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Patent Valuation within the context of Patent Auctions

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Introduction

As the economy becomes more knowledge-based and innovation-driven, the issue of how knowledge is created, disseminated, retained and used to obtain economic returns is increasingly more relevant. The economic performances and growth for firms and countries will be more and more crucially affected by the knowledge embodied in intellectual assets like human capital, R&D, patents, software and organizational structures.

According to a recent study, see OECD Council (2006), investment in unmeasured intellectual capital in the United States in 1995-2003 was roughly equal to that in tangible capital, 10-11% of GDP, and contributed as much as tangible capital to labor productivity growth during those years. Between 1992 and 2002, the number of patent applications filed in Europe, Japan and the United States grew by more than 40 percent. (*The economic importance of patents, EPO, 2008*). The reason for that is partly attributable to individual inventors, SMEs, large companies and research institutions realizing the importance and economic impact of patenting their innovations. Additionally, the growing strength of emerging countries in manufacturing operations has obliged OECD economies to better exploit their comparative advantage in the production and use of human capital and knowledge. Other studies, see EPO-OECD-BMWA Conference (2005), also show an order-of-magnitude increase in the estimated value of patents, although considerable variation remains in the value of individual patents, with a large share of the total value of patent portfolios deriving from a small number of patents.

Firms are constantly changing their businesses from traditional scale-based manufacturing, mainly relying on tangible assets, toward new innovation-oriented activities largely based on human capital and knowledge, because in fact the overall value for companies is defined also by the number of high-quality patents under its property: the stronger a company's patent portfolio, the more it is worth on the stock market, and the higher the price a competitor must pay in the case of a takeover.

Together with intellectual assets, also networking, co-operation and knowledge flows within and across firms and national borders are also gaining in importance. Companies exploiting their patents in a wider variety of ways like incorporating protected inventions into new products, processes and services, but also licensing them to other firms or public research organizations, using them as bargaining chips in negotiations with other firms, and leveraging them to attract external financing from banks, venture capitalists and other sources, see Kamiyama, Sheehan, Martinez (2006). These uses of patents as vehicles for transferring information to markets, investors and customers call for more reliable and valid information regarding patent value, upon which to base decisions: firm managers, for instance, must be able to value patents in assessing royalty rates for patent licensing contracts, or when estimating the value of a possible merger or acquisition, and when investigating their own corporate value;

financial institutions need to calculate the value of patents when they are used as collateral for bank loans; and investors and financial analysts value patents to capture the value of firms as a basis for their investment decisions and recommendations. Effective markets for technology will play an essential role in the exploitation of patents and should provide significant social benefits by increasing the efficiency of innovation processes through a well-functioning re-allocation of resources, by enhancing the diffusion of knowledge and finally putting inventions in the hands of the right players. Difficulties or inconsistencies in valuation can impede such efforts.

Whereas the development and implementation of technology markets is largely a private-sector activity, also governments should play an important role in ensuring the efficient operation of markets, and competition authorities should monitor and prevent anticompetitive licensing behaviors. Policymakers need to ensure that the beneficial effects of intellectual assets are spread throughout the entire economy, encouraging the dissemination of best practices, and pursuing an appropriate balance between the legal control and diffusion of knowledge, see OECD Council (2006). In addition, an inclusion of intellectual assets in measures of economic activity like GDP is crucial for obtaining an accurate picture of economic growth, productivity and cyclical developments. Further analysis to provide improved policy guidance regarding patent valuation and exploitation is fundamental as an efficient and effective patenting system: high-quality patents that are enforceable in the market place and that are issued in a timely fashion, can withstand judicial challenges and also provide innovators and investors with greater confidence in the validity and value of a patent, see EPO-OECD-BMWA Conference (2005). Toward this end, public organizations are taking a number of steps in improving patent administration, enhancing disclosure and traceability of patent and license information, providing match – making services between buyers and sellers.

As will be more clearly explained further on, the new mechanism of patent auctions born from the widespread urgency for facilitating the match between supply and demand on market for technologies. Intellectual properties flow is still hampered by legal concerns (like researching prior art) and the quickly evolving technologies' lifecycle; this is what makes IP buying process really lengthy and difficult, thereby leaving a large number of unused patent files in firms' portfolios. With traditional transactions shrouded in secrecy, potential buyers are generally unaware of the intellectual property acquisition opportunities and consequently are unable to pursue them. Often, operators learn about IP which was for sale only after receipt of a licensing or notice letter. Conversely, the public nature of the auction gives those companies with an interest in licensing or pursuing the development of new technologies and/or portfolio diversification, an equal opportunity to know of and pursue them.

The thesis is structured as follows: in the first chapter the main valuation methods discovered and used till today are described, in order to understand how much are they reliable in patent value measurement. Furtherly, in the second chapter, the new context of patent auctions will be presented, giving also more insight about Ocean Tomo company and its business model. The third chapter will explain how the data have been collected and organized in conducting the research, and finally the fourth chapter will enounce the main results of the investigation.

I. Approaches to Patent Valuation

The economic value of a patent to the holder can be identified as the discounted flows of revenue generated by the patent over its lifetime. But the value of a patent can be thought also from a social point of view, that is, its contribution to society's stock of technology. While these two interpretations are closely related, as the revenue generated should be commensurate with the technological contribution, they are not identical, since part of the social value doesn't belong entirely to the patent holder, given the existence of externalities: the published knowledge for instance can be used by other inventors and/or competitors to improve on the initial invention. In addition, a further distinction must be made between the value of the patent itself and the value of the underlying invention. "The former comprises only the value added by the fact that the invention is patented – it is the difference between the value of the invention as it is patented and the value it would have had if it had not been patented. The latter refers to the technological content or "quality" of the invention, that is, its contribution to the state of the art. An invention with a significant contribution to the state of the art will affect future technological developments. The two notions differ to the extent that the patent improves the appropriability of the benefits of certain inventions more than others. Yet the capacity of patents to ensure appropriability of the income generated by inventions is known to differ, for instance, across technical fields", see OECD Patent Statistics Manual (2009).

One property of either patented inventions or patent protection is the skewness of their statistical distribution. This result has been obtained by different researchers like Schankerman and Pakes in 1986 using data on patent renewal or Silverberg and Verspagen in 2007 using patent citations. The skew nature of patent value has been also confirmed by recent studies on the statistical relationship between stock market values of enterprises and their patent portfolios by Hall, Jaffe and Trajtenberg in 2005. This skew distribution means that while some few patents have high value, the larger majority of the others have little or remain unexploited. Practically mediocre returns, or even failure, are the norm, rather than the huge innovation returns. In the aggregate, these many failures are offset by the few innovation projects with very high returns. As a result, patent counts, which give the same weight to all patents become clearly misleading.

Another difficulty in estimating patent value is timeliness, properly the need to have reliable indicators reflecting the economic or technological value of an invention early enough, see OECD Patent Statistics Manual (2006). Timeliness affect several patent value indicators like forward citations, renewals, litigation and family size. In order to manipulate data relating to them, researchers need to use some "tricks" to make the figures homogenous across the time and correctly compare patents between them. For instance citations data are "truncated", i.e. considered only in the first five or sometimes four years after the patent publication, period in which it is statistically proven that the majority of citations are received.

In addition intellectual assets are not always separately identifiable, but tend to be complementary and can overlap significantly. Not only, they are often risky and have high rates of depreciation. The relative lack of recognition of intangibles in accounting, coupled with their growing importance in the value creation process, means that financial statements are losing some of their value for shareholders. Valuing patents can be difficult for large firms that have large patent portfolios and/or single patents lacking market equivalents, as well as for small firms that may lack the resources and expertise to properly value their patents. Venture capitalists have some experience in assessing patent value, but usually in the context of an overall valuation of the firm that does not take patents specifically into account. All such efforts, however, will have to face the challenges presented by the high context-specific nature of patent value. Value is strongly influenced by the novelty of the invention and the availability of alternative routes to the same solution (*i.e.* inventing around a patent). It is highly context-dependent and relates to the ability of a firm to extract the value from its patents through competent management, as well as on the particular market environment facing a patent holder. Differences across sectors are driven by factors such as patent strength, market structure, technology characteristics, company strategies and firm size, see EPO-OECD-BMWA Conference (2005).

Three main economic approaches to patent valuation have been developed through years: conducting surveys asking inventors or holders about the economic value of their patents; estimating value from financial data like through market value of companies; analyzing data from the patenting procedure like grant or refusal of the application, citations, renewal, geographical scope of protection.

The "survey method" born from the evidence that the large majority of patent data and indicators presently employed are taken from patent documents; conversely data not included in these documents are mostly unavailable, see Griliches (1990). This implies that practically there are few information about certain aspects relating to these missing data, for instance about inventors, the inventive process, whether the patent is used or not, whether it is licensed or whether it is further developed into a new product by the applicant. A survey is the most obvious solution to collect these kind of data. The merit of this approach is to gather information directly from the source. However, it may be subject to bias, as the inventor or the patent owner might not have, or might not be willing to provide, accurate information. The most extensive and accurate survey of patent holders was conducted over 30 years ago by Barkev Sanders. He wanted to fill the absence of objective and factual conclusion about the role of inventions in the economy, by investigating the use of patented inventions when the term *use* means that "prior to the expiration of the sampled patent, the patent is being produced for sale or is being used in the manufacture of articles for sale". The study would have determined how soon patents used in production were put to use after the filing of the patent application, how many of these were put to use prior to the issuance of the patent, for what periods, the length of time patents are generally used, and the extent of such use. The survey has been conducted through mail questionnaires to inventors and assignees of a 2% sample from all patents issued in 1938, 1948 and 1952. Initial interviews were conducted with a limited number of inventors and assignee in order to develop and pre-test mail questionnaires. Given the possibility that refusals to respond would have introduced a bias in the returns, a subsample of inventors and assignees who failed to respond to the questionnaire were contacted through personal interview. There were two mayor findings in this survey: the first is that a surprisingly large fraction of patents have been used, with higher "use percentage" for small companies. The second is that reported economic gain from the innovations associated with these patents was highly dispersed, confirming the skewness of value distribution.

There have been only very few other attempts at such a survey and they all reach rather similar conclusions. More recently Griliches (1990) himself noted that patent surveys had not been undertaken for a long time. Since then, Scherer, Harhoff and Vopel conducted a patent survey in the US and Germany to explore the distribution of the economic value of patents, see Scherer and Harhoff (2000), Harhoff et al., (2003b). The Yale survey by Levin *et al.*, (1987) and the CMU survey by Cohen *et al*., (2000), investigated the motivations for patenting of US firms. Cohen *et al.* (2002) presented survey evidence on the role of patents for diffusing information in Japan relative to the US. Arundel and Steinmueller (1998) used the Community Innovation Survey to look at patents as information channels in Europe. Given that these surveys provided limited European coverage and were mostly biased towards large companies, in 2003 the PatVal project was launched. PatVal is a large-scale survey designed to be representative of the universe of patents in our EU6 countries (Spain, France, Germany, Italy, Great Britain, Netherland). It covers all technological fields, deals with both for-profit and non-profit applicants, and collects information on small, medium and large business companies. The questionnaire was submitted to the inventors of 27.531 patents granted by the EPO with a priority date of 1993-1997, and located in France, Germany, Italy, the Netherlands, Spain and the United Kingdom. The survey produced the following results: a deeper description of European inventors confirming the extremely limited participation of women in innovation activities in Europe; new information about the motivation of inventors to invent, highlighting the preference for personal and social reward rather than for monetary rewards and career advances; customers are the most important source of knowledge for the patented innovation, followed by other patents and the scientific literature. Surprisingly, university and non-university research laboratories are the least important source in all of our EU6 countries; information about the use and non-use of patents; differences in licensing practices between small and large firms and finally a further confirmation that distribution of patent values is highly skewed, and only a few patents yield large returns.

Another line of work has used data on the stock market valuation of firms to investigate both the "value" of patents and the information content of the variability in their numbers. The use of stock market values as an "output" indicator of the research process has one major advantage: while all other indicators of success, such as profits or productivity, are likely to reflect it only slowly and erratically, the full effect on the expected present value of a firm's future net cash flows caused by a market event is immediately recorded. The downside of this type of measurement is the large volatility in stock market measures. "The needle might be there but the haystack can be very large" (Griliches, 1990). The simplest market value model starts from the market valuation identity, with the market value of the firm proportional to its physical ("tangible") and intangible capital, the latter being in part the product of its past R&D investments and possibly also reflected in its accumulated patent position, see Griliches 1981, Uri Ben-Zion 1984, Hirschey 1982, Cockburn and Griliches 1988, among others. Putting these variables into an equation, and manipulating the term, it is possible to obtain as dependent variable the logarithm of what has come to be called *Tobin's Q*, a ratio comparing the market value of a company's stock with the value of a company's equity book value, developed by James Tobin in 1969. A more dynamic point of view is taken by Pakes (1985) in his analysis of the relationship between patents, R&D, and the stock market rate of return. Pakes found, not surprisingly, that the stock market did take account of unpredictable changes in R&D levels and levels of patenting by firms. A result which Griliches has also referred to, However, Pakes also commented that the results "may reflect an extremely dispersed distribution of the values of patented ideas". Whilst this may not be of immediate practical help in valuing patents it is relevant to the idea that patent's values are to a certain extent reflected in stock market valuations. Pakes finds no evidence that independent changes in the number of patents applied for (independent of current and earlier R&D expenditures) produce significant effects on the market's valuation of the firm. Hence it is not possible to distinguish between demand shocks, where demand shocks are loosely defined as events that cause increases in patenting only through the R&D expenditures they induce, and technological or supply shocks that may have a direct effect on patents as well as an indirect effect via induced R&D demand, see Griliches (1991). The difficulties in implementing such models arise to a large extent from the large "noise" component in patents as indicators of R&D output in the short-run within-firm dimension. This however supports at least a possibility of finding shares which might reflect the volatility of patent values which may be helpful in option based valuation methods which require a knowledge of the volatility of the returns to a patent, see Pitkethly (1997).

Analyzing data from the patenting procedure is a method trying to cast light on the value of patents by using patent information mainly provided by bibliographic sources (publications, search and examination reports, opposition, etc.). Researchers and economists have largely focused on this method because, a patent document, besides information on the names of inventors and their addresses and the name of the organization to which the patent right may have been assigned, it also lists one or more patent classes to which it has been assigned by the examiners, cites a number of previous patents and sometimes also scientific articles to which this particular invention may be related, and also finally, but from the social point of view most important, provides a reasonably complete description of the invention covered by this particular patent. In the U.S., aggregate patent statistics classified in a variety of ways are released by the Office of Documentation at the U.S. Patent Office. Given the advanced search software available on these services it is possible to conduct a variety of specific searches of such data bases, looking for patents in a particular area or those mentioning a particular material, instrument, or a specific earlier patent, and tabulate the results at a reasonable cost. Patent data for other countries are being collected by the International Patent Documentation Center in Vienna, Austria, and published annually in World Intellectual Property Annual. Country summaries are published in

OECD, Main Science and Technology Indicators, and by various country statistical offices, such as Statistics Canada. Current information on individual foreign patents is available on line from Dialog (Griliches, 1990). A number of patent characteristics have been investigated and were found significantly correlated with patent value. In the following, the main indicators are briefly presented.

Number of Inventors. Several economic studies (Guellec and van Pottelsberghe, 2001; Gambardella *et al.*, 2005) have associated the number of inventors listed in a patent with the economical and technological value of patents. The number of inventors may proxy the cost of the research behind the invention, which itself is statistically related to the technical value of the invention: the more resources involved, the more research-intensive and expensive the project, the highest the value of the invention.

Family Size. The value of patents is also associated with the geographical scope of patent protection; that is, with the number of jurisdictions in which a patent grant has been sought. The fact of applying for patent protection abroad already constitutes a sign of economic value, as the decision reflects the owner's willingness to bear the costs of international patent protection. The rationale is closely related to the decision to renew a patent; it is costly to make a patent valid in more than one country and to maintain the protection . The geographical scope of protection, as reflected in international patent grants for a given invention, reflects the *market coverage* of an invention: there is consistent evidence that family size reflects economic value. For instance, Lanjouw and Schankerman (2004) find a strong positive relationship between a quality index of patents and family size (in a sample of US patents). Guellec and van

Pottelsberghe de la Potterie (2000) report a positive association between family size and the likelihood that a European patent will be granted. Harhoff *et al.* (2002) provide evidence that patents that are part of large international patent families are more strongly associated with economic value. In the group of pharmaceuticals and chemicals, this indicator carries the highest coefficient of all technology-specific sets of results.

Scope. The number of technical classes (as indicated by the number of IPC classes) attributed to a patent application has also been used as a proxy for the scope, and hence the value, of a patent. This approach was proposed by Lerner (1994) in a study of the market value of biotechnology patents as a measure of the value of a patent portfolio. He finds a positive and sizeable correlation between the firm's market value and the average scope of its patents. Lanjouw and Schankerman (1997) find that the number of IPC classifications has a small positive effect on the probability of infringement litigation relating to US patents. However, using information from a survey on the perceived economic value of patents by German inventors, Harhoff *et al.* (2002) did not find the number of four-digit IPC classes informative of the patent value in any of the technology fields analyzed.

Breadth. It defines the legal dimensions of protection and thereby the extent of market power attributed to the patent. A wider breadth refers to a broader area of technology from which others are excluded. Several economists have used the *number of claims* to proxy the legal scope of patents. It has been argued that, as each individual patent represents a bundle of inventive components, each reflected in a claim, the number of claims can be indicative of the value of the entire patent.

Nevertheless, the tendency of certain applicants to “inflate” the number of claims for strategic purposes makes the relationship between scope and number of claims quite noisy. In addition, the claims that appear in granted patents are those that are included following the examination. Empirical analysis on this matter is scarce but quite positive. In their factor model of patent quality used to analyze research productivity in the United States, Lanjouw and Schankerman (2004) found that the number of claims was the most important indicator of the quality of patents in six out of seven technological fields studied. It has also been found that the likelihood of a patent being litigated, which reflects its breadth, increases with its number of claims (Lanjouw and Schankerman, 1997).

Renewal. Studies in this field exploit the fact that it is expensive to holders to maintain patent protection for an additional period of time and in additional countries. Hence it is hypothesized that the value of continuing patent protection over time and of expanding it geographically is associated with the economic importance of the invention. Not surprisingly, the two types of indicators have been found to be highly correlated. The renewal fee increases over time, and, at the end of every period, patent holders must decide whether or not to renew. Failure to do so results in the lapse of the patent, which releases the invention into the public domain. Observations of the proportion of patents that are renewed at different ages, together with the relevant renewal fee schedules, provide information on the distribution of the value of patents and the evolution of this distribution over patent’s lifespan. The rationale behind this approach is based on economic criteria. Patents are renewed only if the value of keeping the patent alive (based notably on the discounted expected stream of profits) is higher than the cost of renewing the patent: when the renewal fee is not paid, the patent has expected returns (in future periods) which are lower than the threshold. As the fees increase over time in most countries, patentees must consider the profitability of renewing for the following period during the current period against the costs of maintenance. There are a number of limitations to the patent renewal approach: in some cases, the dropping of a patent may not be indicative of low value but of a change in a company's strategy, related for instance to an external shock. In technologies that change rapidly, many inventions are of high value when introduced but become obsolete shortly thereafter. Exogenous factors may also influence the decision to renew patents.

Forward Citations. The number of citations a patent application receives in subsequent patent applications (forward citations) has been found to be strongly associated with the economic value of patents (Scherer *et al.*, 1999) and the social value of inventions (Trajtenberg, 1990). The number of forward citations is one of the most frequently used value indicators. Two main arguments support the validity of forward citations as indicators of patent value: first, they indicate the existence of downstream research efforts, suggesting that money is being invested in the development of the technology (and there is a potential market); and second, the fact that a given patent has been cited by subsequent patent applications suggests that it has been used by patent examiners to limit the scope of protection claimed by a subsequent patentee, to the benefit of society. In this sense, forward citations indicate both the private and the social value of inventions.

Nevertheless, the main difficulty in computing forward citations is that they appear over time, and sometimes a long while after the cited patent was filed, granted or even reached full term. For the sake of relevance it is important to ensure the timeliness of indicators. One remedy to this problem consists in counting citations received by patent applications within a given time window. A time window frequently used is five years after publication of the cited patent, as it has been calculated with USPTO patents that more than 50% of the citations received in an entire life of a patent occur within the first five years.

Backward citations. Citations to previous patent documents. Can help to track knowledge spillovers in technology. They make it possible to estimate the curve of obsolescence of technologies, the diffusion of knowledge emanating from specific inventions to institutions, areas, regions, etc. A relatively small scope and—ceteris paribus—low monetary value should characterize a patent whose examination report contains a large number of backward citations (Harhoff, Scherer, Vopel, 2003). The logic behind this is to present subject matter that is held against the claims of the application. Several patent lawyers and examiners are not supportive of this. They point out that a patent application seeking to protect an invention with broad scope might induce the examiner to delineate the patent claims by inserting more references to the relevant patent literature. It is therefore not clear whether the correlation between backward citations and patent value should be positive or negative. Lanjouw and Schankerman (1997) include the number of claims and backward citations per claim in their probit analysis of litigation. The first variable turns out to have a positive and significant coefficient, the coefficient of the latter one is not significantly different from zero.

Non patent literature. As in the case of references to the patent literature, a relatively high number of references to the scientific literature may therefore indicate patents of relatively high value. (Harhoff, Scherer, Vopel, 2003). The average level of non-patent references has frequently been used as a proxy for quantifying the relationship of a technology field with a scientific domain (Narin *et al.*, 1997; Meyer, 2000; Verbeeck *et al.*, 2002). But not all non-patent references refer to scientific sources; they are not a direct measure of the strength of a patent's science linkage. This problem has been studied in detail by Schmoch (1993). A survey of the literature on this topic is contained in Meyer (1999). However, the number of non-patent references is considerably easier to compute than the number of explicit links to the scientific literature. Moreover, it is largely expectable that "science-based" patents contain a relatively high number of non-patent references, having greater explanatory power in science-based industries, such as pharmaceutical and chemical products than in less science-oriented areas. (Harhoff, Scherer, Vopel, 2003)

Disclosure. Greene and Scotchmer (1995) were the first to introduce disclosure as a value-determining parameter. They assumed that disclosing technical information conferred a positive externality on the patent-holder's competitors. Consequently disclosure should diminish the economic value of a patent for his/her owner. Also, as patents may be used for blocking competitors in certain industries, their values should rise the more difficult it becomes to circumnavigate the protected invention with a new technology.

Opposition and litigation. As opposing a patent is a costly move, it can be inferred that only patents with some damaging effects on competition, and thus some economic value, will be opposed. Hence the fact that a patent is opposed can be interpreted as a signal of value. Further, patents that survive such opposition are proven to be strong patents that offer their holders the prospect of high profitability. Some authors have found that opposed and litigated patents are of higher than average value. Harhoff *et al.* (2002) find that successful defense against opposition (in the German patent system) is a particularly strong predictor of patent value. According to Lanjouw and Schankerman (1998), patents that are litigated have particular characteristics. Compared to a random sample of US patents from the same cohorts and technology areas, the authors find that more valuable patents and those with domestic owners are considerably more likely to be involved in litigation. Patents owned by individuals are at least as likely to be the subject of a case as corporate patents and litigation is particularly frequent in new technology areas.

Although these indicators have in common a highly skewed distribution and a serious delay in their measurability, they are, as a matter of fact, weakly correlated with each other and exhibit opposite evolutions, see Van Zeebroeck (2008). It seems that each indicator represents a different dimension of a patent, which all reveal the existence of some market for the patented innovation, and which may hence all contribute to its value in some way as confirmed by numerous studies as the PatVal survey who has confirmed that most of these dimensions are correlated with the monetary value of patents as perceived by their inventors. These indicators seem indeed complementary rather than substitutable, for each of them would miss some patents which were identified as important or valuable by other indicators. In addition all value indicators are varying widely across countries and technologies, (see Van Zeebroeck, 2008). Oppositions may be more frequent in fields where patents play a more important role in competitive processes, technology life cycles are longer in certain fields leading to higher renewal rates, geographical scopes may be more concentrated in traditional industries with high barriers to entry and broader in some high technologies, etc. Similarly, there may be some differences in the average value of patents issuing from European versus non European countries or even between European countries. As some countries are highly specialized, the value of their patents may be perceived as higher or smaller depending on the indicator. All these results suggest that there is a high variance of value indicators across countries and technologies. This means that geographical and sectoral specificities render patent value indicators hard to compare from one country or one sector to the other. In addition, the magnitudes observed within value indicators suggest that countries or sectors with high values along one dimension may be of little value along others, possibly because different indicators capture different dimensions of value and hence identify different patents as most valuable.

The impossibility to attribute in advance a precise monetary value to a patent, together with legal concerns about the patent system and the very short lifecycle for the majority of technologies, make intellectual properties market very hostile for transactions. According to Ocean Tomo CEO Jim Malackowsky, "IP is the largest asset class today and it is the most inefficient, it is illiquid and it is challenging to value."

Almost 98% of the issued patents (about 150.000 every year in US itself) are never commercialized. Purchaser wants to be sure that no pre-existing patents could invalidate its claims. In addition, a patent might seem valuable one day, but an antagonist might challenge its validity the next, based on some other prior art. What's more, patent law is unpredictable and constantly evolving. Patentees increasingly driven by short-term market goals do not commercialize their patents as they often give priority to other inventions. This state of things creates big imbalances in terms of knowledge between owner of the patent and the purchaser or licensee; the latter party can minimize the risk of purchasing or licensing a "zero" or low value patent only by receiving sufficient time to investigate the patents. This is where patent auction comes in. The mechanism of this new transaction tool will be explained in the next chapter.

II. The new context of patent auctions

In December 2004, freepatentauction.com was created to provide a free venue for inventors to post their inventions for licensing or sale. The website does not provide any guidance or support to buyers , and no information is available regarding actual sales. Similarly, in April 2006, Ocean Tomo, a Chicago-based IP firm, introduced the idea of holding a public auction, selling patent lots put up for sale by current owners. The results of its last Live IP Auction held on Fall 2008 shown cumulative sales, including buyer's premium, about $12.842.500, producing strong results for buyers and sellers alike, with further transactions anticipated to close in further weeks. More than 500 attendees gathered for the event including large corporations, small and mid-size companies, research institutions, government agencies, legal firms, sole inventors, investors and the media. It must be also highlighted the partnership to commercialize NASA-funded technologies.

There are several other websites, which also provide opportunity to auction the patents, like ipauctions.com, ipmarket.com and shop4patents.com. The growing number of these on-line platform is due to the fact that not all patents are held by giant companies. In actuality most of the patents are held by individuals which try to benefit from the marketplace created by the internet.

Although many deemed the auction a success (even unsuccessful sellers viewed the event as a great marketing tool), some were skeptical. One of the perceived problems with the auction is the broad scope of the inventions being offered for sale. Because the patents ranged from cleaning materials to wireless technology, the broad array of technologies may have diluted the pool of possible bidders, thereby reducing the over-all bidding. Another criticism of the auction is the speculative value placed on each of the patent lots offered for sale, since the sellers provided their own valuations of the patents. Finally some critics fear that the auction would only fuel patent trolls. This is a term used for a company that enforces its patents against one or more alleged infringers in a manner considered unduly aggressive or opportunistic, often with no intention to manufacture or market the patented invention. For example, a company may purchase hundreds of patents from a technology company forced by bankruptcy to auction its patents. The recent Blackberry case shows that companies are very sensitive to patent trolls. The trouble started in 2001 when R.I.M.(the BlackBerry's manufacturers, a Canadian company called Research in Motion), was sued by a small Virginia company called N.T.P. for infringing on five patents that described the design and operation of a primitive wireless e-mail network. In 2003, a judge granted an injunction saying that R.I.M. needed to cut a deal with N.T.P. or shut down the BlackBerry service. N.T.P. is a company without employees or products. It never tried to build a real business around its patents, and it never licensed them to others, until R.I.M. demonstrated just how lucrative wireless e-mail could be. What's more, no one alleges that R.I.M. used N.T.P.'s patents to build the BlackBerry; it invented its system from scratch. N.T.P., holding the patent on an idea and a crude design, waited until another company created a successful business based on similar ideas, and then headed to court. N.T.P. is not alone in such endeavors. In fact some others fear that intellectual property companies like Acacia Research and Intellectual Ventures, which has amassed more than 3.000 third-party patents, will build portfolios just to extract settlements from others.

Ocean Tomo CEO Jim Malackowsky affirmed that criticism are both exaggerated and misplaced. Obviously his thought is that auction can bring numerous benefits to both seller and buyer.

From a seller perspective, the auction is the first forum for transacting intellectual property in which the burden of purchasing is actually shifted to the buyer. The auction structure and format enable a seller to offer a pre-set terms and conditions including a minimum price, *"the reserve"*.

The live auction brings sellers closure and the benefit of a true "market sale", while also affording their intellectual property great exposure even if a sale is not completed on the auction floor. Historically, the intellectual property market has been insulated as transactions have been conducted privately without public discussion as to buyers or price.

For buyers, the auction provides an entirely different set of advantages. The foremost benefit is open, informed access and an equal opportunity to buy. The auction also provides market transparency and price discovery. Without auction floor, buyers of IP have extreme difficulty in understanding "market pricing" as a very limited public data set for comparable transactions is available. This framework should facilitate strategic patent purchases ensuring that all potential purchasers have an opportunity to bid on patents in which they are interested.

While the auction brings transparency to the IP marketplace, buyers can conduct diligence and bid for auction lots anonymously. Significantly, all bidders and sellers represent and warrant that no involvement in the auction by other sellers or buyers will be used as evidence in any future litigation. It is true that many attendees want simply "to test the waters", reserving participation (on both the sell and buy side) for future auctions. Practically they want to keep an eye on the competition. Finally it must be considered that post-auction discussions between bidders and sellers usually end in additional sales.

Ocean Tomo LLC is the most developed platform for patent auction. Established in 2003 in Chicago, is the leading Intellectual Capital Merchant Bank firm. The name Ocean Tomo reflects the firm's vision as:

Ocean reflects the cross-oceanic nature of intellectual property as well as the legal acronym for the adverse possession of property (Open, Continuous, Exclusive, Adverse and Notorious);

Tomo is a Japanese word for intelligent and friendly and reflects the Asian notion of an integrated, friendly group of related businesses.

Ocean Tomo provide the following services:

- Expert Services including Financial Testimony and Surveys;
- Valuation opinions including Appraisals, Patent Analytics and Patent Ratings;

- Asset Management services including Private Capital, Public Equities and Patent Sale/License-Back;
- Risk Management;
- IP Transactions, offering four primary products: Private IP Brokerage, Live Multi-Lot IP Auctions, Patent/Bid-Ask, and The Dean's List Online IP Exchange (TDL).

Focusing only on the auctions, they are organized as a two day event with the presence of sponsors and media, and concluded by a gala dinner. During auctions patents, trademarks (or brands), copyright and domain name can be sold. The following are areas with high buyer interest: Consumer Products, Digital Music & Video, e-Commerce & Web Services, Integrated Circuits & Semiconductors, Integration Technology, Interactive TV & VOD, Online & Mobile Advertising, RFID & Barcode Technology, Security/Digital Rights Management, Social Networking & Web 2.0, User Interface Technology, Wireless/Network Communications.

Ocean Tomo will conduct an initial assessment of submitted IP to determine if it is appropriate for live auction. For the patent assets, Ocean Tomo utilizes its proprietary rating and assessment platform, the Intellectual Property Quotient or (IPQ), which objectively scores and rates patent assets based on a proven statistical methodology.

Once an IP has been qualified for the auction, sellers will execute two documents. The first is the Seller Consignment Agreement, in which consigns his/her IP to Ocean Tomo for the purpose of selling it at the Auction, and outlines general terms and conditions of the listing and sale. Here Sellers can also place a reserve price, the minimum amount accepted for the patent. Reserves remain confidential. The second document is the IP Sale Agreement, signed between the seller and the buyer for the sale of the IP.

Once the patent has been sold, the seller will receive 85% of the hammer price while the bidder will pay a 10% buyers premium. For example, with a $1M IP sale at the auction, the seller will receive $850,000 and the bidder will pay $1.1M. Practically Ocean Tomo earns a 15% seller's premium of the final bid price, plus the buyer premium. Listing fees for sellers go from a minimum of 1.000$ to a maximum of 6.000$.

Conversely bidders should register themselves before the auction by signing the bidder agreement and contextually paying the bidder fee, and following some few requirements, like a letter of guarantee. Bidder registration fee amount is 1.500$. The winning bidder must pay the bid amount plus the 10% premium within 5 business days. Ocean Tomo may impose 18% interest per annum, or the maximum allowed by law, on any late payment and no transfer document will be released until the payment.

Bidder identity is strongly protected. They will be identified by paddle number only. For those bidders that prefer "double-blind" anonymity, an Ocean Tomo representative may execute bids on your behalf in accordance with your written instructions. Bidders maintain the right of anonymity also during due diligence process. They will utilize online secure data room, maintained by an independent third party, to assist the due diligence process. The Data Room is secure by definition, and therefore bidders are assured that their activity is confidential and anonymous.

Regarding the Due Diligence Procedures for intellectual properties offered during the auction, Ocean Tomo established a variety of ways through which prospective buyers may conduct their investigation: the printed *auction catalogue* versions have varied significantly with respect to the first auction, and maybe they will vary again following the constant evolution of buyers' and sellers' needs. In actuality they provide the following information:

- Patent numbers/Trademarks/Copyrights/Domain Names;
- Assignee/Seller;
- Related IP;
- Expected Value provided by the seller;
- Brief description of property being sold;
- Forward citations analysis;
- Potential Licensees;
- Title, Inventors, issue and filing date;
- Representative independent claim.

The print version of the auction catalogue is generally available one month before an auction event. The online version may be available earlier.

Qualified bidders will have also access to a password-protected online *secure data room* that will contain detailed information regarding the intellectual property and related items for sale.

Finally bidders will have the option of arranging *private due diligence meetings* with the seller prior to the event and during the event. These meetings will provide the bidder with the opportunity to interact with the seller and/or corporate representative and conclude any remaining due diligence.

III. The Research

The new information coming from the Ocean Tomo Auction Environment have been linked in this thesis with other data like patent metrics and characteristics, in the attempt to verify to what extent some of them are able to explain the monetary value of a single patent. The research is based upon a sample of 343 U.S. patents listed in the auctions between 2006 and 2008. During this period 6 auctions have been conducted across San Francisco, New York and Chicago, according to a semiannual schedule (Spring and Fall), plus 2 extraordinary Europe based auctions, one in London (Summer 2007) and the other in Amsterdam (Summer 2008), summing a total of 8 auctions. Intellectual properties are usually offered through “lots” sometimes including more than only one patent, but consistently with the aim of investigating single patent monetary value, “multi-patent lots” have been left out of the sample.

The observations will be analyzed through 23 different metrics providing information about patents’ selling prices, technological classes, inventors, sellers and its entity, buyers, cost of the invention, breadth, scope, novelty, technological impact and disclosure. Sources for the data are Ocean Tomo website, online patent database provided by USPTO, EPO and WIPO, and also Dialog Select online database for information about legal disputes and family size.

Of the 343 patents 175 remained unsold, while 168 were successfully transferred to new owners, for a total sales volume of $47.005.508. The Fall 2008 event has recorded the highest number of listed patents, 73, and highest sales volume for an amount of $9.064.000. Summer 2008 auction presents both the highest mean price ($387.980) and median price ($215.545) at the same time, and finally Spring 2008 event achieved the highest "success rate", selling the 63,9% of the listed patents. Selling prices go from a minimum of $2.200 to a maximum of $4.895.550, presenting a mean price of $282.708 and a median price of $110.000[1]. Already from this first figures it is possible to confirm the skewness property of patents' value distribution, given that only very few patents have been sold at higher prices. This result is supported by a skewness index of 5,64. Almost half of the patents listed for sale, as for sold ones, have been granted between 2004 and 2007, but to the latter belongs the best ratio between sold and listed (65,7%). According to International Patent Classification System (IPC), all the listed patent are included in the technical classes of Computing, Calculating, Counting (G06) and Electric Communication Technique (H04); more precisely almost the 34% belong to Electric Digital Data Processing (G06F). This outcome is obviously confirmed by the U.S. Classification System (more dispersive than IPC), according to which the 29,7% of listed patents' are classified in the field of Data Processing (705), Multicomputer Data Transferring (709) and Telecommunications (455). A very large number of different sellers have participated to the auctions: Sun Microsystems has

[1] *For all summary descriptive statistics about both continuous and discrete variables see Appendix (I,II).*

been the more active, but with only 10 patents, then Motorola with 9, Iomega Corporation with 8, Gutman Levitan (a private inventor) with 6 and Siemens with 5, among the others. Also NASA participated as seller to a public auction through a partnership for the Fall 2008 event. It must be also considered that sometimes sellers have listed the same unsold patent in further auction, so that, for the last ranking, it is better to talk of "participation to auctions" rather than "patents". Another remark is that USPTO distinguish among the patents' owner between "Large and Small Entities". A Small Entity is either an independent inventor, collaboration of independent inventors, a nonprofit organization, or a company with under 500 employees, who is allowed to pay reduced renewal fees with respect to large entities. While in the sample the majority of listed patents belongs to small entities with 186 against 157, large entities are the most successful sellers with 96 patents against 72, confirming what already was found by Bessen (2006). With respect to the buy side, it has been more difficult to find data because Ocean Tomo hide the identity of the buyers while USPTO website provide data only partially. Anyway only few known companies like Apple, Garmin, Intel and Samsung participated to the auctions, whereas the great majority of buyers are intellectual property companies like Intellectual Ventures, Amstr. Investment and Jordaan Consulting, among the others. Finally the sample of 343 is the result of the inventive activity of 495 different inventors. The ones who saw their patents listed more are W.L. Reber, C.D. Perttunen and G. Levitan. The first two mainly working for Motorola, and the last one by itself. However none of their patents were never sold. Conversely the most "successful" inventors have been K. Shenay and E.A. McShane, both working for Shakti System, with their patents bought by IP companies

(Patent Leather LLC, American Patent LLC), and also Chien-Tzu Hou, who worked for Mentor Arc Inc. and Geneticware Co. Ltd., with 3 patents bought by other IP company like Open Invention Network.

The remaining metrics provide information to 6 different area of interest correlated with patent value: proxies of the invention's cost, breadth, technological and geographical scope, novelty, technological impact and disclosure.

It is possible to extract value from an invention only if the profits it will generate will be higher than the cost sustained, and this is why costs measures are correlated with patent value. Number of inventors, surcharges in renewal fees payment and legal disputes are here considered as proxies of the cost. In the sample, *Number of Inventors* goes from a minimum of 1 to a maximum of 6, with a distribution really concentrated around the mean of 1.66 (1.69 for only sold patents). With respect to renewal fees, the 12,8% of patents was paid in delay at the fourth year deadline, the 8,2% at the eighth year and the 1,7% at the twelfth year, with only 8 patents expired before term, whose 3 were sold on auctions. The percentages remain almost equal if considering only sold patents, so that this metric doesn't seem to be so relevant for a patent's "sale potential". The last cost-proxy is legal dispute: the 2,9% of listed patents have been opposed, whereas this percentage increase to 4,2% if considering only sold patents. However it should be remarked that the 70% of litigated patents is in the "sold" sub-sample.

Geographical and technological scope are supposed to be correlated with value because index of potential market application. The first deals also with invention cost since applying for a patent abroad is costly. The metric for that is *Family Size*, going in the sample from a minimum of 1 to a maximum of 16, registering a slightly higher mean for unsold patents (3,05) rather than for sold ones (2,88). Conversely the number of IPC classes is the proxy for *technological scope*. It goes from a Min of 1 to a Max of 16, as for Family Size, but here the “sold mean” (3,26) is higher than the unsold one (2,85), but also with an higher standard deviation.

Breadth also refers to scope, in a sense, but from a legal point of view. It indicates areas of technology from which others are excluded. The proxy in this case is the *number of claims*, each of them representing an inventive component. In the research they have been further separated between *independent* and *dependent*, the first having an higher degree of originality, and the second depending in turn by each independent one. In the sample total claims go from a Min of 1 to a Max of 108, while the independent from 1 to 28 and the dependent from 0 to 100. Independent are always the minority but they seems more correlated with sale potential since the “sold-mean” (3,8) is higher than the unsold one (3,6). Conversely total claims present an higher unsold mean, but it probably suffer the influence of dependent claims. According to this data it is possible to draw a first partial conclusion: a relation of different sign between independent and dependent claims with a patent sale potential, and their contrasting influence on total claims variable; but it will be better investigated later on.

The degree of novelty describe the technological distance between the patented invention and the prior art, see Reitzig (2003). Proxy is *backward citations* which however is a very noisy variable with respect to patent value, see Lanjouw and Schankerman (1997). In the sample backward citations were also divided into domestic patent citations, foreign patent citations and non-patent literature. Total backward citations go from a Min of 1 to a Max of 197, with a mean of 20,3; domestic from 0 to 164, with a mean of 15,5; foreign from 0 to 22, with a mean of 1,27 and non-patent literature from 0 to 65 with a mean of 3,6. Out of the 4 variable only foreign patent citations presents a slightly higher unsold mean, but it doesn't seem so much relevant.

The proxy for the technological impact of a patent is the number of *forward citations* received. In actuality it seems to be the indicator with the strongest correlation with value, proving that money is being invested in the development of the technology and the concrete existence of a potential market. In the sample forward citations go from a Min of 0 to a Max of 151 with an enough higher sold mean (14,26) with respect to the unsold one (10,5).

Disclosure is the last analyzed variable. It is assumed to have an inverse correlations with value since giving more technical information about the patent, means also conferring some positive externalities to patentee's competitors. Proxies for this variable are *Drawings* and *Lines*, the latter considered as the lines' number of the two column patent's description, excluding the claims from the count. In the sample drawings go from a Min of 0 to a Max of 127, while lines from 134 to 15142. None of the two has a sold mean higher than the unsold, implying that maybe disclosure has a negative effect also on sale potential.

Sampling the data about patents sold for prices higher than $1.000.000[2], it is possible to list some first insights about value rather than sale potential. The 45% of these high value patents were granted between 1998 and 1999, thus not referring to very recent

[2] *For results see Appendix (III).*

technologies. Even though large entities have been more successful in selling their patents, out of the 11 high value ones, 6 have been sold by small entities. None of the eleven presents foreign patent citations nor non-patent literature. The 64% were created by a single inventor, and every patent of the subsample by a different inventive entity. Finally the most relevant data is that 3 patent out of 11 have been litigated; it means that the 30% of all the litigated patents stay in the most valuable 3,21% of the entire sample.

After having analyzed the possibility a patent has to be sold in an auction, the estimation of correlation and regression coefficients between the logarithm of the price and the considered variables will provide more insight about the contribution of each patent characteristics to its value[3].

The anticipated assertion about *Total Claims* is here confirmed, whereas they are almost not correlated with price (0,0027), while *independent claims* are positively correlated (0,0384) and *dependent claims* present a very weak negative correlation (-0,007). This results is also confirmed by the regression run between the logarithm of price as dependent variable and the most important and "able to regress" patent metrics as independent ones (see Table *n*). Accordingly, *total claims* as *dependent claims* shown negative regression coefficients, while *independent claims* one is positive. A similar analysis can be pointed out for *Total Backward Citations* presenting a slightly negative correlation coefficient (-0,0505). Analyzing this indicator by its *domestic, foreign and non-patent literature* components, the first show the highest coefficient out of the three, but of negative sign (-0,0957), while the other two have a

[3] *Results are shown in Appendix (IV,V,VI,VII,VIII,IX).*

weak positive correlation, respectively of 0,0612 and 0,0314. Thus, the result is once again an influence of opposite sign between *domestic patent citation*(-), from a side, and *foreign patent citation* (+) and *non patent literature* (+) on *total backward citations* form the other, making its correlation with value enough noisy. This conclusion is supported also at regression level, where the coefficients present the same sign of the correlation ones.

Even showing a relatively low degree of correlation, *Forward Citations* (0,2969), *Legal Disputes* (0,2375), *Expiration after the fourth year* (-0,214) and *Surcharge at the fourth year renewal fee* (-0,1575), are the indicators correlated more with value, whereas *Familysize, Scope* and *Number of inventors,* who were supposed to be positively correlated, turned out to be not as consistently. In addition *Scope* presents a negative coefficient, as confirmed also at regression level, maybe explaining that a patent could be considered more valuable when its potential market application is addressed to a better specified technical field. Definitively is possible to say that according to this research, measures of scope are not a good proxy of value for a patent.

Drawings and *Lines*, who were expected to be negatively correlated with value, being proxies for *Disclosure*, turned out to be weakly but positively correlated with value. However according to the regression analysis, the first indicator confirmed a positive coefficient, while the second a negative one. One possible explanation may be that while *Lines* really allows for the existence of externalities to be exploited by patentee's competitors, *Drawings* are rather a measure for "science linkage", and as for *non-patent literature*, is poorly but positively correlated with value.

While *Entity* could be considerate a proxy for a patent's sale potential, it is not for value given its low correlation coefficient. Also data on *Renewal Fee* at eighth and twelfth year seems not so relevant.

Among all the correlation coefficients between the entire sample, two could be considered of interest. The first correlates *Drawings* and *Non patent literature* with a coefficient of 0,3748, thereby additionally proving the reliability of the former as "scientific linkage" proxy for a patent. I've tried to combine the two in a single indicator with the aim of finding a possible correlation between science and patent value, but with poor results.

The other pair of variables are *Forward Citations* and *Scope,* correlated by a coefficient of 0,2127[4]. This results maybe indicates that a patent with more technical classes assigned, has higher chances to generate diverse downstream research efforts for different market applications, but also to be cited by examiners to limit the scope of protection claimed by subsequent patentees accordingly belonging to different technical fields. Further investigating this relation, a new indicator consisting of the ratio between *Forward Citations* and *Scope* was created, and it finally turned out to be relatively quite consistently correlated with value, by a coefficient of 0,2803, the second more strongly correlated coefficient after *Forward Citations.* This ratio maybe explain to which degree a relatively new technology (as *Forward Citations* operationalize the technological impact) is concretely ready and addressable to a clearly defined and identified market (as *Scope* operationalize potential market applications). Finally I run two kind of regressions, one considering only the variables

[4] *See Appendix (X,XI,XII).*

with correlation coefficients higher than 0,15, and the other including also variables with coefficient higher than 0,05. In both cases coefficients present the same sign of correlation ones, with *Legal Disputes* being the higher (1,148). In a second step I've substituted to *Forward Citations* variable the ratio considering also *Scope*, and it turned out to have an higher regression coefficient (0,03) than *Forward Citations* (0,01).

Conclusions

As the original purpose for this thesis was to exploit data coming from new patent auctions environment with the attempt to precisely estimate single patent monetary value, we should say the goal failed to be hit. It still seems impossible to define the “golden regression equation”, always able to predict the exact market value for a patent or at least to approximate it with a constant standard error. This is due to the fact that, as sustained by Van Zeebroeck (2008), each patent indicator captures a different value component, being complement of the others indicators rather than substitute. This in turn lead them to alternatively underestimate or overestimate the patent characteristic they operationalize, returning results sometimes closer the real market price, but sometimes very far from it.

Conversely, the thesis produced interesting conclusions with respect to the attitude of some patent metrics (or characteristics) to be good or bad “indicators” of value, rather than econometric estimators, but also with respect to their ability the predict the possibility a patent has to be sold in an auction, or better to achieve or exceed the reserve price eventually applied by the seller.

First of all patents sold confirmed the positive skewness of their distribution value, being only the 3,21% of the entire sample sold for prices higher than $1.000.000. *Litigations* and *Forward Citations* confirm themselves as the most strongly reliable indicators of value and sale potential. The second one presents the highest correlation coefficient among all the variables, while for *Litigations* it is enough to know that the within the most valuable 3,21% of the sample there is the 30% of all litigated patents, that is, within the 11 patents sold for prices higher than $1.000.000, three are litigated. The last metric definable as substantially correlated with value, but negatively, is the *delayed payment of Renewal Fee at the fourth year*, whereas the verification of this event at the *eighth or twelfth year* is less relevant. *Family Size* and *Number of inventors*, which are supposed to be positively correlated with value because proxy of the cost, turned out, from the research, to be not good and reliable indicators. Large *entities* better ability to sell patents, as already anticipated by Bessen (2006) is here confirmed, but it is not a good proxy for value. Both *Claims* and *Backward Citations* seems noisy variables, not really correlated with value, probably because of the contrasting effect of their different components, that are, *independent and dependent claims*, where the first is positively correlated while the second negatively, and *Domestic Patent Citations, Foreign Patent Citations and Non Patent Literature*, where the first is negatively correlated and the remaining two positively. Also for *Disclosure* similar conclusions can be drawn since it has a poor correlation coefficient, whereas *Drawings* seems slightly positively correlated with value as indicator of “science linkage”, and *Lines* slightly negatively as source for externalities to be exploited by patentee’s competitors. Of the analyzed variables the last considerations have to be done regarding *Scope*, revealing a slightly negative correlation coefficient, as found by Sneed and Johnson (2007), probably indicating that a not well-defined identification of the potential market for a patent detracts from value.

Among all the correlations within the variables, the two strongest pairs are *Drawings* with *Non Patent Literature* and *Forward Citations* with *Scope*. The first prove *Drawings* are proxy for "science linkage" as *Non Patent Literature* and calls for further investigations aiming at merging the two in a unique indicator of scientific value of the patent. The second maybe indicates that a patent with more technical classes assigned, has higher chances to generate diverse downstream research efforts for different market applications, but also to be cited by examiners to limit the scope of protection claimed by subsequent patentees accordingly belonging to different technical fields. Creating a ratio between *Forward Citations* and *Scope* a new indicator of value turns out, presenting the second highest positive correlation coefficient among all the analyzed variable. It also has a regression coefficient higher than *Forward Citations* alone. This result probably explain that a relatively new technology is more valuable when its market application is clearly identified.

Investigating patent value through the auctions mechanism presents the main advantage of having easy access to a constant flow of data about selling prices, not always disclosed by companies. In addition, the flow seems designated to enlarge as the auction mechanism became more and more popular among sellers, despite some skepticism. The main limitation is the difficulty in collecting data about buyers, given the strong protection Ocean Tomo reserves to bidders' identity. This probably could be the real missing piece in predicting patent value. In further researches more effort will be devoted to the task of finding the identities of buyers in order to determine their patent portfolios' strategies. The value of a single patent could not clearly depend only upon some characteristics of its own token alone, but also upon the role it will play in the portfolio and the interaction with the other intellectual assets a company owns. Two approaches could be developed: one comparing and linking patents portfolio's characteristics, understanding the actual degree of development of the technologies to the market and benchmarking it with the average degree of competitors, and finally correlating these data with the expected future economic trend of the markets the technologies will be developed for; the second starting from the determination of the whole patent portfolio value, and then assigning a corresponding "value weight" to each patent according to its characteristics. Clearly this kind of research could be conducted on patents not yet transacted, assuming them in the portfolio of selected potential and interested buyers.

Appendix

I. *Descriptive Statistics: Continuous variable*

ENTIRE SAMPLE						
	Mean	Std. Dev.	Min	Max	Skew	Kurt
Price	282.708,4	513.804,9	2.200	4.895.550	5,64	4,44
# Inventors	1,659	1,01	1	6	1,777	6,244
Family Size	2,968	2,823	1	16	1,853	6,586
Scope	3,052	1,940	1	16	1,659	8,556
Tot Claims	22,204	17,257	1	108	1,7592	6,923
Ind Claims	3,738	3,123	1	28	3,284	2,084
Dep Claims	18,466	15,771	0	100	1,8383	7,422
Backward Citations	20,350	23,124	1	197	4,009	25,315
Dom.Pat.Citations	15,483	17,317	0	164	4,5458	34,397
For.Pat.Citations	1,271	3,017	0	22	4,2	24,202
Non.Pat.Literature	3,594	7,922	0	65	4,281	26,235
Forward Citation	12,376	21,304	0	151	3,241	15,895
Drawings	8,583	10,084	0	127	5,93	60,55
Lines	846,66	980,24	134	15142	9,621	134,217

SOLD						
	Mean	Std. Dev.	Min	Max	Skew	Kurt
# Inventors	1,696	1,008	1	6	1,657	5,685
Family Size	2,887	2,673	1	16	2,036	8,028
Scope	3,262	2,181	1	16	1,781	9,068
Tot Claims	20,518	15,237	1	88	1,662	6,571
Ind Claims	3,821	3,548	1	28	3,807	23,475
Dep Claims	16,696	13,526	0	76	1,619	6,244
Backward Citations	21,833	25,008	1	196	3,627	20,523
Dom.Pat.Citations	16,535	18,184	0	163	4,068	28,73
For.Pat.Citations	1,25	3,154	0	22	4,521	26,729
Non.Pat.Literature	4,047	9,084	0	65	4,321	25,363
Forward Citation	14,261	24,954	0	151	3,029	13,325
Drawings	8,434	7,765	1	48	2,007	7,838
Lines	846,66	648,68	176	4422	2,21	9,549

UNSOLD						
	Mean	Std. Dev.	Min	Max	Skew	Kurt
# Inventors	1,623	1,015	1	6	1,899	6,822
Family Size	3,046	2,965	1	15	1,701	5,545
Scope	2,851	1,658	1	9	1,073	3,848
Tot Claims	23,822	18,897	1	108	1,71	6,46
Ind Claims	3,657	2,660	1	13	1,713	5,857
Dep Claims	20,166	17,532	0	100	1,802	6,955
Backward Citations	18,926	21,132	2	197	4,488	32,435
Dom.Pat.Citations	14,474	16,43	0	164	5,141	42,154
For.Pat.Citations	1,291	2,888	0	21	3,776	20,384
Non.Pat.Literature	3,16	6,615	0	44	3,557	17,716
Forward Citation	10,565	16,962	0	120	3,008	15,007
Drawings	8,725	11,914	0	127	6,523	50,601
Lines	846,66	1218,513	134	15142	9,539	110,06

II. Descriptive Statistics: Discrete Variables

SELLERS		BUYERS	
Name	*Frequency*	*Name*	*Frequency*
Sun Microsystems, Inc.	10	*IP Properties L.L.C. A Delawar*	23
Motorola	9	*C.H.I Development MGMT*	20
Iomega	8	*Lot n Acquisition Foundation*	15
Gutman Levitan	6	*Auctnyc*	9
Siemens	5	*Palus*	9

INVENTORS		
Name	*Frequencies*	
	Total	*Sold*
WLReber	9	0
CDPerttunen	7	0
GLevitan	6	0
Chien-Tzu Hou	5	3
KShenai	4	4
CLBallard	3	0
EAMcShane	3	3
JGToler	3	0
YBinder	3	3

ENTIRE SAMPLE					
		Frequencies		Percentage	
		Total	*Sold*	*Total*	*Sold*
Entity	*Large*	157	96	45,77%	57,14%
	Small	186	72	54,23%	42,86%
Issue year	*2006*	46	22	13,41%	13,10%
	2005	43	18	12,54%	10,71%
	2004	36	20	10,50%	11,90%
	2007	35	23	10,20%	13,69%
US Class	*705*	45	27	13,12%	16,07%
	709	32	15	9,33%	8,93%
	455	25	14	7,29%	8,33%
	370	17	8	4,96%	4,76%
	707	15	10	4,37%	5,95%
IPC	*G06F*	116	61	33,82%	36,31%
	G06Q	22	17	6,41%	10,12%
	H04L	22	12	6,41%	7,14%
Legal Disputes	*Litigated*	10	7	2,92%	4,17%
Renewal Fee	*Expired (4)*	2	2	0,58%	1,19%
	Surcharge (4)	44	21	12,83%	12,50%
	Expired (8)	5	1	1,46%	0,60%
	Surcharge (8)	28	14	8,16%	8,33%
	Expired (12)	1	0	0,29%	0,00%
	Surcharge (12)	6	3	1,75%	1,79%

III. Descriptive Statistics: Patents sold for prices > $1.000.000

PATENTS SOLD FOR PRICES > $1.000.000			
		Frequency	*Percentage*
Issue Year	*1998*	3	27,273%
	1999	2	18,182%
	1992	1	9,091%
	1995	1	9,091%
	2002	1	9,091%
	2003	1	9,091%
	2004	1	9,091%
	2006	1	9,091%
Family Size	*1*	4	36,364%
	2	2	18,182%
	12	1	9,091%
	8	1	9,091%
	6	1	9,091%
	5	1	9,091%
	4	1	9,091%
Legal Disputes	*Litigated*	3	27,273%
# Inventors	*1*	7	63,636%
	2	2	18,182%
	3	1	9,091%
	5	1	9,091%
Entity	*Large*	5	45,455%
	Small	6	54,545%
ForPatCitations	*0*	8	72,727%
	1	1	9,091%
	8	1	9,091%
	11	1	9,091%
NonPatLit	*0*	5	45,455%
	1	2	18,182%
	4	1	9,091%
	7	1	9,091%
	11	1	9,091%
	21	1	9,091%

IV. Correlation Coefficient

	LogPrice	FamilySize	Litigation	#Inventors	SmallEntity	Exp(4)	Surch(4)	Exp(8)	Surch(8)	Exp(12)
LogPrice	1									
FamilySize	0,0914	1								
Litigation	0,2375	-0,0247	1							
#Inventors	0,0368	0,1584	-0,1149	1						
SmallEntity	0,0581	-0,049	0	-0,0736	1					
Exp(4)	-0,214	-0,0365	-0,0229	0,0878	0,1267	1				
Surch(4)	-0,1575	-0,1123	0,1013	-0,065	-0,0364	-0,0415	1			
Exp(8)	0,0176	0,0323	-0,0161	0,1004	-0,067	-0,0085	-0,0292	1		
Surch(8)	0,0069	-0,0276	0,1527	0,0482	0	-0,0331	0,0814	-0,0233	1	
Exp(12)	-	-	-	-	-	-	-	-	-	1
Surch(12)	-0,0641	0,0732	-0,0281	-0,004	-0,0259	-0,0148	-0,051	-0,0104	-0,0407	-
TotClaims	0,0027	0,0842	0,0458	0,2607	0,0188	0,0468	0,0582	-0,0587	0,0436	-
IndClaims	0,0384	-0,0167	0,1116	0,2527	-0,0481	0,0211	-0,0216	-0,0398	0,137	-
DepClaims	-0,007	0,0993	0,0224	0,2274	0,0338	0,0472	0,0712	-0,0556	0,0132	-
Scope	-0,0338	-0,0719	0,0982	-0,0045	-0,0545	0,1382	0,0786	0,0974	0,033	-
BackCit	-0,0505	0,0186	-0,0643	0,1845	0,0198	0,0954	-0,0148	-0,0429	-0,0818	-
DomPatCit	-0,0957	-0,0127	-0,0423	0,1217	0,0567	0,0694	0,0146	-0,0492	-0,0695	-
ForPatCit	0,0612	0,1604	-0,0829	0,1597	-0,1224	-0,0436	-0,0587	0,0431	-0,0856	-
NonPatLit	0,0314	0,0209	-0,0636	0,209	-0,0165	0,1388	-0,0497	-0,0346	-0,0563	-
ForCit	0,2969	-0,0908	0,3438	-0,0192	-0,0144	-0,0453	-0,0785	-0,0008	0,1345	-
Draw	0,0631	-0,0167	0,0152	0,0881	0,1844	0,0505	-0,163	-0,0143	-0,0197	-
Lines	0,0048	-0,0129	-0,0249	0,0606	0,0134	-0,0285	-0,077	-0,0372	-0,0639	-

	Surch(12)	*TotClaims*	*IndClaims*	*DepClaims*	*Scope*	*BackCit*	*DomPatCit*	*ForPatCit*	*NonPatLit*	*ForCit*	*Draw*	*Lines*
LogPrice												
FamilySize												
Litigation												
#Inventors												
SmallEntity												
Exp(4)												
Surch(4)												
Exp(8)												
Surch(8)												
Exp(12)												
Surch(12)	1											
TotClaims	-0,0786	1										
IndClaims	-0,0821	0,5717	1									
DepClaims	-0,067	0,9766	0,3816	1								
Scope	0,1078	0,0137	0,061	-0,0005	1							
BackCit	-0,082	0,1564	0,0934	0,1517	-0,0563	1						
DomPatCit	-0,0833	0,0865	0,0767	0,0773	0,0046	0,9109	1					
ForPatCit	-0,0107	0,19	0,0302	0,2061	-0,0627	0,6281	0,3841	1				
NonPatLit	-0,0553	0,1915	0,0931	0,1913	-0,1424	0,7114	0,3724	0,6129	1			
ForCit	0,0004	-0,0285	0,0761	-0,052	0,2127	-0,1123	-0,0941	-0,1112	-0,0823	1		
Draw	-0,0888	0,281	0,2753	0,2443	-0,0068	0,2242	0,1156	0,031	0,3748	0,0828	1	
Lines	-0,0557	0,1964	0,2051	0,1674	-0,0064	0,2155	0,1661	0,0682	0,2371	0,1523	0,6188	1

V. Regression with major indicators

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
familysize	.0533234	.0362639	1.47	0.143	-.0182975	.1249444
numinv	.0368975	.0998413	0.37	0.712	-.1602887	.2340836
totclaims	-.0007549	.0067374	-0.11	0.911	-.0140611	.0125514
scope	-.0571605	.0447157	-1.28	0.203	-.1454738	.0311528
totbackcit	-.0013288	.0040263	-0.33	0.742	-.0092807	.0066232
forcit	.0170141	.0040005	4.25	0.000	.0091131	.0249151
drawings	.0178439	.0159996	1.12	0.266	-.0137552	.049443
lines	-.0002097	.0001895	-1.11	0.270	-.000584	.0001646
_cons	11.588	.2871336	40.36	0.000	11.02091	12.15509

VI. Regression – Claims Effect

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
familysize	.053319	.0362472	1.47	0.143	-.018269	.124907
numinv	.031202	.1002672	0.31	0.756	-.1668253	.2292294
indclaims	.0037945	.0288292	0.13	0.895	-.0531431	.0607322
scope	-.0576555	.0447554	-1.29	0.200	-.1460473	.0307362
totbackcit	-.0013513	.0040206	-0.34	0.737	-.009292	.0065895
forcit	.0170136	.0039994	4.25	0.000	.0091147	.0249124
drawings	.0171147	.0159696	1.07	0.285	-.0144253	.0486546
lines	-.0002113	.0001896	-1.11	0.267	-.0005857	.0001631
_cons	11.57732	.2833358	40.86	0.000	11.01773	12.13691

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
familysize	.0535147	.0363024	1.47	0.142	-.0181823	.1252118
numinv	.0373232	.0990458	0.38	0.707	-.1582918	.2329382
depclaims	-.0011819	.007467	-0.16	0.874	-.0159291	.0135654
scope	-.0571631	.0447003	-1.28	0.203	-.1454459	.0311197
totbackcit	-.0013149	.0040276	-0.33	0.744	-.0092693	.0066396
forcit	.0169956	.0040038	4.24	0.000	.0090882	.024903
drawings	.0179193	.015923	1.13	0.262	-.0135286	.0493671
lines	-.0002096	.0001895	-1.11	0.270	-.0005839	.0001646
_cons	11.59026	.2866738	40.43	0.000	11.02408	12.15644

VII. Regression – Backward Citations Effect

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
familysize	.052427	.0362218	1.45	0.150	-.019111	.1239649
numinv	.0404179	.0990752	0.41	0.684	-.1552552	.236091
totclaims	-.0007555	.006718	-0.11	0.911	-.0140236	.0125125
scope	-.0556494	.0446423	-1.25	0.214	-.1438177	.0325189
dombackcit	-.0043394	.0053694	-0.81	0.420	-.014944	.0062652
forcit	.0167903	.0039877	4.21	0.000	.0089146	.024666
drawings	.0173728	.0158993	1.09	0.276	-.0140283	.0487739
lines	-.0001961	.0001897	-1.03	0.303	-.0005707	.0001785
_cons	11.61807	.2890139	40.20	0.000	11.04727	12.18887

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
familysize	.0487644	.0364101	1.34	0.182	-.0231454	.1206742
numinv	.0213936	.0988327	0.22	0.829	-.1738007	.2165878
totclaims	-.0019422	.0067786	-0.29	0.775	-.0153299	.0114455
scope	-.0550139	.0445792	-1.23	0.219	-.1430577	.0330298
forbackcit	.0337927	.0313096	1.08	0.282	-.0280437	.0956291
forcit	.0175983	.0039676	4.44	0.000	.0097624	.0254343
drawings	.0182466	.0158961	1.15	0.253	-.0131481	.0496412
lines	-.0002316	.0001881	-1.23	0.220	-.0006031	.0001399
_cons	11.58039	.2837952	40.81	0.000	11.0199	12.14089

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
familysize	.0538939	.0362591	1.49	0.139	-.0177177	.1255056
numinv	.0249781	.1002013	0.25	0.803	-.1729192	.2228754
totclaims	-.0010099	.006736	-0.15	0.881	-.0143134	.0122936
scope	-.0543704	.0450935	-1.21	0.230	-.1434299	.0346892
nonpatlit	.0046191	.0116903	0.40	0.693	-.0184692	.0277075
forcit	.0173362	.0039786	4.36	0.000	.0094785	.0251939
drawings	.0154982	.0165921	0.93	0.352	-.0172711	.0482675
lines	-.0002182	.0001882	-1.16	0.248	-.0005899	.0001535
_cons	11.57738	.2846918	40.67	0.000	11.01512	12.13965

VIII. Regression with variables having correlation coefficients > 0,15

Source	SS	df	MS
Model	36.2982324	3	12.0994108
Residual	236.211501	164	1.44031403
Total	272.509733	167	1.63179481

Number of obs =	168
F(3, 164) =	8.40
Prob > F =	0.0000
R-squared =	0.1332
Adj R-squared =	0.1173
Root MSE =	1.2001

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_Iuslitiga~2	1.124999	.4981443	2.26	0.025	.1413954	2.108602
_Ifourthyr_2	-.6076073	.2835144	-2.14	0.034	-1.167416	-.0477983
forcit	.0114563	.0039925	2.87	0.005	.0035729	.0193397
_cons	11.65489	.1138066	102.41	0.000	11.43018	11.87961

IX. Regression with variables having correlation coefficient > 0,05

Source	SS	df	MS
Model	43.6323095	7	6.23318707
Residual	228.877424	160	1.4304839
Total	272.509733	167	1.63179481

Number of obs =	168
F(7, 160) =	4.36
Prob > F =	0.0002
R-squared =	0.1601
Adj R-squared =	0.1234
Root MSE =	1.196

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_Iuslitiga~2	1.148447	.496843	2.31	0.022	.1672306	2.129663
_Ifourthyr_2	-.5461341	.2870535	-1.90	0.059	-1.113037	.0207684
forcit	.0117002	.0040163	2.91	0.004	.0037684	.0196319
drawings	.002279	.0124069	0.18	0.854	-.0222233	.0267813
dombackcit	-.0090621	.0055923	-1.62	0.107	-.0201063	.0019822
forbackcit	.0615827	.0324266	1.90	0.059	-.0024566	.1256219
_Ientity_2	.2047885	.1924079	1.06	0.289	-.1751981	.5847752
_cons	11.60864	.1843031	62.99	0.000	11.24466	11.97262

X. Forward Citations / Scope - Correlation

	Logprice	*ForCit/Scope*
Logprice	1	
ForCit/Scope	0,2803	1

XI. Forward Citations / Scope - Regression with variables having correlation coefficients > 0,15

Source	SS	df	MS
Model	35.3862723	3	11.7954241
Residual	237.123461	164	1.44587476
Total	272.509733	167	1.63179481

Number of obs	=	168
F(3, 164)	=	8.16
Prob > F	=	0.0000
R-squared	=	0.1299
Adj R-squared	=	0.1139
Root MSE	=	1.2024

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_Iuslitiga~2	1.211496	.4910405	2.47	0.015	.2419197	2.181073
_Ifourthyr_2	-.6221393	.2836172	-2.19	0.030	-1.182151	-.0621274
A	.0319019	.011594	2.75	0.007	.0090091	.0547946
_cons	11.66517	.1133094	102.95	0.000	11.44144	11.8889

XII. Forward Citations / Scope - Regression with variables having correlation coefficients > 0,05

Source	SS	df	MS
Model	43.0257164	7	6.14653091
Residual	229.484017	160	1.43427511
Total	272.509733	167	1.63179481

Number of obs	=	168
F(7, 160)	=	4.29
Prob > F	=	0.0002
R-squared	=	0.1579
Adj R-squared	=	0.1210
Root MSE	=	1.1976

logprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_Iuslitiga~2	1.228537	.4897611	2.51	0.013	.2613066	2.195767
_Ifourthyr_2	-.5564774	.2871333	-1.94	0.054	-1.123537	.0105827
A	.0329645	.0116248	2.84	0.005	.0100068	.0559222
drawings	.0029937	.0124074	0.24	0.810	-.0215097	.0274971
dombackcit	-.0094757	.0055938	-1.69	0.092	-.0205229	.0015715
forbackcit	.0611235	.0324623	1.88	0.062	-.0029864	.1252334
_Ientity_2	.2137428	.1928267	1.11	0.269	-.167071	.5945566
_cons	11.61464	.1843525	63.00	0.000	11.25056	11.97872

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