et al., 2011), provides insights on the potential positive gains associated to a socially responsible behaviours. According to these studies (e.g. Ambec and Lanoie, 2008; Margolis and Walsh, 2003), irrespective of whether the adoption of cleaner technologies can be a by-product of a strategy aiming at improving firms' market evaluation, or the access to new (green) markets, or as part of a cost-reduction strategy (Ambec and Lanoie, 2008), such an adoption might still engender positive business performance effects.

Given this framework of analysis, a range of empirical studies have been devoted to test the relationship between financial and environmental performance in a firm-level analysis (e.g. Freedman and Jaggi, 1992; Jaggi and Freedman, 1992). Those studies provided a very mixed picture on the signs of this relation and on the empirical strategies to be adopted. According to Horváthová (2010), 15% of them found a negative, 55% a positive, and 30% found no effect of environmental performances on economic performance. In studying the profitability effects, measured as Returns on Equity (ROE), of environmental performance ratings in the pulp and paper industry, Bragdon and Marlin (1972) found support that it pays to be green. The same positive sign, but with different measures of financial performance, can also be found in Russo and Fouts (1997), adopting Returns on Assets (ROA), in Salama (2005), assessing the Corporate Financial Performance, and in King and Lenox (2001) and Dowell et al. (2000), adopting the Tobins'*q* index. King and Lenox (2002) provided some further insights by showing that the positive correlation between financial and environmental performance were driven by a particular type of practice, i.e. the waste prevention methods. A confirmation that less polluting firms benefit from improved financial performances also comes from Hart and Ahuja (1996), who furthermore highlighted that Operating Performance (Returns on Sales (ROS) and ROA) was benefiting from the year after the initiation of pollution prevention strategies, while it required two years before financial performance (in terms of ROE) was positively affected. To overcome the simultaneity problem that may arise in a cross section setting, i.e. that environmental and economic performance usually go hand in hand as they are jointly determined and jointly depending on the unobservable firms' management strategy, Al-Tuwaijri et al. (2004) adopted a Three Stages Least Squares estimation (following Ullmann, 1985) and still found support of a positive relationship between environmental and economic performance.

Contrarily to those evidences, in studying the effect of environmental performance on financial performances measured as ROS on a sample of US firms in a cross-section setting, Sarkis and Cordeiro (2001) and Cordeiro and Sarkis (1997) found support for short-term negative effects, which were stronger for *pollution prevention strategies* than for *end-of-pipe measures*. A negative effect on the Return on Capital Employed (RoCE) was also found in the European context, in particular, on the European paper industry using a simultaneous structural model, but when adopting different measurements for the financial performance, such as ROE or ROS, the effect was no longer significant (Wagner et al., 2002). Similarly, a neutral effect is also detected by Freedman and Jaggi (1992). However, Elsayed and Paton (2005) suggested that previous mixed results were driven by misspecification issues, which

[3] The NRBV somehow challenges the Resource Based View of the firm as it ignored how the interaction between an organisation and its natural environment helps explaining the competitive advantages (Hart, 1995). According to this view, and without the willingness to be exhaustive, three key strategic capabilities are at stake: *pollution prevention, product stewardship,* and *sustainable development*, each of them facing different drivers, building upon different resources and engendering heterogeneous competitive advantages (Hart and Dowell, 2011).

[4] All in all, the concept of dynamic capability, originally developed by Teece and Pisano (1994) has been applied to the "environmental" realm. In such a framework developing and adopting environmental strategies has been interpreted as a way itself for the firm of developing dynamic capabilities (Aragon-Correa and Sharma, 2003; Hart and Milstein, 2003).