THE METHODOLOGIES FOR ASSESSING PATENT VALUE: A SISTEMATIC LITERATURE REVIEW

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Abstract

Patents play a strategic role in many business fields, with most involving sales, licensing decisions, or internal management. These decisions have become increasingly strategic as these intangible assets are now recognized as crucial for company performance and value operating in an increasingly globalized and competitive market. Patent management can benefit from insights gained through patent evaluation. This study examines the evolution of managerial literature on patent value and reviews the most important methodologies applicable to patent evaluation, developed through a comprehensive literature review on the subject. The focus is specifically on frameworks applicable at the corporate level, especially in companies without dedicated Intellectual Property (IP) departments and where Research and Development (R&D) assets are not managed strategically. An original systematization of current methodologies is provided, along with managerial implications and suggestions for future research directions.

Keywords: Patent value; Patent management; Methodologies for patent evaluation; Intellectual property.

1. Introduction

Patents are a form of Intellectual Property Rights (IPRs) that specifically protect innovations from imitation by competitors and are recognized as valuable intangible assets

that contribute to a company's performance and value. Since patents can be sold or licensed, companies must actively monitor them, making it essential to understand their characteristics and evaluation methods. This knowledge enables more informed operational and strategic management.

The literature on patent evaluation highlights the fragmented nature of existing studies and the need for a systematic organization of research on this topic (Grimaldi & Cricelli, 2020; Girgin Kalip *et al.*, 2022). Moreover, most publications focus on aggregate data rather than individual company-level analyses (Pitkethly, 2006), favoring an inter-sectoral macroeconomic perspective over a microeconomic, corporate-focused approach. As a result, corporate case studies in this area remain scarce. To the best of our knowledge, few contributions trace the evolution of patent evaluation methodologies, and even fewer explore their practical application in corporate settings. The study is guided by the following research questions (RQs):

RQ1*:* How has the managerial and economic literature on patent valuation evolved over time?

RQ2**:** What are the key characteristics of the conceptual models used for patent evaluation in firms?

To address these questions, specific research methodologies and techniques were established. To answer the first research question, we analyzed the evolutionary trajectory of studies on patent value and conducted a systematic literature review (Tranfield *et al.*, 2003; Pittaway *et al.*, 2004). This approach allows for the structured organization of fragmented research on the topic, providing scholars, policymakers, and industry professionals with a comprehensive overview of the current state of knowledge. For the second research question, we examined the characteristics of various patent evaluation approaches and models, aiming to offer insights into their application in corporate settings.

2. An overview of the current state of research on patent value

Technological innovations have fostered global market unification, accelerating globalization while increasing the threat of imitation by multinational competitors. This has increased the need for innovation protection, which can be achieved through patents, providing innovators with a semi-monopolistic position, enabling commercial exploitation of their creations.

Over time, "patent statistics" have gained popularity as indicators of inventive and innovative performance (Griliches *et al.*, 1986; Griliches, 1990). However, simple patent counts do not adequately reflect the quality or value of new products and processes developed by companies, research centers, and universities. As a result, numerous academic studies have examined "patent value" from various analytical perspectives, with different research designs and methodologies (Sapsalis and van Pottelsberghe de la Potterie, 2007) that differ in relation (Figure 1):

- To the definition of the dependent variable and of the independent variable(s):
  - The dependent variable can be the monetary value of the patent (Harhoff *et al.*, 1999, 2003), a value discounted by experts through large-scale surveys (Reitzig, 2003), a composite quality indicator (Lanjouw and Schankerman,

1999), data relating to the patent opposition and data relating to renewal (Pakes and Schankerman, 1984; Pakes, 1986; Pakes and Simpson, 1989, Lanjouw and Schankerman, 1997) and the number of Forward Patent Citations, FPCs (Lerner, 1994);

– The independent variable(s) tested can be correlated (positively or negatively) or not correlated to the value of the patent and are considered "determinants" (or not) of the value; independent variables may be the number of FPCs, the number of Backward Patent Citations, BPCs, the geographical scope of protection (that is the number of countries that fall within the patent family), the opposition procedures, the data on renewals and the number of Non-Patent literature Citations, NPCs;

- To the type of estimated model, which can be stochastic, probit, Ordinary Least Squares (OLS);

- To the sample of used patents: the studies differ in the size of the sample used and in the fact that they rely on different datasets, including cross-sectoral or different countries or different time-lapses (for example, all patent applications in a regional office, a particular sector, a sample of firms in a given country).

Figure 1 – Overview of patent value literature

	Patent Value		*Patenting Procedure*					*Patent characteristics*									*Others*
Authors	*PV*	*QI*	*OP*	*AP*	*GP*	*RP*	*FC*	*FPC*	*BPC*	*NPC*	*Claim*	*Scope*	*Size*	*IPC. Class*	*Time*	*Owner char.*	*Others*
Schankerman and Pakes (1986)						D°											
Lerner (1994)								D				+			+		
Lanjouw and Schankerman (1997)			D					+	+		+	−				+	*
Lanjouw (1998)						D°											
Harhoff *et al.* (1999)	+							D						*			
Lanjouw and Schankerman (1999)		D						+	+		+		+	*			
Lanjouw and Schankerman (1999)						D		+	/		/		+	*			
Lanjouw and Schankerman (1999)			D					+	/		+		+	*			
Guellec, van Pottelsberghe (2000, 2002)					D							−	+		+	+	+
Shane (2001)							D	+				+		*	+		*
Harhoff and Reitzig (2002)			D					+	/	/		−	+	*		*	*
Harhoff *et al.* (2003)	D		+	+				+	+	+		/	+				
Reitzig (2003)	D°°														+		*
Conclusions	+		+	+				+	(+)	(+)	+	(+/−)	+	*	+	*	*

PV: Monetary Patent Value or Net Present Patent value; QI: quality index; OP: opposition/ litigation procedure; AP annulment procedure; RP: Renewal data; GP: Granting of patent application; FC: Firm creation. The signs are D: Dependent variable; +: Positive and significant impact; −: Negative and significant impact; /:No significant impact. *:The variable description hides a set of manifold variables. Among those, some have a positive or a negative impact and others have no significant impact °:Model of patent renewal decision is constructed around the following variables: legal fees, renewal fees, annual return and expected future value. °°: The model relies on variables like the importance of the patent for current and future technical developments; the difficulty to invent around the patent and to prove its infringement; the learning value for competitors, the number of competitor and the fact that the patent is the basis for other ones. These variables have been evaluated by experts on Likert scales.

Source: Sapsalis, E. & van Pottelsberghe de la Potterie, B. (2007, pag. 142).

As Pitkethly (2006) argues, most econometric patent valuation methods focus on aggregate rather than individual patent values. Among the few studies addressing individual patents, only Reitzig (2003) evaluates patents from a semiconductor company. Few studies have explored the evolution of patent valuation methodologies since the 1980s.

This gap is addressed in the present work, which aims to answer the RQs outlined in the Introduction. Scholars such as Grimaldi and Cricelli (2020) and Girgin Kalip *et al.*

(2022) highlight the need for systematic organization of frameworks in patent evaluation, further emphasizing the importance of this study.

3. Research method

To identify and compare the key patent evaluation frameworks discussed in the patent value literature, a systematic literature review (SLR) was selected as the research methodology (Tranfield *et al.*, 2003; Pittaway *et al.*, 2004), ensuring replicability for future research systematically finding, analyzing, and synthesizing existing research in a transparent, thorough, and reproducible manner.

The review process is divided into the following stages: collection and systemisation of the publications, selection of the sample and analysis of the sample.

Regarding collection and systematisation of scientific papers, two widely used academic sources were chosen: Google Scholar and the Scopus database. These sources index a broad range of publications in accredited journals and offer significant advantages for academic research (Jacsó, 2008; Falagas *et al*., 2008). Google Scholar provides extensive coverage, including sources not always indexed by Web of Science, while Scopus ensures a balanced combination of quality and breadth. Given the objective of conducting the most comprehensive analysis possible, Web of Science was considered less essential for this study compared to the selected databases. The string of keywords "Patent value" through an advanced search was used for the collection of scientific articles of which a classification and a timeline are proposed.

For the selection of the sample, bibliographic references were retraced in order to acquire the most influential and essential ones in the field of patent value, i.e. the most cited, pioneering and, at the same time, relevant to the purposes of the research and a selection criterion was developed to ensure relevance to the study.

For the analysis of the sample, the articles meeting the selecting criteria were carefully reviewed and tabulated to analyze descriptive variables, including theories/frameworks and research design. The data was then converted into representations to enhance the understanding of the findings.

4. Results

4.1 Evolution of patent value literature

The main results obtained by answering the first research question (RQ 1) focused on the evolution of the literature on patent value are the following: a) the list of scientific articles from the keyword search, b) the classification of publications in accredited scientific journals and c) the timeline of publications.

The first result for RQ1 relates to *the collection of scientific articles* that started with a keyword search in Google Scholar using the advanced search function. The phrase "Patent value" was initially searched across the entire text using the logical operator "AND" to refine results, as searching individual words yielded millions of entries. Given the excessive number of results (hundreds of thousands), the search was subsequently restricted to article titles.

The process continued in the Scopus database, where keyword searches were inherently more focused, as they were applied to titles, abstracts, and keyword sections.

Initially, keywords were searched individually using the "AND" operator, generating a large but more manageable dataset compared to Google Scholar. To further refine results, the keywords were subsequently searched as a phrase within the same fields.

The results of this process of refinement of keyword searches are summarised below (Table 1).

Table 1- Google Scholar and Scopus results

Source	Google Scholar	Source	Scopus
Results for "Keywords" throughout the article ("*Patent value"*)	7,250	Results for Keywords throughout Title-Abstract-Keywords (*Patent AND Value*)	11,770
Results for allintitle: "Keywords" (*allintitle: "Patent value"*)	420	Results for "Keywords" throughout Title-Abstract-Keywords (*"Patent value"*)	275
Duplicate Publications	50	Duplicate Publications	3
Non-Duplicate Publications	370	Non-Duplicate Publications	272
Duplicated articles between Google Scholar and Scopus: 84			
Total Publications: 558			

Source: Authors' elaboration.

Of the 695 articles collected, 53 duplicates were removed (50 from Google Scholar and 3 from Scopus), along with 84 additional duplicates found across both databases. This resulted in a final dataset of 558 unique articles.

It appears that with both Google Scholar and with Scopus, "Patent value" is the string of keywords that exhaustively summarises the meaning of the search, returning a great number of results. Some further terms such as "assessing", "indicator", "measure", "method", "metric" and "model" have been used to integrate the research with further articles but did not enrich the picture that emerged.

The second result for RQ1 pertains to *the classification of publications*. The analysis distinguishes between publications in ANVUR-accredited scientific journals, conference/workshop proceedings, online sources, and book chapters or e-books.

ANVUR (Agenzia Nazionale per la Valutazione del Sistema Universitario della Ricerca) is Italy's National Agency for the Evaluation of the University Research System. It compiles and updates lists of scientific journals based on specific criteria, which are used to assess research output for National Scientific Qualification indicators (since 2012) and PhD program accreditation.

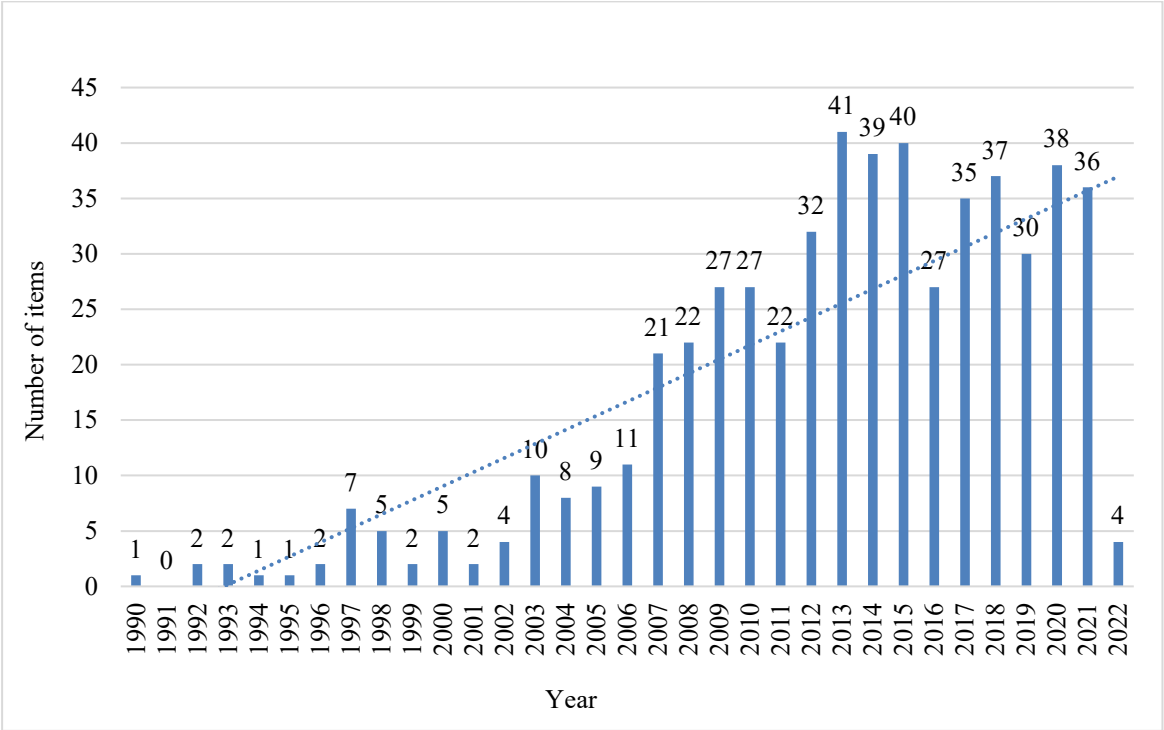
While acknowledging that ANVUR's classification is designed for evaluating Italian scholars and may be incomplete, we have adopted this distinction to assess the consideration given to the "Patent Value" theme in ANVUR-accredited journals compared to non-accredited ones.

Below, is the classification of all 558 publications collected jointly in the two databases, divided and counted into articles:

- Published in an ANVUR-accredited scientific journal: 198;
- Published in a non-ANVUR-accredited scientific journal: 102;
- Published exclusively online (databases and online libraries, company reports, university working papers, theses): 73;
- Presented at a conference/workshop: 72;
- Published as a book or a chapter of a book or e-book: 15;
- Referred to by simple quotation; this work is not present in the list of results since, otherwise, it has already been counted among the duplicates: 98 (the distinction has the same values as Google Scholar since in Scopus the citations are null):
    i. Citation to articles published in an ANVUR-accredited journal: 4;
    ii. Citation to articles published in a non-ANVUR accredited journal: 43;
    iii. Citation to articles published exclusively online: 33;
    iv. Citation to a conference paper: 16;
    v. Citation to a book or a chapter of a book or e-book: 2.

Finally, the third result for RQ1 regards *the timeline of publication*s. The analysis identified trends over time in research on patent evaluation (Figure 2). For clarity, the earliest articles, dating back to 1971 and 1973, were omitted as outliers. Additionally, six articles from Google Scholar were excluded due to incomplete information (e.g., inaccessible or blocked websites). This resulted in a final dataset of 550 fully documented articles, with each column representing the number of publications per year.

Figure 2 - Timeline of publications (Google Scholar and Scopus)



Source: Authors' elaboration.

The analysis highlights temporal trends in research on patent evaluation, revealing a general increase in publications, particularly between 2010 and 2015, with continued

growth in recent years. The topic of patent valuation has garnered increasing attention from the scientific community, with over half of the publications appearing in scientific journals, two-thirds of which are ANVUR-accredited. The collected studies primarily belong to the economic domain - specifically in management, accounting, econometrics, and finance - as well as the pharmaceutical and biotechnology sectors, reflecting the significance of patents in these fields. These works are published in accredited journals, as well as indexed databases and online libraries.

4.2 Methodologies for assessing patent value

The main results obtained to answer RQ2 are three: a) the sample selection, b) the methodologies for assessing patent value and c) the main characteristics of approaches used to evaluate individual patents.

Regarding the first result, *the sample selection,* a total of 740 articles were identified. This included 695 publications retrieved through keyword searches on Google Scholar and the Scopus database, along with 45 additional publications obtained through manual research. The latter focused on reviewing bibliographies of the initially identified articles to ensure the inclusion of the most influential and essential works (Table 2). The final dataset comprised 62 articles published between 1986 and 2022.

Table 2- Selection criteria

Exclusion Criteria	Criteria Code	Identified Publications
Total identified publications (Google Scholar, Scopus and manual search)		740
Duplication	D	137
Not Found	NF	72
Other Publications	OP	7
Publications Not in English	PNE	11
Incomplete Information	II	2
Unreliable Information	UI	2
Not Relevant to the Research Questions	RNRQ	447
Total excluded publications		678
Total included publications		62

Source: Authors' elaboration.

Of the 62 selected studies, 40 analyze large patent datasets, while 22 focus on individual patents. The second result addressing RQ2 thus concerns *the methodologies for assessing patent value*, distinguishing studies based on the unit of analysis: aggregate or individual.

Aggregate (40 studies): These studies (Table 3) employ large datasets or panels to develop econometric models, estimate mean or median patent value distributions, and test hypotheses (e.g., correlations with renewals and citations). The datasets typically cover patents from specific regions, countries, industries, or periods.

Table 3− Aggregate unit of analysis (macroeconomic/sectoral perspective of analysis)

Stream of research	Selected publications
Econometric models are generally deterministic and stochastic, based on data relating to patent families or patent renewals. These models consider the value deriving from patent protection as the difference between revenues and costs discounted over time and the value of real options.	Pakes, 1986; Schankerman and Pakes, 1986; Sullivan, 1994; Lanjouw, 1998; Wu and Tseng, 2006; Leone and Oriani, 2007; Grönqvist, 2009; Hiller et al., 2018.
Models that correlate certain variables/characteristics of the patent with its value, which is expressed through an economic indicator or other value indicators. Different variables are investigated and new indicators validated and this is generally done through a regression function.	Trajtenberg, 1990; Lerner, 1994; Harhoff et al., 1999; Guellec and van Pottelsberghe de la Potterie, 2000; Lanjouw and Schankerman, 2001; Harhoff et al., 2003; Reitzig, 2004; Hall et al., 2005; Sapsalis and van Pottelsberghe de la Potterie, 2007; Gambardella et al., 2008; Lee, 2009; Martinez-Ruiz and Aluja-Banet, 2009; Suzuki, 2011; van Zeebroeck, 2011; van Zeebroeck and van Pottelsberghe de la Potterie, 2011; Caviggioli et al., 2013; Squicciarini et al., 2013; Fischer and Leidinger, 2014; Thoma, 2014; Odasso et al., 2015; Wang and Hsieh, 2015; Wu et al., 2015; de Rassenfosse, and Jaffe, 2018; Trappey and Trappey, 2019; Cativelli et al., 2021; Eom et al., 2021; Svensson, 2021; Song et al., 2022.
Hybrid models, which combine characteristics of the two previous research lines.	Lanjouw et al., 1998; Serrano, 2005; Bessen, 2008; Danish et al., 2020.

Source: Authors' e Source: Authors' elaboration elaboration.

Individual (22 studies): These studies (Table 4) examine patent-specific characteristics, such as renewals and citations, often focusing on patents held by particular companies or competitors to provide detailed insights. The methodologies used are assessed against the International Valuation Standards (IVS, 2013; updated 2016) and the European Commission Expert Group Report (ECEGR, 2013).

The third finding addressing RQ2 concerns the key methodologies used to evaluate individual patents, specifically the:

- cost approach,
- market approach,
- income approach,
- real options approach, and
- indicator approach.

Table 4 — Individual unit of analysis (microeconomic/corporate perspective of analysis)

Stream of research	Practical specifications of the methods	IVS	ECEGR	Selected publications
Cost-based methods		X	X	Parr and Smith, 1994; Pitkethly, 1997; Razgaitis, 2002; Chiesa et al., 2005; Lagrost et al., 2010; Reilly and Schweihs, 2014; Parr, 2018.
Market-based methods		X	X	
Income-based methods		X	X	
Option pricing-based methods				
Indicator-based methods Scoring/Rating/Ranking			X	
Cost-based methods	Replacement cost method	X	X	Chiesa et al., 2005; Lagrost et al., 2010; Reilly and Schweihs, 2014; Parr, 2018.
	Reproduction cost method/Historical cost method	X	X	Pitkethly, 1997; Razgaitis, 2002; Chiesa et al., 2005; Lagrost et al., 2010; Reilly and Schweihs, 2014; Parr, 2018.
Market-based methods	Direct market value method (Relief from royalty method categorised or in market or in income methods)	X	X	Lagrost et al., 2010; Reilly and Schweihs, 2014; Parr, 2018.
	Analogy method (Transaction price of similar assets)	X	X	Pitkethly, 1997; Razgaitis, 2002; Lagrost et al., 2010; Reilly and Schweihs, 2014.
Income-based methods	Excess profits method	X	X	Razgaitis, 2002; Lagrost *et al.*, 2010; Reilly and Schweihs, 2014; Parr, 2018.
	Incremental cash flow method	X	X	Pitkethly, 1997; Reilly and Schweihs, 2014; Parr, 2018.
	Direct cash flow method	X		
	Distributor method (disaggregated method)	X		
Option pricing-based methods	Real Options			Pitkethly, 1997; Razgaitis, 2002; Chiesa *et al.*, 2005; Lagrost *et al.*, 2010; Reilly and Schweihs, 2014; Parr, 2018.
	Monte Carlo			Razgaitis, 2002; Lagrost *et al.*, 2010; Reilly and Schweihs, 2014; Parr, 2018.
	Decision Tree Analysis			Pitkethly, 1997; Lagrost *et al.*, 2010; Parr, 2018.
Indicator-based methods Scoring/Rating/Ranking	Guidelines/ Description of the method		X	Raitzgaitis, 2002.
	pecific Tools/Platforms			Nielsen, 2004; Tekić *et al.*, 2014.
	Synthesis of indicators into a (few) Single (s) Index(es)			Ernst and Omland, 2011, Grimaldi *et al.*, 2018; Grimaldi and Cricelli, 2020; Song *et al.*, 2019.
Methods developed ad hoc for specific applications	Income-based methods			van Triest and Vis, 2007.
	Indicator-based methods Scoring/Rating/Ranking (MCDM, AHP, TOPSIS)			Reitzig, 2003; Malewicki and Sivakumar, 2004; Chiu and Chen, 2007; Chuang and Tanaka, 2010; Hsieh, 2013; Grimaldi *et al.*, 2015; Makundan *et al.*, 2019; Cricelli *et al.*, 2021

4.2.1 Cost Approach

This method estimates a patent's value based on the past costs of developing the innovation, assuming that a buyer would not pay more than the cost of obtaining a similar asset.

- *Revalued Historical Cost*: Considers research, development, and legal costs, adjusted for inflation (e.g., using ISTAT indices). However, it fails to account for future economic benefits.
- *Reproduction Cost*: Estimates the cost to recreate an identical patent, but due to the uniqueness of patents, exact replication is unrealistic.
- *Replacement Cost*: Evaluates the cost of developing a functionally similar patent, providing a more realistic valuation.

While the cost approach offers a minimum patent value, it is less relevant for potential buyers, who prioritize future cash flows.

4.2.2 Market Approach

This approach determines patent value based on actual transaction prices of similar patents. Unlike the cost approach, which focuses on expenses, the market approach relies on real-world sale prices.

- *Direct Market Value (Relief from Royalty)*: Estimates value based on hypothetical royalty savings if the patent were internally produced rather than licensed. This requires data on comparable licensing agreements.
- *Analogy Method*: Values a patent by adjusting transaction prices of similar patents. However, since patent transactions are often confidential, finding comparable data can be difficult.

This approach provides realistic valuations but depends on the availability of comparable market data.

4.2.3 Income Approach

The income approach calculates patent value based on future cash flows, discounted to their present value. This method requires estimating future revenue, its duration, and a suitable discount rate to reflect risks.

- *Multi-Period Excess Profits*: Isolates the patent's contribution to earnings by deducting returns from other assets.
- *Incremental Cash Flow*: Compares cash flows from patented vs. unpatented technology to determine additional earnings from the patent.
- *Direct Cash Flow (Greenfield)*: Directly links patent-generated revenue, often used when patents are licensed.
- *Distributor (Disaggregated) Method*: Applies a variation of the multi-period method, isolating earnings linked to customer relationships.

All these methods focus on future financial performance, making them widely accepted in patent valuation.

4.2.4 Real Options Approach

This approach, based on **option pricing theory**, views a patent as a call option - an opportunity (but not an obligation) to invest, abandon, or defer commercialization.

- *Net Present Value (NPV) Extension*: Considers both expected cash flows and strategic opportunities (e.g., investment, abandonment, deferral).
- *Pay-Off Model*: A patent is renewed if expected returns exceed renewal fees (V > X), otherwise, it is abandoned.
- *Strategic Options*: Includes growth options (expanding use), exchange options (alternative business models), and composite options (stacking multiple options).

This method is useful for patents with high uncertainty and potential future value.

4.2.5 Indicator (Scoring/Rating) Approach

Developed by Richard Razgaitis (2002)**,** this qualitative method ranks patents using predefined criteria, rather than financial models.

- *Scoring System*: Uses Likert scales (1-5 or 1-7) or categorical ratings (e.g., high/medium/low) to assess factors like geographic coverage, patent age, and technological relevance.
- *Weighting Factors*: Assigns importance to each criterion to create a composite patent score.
- *Visualization*: Results are displayed in radar charts (pentagon shape with criteria at vertices) or 2D tables.

5. Discussion and Conclusions

This study aimed to address the following research questions:

RQ1*:* How has the managerial and economic literature on patent valuation evolved over time?

RQ2**:** What are the key characteristics of the conceptual models used for patent evaluation in firms?

The main finding in response to RQ1 - regarding the evolution of the literature on patent valuation - is an original systematic classification of theoretical contributions. These contributions are categorized by publication source (ANVUR classification) and analyzed over a timeline (1986–2022) using data from Google Scholar and Scopus. The fragmentation of the existing literature is evident, with studies differing in objectives, target audiences, and methodologies. While numerous works address patent valuation, the lack of a structured synthesis makes it difficult for scholars, policymakers, and business practitioners to navigate the field and identify the most suitable methodologies for specific evaluation needs. To bridge this gap, our study provides a rigorous systematic literature review, organized around research trends, analytical perspectives, and conceptual

frameworks, with a particular focus on corporate applications. This contribution is highly significant in a field that is becoming increasingly important within innovation management, which is fundamental to competitive success in international markets.

Our analysis highlights that scientific interest in patent valuation has grown significantly. More than half of the reviewed publications appear in scientific journals, with two-thirds of these published in ANVUR-accredited journals. The dominant fields of study include economics, management, accounting, econometrics, and finance, with a strong emphasis on pharmaceuticals and biotechnology, where patents play a crucial role. These studies are widely disseminated across accredited journals, databases, and online research libraries.

This study makes a significant contribution to the literature on patent valuation by systematically organizing and synthesizing previously fragmented research (Grimaldi & Cricelli, 2020; Girgin Kalip et al., 2022). Through a temporal analysis of the evolution of studies in this field, it maps the distribution of publications over time and identifies the key sources of scientific articles. By addressing the first research question, the study offers an original systematization of the literature, distinguishing between macro-level and micro-level analyses. This classification highlights the predominance of macro-level studies and underscores the need for further exploration of micro-level perspectives, which remain relatively underdeveloped despite their relevance for corporate decision-making.

The main result from addressing RQ2 - focused on the characteristics of conceptual models for patent evaluation in firms - is a structured classification of studies by macro and micro levels, along with an in-depth examination of the various methodologies used in corporate settings.

Our study confirms a growing academic interest in patent valuation, with macro econometric models (e.g., Pakes and Schankerman, 1984; Schankerman and Pakes, 1986; Pakes, 1986; Sullivan, 1994; Lanjouw, 1998) dominating over microeconomic models applicable in business contexts (e.g., Parr and Smith, 1994; Pitkethly, 1997; Reilly and Schweihs, 1998, 2014; Razgaitis, 2002, 2009). As Pitkethly (2006) noted, most econometric studies focus on aggregate patent values rather than on individual patents, reflecting the difficulties of conducting company case studies due to the sensitivity of patent data.

At the macroeconomic level, two main research streams have emerged. One stream investigates patent renewal behavior and value distribution, while the other uses regression models to examine variables correlated with patent value. Some studies, such as those by Lanjouw et al. (1998) and Bessen (2008), integrate both approaches.

At the microeconomic level, patent evaluation in a business context typically involves quantitative methods that assign monetary values based on factors like cost, income, and real options. While these methods offer financial estimates, they often miss a broader strategic perspective. In contrast, qualitative methods evaluate a patent’s quality, effectiveness, and feasibility using scoring systems based on key performance indicators (KPIs) (Razgaitis, 2002; Grimaldi et al., 2018). These qualitative assessments provide strategic insights useful for internal decision-making, such as determining whether to renew or abandon a patent.

Another key theoretical contribution of our study is the need for developing hybrid valuation models that integrate both quantitative and qualitative methods. Such models would offer a comprehensive assessment by combining monetary valuation with evaluations of patent quality and strength. Although these hybrid models can reduce

subjectivity, challenges remain due to the difficulty of accessing confidential, company-specific data for research activities. This analysis underscores a significant avenue for future research: the development of integrated hybrid models that effectively combine qualitative and quantitative approaches to patent evaluation. Furthermore, there is a clear need for sector- or company-specific tools, as many existing models are overly generic. Key questions that merit further investigation include: Which specific tools, including hybrid models, are most suitable for multinational corporations? What simplified models could better serve the needs of small and medium-sized enterprises (SMEs)? Are there distinct evaluation models for high-tech industries compared to those appropriate for companies in more traditional sectors? Additionally, is it feasible to develop universal models applicable across countries, or should national differences be explicitly accounted for? These are important research questions that future studies could explore.

Another significant avenue for future research is the development of case studies that explore best practices in patent evaluation within specific sectors and company sizes through longitudinal studies. This research could offer an in-depth understanding and valuable insights to help companies of all types strategically manage and maximize the value of their patents.

This study has some limitations connected to the restricted use of keywords, database sources, and the publication period considered. Nonetheless, it provides an in-depth overview of the primary patent valuation methods in the most important database sources and for a considerable period. The findings reveal that most scholarly work adopts a macroeconomic, econometric perspective to understand patents' impact on national economies or entire industries. In contrast, patent valuation at the individual company level - especially in the context of strategic R&D management - has received comparatively less attention, even though a patent's value is closely linked to the specific methodologies used and the objectives of the evaluation.

From a managerial perspective, this study provides a valuable framework of evaluation methods that can support managers of multinational corporations as well as entrepreneurs leading SMEs across various sectors in assessing patents and identifying acquisition opportunities. Since the late 20th century, the evolution of income-based approaches has been marked by the introduction of more sophisticated corporate finance techniques, such as real options analysis, Monte Carlo simulations, and decision tree methodologies. A key implication of this study is its potential to raise awareness among managers and entrepreneurs about the strategic importance of effective patent management. This is a critical step toward encouraging the adoption of increasingly comprehensive and advanced evaluation methods - ones that move beyond cost-based considerations to also incorporate factors such as product quality, design, brand value, and, more broadly, the competitive strengths and market opportunities. Finally, a stronger emphasis on the culture of patent evaluation, along with the methods used for assessment, should be integrated into university curricula, managerial training programs, and professional development initiatives. In addition, governments should actively promote and incentivize the adoption of these tools to strengthen innovation management and enhance international competitiveness across sectors.

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