Basile Tukoff-Guimarães, Yuri; Terezinha Kniess, Claudia; Penha, Renato; Silva Ruiz, Mauro

Patents valuation in core innovation: case study of a Brazilian public university

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Yuri Basile Tukoff-Guimarães
*Post Graduation Program in Business Administration,
Nove de Julho University, Sao Paulo, Brazil*

Claudia Terezinha Kniess
USP Cidades Program, Universidade Federal de São Paulo e da Universidade São Judas, Sao Paulo, Brazil, and

Renato Penha and Mauro Silva Ruiz
*Post Graduation Program in Business Administration,
Nove de Julho University, Sao Paulo, Brazil*

Abstract

Purpose – The purpose of this paper is to assess how technology transfer offices (TTOs) of a public university of the state of São Paulo use patent valuation methods in the process of using developed technology value and transferring technology to industry.

Design/methodology/approach – This study is an exploratory qualitative investigation based on a case study conducted in a public university in the state of São Paulo. The university has a TTO and an internal structure for technology transfer. In-depth interviews were conducted with the TTO manager about patent valuation and the answers given were analysed.

Findings – The results on how TTOs use patent valuation methods in the process of assigning value to technology indicate which factors facilitate and which factors hinder the valuation of patents in technologies developed at universities.

Research limitations/implications – The possible lack of data disclosure due to confidentiality regarding royalties and trading fees makes further comparisons between Brazilian public universities difficult. Therefore, this study recommends that further studies on patent valuation and technology transfer process at private universities, research institutes and public and private companies should be performed.

Practical implications – In the practice, this study contributes to companies and TTOs by increasing their synergies in licensing negotiations, as well as by reducing the gap of information, between the business parties for assignment and transfer of technologies. With regard to theoretical contribution, this study can cite advances in the methods to measure the financial benefits arising from the valuation of technologies embedded in the patents.

Originality/value – Owing to the lack of research on the methods of valuation used by TTOs of Brazilian universities, the present study can be useful in serving as a theoretical source for future

research and in supporting future TTO negotiations in the process of transferring technologies to productive industry.

Introduction

The gradual relevance of technological innovation, the relationship between business and universities and the technology transfer from academic studies to the productive sector all contribute to the growing evidence on patent valuation in the technology transfer process. Some actions to increase the process of patent valuation have been launched in recent years as Patent Valuation Indexes for Technology Transfer (Kamiyama, Sheehan, & Martinez, 2006), IP Score (Engel, 2010; European Patent Office, 2010) and Handbook of Patent Valuation by the Hungarian Patent Office (Kaldos, 2011).

The transfer of technology involves, in all its tasks, the licensing of patents. This process is associated with marketing and financial returns from a specific innovation. Patent data can show changes in the structure and development activities regarding technologies, industries and businesses. To establish the market use value or technology transfer is a complex task because of the difficulty in determining the allocation of values for intangible assets generated by a technological innovation (Boer, 1999).

With regard to the Brazilian scenario, the initiatives and research in this direction are still restricted. There are academic articles and dissertations on the application of patent valuation techniques to a given technology (Souza, 2009), but the valuation in the innovation management process of technological innovation centers (TICs) continues to be unexplored by academic and technical studies (Tukoff-Guimarães, Kniess, Maccari, & Quonian, 2014). At the same time, there is an indication that new advanced studies at the universities are aimed at reaching a professional consensus on technologies (Garnica, 2007). In this context, there are opportunities to improve research related to the use of the patent valuation in the TICs of the universities. Moreover, this study seeks to answer the following research question: How technology transfer offices (TTOs) of public universities in the state of São Paulo use patent valuation methods for assigning values to technology? The objective of this study is to understand the process of patent valuation at these public universities.

This is an exploratory qualitative study conducted at a public university in which the research question was addressed through a case study. The university has a TIC and internal structure for technology transfer. In-depth interviews were conducted with the TTO manager about studies on patent valuation and the answers given were analysed.

In the next section, a literature review was performed to address technological innovation, patent valuation and the relationship between universities and companies regarding the process of technology transfer was performed, including methodological procedures. The results will be presented throughout the article. Finally, we present the conclusions, limitations of the study and directions for future research.

Theoretical reference framework

Universities as sources of innovation

When it comes to innovation, the literature provides several conceptual models reporting techniques, practices and policies which should be considered in relation to the development of new products and services (Longanezi, de Andrade Coutinho, & Bomtempo, 2008). The Innovation Law, approved in December 2004 and regulated by the Decree number 5563 of October 2005, has encouraged the development of studies at the Brazilian universities

aiming more professional management practices in their TICs. This is a landmark for the production and dissemination of knowledge from academic environments (Leite, 2007).

In this context, universities have gained importance in the innovation process as they generate essential knowledge for application to the market of technologies. The innovation process involves various types of knowledge and technology from several sectors, including research institutes (Hsu, 2005). Such knowledge can be beneficial to the productive sector and adopted in the production of services, which may become an innovation over time (Garcia, 2006). For Ferreira, Ghesti and Braga (2017), technology transfer is one of the ways to establish partnerships between universities and companies in an open innovation model for both actors, despite the challenges involved.

New technologies can be consolidated through scientific knowledge, provided that the research produced at the universities is an innovation to be used for development and improvement of products, services and processes (Leite, 2007). In this context, Wirtz (2012) presents the legitimacy of knowledge embedded in the university environment by stating that universities act as an effective scientific system with the purpose of sharing the knowledge produced. In the current scenario, the use of knowledge production and innovation produced by universities may be considered a relevant factor to fill the gap in the market (Wirtz, 2012), thus making the university an irrefutable source of knowledge and development (Barreto, 1994).

The relationship between university and company can bring benefits to both sides. Haase, de Araújo, and Dias (2009) point out that universities developing research processes and teaching new technologies through a partnership with companies gain access to a huge amount of information and acquire further knowledge in their research centers.

For the companies, the knowledge acquired from other sources (e.g. universities) is seen as a valuable and intangible benefit. To explain this benefit, Eun, Lee, and Wu (2006) point out that universities are considered major sources for creation of knowledge and their relationship with business becomes an important issue.

Technology transfer at the university versus company's relationship
The Brazilian scenario nodded at this relationship in 2004 through the publication of the law number 10.973, the so-called Brazilian Innovation Law. The law allows the installation of a TTO in scientific and technological research centers in the Brazilian territory (Brasil, 2004). For Garnica and Torkomian (2009), TTOs play a role in contributing to the innovation management in research centers, as well as to preserve and commercialize the knowledge acquired and technologies produced from academic research, meaning a relationship between university and companies. According to Abreu Paiva and Shiki (2017), when technology transfer involves a patent application, royalties are usually generated or the technology is granted, showing that one should be aware of the value of the technology transferred.

In São Paulo, the project called Consolidation and Protection Methods of Standards and Technology Commercialization (*Pro-NIT/SP*) (Inova São Paulo, 2016) aimed to bring closer the relationship between universities and companies by establishing a partnership with seven universities and research institutes. They are the University of São Paulo (*USP*), the State University of Campinas (*UNICAMP*), São Paulo State University (*UNESP*), Institute for Technological Research (*IPT*), Department of Aerospace Science and Technology (*DCTA*), Federal University of São Carlos (*UFSCar*) and Federal University of São Paulo (*Unifesp*).

To confirm the importance of the universities in the process of negotiating industrial property rights, Grynszpan (1999) highlights that systemic competitiveness relies on a set of

basic factors enabling the companies to maintain sustainable competitiveness, which requires an innovative environment in which universities set high standards.

Patent valuation

The use of patents as a means of technology transfer is still a restricted channel because researchers publish their studies more than perform patent applications (Agrawal & Henderson, 2002). In terms of technology in the patents, Ferreira, de Souza, Silvão, Marques, de Faria, and Ribeiro (2020) pointed that when registering an invention or utility model, the inventor or holder of the new technology can prevent any procedure related to the object of the patent in order to detail the technical content of the protected patent. Finally, the authors emphasize that the protection of the invention by means of the patent, in addition to the gains generated to the holder and society, also enriches itself with the knowledge of a technology that, if not protected, would remain confidential (Ferreira, de Souza, Silvão, Marques, de Faria, and Ribeiro, 2020; Silveira, Schnorrenberger, Gasparetto, & Lunkes, 2017; Loiola & Mascarenhas, 2013).

The valuation of technology through patents is a complex task because technology can be intrinsic to the intellectual capital or to assets valued based on a historical basis, thus making it difficult to establish the future value of a technology (Boer, 1999). For Adriano and Antunes (2017), patents are a type of industrial property and the economic justifications for patenting inventions are based on stimulating and disseminating the scientific and technological development.

To guide the process of valuation, Pitkethly (1997) presents the main methods to evaluate the degree of sophistication in every way to value a patent, namely:

- Cost: methods based on the patent's development costs.
- Market: methods based on the comparison with similar technologies available in the market.
- Revenue: methods based on expected cash flows.
- Discounted Cash Flow (DCF) over time: methods based on DCF taking into account the value of money over time.
- DCF based on uncertainty: methods based on DCF according to the risks involved in the cash flows.
- DCF flexibly: methods based on DCF combined with Decision Tree Analysis.
- Theory of Real Options (TOR): based on the Binomial model (BM) or Black-Scholes model (B-S).

In accordance to the vision of Parr and Smith (1994), the valuation of intangible assets methods seeks to calculate the monetary value of a patent. The methods are based on cost approach, market, and income. Table 1 shows the evaluation methods used to valuate patents in the present study.

For Santos, Solleiro and Lahorgue (2004), the valuation of technologies is related to:

- interest in the purchase or sale of a technology;
- interest in a technology license;
- decision to invest in R & D projects;
- prioritization of projects in a portfolio of alternatives; and
- disclosure of financial results for intangible assets.

Approach	Strengths	Weaknesses	Main methods	Authors
Cost	Low demand for assumptions and estimates. Applicable when future benefits from technology values are not evident.	Disregard of the future value of technology. No direct cost related to the development of a technology with potential future earnings. Method can encourage additional spending on R & D.	Accounting methods. Valuation of the cost of IP replacement or reproduction. Sunk Cost.	Pitkethly (1997). World Intellectual Property Organization (2003). Santos and Santiago (2008a). Santos and Santiago (2008b). Kaldos (2011).
Market	Directly valued technology. Useful in case of comparable assets. Useful to check other validation methods.	Difficult to find new technologies similar to assets. Few markets established for application of highly innovative technologies. The higher the PI specificity, the more difficult is the direct comparison with other technologies.	Equity market value. Price/Earnings. Price/EBITDA. Price/Sales. Royalty Rates.	Pitkethly (1997). Parr (2012). Goldscheider, Jarosz, and Mulhern (2007). Santos and Santiago (2008a). Santos and Santiago (2008b). Fernandes, da Silva, and de Barros (2011). Kaldos (2011).
Finance	In the case of DCF, the concept is relatively simple. In case of real-options model, one should consider uncertainties and management decisions.	By estimating future cash flows, the methods may be subjective and bring a lot of uncertainties. The higher the number of periods of the model, the greater the uncertainty in the estimation of risks and cash flows.	Cash flow projected; cash flow discounting (time). Cash flow discounting (uncertainty). Cash flow discounting (flexibility). Pricing options (Black- Scholes binomial model: financial options and real options).	Black and Scholes (1973). Dixit and Pindyck (1994). Trigeorgis (1995). Pitkethly (1997). Copeland & Antikarov (2002). Meirelles, Rebelatto, and Matias (2003). Santos and Santiago (2008a). Santos and Santiago (2008b). Fernandes et al. (2011). Kaldos (2011). Erbas and Memis (2012).

Table 1.
Rating approaches
for patents based on
Parr and Smith
(1994)

Source: Prepared by the authors from survey data

Given the above, this study is based on the following propositions:

P1. Is the use of sunk cost method for patent valuation cost approach positively linked to TTOs of Brazilian public universities? (Santos & Santiago, 2008a).

P2. Is the use of royalty rate method for patent valuation market approach positively linked to TTOs of Brazilian public universities? (Parr, 2012).

P3. Is the use of DCF rate method for patent valuation income approach positively linked to TTOs of Brazilian public universities? (Killen, Hunt, & Kleinschmidt, 2007).

Method

This article is structured from an exploratory qualitative approach in which a single case study was used as research strategy. Among the qualitative research methods, the case study as viewed by Patton (2005) aims to provide systematically accurate and succinct information on the phenomenon to be studied. For Yin (2015), the case study demonstrates a kind of empirical research base designed through a comprehensive method and allows that one can have knowledge about a little-explored subject (Eisenhardt, 1989).

This study's approach is qualitative with the application of in-depth interview, which is a research strategy used to capture the reality of the interviewee in greater depth in order to better understand the phenomenon studied (Legard, Keegan, & Ward, 2003; Della Porta, 2014). The study was conducted at a public university in the state of São Paulo. The university has TTOs and an internal structure for technology transfer. The objective of the study was to identify the personnel's knowledge as well as documents regarding the methods of patent evaluation and the technology transfer process for industry. For doing so, data were collected from the direct observation of the employees working on research and contracts in the TTOs, as well as from semi-structured interviews with the TTO manager involved in the execution of contracts and technology transfer processes. The resulting data were transcribed and analysed by using the content analysis technique before being categorized according to the objectives and constructs of the present study.

Case study

This case study was carried out in a selected TTO of a public university in the state of São Paulo and which represents a regional university center with the second highest number of patents in the last 15 years. All the patents for inventions and utility models registered at the National Institute of Industrial Property (INPI), an agency responsible for registering and controlling patents in Brazil, were analysed.

The Figure 1 shows the number of patent applications from public universities in the state of São Paulo in the period between 2000 and 2015. The university object of this study is represented in the chart as University B, which was chosen because it has one of the highest amounts of TTO assets in relation to financial results (i.e. R$1,937,305 in 2015). These results come from their intense interaction with industry and entrepreneurship, as well as
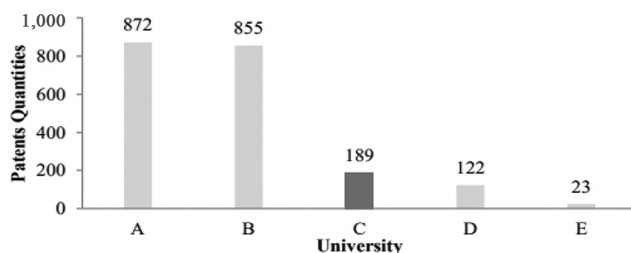
Source: Prepared by the authors from Questel (2016); prepared by the authors from survey data

from royalty payments for patent licensing. Moreover, the university has great experience in patent valuation and technology transfer.

University C was the only one whose TTO manager had academic and professional experience, with five years in the private sector as coordinator of scientific intelligence, totalizing eight years in activities related to project management of technological innovation and technology transfer to industry. Another reason for choosing the University C is that it uses the largest number of patent valuation methods used in this study.

Data collection

Data collection was performed by means of observational procedures, document analysis and semi-structured interview (Creswell, 2013). Observation was employed in a direct way, that is, from the personal contact with the respondents working in the TTO. Descriptive reports of the invention and utility model patents were analysed, in addition to internal procedures for elaboration of categorization documents and technology pricing related to the patent and according to the patent valuation methods used in this study. The direct observation, as appointed by Quivy and Van Campenhoudt (1998), allows the researcher to collect data without intervention of those involved in the study.

Document analysis was carried out based on TTO contracts and market studies. This process was conducted from the perspective of patent valuation studies and from the results of quantitative studies on technology transfer. Document analysis, according to Godoy (1995), justifies the analysis of documents inserted into an unexplored environment as data can be analysed and re-analysed for new or complementary explanations about the study.
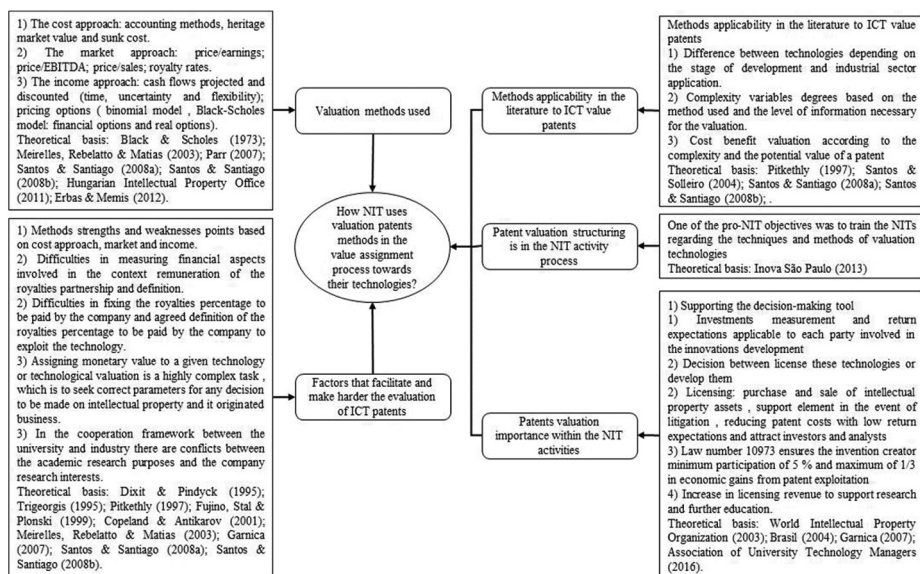
The in-depth interview is semi-structured and based on the construct proposed by Theóphilo and Martins (2009), being conducted with the manager of the TIC who was directly involved in TTO activities and lasting 1 h and 45 min. The objective was to identify in the literature the methods of patent valuation and their applicability to value academic technologies, as well as factors facilitating and hindering the valuation of patents. Figure 2 shows the connection between propositions of the study, research question and theoretical basis for each proposition.

One of the strengths of the data collection for preparation of a case study is the possibility of using the information triangulation generated by data collection instruments as a research validation strategy. According to Yin (2015), triangulation of data enables the researcher to present adequate evidence to justify the search. For de Souza and Zioni (2003), the analysis of data provided from the triangulation process allows the researcher to have a further insight into the study, including aspects of the facts and possible actions by those in the research setting.

Data analysis

From the process of observation and analysis of documents, it is possible to identify whether the individuals have knowledge and routinely use practices and patent valuation techniques in the technology transfer process for industry in their scientific and technological institutions. The purpose of the observation process was to analyze how the TTO of a public university in the state of São Paulo use patent valuation methods in the process of assigning value to developed technologies based on five main data sources, namely:

(1) valuation approaches and methods used and known by the universities;

(2) applicability of the patent valuation approaches and methods;

(3) patent valuation process in the context of the TTO's activities (i.e. structuring of the activity, employee roles and responsibilities);

1) The cost approach: accounting methods, heritage market value and sunk cost.
2) The market approach: price/earnings; price/EBITDA; price/sales; royalty rates.
3) The income approach: cash flows projected and discounted (time, uncertainty and flexibility); pricing options (binomial model, Black-Scholes model: financial options and real options).
Theoretical basis: Black & Scholes (1973); Meirelles, Rebelatto & Matias (2003); Parr (2007); Santos & Santiago (2008a); Santos & Santiago (2008b); Hungarian Intellectual Property Office (2011); Erbas & Memis (2012).

1) Methods strengths and weaknesses points based on cost approach, market and income.
2) Difficulties in measuring financial aspects involved in the context remuneration of the royalties partnership and definition.
2) Difficulties in fixing the royalties percentage to be paid by the company and agreed definition of the royalties percentage to be paid by the company to exploit the technology.
3) Assigning monetary value to a given technology or technological valuation is a highly complex task, which is to seek correct parameters for any decision to be made on intellectual property and it originated business.
3) In the cooperation framework between the university and industry there are conflicts between the academic research purposes and the company research interests.
Theoretical basis: Dixit & Pindyck (1995); Trigeorgis (1995); Pitkethly (1997); Fujino, Stal & Plonski (1999); Copeland & Antikarov (2001); Meirelles, Rebelatto & Matias (2003); Garnica (2007); Santos & Santiago (2008a); Santos & Santiago (2008b).

Valuation methods used

How NIT uses valuation patents methods in the value assignment process towards their technologies?

Factors that facilitate and make harder the evaluation of ICT patents

Methods applicability in the literature to ICT value patents

Patent valuation structuring is in the NIT activity process

Patents valuation importance within the NIT activities

Methods applicability in the literature to ICT value patents
1) Difference between technologies depending on the stage of development and industrial sector application.
2) Complexity variables degrees based on the method used and the level of information necessary for the valuation.
3) Cost benefit valuation according to the complexity and the potential value of a patent
Theoretical basis: Pitkethly (1997); Santos & Solleiro (2004); Santos & Santiago (2008a); Santos & Santiago (2008b); .

One of the pro-NIT objectives was to train the NITs regarding the techniques and methods of valuation technologies
Theoretical basis: Inova São Paulo (2013)

1) Supporting the decision-making tool
1) Investments measurement and return expectations applicable to each party involved in the innovations development
2) Decision between license these technologies or develop them
2) Licensing: purchase and sale of intellectual property assets, support element in the event of litigation, reducing patent costs with low return expectations and attract investors and analysts
3) Law number 10973 ensures the invention creator minimum participation of 5% and maximum of 1/3 in economic gains from patent exploitation
4) Increase in licensing revenue to support research and further education.
Theoretical basis: World Intellectual Property Organization (2003); Brasil (2004); Garnica (2007); Association of University Technology Managers (2016).

Source: Prepared by the authors from survey data

(4) importance of patent valuation among the activities of TICs in support of the decision making process and perception of benefits; and

(5) factors facilitating and hindering the valuation of patents. The techniques have been identified and were subsequently grouped (Gil, 2002).

For Rubin and Rubin (2011), the information resulting from interviews help to identify a process as a discovery factor occurring in the study setting. In the case of this study, this information describes the TTO performing a patent valuation, which is the object of study. The data obtained from the interviews were recorded, transcribed and their contents analysed by using the content analysis technique, as described by Bardin (1977).

Data analysis allowed the significance of the answers to be grouped and then categorized. Next, the resulting categories were crossed, showing the construct of study, such as the TTO's validation of technologies. According to Pita (2010), these methods of patent valuation are effective to measure the transfer of technology to patents until its use by the companies.

Results

This section presents the results according to the construct of study.

Valuation approaches and methods used by technology transfer offices

To establish the value of the investment, the TTO considers the values regarding the use of laboratories, non-research personnel involved in the study, business sponsorship contracts, use of outsourced employees, input required for the study, and scholarships for master's and doctorate degrees from the beginning of the study to the filing of the patent application. The costs involved in the patent licensing process are transferred from the university to the

licensees, including future costs. As a result of the interview, it was identified that investments in research involves a cost of BRL 500,000, on average.

TTO is also based on the market royalty rate approach, in which book royalty rates for licensing intellectual property (Parr, 2012) are used in the technology license. As a result, and considering the use of royalty rates, 90% of the cases analysed have fees charged by the TTO for licensing patents, varying between 3% and 5% *per* sector, on average. These fees are collected on sales turnover of the patented products developed by the university.

After the licensing, the patent is placed in a public offering at the Brazilian Intellectual Property Office (*INPI*). The TTO used the income method only once throughout the study period, whereas cash flow discount method was used during the patent licensing negotiation process. Valuation calculation was based on the development costs, without considering future revenue expectations.

In terms of cost approach, the sunk cost method is the most used by the TTO. One of the highlights is that this method provides inputs that serve as parameters for the process of valuation, thus helping the TTO to have greater assertiveness in the composition of the data. On the other hand, the complexity in drawing up a list of inputs for use of the method by the TTO was considered an obstacle. This drawback contradicts the study by Santos and Santiago (2008a, 2008b), who state that the sunk cost method requires few assumptions for their application and cannot clearly reflect the potential of the technology to be licensed.

Applicability of the methods to value patents

With regard to the market approaches, the TTO applies the royalty rate method to the process of technology valuation. As positive factors for the TTO, one can highlight that the method has a large, respected and reasoned bibliography. The partnership established between the TTO and relevant international institutions (i.e. University of Georgia and University of Oxford) contributes to benchmarking and pricing of its technologies due to the royalties charged. These partnerships allow the TTO learn about new valuation methods and become more assertive in the licensing negotiations of patents and technologies.

No relevant factor was found in the income approach during the interview. However, several negative factors were detected. The DCF method is still little used and does not support the negotiation of new patent licenses. Another negative factor was highlighted in the interview regarding trading values. For the TTO, the values invested by using the DCF method are less reliable than those by using the cost and market approaches. This scenario is supported by the TTO, which highlights that the use of the income method for technology valuation is not justifiable for the client partner and university, resulting in unreliable projections (Killen, Hunt, & Kleinschmidt, 2007).

Factors facilitating and hindering valuation of patents

In terms of valuation methods, Table 2 shows the positive and negative aspects of each approach and method used by the TTO.

Comparison of research constructs

From the presentation of the results, Table 3 shows a summary of the main topics of the case study in relation to the research constructs.

In view of the results, the following question arises: How is this theme currently being addressed in international literature? In the last two decades, an expansion of patent applications occurred and thus the patentability of the inventions increased, which is observable with the inclusion of new areas (*INPI*, 2020). However, one of the significant

challenges for managers of organizations with intensive research and development is to identify and, mainly, measure the assets related to intellectual property.

The primary function of the valuation is to find a balance between risk mitigation and fair price to be applied to the asset. For doing so, quantitative, and qualitative methods are used for valuation calculation and financial return (Silveira, Schnorrenberger, Gasparetto, & Lunkes, 2017). Despite its relevance, the literature on patent valuation is still limited as this subject has just recently received special attention from researchers, companies, and universities.

According to Soares *et. al.*, (2018), the USA leads the ranking of publications in the international literature on intellectual property valuation, followed by China and Slovakia. Finland, Italy, South Korea, Australia, Poland and Taiwan are among the top nine countries with more publications. With regard to research areas, administration and economics account for most of the publications. This result is probably because valuation methodologies originate from management and accounting theories and models based on the estimation of companies' economic value, such as intrinsic value (DCF model) and company's market value.

From the present study, it was found that the different methodologies for valuation, mainly of patents, are based on theories of real options and hierarchical process analysis – which is based on income and royalties. An important fact is that few studies have presented methodologies for patent valuation in universities, thus demonstrating a gap which should be studied in more depth.

With regard to the main studies on the theme already developed in Brazil, one can cite those conducted by Ferreira, de Souza, Silvão, Marques, de Faria, and Ribeiro (2020), Adriano and Antunes (2017), Loiola and Mascarenhas (2013), Abreu Paiva and Shiki (2017), Ferreira, Ghesti, and Braga (2017), Tukoff-Guimarães et al. (2014) and Pita (2010).

Discussion
This study aimed to identify how TTOs use the methods of patent valuation in the process of assigning value to technology and was conducted as a single case study at a public

Approach	Strengths	Weaknesses	Main methods
Cost	Sunk Cost	It provides the basis for patent valuation.	Considered the worst by the TTO for not clearly reflecting the potential of the technology. Inputs survey.
Market	Royalty Rates	Consolidated and reliable bibliography. Support from renowned international institutions (e.g. benchmarking). TTO's trading history on a database.	Basis for Royalty Rates for Licensing Intellectual Property (Parr, 2012) is considered outdated by the TTO.
Finance	Cash Flow Discounting	No relevant point was highlighted or checked during the interview.	Little used by the TTO. Does not support negotiation. Values less reliable than those obtained with market and cost approaches. Less justifiable for university and clients.

Source: Research data

Construct	Subject
Valuation methods used by universities	Most used approach: cost. Most used method: sunk cost. Approach often used: market. Method often used: royalty rates. Approach used sporadically: income. Method used sporadically: discounted cash flow.
Identification in the literature of the applicability of the methods to value the academic technologies	Valuation is performed according to the industrial sector to which it applies: use of the royalty rates method (Parr, 2012). Evaluation of target markets is made with support of the Business Model Canvas methodology (Osterwalder & Pigneur, 2010). Valuation method is not chosen according to the development stage of a technology, although the TTO glimpse this possibility. TTO has difficulties in obtaining inputs needed for patent valuation, mainly regarding the cost approach. TTO does not take into consideration the cost benefit of a patent valuation despite the rate markets and target companies.
Identification of how the valuation of patents is structured in the TTO's activities	The activity is not formally structured. There is a preliminary assessment of the technology's potential for commercialization. The activity is carried out after evaluation and before the patent licensing. The personnel participate in courses related to patent valuation and international collaborative networks related to the theme. Academic level of the TTOs personnel: *lato sensu* and *stricto sensu* graduation
Analysis of the importance of patent valuation in the TTO's activities	For the TTO, valuation does not help in licensing patents. The technology is licensed based on their development costs, although the TTO has problems with accurate survey data. The technology is well evaluated, but there is no licensing decision *versus* development based on valuation. Patent valuation is done for licensing. There is an awarding policy for inventors. The TTO seeks partnerships.
Identification of the factors that facilitate and hinder the patent valuation at public universities in the state of São Paulo	It provides the basis for patent valuation. Considered the worst by the TTO for not clearly reflecting the potential of technology. Inputs survey. Consolidated and reliable bibliography. Support from renowned international institutions (e.g. benchmarking). TTO's trading history available on database. Royalty Rates for Licensing Intellectual Property (Parr, 2012) is considered outdated by the TTO. No relevant aspect relating to market approach. The TTO considers difficult to establish the main

Construct	Subject
	application field of the technology.
Difficulty in reaching a consensus on the percentage of royalties: negotiation with the productive sector is a challenge for the TTO.
Difficulty in reducing costs for research and development; the TTO has improved its methods of patent valuation.
The academic community understands the role of the TTO and was not reported the existence of conflicts between the purposes of academic research and the research of interest to the company.

Source: Prepared by the authors from survey data

Table 3.

university in the state of São Paulo. It is expected that this study will help in the process of technology transfer from universities to companies.

With regard to the sunk cost method, the results did not corroborate the proposition P1 of this study regarding low requirement for assumptions and estimates, since the TTO considered that this is a comprehensive approach requiring expenditures for timely information to develop technologies. Analysis of the results suggests that the use of the sunk cost method is less detailed because of the research and support costs (i.e. patent management and drafting, administrative support) to design the technology. On the other hand, analysis of the details on spending and future investments in technology development might combine the use of this sunk cost method with market parameters and income approaches, for example.

Despite the weaknesses regarding the use of the royalty rates in the process of patent valuation, the results confirm *P2* of the study. Therefore, we can say that the royalty rate method for patent valuation market approach had a positive relationship with TTOs of Brazilian public universities, since the method has a bibliography systematically used by other TTOs in the state of São Paulo. Moreover, the use of market parameters ensures greater legal and business security for TTOs.

With regard to the use of the DCF method, the results did not corroborate the proposition P3 of the study. Therefore, we can say that the use of the DCF method did not have a positive relationship with TTOs of Brazilian public universities. For this reason, it is suggested that income methods, especially DCF, should be systemically used in the context of negotiation of intellectual property rights to complement the analysis of standard market royalty rates. In addition, costs should also be used as a basis for expected future revenues in the light of financial indicators (e.g. net present value, internal rate of return, payback, among others) so that the economic feasibility could be analysed in the patent negotiations. The use of methods based on decision factors and real options should be examined in terms of advantages (e.g. potential to reduce uncertainties in future estimates) and disadvantages (e.g. complex and slow methods) in the context of patent negotiations with the productive industry.

By addressing the importance of patents valuation among the activities of a TTO, it was highlighted that the TTO considers that valuation methods is not helpful in the patent licensing process. Nevertheless, the TTO uses valuation methods for licensing of the productive sector. For Garnica (2007), this practice is a potential reason to perform the valuation of patents.

Another important point is the award granted to inventors, which is ruled by the Law number 10973 (Brasil, 2004). However, the inventors linked to the university and TTO have no knowledge

about methods of patent valuation. It is worth noting that patent valuation is not used by the TTO as a support tool for internal development decision to increase the potential value of the technology, but rather as a license to use it in the state they are, unlike recommended by Garnica (2007).

Based on the document analysis, it was found that the TTO performs the accounting of amounts received from royalties for licensing patents to the productive sector. Nevertheless, the calculation of future income to support new research is not counted by the TTO, which goes against the recommendations by the Association of University Technology Managers (2016).

With regard to factors facilitating and those hindering the valuation of patents, it was identified in the interview that the values are obtained by using the sunk cost method (Pitkethly, 1997; Santos & Santiago, 2008a, 2008b; Kaldos, 2011). However, this method does not allow obtaining future revenue estimates and, therefore, should at least be combined with another approach to reveal further information on the value of technologies, which will help TTO managers in their decision on patent negotiations.

Faced with the above results discussed in this section, the question on how the technological innovation center uses methods of patent valuation in the value-assignment process for technologies at a public university in the state of São Paulo can be answered as the following: the technological innovation center the university uses the market and cost approaches. In this sense, royalty rates and sunk cost methods are exclusively applied to such a scenario. In fact, these methods act as a support to the negotiation of industrial property rights in the transfer of technology to the productive sector.

With this study, it is hoped that the approaches and methods of patent valuation reveal practices of TTOs which can contribute to the transfer of technologies to the productive sector in Brazil. Due to the lack of research on the use of valuation methods by TTOs of Brazilian universities, the present study can be useful by serving as a source for future research, at least theoretically, and by supporting future negotiations of TTOs in the process of transferring technologies to industry productive.

This study also provides a practical contribution to companies and TTOs by being a means of increasing their synergies in licensing negotiations, value assignment and technology transfers, in addition to reducing the gap of information on business practices between the parties. In terms of theoretical contribution, the advances in the methods to measure the financial benefits arising from the valuation of technologies embedded in patents are highlighted. This theme has already brought reflections on the valuation of intangible assets in a practical way, with emphasis on patents, but which has been little discussed in the Brazilian literature, as can be seen in works by Ferreira et al. (2020), Loiola and Mascarenhas (2013), and Silveira et al. (2017).

The possible lack of data disclosure due to confidentiality regarding royalties and trading fees restricts further comparisons between Brazilian public universities regarding patent valuation and technology transfer process. Therefore, we recommend the replication of these studies with other organizations (e.g. private universities, research institutes and public and private companies) which have research and development activities, technology licensing, value assignment and technology transfer to obtain new knowledge on processes and methods of patent valuation and on their technology negotiations.

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Corresponding author
Renato Penha can be contacted at: renato.penha.12@gmail.com