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**EXAMINING AN UNOBTRUSIVE MEASURE:
PATENT REFERENCES AS CITATIONS ?**

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Unobtrusive measures are desired in deductive research in the social sciences. Deductive research relies on sequential logical arguments and assumptions in order to test hypotheses. A key activity in deductive research is finding and using data that serve as proxies, representations, and measures of dependent or independent variables. Some researchers prefer to use unobtrusive data because of their belief that those who are studied do not alter their behavior and hence, the unobtrusive measures are not biased (Webb, Campbell, Schwartz, Sechrest 1966). An important unobtrusive data in the social sciences is U.S. patents. Researchers have extensively analyzed information listed under “References Cited,” treating them as records of the inventor’s or the applicant’s knowledge. Labeled “patent citations,” patent references have been subject of citation analysis and co-citation analysis. Citation analysis is premised on authors citing documents they consider to be important in the development of their research or work. Co-citation analysis is used to study the similarity of content in two documents.

The treatment of patent references as citations is rooted in the meaning conferred in the social sciences. Academic citations are treated as “frozen footprints on the landscape of scholarly achievement” and “reusable knowledge” (Cronin 1984:24; Rabeharisoa 1992). They are regarded as “relatively objective data” (Mulkay 1974). Citations in scientific publications are approximate measures of “intellectual debts” (Crane 1972 as discussed in Cronin 1984). Patent citations to scientific papers are treated as “loans’ technology taken from science” (Rabeharisoa 1992). Applying a transitive mathematical argument, Meyer views patent citations as “frozen footprints that show to what extent an invention that has been patented is related to other patented technology or science” (Meyer 2000:94).

The choice of patent references as unobtrusive measures was spurred by the digitization of patent data from the United States and Patent Trademark Office (USPTO), as described in

Pakes and Griliches' 1980 paper. The combination of digitized patent data and computing power has resulted in a growing number of studies that employ citation analysis to analyze patent references. By using patents as representations of a firm's knowledge (DeCarolis & Deeds 1999), researchers have employed patent citations to study whether knowledge flows in the United States (Jaffe, Trajtenberg, and Henderson 1992), organizational innovative productivity (Fleming 2001; Ahuja & Katila 2001), and decomposability of knowledge structures—the coupling of elements of technical knowledge (Yayavaram & Ahuja 2008). Patent citations have been employed to study knowledge spillovers, knowledge flows and the locus of what is learned at the firm, regional, and national level (Jaffe, Trajtenberg, and Henderson 1992; Peri 2005). In addition to being a proxy for knowledge, patent references have been used to measure the importance of inventions: the more widely cited a patent, the more important it is (Albert et al. 1991) and the higher its utility (Trajtenberg 1990; Yayavaram & Ahuja 2008). Firms with more highly cited patents have higher stock market valuation (Jaffe, Hall & Trajtenberg 2005). They have also been used to identify firms developing similar technologies (Jaffe, Trajtenberg, Henderson 1993). They have also been used to measure technological positioning and crowding (Stuart 1998). A patent citation “designates the focal invention as a technological precursor to a novel technology” (Podolny 2005: 144). Research has distinguished between self-citing patents versus non-self citing patents as signs of continuation versus departure from innovative activity (Sorenson & Stuart 2000). Patents that cite the same patents have been treated as structurally equivalent representing similar inventions (Stuart 1998).

Comment [D1]: Treated as a paper trail, references have been used as indicators of spillovers (Jaffe, Trajtenberg & Henderson 1993; Caballero & Jaffe 1993). Specific measures include “generality” and “originality” and “science-based” (Hall, Jaffe & Trajtenberg: NBER Citations Data file; Trajtenberg, Jaffe & Henderson 1997). “The presumption is thus that citations are informative of links between patented innovations” (Hall, Jaffe & Trajtenberg: NBER Citations Data file).

Researchers have applied different approaches in their analyses. Some scholars hold that simple counts of the patent citations are not sufficient and have argued for weighted counts of the

citations (Trajtenberg, 1990; Podolny, Stuart, & Hannan, 1996) to be used to support inferences made within their studies.

Underlying different patent measures are different sets of assumptions. The treatment of patent references as knowledge of the inventor assumes the inventor crafted the legal document. This has not been confirmed and may be questionable in light of the role of the patent agent and attorney in the patent process. The treatment of patent references as technology precursors draws from their legal role. Patent applicants must recognize all patented precursors and “ must list all previously issued U.S. patents that serve as important technological building blocks for the inventions for which they seek approval” (Podolny Status Signals: 143). Patent citations are regarded as an integral part of the application process because they establish the scope of patents under evaluation. However, compliance of the legal duty has not been studied and confirmed. To study technological positioning and networks, patent references are used as measures of deference by the inventor to a preceding inventor, much like academic citations are used as signals of deference (Podolny, Stuart & Hannan 1996).

More recent research on U.S. patent reference lists has identified bias towards inventors and under recognition of the patent examiner’s contribution to reference lists. Even though Griliches had noted that citations “are largely contribution of patent examiners” in 1990, researchers have continued to treat them as contributions by inventors (Griliches 1990: 1689). Alternatively, the role of the examiner has been reduced to that verification, i.e., they verify the information that the applicant discloses (Podolny 2005; Sorenson & Stuart 2000). Employing new patent data from the USPTO that label references contributed by examiners with asterisks, researchers have found that over half of references are contributed by examiners (Meyer 2000;

Thompson & Fox-Kean 2005¹ Alcaccer & Gittelman 2006). There is conflicting reports in the literature about creation of reference lists on the coversheet. XXX Meyer describes it as “legally and socially shaped, as well as reflecting underlying national differences” (100).

Despite the volume of studies that treat patent references as citations, few studies have confirmed that patent references are citations like those found in academic papers. That patent references are treated like academic references may be attributable to similarities in their format. For example, Walker describes that the patent specification, a part of the patent, “roughly corresponds to a journal article” (138). U.S. patents contain four sections: a cover sheet with a section titled “References Cited,” figures, the specification or text, and patent claims.¹ Similarly, academic papers have the following sections: a first page rich in information, introduction, the body or argument, contributions, references, and any figures or tables. Within the body of the patent document, the background of the invention section outlines what hole or gap the inventor is filling, and the detailed description of the invention section explains how the invention fills the hole or gap. Similarly the introduction section of a scholarly article outlines what is known in the extant literature, where a gap or hole is, and how the author plans to fill the gap. The front page a U.S. patent, the cover sheet, contains a wealth of information: the title of the patent, the name(s) of the inventor, the town and state she lives in, the country of their residence if outside of the U.S., when the patent was filed, the name of the law firm handling the application, the name of the patent examiner, the date of filing, the date of issuance, and an abstract of the invention. The first page of an academic paper provides the name of the author, her academic affiliation, the title of the paper, the name of the university/employer, when the article was first submitted, when it was accepted, when it was published, and an abstract. Despite the similarity in format, there are

¹The specification can be further broken down into: claim of priority; field of invention; related art; summary; brief description of the drawings, and detailed description.

differences that may not be apparent in downloadable digitized patent data. Academicians today list references at the end of their papers in a section titled “References” and the items that appear are referenced in the body of the paper. An example illustrating this practice is this paper.² Patent references, however, appear on the coversheet under “References Cited.” Under this heading, they are further subdivided into “U.S. Patent Documents,” “Foreign Patent Documents,” and “Other Publications,” as depicted in a randomly selected patent in Figure 1.

****Insert Figure 1 here****

METHOD

This research employs inductive qualitative and quantitative data [Refer and cite Barbara Lawrence’s work]. Unlike previous papers on patent citations that solely rely on the patent document, I treated the patent document as an end product of the patent process and collected and used other sources of data to gain insight into what appears in the final document. Rather than rely on downloadable digitized patent data, I printed randomly sampled patents, reviewed them, and generated data from the archival data. I also employed data from interviews and observations.

Data

Interviews. I employed interview data from another project, my dissertation. The following professionals involved in the creation of patents were interviewed (in parentheses are the number of professionals, and total number of hours): inventors, intellectual property

² However, this convention is relatively new. In older academic papers, some scholars labeled the section at the end of their papers “works consulted.” The items that appear in this list were not always references in the body of the paper, leaving readers in the dark about how the author(s) used these sources. An example illustrating “works consulted” is Griliches and Pakes 1968 paper in which X sources are itemized but not referenced in the body of their x page paper.

managers, patent agents, and patent examiners. I conducted semi-structured interviews in which the interviewee described the process of obtaining a patent. Due to the proprietary nature of intellectual property, the majority of interviewee spoke in general and did not refer to specific cases. I also interviewed several inventors and patent agents during the course of their patent application. These interviews pertain to specific patent applications.

Observations.

Archival Data. The archival data is composed of 360 U.S. patents. I selected U.S. patents because they are widely analyzed in the social sciences. The patents were roughly divided into two types of organizations: patents assigned or owned by for-profits and the other half assigned to academic types of organizations, such as universities and colleges. Because I am interested in comparing potential differences across patent classifications, I sampled patent classes that are frequently classified as basic sciences or engineering. Many of these classes have been the subject of previous research. Sampled classes in basic sciences included chemical composition (Class 252) (Ahuja 2000; Ahuja & Katila 2001) and drug composition (Class 424). Sampled classes in engineering included semiconductor or solid state devices (Class 257) (Podolny & Stuart 1995; Podolny, Stuart & Hannan 1996; Katila & Chen 2008) and robotics (Class 901) (Katila 2002; Katila & Ahuja 2002).

Using advance search on the USPTO's website, I searched for patents within the patent class of interest. When selecting patents owned by academic types of organizations, I added the key words "college" or "university" under assignee (patent owner). I constrained my search within the first half of 2003. I selected this window because the USPTO rolled out their free file wrapper service starting in 2002 and because more recent windows would have yielded fewer

Comment [D2]: Current count

Comment [D3]: Descriptions of classifications at the USPTO can be found on the USPTO website
<http://www.uspto.gov/web/offices/opc/documents/cl assescombined.pdf>

issued patents (patent prosecution or examination can be lengthy and unpredictable). File wrappers contain all correspondence exchanged between the patent applicant and the United States Patent and Trademark Office (USPTO); and the procedural and prosecution paperwork generated by the USPTO during a patent's examination. When search results yielded more than 30 potential candidates, I randomly selected patents across our search window. I reviewed each patent to ensure that the assignees fit our criteria of purely academic or non-profit organizations. I excluded patents owned by research institutions that were not academic organizations, e.g., Korean Institute of Science and Technology and Stanford Research Institute, and those owned by multiple organizations. Only in one search (academic organizations and robotics) did we expand the window in order to identify 30 patents.

Analytical Approach

From the archival data, I generated two types of quantitative data with the assistance of four research assistants: correspondence and timing of disclosure.

Measuring Correspondence. To learn if the content of the "Reference Cited" (RC) found on the patent cover sheet is a citation, we analyzed the correspondence between RC and the body of the patent (Body). If patents are like academic publications and the content of RC are citations, the correspondence should be 100% in both directions, i.e., all information in "References Cited" should appear in the body of the legal document (RC→Body) and all references in the body of the patent should appear in the cover sheet under "References Cited" (Body→RC). In the RC lists, we focused solely those without asterisks, i.e., those not contributed by the examiner. By default, they should be contributed by the applicant.

For each patent, we analyzed and measured the correspondence between the information in the “References Cited” found on the patent cover sheet (RC) and the body of the patent (Body) in two ways. In the first measure of correspondence (RC→Body), we started first by identifying the information found in each of the three categories of the RC list (i.e. U.S. patents, foreign patents, and other publications) and excluded those tagged with “asterisks” because they are indicated as those contributed by the examiner. We then analyzed each section of the body of the patent (i.e. background of the invention, summary of the invention, brief description of the figures and drawings, and the brief or detailed description of the invention) to learn if each appears in the body of the patent. If there was or was not a match, then we counted that piece of information as a correspondence or no correspondence, respectively. We used this procedure for each piece of information that appeared in the RC list. The database we constructed recorded the number of pieces of information that was or was not a correspondence by the following categories in the References Cited: U.S. patents, foreign patents, and publications.

In the second measure of correspondence (Body of patent→RC), we systematically and meticulously reviewed each section of the patent and identified each piece of information that could be cited. We considered U.S. patents, foreign patents, publications, products, and gene sequences as potentially citable. We then turned to the RC and determined whether the piece of information appeared or not appeared. The database we constructed recorded the number of pieces of information that was or was a correspondence in each section of the patent we analyzed.

Each patent was analyzed by two authors or research assistants. After the data was completed, a third person checked the data for and identified discrepancies. The two previous researchers then reviewed discrepancies and the data together to resolve the discrepancies.

Frequency of Information Disclosure. To understand why correspondence may not be 100% in either direction (RC→Body, Body→RC), we studied the timing of information disclosure. According to Section 1.56 of the Manual for Patent Examination Procedure, applicants are legally required to disclose any known “prior art” that are materially relevant to the patent application. We were interested in the frequency and number of disclosures over the duration of the patent examination.

For each patent, we reviewed the history of correspondences between the applicant and the examiner at the USPTO and focused on downloaded forms called the Information Disclosure Sheets (IDS) from the USPTO’s website. This form is completed and filed by the applicant. As shown in a randomly selected IDS form in [Figure 1](#), three types of information that may be disclosed: U.S. Patents, Foreign Patents, and Publications. For each patent history, we counted the number of IDS filed and recorded the number of months that had lapsed between the filing of the patent application and each IDS form. We also then analyzed each IDS form and counted the number of pieces of information disclosed under U.S. patents, foreign patents, and publications.

Each patent history was analyzed by two research assistants. After the data was completed, a third person checked the data for and identified discrepancies. The two previous researchers reviewed the discrepancies and the data together to resolve the discrepancies.

FINDINGS

Findings show that patent references are not citations. One reason for lack of complete correspondence is the temporal flow of disclosed references as required by legal and procedural rules. Another is the misinterpretation of the term “references” by users. Its legal definition is not the same as its usage in academic writing.

Correspondence: Are “References Cited” Citations?

Comment [D4]: The average number of pieces of information listed in “References Cited” was XXX. The range was zero to XXX. The average number of pieces of information in the body of the patent was XXX. The range was zero to XXX. The average number of information disclosures filed during a patent’s history was X. The range was zero to XXX.

Reasons for Lack of Complete Correspondence

Growth in disclosed information over time. As patent prosecution continues to proceed, the number of IDS forms and hence, the number of pieces of information listed therein is “at risk” to increase over time.

DISCUSSION AND CONCLUSION

In this paper, we examine the differences found in what is stated to be prior art on the front page of the patent document, and what is actually found within the pages of the body of the patent document. Such differences that are found are an important source of new information for academic scholars concerning the accuracy and completeness of these content sources.

The treatment of patent references as citations has become institutionalized. Over time, this practice has become unquestioned and taken for granted.

Correspondence is not 100%. Some patents may have many more references cited on the cover sheet than are found in the body, and some may have more references in the body than are found on the cover sheet. As a result, academic scholars utilizing patent documents as their content source for studies will not get a complete or accurate portrayal of what references the author of the document,

Implications.

Future Direction. As this study revealed, assumptions should not be made about the creation and the meaning of patent reference lists. More research is needed to understand how reference lists are created and the factors that shape the lists. As Meyer described, reference lists are “legally and socially shaped as well as reflecting underlying national differences” (2000: 100). As researchers turn their attention to patents from other countries, researchers should examine differences in legal requirements and the work behind the creation of patents and their reference lists. Studies of how and why data are needed to ground not only theory but also research methodology, notably measures. For example, to apply citation analysis to European patents would not be appropriate for a different reasons. Applicants historically have no legal requirement to disclose material information when they apply to the European patent office. However, they do when they apply for patents in the U.S. Therefore, patent references that appear on European patents are entirely those of the patent examiner.

Outside of the patent context, this study calls attention to the care required for the use of unobtrusive measures. With the digitization and availability of data, researchers may increasingly identify unobtrusive measures. Although they offer benefits, they also require more diligence about testing assumptions. To address this concern, more studies on the work underlying the creation of the data is needed to confirm that these assumptions hold. This is an important step in holding together the sequence of logical arguments underlying deductive research.

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Figure 1 Cover Sheet of Randomly Selected Patent (US 7,226,085)



(12) **United States Patent**
Baker

(10) **Patent No.:** **US 7,226,085 B2**
(45) **Date of Patent:** **Jun. 5, 2007**

(54) **GUARD FOR IN-LINE ROLLER SKATE**

(76) Inventor: **James Baker**, 10 Moyse Drive,
Courtice, Ontario (CA) L1E 2V4

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/332,267**

(22) Filed: **Jan. 17, 2006**

(65) **Prior Publication Data**

US 2006/0157969 A1 Jul. 20, 2006

(30) **Foreign Application Priority Data**

Jan. 17, 2005 (CA) 2492732

(51) **Int. Cl.**
A63C 3/12 (2006.01)

(52) **U.S. Cl.** **280/825; 280/809; 280/11.13;**
280/811

(58) **Field of Classification Search** **280/809-825,**
280/11.13
See application file for complete search history.

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Primary Examiner—Christopher P. Ellis

Assistant Examiner—Cynthia F. Collado

(74) *Attorney, Agent, or Firm*—Birch, Stewart, Kolasch &
Birch, LLP

(57) **ABSTRACT**

The guard is formed of moldable, flexible material and has a number of wheel-receiving wells formed in an in-line configuration in its upper wall. The forward and rear edges of each well are located high enough to prevent a wheel from rolling forward or rearward within the well. Laterally extending grooves are formed in the wells to minimize forward and backward movement of the wheels within the wells while the side walls of the wells contact the side walls of the wheels in order to minimize lateral movement.

5 Claims, 4 Drawing Sheets

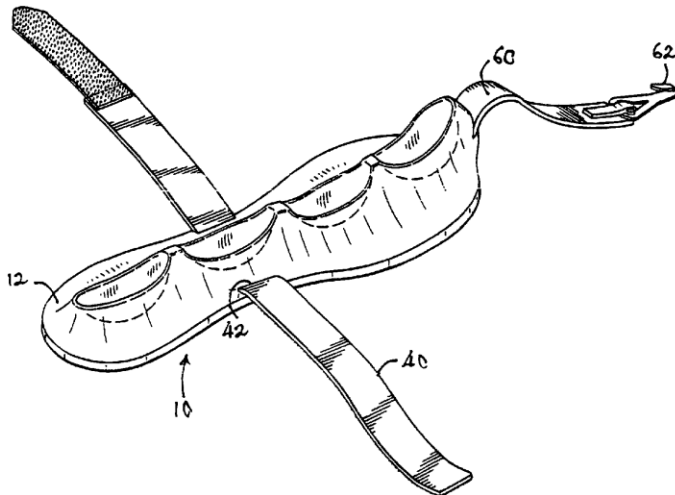


Table 1 Correspondence between Patent in-Body Text and Patent References Cited
(n=94)

Cover Sheet			
	In Specification	Not in Specification	
References Cited			
U.S. Patents	1.24*	13.29	
	8.53%	91.47%%	
Foreign Patents	0.22	1.97	
	9.95%	90.05%	
Publications	4.66	17.58	
	20.97%	79.03%	
Total	6.12	32.84	
	15.71%	84.29%	
Specification			
	In “References Cited”	Not in “References Cited”	
Background of Invention			
Patents	1.35	.40	
	77.01%	22.98%	
Publications	2.26	.50	
	81.89%	18.11%	
Summary of Invention			
Patents	.01	.01	
	100.00%+	.00%	
Publications	.00	.00	
Brief Description of Figures			
Patents	.02	.00	
	100.00%+	.00%	
Publications	.00	.00	
	0.00%	.00%	
Brief Description of Invention			
Patents	.11	14.66	
	.74%	99.26%	
Publications	2.36	4.22	
	35.87%	64.13%	
Total	5.98	19.37	
	23.58%	76.42%	

Note: For each cell, the top number is the average number of pieces of information and the bottom number is percentage. The percentage in each row sums to 100%.

*In this particular example, across the 94 patents, there was on average 14.53 pieces of information referring to U.S. Patents in “References Cited.” 1.24 pieces (8.53%) were cited in the specification or body of the patent. 13.29 pieces on average (91.47%) was not cited.