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Linking emission trading to environmental innovation: Evidence from the Italian manufacturing industry

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ABSTRACT

This paper examines the different forces underlying the adoption of environmental innovations (EI), with a focus on policy related EI. In particular, exploiting the 2006–2008 wave of the Italian Community Innovation Survey (CIS), we investigate whether the first phase of the European Emissions Trading Scheme (EU ETS) exerted some effects on EI in CO_2 abatement and energy efficiency controlling for other variables, grouped as internal/external to the firm, and additional environmental regulation factors. Our empirical analyses show that a few factors emerge as particularly relevant such as relationships with other firms and institutions, sectoral energy expenditure intensity and current and future expected environmental regulation. For the specific role of the EU ETS, we find that, on the one hand ETS sectors are more likely to innovate than non-ETS sectors but on the other hand that sector's specific policy stringency is negatively associated with EI, possibly due to anticipatory behavior from early moving innovative firms and some sector idiosyncratic factors.

1. Introduction

The rapid increase of many environmental problems observed in recent decades calls for innovations that may reduce the environmental impact of economic activity. This is feeding debate on the drivers of environmental innovations (EI). Although there is no standardized definition of EI (cf. Kesidou and Demirel, 2012; Rennings and Rexhauser, 2011; Horbach et al., 2012), the term is used generally to refer to any product, process, organizational, social or institutional innovation that is able to reduce environmental impact and resource use (Kemp, 2010; OECD, 2009; Rennings, 2000; Del Rio Gonzalez, 2009).

Numerous contributions have tried to determine the forces underlying EI. In particular, following the classification proposed by Horbach (2008), Horbach et al. (2013) and De Marchi (2012), it is possible to distinguish drivers of EI that are internal (e.g. training activities) and external (e.g. cooperation with other agents) to the firm. Among external drivers, particular attention has been devoted to environmental regulation. Following the seminal contributions by Porter (1991) and Porter and Van der Linde (1995), many studies have tested whether and to what extent environmental policies might trigger innovation (cf. Costantini and Mazzanti, 2012, and the literature cited therein). Most contributions find that environmental regulation is the major driving force of EI together with technology push, market pull and firm-specific factors (Rennings and Rexhauser, 2011; Horbach et al., 2012). However, other studies do not support this view (Jaffe and Palmer, 1997; Snyder et al., 2003), and the results for the innovation effects of environmental regulation tend to differ according to the level of analysis (Kozluk and Zipperer, 2013), resulting in a lack of consensus on this issue in the literature.

This paper intends to contribute to this literature by focusing on a specific environmental policy – the European Emission Trading Scheme (EU ETS) – that is receiving increased attention from scholars and policy-makers. The EU ETS involves about 11,000 industry firms in 31 countries and is the first transboundary cap-and-trade system and the largest international scheme for trading greenhouse gases (GHG). Although some shortcomings emerged during its implementation (see Section 2.2 below), the EU ETS is currently the most important carbon market and is recognized generally as a suitable prototype for the other ETS that are rapidly spreading worldwide (Ellerman, 2010). The EU ETS can provide a useful experience for new carbon markets, making a thorough analysis of its potential innovation effects particularly important. However, its innovation potential is still debatable; because of its recent origin, quantitative analyses of the EI effects of this policy are scarce in

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part also due to the problems involved in carrying out robust meso and micro level studies of innovative activity in firms.

To fill this gap, we use Italian firm level data from the 5th wave of the Community Innovation Survey (CIS) to examine empirically whether the EU ETS and its 'stringency' are significantly related to EI in the Italian manufacturing industry, taking account of the internal and external factors that might be correlated with EI. Manufacturing is particularly relevant today given the 're-manufacturing target' of the EU, which aims at accomplishing a 20% share of manufacturing industry in EU GDP by 2020 from its current share of 16% (EEA, 2014).

The analysis of Italian manufacturing provides interesting insights for several reasons: (i) Italy is one of the main GHG emitters, ranked 3rd in Europe and 9th among the Annex I countries (UNFCC, 2014), (ii) its industry structure is based mostly on small–medium enterprises (SME) that have been actively involved in innovation in the past although less so in EI (see below), and (iii) it allows comparison with some other European case-studies that have been examined in the literature on this issue (see below).

The paper is structured as follows. Section 2 reviews the literature on the induced innovation effects of environmental regulation, devoting particular attention to the relationship between EI and the EU ETS. Section 3 discusses the rationale behind the construction of policy stringency ETS related indicators. Section 4 presents the econometric analyses of EI using CIS 2006–2008 data. Section 5 offers some concluding remarks on the main results of our analyses.

2. Related literature

2.1. Environmental regulation and induced environmental innovation

Analysis of the forces underlying EI builds on the findings of three main research areas: innovation, management science and environmental economics.[1] According to the traditional innovation literature (cf. Carter and Williams, 1959; Kleinknecht and Verspagen, 1990; Schmookler, 1966; Walsh, 1984), innovation is mainly driven by three factors: (1) advances in science and R&D (supply side or technology-pushed innovations), (2) market conditions (demand-pull innovations) and (3) new public policies (regulation-pushed innovations). The supply side (technology push) factor is particularly important in the initial phase of development of a new product (cf. Rosenberg, 1974; Baumol, 2002), while demand from customers, other firms and exports generally play a relevant role in the diffusion phase (Pavitt, 1984; Rehfeld et al., 2007). As to the public policies, they can affect both the innovation itself and its diffusion, taking several forms such as regulations or financial support to research and enterprises.

The literature on EI is largely based on the explanations underlying general innovation, presenting many similarities but also a few important differences with respect to the standard innovation literature (Horbach, 2008). Like the studies on traditional innovation, the literature on EI examines the role of both demand-side and supply-side drivers of EI. Among the latter, particular attention has been devoted to the firms' technological capabilities (Horbach, 2008). Since technological and organizational innovations are likely to develop along complementary lines (Antonioli et al., 2013), the role of environment-related organizational innovations, such as Environmental Management Systems (EMS) and auditing schemes, has also received strong attention among the supply-side drivers of EI (Arimura et al., 2008; Frondel et al., 2004; Wagner, 2007, 2008; Johnstone and Labonne, 2009). Among the demand-side factors, a crucial role is played by public opinion pressure and current and expected customer demand of environment-friendly products.[2] In particular, empirical studies on German manufacturing firms underline the importance of collaboration with stakeholders in inducing EI (Wagner, 2007).

Despite the importance of demand- and supply-side factors, however, market pull and technology push effects alone are insufficient to foster EI which "in contrast to such technologies as microelectronics and telecommunications, [are] normally not self-enforcing" (Rennings, 1998, p. 11). In fact, although EI have the same general drivers as standard innovations, they also have specific features which make them depart from non-environmental innovations and enhance the importance of the role played by the regulation factor for EI (Horbach, 2008; Villiger et al., 2000). In particular, the environmental nature of EI implies a double externality, both in terms of knowledge spillovers (as any other innovation) and in terms of (environmental) public goods (Rennings, 1998, 2000). On the one hand, technological spillovers prevent (eco) innovators from the full appropriation of the value of the innovation; on the other hand, EI tend to benefit the general public by improving environmental quality. While the first externality is common to any other technological innovation, the second is specific to EI. It follows that firms generally have little/no incentive to perform EI unless they are induced (or forced) to do so by a proper environmental regulation. This seems to be confirmed by the empirical literature on this issue, which finds that returns of investing in EI are extremely uncertain. From a meta-analysis of the numerous contributions on this issue (Horváthová, 2010), it turns out that about half of the studies find that the economic returns of "going green" are positive, while the other half conclude that such returns are absent or even negative.[3] Public regulation, therefore, plays a particularly important role as compared to private incentives in the environmental context, which makes EI more regulation-driven than standard innovations. In other words, as argued by Rennings (1998, p. 11) the double externality feature characterizing EI implies a second specialty of EI with respect to traditional innovations, that is, "the importance of the regulatory framework as a key determinant of eco-innovative behavior", (what he defines "regulatory push/pull").

A second research area that investigated the drivers of EI is the management science literature on Corporate Social Responsibility (CSR). The studies in this field generally stress the role of demand drivers, underlining that they tend to affect firms' decisions to undertake EI rather than the level of investment (Kesidou and Demirel, 2012). Several studies point out that many firms make minimum investment in EI and adopt CSR policies mainly to improve their "green" image (e.g. Suchman, 1995; Bansal and Hunter, 2003).

As to the environmental economics literature, since the early 1990s there has been heated debate over the economic effects of

[1] The classification proposed here is obviously an oversimplification of the existing literature. Much of the work referred to in this section, lie at intersection among the three literature strands identified above. In what follows we group contributions according to the field to which they seem more closely allied.

[2] Although expectations on demand can play a relevant role for EI, this is not peculiar to such innovations. As a matter of fact, favorable demand conditions have a positive effect on EI (cf. Rehfeld et al., 2007; Horbach, 2008; Horbach et al., 2012) as well as on standard innovations (Schmookler, 1966). Moreover, when comparing the drivers of EI with those of other innovations, Horbach (2008) finds that demand expectations are more relevant for the latter.

[3] Results largely depend on the kind of EI taken into account. For instance, Ghisetti and Rennings (2014) find that EI that aim at reducing energy and material use are positively and significantly related to firms' profitability, while the opposite occurs for EI aiming at reducing waste and pollutants, which will not therefore be pursued in the absence of environmental regulation.