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DRIVERS OF BEAUTIFUL INNOVATION: ARTWORKS RESTORATION BY MUSEUMS

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This paper examines whether the restoration and conservation departments of museums innovate, and, if they do, what explains their ability to innovate; that is, what are the innovation drivers? The study is based on a survey responded to by restoration and conservation departments in 167 museums in 43 countries. The importance of this paper lies in the fact that restoration activity is included in the form of one of the NACEs ignored by the Community Innovation Survey, elaborated by Eurostat, namely NACE 90. Taking into account complementarities between internal and external knowledge resources, three important conclusions can be inferred from the results obtained in this paper. The first is that the number of specialists in artworks restoration activities determines the total production of innovations. The second is that the size of a restoration department influences the amount and variety of skills available and the propensity for cooperating in R&D. The third is that the production of innovations also depends on an external information effect, which is amplified by the availability of a department's skills and the propensity to engage cooperatively in R&D.

Keywords: innovation, creative industries, cultural industries, museums, conservation and restoration of artworks

1. Introduction

The museum activity analyzed in this work - the restoring of works of art such as paintings - is included in NACE 90, and is called "creative, arts and entertainment activities". This activity is considered as creative by most institutional reports on the creative and cultural industries (e.g. UNCTAD 2010, ESSnet-Culture 2012, KEA 2006), but in others, such as DCMS (2009) and WIPO (2003), it is not included because it is thought to have lesser implications for the business sector and has only a low number of copyright registrations. In addition, some authors (e.g. Stam et al. 2008) assume that arts are less innovative because of their dependency on subsidies. As a consequence, most surveys about innovation (e.g. the Eurostat Community Innovation Survey) neglect service activities such as arts, heritage and recreation (NACE codes 90, 91 and 93).

But does this mean that such activity has little innovative potential? Despite the differing opinions, in fact not much is known about the creative-cultural service industries and their innovation patterns - yet. As Cunningham and Higgs (2009) point out, recognizing the importance of the creative service industries for innovation "may

have important implications for innovation policy, which has traditionally been associated with the science and technology based industries". The (still as yet limited) literature about innovation in the creative industries has reviewed cases of innovation in studio record companies (Handke 2007), design consultancy (Sunley et al 2008), the fashion industry (Tran 2010), film, media and advertising (Chapain et al. 2010), and publishing, music, videogames and product design (Miles and Green 2008; Stoneman 2010). Although the production of innovations has proved to be significant in all these industries, Müller et al. (2009) in their study about the Austrian sectors of content/design, architecture/engineering, advertising, software and consultancy, conclude that some creative service industries are more innovative than others. Muller et al. also point out that the measurement of innovative output is highly related to the definition of innovation, which might have a particular character in the creative industries.

The attempts to contextualize innovation specific to the creative industries have produced different names to describe it: *aesthetic* (Alcaide-Marzal and Tortajada-Esparza 2007), *stylistic* (Cappetta et al 2006), and *soft* (Stoneman 2010). In all of these cases, innovation refers to changes in product appearance, ignoring processes. In the art segment, Gallenson (2008) uses the term *artistic* innovation to refer to advances developed by artists. An organizational perspective has also been introduced, for example in the study of Garrido and Camarero (2010) of Spanish, French and British museums; however, their analysis follows an approach that would apply to any sector, rather than to the specific context of museums or arts organisations. Despite the attempts to explain the peculiarities of the creative industries, the literature about innovation in the arts and cultural sector is still limited (Bakhshi and Throsby 2010). The consequence of this deficit is that there is no clear definition of innovation when applied to arts organizations.

Our work tries to fill this gap, and so is contextualized to the CIS survey's analysis of innovation in the creative activity of restoration and conservation of works of art by museums. This activity is included within NACE 9003 (*artistic creation*), while the rest of museum activities are included in NACE 91 (Libraries, archives, museums and other culture activities). The majority of innovations in restoration occur in processes, and only sometimes in respect of the product. The latter occurs when restoration generates a noticeable change in an artwork's appearance, as occurred, for example, with the emergence of bright colours following the restoration of Michelangelo's Sistine Chapel, and also as happened in the recent case of Prado's Museum copy of *La Gioconda*. This kind of innovation is of a kind similar to those named as aesthetic, stylistic or soft. In order to provide an expression which allows us to include both product and process innovation in artworks conservation and restoration, we use the term *beautiful* innovation.

The painter Francisco de Goya was against the restoration of paintings. In 1801, he wrote about the restoration of the paintings of the "Real Sitio del Buen Retiro": "It is

not easy to retain the fantasy or the chord and concert that were proposed in the first run. And if this is indispensable to an accomplished artist, what if who performed the restoration does not have the necessary skills?" (Revista de Archivos, Bibliotecas y Museos, 1872). However, we can say that the current knowledge in the field reduces the validity of at least some of his comments, whether they be about those who undertake restoration, or the methods they use.

The objective of this paper is to gain insights about the innovation drivers in museum restoration departments. When analysing these drivers, reference is made to the literature on complementarities[1], between, firstly, different internal resources of a firm (Milgrom and Roberts 1995, Stieglitz and Heine 2007, Hess and Rothaermel 2011), and, secondly, between internal and external resources (Chesbrough 2003, Caloghirou et al 2004, Cassiman and Veugelers 2006, Tether and Tajar 2008, Spithoven et al 2010, Fu 2012). Hitherto, the literature on creative industries has generally studied the second set of complementarities, since the authors have associated these industries with open innovation and absorptive capacity (Potts 2007, Müller et al 2009, Bakhshi and Mc Vittie 2009, Chapain et al 2010). However, as Bakhshi and Throsby (2010) point out, such studies have ignored the arts industry.

In order to fulfil this paper's purpose, data was obtained from a world-wide survey of 167 museums in 43 countries, 90 of which had a restoration department. The survey's questionnaires were sent out in two rounds between December 2010 and July 2011. The questionnaire was based on the Community Innovation Survey[2] (CIS), adapted for the artworks restoration sector.

This paper is structured as follows. After this introduction, Sections 2 and 3 summarise basic theory about innovation in the creative industries, including the arts and cultural sectors. Then, in Section 4, an empirical study is presented about the drivers of innovation in museum restoration departments. Our conclusions can be found in Section 5.

2. Innovation in the creative and cultural industries

2.1. *Relationship between the creative industries and innovation*

The literature about innovation in the creative industries has focused on: how they contribute to regional innovation in the places where they are located (The Work Foundation 2009, Chapain et al 2010); how they influence innovation in other industries (Müller et al 2009, Bakhshi and McVittie 2009, The Work Foundation 2009, Chapain et al 2010); and how innovative they are (Miles and Green 2008; Müller et al. 2009;

[1] We use complementarities in the sense of Teece (1986) referring to co-existence and synergies. However, we do not present complementarities in the sense of Milgrom and Roberts 1995 or Cassiman and Veugelers, 2006, due to the fact that complementarity tests are not used. Nevertheless, those concepts refer the general idea we expect about combining different knowledge bases and different types of skills.

[2] CIS surveys consulted were by the Spanish National Statistics Institute (Survey of Innovation in Enterprises) and the Department for Business, Innovation and Skills in the UK (CIS6, available at www.bis.gov.uk/policies/science)

Stoneman 2010; Sunley et al. 2008; Chapain et al 2010). Therefore, most of this literature has a regional perspective. In this paper, we will focus on the third issue: how innovative are the creative industries, and what are the innovation drivers? We will analyse innovation in artworks restoration from a management perspective, looking at the existing gap in knowledge about the creative industries by focussing on one of its subsectors.

a) *How creative industries contribute to regional innovation in the places where they are located*

Reid et al. (2010), Cunningham and Higgs (2009), Gwee (2009), and Potts (2007) include the creative industries in an economy's innovation ecosystem because of the influence on the innovative environment. The influence by creative industries on regional innovation can be both direct and indirect (Chapain et al 2010). Direct effects relate to innovation undertaken by creative firms, while indirect effects depend on whether innovation in creative sectors influences other industries, through input-output linkages and spillovers.

In respect of the direct influence of creative industries, the potential to generate innovation has been highlighted in some studies, albeit that performance is thought to depend on particular sectors and locations, and that some creative industries are more innovative than others (See, for example, The Work Foundation 2009; Chapain et al 2010).

b) *How creative industries influence innovation in other industries*

The role that creative industries play in other industries' innovation has been addressed by Bakhshi and McVittie (2009), Chapain et al. (2010), Cunningham and Higgs (2009), Davis et al. (2009), Muller et al. (2009), Sunley et al. (2008), Gwee (2009), and Potts (2007). Two basic mechanisms have been observed here: the transmission through input-output linkages between creative and non-creative industries (Bakhshi and McVittie 2009, Muller et al. 2009), and externalities or spillovers from creative industries to the rest of the economy (Chapain et al. 2010, Davis et al. 2009, Sunley et al. 2008, Gwee 2009, Potts 2007).

Bakhshi and McVittie (2009) and Müller et al. (2009) state that creative industries introduce innovations both directly and indirectly through supply chain linkages. Indirect innovations occur thanks to creative industries supporting innovation in other industries through creative inputs and through knowledge exchange, which can happen either upstream (during the process of goods and services being sold by enterprises as inputs to the creative industries) or downstream (when creative' goods and services are purchased by firms in other industries). For example, Bakhshi and McVittie (2009)

estimate that "*if a typical firm in the UK spends double what it does on creative products – around 6 percent as opposed to 3 percent of its gross output – the likelihood that the firm introduces a product innovation either new to the firm or to its market is around 25 percent higher*".

Chapain et al. (2010) attest that some creative industries are more innovative than both the high-tech manufacturing industries and the non-creative knowledge intensive services. However, the three sectors tend to co-locate, indicating that creative industries influence innovation in other sectors. They found such a relationship when considering different types of spillovers from creative businesses: namely knowledge, product and network spillovers. Work Foundation and NESTA (2007) maintain that job mobility spillovers are the most potent ways the creative industries can create spillovers. Such spillovers were found by Kloosterman (2008) to occur in the Dutch architecture sector thanks to the influence of mobile young workers, many of them from outside the Netherlands.

c) How innovative are creative industries?

In general, there is no consensus on how innovative are the creative industries. Chapain et al (2010) say that some creative industries in the UK have innovation outputs below the national average. The industries they say are less innovative are: Film, Video and Photography and Arts and Antiques. However, Müller et al (2009) find that Austrian creative industries are among the most innovative sectors. In the same vein, Bakhshi and McVittie (2009) point out that creative industries in the UK appear to be more innovative than other sectors, although these higher rates occur just in product and not in process innovation.

However, there is consensus about how measurement in the Community Innovation Survey should be adapted to the specificities of the creative industries (Handke 2007, Alcaide-Marzal and Tortajada-Esparza 2007, Sunley et al. 2008, Miles and Green 2008, Stoneman 2010, Chapain et al. 2010). Abreu et al. (2010) indicate that there is an implication of a need to use different indicators for each industry, but point out, however, that this would complicate matters should it be desired to compare them. Innovation surveys based on the Oslo Manual (OECD 2005), are being conducted in more and more countries. However, differences in the sectors covered and the measurements made make benchmarking among countries difficult (Bloch and López-Bassols 2009). Despite the complications, indicators are being used by authors to measure innovation, looking at both innovation inputs and outputs; the inputs refer to internal and external sources, while outputs indicate innovation performance.

What authors have not mentioned is that some creative services are not included in the Community Innovation Survey (CIS) elaborated by Eurostat. NACE codes representing creative services not incorporated in the Community Innovation Survey are:

- NACE 90: Creative, arts and entertainment activities. This NACE includes restoring works of art such as paintings, that is, the subsector analysed in this paper.

- NACE 91: Libraries, archives, museums and other cultural activities.
- NACE 93: Sports activities and amusement and recreation activities.

Such activities also tend to be excluded in innovation surveys in countries less liable to engage in CIS surveys. However, some exceptions can be found. For example, the Australian Bureau of Statistics and the Spanish Bureau of Statistics both include "arts and recreation services" in their business innovation surveys.

2.2. *Knowledge bases and innovation. Incorporating symbolic knowledge*

The symbolic meaning of goods produced by the creative and cultural industries have been written about by various authors, such as Hoelzl (2005), Miles and Green (2008), Sunley et al. (2008), Stoneman and Bakhshi (2009) and Jaaniste (2009). The occurrence of symbolic meaning implies the existence of a symbolic or cultural knowledge base. In fact, as Klein (2011) observes, this requirement may involve a combination of different (synthetic and symbolic) knowledge bases.

The division of knowledge bases into three types -analytical, synthetic and symbolic- has been studied by scholars using a geographical perspective (Dolfman et al 2007; Throsby 2008, Asheim and Hansen 2009; Acs and Megyesi 2009; Markusen 2010; and Andersen et al. 2010), focussing on specific industries. Data about skills related to knowledge bases (such as skills in design, graphic arts, engineering, mathematics, and others) can be obtained through the Community Innovation Survey. However, this data is not available for NACEs 90 through to 93.

In the future, information about NACEs 90 to 93 could be available if national statistics offices were to follow Eurostat's example to increase the amount of data collected. In pursuit of this aim, the Community Innovation Survey has adapted statistics about types of innovations and activities. In CIS4 (year 2004), new types of innovation were included following the advice of the Oslo Manual (2005); consequently organizational and marketing innovations were incorporated. More recently, CIS 2010 integrated a new innovation activity category for product and process innovations related to design, named "design activities to improve or change the shape of the appearance of goods or services". Innovation related to changes in appearance is explained below.

2.3. Specificities in creative and cultural industries innovation

In an attempt to highlight the specificities of the creative industries - i.e. the symbolic features that differentiate these industries (Cappetta and Cillo 2008, Cunningham and Higgs 2009) - various concepts have been used to refer to creative innovations. These include: *aesthetic, soft, content,* and *artistic.*

Cunningham and Higgs (2009) used the term symbolic when they identified creative industries as those which create and exploit *symbolic* products and services. Cappetta and Cillo (2008) supported the view that symbolic characteristics distinguish the creative industries when they asked: "what do fashion companies, music firms, museums and theatres have in common?" The similarity they found is that in all these sectors firms need to integrate their management activities with those of the people responsible for *symbolic* value creation. With reference to symbolic attributes, several concepts have been developed to describe innovation specificities in the creative industries, although the focus has been on product rather than process innovation.. The reason why processes are neglected derive from authors' particular viewpoints, such as, for example, that of Sunley et al (2008) who declare that "it is vain to try to separate innovation from the effects of creative inputs".

Stoneman (2010) designates the label *soft innovation* to innovations "concerned with changes in products (and perhaps processes) of an aesthetic or intellectual nature, that (have) been ignored in the study of innovation prevalent in economics". Cappetta et al (2006) attributes the term *stylistic innovations* to those related to the fashion industry, but in this case innovations "result from the reassignment of social meaning to an existing product and/or from the change of the aesthetic characteristics of a product, generating both a new product – from a physical point of view – and a new meaning". Alcaide-Marzal and Tortajada-Esparza (2007) use the term *aesthetic innovations* for fashion oriented products (footwear) in which "appearance is the most strongly perceived value, and is its main novelty". They emphasise the importance of this kind of innovation because its result can imply that a product "can be perceived as being radically different and can displace earlier products".

In respect of the arts and cultural sector, Bakhshi and Throsby (2010) state there is a lack of studies and that the sector isr, ignored by those conducting research into the creative industries. The result is that there is no clear definition of innovation when applied to arts organizations. They mention the specific characteristics that differentiate arts and culture sectors from other creative industries: their not-for-profit objective and to serve a broader social purpose. Finally, they identify four types of innovation that are common to cultural institutions in the creative arts: innovation in audience reach, in artform development, in value creation, and in business management and governance. *Artistic innovation*, a term used by Galenson (2008), could be considered as the type of innovation that Bakhshi and Throsby (2010) refer to as artform development. Galenson (2008) talked about successive changes that artists introduce over time. He distinguished two types of artist, depending on how they innovate: experimental and conceptual artists. The latter artists often arrive at their contributions precipitously, while the former develop their contributions gradually.

Camarero et al (2011) distinguish three types of innovations occurring in museums: technological – as used for reaching audiences, for example-, organizational, and value

creation. They reveal that small museums lack internal resources, such as human resources, necessary for engaging in innovation.

Bakhshi and Throsby (2010) say that innovation in value creation can be of a *use* or *non-use* kind. The use value refers to the benefit obtained for a person who, for example, looks at the restored copy of *La Gioconda* in the Prado Museum, which resulted in the recovery of the landscape beneath the black background. A non-use value refers to a situation where, for example, people may value the fact that the paintings in the Prado Museum have been restored, even if they themselves do not visit the museum. In fact, nowadays, new technologies which allow online access to restored paintings in museums may connect use and non-use values.

These types of innovations are related to products, not to processes. Kloosterman (2008) confirms that, in general, innovation in cultural industries is mostly product innovation. However, a characteristic of restoration and conservation is that both product and process innovation can be carried out. The other terms used for innovation in creative industries also refer to products. For example, Stoneman and Bakhshi (2009) distinguish between *soft* (aesthetic) and *technological* innovation. Moreover, they identify two types of soft innovation: product changes that are aesthetic in nature (for example new books or movies), and innovations in goods and services that are primarily functional in nature (for example new furniture or car models). For Stoneman and Bakhshi (2009) also the types of innovation they refer to relate to new products (such as new book titles, video games, films, theatre production, advertising promotion, and clothing lines).

Therefore, taking into account how authors (e.g., Alcaide-Marzal and Tortajada-Esparza 2007) characterise aesthetic innovation as changes in a way that a product is perceived as new or different, some artworks restorations could be also referred to as aesthetic innovations. For example, the restoration conducted by El Prado Museum to its copy of *La Gioconda* could be said to be aesthetic since the result is a new appearance which adds value to the painting. But it is only possible to name it as an "aesthetic" innovation when the innovation affects the appearance, which means an innovation related to a product. As a result, we will use the term *beautiful* innovation to refer to both product and process innovations in the restoration and conservation of artworks.

To contextualise the CIS survey to the specificities of artworks restoration, and in an effort to counter Bakhshi and Throsby (2010)'s point about the lack of a clear definition for innovation when applied to arts organizations, we will explain what we mean by innovation in our study (this explanation was included in the survey we sent to museums):

«By innovation we mean anything that involves an advance or improvement, whether it is incremental (involving small improvements) or radical (involving improvements that completely change the way in which works are examined and analysed, or the way processes of conservation and restoration are undertaken), which generates:

- *An intermediate product (tools, technologies or materials) that facilitates or enhances examination, analysis, conservation and restoration. Included are technological advances in other sectors, such as nano-technology, which can be used in restoration.*

and/or

- *An increase in the speed of examination, analysis, conservation and restoration. An example of this would be a database that enables the swift identification of pictures and painters.*

and/or

- *An increase in the quality or accuracy of the examination, analysis, conservation and restoration process. An example of this would be the use of new systems for accurately identifying age, the composition of the mounting or substrate and colours (note the innovation would be the new systems used, not the "discovery" of the colours used by the artist).*

The innovation must be new or an improvement for your museum, but does not have to be new in your sector or market. It does not matter whether the innovation was originally developed by your museum or by other museums, institutes or companies».

3. Drivers of beautiful innovation

The organizational perspective based on the Resource-based View (RBV) [e.g. Barney 1991, Peteraf 1993] stressed that a firm's unique internal resources and capabilities determine a firm's performance. Barney (1991) said the RBV referred to all types of assets, organizational processes, knowledge capabilities and other potential sources of advantage. Currently, the framework used for understanding innovation drivers is clearly set around the idea of internal and external sources of knowledge which compose a firm's repository of capabilities (e.g., Cassiman and Veugelers 2006; Vega-Jurado et al., 2008; Hervas-Oliver and Albors-Garrigos, 2009).

In respect of the idea of a firms' internal resources as drivers for explaining innovative performance, most of the evidence is focused on R&D (e.g., Huergo, 2006; Vega-Jurado et al., 2008). This is despite a burgeoning criticism of this perspective by scholars who question a technological approach focused only on R&D (e.g. von Tunzelmann and Acha, 2005; Mendonça, 2009). In fact, R&D expenditures present rather weak evidence (Raymond and St. Pierre, 2009; Brouwer and Kleinkecht, 1997; Roper and Love, 2002) for explaining innovation, especially when industries are of low or medium technology intensity or are composed of small firms in non-high technology industries.

In our particular case, for NACE 90, "Creative, arts and entertainment activities", R&D is less important as an innovation driver due to the fact that these industries mostly exhibit a DUI (doing, using and interacting) innovation mode, in the sense of Jensen et

al., (2007), rather than a STI (science, technology and innovation) mode. Although it is recognised that some part of these industries may be based on analytic or synthetic knowledge bases which will require R&D activities (see Asheim et al., 20011), firms hardly in fact perform R&D activities, at least in the formal sense. Therefore, it makes more sense to use the specific knowledge bases in terms of the available skills that firms in these industries possess. In particular, these skills include employees graduated in science (i.e. having an analytic knowledge base), engineering (i.e. having a synthetic knowledge base), and restoration - i.e. skills in fine arts, history, artisanship, and otherds (i.e., having a symbolic knowledge base). These knowledge bases and, most importantly, their combinations and complementarities (in the sense of Teece, 1986 or Milgrom and Roberts, 1990), make up the key repository of knowledge and capabilities of a firm.

In addition, the combination of knowledge bases also defines the stock of activities a firm can perform. For instance, whether a firm has or not chemists (with analytic knowledge) determines the range of activities focused on applying colour and decoration to paintings being restored by fine arts employees (with symbolic knowledge). The rationale of this argument is as follows. Where a company has limited skill resources, maybe having only fine arts employees, the scope of restoring activities is limited. However, when a firm has engineers or/and chemists (with synthetic and analytic knowledge), then the performance of the fine arts activities can be upgraded thanks to support from other skills (with different knowledge bases). Skills "complement" one another forming a *relation among groups of activities*, such that as stated by Milgrom and Roberts, 1995:81) "…if the levels of any subset of activities are increased, then the marginal return to increases in any or all of the remaining activities rises". The power of this complementary effect is confirmed by Müller et al (2009) in their study of Austrian creative industries. Thus, the following hypotheses can be stated:

Hypothesis 1a: In cultural-driven creative industries, the number of skilled employees in the restoration department is a measure of a firm's capabilities and is positively related to its innovative performance.

Hypothesis 1b: In cultural-driven creative industries, the variety and combination of knowledge bases embedded in the available skills, and their associated restoration technologies, produce complementarities which are positively related to innovative performance

A second aspect of a firm's internal resources is its absorptive capacity (AC) (Cohen and Levintal 1989, 1990), which provides an indication of a capability to access external sources of knowledge that may facilitate innovation. Thus, a firm's internal resources determines the possibility to use and exploit external knowledge, and thus

improve capacity for innovation (e.g. Cohen and Levintal 1989, 1990; Klevorick et al., 1995). Lundvall and Nielsen (1999) emphasized that higher levels of skills and training reinforce the creation and exploitation of external knowledge, although they provide no empirical evidence to support this view.

Although R&D expenditures are frequently used as a proxy for AC, (e.g. Caloghirou et al., 2004; Vega-Jurado et al., 2008), some works link AC to the existence of a firm's other internal variables, such as the existence of a design office (Bougrain and Haudeville, 2002), or its educational and training policy which gives people a basis for introducing innovation (Lundvall and Nielsen, 1999). Hervas-Oliver and Albors-Garrigos (2009) highlighted the roles of skills in the production and design department. In fact different contexts and focuses have resulted in a variety of variables being linked to the existence of AC. Consequently, Nieto and Quevedo, (2005) point out that absorptive capacity could be measured by a set of factors instead of just a single indicator such as R&D expenditures on sales, patents, or the existence of a formally established R&D department in a company. Thus, building on such findings for application to our particular industry, we hypothesize that:

Hypothesis 2: In cultural-driven creative industries, the variety and combination of knowledge bases provides a platform for facilitating access to external sources of knowledge. Thus, the higher the variety of knowledge bases in a firm, the greater the access to external sources of knowledge.

However, RBV cannot explain how firms improve their innovation performance by drawing on external sources of knowledge. In this vein, the relational view (Dyer and Singh, 1998; Lee et al., 2001; Capaldo, 2007) argues that a firm's critical resources go beyond a firm's boundaries and that inter-firm collaborative linkages generate further significant returns (Dyer and Singh, 1998). External knowledge improves innovation capacity and can be found in sources such as customers, suppliers, competitors or universities, and other public research organisations (von Hippel, 1988; Katila and Ahuja 2002; Laursen and Salter 2006).

The creative industries are seen as following a DUI mode of innovation. Thus, the higher the access to external sources of knowledge, and the interactions that implies, the better the learning effect and the innovative performance. In particular, in respect of the creative industries the literature supports this view. Chapain et al., (2010), in respect of the software, film, or media industries, and Müller et al. (2009) or Sunley et al. (2008) for musing or performing arts, have provided evidence of how the open character of these industries facilitates innovation. Thus, a third hypothesis can be stated as follows:

Hypothesis 3: In cultural-driven creative industries, access to external sources of knowledge is positively related to innovative performance.

4. Empirical Analysis of Innovation in Museum Restoration and Conservation Departments

In this section, two questions are answered. The first question refers to whether museum restoration and conservation departments innovate; the second addresses why museum restoration and conservation departments are able to innovate - i.e. the innovation drivers.

4.1. *Data collection*

Data about innovation in museum restoration and conservation departments was obtained from a survey undertaken in 167 museums in 43 countries over the 5 continents. The questionnaire was adapted for museum restoration and conservation departments from the Community Innovation Survey[3] (CIS), which was itself drawn up following the recommendations of the Oslo Manual (OECD 2005). The CIS specifies the NACE codes to be used for the manufacturing and services sectors for the various countries surveyed, but does not include creative industries such as culture and entertainment (NACEs Rev.2: 90, 91 and 93).

Our adaptation of the CIS was guided by advice from conservation and restoration departments in some of the leading Spanish museums and restoration institutes and also several German museums[4]. The adaptation and design of the final version took a year.

The main difficulty we encountered in selecting the sample and obtaining information about who to contact was that in many cases directors and officers changed over the period between when we drew up our list of museums and when we started sending out emails and letters; and there were also changes in websites, contact addresses and postal addresses during that time. The questionnaires were translated into a number of languages including English, French, Italian, German and Spanish.

A requirement for selecting museum departments for the sample was that museums should have paintings in their permanent collection. This is because the study is part of a research project focused mainly on painting. As a result, museums which did not have a permanent collection, or did not have paintings, were excluded. The final sample consisted of 900 museums in 43 countries, from which 167 responses were received, i.e. 18.55% of the sample, with a confidence interval of 6.8% for a confidence level of 95%.

The surveys were sent in two rounds between December 2010 and July 2011 and we have considered replies received up to October 2011. 90 museums were found to have

[3] CIS surveys consulted were by the Spanish National Statistics Institute (Survey of Innovation in Enterprises) and the Department for Business, Innovation and Skills in the UK (CIS6, available at www.bis.gov.uk/policies/science)
[4] No names are given to preserve the anonymity of the survey.

restoration and conservation departments, and carried out restorations. Results analysed in this paper come from these 90 departments.

Table 1. Summary of responses received and countries where the museum restoration & conservation departments are located

Continent	Responses (number of museums)	Have restoration & conservation department and carry out restorations (number of museums)	Countries
Europe	112 from 29 countries (67%)	68	Austria, Belgium, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey (European area), United Kingdom
Americas	39 from 8 countries (23%)	14	Argentina, Brazil, Canada, Chile, Costa Rica, El Salvador, Guatemala, United States
Asia	7 from 3 countries (4%)	2	Japan, Republic of Korea, Taiwan
Africa	3 from 1 country (2%)	3	South Africa
Oceania	6 from 2 countries (4%)	3	Australia, New Zealand
TOTAL	**167 from 43 countries**	**90 museums**	

Compiled by the authors using data from the survey.

An innovation-related question asked what innovations the museum's restoration and conservation departments had carried out over the previous 3 years, the period recommended by the Oslo Manual (OECD 2005). Innovation in restoration and conservation studied in this paper is about processes, according to the definition of innovation types in the Oslo Manual (OECD 2005). However, thanks to innovation attempts to minimize the deterioration of an object, or to return it to an earlier condition or appearance (Lord and Lord 2008), sometimes innovations carried out would also

affect the product. Both types of innovations we named earlier in Section 2 as *beautiful* innovations.

Innovations in our survey concerning the displaying of works in exhibition halls (such as in terms of use of, or responding to, microclimates, light, or mountings), are seen as being related to artworks conservation rather than marketing. Other type of innovations (such as organisational and marketing innovations) would have appeared in our responses if the survey had considered all the departments in a museum.

4.2. Method

Variables (See Table 2) were measured using questions from the survey elaborated specifically for museums restoration and conservation departments, and are divided into innovation inputs and outputs. We have based our variables on the two types of complementarities revealed in the theoretical section (see Section 3). Data have been set out in a scheme (See Figure 1) that contains three groups of variables: internal and external knowledge inputs and innovation outputs. The first includes two separate sets of variables named as Skills and Specialists.

i. Internal Knowledge Inputs

a) *Skills*. This category includes two variables: knowledge bases and technologies.
   - *Knowledge Bases*. This variable measures qualifications held by specialists working in museum restoration and conservation departments. The relevant question in the survey was: "What qualifications do the specialists who work in the restoration department have?" Eleven qualifications were included in the answers (See Table 2). In Table 2, qualifications are classified according to the knowledge-based approach of Asheim and Hansen (2009): symbolic (arts), analytic (science) and synthetic (engineering) bases.
   - *Technologies*. This variable provides a measure of works that departments restore, or are able to, restore. The relevant question in the survey was "Which works in your museum does it restore, or can it restore?" Fifteen answers were included (See Table 2).

b) *Specialists*. This variable measures the number of specialists in museum restoration and conservation departments. In fact, the departments were very heterogeneous, with the number of specialists ranging from 1 to 65.

ii. External Knowledge Inputs

The second group includes two variables: Cooperation and Information.

a) Cooperation. This variable refers to joint research projects for innovation in restoration carried out by museum departments with external organisations: other museums, universities, restoration institutes and specialist companies. Cooperation reveals that museum departments are involved in an open innovation model, rather than a closed or outsourced model.

b) Information. This variable refers to the sources of external information used by museum restoration and conservation departments to obtain ideas that lead to innovation. Nine sources of information were integrated (See Table 2), such as, for example, universities and other R&D institutions.

iii. Innovation Outputs

The third group includes the different types of innovation occurring in restoration and conservation.

- *Types of innovation.* This variable refers to the types of innovations undertaken by departments. Eight innovations were defined (See Table 2), taking into account the phases of artworks conservation and restoration: examination, analysis, conservation and restoration. The division of innovations according to these phases follows from an intention to explain clearly to curators what is meant by innovation in restoration and conservation (Bakhshi and Throsby 2010)

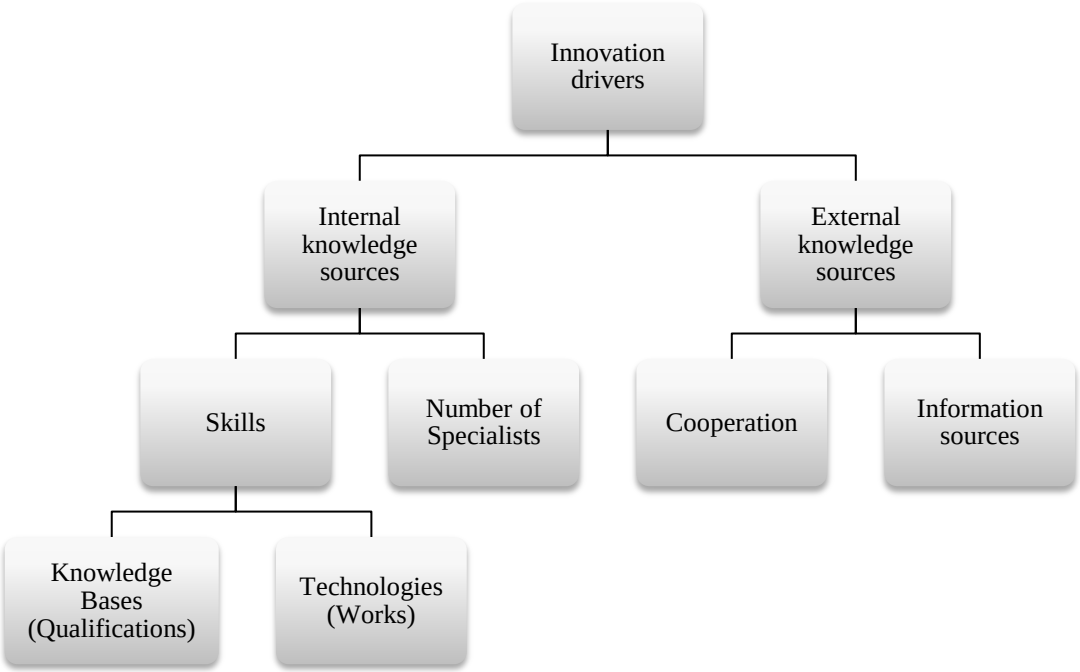


Figure 1. Scheme for innovation variables

Table 2. Variables to determine innovation in restoration & conservation

Variable		Measure
Internal knowledge inputs	1. Knowledge bases	Q1: Fine arts … *Symbolic Knowledge* Q2: Fine arts (specialising in restoration) … *Symbolic Knowledge* Q3: Conservation and restoration… *Symbolic Knowledge* Q4: Chemistry… *Analytic Knowledge* Q5: Physics… *Analytic Knowledge* Q6: Biology… *Analytic Knowledge* Q7: Engineering…*Synthetic Knowledge* Q8: History Q9: Art history Q10: Photography… *Symbolic Knowledge* Q11: Other
	2. Technologies	W1: Easel painting W2: Mural painting W3: Gilding and altarpieces W4: Polychrome sculpture W5: Palaeontology W6: Works in stone W7: Textiles W8: Metal and gold or silverware W9: Ceramics W10: Furniture W11: Glass W12: Photography W13: Archive documents W14: Film and video art W15: Other
	3. Specialists	Number of specialists in museum restoration and conservation departments
External knowledge inputs	4. Cooperation	Joint research projects with other institutions
	5. Information	INF1: From museums INF2: From professional associations INF3: From conferences and seminars INF4: From private R&D institutes and laboratories INF5: From Internet and specialised websites INF6: From public research centres INF7: From machinery, materials and software suppliers INF8: From scientific journals and technical publications INF9: From universities
Innovation outputs	6. Types of innovations	I1: in methods and instruments used to examine and analyse art objects I2: in products and reagents used to examine and analyse art objects I3: in techniques or procedures used in restoration I4: in tools or instruments used in restoration I5: in consumables (glazes, solvents, biocides, etc.) used in restoration I6: in displaying works in exhibition halls (in terms of the microclimate, light, mounting or substrate, etc.) I7: in storing works in storage rooms I8: in transporting works

In order to analyse the relationships between the variables and to test our hypotheses, a statistical analysis was conducted: considering partial correlations and a path analysis.

4.3. Results

4.3.1. Results which test if museums innovate

Out of all the museums that answered the survey, 90 had a restoration and conservation department (53.9%) and 77 did not (46.1%). In 72 of the 90 positive cases the department appeared in the museum's organisation chart, while in the other 18 it did not. Because the focus of our analysis is restoration and conservation, we will include the 90 positive cases when referring to "museum restoration and conservation departments" because all of them restore artworks.

An examination of the geographic location of the museums that responded to the survey showed that 60.7% of responding museums in Europe have a restoration and conservation department, while the figure in the USA and Canada is 34.4% and in Asia only 28%. It should be borne in mind that the organisation of the restoration sector varies between countries, depending on the role of restoration institutes and specialised companies.

100% of the museums that have a restoration and conservation department had carried out restoration work in the previous 3 years. Of all these museums:

- 95.6% restored works in their permanent collection and paid for the cost of restoration.
- 4.4% restored works in their permanent collection but did not pay for it or only paid a small part.
- 37.8% restored works in temporary exhibitions and paid for the cost of restoration.
- 21.1% restored works in temporary exhibitions but did not pay for it or only paid a small part.

About 90% of the museum restoration and conservation departments surveyed carried out some kind of innovation in restoration (See Figure 2). This means that 81 museum restoration and conservation departments are innovative and 9 are not. The average for innovations by the 81 innovative museum restoration and conservation departments is 4.6. This figure is the same as the average for innovative European restoration and conservation departments, while for departments in the USA and Canada it is 4.4.

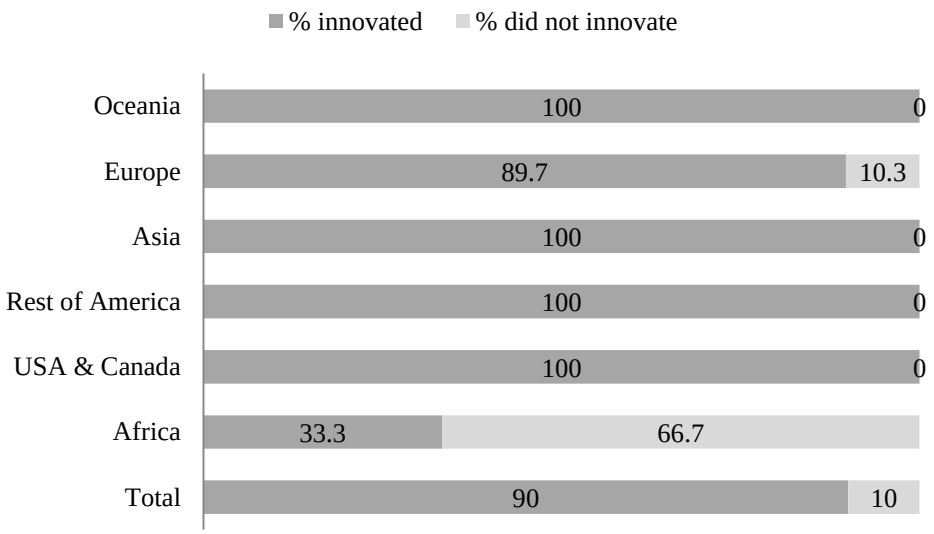


Figure 2. Museum restoration and conservation departments which carried out innovations (percentage). Compiled by the authors using data from the survey.

The results show that museum conservation and restoration departments do in fact innovate. Even though authors such as Stam et al. (2008) argue that "arts" sectors are clearly less innovative than others, as long as these sectors are not included in surveys such as the European Community Innovation Survey there will be no data to confirm such drastic conclusions.

Of the 90 museums with a restoration and conservation department, only 2 had taken out a patent in the last 3 years, one in the United States and one in Europe. The former did so in partnership with a university in its country, while the latter's patent came out of working with universities and specialist companies in both its own country and abroad.

4.3.2. Results about innovation drivers (testing hypothesis)

The richness of the survey means that each theoretical concept proposed by the hypotheses can be measured using more than a proxy, increasing the reliability of the results. The three hypotheses can be contrasted separately by a single test of hypothesis (Table 3), which does not allow for rejecting any of the three at a significance level of 5%. Thus, the variety and combination of skills is positively correlated with the production of innovations (Hypothesis 1), both when measured as the number of different technologies or works ($r = 0.36$) or number of knowledge bases ($r = 0.29$). The diversity of skills (technologies, knowledge bases) is positively correlated with external

knowledge sources (cooperation in R & D, external information) (Hypothesis 2), with statistically significant correlation coefficients around 0.27 (except in the case of the relationship between cooperation in R & D and knowledge bases, with a lower coefficient and statistically significant only at 10%). Finally, access to external knowledge sources (cooperation in R&D, external information) is also positively correlated with the production of innovations (r = 0.33 and r = 0.49 respectively).

However, the simple tests cannot show how the three hypotheses work together in a complex model, or whether the effects are direct or mediated by other variables. Therefore path analysis is performed, the results of which are summarized in Figure 3 (the coefficients reported are those statistically significant at 5% and have been standardized)[5]. While we can affirm that the three hypotheses continue to be confirmed, there are important nuances, which are described below.

Hypothesis 1 states that the variety and combination of knowledge bases, and their associated restoration technologies, increase the production of innovations. However, the hypothesis does not work directly, but indirectly, mediating the effects of external information. In fact, within the internal knowledge sources, it is size (measured by the number of specialists) that determines the amount and variety of skills (technologies, knowledge bases) available.

Hypothesis 2 states that knowledge bases provide access to external sources of knowledge. The hypothesis is true in the case of external information, the effect of which is amplified by the number of different technologies (beta = 0.27) and the number of different knowledge bases (beta = 0.26). However, cooperation in R&D is not mediated by the knowledge bases, but depends directly on the number of specialists (beta = 0.39).

Hypothesis 3 states that external knowledge sources positively affect the production of innovations. This hypothesis holds for both variables related to external sources. The availability of external information has a direct effect on the production of innovations (beta = 0.45). Cooperation in R&D has no direct effect, but it does have an indirect one (beta = 0.23) through access to external information.

[5] In order to comply with the usual assumptions of path analysis we contrasted: relations between additive and linear variables, multivariate normal distribution and normal residuals, homoscedasticity and absence of correlation between observations. Even if the "number of innovations" is a count variable, it follows a normal distribution in this case (results are quite similar assuming Poisson or negative binomial distributions). "Technologies" and "knowledge base" variables were used separately as measurements of the same concept (skills) are highly correlated.

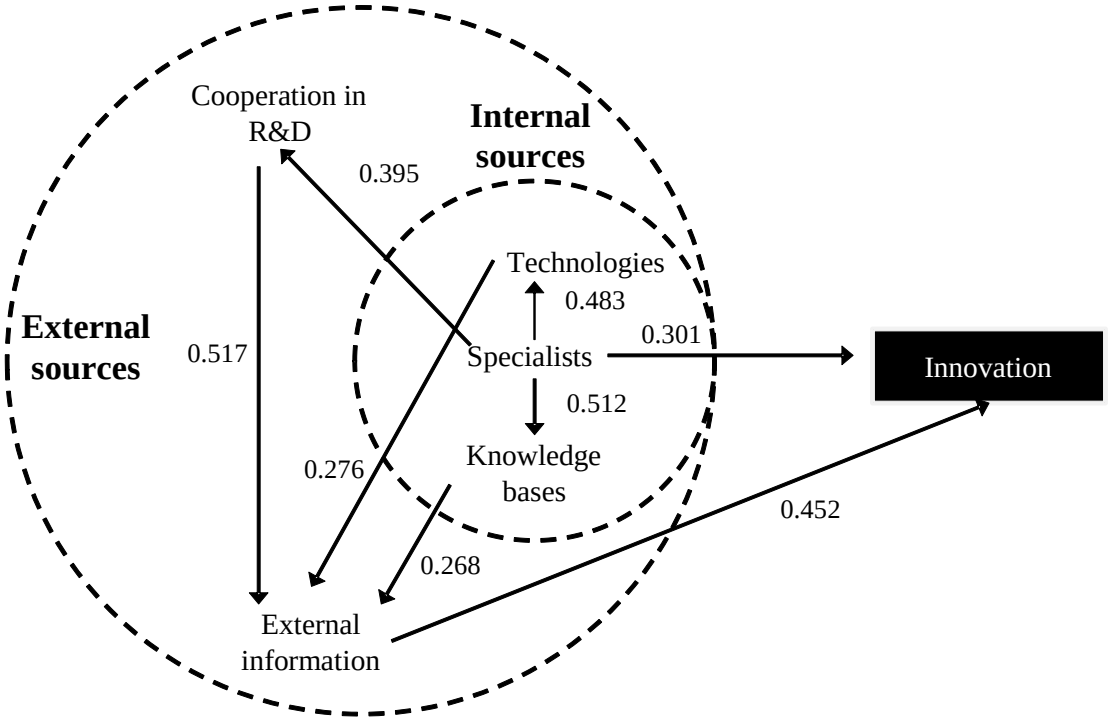
Thus, we have a model of production of innovations in artworks restoration activities (Figure 3). A first key variable is the number of specialists (size), which has a direct impact on the total production of innovations (beta = 0.30), determines the amount and variety of skills measured as technologies (beta = 0.48) or knowledge bases (beta = 0.51), and in turn influences the absorption of external information (beta = 0.27), and also influences the absorption of external knowledge through cooperation in R&D (beta = 0.39). The total effect of the scale is 0.51 (direct effect 0.30 + indirect effect 0.21). A second key variable is external information, which has a direct effect on the production of innovations (beta = 0.45), and mediates the effects of size (through knowledge bases and technologies) and of cooperation in R & D.

Table 3. Partial correlations and statistical significance.

	Number innovations	Technologies	Knowledge bases	Specialists	Cooperation R&D	External information
Number innovations	1.0000					
Technologies	0.3608*	1.0000				
Knowledge bases	0.2917*	0.5728*	1.0000			
Specialists	0.3595*	0.4839*	0.527*	1.0000		
Cooperation R&D	0.3345*	0.2640*	0.1839	0.3787*	1.0000	
External information	0.4913*	0.2762*	0.2685*	0.1281	0.5177*	1

* statistically significant at 5%.

Figure 3. Path analysis. Paths statistically significant at 5% and standardized coefficients.



Note: R2 of partial equations vary between 0.14 and 0.35. The overall R2 is 0.49.

5. Conclusions

This paper analyses the innovation drivers for the museum activity of “restoring works of art such as paintings”, which is included in NACE 90 called "creative, arts and entertainment activities". This sector has been neglected in many ways, both in the literature and in national statistics of innovation.

The difficulty of explaining why and how innovation occurs in the creative industries may be one reason why some activities have been neglected by those studying innovation. Equally, innovations that have been analyzed have tended to focus on the product, neglecting processes. In order to address both product and process innovations in restoration and conservation of artworks, we have used the term “beautiful innovation”.

As for other creative sectors, one of the main features of the sector analysed in this paper is its symbolic nature (Cappetta and Cillo 2008, Cunningham and Higgs 2009), i.e. its ability to create symbolic value. However, in restoration activity the variety of knowledge bases is an important feature. In order to analyze innovation in the restoration of artworks by museums from a perspective that does not neglect knowledge bases, we drew on the literature on innovation management to use a resource-based view of the firm that includes reference to enterprise capabilities and innovative performance. Data was obtained from a survey of 167 museums in 43 countries. The

responses revealed that 90 museums undertake restorations. The results of this study are based on the responses of these 90 museums. Innovation variables were divided into inputs and outputs; the inputs included both the internal and external knowledge resources, while outputs refer to the results of innovation.

Among the variables selected, the number of specialists (The Work Foundation, 2009), their qualifications or knowledge bases (Caloghirou et al 2004, Tether and Tajar 2008), and the technologies or works that the departments are able to restore (Caloghirou et al 2004) were taken into account as internal resources. In respect of external resources, cooperation -measured as joint research projects- and external information sources were included (Caloghirou et al 2004, Fu 2012).

The results reveal important sectoral characteristics:

- The size of the departments affects innovation output;
- The size of the departments affects the variety of knowledge bases (qualifications) and technologies (works) with which the museum can undertake restorations;
- Absorptive capacity, i.e. ability to access external resources, depends on the character of internal resources;
- The sector has an open innovation model, where internal and external sources of knowledge are complementary, in the sense of Teece (1986).

The results about the direct and indirect impact of size, skills (knowledge bases and technologies), cooperation and information sources on the innovation performance of restoration departments, are not only important contributions by this paper to academic debate. They should also be taken into account by those responsible for museum management and policymakers involved in policies affecting cultural industries.

All in all, our model has highlighted in the arts industry capabilities formed by:

A) internal resources (Milgrom and Roberts 1995, Stieglitz and Heine 2007, Hess and Rothaermel 2011) and
B) the combination between internal and external resources (Chesbrough 2003, Caloghirou et al 2004, Cassiman and Veugelers 2006, Tether and Tajar 2008, Spithoven et al 2010, Fu 2012).

Thus, this paper has disentangled the contributions of each part of a firm's capabilities on its innovative performance. As above mentioned, the hypotheses have been confirmed, with empirical evidence presented of the innovation patterns in the restoration and arts industry, a sector traditionally neglected in the innovation literature.

The importance of this paper is that the literature on creative industries has in its analyses of open innovation and absorptive capacity neglected the arts sector (Bakhshi and Throsby 2010), and the relationship with knowledge bases. With our contribution, new research avenues are opened.

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