Knowledge Transfer in Sustainable Contexts: A Comparative Analysis of Periods of Financial Recession and Expansion

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Abstract: Examining the knowledge transfer process in sustainable contexts, we identified various gaps, which we analyzed in this study. First, we compare the temporal context of firms with eco-innovation strategies before and after the financial crisis of the first decade of the 21st century. Second, we analyze the firms’ knowledge transfer, from the use of knowledge sources to innovation through intellectual property. Third, we consider the influence of firm age on firms with eco-innovation goals and the influence of size on intellectual property. We used data from a sample of 3004 firms prepared by the Spanish National Statistics Institute for two different time periods: 2009 and 2014. Our results suggest that firms that achieve sustainable innovations do not show large differences in behavior in the two economic periods. We found that knowledge in firms with eco-innovation goals is transferred through intellectual property. The results show that firm age and size influence these processes during the years analyzed and thus have various implications for theory and for small firms, which are generally family firms. Small and family firms should strengthen their registration of intellectual property so that their knowledge transfer process ends in innovations for both the firm and the market.

Keywords: eco-innovation; knowledge transfer; intellectual property rights; economic recession; knowledge sources; firm size; firm age

1. Introduction

Adopting sustainable management in organizations has been proposed as an active need required by markets and governments [1], making sustainable management a dynamic research field that promotes efficient management of organizations [2]. This consideration leads us to the concept of eco-innovation. Based on the prior literature, we define eco-innovation as the management of processes, products, and services that reduce environmental impacts, take responsibility for the use of natural resources, and are oriented to sustainable knowledge [3]. Eco-innovation is a type of innovation that has greater complexity and that makes greater contextual demands than traditional innovation [4,5].

This study combined two levels of observation in the field of sustainable innovation: (1) the organizational perspective, in which we examined the behavior of firms that use sustainable strategies and (2) the perspective of the economic–financial environment, in which we compared organizations’ actions in two different periods.

A review of the literature on sustainability shows some gaps. First, despite the fact that organizational behavior differs between periods of general economic expansion and recession [6], very little attention has been paid to the comparative study of green innovation processes in different economic periods.
Second, although numerous authors have studied sustainable innovation in recent years, few studies explain the processes that precede the implementation of eco-innovation [7]. Eco-innovation is based fundamentally on an organization’s intangible resources and capabilities and emerges from good management of knowledge resources [8]. Our study was grounded in the knowledge-based view of the firm (KBV), which assumes that the basic resources the firm uses have a high knowledge content [9]. We analyzed the antecedents of eco-innovation from the perspective of knowledge sources as an intangible asset [10].

Third, little attention has been paid to intellectual property rights in the broad sense. Most studies focus on patents as a codified and formalized asset [11] and on analysis of intellectual property as the result of R&D and innovation processes [12,13]. Since property rights form part of the innovation process and the firm’s development [14], we examined knowledge transfer, both from inside and outside the firm and among departments within the firm [15]. Our study thus aimed to show the transfer process in firms that apply knowledge and generate property rights by proposing eco-innovation objectives.

Attending to the gaps identified, this study analyzed the weight of each knowledge source in influencing eco-innovations and intellectual property in order to argue for the creation of hybrid knowledge transfer organizations [16]. Part of the literature shows the influence of knowledge sources on eco-innovation [17], but research has not shown the relative importance of each different knowledge source on eco-innovation management and its resulting materialization in intellectual property. Although prior studies have attempted to help understand part of this problem, we need a better understanding of the effect of each knowledge source on sustainable management to guide adoption of measures and actions.

We also stress that opening the European Union (EU) single market has increased the use of intellectual property rights [18]. Despite this increase, and despite the importance the EU attributes to property rights, scholarship that analyzes the progress of these rights in the EU is minimal [18]. Intellectual property rights have been considered as a temporary way to protect investment in innovations against imitation [19]. Property rights consist exclusively of specific rights as a result of knowledge generated through a study and/or novel development [20]. The eco-innovation literature has not attended to intellectual property rights and the possible repercussions of these rights for greater economic advantage over time in sustainability contexts.

Further, most prior studies investigate the impact of intellectual property, attending fundamentally to patent and branding rights [18]. The intellectual property rights that the EU details are, however, right to patents, branding, utility models, and copyright. Research has hardly studied rights granted through utility models [21] and has completely ignored copyright. Since intellectual property has been considered a key indicator of economic activity [12], an important gap appears in the analysis of two of the four components of intellectual property.

Our study aimed to help fill these gaps in the literature by developing a theoretical model to facilitate understanding of the management of eco-innovation processes. In such processes, the firm selects the right knowledge for the activity, transfers the knowledge into intellectual property, and applies the knowledge to innovation.

This article contributes to the literature in several ways:

First, our model analyzed the influence of different knowledge sources on eco-innovation objectives and intellectual property. These relationships of influence are considered composites of aggregates that determine the relative weight of each knowledge source. Analyzing composites enabled us to specify the predominant knowledge and the most specific knowledge inherent in specific environments, such as eco-innovation. We tried to determine whether eco-innovation requires greater external knowledge sources, as the literature argues [22], or a balance of internal and external knowledge.

Second, our model disaggregated the importance of intellectual property rights. We studied intellectual property by dividing it into the analysis of patents, branding rights, utility models, and copyright. Through this breakdown, we determined how much importance each of these rights has for intellectual copyright.
Third, we analyzed the knowledge transfer process (both external and internal [23]) in the context of sustainability. Once knowledge was generated from its different sources, we studied its influence on innovation (market and firm) through eco-innovation objectives and intellectual property. This analysis determined the influence of property rights on the firm’s innovation capacity [24]. Further, we believe it is of vital importance to understand the effect of firm size on the relationship between eco-innovation and intellectual property. If the moderation of size is positive in this relationship, and if registering intellectual property mediates positively between establishment of eco-innovation objectives and innovation in the firm, then small firms (most of which are family firms [25]) should improve how they manage registration of intellectual property. It was thus important to determine whether the effect of small (primarily family) firm size strengthened registration of intellectual property in small and family firms [26] in sustainable environments.

Fourth, this study proposed a comparative analysis of organizations that apply property rights in eco-innovation in periods of recession (following 2008) and expansion. We examined the evolution of the data before and after the crisis to determine whether there were differences in behavior caused by the firms’ economic contexts. This question was crucial for family (or smaller) firms, which generally have greater financial difficulty in times of crisis.

2. Background

Various studies analyze the use of knowledge sources and their positive influence on innovation [27,28]. Some studies also analyze how knowledge sources influence green innovations [17], exploring the achievement of more lasting competitive advantage by integrating and exploiting knowledge acquired or developed [29]. Such research is linked to the KBV, which views the organization’s basic resources as knowledge-based assets [9]. Intangibles such as knowledge are not easy for the competition to imitate because they have been developed by the organization and remain within its memory [10].

Knowledge sourcing thus emerges as a critical factor for innovation [30]. Knowledge resources enable organizations to achieve success in sustainable innovations [31]. Organizations acquire knowledge and modify behavior that reveals new knowledge [32]. Knowledge in the firm is either tacit (or implicit) or explicit [11]. Whereas tacit knowledge is difficult to formalize and communicate, explicit knowledge is formal and codified in language [33]. Tacit knowledge is thus more strategic when firms seek to prevent imitation by competitors.

The context of green innovations involves using different technical and economic solutions, requiring firms to use knowledge differently [34]. Sustainable innovations must thus coordinate different management activities [3]. This study used the concept of eco-innovation as defined by the OECD (OECD, 2009), which involves the management of process, product, and service innovations oriented by sustainable knowledge. We thus view eco-innovation as a process for introducing organizational, technical, or production innovations that reduce environmental risk [35].

2.1. Knowledge Sources and Eco-Innovation Objectives

Firms with sustainable management in their novel activities not only reduce environmental impacts but also improve production efficiency and are more responsible in their use of natural sources [36]. The green context is more demanding and complex [4]. Despite the benefits associated with using eco-innovation [35], firms incur high costs in eco-innovation, as they must intensify R&D [37] and develop specific green capabilities oriented to reducing environmental burden [38]. They must also train their employees in sustainability programs [39]. These contexts thus require managing the selection, acquisition, and transfer of knowledge [40]. Such transfer can be from outside the organization inward or among departments within the organization [23].

Prior research holds that merely access to information and knowledge does not motivate their use [30]. One must have a process of searching for, accessing, transferring, and applying the knowledge [41]. To achieve transfer, the organization must recognize and apply internal and external knowledge, which comes from the market, to determine the fundamental ability needed and recognize customers and competitors [42]. Firms become oriented to production efficiency,
production of quality, and reduction of environmental impact by using knowledge and establishing specific eco-innovation objectives [43].

Knowledge can be acquired from various sources [44], and these sources can be divided into different origins of knowledge for study. Using diverse knowledge sources can increase complexity, since firms must relate the different information they receive from these sources [45]. Some authors support the view that external knowledge is more relevant in eco-innovation [22]. Combining knowledge when firms are open to external knowledge sources can soften internal constraints on adopting green innovations [46].

Based on the arguments presented, we formulated the following hypotheses:

**Hypothesis 1 (H1).** Using knowledge sources positively and significantly influences eco-innovation objectives.

**Hypothesis 1a (H1a).** Using internal knowledge sources positively and significantly influences eco-innovation objectives.

**Hypothesis 1b (H1b).** Using knowledge sources from private organizations positively and significantly influences eco-innovation objectives.

**Hypothesis 1c (H1c).** Using knowledge sources from the market positively and significantly influences eco-innovation objectives.

**Hypothesis 1d (H1d).** Using knowledge sources from public organizations positively and significantly influences eco-innovation objectives.

### 2.2. Knowledge Sources and Intellectual Property Rights

Knowledge incorporation as a process of learning and comprehension [47] generates an internal tension. This process vacillates between orientation to external knowledge sources through suppliers, customers, and other organizations [48] and focus on the knowledge generated in the organization itself. Some prior studies show that reusing prior internal knowledge improves innovation and makes it more manageable [49], generating a knowledge feedback loop. Other studies propose that it is more effective to acquire knowledge from outside the organization (feedforward), since such acquisition creates new knowledge and new core competences in the organization [50] that enable the creation of innovations. How knowledge is made tangible has been measured by the number of patents and property rights generated [12].

Intellectual property rights were created to protect against unfair market practices [51]. These rights grant the holder’s invention protection against unauthorized commercialization by third parties [52]. The World Intellectual Property Organization (WIPO) defines two essential branches of intellectual property: industrial property and copyright. Industrial inventions that are not obvious receive patents, which are then applied in industry. Patent protection usually lasts for 20 years. Less restrictive than inventions, which can be patented, utility models include devices and tools, and usually last 6–10 years [21]. According to the WIPO, copyright applies to creations and original works, protects ways of expressing ideas rather than the idea itself, and generally lasts for 20 years. Most preceding research has analyzed property rights related to patents and brands [18] and has not addressed utility models, much less copyright.

Various authors believe that intellectual property rights help innovative development [53]. External knowledge is used in such development to innovate in order to reduce costs and risks [54], since using internal knowledge can lead to organizational inertias, making innovation more complex [55].

Other studies focus on combination and integration, in which the firm integrates different knowledge sources to address a problem [41] and fosters achievement of greater combinations of knowledge transfer [50]. We stress, however, that using too many knowledge sources can reduce the use of environmental innovations [46]; it is preferable for the firm to determine the best information source for its innovation [56].

Based on these arguments, we formulated the following hypotheses:
Hypothesis 2 (H2). Using knowledge sources positively and significantly influences intellectual property rights.

Hypothesis 2a (H2a). Using internal knowledge sources positively and significantly influences intellectual property rights.

Hypothesis 2b (H2b). Using knowledge sources from private organizations positively and significantly influences intellectual property rights.

Hypothesis 2c (H2c). Using knowledge sources from the market positively and significantly influences intellectual property rights.

Hypothesis 2d (H2d). Using knowledge sources from public organizations positively and significantly influences intellectual property rights.

2.3. Mediation of Property Rights in the Relationship between Eco-Innovation Objectives and Innovation

Eco-innovation objectives require integrating organizational issues with aspects of corporate strategy [2]. To maintain competitive advantage, firms must implement eco-innovation strategies and actions [57]. In implementing eco-innovation objectives, the firm must attend to market demands as well as normative pressures [58]. Protection of property rights is very important to achieving a larger market share, especially with eco-products [59]. The number of property rights generated has been viewed as a factor to measure innovation intensity [12], and intellectual property rights reflect the last phase in the innovation process on the market [60]. In a more complex context, such as that of sustainability, innovations require greater knowledge and investment [61]. To innovate, the organization must have generated or acquired knowledge that permits it to determine how to solve a problem [33]. Property rights can be seen as a temporary monopoly that protects innovations from imitation through patents and copyright [62].

Innovation has been defined as “the process, outcomes, and products of attempts to develop and introduce new and improved ways of doing things” [63] (p. 4). The literature proposes two types of innovation that occur in organizations: product innovations and process innovations [64]. Product innovations are market-oriented and offer new products or services to the market, whereas process innovations occur with changes in methodology or procedures to increase efficiency [65]. Product innovations thus have a direct connection to the market [66], while process innovations can provide internal flexibility [67].

Innovation is thus considered as the transformative process between the generation of an idea and its implementation [63] in which the selection, acquisition, and transfer of knowledge end in the innovative process [40]. Property rights reflect the organization’s tacit knowledge [33] and protect imitation so that the knowledge is developed and transformed into innovations. Enabling protection of competitive advantage over time in the complex green environment [4], property rights impact innovations in a sustainable context by showing the market new solutions that provide benefits for the environment [68].

Based on these arguments, we formulated the following hypothesis:

Hypothesis 3 (H3). Property rights mediate positively and significantly in the relationship between eco-innovation objectives and innovation.

2.4. The Effect of Firm Age on Eco-Innovation Objectives

Firms that strengthen eco-innovation strategies design their sustainable products and services to enable them to orient the firm toward a better green reputation, improving its competitive position [69] while simultaneously fostering the implementation of innovations. The organization safeguards the resources used, while making it difficult for competitors to imitate its products or services [29]. The use of these resources can also be analyzed, however, from an evolutionary view of organizations that implement eco-innovation [70]. Young firms must develop their own competences [71,72], especially as they begin to introduce new innovation practices [73] to consolidate their successful
activities. The literature has studied how these capabilities are related to business experience prior to the creation of the firm [45]. Young firms incur high costs when implementing eco-innovations [70].

Established firms, on the other hand, have generated their own routines and ways of doing inherent to their trajectories [74]. These routines may limit the integration of new knowledge [75]. Core competences can sometimes become inflexible when the organization limits the exploratory search for innovation [76]. The organization may not even generate new innovations or know how to adapt to the returns of the environments, making their old competences obsolete [77] and causing innovation processes to stagnate [78]. We thus proposed that the organization’s age influences eco-innovation as the firm transitions through different stages: in the first stage, young firms need time to acquire new competences to apply sustainable innovation [79]; in the second stage, incumbent organizations generate inertias and skills that enable them comfortably to achieve sustainable innovations; and in the third stage, organizational inertias prevent innovation [74] and the implementation of eco-innovation objectives.

Based on these arguments, we formulated the following hypothesis.

**Hypothesis 4 (H4).** Firm age has an inverted U-shaped relationship to eco-innovation objectives.

### 2.5. The Effect of the Organization’s Size on the Relationship between Eco-Innovation and Intellectual Property Rights

A new product is introduced on the market, and competitors imitate it or respond to this new option. Intellectual property rights attempt to safeguard the firm’s investment and protect it from competitors’ practices [80]. Firms thus seek to appropriate the benefits of property rights in order to increase the value of the innovation [80].

Firms protect new knowledge from imitation and delay the entry of competitors through intellectual property rights [14]. This protection is different for larger firms (which generate these barriers) than for small firms, which are affected above all in the early stages [81]. Small firms that decide to implement eco-innovation policies do not always have enough financing to access new markets [82]. Further, small firms lack a great capability to acquire knowledge and are more intuitive, while large firms are supported by more sophisticated management [17]. Many small firms are family firms, which are affected by the organization’s size [83]. These firms must decide whether it is advantageous for them to register intellectual property [26]. We stressed that financial decisions that affect small and family firms have a greater impact in periods of crisis [25]. Further, small organizations are more vulnerable to the government’s and the market’s sustainability demands [84] than larger organizations, which have more opportunities to generate and apply more sustainable knowledge as they grow [85].

Based on these arguments, we formulated the following hypothesis:

**Hypothesis 5 (H5).** Firm size positively and significantly moderates the relationship between intellectual property rights and eco-innovation objectives.

### 2.6. The Effect of Periods of Recession and Expansion

Economic cycles are influenced by expansionary and recessive phases [86]. Recession periods are contexts of high uncertainty, therefore, organizational behavior can be compared to periods of expansion [87]. The literature has also shown that economic–political uncertainty can impact only in periods of recession and has no effect on expansion stages [88].

Firms use knowledge sources to be creative and reduce uncertainty [42]. The literature proposes that firms generally maintain better profit levels and devote more resources to innovation in periods of economic expansion, whereas resources are more limited in periods of financial recession [89].

An excess of resources thus increases the possibility of increasing the risk involved in developing innovations [90]. In a period of recession, firms attempt to reduce costs to survive. This attempt can even lead them to reduce their capability to adapt to economic recovery [6], primarily because they have little or no access to financing.
Research confirms that firms reduce employment, R&D expenditure, investments, and dividends in periods of financial crisis [91]. In situations of financial limitation, firms generate less strategic interest in eco-innovation. When firms’ innovation levels decrease, so does their registration of property rights. Further, the literature shows a relationship between the influence of macroeconomic conditions and innovative activities [92].

Based on these arguments, we formulated the following hypothesis:

**Hypothesis 6 (H6). In periods of financial expansion/recession, firms use different knowledge sources, which influence eco-innovation objectives and intellectual property rights positively and significantly.**

3. Research Method

Our study used a sample of 3004 firms from the Spanish Technological Innovation Panel (PITEC) prepared by the Spanish National Statistics Institute (Instituto Nacional de Estadística (INE)). This sample panel has been gathering data on over 10,000 firms since 2003. This study selected data for two periods, 2009 and 2014. Specifically, it analyzed data on the firms that have used intellectual property to determine these firms’ behavior and the relationship they establish between knowledge and eco-innovation. The Spanish case is relevant due to the intense need for policies to stimulate knowledge in Spanish companies, promote collaboration [93], and promote entrepreneurship and intrapreneurship [94]. This could provide the transfer of knowledge. The panel data enabled us to analyze data from two different economic time periods and the support provided by knowledge sources, as well as the influence of the environmental innovation observed on innovation, through the use of intellectual property. The theoretical model is shown in Figure 1.

![Theoretical model](image)

**Figure 1.** Theoretical model.

**Variables Used**

Eco-innovation: We used the questionnaire items that measure orientation to eco-innovation and that ask about a decrease in environmental impact, reduction in energy per unit produced, improvement in health and safety, and fulfillment of environmental requirements. Prior studies have used these items to analyze eco-innovation [95]. The variables are categorical, with responses of 1 = “high”, 2 = “medium”, 3 = “low”, and 4 = “not applicable” for the years 2009 and 2014.
Intellectual property: Four variables were employed: use of protection through utility models, use of protection through branding, use of protection by patents, and use of copyright. These variables are dichotomous (0 = does not employ use of protection; 1 = does employ use of protection), and we collected data for the years 2009 and 2014.

Innovation: The questionnaire uses two dummy variables, novelty of innovations for the market (0 = does not create innovations for the market; 1 = does create innovations for the market) and novelty for the firm (0 = does not create innovations for the firm; 1 = does create innovations for the firm), for the years 2011 and 2016. We used the data from two years later (t + 2) to measure the effect of using the antecedent variables and their effect.

Knowledge sources: We took 11 items that request information about the knowledge sources the firms employ. We divided these 11 items into four variables by type: knowledge from private organizations (includes knowledge from scholarly journals and technical publications; knowledge from professional or industrial associations; and knowledge from consultancies, laboratories, or private institutes), knowledge from public organizations (knowledge from universities, knowledge from public research entities, and knowledge from technology centers), knowledge developed in the firm (includes knowledge developed within the firm or the group), and knowledge from the market (includes knowledge from customers; knowledge from team suppliers; knowledge from competitors; and knowledge from conferences, fairs, and exhibits). The variables for knowledge source are categorical, with responses of 1 = “high”, 2 = “medium”, 3 = “low”, and 4 = “not applicable”. Data were collected for the years 2009 and 2014.

Firm age: We used the variable firm age, which appears on the questionnaire where firms are asked to indicate the year in which the organization was created. The age of the company is considered as a relevant underlying factor for improving the sustainability of the organization [96]. Older and newer companies have notable variations in their behaviors [97].

Firm size: The variable size was drawn from the questionnaire, which asks the number of employees for each year analyzed. The number of employees is a good predictor of firm size [98]. Thus, the literature shows differences between large and small companies; it is considered that larger companies have better access to information sources and this access allows them to carry out sustainable innovations [17]. The variable size was the object of study due to different perspectives of size in sustainable contexts [99,100].

4. Results

The average firm age in the sample of 3004 firms was 37.44 years. As a description of the characteristics of the sample, we indicated that the average number of employees, by year, was as follows: 2009 = 403.55 and 2014 = 364.78. Average percentage distribution of women was as follows: 2009 = 20.63 and 2014 = 27.41.

We used the SPSS Statistics 26 software and performed the means of the knowledge sources used in the study. Table 1 displays the means of the results for the variable knowledge used for the two years analyzed.

| Knowledge Source          | 2009  | 2014  |
|---------------------------|-------|-------|
| Private knowledge         | 2.740 | 1.531 |
| Public knowledge          | 3.001 | 1.435 |
| Market knowledge          | 2.439 | 1.828 |
| Internal knowledge        | 3.092 | 2.441 |

The graph in Figure 2 shows the percentage distribution of the way the firms use the knowledge.
Table 2 shows the means of the responses from firms that registered industrial property, divided into the four uses distinguished by the European Commission. This descriptive analysis was made with SPSS Statistics 26 software. We saw the tendency to use more internal knowledge than external and a stable tendency to use the same knowledge sources.

Table 2. Mean of use of property rights.

| Property Rights         | 2009  | 2014  |
|-------------------------|-------|-------|
| Use of utility model    | 0.187 | 0.093 |
| Uses of copyright       | 0.040 | 0.023 |
| Use of branding         | 0.440 | 0.287 |
| Patents                 | 0.295 | 0.221 |

Figure 3 shows the percentage distribution of adoption of the four forms of intellectual property. Here too, we see the marked residual character of use of copyright in both years and the same tendency in use of utility models.

To check the variation in the sectoral structure in the two periods studied, we carried out the Student’s t-test in which we analyzed the frequencies of the companies in each sector: in the recession period ($M = 52,867$, $SE = 57,497$) and in the period of expansion ($M = 174,667$, $SE = 543,243$). It was verified that $t(91) = -1496$, $p = 0.138$ (C.I. 95% = $-283,557; 39,957$), so it was not assumed that the...
frequency averages of the companies in each sector were different. We considered that there has been no significant variation in the sector structure in the two periods analyzed.

We used SmartPLS software to test our theoretical model and hypotheses [101], applying the variance-based SEM technique and PLS estimation method. We used PLS and not CBSEM estimation (covariance-based methods) because our model used common factor variables. These variables explained the model through the maximization of the variable estimated [102] and not the theoretical covariance matrix, as estimated in the CBSEM method [103]. PLS enabled us to use and analyze variables linked to a construct, that is, the weighted combination of its indicators [104]. Further, one of the goals of our model was to determine the weight of the knowledge sources described by the organizations that decided to use intellectual property rights. It was thus important in our study to consider the significance of eco-innovation and its influence on property rights, divided into copyright, brands, utility models, and patents, as this division enabled us to determine four parameters and their relative importance in shaping the relationship. To make these goals concrete, we used PLS estimation, which determines the weights and differences among the items that compose the variable [105]. PLS estimation is also accepted as appropriate for analyzing secondary data [105,106].

To estimate the measurement model and the relevance of the weights, loadings, and coefficients, we executed the bootstrapping algorithm. We established the measurement model (external model) as a reflective model (variable eco-innovation) and a formative model (variables knowledge sources, intellectual property, and innovation). Due to its characteristics, the variable eco-innovation is expressed as a reflective latent variable. The data showed that the indicators correlated highly among themselves. Table 3 presents the items’ reliability, internal consistency, and discriminant validity. The loadings on the variables were all above 0.7. The values for composite reliability were also greater than 0.7 [107]. The average variance extracted (AVE) was above 0.5 [108].

Table 3. Construct reliability and validity.

| Loadings | p-Value | Alpha Cronbach | Composite Reliability | AVE   |
|----------|---------|----------------|-----------------------|-------|
| Ecoinn. 2009 |         |                |                       |   |
| ecoinn1-09 | 0.757 *** | 0.000          | 0.927                 | 0.762 |
| ecoinn2-09 | 0.908 *** | 0.000          |                       |       |
| ecoinn3-09 | 0.916 *** | 0.000          |                       |       |
| ecoinn4-09 | 0.901 *** | 0.000          |                       |       |
| Ecoinn. 2014 |         | 0.904          | 0.934                 | 0.780 |
| ecoinn1-14 | 0.781 *** | 0.000          |                       |       |
| ecoinn2-14 | 0.905 *** | 0.000          |                       |       |
| ecoinn3-14 | 0.919 *** | 0.000          |                       |       |
| ecoinn4-14 | 0.919 *** | 0.000          |                       |       |

Note: *** p < 0.001; n = 3004. AVE—average variance extracted.

For the variables knowledge sources, intellectual property, and innovation, we established formative measurement models. In this case, the indicators could be independent of the construct and needed not correlate [104]. We could thus analyze the contribution of each indicator to the variable or construct. Table 4 presents the results of these variables and their indicators.

Table 4. Discriminant validity of the model.

| Fornell–Larcker | Heterotrait–Monotrait Ratio (htmt) | 1  | 2  | 3  | 4  | 1  | 2  | 3  | 4  |
|-----------------|-----------------------------------|----|----|----|----|----|----|----|----|
| Internal K. 09  | 1                                 | 1  | Internal K. 09 |      |      | 1  | Internal K. 09 |      |      |
| Market K. 09    | 0.195 n.a                         | 2  | Ecoinn. 09     | 0.141|      |    |                |      |      |
| Private K. 09   | 0.250 0.685 n.a                   | 3  | Size 09        | 0.036| 0.155|    |                |      |      |
Table 5. Weights of knowledge source variables.

| Knowledge Source Variables | 2009 | 2014 |
|----------------------------|------|------|
|                            | t Value | Weights | t Value | Weights |
| Private centers of knowledge | | | | |
| Knowledge: scholarly journals, technical publications | 11.193 *** | 0.530 | 15.926 *** | 0.579 |
| Knowledge: professional or industrial associations | 5.383 *** | 0.446 | 11.325 *** | 0.296 |
| Knowledge: consultancies, laboratories, or private institutes | 7.391 *** | 0.393 | 9.912 *** | 0.329 |
| Public centers of knowledge | | | | |
| Knowledge: universities | 6.486 *** | 0.372 | 5.919 *** | 0.433 |
| Knowledge: public research entities | | | | |
| Knowledge: technology centers | 1.811 | 0.154 | 2.138 ** | 0.139 |
| Knowledge: team suppliers | 8.397 *** | 0.611 | 10.226 *** | 0.534 |
| Knowledge: customers | 7.280 *** | 0.302 | 6.769 *** | 0.333 |
| Knowledge: competitors | | | | |
| Knowledge: conferences, fairs, exhibits | 12.954 *** | 0.502 | 11.632 *** | 0.555 |

Note: ** p < 0.01; *** p < 0.001; n = 3004.
Table 6 similarly shows the weight of each variable’s contribution to process or product innovation within the variable innovation.

**Table 6.** Weights of innovation variables.

| Variable              | 2009         | 2014         |
|-----------------------|--------------|--------------|
|                       | t Value      | Weights     | t Value      | Weights     |
| Innovation in market  | 15.488 ***   | 0.568       | 16.698 ***   | 0.549       |
| Innovation in firm    | 4.293 ***    | 0.667       | 9.578 ***    | 0.694       |

Note: *** p < 0.001; n = 3004.

Table 7 displays the weights of the items for intellectual property in the composition of the variable. We see a variation in the tendency toward copyright or branding over the five years.

**Table 7.** Weights of intellectual property variables.

| Variable      | 2009      | 2014      |
|---------------|-----------|-----------|
|               | t Value   | Weights   | t Value   | Weights   |
| Copyright     | 0.789     | 0.064     | 0.265     | 0.093     |
| Patents       | 21.169 ***| 0.890     | 22.482 ***| 0.942     |
| Brands        | 3.139     | 0.260     | 1.430     | 0.123     |
| Utility models| 1.629 †   | 0.153     | 0.328     | 0.028     |

Note: † p < 0.1; *** p < 0.001; n = 3004.

We also assessed whether the model showed a good level of fit with the data. The indicators obtained show the standardized root squared residual (SRMR), unweighted least squares (ULS) discrepancy (d_ULS), geodesic discrepancy (d_G), and the normed fit index (NFI). Analysis of the data showed that all discrepancies were below a 95% significance level, indicating that we should not reject them. Table 8 presents the analysis, which registers reliable and valid data, enabling us to conclude that the model fit the data well.

**Table 8.** Fit of the two periods analysed.

| Model Fit  | 2009 | 2014 |
|------------|------|------|
| SRMR       | 0.040| 0.033|
| d_ULS      | 0.432| 0.295|
| d_G        | 0.116| 0.120|
| Chi-square | 1850.474| 1927.3|
| NFI        | 0.920| 0.934|

Note: n = 3004. SRMR—standardized root squared, d_ULS—unweighted least squares discrepancy, d_G—geodesic discrepancy, and NFI—normed fit index.

We constructed the structural model (internal model) and analyzed the path coefficients. These were positive and thus consistent with the hypotheses. Table 9 presents the determination coefficients \( R^2 \), which establish the explanatory value of the variance. The majority of the constructs were explained by the predictive variables of the model’s endogenous constructs. Chin [102] proposes the following values for \( R^2 \): substantial = 0.67, moderate = 0.33, and weak = 0.19. We also examined predictive relevance using \( Q^2 \). All values were above 0, indicating that our model had predictive relevance. Further, most t-values were significant. We also specified the effect size of the \( f \)-statistic which, according to Cohen [109], can be characterized as small (\( f^2 = 0.02 \)), medium (\( f^2 = 0.15 \)), or large (\( f^2 = 0.35 \)). We present the data, the p-value, and the confidence interval for the model relationships.
Table 9. Direct effects on endogenous variables, t-value, R², confidence interval, Q², f, and variance explained, which test endogenous variables.

| Year of Economic Recession (2009) | Path Coef | t-Value | p-Value | Confidence Interval (2.5%; 97.5%) | R² | Q² | f | Variance Explained |
|----------------------------------|-----------|---------|---------|-----------------------------------|----|----|---|-------------------|
| H1a: Internal K. 09 -> Ecoinn. 09 | 0.014     | 0.914  | 0.181  | (-0.012; 0.039)                  | 0.00 | 1 |   | 0.002             |
| H1b: Private K. 09 -> Ecoinn. 09 | 0.231     | 8.923  | 0.000  | (0.189; 0.274)                   | 0.03 | 2 |   | 0.110             |
| H1c: Market K. 09 -> Ecoinn. 09 | 0.236     | 9.486  | 0.000  | (0.196; 0.278)                   | 0.04 | 1 |   | 0.108             |
| H1d: Public K. 09 -> Ecoinn. 09 | 0.121     | 6.026  | 0.000  | (0.088; 0.154)                   | 0.01 | 3 |   | 0.045             |
| H2a: Internal K. 09 -> Intelec. P. 09 | 0.075     | 4.450  | 0.000  | (0.047; 0.102)                   | 0.00 | 6 |   | 0.009             |
| H2b: Private K. 09 -> Intelec. P. 09 | -0.039    | 1.237  | 0.108  | (-0.092; 0.013)                  | 0.00 | 1 |   | -0.007            |
| H2c: Market K. 09 -> Intelec. P. 09 | 0.066     | 2.423  | 0.008  | (0.022; 0.112)                   | 0.00 | 2 |   | 0.012             |
| H2d: Public K. 09 -> Intelec. P. 09 | 0.132     | 4.837  | 0.000  | (0.088; 0.179)                   | 0.01 | 2 |   | 0.027             |
| H4: Squared eff. (age) -> Ecoinn 09 | -0.035    | 4.162  | 0.000  | (-0.049; -0.022)                 | 0.00 | 9 |   | -0.001            |
| H5: Moderating eff. (size) -> Intelec. P. 09 -> Ecoinn 09 | 0.059     | 3.534  | 0.000  | (0.032; 0.087)                   | 0.00 | 4 |   | 0.003             |

Intelec. P. 09

| Year of Economic Growth (2014) | Path Coef | t-Value | p-Value | Confidence Interval (2.5%; 97.5%) | R² | Q² | f | Variance Explained |
|--------------------------------|-----------|---------|---------|-----------------------------------|----|----|---|-------------------|
| H1a: Internal K. 14-> Ecoinn. 14 | 0.136     | 6.945  | 0.000  | (0.103; 0.169)                   | 0.02 | 1 |   | 0.047             |
| H1b: Private K. 14-> Ecoinn. 14 | 0.136     | 4.020  | 0.000  | (0.082; 0.193)                   | 0.00 | 9 |   | 0.065             |
| H1c: Market K. 14-> Ecoinn. 14 | 0.247     | 7.882  | 0.000  | (0.197; 0.300)                   | 0.03 | 4 |   | 0.123             |
| H1d: Public K. 14-> Ecoinn. 14 | 0.156     | 5.872  | 0.000  | (0.113; 0.200)                   | 0.02 | 0 |   | 0.065             |
| H2a: Internal K. 14-> Intelec. P. 14 | 0.062     | 3.222  | 0.001  | (0.029; 0.093)                   | 0.00 | 3 |   | 0.010             |
| H2b: Private K. 14-> Intelec. P. 14 | 0.006     | 0.164  | 0.435  | (-0.056; 0.073)                  | 0.00 | 1 |   | 0.001             |
| H2c: Market K. 14-> Intelec. P. 14 | 0.061     | 1.654  | 0.049  | (0.001; 0.119)                   | 0.00 | 1 |   | 0.012             |
To determine the effect of the mediating variable, which analyzed intellectual property, we showed the specific indirect effects that made up the type of effect [110]. Table 10 presents the results. For effect size, the variance accounted for (VAF) was 0.37 for 2009 and 0.45 for 2014. We thus found partial mediation [111], complementary in this case, as all path coefficients were positive.

Table 10. Specific indirect mediation effects.

| H3: Ecoinn. 14 -> Intelec. P. 14 -> Innovation 16 | Path Coef | t Value | p Value | Confidence Interval (2.5% 97.5%) |
|--------------------------------------------------|-----------|---------|---------|---------------------------------|
| H3: Ecoinn. 09 -> Intelec. P. 09 -> Innovation 11 | 0.012     | 3.004 **| 0.001   | (0.006;0.019)                   |

Note: * p < 0.05; ** p < 0.01; n = 3004.

As to H4, which analyzed the quadratic effect of firm age on eco-innovation for 2009 and 2014, Table 9 shows the direct effect of the positive and significant relationship for both years.

To analyze H5, which studied the moderation of the variable size in the two years studied, we performed bootstrap analysis and tested for differences in the groups, in this case measured by a single indicator [112]. Table 9 shows the significance of the direct effects of the moderation relationship, which was positive and significant.

Figures 4, 5 present the analysis of the slopes for the two years studied.
Figure 4. Slope of moderating effect of variable size on property rights for 2009.

Figure 5. Slope of moderating effect of variable size on property rights for 2014.

The INE established rates of gross national product for the years studied (https://www.ine.es/prensa/cna_pa_2018.pdf). Growth in volume was as follows: for the years of recession, 2009 = −3.6 and 2011 = −1.0; for the years of expansion, 2014 = 1.4, 2015 = 3.8, and 2016 = 3.2. The data showed the period of expansion and economic growth (2015 and 2016) vs. the period of economic recession and negative growth (2009 and 2011). The literature has considered relevant to analyze the behavior of company management in periods before and after the financial crisis of the early 21st century [87].

To analyze the differences between the periods of expansion and the periods of recession, we performed a multigroup comparison test. Table 11 displays the results.
Table 11. Multigroup comparison test results.

| Path Coef.  | 2009 Path Coef. | 2014 Path Coef. | t Value | p Value | 2009 p Value | 2014 p Value | Confidence Interval | Confidence Interval | Path Coef. | 2009 t Value | 2014 t Value | p Value |
|------------|----------------|----------------|---------|---------|-------------|-------------|---------------------|---------------------|------------|--------------|--------------|---------|
| H1a: Internal K. -> Ecoinn. | 0.155 | 0.138 | 8.31 | 7.06 | 0.00 | 0.00 | (0.127; 0.188) | (0.105; 0.170) | 0.017 | 0.62 | 0.26 | 2 | 7 |
| H1b: Private K. -> Ecoinn. | 0.119 | 0.113 | 4.42 | 3.44 | 0.00 | 0.00 | (0.075; 0.163) | (0.061; 0.167) | 0.006 | 0.13 | 0.44 | 0 | 8 |
| H1c: Maket K. -> Ecoinn. | 0.230 | 0.264 | 8.79 | 8.72 | 0.00 | 0.00 | (0.185; 0.272) | (0.212; 0.312) | −0.034 | 0.84 | 0.19 | 5 | 9 |
| H1d: Public K. -> Ecoinn. | 0.155 | 0.171 | 7.25 | 6.58 | 0.00 | 0.00 | (0.119; 0.190) | (0.127; 0.212) | −0.016 | 0.48 | 0.31 | 0 | 6 |
| H2a: Internal K. -> Intelec. P. | 0.058 | 0.062 | 2.94 | 3.24 | 0.00 | 0.00 | (0.025; 0.090) | (0.030; 0.094) | −0.004 | 0.14 | 0.44 | 6 | 2 |
| H2b: Private K. -> Intelec. P. | 0.001 | 0.033 | 0.02 | 0.93 | 0.48 | 0.17 | (−0.052; 0.024) | (−0.082; 0.091) | −0.032 | 0.67 | 0.25 | 3 | 0 |
| H2c: Market K. -> Intelec. P. | 0.037 | 0.043 | 1.25 | 1.27 | 0.10 | 0.10 | (−0.011; 0.094) | (−0.098; 0.084) | −0.007 | 0.14 | 0.44 | 6 | 2 |
| H2d: Public K. -> Intelec. P. | 0.126 | 0.145 | 4.59 | 4.47 | 0.00 | 0.00 | (0.078; 0.169) | (0.090; 0.197) | −0.019 | 0.45 | 0.32 | 1 | 6 |
| H3: Ecoinn. -> Innovation | 0.089 | 0.137 | 3.99 | 6.22 | 0.00 | 0.00 | (0.050; 0.122) | (0.099; 0.172) | −0.048 | 1.54 | 0.06 | 1 | 2 |
| H3: Ecoinn. -> Intelec. P. | 0.123 | 0.056 | 4.39 | 2.29 | 0.00 | 0.01 | (0.075; 0.167) | (0.017; 0.098) | 0.067 | 1.79 | 0.03 | 7 | 1 |
| H3: Intelec. P. -> Innovation | 0.116 | 0.131 | 5.19 | 5.78 | 0.00 | 0.00 | (0.075; 0.149) | (0.090; 0.165) | −0.015 | 0.47 | 0.31 | 3 | 8 |
| H4: Squared eff. -> Ecoinn. | −0.039 | −0.031 | 4.62 | 3.64 | 0.00 | 0.00 | (−0.052; −0.046) | (−0.025; −0.019) | −0.007 | 0.59 | 0.27 | 6 | 5 |
| H5: Moderating eff. -> Intelec. P. -> Ecoinn. | 0.031 | 0.036 | 1.04 | 1.62 | 0.14 | 0.05 | (0.001; 0.083) | (0.005; 0.075) | −0.006 | 0.15 | 0.43 | 6 | 8 |

Note: * p < 0.1; ** p < 0.05; *** p < 0.01; **** p < 0.001; n = 3004.

Table 11 shows the differences between the paths for the two years compared and the results of the multigroup analysis using Henseler's indicator [113]. The results indicated that the comparison was very close, as the Welch–Satterthwaite tests of differences between groups revealed that none of the variables was moderated by the effect of the years analyzed.

5. Analysis

In the first instance, comparing the means of the knowledge used in the two years studied revealed a difference in quantity. Knowledge used was visibly lower in the year of expansion than in the year of recession. Note that the firms used at least the same level of internal and public knowledge in the year of recession but used internal knowledge most in the year of expansion. As to the significance of the weights of the knowledge sources, note the high significance of all sources and the lowest significance of knowledge from competitors.

For H1 of our model, which related the influence of internal and external knowledge to the strategic objective of eco-innovation, we observed a positive and highly significant influence that held for all types of knowledge during both years of the study. We thus confirmed the hypothesis proposed, which is only non-significant for internal knowledge in the year of recession. H2, which related knowledge to intellectual property rights, varied somewhat more in these two years. Private knowledge lost significance, and market knowledge had little significance in the year of economic expansion.

H3, which proposed the mediation of intellectual property rights in the relationship of eco-innovation objectives and innovation after two years of implementing the sustainable strategy, was supported for the two years studied. The data also showed the appropriate effect and magnitude of the complementary partial mediation. H4 proposed the quadratic effect in the form of an inverted U of age on eco-innovation objectives, and we confirmed the significance of this relationship. H5, which
Similarly proposed a relationship of moderation between firm size and use of intellectual property, was also confirmed.

H6 proposed the influence of different use of knowledge sources on eco-innovation objectives and intellectual property rights. We basically considered two periods with different growth, one of recession and the other of expansion. Since the multigroup comparative analysis confirmed that there were no significant differences between the groups, we did not consider the variables to be influenced by recession or expansion during the two years studied.

6. Discussion

This study proposed to analyze knowledge sources as variables that preceded eco-innovation objectives and intellectual property rights in Spanish firms in two different economic periods, one of recession and the other of expansion.

Our study differed from prior studies in that it analyzed the implementation of green strategy from various levels; from the temporal perspective, the study compared the behavior of firms that applied eco-innovation objectives and used property rights in two different economic periods. From the organizational perspective, it analyzed the behavior of firms through knowledge transfer that occurred from knowledge sources to innovation. Finally, the study analyzed the influence of firm age on eco-innovation implementation and of firm size on uses of property rights.

We stress that intellectual property has often been considered as the result of the firm's R&D processes [114]. This conception considers the process of knowledge transfer to end with the registration of property rights [12,13]. Our study, in contrast, did not analyze property rights as the result of a process but as a mediating and support tool acting between the knowledge sources and innovation in contexts of sustainable innovation.

On the other hand, it is widely accepted in the literature that innovations are a fundamental element in maintaining competitive advantage [29]. Both government sectors and firms are conscious of the advantages gained by registering property rights to the innovations developed [18]. Still, the importance of property rights in sustainable contexts has rarely been analyzed.

Although the literature recognizes that the firm's internal and external knowledge can help to develop the organization's innovation processes [49,50], research has not determined how firms use the different types of knowledge as preexisting variables or how these knowledge types influence intellectual property and, in turn, management of sustainable innovation.

Our study has various implications for research.

First, for the debate over whether protection of property rights can generate distortions and inefficiencies [115] and may not always foster innovation [116], our study confirmed that property rights positively influenced eco-innovation objectives. The results suggested that intellectual protection was positive and supported innovation processes efficiently in contexts of eco-innovation objectives. These results supported the literature that stresses the important role of technological innovation in strengthening sustainable industries [117]. The information obtained suggests that the protection of rights contributes to achieving sustainable processes. We thus confirmed the positive influence of the mediation of intellectual property on eco-innovation strategy and innovation, providing greater support to innovative processes.

In contrast to studies that consider intellectual property rights a measure of innovation [114], our study sought to analyze the behavior of intellectual property as a way to render innovation tangible in the firm, that is, as the transfer of applied knowledge [118]. Our study thus proposed a conceptual model in which intangible assets were transformed into expressed knowledge by registering intellectual property and thus enabled the firm to innovate with its tangible assets.

Second, as determined in recent research, we stress that knowledge influences sustainable management objectives [17]. We provided greater detail, however, for understanding the behavior of the relationship, since we not only specified the significance of the source used but also showed the relative intensity of its influence on eco-innovation. Our study identified the effect of each of the knowledge sources on the eco-innovation objectives. These firms were distinguished by their use of internal knowledge as a great ally in eco-innovation. The results suggested that firms that bid for eco-
innovation not only ground their activity in external knowledge but also transformed and transferred this knowledge by combining internal and external knowledge. Finally, we did not find large differences in the use of the knowledge sources between the years of recession and expansion.

Third, our study analyzed the behavior of firms regarding intellectual property in the context of sustainability and performed this analysis in a period of recession and a period of expansion. Against prior research proposing that economic periods affect organizational processes [6,89], our research showed no significant changes in the organizations’ behavior in these two periods. According to our study, the knowledge proceeding from public entities in both economic periods was considered an important knowledge source for generating intellectual rights [16] and promoted intellectual property by generating knowledge and economic results.

Fourth, we found that the studies in the literature that analyze property rights stress brands, patents, or utility models, neglecting copyright [18]. Our study indicated the magnitude of copyright in the total property rights and underscored its minimal weight and importance in the total property rights. Our study also provided information on copyright and the loss in significance of copyright during periods of expansion.

Finally, we analyzed two interactions for the two years analyzed: the effect of firm age on eco-innovation objectives and the effect of firm size on intellectual property. In both cases, the hypotheses were supported. For age, as the literature indicates, we saw that organizations that implement sustainable processes were affected by their stage of evolution [70]. First, young organizations had difficulty innovating [73], while mature firms generated successful routines [74]. These routines or competences can subsequently become inflexible for innovation [76], again making it difficult for older firms to develop eco-innovations. As to the interaction effect of size, we confirmed that small firms had difficulty accessing financing and new markets [82], whereas large firms had more possibilities for accessing sustainable management [85]. This study also has interesting implications for the family firm, which is generally small [25]. The findings suggested that the smallest firms should make a greater effort to register intellectual property. These two interactions occurred in periods of both expansion and recession.

7. Conclusions

Our study analyzed the implementation of eco-innovation strategies through intellectual property in market innovations and innovations inside the firm in two different economic periods. We studied the process of transfer from knowledge sources to the development of innovations through the use of intellectual property. We also found that the firm’s behavior in this knowledge transfer process was not significantly different despite the influence of economic context in periods of recession and expansion.

8. Limitations and Futures Lines of Research

This study did not tackle san in-depth analysis of copyright. Rather, it analyzed the relative role of copyright within intellectual property rights. We believe that future studies must study the behavior of organizations based only on registration of copyright. Firms that focus on these rights are especially linked to what are coming to be called culture and creative industries.

This study analyzed the behavior of knowledge sources and their transformation through eco-innovation in firms that have used intellectual property. It would be interesting for subsequent studies to compare firms that use property rights to firms that do not. Additionally, our future research will be enriched with approaches oriented towards the circular economy [119].

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