Industry relative advantage across the value chain and the diffusion of quality certificates

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Abstract

The study explores whether and how cross-country and cross-industry differences in the diffusion of innovations are affected by the relative advantage of national industries across the value chain. We use diffusion literature to develop an analytical framework of how industries with diverse comparative advantage across the value chain may observe different rates of management innovation adoption. Empirically, it focuses on the diffusion of ISO9000 certificates, between 2001 and 2004, across manufacturing industries, in seven OECD countries. Taking into consideration the international trade relationships as well as industry, country, and time fixed effects, regression results suggest that the differences in industry comparative advantage in the knowledge, conversion and product markets, generates differences in the levels of innovation adoption. These effects are not homogeneous across low-tech and high-tech industries or across countries occupying diverse positions on the global trade networks.

Keywords: innovation diffusion, value-chain, cross-country analysis

JEL codes: O33, L60

1. Introduction

The pattern and speed of innovations are quite heterogeneous throughout the world. Independently of the technological and managerial merits of the innovation and of the institutional factors in supporting innovation diffusion, adoption depends on the adopters' expectations on the net benefit from using the innovation (Griliches, 1975; Nelson and Winter, 1975; Geroski, 2000). These expectations are formed within the specific underlying existing capabilities, competitive challenges and business models of potential adopters. In other words, the expected benefits from innovation adoption may depend on the competitive advantage of adopters in undertaking different activities across the value-chain, i.e. from product design to the final customer (Porter, 1985; Kaplinsky, 2000; Amit and Zott, 2002; Chesbrough and Rosenbloom, 2002). Conceptualizing industry differences in comparative advantage across the value chain permits to examine the dynamics of rents, labor division and governance in international trade, overcoming the problems of earlier industry analysis of international trade in accessing and interpreting data on output, sales, and costs (Hergert and Morris, 1989; Kaplinsky, 2000). However, how the comparative advantage of national industries across the value chain results in cross-industry and cross-country differences in the level of innovation adoption have not been conceptually and empirically examined.

Within a country, industrial characteristics - such as market concentration and competition, appropriation conditions, or the knowledge and technology bases- were shown to influence firms' innovative behavior, performance and level of innovation adoption (Romeo, 1975; Datta and Rajagopalan, 1998; Greenan, 2003; Datta et al., 2005; Aghion et al., 2005; Fixson and Park, 2008; Bodas Freitas, 2011). Qualitative comparative studies show that cross-country differences in industrial performance reflect differences in the structure and organization of national industries (Lester and McCabe, 1993; Nelson, 1993; Chesbrough, 1999; Gittelman, 2006). National industries vary in the technological capability to design competitive products, to identify most appropriate producing technologies, to source and combine internal and external knowledge, activities, and components, and to differentiate products in the final markets (Nelson, 1993; Teece, 1996; Whitley, 2000; Owen-Smith et al., 2002). Therefore, the analysis of cross-country differences in the levels of innovation diffusion may need to take into consideration the fact that national industries have different relative advantage across the value-chain business activities. Previous studies focusing on international diffusion analysis neglected the structure and the relative advantage of national industries across the value chain (for example Zhu et al., 2006). Taking into consideration the relative advantage of industries across the value chain seems particularly important issue when innovation adoption provides a quality market sign that firms can use to increase their market power (Stiglitz, 2002; Spencer, 2002); therefore it forms the motivation of our study.

From the 1980s, in a context in which globalization of production and markets and more demanding customer bases were gaining relevance, voluntary process standards and certification schemes became important signs allowing entry in international markets (Larsen and Häversjö, 2001; Terlaak, 2001). ISO9000, the quality management system standard, became the most widespread and popular standard of International Standard Organization (ISO) ever (ISO, 2001, 2005, 2010). Indeed, since the late 1990s, as certification became a market sign of quality management that facilitated access to international markets, the number of ISO9000 certificates keeps growing significantly worldwide (Withers and Ebrahimpour, 2000; Nelson et al., 2004; Terlaak and King, 2006). Not even the lack of consensual performance information on the impact of the certification on firms' slowed down its diffusion in the 2000s (Nelson et al., 2004; ISO, 2010). Nevertheless, industry and national differences exist in the level of adoption and motivations for certification (Pan, 2003; Corbett et al., 2004; ISO, 2005, 2007, 2010); and some firms decided not to renew their certification (Wiele, 2006). Previous research has however not provided evidence on whether and how the relative advantage of national industries across the value chain can explain differences in the level of adoption of ISO9000. Understanding how differences in the operational advantage of national industries influence adoption of certification of quality management systems will permit to provide insights for managers on whether investment in certification is worthwhile, as well as for policy-makers that are concerned with the lack of national capabilities to compete in international markets.

In our study, we examine empirically the effect of relative advantage of national industries across the value chain on the differentiated level of ISO9000 certificates, from 2001 to 2004; in 15 manufacturing industries, in seven varied OECD countries. Taking into consideration the international trade relationships, as well as time, industry and country fixed effects, our evidence suggests that the diverse industry relative advantage in design, production and marketing activities, and consequently in the knowledge, conversion and product markets, explains the cross-industry and cross-country differences in the level of ISO9000 certificates. Moreover, our results suggest that these effects are not homogeneous across low-tech and high-tech industries or across countries occupying diverse positions on the trade networks.

The paper is organized as follow. Section 2 reviews the existing diffusion literature focusing on the identified factors for cross-industry and cross-country differences in the level of innovation adoption, and on how differences in the comparative advantage of industries across the value chain compete to explain these differences. Section 3 addresses the characteristics of the ISO9000 standard and of its certification, and derives expectations of how ISO9000 diffusion may have been influenced by the industry comparative advantage across the value chain. Section 4 presents the data and methodology used in this study. Section 5 presents and discusses the results of the regression analyses, and Section 6 concludes the paper.

2. Innovation diffusion and cross-country and cross-industries differences

Innovation diffusion reflects the economic cost-benefit analysis of adoption, and consequently both the activity and rationale of different actors involved in the demand and supply of innovation, as well as of the isomorphism behaviour of adopters (Griliches, 1975; Rogers, 1995; Geroski, 2000). The innovation diffusion literature is however characterized by a cleavage in the hypotheses and methodologies used to examine the innovation diffusion process. One approach focuses on epidemic hypotheses related to the institutional, communication and economic process of information dissemination and of institutionalization of the innovation in specific contexts (DiMaggio and Powell, 1983; Guller et al., 2002). A second approach focuses on the technological and managerial characteristics of the innovation and emphasises on hypotheses related to the factors and conditions that leverage the expected profitability from adoption (Geroski, 2000; Keller, 2001).

Innovations differ in terms of nature and content; and consequently in the benefits that they can generate to their adopters. Industries differ in terms of capacity of value appropriation, degree of market competition, regulatory environment, demand, knowledge bases that support technical advances in products and processes, direction of the technical change, as well as the nature and effects of institutional mechanisms legitimizing decisions and technologies (Nelson and Winter, 1975; Gold, 1981; Teece, 1996; Malerba and Orsenigo, 1997). Hence, not only diverse types of technological and managerial innovations may provide asymmetric benefits to different processes and relationships within an industry or to different industrial activities (Gold, 1981; Rogers, 1995), but also innovation adoption in different industrial contexts may depend on distinct factors (Helpman and Trajtenberg, 1996; Comin and Hoijn, 2006). Therefore, technology diffusion and economic growth in a country seems to depend on the sequence of innovation adoption across industries (Helpman and Trajtenberg, 1996).

Additionally, industries are heterogeneous across countries (Nelson, 1993; Chesbrough, 1999; Gittelman, 2006). Examining the rationale for differences in the national capacity of learning and performing of the nuclear plant operation or of biotechnology in the US and France, Lester and McCabe (1993) and Gittelman (2006) stress the influence of the organizational and technological structure of the industry, and its relative advantage in different markets. In different countries, industries develop specific capacity for product design, focus on specific product mix, create particular opportunities for technical advances, rely on production technologies, and equipment with different characteristics and modernity, develop specific organizational forms to combine knowledge, inputs and activities; and benefits from different degrees of market power (Gold, 1981; Nelson, 1993; Chatman and Jehn, 1994; Owen-Smith et al., 2002). In other words, national industries develop business models that focus in achieving different competitive assets in different activities across the value-chain, establish specific learning processes, and consequently benefit from diverse relative advantage across different markets (Porter, 1985; Malerba, 1992; Kaplinsky, 2000). Therefore, national industries may develop specific methods of forming expectations, as well as particular criteria for evaluating innovation adoption (Gold, 1981; Silverberg et al., 1988; Malerba, 1992; Lester and McCabe, 1993; Malerba and Orsenigo, 1997; Gittelman, 2006).

As different stages of value chain provide firms and industries with different opportunities to create rents and achieve market power (Kaplinsky, 2000; Stiglitz, 2002), and benefits from innovation adoption depend on capabilities that already exist in undertaking differences business activities (Rogers, 1995; Geroski, 2000), benefits from innovation adoption may depend on the relative advantage of industries across the value chain (Porter, 1985; Kaplinsky, 2000; Giuliani et al, 2005). Despite the net value of adoption depends on the factors underlying competitive challenges and business models of potential adopters (Griliches, 1975; Nelson and Winter, 1975; Geroski, 2000), innovation adoption is rarely associated with the contingencies of the comparative advantage of adopters in the different activities and markets. Moreover, the relative advantage of national industries across different business activities from product design to the final customer (i.e. across the value-chain) influences their performance in the international markets (Porter, 1985; Kaplinsky, 2000). Hence, a cross-country diffusion analysis may need to take into consideration the fact that national industries have different relative advantage across the value-chain.

The comparative advantage across the different activities of the value chain requires the participation in several different markets (Kaplinsky, 2000). The relative advantage of national industries in the design activities depends on their technological and absorptive capacity, i.e. on their relative knowledge-intensity, and consequently on their advantage in the knowledge markets. The relative advantage of national industries in manufacturing activities depends on the labour productivity that they achieve through their production function, and consequently on their advantage on the conversion market. The relative advantage in marketing activities depends on their capacity to differentiate products in the market, and consequently it reflects their advantage in the product market.

Under imperfect information and competition, quality is difficult to detect and reputations are slowly updated, and productivity gaps per se do not guarantee competitive advantage in international markets (Stiglitz, 2002; Spencer, 2002). In this context obtaining the quality signal becomes a form to avoid penalization in the market and being allowed to enter rather than to effectively increase and certify quality (Stiglitz, 2002; Nelson et al., 2004). Therefore, the objective of this study is to examine how the relative advantage of national industries across the value chain explains cross-country and cross-industry differences in the level of adoption of an innovation that provides a market sign.

3. Relative advantage across the value-chain activities and the diffusion of quality management certification

This section reviews the origins and the characteristics of the ISO quality management standard, ISO9000, and derives expectations about how the industry relative advantage across the different phases of the value chain might influence its diffusion.

3.1. ISO9000, the quality management standard

Given the increasing importance of quality management systems and the co-existence of multiple national and private standards, in 1979, the International Standard Organization (ISO) created the Technical Committee 176 to harmonize the increasing international activity in quality management and quality assurance standards. Departing from the British Standards (BS5750)[1] and the NATO quality procedures, this committee developed an international quality assurance standard. In 1987, ISO9000 was published to replace the national (and private) quality standards that had been used until then by large private and public buyers. By harmonizing quality terms, systems, and standards, the ISO9000:1987 standard was expected to facilitate global trade by ensuring a customer that an order was to be produced and delivered following explicit and agreed specifications. ISO9000 was updated in 1994 and in 2000. From 1994, the standard previews third-party certification of the conform implementation by firms. With the publication of ISO9000:2000, the combined certification with other standards, in particular with ISO14001 became facilitated, and their fit to service sectors was improved.

ISO9000 is a process management standard rather than product standard, which means that instead of focusing on the characteristics of the product, it emphasizes on the processes of developing, producing, and marketing the core technology of a firm (Tassey, 1996). It consists of guidelines to adopt better production management processes as well as to improve them continuously. The adopting firm needs to build up its quality management system, to formulate their policy, objectives and practices following those guidelines (Bénézech et al.,

[1] The British standard BS5750 was published in 1979, and widely promoted from 1981 in the UK and abroad, among British suppliers and affiliated companies (NAO, 1990).

2001). ISO9000 is based on the assumption that firms better control the quality of their products if they have those processes written down; consequently firms need to document their processes to develop their quality manual (Withers and Ebrahimpour, 1997; Bénézech et al., 2001). The effectiveness of the quality system and the concordance between what is written in the firm's quality manual and the actual behaviour is checked by internal and external audits. The certificate is obtained at the end of an external audit, if the certification body determines that the organisational processes in the firm conform to the standard and to the written quality manual. From the adoption decision to certification, it takes about two years, in which the firm needs to review the design and production methods, as well as develop, document and implement control management systems that respects the general standard guidelines. Certificates are awarded for a period of three years, after which an audit is done and the certificates are either extended or withdrawn (Bénézech et al., 2001; Benner and Tushman, 2002; Guller et al., 2002). Hence, ISO9000 certification assures that the firm implemented and is complying with a written set of rules to control product quality rather than a specific quality of the finished product, or the development of a customer-based or a Total Quality Management culture (Bénézech et al., 2001; Larsen and Häversjö, 2001; Prajogo and Saohal, 2003). Thus, ISO9000 is often understood as a market sign for quality management (Withers and Ebrahimpour, 1997; Nelson et al., 2004).

National and industrial differences exist in the number of ISO9000 certificates, and to a lesser extent in motivations for certification (and renewal) (Pan, 2003; Corbett et al., 2004; ISO, 2005, 2007, 2010; Wiele, 2006). Moreover, the ranking of countries with highest number of certificates has not been static (ISO 2001, 2004, 2007). Graph 1 represents the total number of valid ISO9000 certificates, in 2001 and 2005, among a sample of countries with the highest levels of certification as well as the countries used for our regression analysis in section 5.

[Insert Graph 1 about here]

Until 2001, the UK was the country with the highest number of ISO9000 certificates. France, instead, lagged behind in third place behind the UK and US until 1994, and fifth from 1997 to 1999 following the US, Germany and Italy. In December 2001, the UK is followed immediately by China, followed by Italy, Germany, and the US. Following the publication of ISO9000:2000, there was a shift in the ranking of countries concerning the total number of ISO9000 certificates. In December 2005, China and Italy were the leaders in the number of ISO 9001:2000 certificates, followed by Japan, Spain, UK, US and then Germany.

Concerning the industrial (manufacturing and services) distribution of ISO9000certificates, in

2005, the ten largest adopting industries are construction, basic and fabricated metals, electrical and optical equipment, machinery, wholesales, business services, rubber and plastic, foods and beverage, chemicals and transport, storage and communication. These industries have been the largest adopters of certification since the late 1990s (ISO, 2001, 2005). Laggards are water, gas supply, publishing, shipbuilding, aerospace, wood products, publishing and nuclear fuels.

During the 1990s, ISO9000 diffused widely worldwide surrounded by controversy and criticism. Given the cost of certification and the fact that ISO9000 became increasingly important for coordinating global production systems and accessing international markets (Withers and Ebrahimpour, 2000; Nelson et al., 2004), the diffusion of ISO9000 may be affected by the relative advantage of national industries across the different phases of the value chain.

3.2. Industry relative advantage across the value chain and ISO9000 diffusion

The value chain is a descriptive construct that describes the full range of activities, which are required to bring a product from conception/design through intermediate processes (including production) to final users (Porter, 1985; Kaplinsky, 2000; Giuliani et al, 2005). This construct permits to examine the competitiveness challenges and assets of industries and firms in different business activities and consequently in different markets, in particular in the knowledge, conversion and product markets (ibid.).

In design activities, and consequently in knowledge the markets, ISO9000 seems associated with technology capacity to undertake exploitation rather than exploration innovation management strategies (Benner and Tushman, 2002).

In manufacturing activities, and consequently in conversion markets, ISO9000 may be associated with labor and natural resource-intensive production functions in which internal organizational and process improvements (such as product conformity and reliability, reduction of non-conformities and waste, process efficiency and customer satisfaction awareness) are particularly important for improving competitiveness, and these may be relatively easy achieved through ISO9000 implementation (Curkovic and Pagell, 1999; Withers and Ebrahimpour, 2000; Pan, 2003; Casadesús and Karapetrovic, 2005; King et al., 2005; Terlaak and King, 2006). ISO9000 is also found to enable standardization of procedures and technologies, and consequently bridging over diversity in and between firms, and ensuring compatibility of business processes among different affiliates (Bénézech et al., 2001; Larsen and Häversjö, 2001; Lazaric and Denis, 2005).

In marketing activities, and consequently in products market, ISO9000 certification seems to be particularly important to access international markets (Blind and Hipp, 2003; Pan, 2003; Hatanaka et al., 2005; Jaffee and Masakure, 2005; King et al., 2005). Multinationals, supply-chains, and foreign direct investment are often found to be the most important channels for the diffusion of certification (Christmann and Taylor, 2001; Guller et al., 2002; Yeung and Mok, 2005).

These studies however did not examine how the relative advantage of national industries across the different phases of the value-chain influences their adoption of ISO9000. Nevertheless, the competitive challenges and capabilities are specific to the different stages of the value-chain, and benefits from innovation adoption depend on existing capabilities. Hence, benefits from adoption of ISO9000 are also expected to vary for adopters with diverse relative advantage in undertaking different business activities across the value chain.

Relative advantage in the Knowledge market

National industries invest differently in knowledge development; innovation and in the creation of new products and market opportunities (Nelson, 1993), and consequently develop different competences to adopt new technologies and management practices (Silverberg et al., 1988). National industries with relative advantage in knowledge markets, and consequently reliant on knowledge-intensive activities, have technological competencies and absorptive capacity to design technological competitive products (Cohen and Levinthal, 1990; Kaplinsky, 2000). Indeed, ISO9000 is found to be less likely to be adopted when competences to overcome innovation rigidities are not present (Blind and Hipp, 2003).

Investments in knowledge creation enable not only the development of new knowledge and competences to undertake design activities, but also the development of absorptive capacity to identify, access, and use external knowledge to develop new or improve existing products, technologies, processes and organization routines (Cohen and Levinthal, 1990). Investment in knowledge development permits adopters to face reduced costs from innovation adoption, once the costs of accessing, transforming and using information on the innovation will be in average lower than those faced by industries with no or very little investment in knowledge development. Consequently, adopters with relative advantage in knowledge markets and consequently with in design activities may expect higher net benefits from innovation adoption.

On the other hand, industries and firms, investing highly in the development of new knowledge, competences and innovative opportunities are likely to have capabilities to design technological differentiable products that are competitive in the international markets. Being a quality management signal that can facilitate access to international markets and improve internal process efficiency, ISO9000 certificate may be of less importance in industries with high rather than moderate relative advantage in knowledge markets. Indeed, Benner and Tushman (2002) show that ISO9000 is associated with exploitative rather than with explorative technological innovation strategies. Based on the above, we expect that too much or too little competences to undertake design activities to be associated with a lower number of ISO9000 in an industry.

> *H1: Relative advantage in the knowledge market has a U-inverted relationship with the diffusion of ISO9000 certificates.*

Relative advantage in the Conversion market

Reflecting the institutional conditions and resources availability of the national economies, national industries tend to develop and rely on different technologies and production functions (Nelson, 1993; Whitley, 2000), and consequently to observe different levels of labor productivity. Production technologies and production functions are characterized by their factor composition, in particular by different degree of labor-intensity and labor-productivity. These characteristics of the production technologies may influence the perceived costs and benefits from adoption of new technologies or management practices (Rogers, 1995; Greenan, 2003). National industries reliant on relative labor-intense technologies often make use of obsolete equipment and work organization, and low-qualified employees, and tend to observe low levels of labor-productivity, product reliability, and competitiveness (OECD, 2009).

ISO9000 adoption involves the definition of internal performance standards related to product reliability and conformity, on-time production, energy and resources used, and so on (Withers and Ebrahimpour, 2000; Bénézech et al., 2001; Blind and Hipp, 2003; Casadesús and Karapetrovic, 2005; King et al., 2005). Therefore, ISO9000 adoption tends to lead to improvements in organizational and process efficiency - such as product conformity and reliability, reduction of non-conformities and waste, process efficiency and customer satisfaction awareness (Curkovic and Pagell, 1999; Withers and Ebrahimpour, 2000; Pan, 2003; Casadesús and Karapetrovic, 2005; King et al., 2005; Terlaak and King, 2006).

Thus, expected benefits from ISO9000 certification may be higher in industries with low labor productivity using labor-intensive production functions. In these industries, characterized by low labor productivity, ISO9000 certificate not only supports operational efficiency improvements, but it serves as market signal that permits to differentiate their ability to produce according to specifications and deliver on-time, and in this manner to be accepted to produce for international markets and for global supply-chains (Guller et al., 2002; Vandergeest, 2007).

On the other hand, very low levels of labor productivity and reliance on highly labor-intensive technologies reflects the use of obsolete equipment and management practices, and consequently large gaps of productivity and competences with international counterparts. In this case, the adoption of new technologies and management practices may be difficult due to the involved cost that adoption represents for these adopters (Silverberg et al., 1988; Geroski, 2000). Based on the above, we expect that too much or too little labor productivity and reliance on labor-intensive production technologies to be associated with a lower number of ISO9000 in an industry.

> *H2: Relative advantage in the conversion market has an U relationship with diffusion of ISO9000 certificates.*

Relative advantage in the Product market

Advantage in marketing activities permit industries to differentiate their products in the market, and consequently to generate high value-added. This performance in the product markets influence firms expectations and consequently the timing and the level of innovation adoption (Quirmbach, 1986). Cross-national differences in the industry relative advantage in the international product market may create different incentives for innovation adoption, especially of innovations that provide a signal of quality management and product conformity.

Relative advantage in the product market allows retaining domestically a large share of the value added created. Consequently, the higher the relative advantage in the product market, the higher is the expected adoption of innovations. Among industries with relative advantage in marketing activities and consequently in the product market, adoption of innovation is crucial to maintain competitiveness in international markets. Moreover, ISO9000 is often argued to be crucial to enter in global markets or to produce for supply-chains—and to avoid potential export barriers to enter in some foreign markets – especially in industries reliant on domestic sources (Ringe and Nussey, 1994; Terlaak and King, 2001; Guller et al., 2002; Pan, 2003; Terziovski et al., 2003; King et al., 2005; Vandergeest, 2007). In absence of ISO9000 certification, firms may face an inability to enter and compete in a specific market (Larsen and Häversjö, 2001; Guller et al., 2002; Stevenson and Barnes, 2002; Corbett, 2004; Casadesús and Karapetrovic, 2005). By providing a market signal for reliability and conformity of production and quality management, ISO9000 certificate might allow these industries to access international and deregulated final markets, and consequently improve/maintain rents of the industry (Kaplinsky, 2002; Gereffi et al., 2001).

Contrary, industries that have reduced relative advantage in the product market cannot create rents from their value-added in international markets. Among industries that have reduced relative advantage in the product market are less likely to get a quick return of investment in innovation adoption. Moreover, ISO9000 may be less relevant to improve the terms of the trade. Thus, the cost of adoption may be particularly high in industries with low relative advantage in product markets.

Based on the above, we expect that the higher the relative advantage in the product market, reflecting high competence in the marketing activities, the higher the number of ISO9000 in an industry.

> *H3: Relative advantage in the product market creates increasing benefits for the diffusion of ISO9000 certificates.*

Diffusion of ISO9000 and in Low and High tech industries

Studies examining international competitiveness and the innovative activity of firms and industries often take in consideration that industrial activities differ in maturity of their products and the level of reliance on new sources and technological inputs, and subdivide industries into low-tech, medium-low tech, medium-high tech, and high-tech (Pendeder, 2003; OECD, 2005). Given the nature of low and high-tech industries, the competitive challenges faced and consequently the importance of the business activities across the value-chain tend to be different (Kaplinsky, 2002; Gereffi et al., 2001). Therefore, the expected benefits from innovation adoption, especially of management innovation that provide a market signal may be diverse.

In high-tech industries, product design and production determines product quality and competitiveness, assures product differentiation and defines industry capacity to generate and appropriate rents in the final market. Hence, industry's involvement in the design and production activities plays an important role in defining the dynamics of rents generations (Kaplinsky, 2002; Gereffi and Korzeniewicz, 1994; Gereffi et al., 2001). Thus, the industry relative advantage in the knowledge and conversion markets may be particularly important to define the business models and expectations of benefits from innovation adoption in high-tech industries.

In low-tech industries products, in which products and technologies are to a certain extent more mature, the possibilities to differentiate products' quality, technology and design are much reduced and lesser relevant for firms' competitiveness (Gereffi and Korzeniewicz, 1994; Gereffi et al., 2001). Relative advantage in marketing activities is instead particularly important in defining the dynamics of rents generation in low-tech industries (Kaplinsky, 2002; Gereffi and Korzeniewicz, 1994; Gereffi et al., 2001). Moreover, conformity, reliability, on-time delivery, traceability and price are particular important attributes of products in the low-tech industries, defining national industries capacity to create and appropriate value from their production and entry in global supply chains (Gereffi and Korzeniewicz, 1994; Gereffi et al., 2001). Hence, the industry relative advantage in the product market may be particularly relevant to influence the benefits of innovation adoption, and consequently the level of innovation diffusion in low-tech industries.

Based on the above, we expect that the diffusion of ISO9000 certificates in Low-tech industries to be especially affected by the industry's relative advantage in the product market, while in high-tech industries to be mainly affected by the industry's relative advantage in the knowledge and conversion markets.

> *H4a: Relative advantage in the knowledge market is more important to explain diffusion of ISO9000 certificates in high-tech than in low-tech industries.*
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> *H4b: Relative advantage in the conversion market is more important to explain diffusion of ISO9000 certificates in high-tech than in low-tech industries.*
>
> *H4c: Relative advantage in the product market is more important to explain diffusion of ISO9000 certificates in low-tech industries than in high-tech.*

4. Data and Method

Dependent Variable

Our dependent variable is the number of ISO9000 certificates in 15 manufacturing industries in seven OECD countries from 2001 to 2004. We collected this information from the ISO surveys. We focus only on manufacturing industries due to the non-availability of information on the independent variables for services sectors across our sample of countries. We focus on seven OECD countries Czech Republic, Finland, Italy, Japan, South Korea, and Portugal, and Spain. These countries were chosen based on the availability of data on certification at industry level. Moreover, they represent a diverse group of countries in terms to size, level of income and being members or non-members of European Union.

Explanatory variables

We obtain data for our independent variables, which characterize the organization of the economic activity of industries across the value chain, from the OECD STAN and ANBERD datasets. To rule out the possibility of reverse causality and account for the time lag between the decision and the achievement of the certification, our independent and control variables are lagged 2 years.

We included in analysis one variable that characterize the industry's relative advantage in the knowledge market (*Design*), one variable that provides information on the industry's relative advantage in the conversion market (*Production*), and one variable characterizing the industry's relative advantage in the product market (*Marketing*).

The variable *Design* provides information on the industry advantage in knowledge markets, i.e. introducing improvements in products, technologies and markets, create innovative opportunities, and competences to undertake design activities. It is measured by industry knowledge-intensity; by the expenses in R&D as percentage of the industrial value added. We include the linear and square term of this variable.

The variable *Production* provides information on the industry advantage in conversion markets, i.e. on the efficiency and labor productivity of the industrial production, and consequently on the degree of labor-intensity of production. It is measured by the percentage of industrial labor costs on the total industry value added. The higher is this measure, the lower is the labor productivity and the higher is reliance on labor-intensive production technologies. We include the linear and square term of this variable.

The variable *Marketing* provides information on the relative advantage of industry in the product markets. It is measured by the ratio of total exports to imports.

Controls

Researchers of social networks tend to emphasize the importance of networks as source of learning and diffusion of similar patterns of behavior. They argue that because actors interact and share certain number of rules, there might be place for mutual influence (DiMaggio and

Powell, 1983; Abramhamson and Rosenkopf, 1993). These relationships may have generated coercive isomorphism through contractual or authoritarian relationships; however, most often firms' imitation tends to result from competitive pressure from competitors, as they expect to be penalized in the market if they did not imitate (Greve, 1996, 1998; Haunschild and Miner, 1997, Ahuja, 2000; Nelson et al., 2004). In the case of the diffusion of ISO9000 certificates, it is often argued that process of imitation occurred across countries closely connected by trade relationships (Guller et al., 2002 Albuquerque et al., 2007). Both exporting and importing firms may import management practices from that region back to their home country (Guller et al., 2002; Corbett, 2004).

The effect of trade relationships on the adoption of ISO9000 may be particularly important when involving specific demanding trade regions or leader countries. Regions such as the US or the European Union set specific regulation for the domestic market, often including ISO9000 into global assessment procedures of some products from non-EU countries (Withers and Ebrahimpour, 2000; Pan, 2003; Yeung and Mok, 2005). Trade with technologically leader countries such as Germany or with countries that pioneered the development and adoption of ISO9000 such as the UK may have been important sources of ISO9000 diffusion (Pan, 2003; Franceschini et al., 2004; ISO, 2005; OECD, 2010).

To account for these trade relationships that may create isomorphism in the adoption of ISO9000, we include in the analysis information on the trade relational structures of industries with the UK, Germany, US and EU. Variable *Trade-UK*, *Trade-Germany*, *Trade-EU*, and *Trade-US* are measured by the share of industry trade (imports and exports) with the respective country or region. Data has been collected from the OECD STAN database. Furthermore, we include in the analysis a control for the level of industry openness to international market. *Trade openness ratio* is measured by the sum of the exports and imports as share of industrial Gross Domestic Product (GDP). Information on the level of foreign direct investment at two-digit industry level is not available for the analyzed countries.

Finally, we include a control for the relative size of the industry in the national economies. The variable *Industry Size* is proxied by the share of industrial Gross Domestic Product (GDP) on the national GDP. Time, country and industry fixed effects are also included in the analysis to control for other sources of time-invariant unobserved heterogeneity across time, countries and industries.

Table 1 provides correlation coefficients and the descriptive statistics of the dependent, explanatory and control independent variables.

[Insert Table 1 about here]

Analysis

Given the count nature of our dependent variable, the observed level (number) of ISO9000 certificates in an industry, we use a negative binomial model, which allows relaxing the Poisson assumption of equal mean and variance because the dependent variables are overdispersed (Long and Freese, 2003). To test robustness of this analysis, we transform the dependent count variable into a continuous variable, by using the natural logarithm of one plus the number of ISO9000 certificates, and we run a linear regression model on the continuous variable. Results provided by the linear regression model on the logarithm of one plus the number of certificates provided similar results, in terms of sign and significance of the coefficients, to those found with the negative binomial model on the number of certificates. Given the similarity of the results and facility to interpret the coefficients of the linear model, we present these on the paper. The negative binomial results are provided upon request from the authors.

First, we run the model for the full sample of industries and countries to test H1 to H3. Second, we run the model separately for industries with different product maturity to test H4. According to the OECD categorization of the technological-intensity of industries, we consider the group of Low and medium-low technology intensive industries (food, textiles, wood products, pulp and paper, printing and publishing, coke, rubber and plastics, non-metallic minerals, metals and other manufacturing) and the group of medium-high and High technology-intensive industries (electronic and optical equipment, pharmaceuticals, machinery, other transport equipment, motor vehicles) (Peneder, 2003, 2010).

5. Industry relative advantage across the value-chain and the diffusion of ISO certification

Table 2 presents the results of the linear regression of the logarithm of one plus the number of ISO9000 certificates run for the full sample of industries and countries. Table 3 presents the results separately for Low-tech and High-tech industries. Model 1 is the baseline model with controls only. Model 2 adds the linear effects of design, technology, production and marketing. Model 3 adds the square terms of design, technology, and production. We also present Model 3 run using the backward stepwise rather than enter method.

[Insert Table 2 about here]

Results suggest that our predictions about the effect of the relative advantage of industries across the value-chain on their level of use of ISO9000 are strongly supported. Considering the full specification of the model in model 3, using both the enter and the backward stepwise methods, we find strong support for hypotheses H1 to H3.

Our results confirm H1 and H2. H1 and H2 refer to the relative advantage of the industry in the knowledge and conversion markets. They state that the level of ISO9000 in an industry is higher, the higher the national technology capacity of the national industries to design, and the lower the labor productivity (i.e. more labor-intensive are the production technologies); however for very high levels of technology capacity and of labor-intensity of production technologies used their effect on ISO9000 diffusion become negative. Moreover, our results corroborate our predictions (H3) about the effect of the relative advantage in the product market on the diffusion of ISO9000. The higher the relative advantage in the product market the higher the number of certificates in that industry.

The control variables in the model behaved as followed. Trade with Germany encouraged ISO9000 certification. Similarly, the coefficients of the variables *trade openness* and *industry size* are significant; they influence negatively and positively, respectively, the level of certification in an industry. Furthermore, time, industry and national fixed effects are significant.[2]

[Insert Table 3 about here]

Results for the slip sample of Low-tech and High-tech industries provide strong support to our predictions stated in H4b and H4c, but not for H4a. In Low-tech industries, the number of ISO9000 certificates is higher the greater is the relative advantage of industries in the product market. In High-tech industries, the number of ISO9000 certificates observes an U-inverted relationship with the relative advantage in the conversion market. We do not find support for our prediction that relative advantage in knowledge market was particularly important in

[2] Compared to "other manufacturing activities", which is our reference category, food, rubber, non-metallic metals, metals, machinery, electrical and optical equipment have a significant higher level of certification with ISO9000. Instead, pharmaceutical and transport equipment has a significant negative coefficient. Compared to Spain, which is our reference category, Czech Republic, Finland and Portugal have a significant lower level of ISO9000 certification, while Japan and Italy provide have a significant higher level of certification than Spain.

high-tech industries to explain innovation adoption.

Additionally, we find a differentiated effect of the control variables in the Low and High-tech industries. The number of ISO9000 certificates is higher in High-tech industries with strong trade relationship with Germany and weak trade relationship with EU. In Low-tech industries instead the strong trade relationships with EU and US seems to lead to a small number of ISO9000 certificates in an industry. Finally, the relative size of an industry is only positive and significant among High-tech industries [3]

Further analysis

The effect of organization of the economic activity across the value chain on explaining the diffusion of ISO9000 in an industry may not be homogeneous across countries occupying different positions in the global trade networks. For example, small and large countries have different characteristics in terms of industrial specialization, as well as exposure to international markets. Similarly, countries that are members of common trade area and those that are non-members may face different type of efforts to be able to trade internationally. Therefore, firms active in countries occupying different positions on the global trade networks may have not only form their perceptions and collect relevant market and technological information diversely, but they may also have different assessment of the costs and benefits of ISO9000 certificate.

In the analysis reported before in Table 2 and 3, we only account for country-specific effects, we examine now whether our predictions are also confirmed across groups of countries with similar characteristics in terms of their economic size as well as membership to specific market zones. For this purpose, according to the level of GDP, we grouped countries into two groups: small and large countries. The large countries group includes Japan, Italy, Spain and South Korea. The small countries group includes Czech Republic, Portugal and Finland. We then define two groups according to the membership to the European Union before 2004. The group of the EU countries includes Finland, Italy, Portugal and Spain. The group of the Non-EU countries includes Czech Republic (joined EU only in 2004), South Korea and Japan.

Table 4 provides results for the split sample of Large and Small countries, as well as for the split sample of EU and Non-EU member countries. For space reasons, only the results of the full model, Model 3, are reported.

[3] Concerning the countries dummies, Czech Republic does not present significant lower levels of certification across low-tech industries compared to the reference category (i.e. Spain). Italy and Japan do not present significant higher levels of certification across high-tech industries than the reference category (Spain). The level of industrial certification in 2003 and 2004 is significantly different that in 2001, especially in low-tech.

[Insert Table 4 about here]

Results for the slip sample of EU and non-EU member countries corroborate H1, H2 and H3. Among EU countries (Table 4, columns 2) we find support for our predictions stated in H1, H2 and H3 on the effect of the industry's relative advantage in the knowledge, conversion and product markets on the diffusion of ISO9000 certificates. Among Non-EU countries (Table 4, columns 1), we find support for H2, stating the curverlinear relationship between relative advantage in conversion markets and the diffusion of ISO9000.

Results for the slip sample of Small and Larger countries also provide support for H1, H2, and H3. In both Small and Large countries (Table 4 columns 3 and 4), H1 and H2, stating the curve-linear relationship between industry relative advantage in the knowledge and conversion markets and ISO9000 diffusion, are supported. We find support for H3 only among Small countries.

5.3. Discussion

Our analysis suggests that the relative advantage of an industry across the value-chain explains adoption of management innovations. This influence is not similar across industries characterized by different product maturity and reliance on high-tech inputs or across industries in countries occupying different positions on the trade networks.

Our results confirm our hypotheses H1 and H2 that state a curve-linear relationship between industry's relative advantage in the knowledge and conversion markets and the diffusion of ISO9000. They show that the number of ISO9000 certificates is higher among knowledge-intensive industries with capacity to design, as well as in low labor-productivity industries reliant on labor-intensive production functions. As suggested in the literature, in industries with reduced investment in the generation of knowledge and innovation opportunities in products, technologies and processes or with relative low-productivity and obsolete labor-intensive production functions, competences to adopt ISO9000 are reduced and perceived costs of adoption very high (eg. Silverberg et al., 1988; Nelson, 1993). On the other hand, industries characterized by high capacity to develop knowledge and innovations and by high labor-productivity production functions instead have the competences to adopt ISO9000 but they value low the benefits of ISO9000 certificate to improve access to international markets or to increase the market value of their products.

Our results also corroborated H3 showing that the linear relationship between the relative advantage of industries in the product market and the level of ISO9000 diffusion. In particular, results show that the greater advantage industries have, the higher the number of ISO9000 certificates in the industry, revealing the existing competences to adopt, as well as the value of innovation to increase rents in the product market.

Additionally, our results provide strong support to our prediction in H4b and H4c which state that relative advantage in conversion and product markets have a different role in explaining the diffusion of ISO9000 in Low-tech and High-tech industries. We did not find empirical corroboration for H4A stating that industry relative advantage in design activities is particularly relevant to explain innovation adoption in high-tech industries.

Our results show that relative advantage in production activities is particularly relevant in explaining ISO9000 adoption among High-tech industries. Indeed, these activities seem to be particular important in high-tech industries, in which the technological characteristics of the product are among the most relevant competitiveness factors, to develop and bring to the market products with competitive design and technology (Pavitt et al. 1989). These results suggest that industry's relative advantage in conversion markets is most important in high-tech industry to define access to information to evaluate the benefits of innovation adoption as well as competences to adopt them.

Industry's relative advantage in the product market is found most relevant to explain diffusion of ISO90000 in Low tech industries. Indeed, in Low-tech industries, product market defines industry competitiveness challenges and marketing activities provide industry opportunity to appropriate value (Pavitt et al., 1989; Peneder, 2003; Gereffi and Korzeniewicz, 1994; Gereffi et al., 2001; Vandergeest, 2007). Entering in international markets and producing for global supply-chains in which production is internationally allocated according to price competitiveness of industries to perform an activity or a component for the final product may be of particular importance to these industries. Therefore, among Low-tech industries, industry relative advantage in the product market is crucial to explain innovation adoption. In particular, ISO9000 seems a particular crucial market sign that may permit entry into international markets (Gereffi and Korzeniewicz, 1994; Gereffi et al., 2001; Pan, 2003; Vandergeest, 2007).

A further analysis of our hypotheses was undertaken to examine whether empirical support was also found when considering a subgroup of more homogenous countries in terms of their position on the global trade network. Results also provide support for our predictions.

Following contributions on the importance of isomorphism behavior resulting from trading relationships (eg. Greve 1996; Gulller et al., 2002), in this study, we controlled for the effect of the industrial trade linkages on the number of ISO9000 certificates. Our results suggest that the influence of the trade linkages on ISO9000 diffusion depends on the industrial characteristics of the partners. In particular, trading with Germany provides incentives for ISO9000 certification especially in High-tech industries, which may reveal the German competitiveness in these industries (OECD, 2010). Trade with the EU and the US instead provides positive incentives for certification in the Low-tech industries, which may reveal instead the importance of trade regulations to access these large market zones (Withers and Ebrahimpour, 2000; Pan, 2003). Additionally, the effect of structure of the industrial trading relationships on the level of ISO9000 certificates is not similar across countries occupying different position on the global trade networks. In sum, our results suggest that the effect of specific trade linkages, as precursor of isomorphism behavior, depends not only on the characteristics of the partners with which national industries trade, but also on the position of the national country on the global trade networks.

6. Conclusions

Our study examined how industry relative advantage across the value-chain explains cross-country and cross-industry differences in the level of innovation adoption in an industry. Specifically, we analyzed whether the industry's relative advantage in design, production and marketing activities, and consequently in the knowledge, conversion and products markets explain differences in the level innovation adoption of management innovations that produce a market signal. We propose and find support for the idea that the industry relative advantage across the value chain has a significant effect on the level of innovation adoption. Empirically, we focused on certification with ISO9000, and we used data from 15 manufacturing industries, in seven OECD countries, and we took into consideration potential epidemic effects recurrent from trade linkages and openness to international markets, as well as time, industry, and countries fixed effects.

With this study we make several contributions to the innovation diffusion literature. First, we contribute by proposing and finding support for the idea that the industry relative advantage across the value-chain explains differences in the level of adoption. Benefits of innovation adoption depend on capabilities that exist already, hence on the relative advantage of the industry across the value chain. The empirical literature, concerned with the examination of the rank-effects associated with innovation adoption tends to focus on the examination of how adopters' characteristics in terms of size, technological and organizational capabilities influence their decision to adopt. These contributions neglected the examination of the effect of differences in the technological and organizational structure of industries, and consequently their relative advantage across the value-chain business activities on the process of innovation diffusion. In this study, we argue and provide evidence that the relative advantage of national industries in the knowledge, conversion and product markets is central to the understanding of the different patterns of innovation adoption. Additionally, we contribute by proposing and providing evidence that the effect of the rank-effects is differentiated for industries with different characteristics in terms of maturity of the product and production process, as well as for industries in countries occupying different position in the global trade network.

Second, we contribute by examining the importance of rank-effects associated with the relative advantage of the industry across the value-chain, taking into consideration the potential channels of epidemic adoption such as trade linkages, and openness to international markets. Very rarely have the literature of innovation adoption addressed simultaneously rank and epidemic effects that may lead to innovation diffusion. By taking both simultaneously into consideration, our empirical analysis provides evidence on how both types of effects are complementary rather than substitute, as often implicitly referred in the literature. Both rank and epidemic effects exert simultaneous influence (even that with contradictory effect) on the process of innovation diffusion.

Third, we contribute by providing evidence that the influence of epidemic mechanisms on process of innovation diffusion depends not only on the potential channels for information and knowledge transfer, but also on the characteristics of both partners involved in the interaction and transfer. Hence, more than information and knowledge spillovers, it is the characteristics of both partners involved that shapes the content and the intensity of the incentive to adoption.

This study is not without limitations. Addressing these limitations could open up several avenues for future research. First, the analysis has been carried out using 2-digit industry level data. Despite providing already some degree of detailed, the 2-digit industry level is still a quite aggregate level of analysis. It would be interesting to replicate this study at lower levels of industry aggregation, which however would require the use of alternative types of data since the form in which ISO surveys are implemented makes it almost impossible to have higher levels of disaggregated data on the number of certificates.

Second, national industries are likely to occupy different positions on the industry value chains, and consequently to be specialized into different product categories. Hence, further research is needed to examine whether these findings could be replicated when the unit of analysis would be the product category rather than the industry. This study would also allow controlling for differences in the national specializations within each industry. Again this further research would need to rely on different sources of data. Indeed, qualitative research based on interviews and case studies could help provide rich insights into these meso-level processes and the implications for innovation adoption literature.

Third, the unit of analysis of this study is the industry rather than the business firm. It would be interesting to further investigate whether these results hold when the unit of analysis is the business firm rather than the industry.

In conclusion, our study was a first attempt to open up the impact of the relative advantage of national industries across the value chain on their level of adoption of innovations.

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Table 1. Descriptive statistics and Correlation coefficients of explanatory variables

	N.	Mean	Std. Dev.	Min.	Max.	Design	Production	Marketing	Openness	Trade Ger	Trade UK	Trade US	Trade EU	Industry Size
Design	426	1.39	3.01	0.00	30.23	1								
Production	438	57.25	15.81	4.01	127.27	-0.064	1							
Marketing	438	1.49	1.77	0.01	10.70	0.012	-0.01	1						
Openness	438	1.62	3.71	0.01	35.53	0.119*	0.270**	-0.176**	1					
Trade Ger	410	0.28	0.23	0.00	0.96	-0.091	0.009	-0.008	0.121*	1				
Trade UK	410	0.11	0.06	0.00	0.35	0.105*	0.188**	0.039	0.163**	0.162**	1			
Trade US	410	0.21	0.20	0.01	1.23	0.257**	0.083	0.262**	-0.051	-0.426**	-0.291**	1		
Trade EU	410	1.01	0.52	0.01	2.11	-0.075	0.156**	-0.123*	0.155**	0.655**	0.624**	-0.632**	1	
Industry Size	438	0.02	0.02	0.00	0.17	-0.023	-0.161**	0.075	-0.223**	0.140**	-0.111*	-0.043	-0.058	1

Robust standard errors in parentheses** p<0.01, * p<0.05

Table 2. Results of the linear model for the effect of industrial relative advantage across the value chain on the diffusion of ISO9000. All industries and countries.

		Model 1	Model 2	Model 3	Model 3 Backward Stepwise
knowledge Market	Design		0.056**	0.149**	0.146**
			[0.011]	[0.002]	[0.001]
	SQ Design			-0.004**	-0.004**
				[0.016]	[0.022]
Conversion Market	Production		0.009**	0.075***	0.074***
			[0.023]	[0.000]	[0.000]
	SQ Production			-0.001***	-0.001***
				[0.000]	[0.000]
Product Market	Marketing		0.107***	0.087***	0.086***
			[0.000]	[0.001]	[0.001]
Trade linkages	Trade GER	1.085*	1.522**	1.893***	1.792***
		[0.086]	[0.031]	[0.006]	[0.001]
	Trade UK	0.476	2.447	1.729	1.822
		[0.731]	[0.132]	[0.239]	[0.145]
	Trade US	0.771**	0.633*	0.368	0.347
		[0.016]	[0.056]	[0.351]	[0.280]
	Trade EU	1.510***	0.995***	0.323	0.402*
		[0.000]	[0.005]	[0.324]	[0.072]
	Openness	-0.066**	-0.045	-0.057**	-0.055**
		[0.013]	[0.105]	[0.037]	[0.039]
Industry Size	Industry Size	4.975**	4.102*	4.008*	3.991**
		[0.017]	[0.051]	[0.067]	[0.034]
	Constant	3.586***	3.133***	2.294***	2.238***
		[0.000]	[0.000]	[0.000]	[0.000]
Fixed effects	Country dummies Industry dummies Time dummies				
	Observations	410	402	402	402
	Degrees of Freedom	27	30	33	28
	F Statistic	76.4	69.38	97.18	71.97
	log Likelihood	-473.4	-443.6	-422	-422.1
	R Squared	0.813	0.826	0.844	0.844

Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Table 3. Results of the linear model for the effect of industrial relative advantage across the value chain on the diffusion of ISO9000. Low-tech and High-tech industries separately.

		Low- Tech				High-Tech			
		Model 1	Model 2	Model 3	Model 3 Backward Stepwise	Model 1	Model 2	Model 3	Model 3 Back. Stepwise
knowledge Market	Design		-0.296**	-0.350	-0.307**		0.01	0.062	0.058
			[0.037]	[0.517]	[0.043]		[0.599]	[0.329]	[0.207]
	SQ Design			0.018				-0.002	-0.002
				[0.923]				[0.441]	[0.327]
Conversion Market	Production		0.005	0.011	0.005		-0.009	0.045**	0.041**
			[0.311]	[0.475]	[0.294]		[0.169]	[0.036]	[0.036]
	SQ Production			-0.000				-0.000**	-0.000***
				[0.683]				[0.017]	[0.008]
Product Market	Production		0.148***	0.148***	0.148***		0.092**	0.045	0.059
			[0.000]	[0.000]	[0.000]		[0.035]	[0.320]	[0.122]
Trade linkages	Trade GER	-1.257	-1.094	-1.054	-1.303*	1.609**	1.529*	1.908**	1.744***
		[0.139]	[0.227]	[0.246]	[0.090]	[0.026]	[0.057]	[0.016]	[0.006]
	Trade UK	2.992**	2.005	1.863	2.171	1.606	1.151	1.815	1.655
		[0.048]	[0.304]	[0.358]	[0.175]	[0.420]	[0.551]	[0.324]	[0.286]
	Trade US	1.409**	1.650***	1.607**	1.654***	-0.914**	-0.881*	-0.748	-0.714*
		[0.035]	[0.009]	[0.012]	[0.002]	[0.048]	[0.097]	[0.152]	[0.057]
	Trade EU	1.064**	1.033**	1.029**	1.192***	-0.454	-0.664	-0.871**	-0.819**
		[0.027]	[0.020]	[0.021]	[0.000]	[0.307]	[0.125]	[0.031]	[0.013]
	Openness	-0.227**	-0.124	-0.128	-0.122*	-0.023	-0.001	-0.021	
		[0.030]	[0.170]	[0.166]	[0.058]	[0.352]	[0.975]	[0.408]	
Industry Size	Industry Size	2.561	1.851	1.882	1.869	17.54***	16.356**	15.459***	16.826***
		[0.190]	[0.346]	[0.340]	[0.261]	[0.001]	[0.003]	[0.002]	[0.002]
	Constant	4.23***	3.86***	3.758***	3.68***	7.05***	6.34***	6.279***	6.397***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Fixed effects	Country dummies	Significant							
	Industry dummies	Significant							
	Time dummies	Significant							
	Observations	252	244	244	244	158	158	158	158
	Degrees of Freedom	23	26	28	23	19	22	24	21
	F Statistic	94.49	91.82	86.9	77.6	68.46	82.33	98.05	68.05
	log Likelihood	-232.8	-205.8	-205.8	-206	-135.5	-130.3	-125.8	-126.2
	R Squared	0.878	0.89	0.89	0.89	0.902	0.908	0.913	0.913

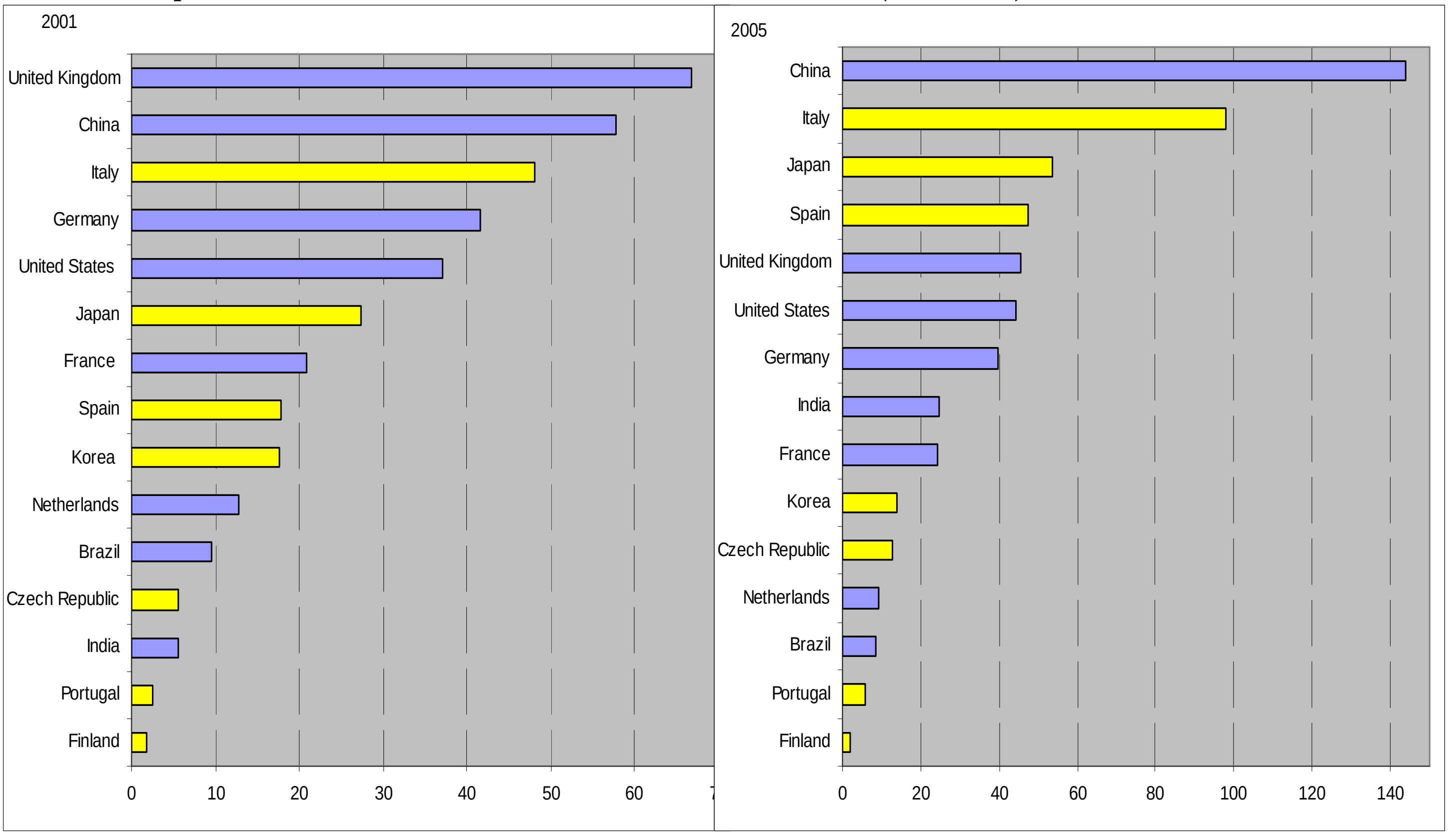
Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Table 4. Results of the linear model for the the effect of industrial relative advantage across the value chain on the diffusion of ISO9000. EU and Non-countries separately; and large and small countries separately.

		Non EU countries	EU countries	Small countries	Large countries
knowledge Market	Design	-0.027	0.281***	0.311***	0.258**
		[0.880]	[0.000]	[0.000]	[0.017]
	SQ Design	0.005	-0.008***	-0.010***	-0.018**
		[0.714]	[0.000]	[0.000]	[0.015]
Conversion Market	Production	0.080***	0.117***	0.133***	0.070***
		[0.001]	[0.000]	[0.000]	[0.000]
	SQ Production	-0.001***	-0.001***	-0.001***	-0.001***
		[0.001]	[0.000]	[0.000]	[0.000]
Product Market	Marketing	0.025	0.071**	0.190***	-0.049
		[0.607]	[0.022]	[0.000]	[0.236]
Trade linkages	Trade GER	-0.523	3.074***	0.270	2.870***
		[0.742]	[0.000]	[0.782]	[0.002]
	Trade UK	2.017	-1.344	0.451	4.448*
		[0.579]	[0.372]	[0.848]	[0.061]
	Trade US	0.055	0.663	-0.112	1.711***
		[0.944]	[0.168]	[0.876]	[0.002]
	Trade EU	1.089	0.447	0.409	0.396
		[0.350]	[0.344]	[0.479]	[0.400]
	Openness	-0.358**	-0.012	-0.054*	-0.452***
		[0.012]	[0.618]	[0.063]	[0.005]
Industry Size	Industry Size	-0.340	34.678***	2.613	5.385***
		[0.885]	[0.000]	[0.407]	[0.001]
	Constant	4.046***	0.195	-0.393	1.578**
		[0.000]	[0.675]	[0.655]	[0.015]
Fixed effects	Country dummies	Significant			
	Industry dummies	Significant			
	Time dummies	Significant			
	Observations	171	231	163	239
	Degrees of Freedom	28	29	28	29
	F Statistic	41.36	151.9	130.7	67.65
	log Likelihood	-185.7	-148.5	-148.2	-216.2
	R Squared	0.798	0.937	0.812	0.848

Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Graph 1 – Number of ISO9000 certificates in 2001 and 2005 (thousands)



Note: The graph relative to 2001 refers to both ISO9000:1994 and ISO9000:2001.