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Default risks of companies with valuable patents

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Summary

The risk of corporate default is the main driver of bond interest rates. Therefore, riskier bonds are usually priced with a higher yield and receive a lower rating. These high-yield bonds are excluded from certain investors from the outset due to their lower rating.
In this context, the size of the enterprise itself is an important determinant: small enterprises would be expected to have higher default rates than medium or large enterprises.
However, there are significant differences: companies - regardless of size - that document their innovation potential through valuable patent portfolios default significantly less often or are liquidated less frequently. This finding opens up new aspects for investment products in the fixed-income sector: riskier bonds from companies with valuable patent portfolios combine a low default risk (low-risk) with a high yield.

Description of the basic idea

Various factors play a role in a company's creditworthiness, including its size (market capitalization). Increasingly, however, its innovative strength is also to be given greater consideration[1]. The major problem for innovative firms is the greater degree of information asymmetry as innovation is hard to represent – the simple number of patent filings is not a sufficient indication[2]. Still, in other studies there was a positive link found between the average family size of a company's patent portfolio and its credit ratings[3], also the higher resilience of patent owning companies has been shown exemplarily[4]. However, the patent filing activity is just representing the cost side of patents. The patent values represent the asset side. Hence a company's patent **values** play a central role here as a blueprint for innovation efforts.

The following study examines the default-rates of listed companies over the last 10 years. Based on their market capitalisation, these companies are divided into 4 size groups. After 10 years, the survival rates of these companies are monitored. Those that don't survive are counted per size class. We then look at how strong their patent portfolio was (if they had one) and count those among the non-survivors that had a high value patent portfolio.

Results

1. Population

This study only considers listed companies: On the one hand, the study aims to examine the potential of corporate bonds and, on the other hand, market capitalisation is used to determine the class size of the respective company. There is no geographical focus. Four different size classes were defined. The following thresholds have been used:

- Small (S): up to 1 bn USD market capitalisation
- Medium (M): between 1 and 5 bn USD market capitalisation

[1] Hsu, Po-Hsuan, et al. "Corporate innovation, default risk, and bond pricing." *Journal of Corporate Finance* 35 (2015): 329-344.

[2] Milani, Sahar, and Rebecca Neumann. "R&D, patents, and financing constraints of the top global innovative firms." *Journal of Economic Behavior & Organization* 196 (2022): 546-567.

[3] Frey, Carl Benedikt, Peter Neuhäusler, and Knut Blind. "Patents and corporate credit risk." *Industrial and Corporate Change* 29.2 (2020): 289-308.

[4] Barontini, Roberto, and Jonathan Taglialatela. "Patents and small business risk: Longitudinal evidence from the global financial crisis." *Journal of Small Business and Enterprise Development* 29.2 (2022): 279-292

- Large (L): between 5 and 50 bn USD market capitalisation
- Very large (XL): bigger than 50 bn USD market capitalisation.

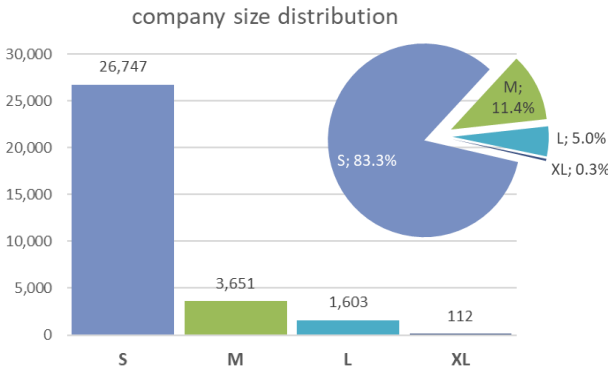

Image 1: Size distribution inside the complete population. These data and the size distribution were gathered in January, 2012.

As expected, the largest group is that of small companies. 26,747 (83.3 %) of the companies listed in 2012 belong to this size category. The smallest group is that of very large corporations. Only 112 companies (0.3 %) are found in this group.

2. Non-survival reasons

The reason for non-survival doesn't necessarily had to be a default. This study considers the following 5 different reasons, why a company did not survive over the following 10 years after the investigation started:
bankruptcy, merger or take-over, dissolved, liquidation and de-merger[5].

Image 2: distribution of the several non-survival reasons for all companies in a 10-year term starting January 2012

The main reason for a non-survival was a dissolving, not necessarily due to a default. The second most common case of why a company did not continue in its original form after 10 years was M&A activities. Insolvency/bankruptcy was only the fourth most common reason why a company did not survive, although it was not always clear when liquidation - the third most common case - or bankruptcy occurred. For example, the bankruptcy of the Wirecard group was classified as a liquidation and not a bankruptcy. For this reason, the two cases of liquidation and bankruptcy are both considered in particular.

The group of small companies is the largest class here, hence the distribution of non-survival reasons follows quite closely the one shown above.

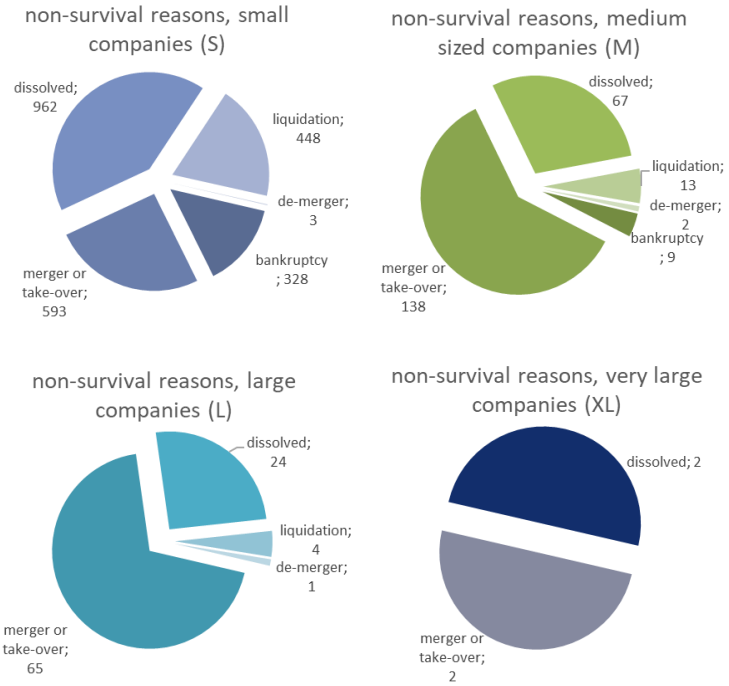

Image 3: distribution of the several non-survival reasons split into the size classes of the respective companies in a 10-year term starting January 2012

Obvious to see is that that the group of very large companies does not include any liquidations or bankruptcies. In general, the fewest changes have occurred in this group. However, this group is also comparably small containing only 112 companies in 2012.

[5] Data provided by Moodys, Softwareproduct „Orbis" - https://www.bvdinfo.com

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3. Probabilities of default: liquidations and bankruptcies

In the following analysis, the frequency of default over a 10-year period was determined for the 4 different size groups mentioned.

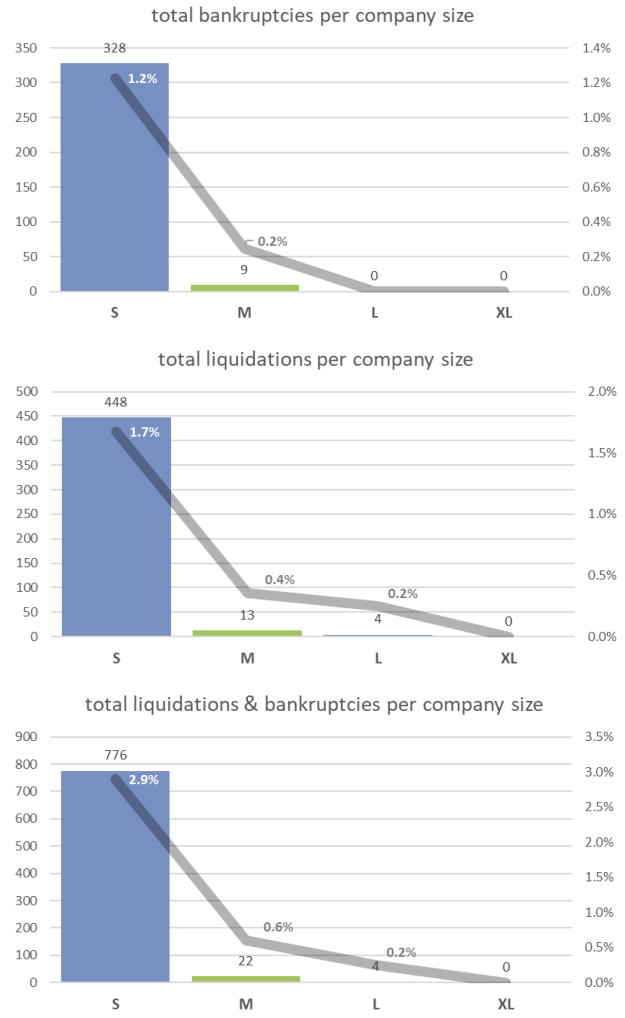

Image 4: absolute (bars, referring to the left axis) and relative (grey line, referring to the right axis) probability of default. Default was defined by either bankruptcy or liquidation (lowest graph).

The highest probability of default was seen as expected in the group of small companies. 328 bankruptcies and 448 liquidations (776 in total) out of a group of 26,747 small companies corresponds to a probability of default of 2.9% in that group. For the medium sized companies, the probability of default was only 0.6%, for the large 0.2% and for the very large companies 0 – there was no default at all in the analyzed 10-year term.

4. valuable patent owners

The study will examine how default rates change when companies own valuable patents[6]. The first step, therefore, is to define what constitutes a valuable patent portfolio - a threshold has to be defined: When looking at the value distribution in general, it is obvious to see that this follows a 1/x distribution: Many companies with few patent values and few companies with high values. This again illustrates the importance of setting a specific threshold or multiple thresholds. Different approaches can be tried to determine appropriate limits for this:

Method 1. Pareto principle: The threshold is set so that 80% of the companies have patent values below the threshold; conversely, this means that 20% of the companies (with patents) have patent portfolio values above the threshold.

Method 2. distribution characteristics: Here, the distribution itself is used to examine where there are significant boundaries within which a distribution changes significantly.

The aim is generally, to find suitable thresholds of patent portfolio values that includes as much equities as possible and reduce the total number of defaults significantly at the same time. The patent portfolio value used for the current analysis is point of time data, this means, that the patent value of each equity has been taken as they were 10 years ago. Finally, it was examined that the patent value of each equity did not drop below a set threshold over the 10-year analysis (see image 10).

The biggest groups of patent portfolios (58%) has a value range of below 1m as shown in image 5. These portfolios are not considered to be "valuable" in the definition of this study. The threshold is hence supposed to be ahead of this number.

According to the pareto principle, 80% of the companies have values that are below 8 mUSD. That means that 20% of the most valuable patent portfolio values are bigger than these 8m.

[6] Patent value definition: Market values of patents, calculated by using reference values of traded patents in the past and an indicator-based market analogy method (own development).

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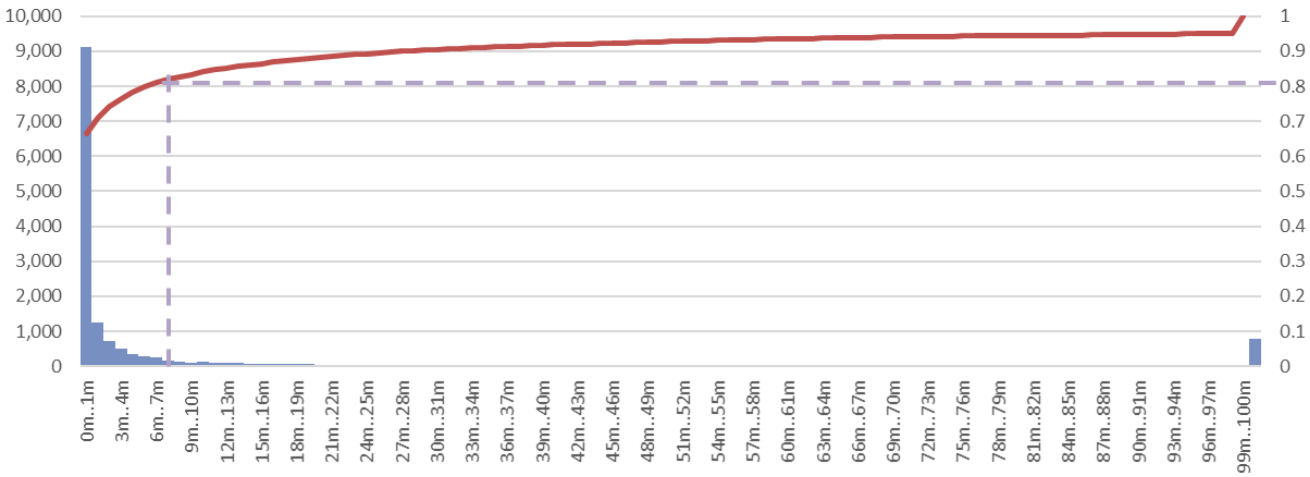

Image 5: histogram of the patent portfolio distributions (blue) and the pareto-line (red). The y-axis represents the total number of companies, the x-axis the respective patent portfolio value ranges in 1m USD steps. All values bigger than 100 mUSD are put in one value class to keep the distribution still readable.

According to method 1 this can be considered as a first threshold (threshold 1).

Method 2 is trying to split the histogram in more or less significant groups. Therefore, certain patterns were tried to get identified inside the histogram. Most obvious to see is that the biggest group is the one below 1 mUSD. This is from the distribution point of view the first (and biggest) group. As mentioned before, patent portfolios below this value are not considered to be "valuable" in the definition of this study, because there are companies owning e.g. only a few patent applications, grants or utility models but no significant patent portfolio of several patent families, which would suggest a clear IP strategy.

The second group is characterised by the fact that each group is smaller than the previous one, i.e. with each change in the patent portfolio size class, the set of companies fulfilling this condition becomes smaller. All patent portfolio values being bigger 1 mUSD but smaller than or equal to 2 mUSD are in this class: 4,520 small, 1,199 medium sized, 676 large and 84 very large companies have a patent portfolio bigger than 1 mUSD.

In the third group, on the other hand, the number of companies becomes larger again for the first time: i.e., at a value of 10 mUSD or more, the number of companies is larger than that of the previous size class for the first time, and this also

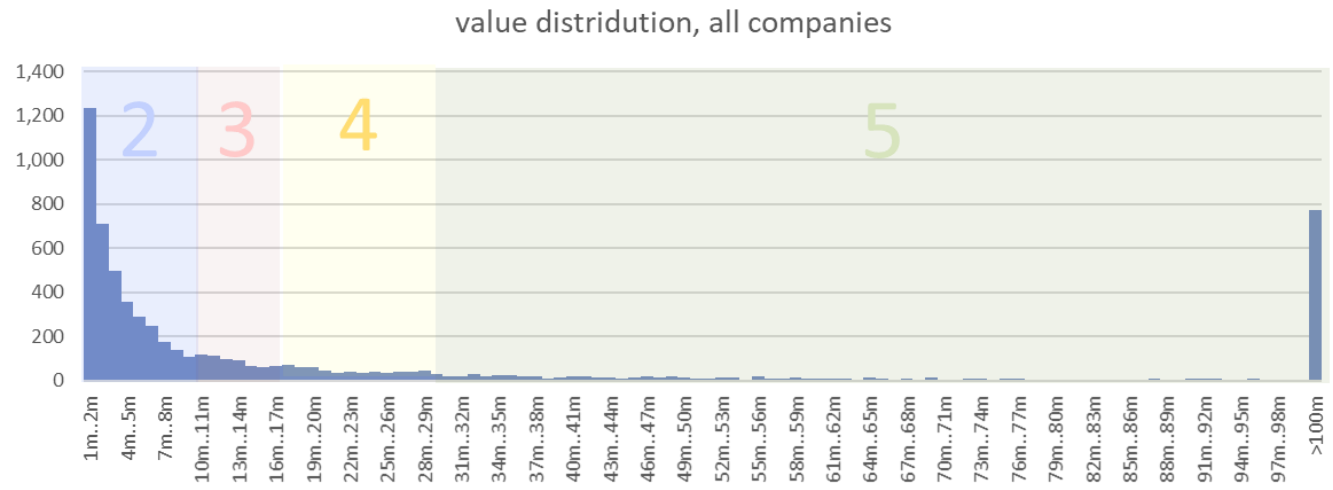

Image 6: value distribution as also used in image 5, slightly simplified: The biggest group of values below 1 mUSD has been removed in the graph for a better readability. It is considered as group 1

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applies to the following size class. This means that from this size class onwards, a more significant proportion of companies apparently maintain patent portfolios. In this size class, one can in any case already speak of valuable patent portfolios. In this group of companies with patent portfolio values bigger than 10 mUSD there are still 1,427 small, 737 medium-sized, 481 large and 73 very large corporations.

Group 4 is characterized by a more or less homogenous size distribution: in all the value classes 44 to 66 companies are found. The size classes are stable in size. This group starts at 17 mUSD. There are in total 1,013 small, 650 mediu-sized, 445 large and 71 very large companies having patent portfolio values bigger than 17 mUSD.

Group 5 starts at 30 mUSD and includes all patent portfolio values bigger than that value. In total there are 577 small, 512 medium-sized, 395 large and 70 very large companies remaining.

Applying the above filtering rules to the total set of companies, the respective size of groups S, M, L, XL understandably becomes smaller. In the following chart, the effects of the limits for 8, 10 and 30 mUSD were examined exemplarily with regard to their filter effect. As expected, the group of remaining companies becomes smaller and smaller as the threshold value increases, and the phenomenon is most clearly observed in the case of small companies.
Comparing the data from Image 7 with those from Image 1, it becomes clear how strongly the filters applied have an effect: among the small companies, only 1,608 companies remain at the smallest threshold of 8 mUSD, which corresponds to 6%. For the large companies, the filter effects are significantly lower: here, 76 companies remain at the smallest threshold value, which corresponds to almost 68%.

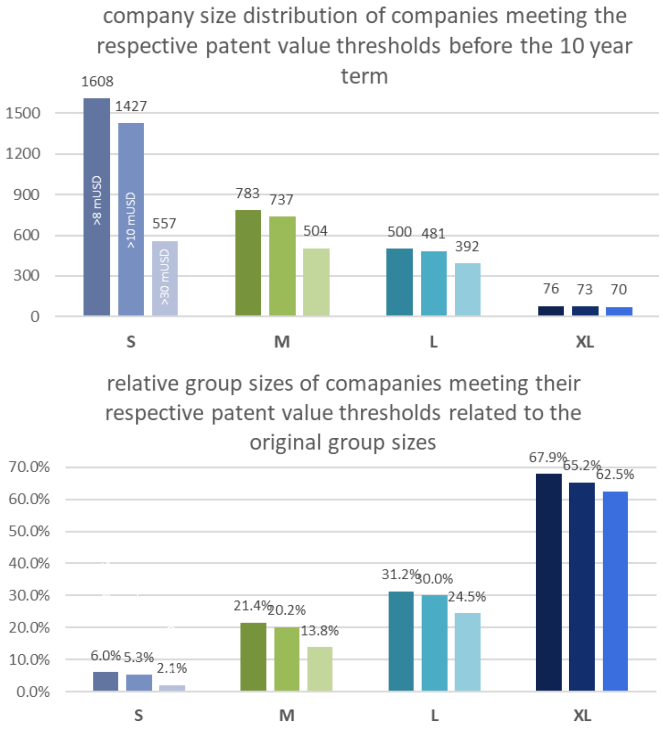

Image 7: remaining companies after applying the patent value thresholds of 8 (left bars), 10 (middle bars) and 30 mUSD (right bars in the respective size groups). Lower graph: remaining companies from upper graph related to the original group sizes from image 1.

5. Probabilities of default (liquidations and bankruptcies) of companies having valuable patent portfolios

According to the distribution methods mentioned before, there will be different thresholds for patent portfolio values tested and the default rates of those companies hitting the threshold criteria will be compared to the total default ratios as shown in chapter 2.

Threshold 1: 8 mUSD total patent portfolio value according to the pareto-theorem.

In the following graph the total number of bankruptcies as well as liquidations of all companies in the 4 size classes (S, M, L, XL) are shown in direct comparison to those owning a patent portfolio of bigger than 8 mUSD in value. The observed time period was 10 years. Afterwards (image 11) also the remaining ratios are shown.
As seen in graph 3 already, there were no bankruptcies in the large and very large companies and only four liquidation in the group of large

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companies. However, a rather striking default-rate of 2.9% was found among the small companies.

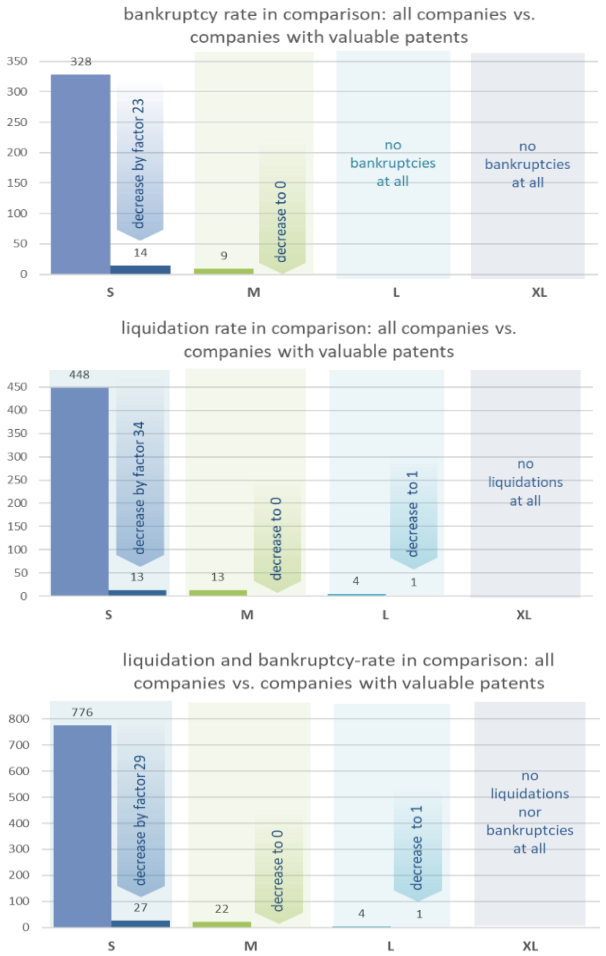


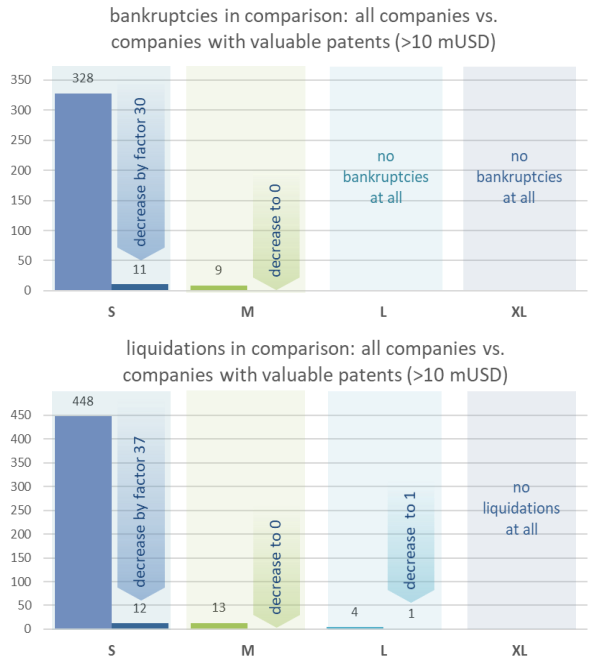
Image 8: number of bankruptcies (upper), liquidations (middle) and both (lower graph) for small (S), middle (M), large (L) and very large (XL) sized companies. Left bar shows all the total number of bankruptcies/liquidations, the right bar the ones of companies owning valuable patents. Here, per definition a patent portfolio value of bigger than 8 mUSD.

However, for this group of small sized companies who own a patent portfolio of bigger than 8 mUSD in value, the survival probability increased significantly: only 14 bankruptcies (out of remaining 1,608 companies) occurred in contrast to 328 (out of 26,747 companies) in total in the same size group. This corresponds to a decrease by factor 23. In the group of medium sized companies, the number of bankruptcies went down from 9 to 0 (out of 783 remaining companies as seen in image 7).

The liquidation ratio was even more significant: the valuable patent owners had only 13 liquidation in the 10-year term in contrast to 448 in the same size group. Also, there were no liquidations at all in the middle-sized group of valuable patent owners in contrast to 13 in the group who had no or less valuable patents. As already mentioned, there were 4 liquidations in the group of large companies, but only one in the large companies-group of valuable patent holders. Combining both reasons for non-survival - as shown in the bottom graph in Figure 8 - we see an impressive effect of valuable patent portfolios: The non-survival probability reduced for small companies by an impressive and very significant factor of 29. No bankruptcies nor liquidation in the medium sized group and only one in the large group of valuable patent owners who have a patent portfolio of bigger than 8 mUSD in value.

Threshold 2: 10 mUSD patent portfolio value.

According to the second method the threshold was even higher. The main question is: does the probability of default improve again in terms of lowering the bankruptcies and liquidations?



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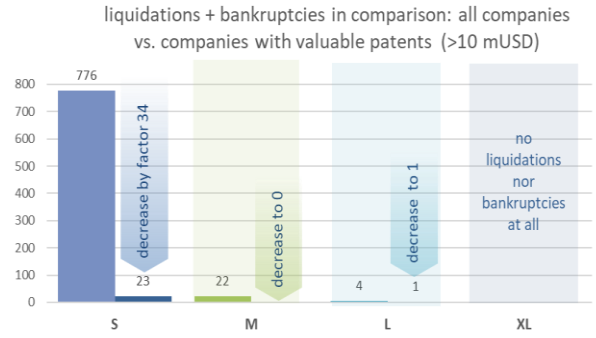

Image 9: number of bankruptcies (upper), liquidations (middle) and both (lower graph) for small (S), middle (M), large (L) and very large (XL) sized companies in comparison to those having valuable patents according to Image 6. Here, per definition a valuable portfolio value is bigger than 10 mUSD.

Image 9 is corresponding to Image 8 but simply using a threshold of the above-mentioned 10 mUSD. The general picture is quite similar to the former ones; however, the total numbers of bankruptcies and liquidations have again significantly decreased. For the group of small companies, only 11 (out of 1,427) went bankrupt and only 12 were liquidized in the 10-year term. In total, the probability of default (bankruptcies and liquidations) was reduced by a factor of 34. This means that less than 3% of those small companies that were bankrupt or were liquidated had a significant patent portfolio value of more than 10 mUSD. The probability of default for small companies in a 10-year term was according to Image 4 reduced from 2.9% down to 0.09%, taking all small sized companies into account.

Further thresholds in comparison

The lower default rates suggest that there is a trend: the higher the value of the patent portfolio, the lower the risk of default. As there were almost no defaults in the medium, large and very large enterprises at the threshold of USD 8 million (apart from one liquidation case in the large enterprises), the focus is on the group of small enterprises.

Image 10 shows this trend impressively: the higher the patent portfolio value of a (small sized) company, the lower is it's probability of default. The different thresholds were taken according to the 2 methods mentioned above.

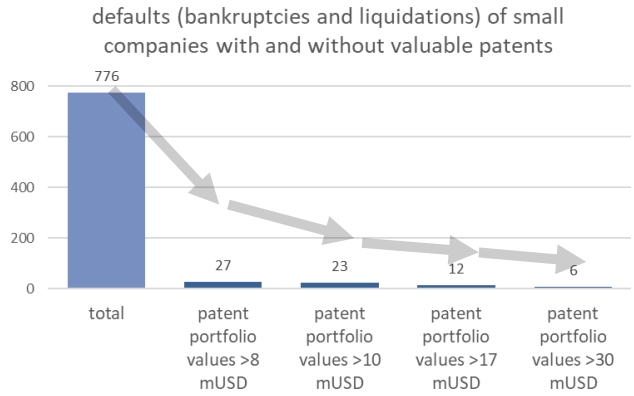

Image 10: Default-rates (bankruptcies and liquidations) for small sized companies having different valuable patent portfolios. The bar to the left-hand side is the total default-number of all small companies

In the above considerations, it was assumed that the respective patent portfolio values were used as the sole selection criterion in addition to company size. This selection criterion led to the significantly reduced default rates.
Of course, it must also be taken into account that the number of companies was significantly reduced by the selection process, as already shown in Image 7. The question now is how the default rates would behave in relation to the selected, smaller groups, i.e. whether the relative default rates would also be lower in relation to the respective selected group size.

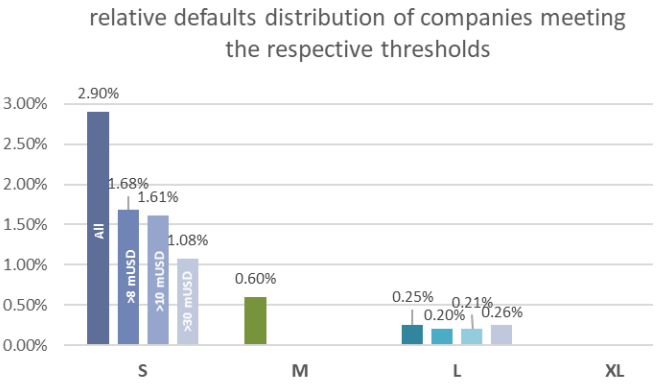

Image 11: relative default rates (bankruptcies and liquidations) of companies in the respective size groups. Left bars: the original default ratios where no filter/threshold was set, 2nd bars (from left to right) the relative defaults using thresholds of 8 mUSD, 3rd bars the relative defaults applying the 10 mUSD patent value threshold and the 4th bars using the 30 mUSD threshold.

As seen in Image 11, even related to the respective threshold-based group sizes, the default rates are decreasing significantly: even in the smallest threshold of 8 mUSD of patent portfolio size, the

relative default rates for the small companies are almost half (1.68%) of the original ratio (2.9%). The higher the threshold, the lower also here the ratios. At the highest threshold of 30 mUSD the relative default rates are only at 1/3 of the original defaults (1.08% vs 2.9%).

Is there room for further improvement? All the above analysis assumes that a patent value is established once and that the probability of survival is determined on the basis of this cut-off date. In other words, the value of a company's patent portfolio developed subsequently was not taken into account.

However, if we add the condition that the value of the patent portfolio may not fall below the original threshold during the period under consideration, the risk of failure is significantly reduced and becomes almost negligible.

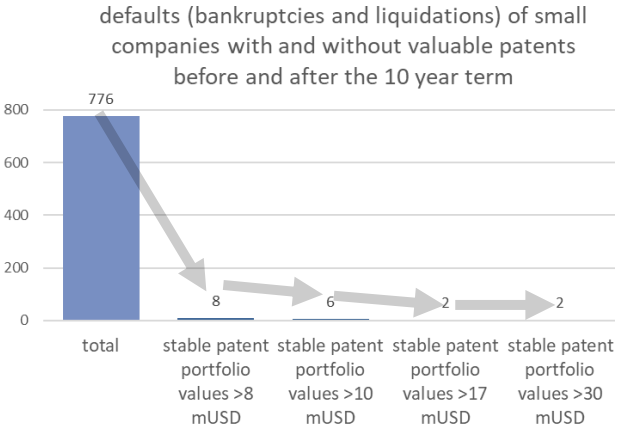

Image 12: Default-rates (bankruptcies and liquidations) for small sized companies having different valuable patent portfolios stable over the 10 year-term, means after the 10 year term the total value was still ahead of the set threshold.

The analysis that was leading to image 9 was a second condition that was taken into account: The patent values were not allowed to be below the respective threshold value even after the 10 years. Interestingly, the initial threshold didn't play that big role anymore: the default rates were reduced by factor 129 already for the lowest threshold set to 8 mUSD – only 8 defaults happened over the full 10 year-period for the small entities.

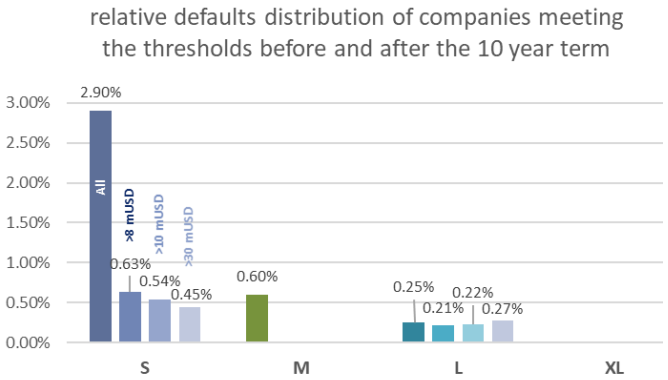

Image 13: relative default rates of companies in the respective size groups based on image 11. Left bars: the original default ratios (no filter/threshold was set), 2nd bars (from left to right) the relative defaults using thresholds of 8 mUSD, 3rd bars the relative defaults applying the 10 mUSD patent value threshold and the 4th bars using the 30 mUSD threshold. The respective thresholds had to be met at the beginning of the 10-year observation-period and also afterwards.

Of course, the total sizes of the selected/filtered groups using the different patent value thresholds also decreased by applying this additional criteria. However, most interesting to see in Image 13 is that the relative default rates (defaults related to the remaining group sizes) again very significantly decreased to less than half of the ratios that were seen in Image 11: for the smallest threshold of 8 mUSD in patent value, the relative default rate for the small sizes companies was only 0.63% compared to 2.9% in the total group of small companies.

Generally, it was observed that the corporates patent portfolio values of the most equities increased heavily over the past 10 years, how the following analysis shows:

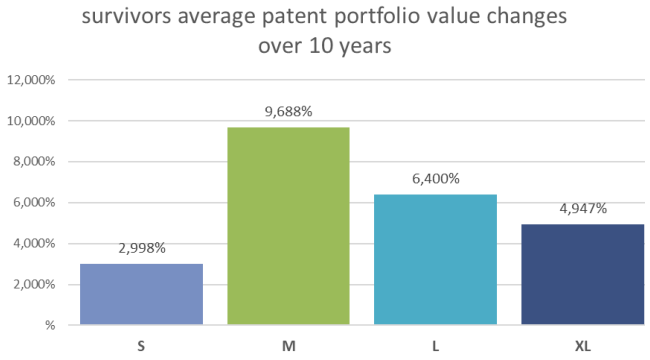

Image 11: patent portfolio value changes over 10 years in % for the different company sizes

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Even for the biggest group of small sized companies, the average patent portfolio values increased by an impressive rate of almost 3,000%.

Conclusion

The initial theory that companies with valuable patents have a much better chance of survival has been impressively demonstrated. However, it does not seem to be so important how high a certain threshold is defined. Even at the lowest threshold of USD 8 million, there is a very large reduction in default-risk. It is important to see that there is a very clear correlation between the existence of a valuable patent portfolio and the survival probability of a company in general. In terms of survival, it is very impressive to see that the smaller a company is, the more important valuable patents are. For the very large companies, there were no failures during the 10-year period of the study; for the large companies, the total number of liquidations was too small to make statistically relevant observations.

When it comes to corporate bonds, this observation is really crucial: Interest rates are usually determined on the basis of a company's rating. In the case of ratings, the size of the company plays an important role. As the study shows, small companies generally have a much higher probability of default (2.9%) than medium (0.6%) and large (0.2%) companies. This default risk is therefore reflected in their higher interest rate. These are typically found as high-risk, high-yield bonds. However, if only companies with high-quality patent portfolios are included in the group of high-yield bonds, the default risk can be significantly reduced, as has been demonstrated in this study. The default rate can be reduced by monitoring the value of a company's patent portfolio: As long as it doesn't fall below the original threshold, the probability of default is almost negligible. This could, for example, form the basis of a product that takes into account high-yield bonds with significantly reduced risk. This could be used to create a profitable low-risk fixed-income product.

Literature

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