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SUSTAINABILITY TRANSITIONS AND FINANCIAL CONSTRAINTS: THE CASE OF THE ITALIAN ECO-INNOVATING COMPANIES

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Abstract:
Following a multi-level perspective, a sustainability transition occurs only when destabilization pressures from the landscape level are exerted towards the current (unsustainable) regime, creating thus windows of opportunity for radical eco-innovations at niche level to emerge. However, the existence of financial constraints to eco-innovating companies can seriously hinder the possibility for a sustainability transition to occur by impeding the development and adoption of eco-innovations at regime level which create the favourable conditions for niche-eco-innovations to succeed. In this framework, the present paper explores the impact that financial constraints exert in the process of environmental sustainability by analysing the case of the Italian eco-innovating manufacturing companies. In particular, it employs an *ad hoc* designed survey to investigate to what extent financial constraints are creating a barrier to the alignment process between sociotechnical regime and niche-eco-innovations. Results seem to suggest the existence of a hierarchy of finance which could be delaying the alignment process between sociotechnical regime and niche-EIs required for the transition towards a more sustainable regime.

Keywords: sustainability, eco-innovations, socio-technical transitions, financial constraints

1. INTRODUCTION

In the last 50 years the need to meet the increasing demand for energy, food, and water has produced a rapid and extensive alteration of ecosystems, soil degradation, loss of biodiversity, and deforestation. At the same time, the growing process of industrialisation across the world has contributed to rising greenhouse gas emissions, air and water pollution, expanding waste volumes, desertification, and chemical pollution. Given these premises, the key challenge for the next years seems to be reducing the environmental footprint of production and consumption patterns by promoting the transition towards a more resource efficient economy (LIFE, 2009). To make this happen, a deep change in the way goods are produced and used is needed, along with a shift in the existing socio-technical structures. Although such a change is typically associated with higher economic costs, it hides a large economic potential along with numerous opportunities for companies to engage in innovations which contribute to improve environmental quality. This kind of innovations - generally labelled as 'eco-innovations' (or, alternatively, as 'environmental-innovations', 'green-innovations', or 'sustainable-innovations') play a crucial role in the transition process towards a green economy, by contributing to manage successfully the environment.

Eco-Innovations (henceforth 'EIs') include all types of innovations which avoid or reduce environmental damages, contributing thus to an improved quality of the environment (Huber, 2005; 2004). They are potentially developed in any economic sector and not exclusively in eco-industries which specifically produce goods and services to prevent or limit environmental burdens. EIs involve technological innovations (i.e. product and process innovations) as well as non-technological innovations (i.e. organizational changes in the management of firms, along with changes at social and political level) (Kemp et al., 2001). Moreover, according to the intensity of innovation, EIs can also be classified as 'incremental' or 'radical'. Incremental EIs take place more or less continuously in companies, although at dissimilar rate in different industries and over time periods (Freeman et al., 1982). By contrast, radical EIs are discontinuous events which are unevenly distributed over sectors and time and are the result of a deliberate research and development process in companies (Freeman et al., 1982).

Following the Multi-Level Perspective (MLP) approach initially introduced by Rip and Kemp (1998) and then refined by Geels (2002), a transition towards more sustainable regimes can occur only when radical technological EIs can enter the current (unsustainable) regime. However, since the existing systems are 'locked in' on many dimensions (e.g. economic, social, cultural, infrastructural, regulatory, etc.) (Elzen et al., 2004), the possibility for radical technological EIs to succeed depends upon the contribution of incremental technological EIs and organizational EIs in creating windows of opportunities at regime level for radical technological EIs to emerge. On this ground, the process of sustainability transition can be seriously hindered by the existence of companies' financial constraints which can hinder the development and the adoption of EIs, preventing thus the creation of favourable conditions at regime level for a systemic change.

In this framework, the present study aims to increase knowledge about sustainability transitions by investigating the extent to which financial constraints hinder the eco-innovative decisions of companies. The paper is organised as follows. Section 2 illustrates the background model. Section 3 explains the role of financial constraints within the MLP approach. Section 4 describes the methodology adopted. Section 5 depicts the empirical results achieved. Finally section 6 ends with some concluding remarks.

2. THE BACKGROUND MODEL

In the frame of evolutionary theories of innovations, the MLP allows capturing the complexity of interlinked relationships as well as the underlying driving forces that can affect sociotechnical transitions towards more sustainable regimes. The MLP describes socio-technical transitions in terms of three linked levels: socio-technical regime, socio-technical landscape, and niche-innovations. The *socio-technical regime* represents the meso-level unit of analysis and can be defined as a relatively stable configuration of institutions, techniques and artefacts, as well as rules, practices and networks that determine the 'normal' development and use of technologies (Berkhout et al., 2004; Rip and Kemp, 1998). The *niche-innovations* level represents the micro-level and consists of protected spaces or 'incubator rooms' (niches) where actors develop and test promising technologies that deviate from existing regimes. Niches aim at enhancing the further development and the rate of application of new

technologies and learning about their desirability (Geels and Schot, 2007; Kemp et al, 1998). Despite niche-innovations may perform poorly in more conventional terms (e.g. in terms of price) they are given the opportunity to be evaluated and matured through gradual experimentation and learning by niche actors (producers, users, researchers, etc.). Finally, the *socio-technical landscape* represents the macro-level and is an external structure or context for interactions of actors where a number of different forces act, exerting pressure upon the meso-level and the micro-level (i.e. the regime and the niche) through social, political and economic channels (Geels, 2002).

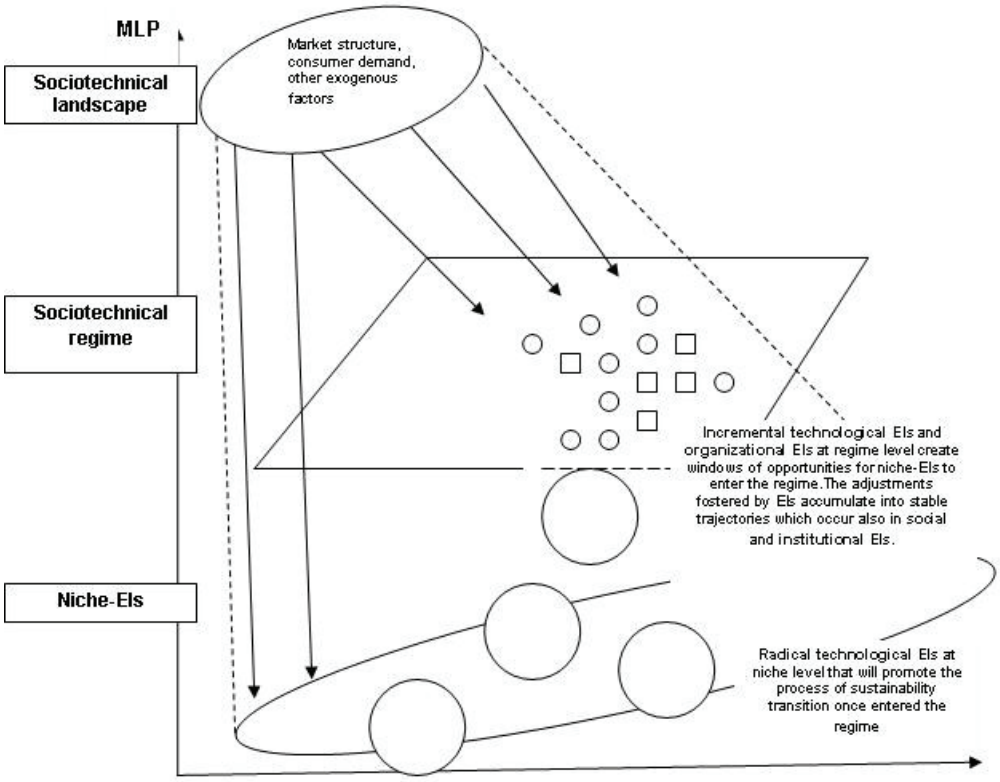
A socio-technical transition is the consequence of the co-evolutionary dynamics of the three above-mentioned levels. In particular, it occurs when pressures from the landscape level couple with sufficiently developed niches. Niche-innovations struggle against the existing regime and therefore require changes in the socio-technical regime (e.g. in consumer practices, public policies, etc.) in order to sufficiently propagate. When the sociotechnical landscape exerts a destabilization pressure on the existing regime (and eventually on the niche), niche-innovations have the opportunity of emerging and competing with the existing regime, going thus into the mainstream markets. Therefore, the ultimate success of a socio-technical transition crucially depends on the following interactions:

a. Changes in the socio-technical regime which create windows of opportunity for niche-innovations.
b. Sufficiently developed niches where radical innovations have been previously tested
c. External-to-the-niche conditions that develop at landscape level and exert destabilization pressures on the regime and, eventually, on the niche.

The above conditions do not cause or drive unidirectionally the others but they link up with, and reinforce, one with each other following a process of 'circular causality' (Geels, 2011).

In the specific case of *sustainability* transitions (i.e. sociotechnical transitions towards more sustainable regimes), the mix of technological, organizational, social, and institutional EIs plays a central role for achieving sustainability (Figure 1)

Figure 1: EIs and sustainability transitions



Source: own elaboration

At regime level *incremental technological EIs* and *organizational EIs* (respectively little circles and squares in Figure 1) importantly contribute to creating adjustments in the sociotechnical regime that

pave the way for the emergence of windows of opportunities to niche-EIs to enter the regime. Incremental technological EIs are mainly (although not exclusively) curative technologies which repair environmental damages after they have occurred and/or additive technologies which are employed to remove contaminants after they have produced but before they are disposed of. Organizational EIs are the incorporation of environmental perspectives and environmental-respectful awareness into companies' strategies and practices and are generally complementary to the adoption of technological EIs at company level. The adjustments fostered by EIs at regime level accumulate into stable trajectories which occur not only in technological ad organizational aspects, but also in social and institutional trajectories that are coordinated by different sub-regimes that interpenetrate and co-evolve with the technological one (Geels, 2011). Social and institutional dimensions can be defined in terms of social and institutional EIs. More specifically, social EIs are changes in lifestyle and consumer behaviour because of an increased awareness about the environmental concerns. Institutional EIs are the creation of new regimes of environmental governance in terms of local network agencies, international environmental organizations, etc. Both of them play a significant role in promoting the process of sustainability transition. Institutional EIs create the basic conditions to manage successfully the transition process by avoiding the risk that radical technological EIs face a mis-match with existing institutions (Freeman and Perez, 1988). Social EIs raise the management awareness of the need to integrate environmental consideration in product development.

At niche level, radical technological EIs (big circles in Figure 1) have the possibility of being experimented, providing thus the seeds for a systemic sustainable change. When the destabilization pressures create windows of opportunities to niche-EIs at regime level, radical technological EIs can enter the regime. However, this can happen only if niches are sufficiently developed in terms of (i) expectations of actors about the future development of the niche, (ii) learning process on various dimensions, such as infrastructure requirements, organisational issues, symbolic meanings, etc., (iii) number of links among actors which characterise the social network architecture of the niche (Geels, 2011; Schot and Geels, 2008).

At landscape level, a number of external-to-the-niche conditions can exert a destabilization pressure towards a sustainability transition, by driving the development and adoption of EIs at regime and niche level. Such conditions are represented mainly by market structure, consumer demand, and exogenous shocks (e.g. an economic crisis) which can create favourable conditions for a paradigmatic shift towards new green patterns of consumption and production (Geels, 2013).

3. MLP AND FINANCIAL CONSTRAINTS

Companies may recur to internal and/or external funds to finance EIs. In general terms, the problem of how to finance an investment project (i.e. whether to recur to internal or external financing and, in the latter case, whether to recur to debts or equity) represents a crucial decision for companies (Santarelli, 1995). At regards, companies seem to exhibit a strict ordering or 'hierarchy of finance' by using internal financing first, then debt, and only when such option is exhausted, turning to equity (Myers, 1984). However, the existence of asymmetric information between companies and perspective investors determines the imperfect substitutability between internal and external financing and the consequent risk for eco-innovating companies to be financially constrained in case of internal funds shortage (Marabel Romo, 2014; Canepa and Stoneman, 2003; Hall, 2002).

In the MLP perspective, the existence of financial constraints can affect the possibility for sustainability transitions to occur by preventing niche-EIs to enter the current regime and succeed. This can happen by means of the joint action at two levels:

a. At niche-level, since financial constraints may hinder the development of radical technological EIs which can promote the transition
b. At regime level, since financial constraints may prevent the development and adoption of incremental technological EIs and organizational EIs, hindering *de facto* the creation of favourable conditions (windows of opportunity) for niche-EIs to emerge.

The inability of eco-innovating companies to fund their desired investment projects creates therefore a barrier to the alignment process between sociotechnical regime and niche-EIs which is necessary for a sustainability transition to take place. In other words, when pressures at landscape level push companies at regime and niche levels to eco-innovate, the existence of financial constraints may limit the degree of eco-innovativeness, delaying thus the possibility for a systemic change to occur. Many

promising radical EIs at niche level are not developed, and the same applies to many possible incremental technological EIs and organizational EIs at regime levels which are not developed and adopted. In this framework, a possible way to reduce the problem of financial constraints by lightening information asymmetries towards perspective investors stems from the environmental reputation of eco-innovating companies. Environmental reputation can be considered as a signal sent from companies to lenders to indicate their lower perceived compliance costs and liabilities (Lee and Hutchison, 2005). Within the above model, environmental reputation makes thus a breach within financial constraints, helping on the one hand, niche-level EIs to enter the current regime, and, on the other, regime-level EIs to create the favourable conditions (windows of opportunities) for fostering the sustainability transition.

4. METHODOLOGY

The present study analyses specifically the impact of companies' financial constraints at regime level. In other words, it investigates to what extent financial constraints jeopardise the possibility for sustainability transitions to occur by hampering the development and adoption of incremental technological EIs and organizational EIs. The study employs a novel approach for recognising eco-innovative enterprises, by using an *ad hoc* designed questionnaire to collect information on the 'who' and 'how' of EIs. In other words, the questionnaire seeks to identify which enterprises from the sample eco-innovated ('who') and what they did in making an EI ('how') before proceeding with some more specific questions about companies' eco-innovative profile (Arundel et al., 1998). The distinctive characteristic of this approach is that companies surveyed are not pre-supplied with a definition of EI, but, instead are asked to offer their own definition of what an EI is. Allowing respondents to provide their own opinion on what EIs are helps to understand their viewpoint on the 'who' eco-innovates and avoids forcing them to adopt a definition which they may not understand or agree with, creating thus a sense of coercion that might alienate them. Furthermore, the questionnaire asks companies to list the most significant EIs which characterise the sector where they operate along with the EIs that they have introduced, collecting thus the 'how' companies eco-innovated. This approach allows thus to collect the viewpoint of companies on what EIs are, which is not be achievable in any other way. Moreover, since EIs can be potentially developed in any productive sector, this approach can be used in any industry allowing thus to identify also eco-innovating companies that do not operate in the traditional greentech sectors.

The questionnaire was administrated to a sample of 400 Italian manufacturing companies, drawn from the AIDA (Analisi Informatizzata Delle Aziende) database provided by the Bureau Van Dijk. The sample was selected using a stratified random sampling strategy to avoid that some companies of the population were less likely to be included in the sample than others. After grouping companies into distinct, independent (not overlapping) strata, a random sample from any stratum was chosen in proportion to each stratum size (Oslo Manual, 2005: 117-134). Strata taken into account were :

a. Sectors, by considering all manufacturing industries according to the NACE rev.2 codes classification (from 10 to 33)
b. Company size, by taking into account large and SMEs according to the European Commission Recommendation 2003/361/EC (i.e. SMEs are companies which employ fewer than 250 workers)
c. Geographical area, by dividing Italy into three macro-regions according to their level of per capita GDP (North, Centre, and South).

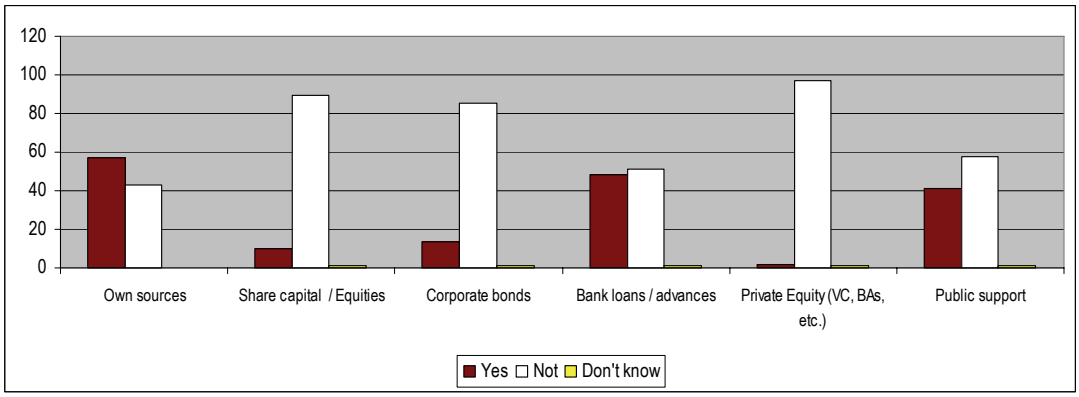
Questionnaires were admistrated by means of the CATI (Computer Assisted Telephone Interviewing) and CAWI (Computer Assisted Web Interviewing) techniques. More specifically, companies were firstly contacted telephonically with the aim to inform them about the research purposes and to identify the most suitable person in charge within the enterprise to answer the questionnaire (e.g. director, strategic planning manager, etc.). According to the respondents' needs, the questionnaire was then administered by telephone (reading the questions from the computer screen and typing the respondent's answers directly into the computer) or, alternatively, by email (sending the web-link to the questionnaire to the respondent's email address).

5. RESULTS ACHIEVED

The percentage of companies surveyed that declared to be eco-innovative was 44.0 per cent of total (absolute percentage) and 72.7 per cent of the innovative firms (relative percentage).

Figure 2 reports the sources of finance for the Italian eco-innovative firms surveyed. EIs were financed mainly by own sources (56.9 per cent of companies), followed by bank loans/advances (48.0 per cent), and public support (41.2 per cent). It is worth noting the low recourse of companies surveyed to corporate bonds (13.7 per cent), share capital/equities (9.8 per cent), and private equity (2.0 per cent). This result can be explained in the light of the specific aspects of the Italian productive system which is typically characterised by a huge presence of SMEs and micro firms that employ large amounts of internal sources to finance their innovative projects.

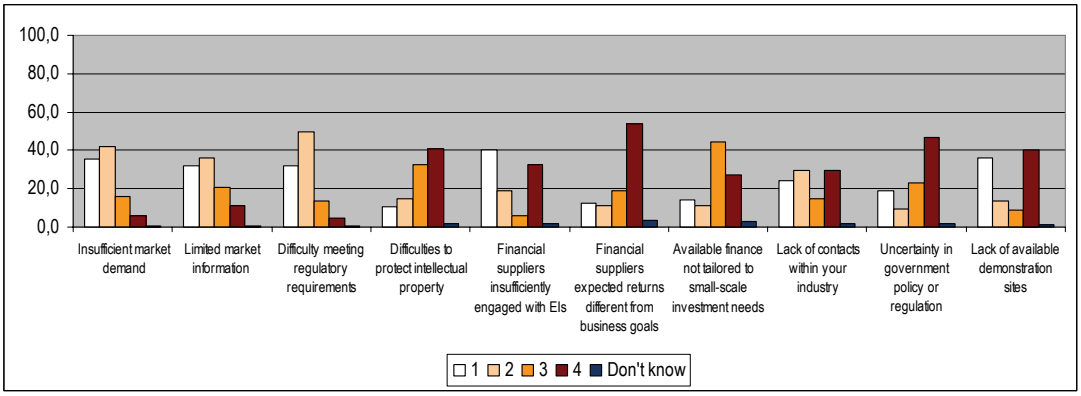
Figure 2: Sources of finance for the Italian eco-innovative firms surveyed (percentage values)



Source: Own elaboration

Figure 3 reports the external barriers encountered by Italian eco-innovative companies when seeking to eco-innovate. Results seem to suggest a large impact of financial barriers on the eco-innovative behaviour of firms, in particular in terms of financial suppliers' expected results different from business goals as well as in terms of available finance not tailored to small-scale investment needs.

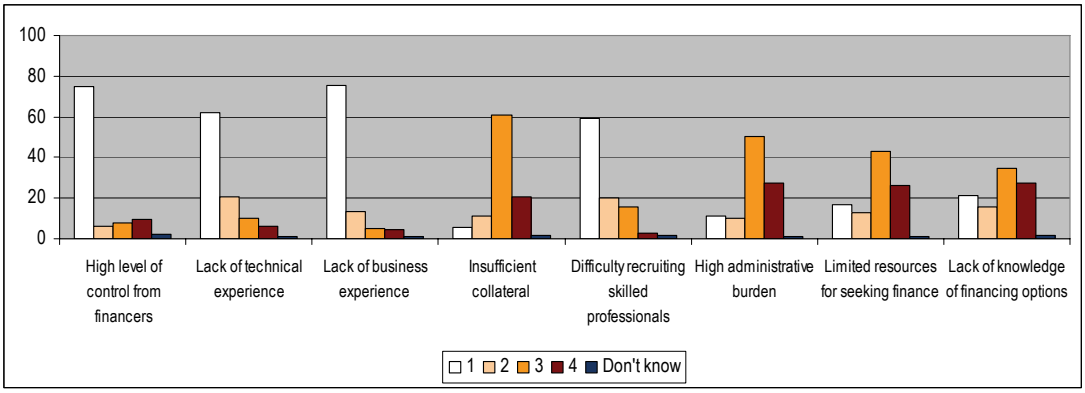
Figure 3: External barriers faced by the eco-innovative Italian companies surveyed (percentage values)



Notes: (i) 1 = not important ..... 4 = very important
Source: Own elaboration

Figure 4 reports results achieved about the internal barriers encountered by Italian eco-innovative companies when seeking to eco-innovate. In general, financial aspects seem to matter significantly for their eco-innovative behaviour. Firstly, the lack of collateral represents a ‘quite important’ barrier to eco-innovative efforts. This results should be analysed in the light of the characteristics of the Italian financial system where the patterns of industrial finance is bank-centred and consequently the relationship between banks and companies is a crucial element for firms to get financed. Secondly, eco-innovative companies asserted to have limited internal resources for seeking finance as well as a general lack of knowledge of financing option.

Figure 4 Internal barriers faced by the not eco-innovative Italian companies surveyed (percentage values)



Notes: (i) 1 = not important ..... 4 = very important
Source: Own elaboration

Finally, 60.53 per cent of eco-innovative companies surveyed declared environmental reputation facilitate the possibility to get financed and approximately 70 per cent asserted that financing EIs is easier than for other types of innovations.

6. CONCLUSIONS

The present study has investigated the impact that financial constraints can exert upon the possibility for a sustainability transition to occur. In particular, in the frame of the MLP approach, the study has focused upon the regime level, by investigating to what extent financial constraints hinder the development and adoption of incremental technological EIs and organizational EIs in the Italian manufacturing sector. Results achieved seem to suggest the existence of a hierarchy of finance for eco-innovative investments. A large percentage of companies surveyed has faced 'very important' external and internal barriers when seeking for external private funds, in terms of financial suppliers insufficiently engaged with EIs, finance not tailored to small-scale investments, insufficient collateral, high administrative burdens, limited resources for seeking finance, lack of knowledge of financing options, etc. Consequently, firms have made a massive recourse to own (internal) sources to finance their EIs. On the other hand, environmental reputation seems to positively contribute to reducing asymmetric information in eco-innovative investments, probably because of the lower perceived compliance costs and liabilities of eco-innovating companies. Overall, the existence of a hierarchy of finance could be delaying the alignment process between sociotechnical regime and niche-EIs required for the transition towards a more sustainable regime, by hindering the development and adoption of incremental technological EIs and organizational EIs. However, environmental reputation seems to be making a breach within financial constraints, contributing thus to create the favourable conditions at regime level for fostering the sustainability transitions.

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