QUANTIFYING SUSTAINABLE PATENTS FOR ENHANCING ESG FACTORS USING BIBLIOMETRIC INDICATORS FROM PATENT PORTFOLIO VALUATION

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ABSTRACT: This paper goal is to present the results the use of patent valuation indicators as alternative data which can determine sustainable patents inside a patent portfolio and generate a ratio of sustainable technologies which are developed by a company. Based on different qualitative patent indicators which address the areas "technology" and "market" the enhancement of an ESG rating was prepared and discussed.

Key words: patent valuation, bibliometric data, ESG, UN SDG, alternative data

1. INTRODUCTION

Sustainability has become the driving factor in analyzing and evaluating companies. Sustainability became in the past decade one of the most important factor for all stakeholders like customers, employees, business partners and investors.

The establishment of the 17 Sustainability Goals from the UN and the Foundation of the UN Global Compact and the UN Principles for Responsible Investments provide an excellent framework and has been proven over years that a focus on sustainability is an important value driver [1].

Sustainability ratings focus on historical data provided by the companies and forward-looking trends are mostly not tangible. Terms like Fair, Clean, Sustainable, are often used but are lacking a clear definition and confuse customers and even investors struggle. Thus, approaches which are transparent, forward looking and objective not relying solely on companies self-reporting are highly desired.

In the most recent "Report on Benchmarks", the EU Technical Expert Group on sustainable finance (TEG) proposes, greater disclosure of the methods and benchmarks used to prevent greenwashing [2]. However, this approach is also criticised, among other things because the proposed benchmarks (the reference values against which a measured sustainability value can be compared and put into relation) would tend to encourage greenwashing due to their lack of variability. The proposals

would primarily help ESG data providers (Investopedia:" Environmental, social and governance (ESG) criteria are a set of standards for a company's operations that socially conscious investors use to screen potential investments. Environmental criteria consider how a company performs as a steward of nature. Social criteria examine how it manages relationships with employees, suppliers, customers, and the communities where it operates. Governance deals with a company's leadership, executive pay, audits, internal controls, and shareholder rights), but less so investors and thus decision-makers. Accordingly, approaches are desirable that allow a sustainability analysis without relying on any "self-assessment" of the company concerned and where benchmarks and methodology are transparent [3].

In a sense, patents are the blueprint for the R&D activities of a (technically or scientifically oriented) company. They document the results of successful investments in tomorrow's innovations. These inventions describe in detail the (innovative) approaches to solving problems that one would like to address with new products in the future.

Accordingly, the value distribution of a patent portfolio is also the reflection of innovative ability and willingness. Thus, a look at the patent portfolio - and its value distribution - allows a deep insight into R&D activities and a presumed product pipeline.

Alternative data (proprietary datasets) in different areas like geo-location, credit card, social/sentiment or web traffic became very popular over the last years at financial institutions promising additional insights beside business data. ESG data providers are giving an insight into a companies' sustainable activities.

Patent data became very popular over the past years because of the currently high quality of the data delivered by the most national patent offices and the possibility to use patent metrics as an indicator to measure the innovation developed by companies [4,5,6,7,8,9,10,11].

A study published by the Canadian company Corporate Knights [12] presents a list of 7500 companies with an annual turnover of at least USD 1 billion, from which those that are supposedly the most sustainable are selected. The ranking of the "top sustainable companies" will be compared with the results of the current patent analysis.

2. AIM OF THE STUDY

The aim of the study is to determine if and how patent indicators derived from different metrics can generate additional intelligence when analysing companies.

This paper shows that patent metrics are suitable to enhance ESG factors and thus can be used for equity selection in financial products.

The main theory for using patent indicators is, that the development of the patent portfolio of a company is an early trend indicator and contemporary representing the present status of a company's research- and development output.

The amount and quality of granted and applied patents are an early stage and trend indicator, because first there is a serious time lag between application and grant of a

patent which depends on the patent office, the patent quality itself and the technological sector and is stated to 1-10 years [13]. Secondly patents can be found after several years of their filing in products of the applicant.

The patenting activity of a company represents as well the current status of a company in terms of revenues and profits, because filing and counter fighting needs available resources in terms of money and human power. Further the development of patents needs a high-class research and development department, which is able to generate innovations, otherwise no patents will be granted. Last but not least, a company which is filing patents with a high quality believes in its own technology and future growth, and is not only optimizing the corporate structure for cost-savings.

These points make patent analysis for fundamental company rating so interesting. Studies have shown that there is a correlation between stock value and patent development [14,15,16].

The current paper endorses the basic theory, that measurement of patent quality is a suitable factor for enhancing ESG factors for selecting equities and generating indexes for investment purposes.

3. DATA SOURCES

For this study different data sources have been used which are described as follows:

1. Business data

The business data have been delivered from Moodys product “Orbis” which is Bureau van Dijk's flagship company database [17]. It contains information on companies across the world and focuses on private company information. It has information on around 300 million companies from all countries. The main information which was exported from the database have been: Company identifier (ISIN), Total assets, Amount on employees, Corporate tree with subsidiaries >51% share.

2. Patent data

The used database for patent data was “Patstat” [18] which is a global database containing bibliographical data relating to more than 100 million patent documents from industrialised and developing countries. It also includes the legal event data from more than 40 patent authorities contained in the EPO worldwide legal event data.

3. Economic data

The economic data used for this study is the GDP from each country. This was downloaded from the Worldbank Open Data [19].

4. PROPOSED SYSTEM FOR THE MAIN INDICATORS

Based on different possible indicators, the proposed main indicators determining patent portfolio quality are:

1. Technology Impact [Ti] = Number of citing patents

2. Market impact [Mi] = amount of family members and GDP of the countries where the patent family members are alive (= patent country distribution)

The indicators are determined like follows:

4.1 Technology Impact [Ti]

There are 2 different types of citation: forward and backward citations. Future citations received by a patent (forward citations) are more important than the backward citations, because in the case of forward citation the main indication is, that an innovation has contributed to the development of subsequent inventions. For this reason, citations have been used in several studies as a measure of the value of an invention [5,20,21] . The main thesis is, that the more often a patent is quoted as prior art during examinations of subsequent patent examinations, the more fundamental its technological contribution to the field, the higher the quality [22].

Backward citations are used to determine the inventory step of the innovation and because this is connected with the patent applying process of the attorney it can't be used as good indicator: some attorneys are using a huge amount of backward citations with the aim to show the examiner that the applied patent is very innovative, other attorneys do not use this very intensively. Also the application process in different countries leads to different amounts of backward citations.

The examiners in the Patent offices have a certain amount of patents they always use for citations (because of time reduction for the examination process) – this behaviour from the practical point of view can have influences. This topic was examined by Criscuolo and Verspagen [23] and Juan Alcácer and Michelle Gittelman [24].

Further the cited documents can be also used as an indicator. Usually there are other patents or utility models cited but also NPL (Non-Patent-Literature) [25]. The main conclusion is, that the closer a patent application is to "fundamental research", as reflected by the non-patent references, the higher its technological quality. NPL is also used like backward citation to show the examiner that the state of the art has been approved before applying.

The forward citation is also a main indicator for the litigation process. In the work of Jean O. Lanjouw and Mark Schankerman [26] it is shown that there is a direct impact between citation and litigation.

The current Technology impact is defined as follows: the amount on foreign citations were divided through the amount on alive patents. The normalization was performed under the backward citation index, average per economy (country) [27].

Self-citations (even intra-corporate from subsidiaries) and references to non-patent literature have been excluded from the count. Approximately 11 percent of all citations in the sample from Jaffe and Tratenberg, 2003 are self-citations. To determine this indicator properly the corporate tree from the company must be available [28].

The technology impact [Ti] is defined to:

$$[\mathrm{Ti}] = \frac{\text{amount on foreign citations (normalized)}}{\text{amount on alive patents}} \qquad (1)$$

4.2 Market impact [Mi]

A number of authors have argued out that information on family size may be particularly well suited as an indicator of the value of patent rights. The studies by Putnam and Lanjouw et al. [29] have shown that the size of a patent family, measured as the number of jurisdictions in which a patent grant has been sought are highly correlated. To measure the potential power of a "family size", it is recommended to obtained the number of nations in which protection for a particular invention was sought from Derwent's World Patent Index (WPI) database.

The study from Adam B. Jaffe, Gáetan de Rassenfosse [30] shows, that there exists as well a bias for the priority application,

The size of a patent family is an indicator for the market impact that the technology described in the patent may have. The assumption is, that the higher the applicants willingness to pay for a large territory protection, the higher the patents value.

There exist some studies [31] showing that triadic patents (patent family applied and/or granted in Europe, Asia and USA) having a higher value then only filed in single countries, but due own experience of the author in several valuation projects the value of a patent depends much more on the certain economy where the patent is filed.

The market impact is therefore defined to the share of the IPC class (distinct 4 digit IPC subclasses) in the certain country where the patent family is filed, expressing the importance of the technology area in the certain country. The shares for each sub-class are exemplarily shown in a study from InTraCoM [32].

The market impact is further directly correlated with the economic size of the country (expressed in GDP), the importance of the certain technology in that country (expressed in share of the IPC class in the country) and the legal status of the patent family (application, grant or utility model).

The Market impact [Mi] is defined to:

$$[\mathrm{Mi}] = \sum_1^n \frac{amount\ patents\ in\ the\ IPC\ class\ in\ the\ country}{total\ amount\ on\ patnets\ in\ the\ IPC\ class} * \frac{GPR\ of\ the\ country}{Global\ GDP} * Co \qquad (2)$$

Co = factor for legal status of the patent family member defined to

Granted patent = 100%

Applied patent = 20 %

Utility model = 10%

5. IPC CLASS DEFINITION

One main task to define sustainable patents is to define the IPC classes in which the patents are applied and granted. The International Patent Classification (IPC) provides for a hierarchical system of language independent symbols for the classification of patents and utility models according to the different areas of technology to which they pertain. It consists of 103 classes, 594 subclasses and 61,397 subgroups. For this study 2,786 classes (out of 260,711) have been identified that either address directly

sustainable technologies or enable or support them. Patents having a direct impact on a sustainable technology are higher weighted than those that are enablers or supporters.

Examples:

A patent that is filed in class Y02E10/10 “Reduction of Greenhouse Gas [GHG] emissions, related to energy generation, transmission or distribution - Geothermal energy” directly addresses a sustainable technology.
A patent being categorized in Y02W90/00 “Climate change mitigation technologies related to wastewater treatment or waste management - Enabling technologies or technologies with a potential or indirect contribution to greenhouse gas [GHG] emissions mitigation” enables A patent filed in class H02S20/00 “Supporting structures for PV modules” only supports a sustainable technology.

6. DATA SAMPLES

The patent analysis was generated and backtested based on the available data from Orbis IP database [17] and Intracom’s proprietary patent database [33]. The data structure is explained in the following table based on a company sample:

Table 1. Sample data of an equity

1	ISIN	AN8068571086
2	valuation date	31.12.2018
3	name	SCHLUMBERGER N.V.
4	country	CW
5	LISTED	Listed
6	TotalAssets in 1,000€	61.578.135 €
7	Employees	100.000
8	IPC sector	E21
9	Technology Spec	E21B
10	Number Of Families	8.907
11	Mi	100
12	Ti	85,33
13	Number of ESG relevant families	247
14	Mi,esg	100
15	Ti,esg	94,93
16	Share of ESG related families	2,77 %

The fields 11. and 12. are the calculations of the indicators from chapter 4. The fields 14-16 are the indicators for the subset of the ESG related patents. For a comparison 2 time slides have been chosen: year 2013 and year 2018. Only companies with more than 30 alive patent families were chosen in order to have a statistical relevant

amount. The total amount on analysed companies was 4,933 for the year 2013 and 4,859 companies for the year 2018.

7. RESULTS

The first question in the analysis was to determine whether sustainable patents have a higher quality then the rest of the portfolio.

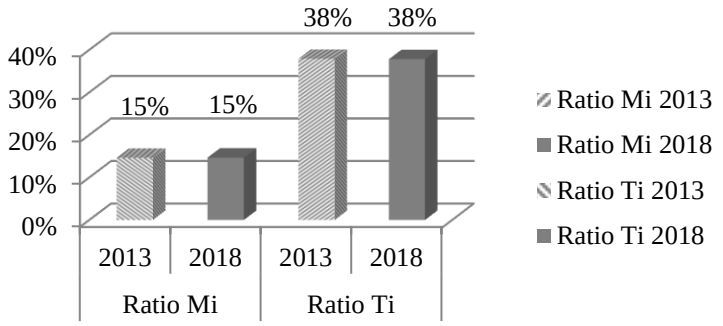

Fig. 1. Ratio Mi and Ti ratio for the years 2013 and 2018

The ratio is always defined to indicator of sustainable patents divided thru the indicator of the complete patent portfolio. The overall analysis shows that only 15% of the sustainable patents have a higher Market impact (Mi) and 38% a higher Technology impact than the rest of the portfolios. Very similar values are for the years 2013 and 2018 therefore the age of the patents can be excluded as factor who has an impact to the indicators. Analysing the companies from the origin of their headquarter delivers the following results:

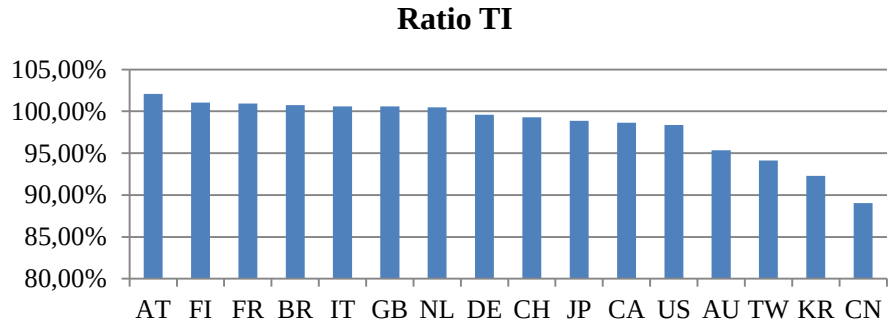

Fig. 2. Ratio Ti for the years 2018 for companies with headquarter [HQ] in country

An interesting result is that companies with HQ in AT, FI, FR, BR, IT, GB and NL have for sustainable patents an even higher technology rating than for the rest of the portfolio.

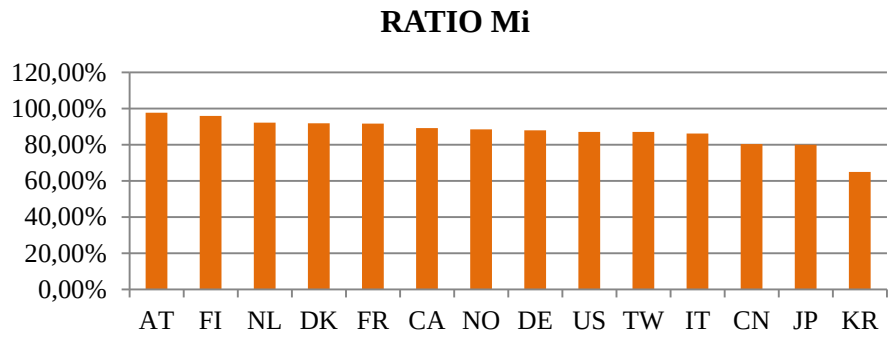

Fig. 3. Ratio Mi for the years 2018 for companies with headquarter in country

The market impact for sustainable patents is smaller than the rest of the portfolio, this can be explained due the sustainable markets which are currently under development.

The equities with the highest Mi- and Ti-Ratio have been compared with the ESG rating provider "Reprisk" [34], where AAA is the best and BBB the worst rating:

Table 3. Top companies with highest Ti- and Mi ratio - year 2018

No	name	Ratio Mi	Ratio Ti	ESG Rating Reprisk
1	EINHELL GERMANY AG	307,29%	131,75%	AAA
2	MISAWA HOMES CO,, LTD,	256,07%	126,45%	A
3	SANKYO TATEYAMA INC	221,14%	122,40%	A
4	SHIMIZU CORPORATION	206,12%	127,03%	BBB
5	NAKABOHTEC Co PROTECTING	186,28%	124,67%	A
6	RAITO KOGYO CO LTD	176,87%	124,59%	BB
7	EAST JAPAN RAILWAY COMPANY	168,15%	135,72%	BBB
8	NISHIMATSU CONSTRUCTION	152,02%	120,14%	BBB
9	XINJIANG BAYI IRON & STEEL,	144,08%	132,96%	N/A
10	TOPPAN FORMS CO LTD	142,76%	131,84%	BBB
11	RECRUIT HOLDINGS CO,,LTD,	138,69%	127,21%	BB
12	SHINRY TECHNOLOGIES	110,46%	127,31%	BBB
13	D,I, CORPORATION	109,17%	125,41%	A
14	NEXEN TIRE CORP,	104,38%	143,37%	BBB

These companies operate in rather conservative sectors but therefore sustainability has a high impact which is expressed by simultaneously high Mi- and Ti-.ratio. Compared to one ESG rating from Reprisk we can identify 8 companies who may have a bad ESG overall rating but they are producing and intending to use sustainable technologies. This additional information could be useful for investors seeking for sustainable companies and to enhance the current ESG rating.

The countries with HQ of companies with a high share on sustainable patents (> 30% of the patent portfolio) are as follows:

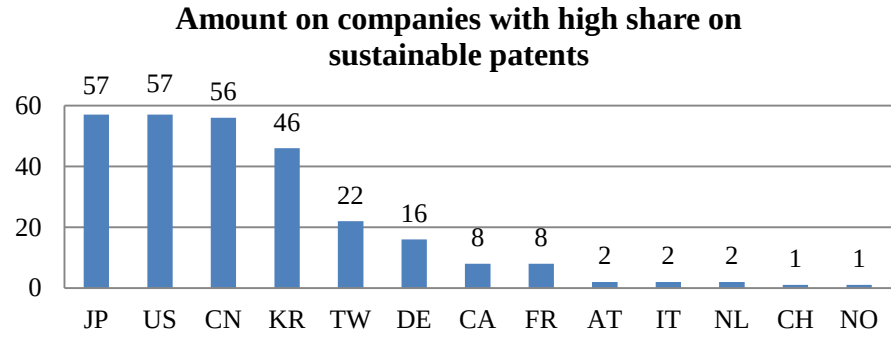

Fig. 4. Amount on companies with HQ in countries with high share on sustainable patents (>30% of the portfolio), year 2018

Surprisingly many companies with HQ in Asia are in the leading position. One possible explanation could be the high patenting activity and at the same time the founding of younger companies or subsidiaries from Fortune 500 who are only active in the sustainable sector.

The analysis of the companies' patent portfolios from Corporate Knights study is primarily intended to take a look behind the scenes. Accordingly, the analysis of the patents with regard to sustainable technologies should help to find out which companies have invested particularly in sustainability-R&D (technologies and procedures). Here, a comparison is to be made between a particularly sustainable perception as well as presentation of a company and the sustainability derived from patenting behaviour. The above-mentioned study "The Most Sustainable Companies In 2019" will again be used for this purpose, in order to compare values. In presenting the results, it is again pointed out that the above-mentioned study takes all ESG (Environment, Social and Governance) factors into account. In contrast, the patent analysis presented here focuses mainly on technology aspects of the "E" of ESG.

For the top 50 most sustainable companies according to the above-mentioned study, the respective Mi- and Ti-ratio share of the sustainable patents compared to the total patent portfolio was determined using the same method as in the previous analyses. As a guideline, the respective industry average was calculated from this ratio in order

to assess whether the respective company is an above-average (marked with “green arrow”) or below-average (“red arrow”) "sustainable innovator" from the patent portfolio perspective. The Corporate Knights study took several factors into account, but in the table below only the "Carbon Productivity Score", "Clean Revenues" and the "Overall Score" are shown, as these are most comparable with the patent value score.

Table 5. Comparison of Top sustainable companies from Corporate Knights study with TI- and Mi.-ratio - year 2018

Rank	Name	country	Overall Score ESG rating	Mi patent ratio	Ti patent ratio	overall rating
1	Chr. Hansen Holding A/S	DK	83,0%			
2	Neste Corporation	FI	80,9%			
3	Orsted	DK	80,1%			
4	GlaxoSmithKline plc	GB	79,4%			
5	Umicore	BE	79,1%			
6	Shinhan Financial Co.	KR	77,8%			
7	Taiwan Semiconductor	TW	77,7%			
8	Pearson PLC	GB	76,9%			
9	Outotec Oyj	FI	76,5%			
10	Cisco Systems, Inc.	US	76,1%			
11	Natura Cosmeticos S.A.	BR	75,6%			
12	Analog Devices, Inc.	US	75,3%			
13	Novartis AG	CH	75,2%			
14	Sanofi	FR	75,2%			
15	Ericsson	BR	74,9%			
16	Bombardier Inc.	CA	74,8%			
17	UPM-Kymmene Oyj	FI	74,4%			
18	bioMerieux SA	FR	72,2%			
19	Royal KPN NV	NL	71,8%			
20	Siemens AG	DE	71,4%			
21	Valeo SA	FR	71,2%			
22	LG Electronics Inc.	KR	71,0%			
23	Ecolab Inc.	US	70,7%			
24	Vestas Wind A/S	DK	69,5%			
25	Electrolux AB	SE	69,2%			
26	Dassault Systemes SA	FR	69,1%			
27	HP Inc.	US	68,3%			
28	Kone Oyj	FI	67,2%			
29	ABB Ltd.	DE	67,0%			
30	Eli Lilly and Company	US	66,9%			
31	Autodesk, Inc.	US	66,4%			
32	Metso Oyj	FI	66,2%			
33	AstraZeneca PLC	GB	65,8%			
34	Alphabet Inc.	US	65,6%			
35	Danaher Corporation	US	64,9%			
36	Halma plc	GB	64,7%			
37	Total SA	FR	64,5%			
38	Novo Nordisk A/S	DK	64,4%			
39	Schneider Electric SE	FR	63,6%			
40	Iberdrola SA	ES	62,9%			
41	Alstom SA	FR	62,5%			
42	Bank of America Corp	US	62,4%			
43	Nokia Oyj	FI	62,2%			
44	Unilever PLC	GB	61,9%			
45	Ingersoll-Rand Plc	IE	61,7%			
46	Acciona SA	ES	61,3%			
47	Tesla Inc	US	61,3%			
48	Itron, Inc.	US	61,2%			
49	Eisai Co., Ltd.	JP	60,0%			
50	OSRAM Licht AG	DE	58,6%			

Due the current patent analysis 25 equities from the ranking list can be definitely classified as sustainable, expressed in the patent metrics for sustainable patents (green arrow). For 3 equities its not sure (yellow arrow) and for 22 equities there is no impact for sustainable developments of the certain company visible (red arrow). The average thresholds for Mi-Ratio was 83.98% and for the Ti ratio 96.02%.

However, the analysis of the patent portfolios primarily has a sustainability focus and it can reflect only technologies that are inventive; the Corporate Knights study also takes other factors into account, such as gender or salary payment issues. Nevertheless, the patent analyses are very helpful, especially if you look at them in relation to the respective industry average. Nevertheless, these results show that the sustainability analysis of companies should not only rely on "self-assessment" of the companies, their own publications or the presentation from sustainability reports.

8. CONCLUSIONS

Patents leave a clear footprint on the activities of a company and it is worth taking a closer look at them, especially since the data has a high availability, is of high quality and highly structured. Patents and metrics for measuring the quality are a well-suited instrument and examined in a over a few hundred studies. Patent metrics are suitable to enrich an ESG profile of a corporation in a sense to make hidden information visible and to make use of high quality, temper proof data. However, patents enlighten only one specific aspect: The R&D activities and their outcome. But his is an important, easy to gather and the missing link within an ESG assessment so far.

The work shows that using patent metrics to determine the quality of a patent portfolio can assist in many tasks delivering insights into the technology development of a company.

9. ACKNOWLODGEMENT

The author would like to thank the Technical University of Cluj-Napoca, Department for Management of Research for the support as well as Dr. Dierk-Oliver Kiehne from InTraCoM GmbH, helping me gathering all the data and construction of the back-tests.

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