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Most (sustainable) innovative countries and unexpected emerging candidates

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Introduction

Bloomberg published their most recent ranking where the worldwide most innovative countries are listed. "South Korea returned to first place in the latest Bloomberg Innovation Index, while the U.S. dropped out of a top 10 that features a cluster of European countries"¹. According to their fast and dominating development in trend technologies like e.g. 5G this sounds credible. However, such a picture should also be reflected in the patenting activities, especially in those activities addressing sustainable technologies.

Description of the basic idea

According to the assumption that patents are the measurable outcome of an (technical or natural scientific) innovative process, the quality and value of patents can be expected to be the forecast of future innovative success.

That means that the measurement of the patent values of companies being located in different countries should also give an impression of the innovative environment of the respective country. However, this must be somehow related to the specific country sizes, of course. This was the basic idea for this analysis: measuring the patent values of companies in different countries and their changes over time, in order to also see impacts of e.g. innovation programs of any kind.

Procedure

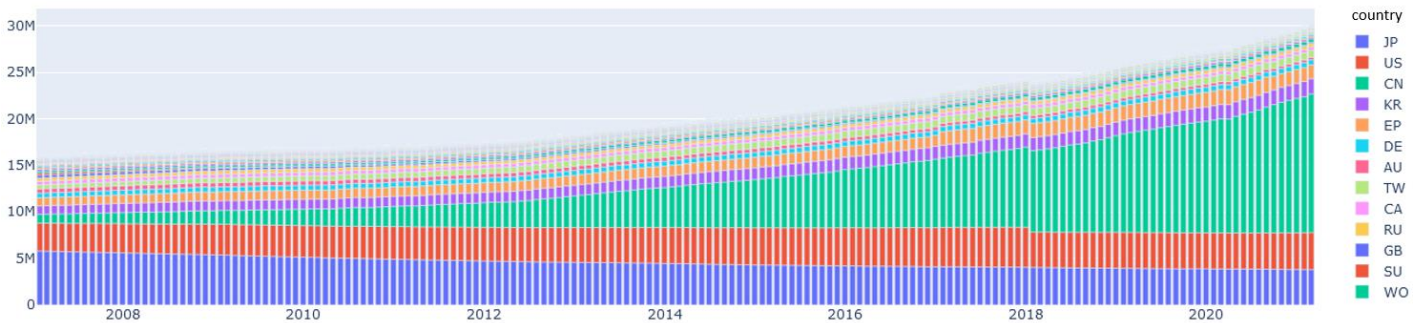
For the investigation all companies worldwide, that are registered in a specific country were analysed: In a first step all those companies that have patents have been filtered, then sorted by their country of registration. Then all patent

values of those companies were summed up per country of registration. The result is a list of all patent values held by companies being registered in a certain country. Then all patent values of all countries were compared. Since countries have different sizes, these values additionally have been related to different country-size specific factors like inhabitants or GDP. The analysis was done for the past 10 years, this also allows to see trends. And development of the different countries. In order to see long term changes, the values were additionally compared in a 5-year term.

In a second step those patents that have a sustainable contribution were filtered in order to make the same analysis based on a sustainability level. In the datasets that were used here (provided by ipr-strategies.com) all patents are additionally evaluated in regards to their sustainability contribution potential. This can be zero, if there is no sustainability impact, it can be low or moderate in case the patent supports or enables certain sustainable technology and high if it directly addresses a sustainable technology. Since patents typically describe technologies that lead to future products, formulations and processes it is called the "Sustainability Active Contribution" or "Sustainable Innovation Potential". This is a different sustainability understanding than a "passive" contribution, where companies e.g. claim to have reduced their emission rate. Typically, the outcome/revenues of patents are only skimmed off in the future – that means, patents are early and that the analysis is a potential forecast to future sustainable contributions. Having that said, countries with **high dynamics** in terms of patent value growth are supposed to also have a good environment for innovations, e.g. in the fields of sustainability.

¹ "South Korea Leads World in Innovation as U.S. Exits Top Ten", 3. Februar 2021 <https://www.bloomberg.com/news/articles/2021-02-03/south-korea-leads-world-in-innovation-u-s-drops-out-of-top-10>

Results



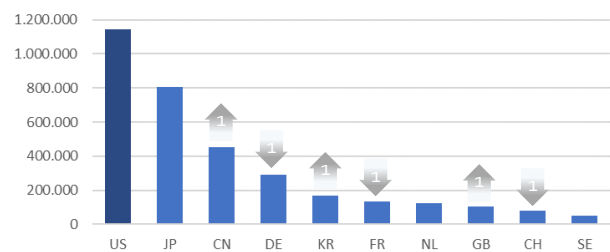
Picture 1. Total number of filings in the different countries

First, in order to explain the general international activity, the patent filing history is shown (picture 1). It shows a constant growth over the past 19 years, whereas the growth is more or less only by Chinese patent filing determined while the patent filings in other countries are stable or even decreasing.

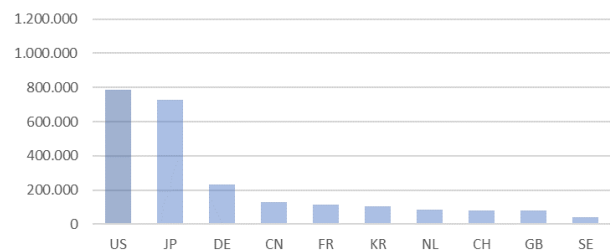
It is important to understand that this only reflects the market side, means that companies (or individuals) are filing patents where they want to lock out their competitors, means in their target markets. This also means that e.g. a US company (being registered in the US) will file patents in China, when it sees a market for its products in China. Also, the patent filing activity reflects only the cost side, not the value side.

When looking at the value side of company owned patents and adding these values up to the company's registration origin, this picture is completely different. Also, the 5-year comparison is interesting. Here only the top 10 are shown.

top 10: countries with companies holding total patent values (Dec 2020) /m€



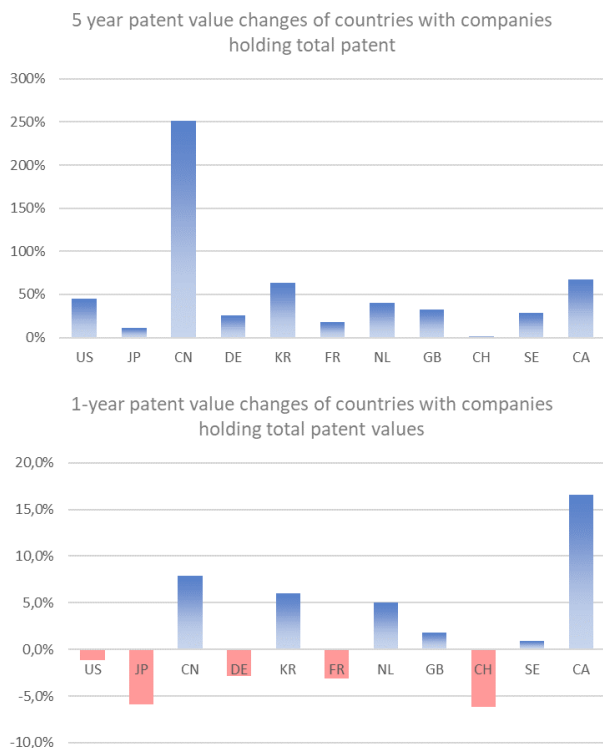
top 10: countries with companies holding total patent values (Dec 2015) /m€



Picture 2: 5-years comparison (2020 above, 2015 below) of the total patent values owned by companies with registrations in the respective countries (find country codes in the end of the paper)

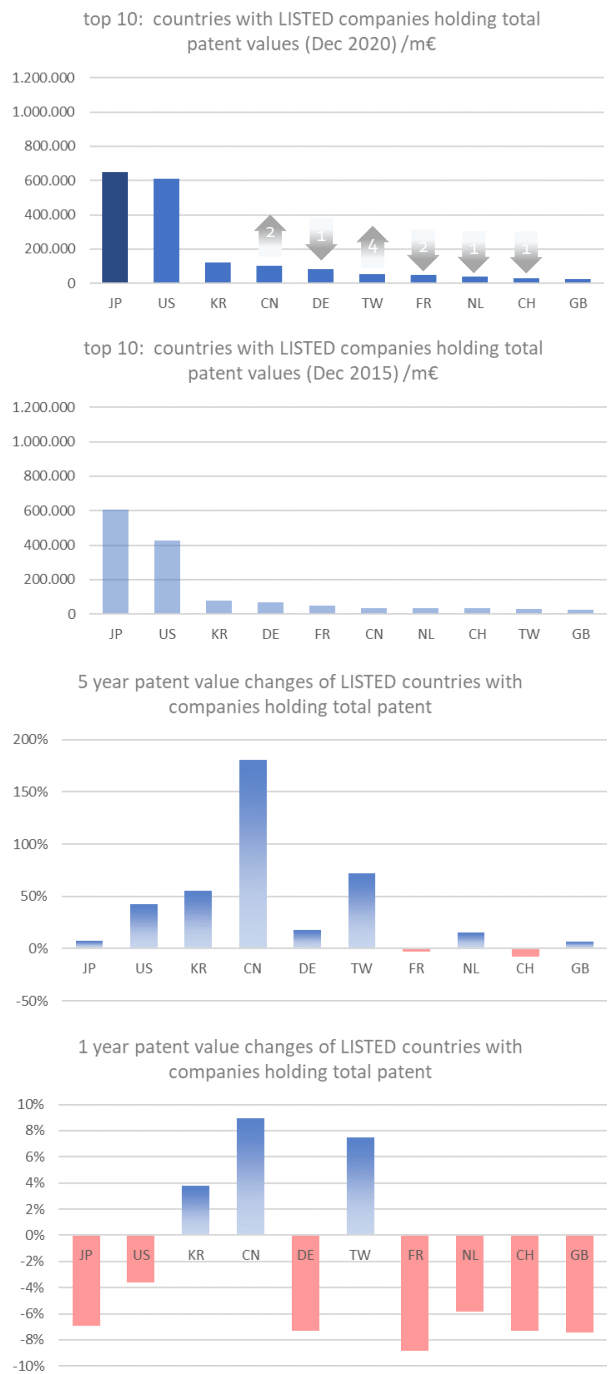
Very obviously, the highest values have been created by US companies, in 2020 as well as in 2015 already. Obviously, their lead over Japan was extended. When looking at the relative growth in these 5 years, the trend is surprising: China (CN) and Korea (KR) have both higher growth rates than the US companies. Well, trends are never linear but even if China's enormous growth does not continue in the same form, it seems only a matter of time before they are replaced by China, despite the current leadership position of the USA – obviously the long-term innovative environment in China is attractive. From a short-term perspective this picture is quietly different. Even though China still has an impressive growth rate,

Canada being on the unfortunate 11th rank in the above graphs has a way bigger growth rate among the companies being registered there, that why we added an 11th bar in the graphs below. Canada is obviously a hidden growth champion.



Picture 3: 5-year patent values growth of the 2020 top 11 countries² (upper graph) and 1-year patent values growth (lower graph).

When looking at the stock listed companies only, the results are similar, but the top positions have changed: Here Japanese companies have the highest total patent values. But also here, it is important to observe the dynamics. In a 5-year term Chinese listed companies are catching up from an IP (Intellectual Property) point of view, of course. Canada is here ranked on no 15 (2020) respectively no 14 (2019). For the listed companies, Canada also has a negative growth rate of -5.5% - that means that the big growth rates seen in picture 3 is going back to non-listed, most probably smaller companies.

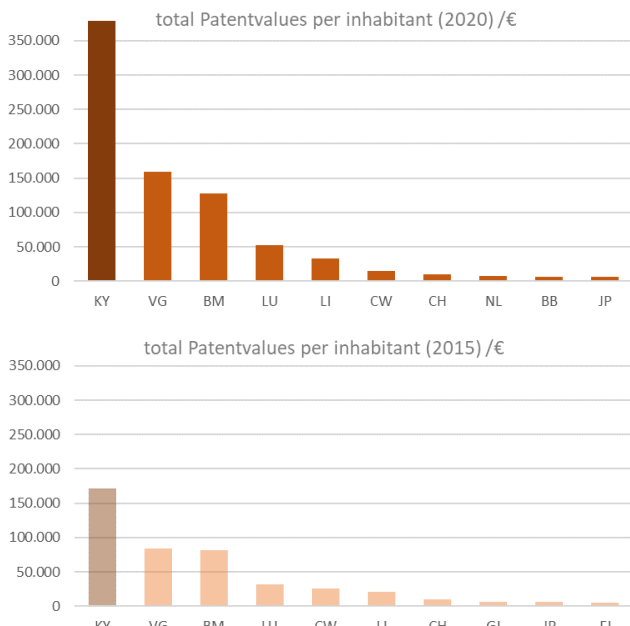


Picture 4: 5 years comparison (2020 above, 2015 upper middle) and relative growth (lower middle) and short-term growth (lower graph) of the total patent values owned by stock listed companies only (registered in the respective countries). For a better comparison to the values in picture 3 the same scaling was used.

All the above comparisons suffer from the inequality of the country/economy sizes. Therefore, size specific indicators were added: Inhabitants and GDP as an indicator for the economy size.

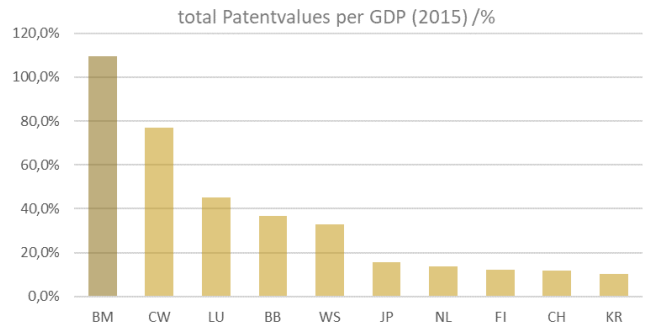
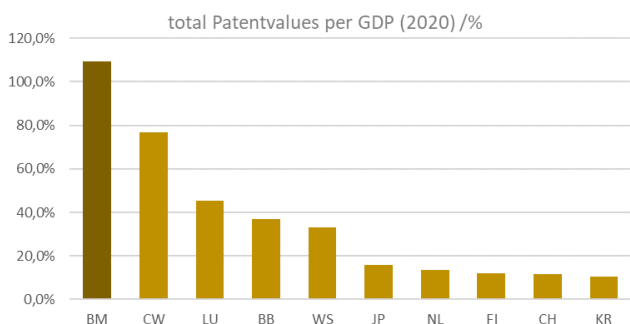
² Values of the patents owned by companies being registered in these countries

When taking the country-size into account, it becomes obvious, that many companies are using patents in order to shift profits: Otherwise, it would be hard to explain why countries like Cayman Islands (KY) or Bermuda (BM) are in the top 10. However, Japan is again among the top 10 in 2020 as well as in 2015.



Picture 5: 5 years comparison (2020 above, 2015 below) of the patent values per inhabitant of the respective country the patent owning companies are registered.

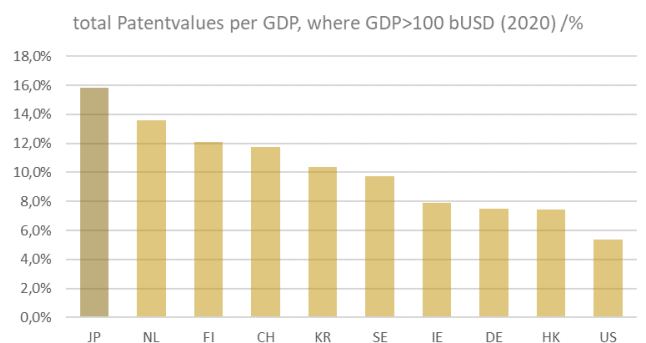
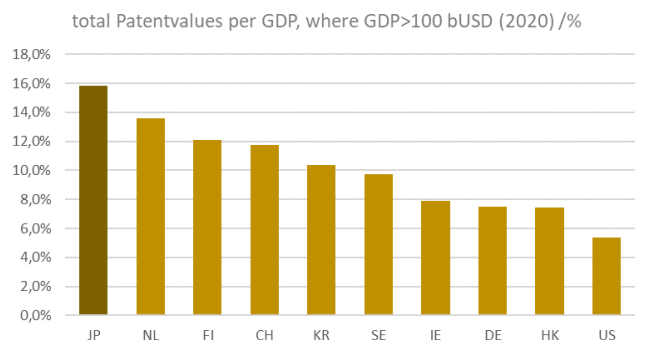
This picture doesn't change significantly when not referring to the inhabitants but to the local GDP. Interestingly Japan is again among the top ten, ranked 6.



Picture 6: 5 years comparison (2020 above, 2015 below) of the patent values per GDP of the respective country the patent owning companies are registered.

Among the top 10 companies in BM holding the most valuable patent portfolios are also well-known western brands.³

When setting a threshold to the GDP and looking only to those countries with a GDP higher than 100 bUSD, the distribution becomes more familiar again – the distribution is well suited to compare patent activities of regional companies in the respective countries.



Picture 6: 5 years comparison (2020 above, 2015 below) of the patent values per GDP where the GDP is bigger than 100bUSD (of the respective country the patent owning companies are registered).

³ There is no warranty to the correct matching of patents to their owners. Some might have been sold or reassigned in

the meantime. Basis is the matching that was found by the official patent offices

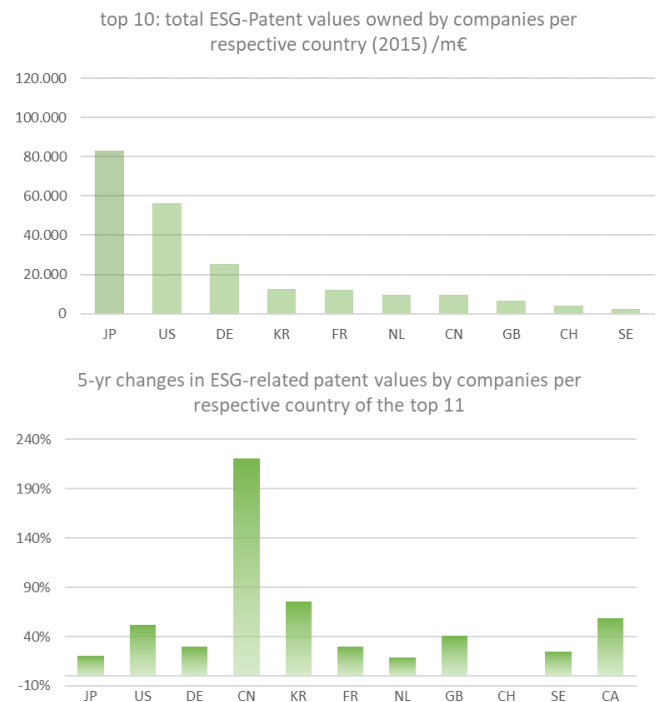
Surprisingly, in none of the top ratings neither 2015 nor 2020 China is listed among the top ten. In the ranking it is found on rank no.16. The relative growth rates are here difficult to read correctly, because the values have 2 determinants, the GDP and the Patent values. That means that if a patent value increases but the relative GDP increase is higher, that the ratio patent value per GDP is negative. So, if that occurs this does only mean that patent value increase is lower than the GDP increase. If both values decrease but the GDP decrease is bigger than the patent value decrease, the ratio is positive. In order to avoid this confusion, we dispense this representation.

Sustainability results

As introduced before, the patent analysis allows to also have a deep look into the inventive sustainability activities of companies by filtering the patents with a higher or lower sustainability contribution.

The first graph is following the same ranking scheme like the ones before, so the result is not really surprising. It is very similar to the scheme in picture 2 or 4 only with a very clear lead of Japanese companies.

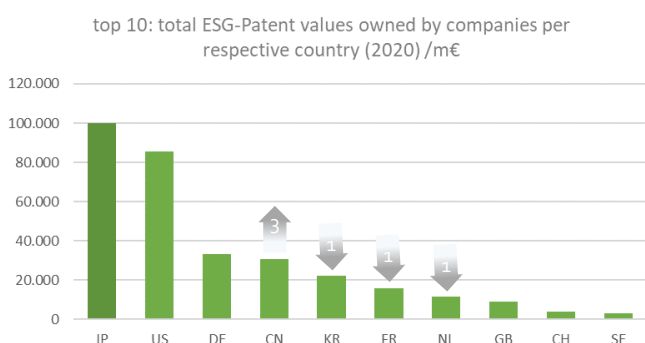
For the graph of the 5-year changes, also the rank no 11 was added. This was just in order to show one very interesting candidate that would have been off the list otherwise: Canada.

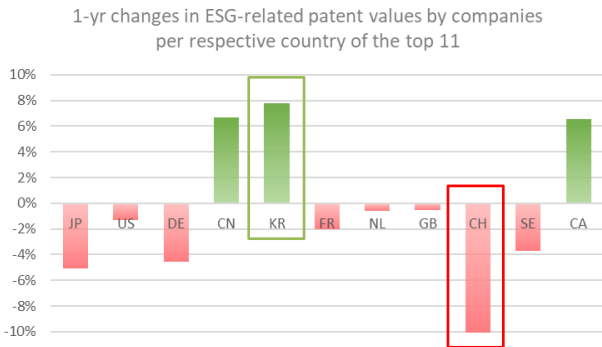


Picture 7: sustainable patent values of companies with registration in the respective countries. (2020 upper, 2015 middle and relative growth below graph)

In order to address the Bloomberg innovation index also on a short-term view, we additionally analysed the 1-year growth rate that represents the value changes of all sustainable patent values per country from December 2019 to December 2020. We used the same order that was used in picture 7. Here, we interestingly identified Korea to be the fastest short-term growing country (sustainable patent values owned by companies registered in Korea). So, from a short-term perspective the patent situation is inline with the Bloomberg innovation index, at least for the sustainable patents.

However, the overall trend is more or less disillusioning: except China, Korea and Canada all other countries have a decrease in sustainable patent values. And China is from the growth perspective not far from Korea – their short-term growth rates are 6.7% (China) vs. 7.8% (Korea).





Picture 8: 1-year growth rates for the sustainable patent values of companies with registration in the respective countries

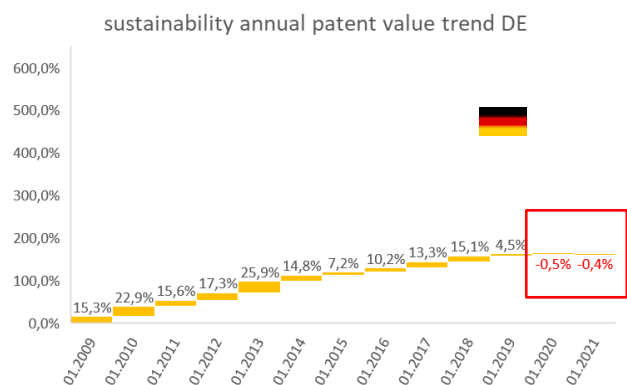
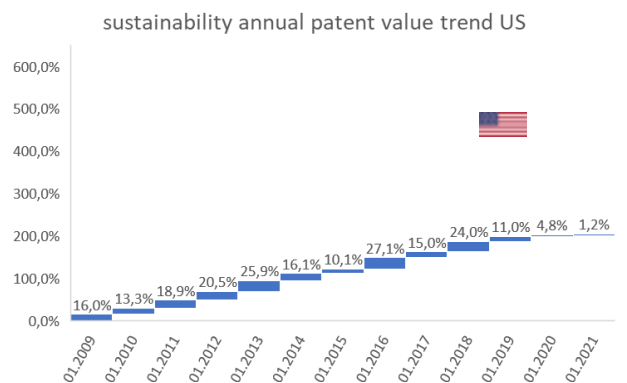
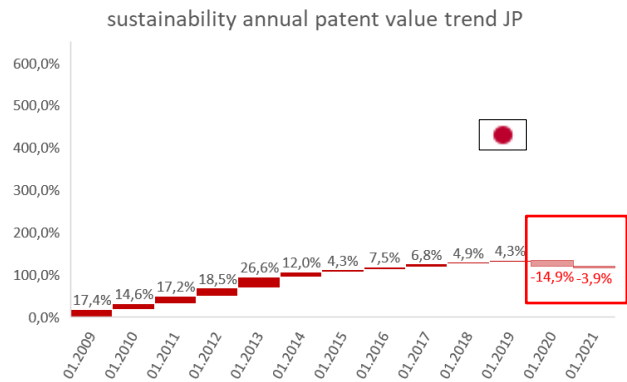
From a sustainable point of view this surprises: In a 5 year term Chinese companies seem to be way more sustainable than their general perception is – at least according to their sustainable active innovation contribution potential. However, they are part of the UN-SDG agreement 2015 in Paris and they also already announced a cooperation with India addressing Green Technologies and Climate Actions - this collaboration goes back already to 2009⁴.

So, when did activities start factually and are they also visible in the companies' patenting activities? In order to find this out, we investigated the past 10 years of the top 5 countries in picture 7 (JP, US, DE, CN, KR). For each year we measured their registered companies' sustainable patent values and their relative growth.

So, following graphs show the relative growth per year as well as the absolute accumulated growth over the years.

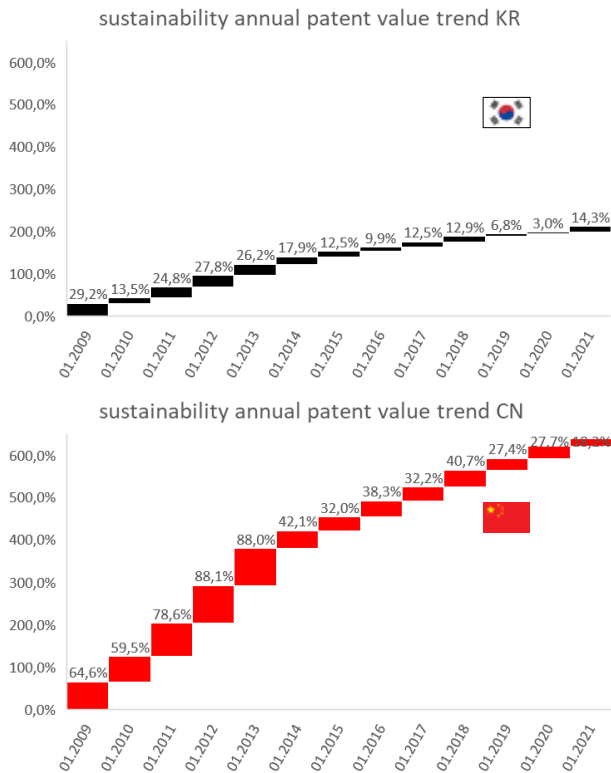
The results are very surprising because they are showing unexpected developments in the different countries: JP – the sustainable winner in 2015 and 2020 has factually the highest decrease among the compared countries in the past 2 years after an almost constant growth the years before. But the growth rates are already significant smaller starting from 2015. Also, Germany has a very small decrease in the past 2 years, after an almost constant two-digit growth rate per year from 2009 to 2018 but then already the downturn starts. The US companies have the stable growth over the years, nevertheless also here the past 2

years the growth rates are smaller compared to all the years before. Also, Korea has a stable growth over the years and even in the last period a 2-digit growth rate. However, Chinese companies outperform all others (last graph), they have the highest growth rates each year without exception and even in the latest year they show a two-digit growth rate, only Korea also has a comparable growth rate in that year.



⁴ China and India agree to cooperate on climate change policy. The Guardian. Oct 22th 2009

<https://www.theguardian.com/environment/2009/oct/22/china-india-climate-change-cooperation>

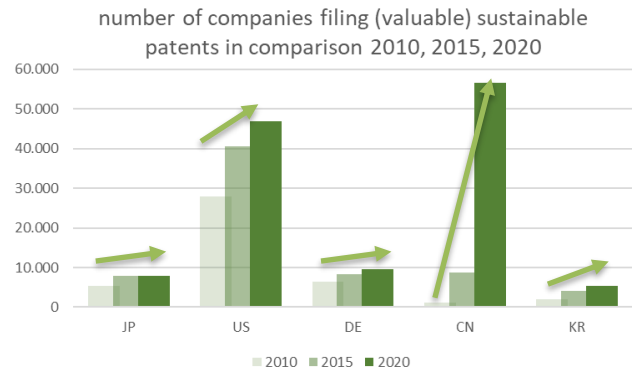


Picture 8: Annual growth rates of sustainable patent values of companies registered in the respective countries. The used scaling was for all companies the same for a better comparability.

In this context it is also interesting to see, how many different companies are responsible for this sustainability innovation-contribution. Are there only few companies being responsible for that sustainability trend or are there multiple? In all the above investigations we were considering the patent values. Hence, the huge and increasing number of patent filings as seen in picture 1 doesn't matter because (worthless) patent applications aren't having big values. But for the counting of companies, this is making a difference: we only want to count those, who are filing potentially sustainable innovations.

The result is again a surprise: Whereas in Germany, Korea and USA there seems to be a more or less constant growth in new sustainability innovation players, Japan has according to their huge amount of sustainable patent values a comparable small amount of companies. This means that comparably few companies are contribution sustainability innovations compared to their dominating sustainable patent values in total. However, again here China is most surprising. Most obviously China has most sustainability innovating companies in total in the last analysed year

2020 and at the same time the smallest number of sustainable innovators – in this comparison - in the year 2010. Obviously, in China more and more companies have discovered this sustainability chance and also many new companies in this field are set up.



Picture 9: total number of different companies filing sustainable patents with an average patent value of more than 50.000 Euro.

Conclusion

The initial question as to which country creates the best conditions for innovation was attempted to be answered on the basis of the patent values generated in the respective countries. In particular, trends that also emerge from the analysis of the past years are especially revealing here. Even though the USA has a clear dominance here and has been able to expand its lead over Japan, China is gradually catching up and has already overtaken Germany, for example, with impressive growth rates. If the speed is maintained in this form, Japan could be overtaken in as little as 5 years, and the USA in 10 years, from the point of view of the generated patent values and accordingly also from the point of view of the innovation potential, of course.

On the topic of sustainability, Asia may not be the first association that comes to mind, especially China. Interestingly, it is the complete opposite.

Japan is – so far – the biggest sustainable innovator but the downside is that they obviously stopped innovating in that intensity: they obviously have the biggest and longest decrease in sustainable patent values. **China has the way biggest growth measured by their companies' patent portfolios.**

Nevertheless, the developments in patent values impressively prove that the Chinese announcement to commit more to climate action and sustainable technologies was definitely more than just lip service.

Just to mention South Korea (KR) – they are found always among the top 5 countries. **Their growth is stable, also their sustainability activities and growth rates are stable for each year.** Finally, Korea is not as flashy as China, but growth rates are always at a high and stable level.

Contact

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Used country codes in the study

AE United Arab Emirates	CW Curacao	IL Israel	SA Saudi Arabia
AT Austria	DE Germany	IT Italy	SE Sweden
AU Australia	FI Finland	JP Japan	SG Singapore
BB Barbados	FR France	KR Korea, Rep.	TW Taiwan
BM Bermuda	GB United Kingdom	KY Cayman Islands	US United States
CA Canada	GI Gibraltar	LI Liechtenstein	VE Venezuela, RB
CH Switzerland	HK Hong Kong	LU Luxembourg	VG British Virgin Islands
CN China	IE Ireland	NL Netherlands	WS Samoa