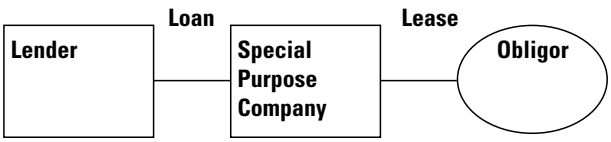
Effects of Cross-Collateralization and Diversification in Aircraft Backed Loans

by **Christophe Beaubron** (c.beaubron@pkair.com)
PK AirFinance – www.pkair.com
Updated 2000-07-04

PK AirFinance (PK AIR) has developed a model with the acronym SAFE (Statistical Aircraft Financing Evaluation), to evaluate aircraft backed loans and investments. This article illustrates further tentative research on applying SAFE to multiple aircraft/multiple obligors transactions.

1. RISK-REWARD EVALUATION IN A ONE-AIRCRAFT/ONE-OBLIGOR TRANSACTION

A basic one-aircraft/one obligor loan with a non-recourse balloon can be represented graphically as follows:



The lender extends a loan to enable a Special Purpose Company to acquire an aircraft that is used as a collateral for the loan. The aircraft is leased to an obligor and the cash flows under the lease are assigned to repay the principal of the loan and the interest. In case of default by the obligor, and hence on the loan, the lender can foreclose against the aircraft to recover the amount due on the loan. Any proceeds beyond the loan amount are then taken by the investor: i.e. the Special Purpose Company. On the other hand, the lender will incur a loss if the value of the aircraft is not sufficient to cover the amount left outstanding on the loan.

- Evaluation criteria:

The value of a senior loan collateralized with an aircraft will be evaluated based on the following main criteria.

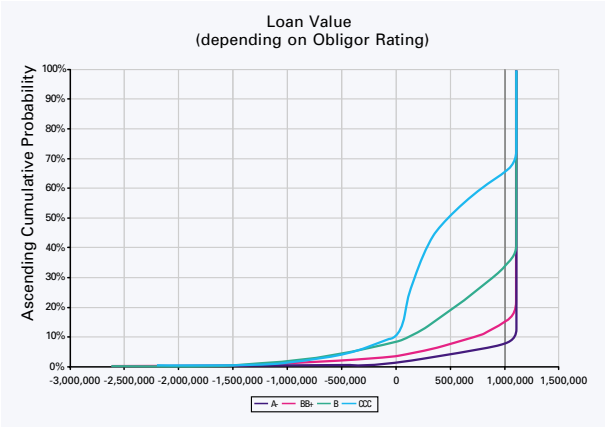
– Expected Value: this is the average present value of the loan proceeds (fees, margin income) less any shortfall following default or balloon payment, given the probability of each scenario occurring.

– Average Downside Risk: this is an assessment of risk measured by the probability-weighted average of all losses occurring.

– Value at Risk: this is the loss that will not be exceeded in more than 1% of the cases, assuming a 99% confidence interval.

The value of the loan to the lender will depend mostly on three factors: the default risk of the obligor, the volatility in the value of the aircraft in relation to the loan to value ratio and the term and price structure of the deal.

The rating of the obligor reflects the default risk. The default of the obligor interrupts the flow of cash to the lender and creates earlier exposure to a downside in the realization value of the aircraft. Not surprisingly, the expected value of the loan typically increases as the rating of the obligor improves and the associated default probability decreases. The graph below represents the ascending cumulative probability of the value of the loan depending on the rating of the obligor.

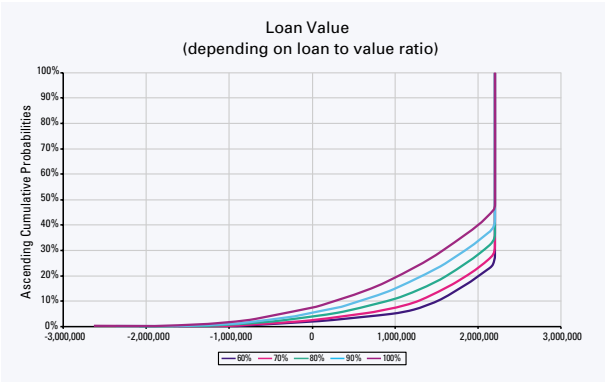


We can observe that the probability of achieving the full potential value of the loan by earning the margin throughout the entire life of the loan and having no shortfall. We also see that the probability of incurring a loss increases as the rating deteriorates.

- The volatility of the value of the aircraft used as collateral. In the event of default and repossession, the lender is exposed in case of a drop in the value of the aircraft but doesn't benefit from the upside; therefore the increase in the volatility has adverse consequences on the Value of the loan and also increases the Average Downside Risk. Indeed in most tradi-

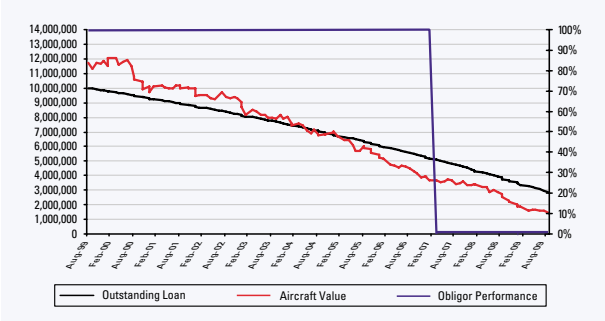
tional asset-based lending, the recovery of the lender is limited to the outstanding amount of the loan. Therefore, a higher volatility in the value of the aircraft will mean a higher chance of the aircraft value falling below the outstanding loan amount, which will expose the lender to a shortfall in case of repossession.

- The term and price structure of the deal and particularly:
  - the loan to value ratio: The lower this ratio at the beginning of the transaction, the less likely it is that the aircraft value will fall below the outstanding loan amount. This is particularly important for fairly volatile aircraft whose value is likely to drop sharply with a downturn in the economic cycle. The graph below represents the ascending cumulative probability of the value of the loan depending on the loan to value ratio.



  - the margin: the higher it is, the higher the expected present value of the deal. Also earnings from higher margins are more likely to compensate for losses due to an asset value shortfall.

The graph below summarizes a simulation of the main parameters of a loan over its 10-year life by showing the outstanding loan amount, the aircraft value and the obligor performance. We have simulated the aircraft value using a random path around a straight-line depreciation. This random path will change with each simulation. The obligor performance is either 100% or 0% upon default. At this time, the aircraft value is insufficient to cover the amount due on the loan.



2. CO-DETERMINATION OF EVENTS

From the basic one-aircraft/one-obligor deal, this study explores the advantages of combining deals in a portfolio approach.

For this purpose, we had to recognize in our analyses that various determinants of the value of a loan are linked among themselves. For instance the probability of default of individual obligors are likely to move somewhat together as obligors in the same industry will be affected by the same events. This is confirmed by observing KMV's[1] airlines default probabilities over time. The performance probability of each obligor will of course also depend upon factors that are endogenous to each company such as the skills of the management or the particular geographic location or market segment where activities are focused.

Similarly the events affecting the individual aircraft values are somewhat linked. The values of all aircraft will tend to go up at time where demand for aircraft will be stronger. Aircraft values will also be affected by endogenous factors such as the maintenance status.

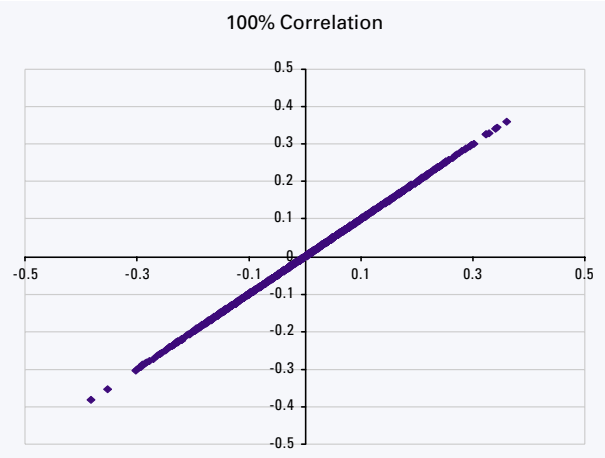
More interestingly, there should also be a relation between obligor performance and aircraft value. Indeed aircraft are likely to be in high demand and thus have high values at times when demand for air transportation is also high, which in turn should make airlines more profitable and thus less likely to default on their loans.

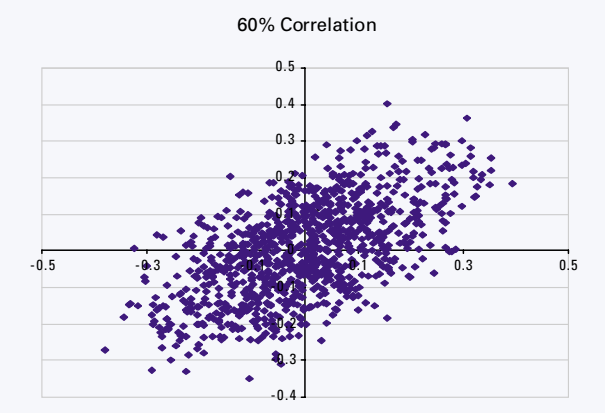
These interdependencies are simulated in the scenarios by using joint pools of random numbers to simulate the state of each determinant. In other words, certain sets of random numbers enter in the computation of several parameters. The number of common sets that are used in the computation of two determinants depends upon the strength of the link that we want to simulate.

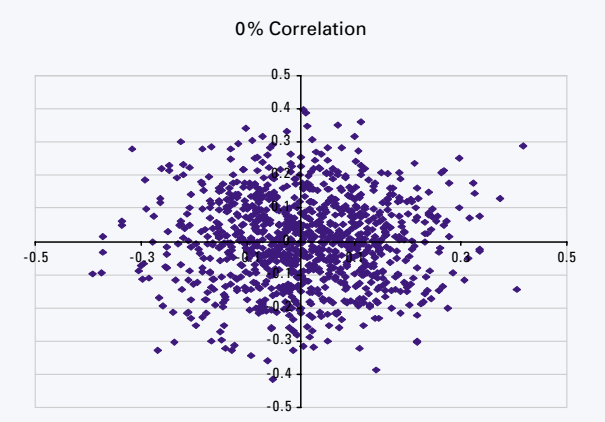
For instance, using the same pools to draw three out of the five numbers used for the calculation of determinants yields equivalent results to having a forced correlation of 60% between the two determinants.

[1] KMV is a leading credit risk analysis firm who publicizes default probabilities for firms in various industries.

The graphs below show the distribution of points obtained at various levels of simulated correlation.







As correlation decreases, the points become more independent. For the model, this means that the performance of one obligor will become less related to the performance of the other obligor or that the evolutions in the values of both aircraft will be more independent.

In the model we used a consistent link of 40% (2 out of 5 determinants) between the obligor performance and the related aircraft value and a consistent link of 60% (3 out of 5 determinants) between the values of both aircraft.

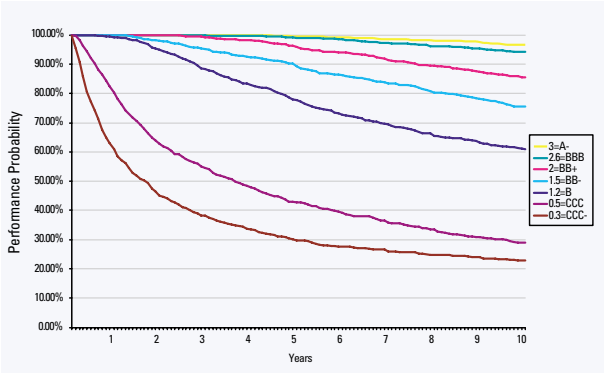
The link between the obligors is varied as indicated in order to simulate the effects of various levels of correlation.

3. METHODOLOGY OF THE STUDY

In order to recognize the uncertainty surrounding several determinants of the loans, two-loan deals were simulated using the following main parameters:

– Aircraft value: is based on a straight-line depreciation over the life of the aircraft plus a volatility reflecting the inherent uncertainty in the future value of the aircraft. This volatility is simulated by multiplying the base value of the aircraft by a volatility factor and by a random number that simulates the uncertainty.

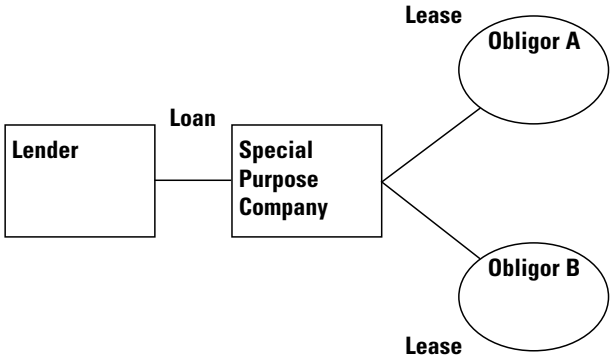
– Obligor performance: is based on the probability that the asset value of the obligor will fall below its liabilities. This is simulated by assigning a score to the obligor. The score is based on an initial margin between asset value and liabilities (equity value) and the volatility of the equity value. This method yields default probability patterns that are similar to those obtained using S&P one-year rating transition matrices and assuming a Markov process.



All the results presented in this paper are based on averages of series of 50 runs of 1,000 simulations. This gives us a large enough sample to accept the results as statistically meaningful.

4. EFFECTS OF CROSS-COLLATERALIZATION

Cross-collateralization means having two or more collateral leases whose proceeds serve to recover the outstanding loan. The collaterals will also supplement each other in case of a shortfall by one of them.

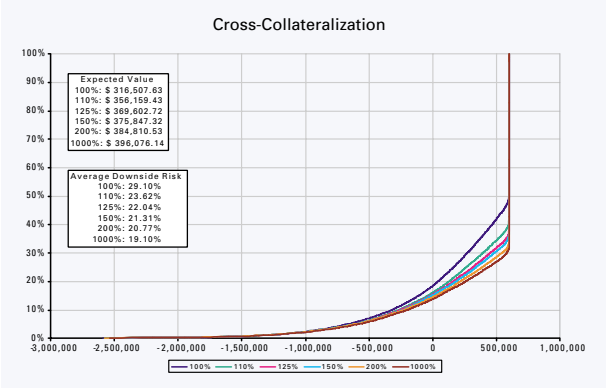


The loan is made up of two tranches each being dedicated to one aircraft. The revenues of the lease of each aircraft are assigned to the repayment of the respective tranche. In case of default by one obligor, the corresponding aircraft is sold to repay the tranche that it was attached to. If the value of the aircraft exceeds the outstanding amount on that tranche a further portion is used to prepay the other tranche of the loan up to the maximum level of cross-collateralization. For instance with a cross-collateralization level of 125%, in case of a default from obligor A, the proceeds from the sale of the aircraft A are first used to repay the attached tranche and a up to a further 25% of that amount is used to prepay tranche B, i.e. the tranche attached to the other aircraft. No distribution is made to the Special Purpose Company unless the value of the aircraft exceeds 125% of tranche A.

In the cases where the value of aircraft upon default is not sufficient to cover the value of the associated tranche, this triggers a default on the entire loan and both aircraft with attached leases are used to cover jointly the full amount of both tranches of the loan.

The level of cross-collateralization can vary between 100%, which is equivalent to no cross-collateralization, and infinity, where the proceeds of the sale of the aircraft are applied first to loan A and then to loan B until both are fully repaid before any distribution to the obligor.

One of the issues with cross-collateralization is that the prepayment that is triggered by the default of one obligor prevents the earning of margin on a part of the remaining loan. In order to overcome this effect, we used an unusual deal structure where income was based on a fixed upfront fee rather than on a margin on the outstanding loan amount.



The outcome of this loan is represented below using different levels of cross-collateralization:

In the example above, the beneficial effects of cross-collateralization on the Expected Value and Average Downside Risk are significant. Indeed we can see that the probability of realizing the full potential of the loan increases with the level of cross-collateralization. Similarly the probability of the loan resulting in a loss decreases from 18.5% with no cross-collateralization to 14.5% with 200% cross-collateralization and 13.8% with infinite cross-collateralization. This is explained by the very fundament of cross-collateralization: in the event of a shortfall in the value of one aircraft, the upside potential in the value of the other aircraft is used to compensate for this shortfall.

The effect of cross-collateralization on Value at Risk (VaR) with 99% confidence is limited: the Values at Risk observed were not significantly different from each other and there doesn't appear to be a consistent reduction in the VaR as the level of cross-collateralization increases. This means that in extreme case, the worst 1% of cases, the values of both aircraft are so low that it is impossible to use the proceeds from the sales to refund more than the share of the attached tranche. This may be due to the presence of only two aircraft in the deal that we simulated. It is likely that the probability that the value of all aircraft ending up below the outstanding tranche amount will decrease as we increase the number of aircraft that enter the cross-collateralization deal. In this case, the percentage of scenarios where cross-collateralization provides benefits should expand with the number of aircraft and could reach 99% if the number of aircraft is high enough. In this case cross-collateralization would result in a reduction of Value at Risk even at a 99% confidence level.

It appears that extremely high levels of cross-collateralization are not necessary to provide benefits. Actually the marginal benefits from the increase in the level of cross-collateralization are declining rapidly. Indeed it will be a very rare occurrence when the value of an aircraft will exceed 200% of the attached tranche.

In order to generate most benefits, cross-collateralization should be used with aircraft whose values are weakly linked. Since one of the underlying ideas of cross-collateralization being that the upside in the value of one aircraft will compen-

sate the downside in the value of the other aircraft, the benefits will be lost in the case where the values of the aircraft collapse together. Unfortunately there doesn't exist a counter-cyclical type of aircraft whose value will go up at times when the economic cycle is in a trough and airlines financials and aircraft values in general are at their lowest. The main source of difference between two aircraft of the same type will be their maintenance status and their position in the maintenance cycle. If an aircraft is just out of a D-check while the other one is going towards one, the value of these two aircraft will be sensibly different. Thus, the position in the maintenance cylce is a source of de-correlation between the aircraft that can be used by the lender.

Still in order to enhance the benefits of cross-collateralization, the lender should seek to diversify the types of aircraft used as collateral by choosing for instance aircraft that have a different sensitivity to the economic cycle. This could mean for instance that the lender could try to blend loans for wide-bodies and narrow-bodies.

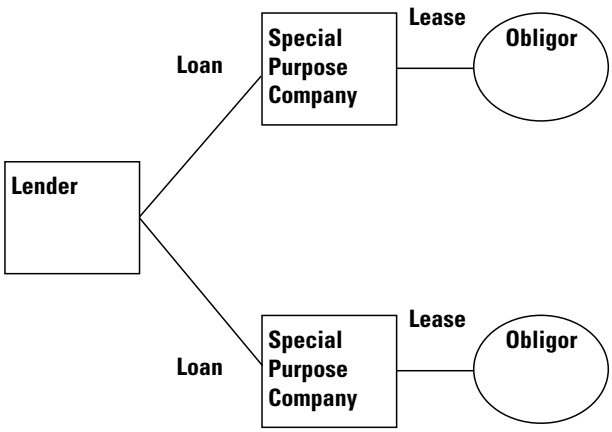
Cross-collateralization could indeed be beneficial for a lender who is uncomfortable with the risk associated with the uncertainty in the value of a wide-body aircraft used as collateral for a loan. In this case a possibility exist to add another aircraft, a narrow-body for instance, as a cross-collateral to the loan. Because the values of both aircraft will have somewhat different reactions to the evolution in the state of the economy, they are likely to be able to adequately complement each other to cover the outstanding loan amount.

Because cross-collateralization requires the combination of default with high aircraft value to provide benefits, the most noticeable improvements will be observed with highly volatile aircraft values since cross-collateralization enable the lender to benefit the increases in the value of the aircraft. However, it should be noted that cases where default coincide with high aircraft values tend to be rare in real life. As noted earlier, airlines financial results (and therefore performance probability) and aircraft values tend to be affected in a similar manner by the mechanisms of the economic cycle. This limits the cases where cross-collateralization can provide substantial benefits.

The loan to value ratio will also be of critical importance to determine how much benefit is provided by cross-collateralization. Indeed if this ratio is too high, the collaterals may not be sufficient to compensate for the gap between aircraft value and the loan amount. Therefore the lender should be very careful to have the value of the loan well covered by the sum of the values of the aircraft used as collateral. If this is not the case, a short fall in the value of one of the aircraft will be more likely and a greater upside in the value of the other aircraft, or a higher level of cross-collateralization will be needed to compensate for this shortfall.

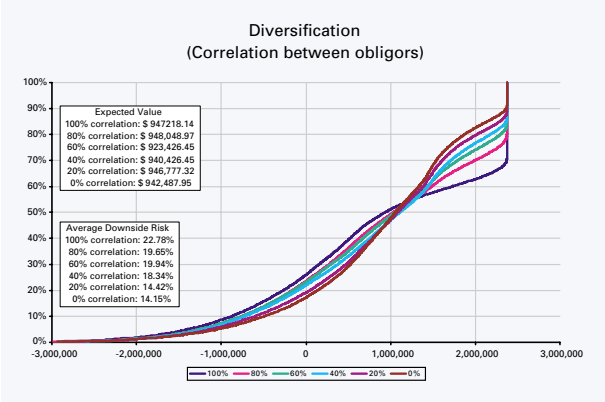
5. EFFECTS OF DIVERSIFICATION

Diversification means issuing several loans to different lessors and assessing the value of these loans from an aggregate point of view. This allows the lender to dilute the risk and reduce the impact of a negative outcome in one of the loans. Whereas of cross-collateralization rested on the concept of having several collaterals to guarantee the loan, Diversification relies on the concept of "untying" the elements of the deals such as the two obligors or the two aircraft. "Untying" implies having two obligors or two aircraft whose reaction to the outside events will be different. This is sensibly easier to find for obligors than for aircraft. Indeed the performance of the obligor will be affected by many factors that can affect only one obligor specifically, such as the state of the economy in the region where the obligor operates most of its routes, changes in law or taxation, labor disputes or the skills of management. For the value of the aircraft however, the market is much more global with the aircraft easily transferable to other regions, which tends to harmonize movements in aircraft values. The only determinant in the value that is purely endogenous to one specific aircraft is its maintenance status.



The extent of the benefits of this diversification has been found to depend greatly upon the strength of the link between the aircraft or the obligors. In the example hereafter we used two obligors with the same rating and varied the correlation between the obligor between 100%, which is equivalent to having a single obligor, and 0%, which means having two completely independent obligors. In practice default correlations between airlines, as measured by KMV, are all positive and mostly between 10% and 40%. The only correlations over 50% observed are among the big-six US airlines (American, Continental, Delta, Northwest, Southwest and United). Because the KMV correlations were all positive, we did not test for cases of negative correlation between the obligors. In our model, correlation was simulated using a joint selection of random numbers as explained above.

The chart below represents the ascending cumulative probabilities of the outcome using several levels of correlation between the two obligors.



It can be observed that, as the difference between two obligors increases (i.e. as the correlation between them decreases), the likelihood that both obligors will default together at a time when aircraft values are low decreases. This is reflected on the graph by a lower probability of large losses when the correlation between the obligor is weak. On the other hand with weak correlations, the likelihood that at least one of them will default increases. Therefore the smaller the correlation between the obligors, the lower the likelihood of earning the maximum amount through the commission on the entire life of the loans. This phenomenon will be amplified as we increase the number of loans to various obligors. We also observed similar results by varying the correlation between the aircraft while keeping the correlation between the obligor constant.

With Diversification, the Expected Value shows no significant changes. When correlation decreases, the lower probability of achieving the full potential of the loan is compensated by a lower probability of incurring losses and particularly very high losses. We can observe a kind of symmetry in the curve where the probability of extreme scenarios decreases on both ends as the level of correlation decreases. Indeed as the movements in the state of two obligors become more independent, the likelihood decreases that both of them will perform through the entire life of the loan or that they will both default at a time when aircraft value is low.

The most remarkable feature of Diversification is that it reduces the Average Downside Risk as the link between the obligor becomes weaker. This feature is observed even though the two obligors have the same rating and therefore convey the same imbedded default risk. The ADR is by definition the probability-weighted average of all losses occurring, as a percentage of the Expected Value of the loan. As we have seen just above, the Expected Value remains unchanged by Diversification. The probability of large losses however will be greatly reduced as correlation between the obligors decreases. Therefore when these decreased probability-weighted losses are put in relation with an unchanged Expected Value, this yields a lower Average Downside Risk.

Concerning Value at Risk (VaR) we can observe an overall reduction as the correlation between the obligors decreases. Although this decrease is interesting, the differences are not statistically significant. These differences are much more clearly marked if we look for instance at VaR with a 95% confidence level: i.e. the loss that will not be exceeded in more than 5% of the cases. We can also anticipate that the reduction in the VaR through Diversification would be more pronounced as we increase the number of obligors.

It is also interesting to observe that all the curves seem to go through (or very close to) the same point. In the above case, this point is close to half the maximum value of the loan. This would mean that the probability of earning half of the maximum possible amount remains the same regardless the correlation between the obligors. Tests with other parameters have showed a similar pattern of all the curves crossing around a same point. This would mean that for a given deal there is a value outcome that will have the same probability regardless the degree of correlation between the obligors.

Given these characteristics, Diversification would be most beneficial to a lender who is satisfied with the expected income from a loan but uncomfortable with the level of risk associated. By putting together these loans to several obligors, the lender will be able to reduce this risk and enter into the deals while staying within his risk tolerance limits.

6. CONCLUSION

This initial research on the effects of cross-collateralization and diversification in aircraft backed loans raises some interesting prospects in terms of reduction of risk for the lender. It highlights the possible benefits of combining loans in a portfolio approach as opposed to having a fragmented vision.

This study shows that Cross-collateralization can help increase the Expected Value and reduce the Average Downside Risk of the loan. It also shows how Diversification can help reduce the Average Downsize Risk. The extent of the benefits provided by Cross-Collateralization and Diversification depends greatly on the terms and structure of the individual loans. Factors like the balloon level or the loan to value ratio, for instance, can make a significant difference in the magnitude of reduction in risk provided.

This portfolio perspective will enable the lender to reduce its risk and enter into deals that wouldn't have made it past the Credit Committee on an individual basis. With the proper structure, Cross-collateralization can enable the acceptance of deals that would otherwise have fallen just short of the lender's return requirement or risk acceptance. Diversification can enable a lender to reduce his risk considerably by diluting his risk over several obligors or several aircraft.

So far we have only studied two-aircraft/two-obligors deals. The results obtained in this study are already very promising. We can certainly expect that these results will be even amplified as the number of aircraft and obligors in the deal increases. Indeed with a greater number of collaterals, we should be able to achieve an even better coverage of the loan through Cross-Collateralization. At the same time with a greater number of obligors and aircraft, we'll be able to find greater differences among them and thus achieve an even greater dilution of risk through Diversification.

Further research still needs to be completed to be able to better quantify our initial findings. It would also be interesting to measure how the effects observed are amplified as the number of loans in the portfolio increases.

These further analyses will be made easier with the new SAFEPORT evaluation model, which is currently being developed by PK AirFinance. This model is the evolution of PK's existing SAFE (Statistical Aircraft Financial Evaluation) model to allow a portfolio analysis of several deals.

An initial test version of SAFEPORT provides a graphical display of the loan outcome in addition to the usual measurements of Expected Value, Average Downside Risk and Value at Risk. This graph enables a more complete representation of the probabilities of the outcome of the loan. This will enable a better comparison between different deal structures and allow the lender to make more optimum choices.

The use of this test SAFEPORT version, coupled with further research should allow us to build a broader experience in multi-aircraft/multi-obligor complex deal structures. This experience will be valuable to enable us to offer increasingly sophisticated structures that could lead to a reduction of risks and thus allow more competitive pricing.