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INHALT

MERGER ARBITRAGE IN HEDGE FUNDS, RISK AND RETURN: CRITICAL ISSUES

HEDGING OF CREDIT RISK IN M&A TRANSACTIONS

Olaf Ehrhardt/Pan Theo Große-Ruyken

1. INTRODUCTION

Credit derivatives play an increasing role in the portfolio-oriented risk management of financial institutions. To hedge the credit risk in M&A transactions, a financial institution can diversify the portfolio by repacking it and selling it off on the credit markets or by entering into syndication. As mentioned before, the pricing of credit derivatives is typically done using cash market benchmarks. If these are not available for any particular market, default probability[1] and recovery rate models are used to price credit derivatives. As per one dealer, option-pricing models have been used to price credit options.

Financial institutions use credit derivatives for leveraged M&A transactions to hedge the credit exposure that they assume by providing bridge financing or syndicated loans. Financial institutions that lend large amounts to their clients in M&A activities use credit derivatives to manage exposure to the acquirer of a target company. Aggrawal (2000) illustrates this with the simple example that the acquirer of a target company intends to finance his acquisition through a syndicated loan. Before permanent financing can be arranged, a financial institution may provide bridge financing for the transaction and possess the credit exposure to the acquirer. Therefore, the lender arranges a default swap contract with other financial institutions, funds, or a combination of dealers, to protect himself against the credit of the acquirer. Since the transaction size in M&A is enormous, a combination of dealers (swap counterparties) is needed to disperse the risk.[2]
Furthermore, credit derivatives are applied to free credit constraints in M&A transactions. If a financial institution exceeds its credit limit to a customer by additional bridge or permanent financing, it can free its lending constraints by using a default swap. The financial institution then has to pay a premium to transfer the risk to the protection seller and is consequently able to expand its capacity towards the customer to assume additional lending and provide further M&A financial support.

Finally, credit derivatives - especially credit spread put options - are increasingly applied by lenders. The bidder, holding debt securities issued by the lender, who already has credit exposures, has to protect himself from the consequences of a potential credit rating downgrade, in which the bidder acquires a target of a lower credit quality. By holding a credit spread put option, the spread on a reference credit can be sold unrestrictedly (e.g. debt securities issued by the bidder, or a loan to the bidder) to the writer of the option for the amount by which the actual spot spread exceeds the strike price of the option. The difference between par and recovery received from the exercise of the option in case of the pre-determined credit event hence compensates the financial institution (holder) for any loss of value on the reference credit due to the ratings downgrade of the merged entity and the resulting widening (i.e. deterioration) of the spread on the reference credit.[3]

Summarizing, we can state that the values of a credit and a credit pool and, thus, also collateralized debt obligations (CDO)[4] depend directly on the credit-worthiness of the respective counterparties. As a result,

[1] Default probability is the likelihood that a counterparty will be bankrupt or will not honor its obligations at the times when they become due over a given period.

[2] See Aggrawal (2000), p. 51.

[3] See also Instefjord (2005).

financial institutions are frequently exposed to cluster risk of many counterparties that can be assigned to the same industry sectors. Depending on its scope, an M&A transaction may represent the same cluster risk in one individual case. If credit-worthiness deteriorates, the spread that is traded in the market will extend. Given a mark-to-market evaluation (MTM), this will lead to a lower value of the reference asset. This risk is particularly high in market value CDOs because it can entail that the market value of the portfolio is no longer sufficient for a securitization. Here, the market value of the assets is relatively unimportant. Only if the reference asset defaults the needed cash flow on the asset side will be influenced. In any case, the note holder's probability increases that he will not retrieve the full amount of the invested capital – a fact that will reduce the value of the tranche. This way, also risk premiums for credit risk hedges on the part of the financial institutions would become more expensive and the credit limit of the reference counterparty further limited. Practically, this means that counterparty credit exposures on credit derivatives should be calculated frequently and compared to credit limits. All counterparties, regardless of collateral status, should be subjected to a sound due diligence process. Buyers of credit protection should evaluate the potential correlation of reference entities and protection sellers and take account of such assessments within their risk management processes in the M&A business. In total, the application of credit derivatives to hedge credit risks in M&A transactions despite potential cluster risks reduces and/or diversifies the portfolio risk, minimizes spread margins, enhances the liquidity of the credit risk market, and allows widening credit limits to reference counterparties. Fitch Ratings points out that 70% of the market is still concentrated among a small group of counterparties and as a result "the market could be negatively affected if one or more of these institutions withdrew from the market for either strategic or financial reasons"[5]. Thus hedging of credit risks through credit derivatives is not only necessary, but also essential for efficient risk management in the capital market nowadays.[6]

2. THE CREDIT DERIVATIVES MARKET

The credit derivatives market grows at a speed that is exceeding that of all other segments in the financial market by far, reaching in 2004 an impressive growth rate of 44% and an aggregate value of USD 5,440 billion according to the International Swaps and Derivates Association (ISDA). The British Bankers Association (BBA) forecasts the market to achieve a volume of USD 8,200 billion by the end of 2006[7]. Although in absolute terms this may account for a comparably modest portion of the overall volume of global risk transfer. The explosive growth rate of credit derivatives, however, illustrates the increasing importance of these instruments as a risk management tool.[8]

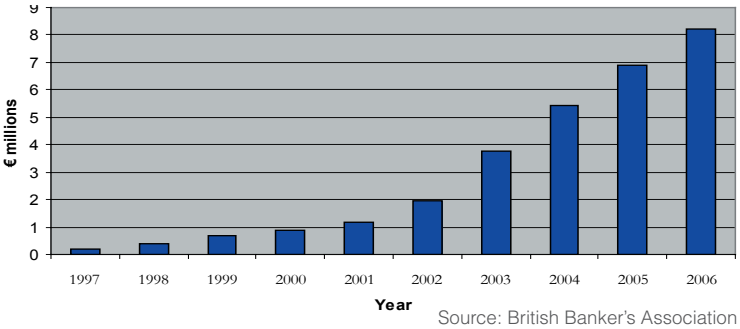
[4] Collateralized debt obligations are securitized interests in pools of assets, generally non-mortgage. Assets, called collateral, usually comprise loans or debt instruments.

[5] See Fitch Ratings (2003), pp. 6.

[7] See Steinherr (2000), p. 274.

[8] See also Fitch Ratings (2004), p. 7.

Chart 1: The rise of the credit derivatives market



Source: British Banker's Association

The growth of credit derivatives over the last years can be mainly explained by three factors[9]:

- Hedge funds prefer the credit derivatives market to the normal cash bond market because they allow themto pursue their strategies with lower capital requirements.
- Several commercial banks have used credit derivates to protect themselves from potential bankruptcies of their clients and to minimize their credit risk.
- Insurance companies, pension funds, and banks work as a driving force in the described scenario. In 2004, these institutions did not only buy credit derivatives but also issued them and, thus, sold protection themselves. By anticipating that the buyers would not make full use of their safety net - an assumption that turned out to be correct -, they could improve their financial profits.

The greater the default risk, the greater the spread. It is greatest in the case of junk bonds for which the probability of an insolvency of the debtor is estimated to be particularly high. What is more, spreads fluctuate with the overall economic situation. Before, risk free interest rates were based on the return on treasury bonds. This was problematic, however, because of the varying methods for credit assessment applied by the different rating agencies. That is the reason why today the more neutral swap rates have gained most acceptances. This development allows financial institutions not only to take into account a possible strategic impact of their business decisions on interest rates but also to better assess the behavior of competitors. More importantly, financial institutions can now optimize their credit portfolio by hedging enormous transaction sums against credit risk. In the M&A business, credit derivatives are attaining ever greater importance thanks to their paramount role not only as guidelines in credit risk measurement but also as reliable instruments in credit risk management.

3. CREDIT DERIVATIVES CONTRACTS

3.1 THE CHARACTERISTICS OF CREDIT DERIVATIVES CONTRACTS

Apart from the duration and the face value, the counterparties of a credit derivative contract (CDC) need to agree on three broad issues:

1. what is the reference entity or obligation(s),
2. how and when will the payment be settled and
3. what should constitute a credit event. Most contracts are based on 1999 International

[9] See Kengeter (2004).

Swaps and Derivatives Association (ISDA) standard documentation.

These three broad issues will be looked into in more detail in the following section.

Determining the premium

Determining the premium and the compensation payment in a CDC both require a valuation of the credit risk. Credit risk is defined as the product of the likelihood of default (Pd) and the actual loss (L), which in turn depends on the recovery (R).

$$C = Pd * (1-R)*100 \qquad \text{where } L = 1-R$$

Assuming a risk-free interest rate (e.g. LIBOR/EURIBOR), the credit spread is a function of P, R and maturity. Furthermore, regulatory capital requirements, liquidity as well as the market sentiment and perceived volatility and shape of curve are usually priced in. As a consequence, in order to price a credit derivate, it is essential to know the credit, its default probability, and recovery rates, which depend on the level of seniority of the debt, plus market information. The rating agencies provide a long history of statistical information on one-year and cumulative default probabilities, as well as recovery rates for different products.

The reference entity or obligation

In a credit derivative contract, a reference entity upon which protection is being written needs to be identified because no particular asset is sold. It may be a corporate, a financial institution, or a sovereign. A CDC may reference a specific obligation of this entity - a reference obligation - and, if this is the case, credit events (CE) will be only linked to this obligation. But more commonly, protection will be written on the reference entity without specifying a particular obligation. Therefore, the seniority and type of obligation that will trigger a credit event will be identified in the documentation.

Chart 2: Definitions of Obligations

Category	Characteristics
- Bonds	- Not sovereign lender
- Bonds or loans	- Not domestic law
- Borrowed money	- Specified currency
- Loans	- Not domestic currency
- Payment	- Pari-Passu Ranking[10]
- Reference obligation only	- Listed:
	Not contingent
	Not domestic issuance

Source: International Swaps and Derivatives Association

(10) A Pari Passu Ranking is defined as an obligation that ranks at least pari passu with the most senior reference obligation in priority of payment or, if no reference obligation is specified, the obligations of the reference entity that are neither subordinated by their terms nor secured, see Bowler/Tierney (15.10.1999), p. 29. For further details, see also ISDA (1999).

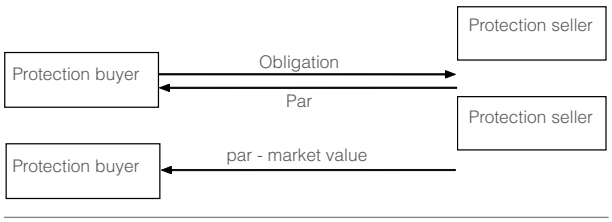
Methods of settlement

The two major methods of settlement for a CDC are physical or cash. Sometimes the parties agree to a binary settled transaction, whereby the risk buyer pays a fixed amount stipulated in the contract.[11]

In a cash settled transaction, the risk buyer (protection seller) pays the difference between market value and par (instead of having an obligation delivered) after a specified period of time (e.g. 60 or 90 days). The risk seller (protection buyer) obtains the market price either from a calculation agent or via a dealer poll. If the market value of a reference obligation cannot be obtained, then a pari-passu ranking obligation with a similar maturity will be valued instead.

In a physically settled CDC, upon the occurrence of a credit event, the risk seller will deliver an obligation to the risk buyer and receive par in return. If credit events (CE) are linked to a reference obligation, the scope of "deliverable obligations" typically extends to comprise all obligations that rank pari-passu with the reference obligation. The protection buyer will receive the obligation that is "cheapest to deliver". The following chart shows the cash and physical settlement of a credit derivative contract[11]:

Chart 3: The settlement of a Credit Derivative contract



Source: Own figure

While the recovery value is typically the unknown variable, there are transactions in which a fixed, predefined cash settlement amount (fixed recovery) is agreed. The result is that the protection seller bears the loss on the obligation, but this loss may differ according to the method of settlement. The protection seller may prefer physical delivery if he thinks that by waiting and allowing the price of the obligation to stabilize, he may realize a higher recovery. Intuitively, one might think physical settlement, or indeed a longer cash settlement period (i.e. 90 days rather than 60), would result in a higher recovery as it gives the price of the credit more time to settle down. However, this is indeed not always the fact.

Credit Events[12]

A credit derivatives contract must define at least one credit event (CE). The 1999 ISDA Credit Derivatives Definitions lists six credit events[13] which will be looked into more closely in the following:[14]

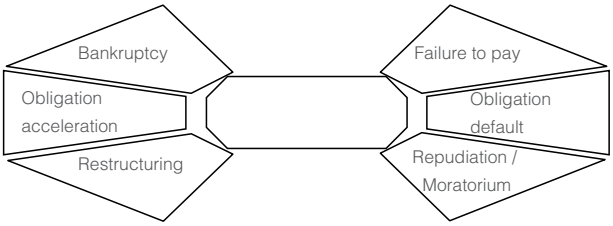
(11) See Heinrich/Grützemacher (2005), pp. 386.

(12) See also ISDA (2005a).

(13) The procedure for notifying the protection seller of a CE is detailed in the documentation. Its occurrence needs to be confirmed by public sources e.g. the news wires.

(14) See also Ali (2001b), p. 3.

Chart 4: ISDA Credit Derivatives Definitions



Source: Own figure

Five of them relate to corporate obligations, whereas repudiation/moratorium is more applicable to sovereigns. Today the majority of contracts are based on bankruptcy and failure to pay.[15]

- Bankruptcy
  A bankruptcy event occurs whenever the reference entity has or is about to become an insolvent. It hereby must be pointed out that according to the ISDA definition a credit event can be triggered already when insolvency is imminent, even though it has not yet ensued.

- Failure to pay
  Failure to pay takes place when the company finds difficulty to honor its obligations to the extent that it is no longer able to meet a previously specified minimum threshold (payment amount).

- Restructuring
  When a company undergoes restructuring measures, its credit quality largely deteriorates - at the cost of creditors, of course. In its 1999 definition, the ISDA names five such restructuring events:
  - a reduction in the rate or amount of principal payable
  - a reduction in the amount of principal or premium payable at maturity or at scheduled redemption dates
  - a postponement or deferral of interest or principal payments
  - a change in the ranking of an obligation causing it to be subordinated
  - a change in the currency or composition of any interest or principal payments.

In an attempt to more clearly define restructuring as a credit event, ISDA introduced new additional definitions termed "modified restructuring" in 2001[16]. [17]However, the new definitions helped little to eliminate the problems and uncertainties that continue to exist in this field. As a result of this, but also due to tight regulations particularly in Europe, market participants have become more and more reluctant to use restructuring as a credit event. Recent developments suggest that it will be dropped as a credit event altogether in the near future.

Obligation acceleration or default

If the counterparty fails to pay its obligations and these are as a result becoming due and payable earlier than under normal conditions, obligation acceleration occurs. Obligation default, however, means that one or more obligations have become capable of being declared due and payable, even though they may not yet have been. In both cases, a minimum threshold amount must be set in the contract so that the event is called on.

[15] For an overview of recent credit events, see Fitch Ratings (2005).

[16] See ISDA (2001).

[17] They include a "Restructuring Maturity Limitation" which limits the maturity of deliverable obligations to 30 months and thereby prevents protection buyers from delivering long-dated obligations that might be trading at a significant discount. To meet the "Pari--Passu Ranking" criterion, an obligation must have the ranking in the priority of payment that the reference obligation had as of the later of the trade date or its issue date. This is to ensure that if a reference obligation is subordinated in a restructuring, protection sellers cannot deliver a subordinated obligation.

or more obligations have become capable of being declared due and payable, even though they may not yet have been. In both cases, a minimum threshold amount must be set in the contract so that the event is called on.

Repudiation/moratorium

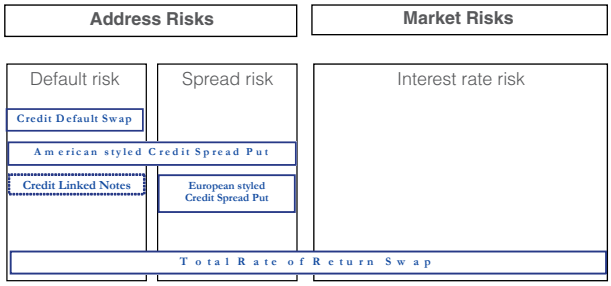
Repudiation/moratorium means the default of sovereigns. The credit event is triggered whenever a sovereign becomes unable to service all or part of its obligations or it decides to postpone the repayment. Also this credit event has to be for an amount exceeding the default requirement.

After describing the elements of credit derivatives, we will now formulate a definition of a credit derivative and then turn to the three most applied and, thus, classic credit derivatives products as well as the most common synthetic asset, called Credit Linked Notes.

3.2 TYPES OF CREDIT DERIVATIVES

Credit Derivatives open up the market for credit risks: Credit positions and portfolios can be reduced, increased, and/or diversified. The three major types of credit derivatives are credit default swaps, credit-spread put options and total-rate-of-return swaps[18]. Among these, credit default swaps (CDS) possess the highest market share and liquidity by far[19]. These transactions can all be structured as off-balance-sheet derivatives contracts embedded in a more traditional on-balance-sheet structure, such as a Credit-linked Note (CLN). Other existing products are hybrids or basket products like Asset Linked Trust Securities (ALTS) or Chase Secured Loan Trust Notes (CSLT). The risks of the reference asset are partly, or even completely, covered (see chart 5) depending on the type of the credit derivative.

Chart 5: Risk management with Credit Derivatives



Source: Own figure

It can be seen that credit default swaps and Credit Linked Notes cover the idiosyncratic credit risk, i.e. the address risk. Total Return Swaps and Credit Spread Options cover market-related interest rate exposure in addition.

The chart infers that different credit risks need different risk covers. While Credit Default Swaps as well as Credit Linked Notes hedge the default risk, European styled Credit Spread Puts protect against spread risks. American styled Credit Spread Puts protect against default and spread risk and thus hedge all address risks. Total Rate of Return Swaps permit not only a hedge of address risks, but also of market risks[20]. Default risk is the risk for which the issuer will not pay interest and/or principal at maturity. According to Moody's, the

[18] See Ali (2000), pp. 75.

[19] According to the British Bankers' Association (2004), credit default swaps are the largest component of the global credit derivatives market.

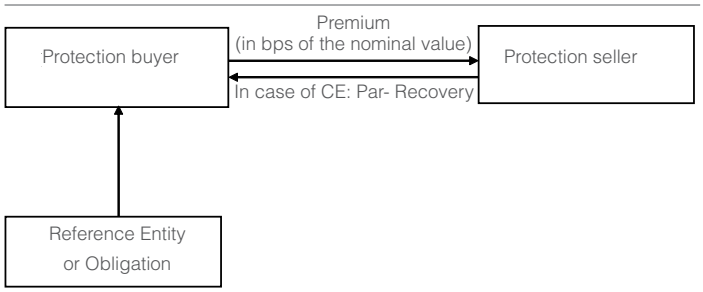
[20] In this context, only interest rate risks play a role. In general, market risks also include commodity price risks, stock price risks or exchange risks.

highest default rate on corporate debt in the United States occurred during the Great Depression and was 9.2 percent in 1932. Spread risk, in contrast, is the risk that the spread on an asset (i.e., its yield premium over the relevant risk-free benchmark) will increase. Credit spread changes are often associated with macroeconomic events in either the domestic or global financial markets. An increase in the spread would cause the asset to underperform the risk-free benchmark on a relative basis. In the following, the different types of credit derivatives will be presented in detail.

Credit Default Swap[21]

A credit default swap (CDS)[22] is a bilateral contract in which one party (the protection buyer) pays a periodic, fixed premium or upfront fee to another (the protection seller) for protection related to credit events on an underlying reference entity or obligation. Usually, the premium is paid quarterly and expressed in basis points per annum of the swaps notional. If a credit event occurs, the protection seller is obliged to make a payment to the protection buyer in order to compensate him for any losses that he might otherwise incur. Thus, the credit risk of the reference entity or obligation is transferred from the protection buyer to the protection seller (see chart 8). Therefore, CDS have the same effect as shorting a bond. The investor gains if the bond decreases in value, but if the bond increases in value, the investor must pay the increase to the dealer. Some credit default swaps are based on a basket of assets and pay out on a first-to-default basis, whereby the contract terminates and pays out if any of the assets in the basket are in default[23]. A CDS is therefore similar to an insurance contract or a financial guarantee, i.e. of unfunded nature. Alternatively, it can be thought of as an unfunded hybrid (which also largely excludes the interest rate risk), with the premium similar to the credit spread over LIBOR.

Chart 6: The structure of a Credit Default Swap



Source: Own figure

Total-Rate-of-Return Swap

Total-rate-of-return swaps (TRORS) are contracts where a series of payments is linked to the total return on a referenced asset in exchange for a series of payments tied to a reference rate (e.g., Treasury issues, LIBOR) plus a spread.

So, TRORS transfer the returns and risks on an underlying reference asset from one party, the "total rate buyer", to another, the "total rate receiver"[24]. A "total return" includes all interest payments on the reference asset plus an amount based on the change in the asset's market value. If the price rises, the total-return buyer gets an amount equal to the appreciation of the value, and if the price declines, the buyer pays an

(21) For further details, see Tavakoli (1998), pp. 65.

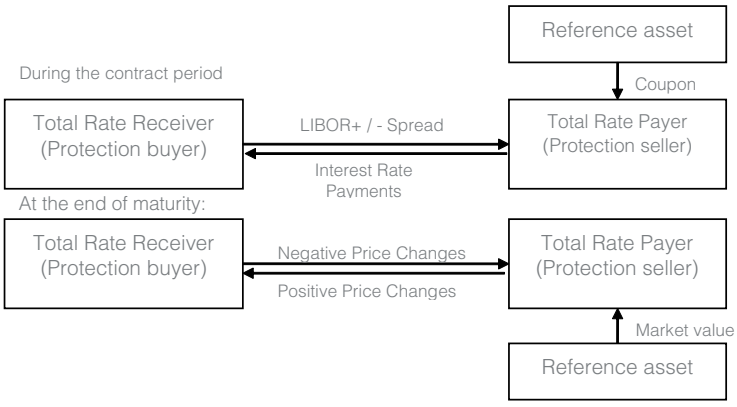
(22) See also Prato (2002), pp. 68.

(23) For further information about First-to-Default-Swap and synthetic CDS, see Gütter (2004).

(24) Therefore, the total payer's position is equivalent to a short risk position which completely hedges the real position in the reference asset and vice versa, the total receiver's position represents the long credit risk position.

amount equal to the depreciation in value. A financial institution may seek to increase or decrease credit exposure. Either of these objectives can be achieved with a total return swap. The total return payer owns the risky asset, while the total return receiver agrees to receive the asset's total return in exchange for a fixed-rate- or floating-rate payment stream. If a credit event occurs prior to maturity, the TRORS usually terminates and a price settlement is made immediately[25]. The structure of this product is as follows:

Chart 7: The structure of a Total-Rate-of-Return Swap



Source: Own figure

The chart explains clearly that the total rate receiver makes a predetermined variable payment based on LIBOR/EURIBOR during the contract period. The total rate payer returns the interest payment of the reference asset. At maturity, the total rate receiver transfers the negative market price changes of the reference asset to the total rate payer, whereas the latter pays for all the positive market price changes.

The benefits of total return credit swaps to the receiver are:

- The number of swap transactions can be significantly less than the individual transactions.
- The recipient of the total return swaps does not have to finance the purchase of underlying assets.
- The receiver may not have a great deal of expertise in credit analysis. The financial institution (TR payer) may have more expertise in this area. Hence, the receiver benefits from the credit analysis the bank has already performed (i.e., the bank has already done the credit analysis "homework").
- Additional leverage can be built into the terms of the swap agreement.

Credit Spread Options

Credit spread options (CSO) are relative options, whereas credit put options (CPO) are absolute options. Credit spread options, also known as underperformance options, have a payoff that is contingent on the relative out-performance of one referenced asset over another. Credit-spread put option contracts isolate and capture devaluations in a reference asset that are independent of shifts in the general yield curve[26]. Essentially, they are default swaps that stipulate spread widening as a credit event (see Chart 8). Typically, the spread is relative to some treasury security. The advantage of the spread put's detachment from defined credit events became in particular apparent during the periods of turmoil in Latin American, Asian, and Eastern European financial markets during the late 1990s where spreads widened dramatically in the

[25] Some contracts allow for optional physical delivery of the reference asset or a pre-agreed substitute asset.

[26] See also Bhansali (1999).

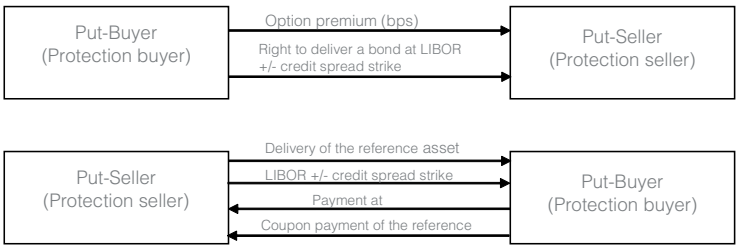
[27] The credit spread call and the credit spread put have similar payoff profiles. The key differences are that the credit call value is easier to calculate, since it is a direct function of the spread, and that there is a risk adjustment factor.

absence of any "event" as defined in typical default-swap documentation by the ISDA.

Credit spread options - European styled CSOs hedge only the spread risk, while American styled CSOs hedge in addition the default risk - protect against credit risks only, whereas credit options protect against both market and credit risk[27]. The spread is regularly calculated as the yield differential between the reference bond and an interest rate swap of the same maturity[28]. Unlike default or total-rate-of-return swaps, counterparties do not have to classify the specific credit events - the payout occurs regardless of the reasons for the credit spread movement.

In a CSO, the put seller agrees to compensate the put buyer in exchange for a contingent payment if the spread widens beyond a pre-agreed threshold level (i.e. deterioration in the spread referable to the reference obligations). This enables the protection buyer to transfer to the protection seller the risk of an increase in the cost of funding the reference obligations[29]. However, credit-spread derivatives can be difficult to hedge and very complicated to model and price, and most investors and hedgers can accomplish their objectives with cheaper default swaps[30]. The structure of a Credit Spread Put is summarized in the following chart:

Chart 8: The structure of a Credit Spread Put



Source: Own figure

As indicated in the chart above, the Put buyer pays an option premium and obtains the right to deliver a bond on LIBOR/EURIBOR basis +/- credit spread strike. This allows the buyer in occurrence of a credit event to deliver this reference asset at the original conditions - at LIBOR/EURIBOR basis +/- credit spread strike - and to receive the payment at par as well as the coupon payment of the reference asset. Thus, the spread risk is optimally hedged.

Credit-linked Notes[31]

All the previously presented credit derivatives have in common that the protection buyer's credit risk has been converted into the credit risk of the counterparty[32]. Synthetic assets can be created by securitizing credit derivatives. A credit-linked note (CLN) can be designed as a collateralized CDS, or alternatively, as a note with an embedded CDS. The protection buyer receives a pay-off that is dependent on the performance of one or more reference credits. Basically, a CLN pays a coupon and redeems on maturity at par

(28) Yield spreads are often calculated against government bonds but such spreads implicitly measure a combination of credit risk and liquidity preference, see Miville/Bernier (1999). Calculating the spread against the swap curve more effectively isolates changes to the perceptions of credit risk. See Fleming (2000) for a U.S. perspective on the government bond versus swap curve "benchmark" issue.

(29) As seen above, in a total rate of return swap, the protection seller assumes the economic incidents (including the credit risk) of the reference obligations.

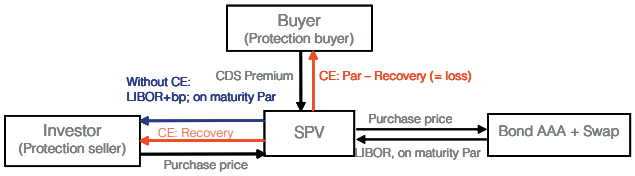
(30) See also Bowler/Tierney (1999), pp. 21.

(31) For further details, see Tavakoli (1998), pp. 206.

(32) Even so financial institutions with a credible policy of "too big to fail" consider the risk of the protection seller's default virtually negligible, the protection buyer has a counterparty exposure to the protection seller (counterparty risk). If the protection seller and the issuer of the reference credit default simultaneously, the buyer will suffer the full loss despite having paid for default protection. Thus the protection buyer must ensure that the correlation risk between the protection seller and the reference asset is low.

provided that no credit events have occurred (see chart 13, blue flash) on the reference entity. If a credit event does occur (see chart 11, red flash), then the notes will be redeemed for their face value less the amount referable to the special purpose vehicle's (SPV's) obligations (par-recovery) to the financial institution under the above credit derivatives. Such synthetic assets pay an enhanced coupon, funded by the fee paid by the financial institution under the credit derivatives and the return of the investment of the subscription proceeds of the notes[33]. The structure of a CLN can be summarized as follows:

Chart 9: The structure of a Credit-Linked Note



Source: Own figure

The chart shows that risk parceling can be achieved through the issuing of obligations. To this end, the SPV is founded which issues the CDN(s). In the case that the SPV issues several CDN who correlate, the issuing price can decrease. In a 100% principal-guaranteed credit-linked note, only the coupons paid under the note bear credit risk. If no credit event occurs, the obligation can be serviced through the sale of the AAA bond. If that is not possible the loss can be serviced through securities and the rest is distributed to the investors.

4. CREDIT RISK VALUATION MODELS

4.1 CLASSIFICATION OF THE CREDIT RISK MODELS

To value and to hedge credit risk in a consistent way, one needs to develop a quantitative model. Existing academic models of credit risk fall into two broad categories[34]: the structural models (option-theoretic approach) and the reduced-form models, also known as the intensity-based models[35]. A third category is that of corporate models which focus on the modelling of the correlation between credit risks in a portfolio context which represent strictly speaking a subgroup of the reduced-form approach. Hence, the development of credit risk models can be categorized as follows[36]:

Structural Credit Models

Structural default models provide a link between the credit quality of a firm and the firm's economic and financial conditions. Following the traditional option price theory by Black/Scholes (1973)[37] as well as Merton (1974)[38], this credit risk category deals with risky debt securities as conditional contingent claims on the company value, dependant on certain exogenous prerequisites, for which a stochastic process is assumed. Thus, defaults are endogenously generated within the model instead of exogenously given as in the reduced-form approach. If the value of the firm[39] falls below the debt value, a default occurs and the creditors receive a precisely specified payment[40]. All option-theoretic approaches tag on the following basic assumptions:

(33) See Das (2000).
(34) See Briys/de Varenne (1997), pp. 239 or Iacona (1995), p. 33; Jarrow/Lando/Turnbull (1995), pp. 1.
(35) See Bielecki/Rutkowski (2002), pp. 26.
(36) See Briys/de Varenne (1997), p. 239 or Iacona (1995), p. 33; Jarrow/Lando/Turnbull (1995), pp. 1.
(37) See Black/Scholes (1973), pp. 637.
(38) See Merton (1973), p. 144.
(39) The amount exposed to a potential default results from the combination of company value and credit amount modelled according to option price theory.
(40) A flaw of the structural approach is that, in order to make valid the standard no-arbitrage argument, it requires an explicit or implicit assumption that the firm's assets represent a tradable security.

- The market is "perfect", i.e. transaction costs and taxes (or tax benefits) are disregarded
- Borrowing and lending can be done at the same rate of interest
- The risk free rate is constant
- Trading takes place continuously in time
- Short sales of all assets are allowed
- All assets can be infinitely divided

Furthermore, the following basic assumptions are fulfilled regarding the valuation of debt capital:

- Value of the firm can be evaluated
- Value of the firm is invariant to its capital structure, no tax as well as bankruptcy costs exist – Modigliani-Miller theorem (M&M)[41]
- Net equity consists only of shares

Classical structural models are among others[42]:

- The Black/Cox (1976) model, which does not only include for the first time first-passage-time models, but also define liabilities of different seniority.[43]
- The Geske's (1977, 1979) model presents a clear solution for coupon bonds with discrete interest payments and a predetermined contract period;
- The Longstaff/Schwartz (1995) approach describes the default process only with a diffusion process.
- The Leland/Toft (1996/1998) valuation models the default threshold as an exogenous factor, in contrast to other first-passage-time models.
- The Zhou (1997) model integrates intensity-based elements into its structural (value-of-the-firm) approach by using a jump-diffusion process[44] for modelling the value of the firm process.

Today, also a stochastic interest rate process correlating with this value of the firm process is applied. Both the value process and the default triggering are the model's primitives. In this context, the concept of Das (1996) is to be mentioned[45]. Longstaff and Schwartz (1995) renounce an insolvency ranking of the creditors and define default as the point in time at which the company value reaches a specified minimum level.[46] Due to the way in which the default time is specified, the models quoted above refer to first-passage-time models[47] and can be distinguished within the first category by the exogenous modelling of the payment in occurrence of a credit event. This first-passage-time technique not only allows valuation of debt instruments with both finite and infinite maturity but it also allows for the default to arrive during the entire life-time of the reference debt instrument or entity.

Reduced-form Credit Models

The reduced-form (intensity-based) approaches that fall under the second category assume a stochastic process for a bond's credit-worthiness instead of the structural approach based on the firm value. While in the first category the process and, thus, the default date can be observed, this is no longer possible in the reduced-form model.

In the simplest version of the intensity-based approach, nothing is assumed about the factors generating the hazard rate. More sophisticated versions additionally include factor processes that possibly impact the dynamics of the credit spreads. Important modelling aspects include the choice of the underlying probability measure (real-world or risk-neutral), the goal of

(41) The M&M theorem is a financial theory stating that the market value of a firm is independent of the way it chooses to finance its investment or distribute dividends; see Merton (1974), p. 460.

(42) Other models are those of Mason and Bhattacharya (1981), Shimiko et al. (1993), Buffet (2000) as well as generalizations of the Black and Cox (1976) model, Kim et al. (1993), Nielsen et al. (1993), Briys and de Varenne (1997), and Cathcart and El-Jahel (1998). For an exhaustive description, see Bielecki/Rutkowski (2002).

(43) For a detailed overview, see Bielecki/Rutkowski (2002), p. 65

(44) Unpredictable jumps are introduced into the dynamics of the firm's value process. As a result, the default time is no longer a predicable stopping time.

(45) See Das (1995), pp. 7.

(46) See Longstaff/Schwartz (1995), pp. 6. That additionally assumes a stochastic process for the default limit.

(47) See further details Amman (1998).

modelling (risk management or valuation of derivatives), and the source of intensities. The specification of intensities is based either on the model's calibration to market data or on the estimation based on historical observations. Therefore, the default time is exogenously specified. In contrast to the structural models, the reduced-form methodology allows for an element of surprise - an appealing feature - and there is no need to specify the priority structure of the firm's liabilities.

Jarrow, Lando and Turnbull (1997/98) approach change in credit worthiness according to credit ratings that follow a Markov[48] process[49]. Further models [50], among others, the models of Das/Tufano (1996), of Jarrow/Turnball (1995), of Duffie/Singelton/ Lando (1998) and of Mandan/Unal (1998) valuate risky bonds as risk free straight bonds that are discounted with a risk adjusted factor[51]. These intensity-based models can be grouped into models that assume independence between the default risk and the interest rate risk and those that do not.[52]

However, the arrangement into these two categories is not very selective because intensity-based models can become structural approaches by using the value of the firm as a variable to determine the default intensity and vice versa. Equally, structural models can be turned into intensity-based models by describing the value of the firm as a steep process[53]. Thus, in both models, the amount of the promised cash flows recovered in case of default, typically specified in terms of the recovery rate at default or, equivalently, in terms of the loss-given-default. The key element to link both models lies in the model's information assumptions. Using a specification of a structural model where investors do not have complete information about the dynamics of the processes which trigger the firm's default, these models derive a cumulative rate of default consistent with a reduced-form model: "It is possible to transform a structural model with a predictable default time into a reduced-form model, with a totally inaccessible default time, by altering the information sets available for modelling purposes."[54]

Corporate Models

None of the models presented so far deals with the valuation of credit risk within a credit portfolio. In practice, however, this is a very important issue. The corporate models help their market participants to increase their awareness in respect to their credit risk positions. They contribute to achieve a more efficient allocation of credit risks in relation to the whole market. Nevertheless, also their empirical validation remains unsatisfying up until today. The risk measurement techniques that have recently gained considerable prominence are as follows:

- The KMV[55] Credit Monitor[56]
- J.P. Morgan's CreditMetrics[57]
- McKinsey's CreditProtfolioView[58]
- The CSFP[59]Credit Risk[+60]

In contrast to structural and reduced-form models, corporate models focus on the modelling of the correlation between credit risks in a portfolio context, which gains ever more importance in the practical implementation at the corporate level, particularly from the view point

[48] A Markov process is a class of stochastic processes or models which define a finite set of states. The essential property of the Markov process is that the future behavior of the process (the progression of the set of states from one state to the next) is independent of past behavior and determinable solely from the current state. Most option pricing models assume that movements in the price of the underlying or, in the case of interest rate options, the zero-coupon curve, are determined by a Markov process.

[49] See Das/Tufano (1995), pp. 161. Das and Tufano build a stochastic recovery and one that is correlated with the interest rate into this model.

[50] It is not possible to quote all relevant references here. Impressive developments of this approach can be found in papers by, among others, Hull and White (1995), Schoenbucher (1996), Monkkonen (1997), Lotz (1998, 1999) and Collin-Dufrense and Solnik (2001). Further credit risks models which anticipate multiple ratings are, among others, Nakazato (1997), Arvanitis et al. (1998), Kijima and Komoribayashi (1998), Thomas et al. (1998) and Wei (2000). For more details, see Bielecki/Rutkowski (2002).

of an efficient risk management. It is worth mentioning that these models - strictly speaking - fall under the category of reduced-form models. In these approaches, credit risks are hedged mainly by reducing concentration/cluster risks, with the result that cluster risks are pointed out. The quality of corporate models depends therefore exclusively on the quality of the input data and the validity of the statistical correlations. The progress achieved by these models lies in the measurement of all risks of a financial institution based on the Value at Risk methodology.

4.2 EMPIRICAL EVIDENCE

Although theoretically the presented models make good sense, they lack empirical research testing their performance. Furthermore "classic" models as well as the majority of the other existing models and their extensions[61] lack a common point of reference for credit risk. Evidently, different approaches to and measures of credit risk make it difficult to compare the models with each other. Risks are only comparable when they are measured with the same yardstick. In the literature, there is only a meagre number of attempts to validate them empirically. Since these attempts fail to generate an unambiguous solution, it seems highly questionable whether one of the presented models is at all suitable to determine the exact risk and thus the premium of a credit derivative. The accuracy of empirical credit risk valuations still lags significantly behind the strong exponential growth of the credit derivatives business of projected 8.2 trillion USD in 2006 according to BBA. The main criterion that is currently being used to assess a model's quality is its capability to describe the spread structure of the market as accurately as possible. If credit risk could be accurately calculated empirically and numerically, the hedging of credit risk would be possible at correct prices. Today, however, the counterparties must reach an agreement on a premium for illiquid credit risks that are mostly not quoted on the stock exchange. They must find ways to overcome problems arising from asymmetric information between financial institutions and market participants[62], between swap and counterparties in particular[63], and agree on the basic principles of credit risk valuation.

The structural models fail to find an accurate credit spread structure for complex credit risk structures because here only the value of the firm determines the default probability and, thus, a sufficient variability of time series cannot be achieved[64]. As a result, in the scenario of a looming insolvency, i.e. the value of the firm approaches the default trigger point, structural models generate only illogical short-term credit spreads. Furthermore, it must be criticized that the value of the firm and its volatility must be determined in these models. This can be particularly problematic for companies that are not quoted on the stock exchange.
The Merton (1974) model - the basic model of the structural models[65] - fails in obtaining the empirical level of credit spreads regarding reasonable parameter values. Above all, this is the case for pure diffusion models[66]. The empirical study of Wie/Guo (1997) shows that there is no clear performance ranking as far as diffusion models are concerned. Notwithstanding this, the Merton (1994) approach achieves better results than the cited, more recent Longstaff/Schwartz (1995)

(51) See Duffie/Singleton (1995). Since the default probability is modelled by mere coincidence, these models will not be described in more detail due to their poor ability to deduce credit risk.
(52) See Lando (1996), p. 375.
(53) Ibid, pp. 369
(54) Guo/Jarrow/Zeng (2005), p. 2.
(55) KMV Corporation was founded by Kealhofer/McQuown/Vasicek; today it is owned by Moodys.
(56) For a more exhaustive description of details, see KMV Corporation, 1996.
(57) For a more exhaustive description of details, see J.P Morgan (1997).
(58) For a more exhaustive description of details, see Wilson (1997a), pp. 111 and Wilson (1997b), pp. 56.
(59) CSFP is an acronym of Credit Suisse Financial Products (ww.csfb.com).
(60) For further details, see CreditRisk+ (1977).
(61) An updated list of extensions and improvements within the literature of structural models is for example provided by Eom/Helwege/Huang (2003), p. 500.

model although the latter model is more realistic and, due to a higher amount of parameters, more flexible than the Merton model. In both models, the credit spread structure starts at zero because both take an expressly restrictive approach when conducting empirical tests due to their continuous modelling of the value of the firm process. If the credit period is infinite, the credit spread structure approaches zero in the Longstaff/Schwartz (1995) approach, whereas in the Merton (1974) model a constant emerges. The N-shape[67] that results from a simple regression with the current spread as the dependent variable and the calculated spreads as the independent variables makes it difficult for both models to adapt to the credit spread structure. Wie/Guo (1997) explain this result by declaring the Merton model the better performing model due to its correlation between default probability and recovery rate. They conclude that the assumption of constant parameters limits the flexibility of the models and that the higher number of parameters as well as the greater complexity of the Longstaff/Schwartz (1995) model cannot offset this deficit. However, their reasoning is not completely convincing because it fails to imitate the N-shape of credit spreads even though studies by Delianedis/Geske[68] (2003) as well as KMV show that traditional models can identify credit events earlier than rating agencies have traditionally changed their ratings.[69]

Hull/Predescue/White (2005) recently extended the Black/Cox (1976) approach further by comparing the model with the widely used Gaussian copula model of survival time and by testing how well the model fitted market data on the prices of collateralized debt obligations (CDO) tranches. Their empirical research shows that default correlations are positively dependent on default rates and that recovery rates are negatively dependent on default rates; this is also supported by a growing body of empirical evidence[70]. Hull/Predescue/White (2005) argue further that research quantifying the relationship between asset correlations[71] and default rates could lead to better pricing models[72]. An extension of the basic structural models to incorporate this phenomenon produce a marginally better fit to market prices. Although statistically significant, this is not proven to be economically significant.

Also the character of the credit risk does not paint a brighter picture for structural models. In diffusion models, the credit defaults are more or less ex ante fixed, i.e. they do not come as a surprise - in contrast to interest rate structure models, in which the default is modeled as a sudden unexpected event. Also more recent models, such as the Zhou model (1997/2001) fail to find a solution for the insufficient variability of time series[73].

The literature offers two ways for solving the predictability effects of structural models[74]:

1. The predictability of defaults springs from the assumption of investors' perfect knowledge of the default trigger point and the firm's asset value. In practice, neither the value of the firm V and its volatility σ nor the level of the default threshold can be deduced from the capital structure of the firm. Considering that in reality information about the value of the firm process and the default thres-

(62) As a result, credit spreads are influenced strongly by agency costs. Leland (1998) shows that given a linear increase in the volatility of the value of the firm, the credit spread will increase exponentially due to the high risk that accompanies it.

(63) See chart 8, p. 25.

(64) See Elizalde (2005a), pp. 3

(65) The basic structural model assumes that asset correlations are constant. Empirical evidence however suggests that asset correlations are positively related to default rates, see Hull/Predescue/White (2005), p. 15.

(66) See also Alfonsi/Brigo (2003) or Cooper/Martin (1996).

(67) Wie/Guo (1997) calculate in their model that the average spread for a week amounts to 45 bps, for a month to 46 bps, for three months to 32 bps, and for six months to 33 bps, which represents an N-shape.

(68) The conclusion of the Delianedis/Geske (2003) study increases the weight of option price models in relation to other valuation methods. Compare also Titman/Torus (1989).

(69) Today, this is no longer correct since ratings are adapted almost on a daily basis.

hold (or both) is incomplete, investors can simply infer a distribution function for these processes, thus making it impossible to predict defaults.[75]

2. By incorporating jumps in the dynamics of the value of the firm, which implies that the asset value of the firm can suddenly drop, the distance to default (DD) between default trigger point and asset value can strongly be reduced, or it can even cause a default if the drop is sufficiently high. Therefore, default events become unpredictable, the default probabilities for short maturities do not approach zero and, ultimately, credit spreads can be generated.

Davydenko (2005) criticizes existing structural models because they obviate liquidity reasons as the core determinants of default for firms. He concludes that "models incorporating both value- and liquidity-based defaults are rare, and little empirical evidence is available to motivate the choice of the default trigger. If, in reality, default is triggered by different factors for different firms, existing models are likely to lack accuracy in predictions[76]."

Reduced-form models, particularly more recent ones[77], are seen as more capable to achieve accurate credit spreads and determine a relatively fair price for credit risks. Jarrow et al. (1997) eliminate the lack of a constant interest rate even though his model still implicitly assumes that the credit spreads within one rating category do not fluctuate. Das/Dufano (1996) remedy this problem by introducing stochastic recovery rates so that a relationship between credit spreads and short rates can be drawn – an essential criterion for the valuation of credit risks whose payments depend explicitly on rating agencies. Lando (1998) succeeds in producing stochastic credit spreads also in fixed ratings and in having short rate and credit spreads correlate with each other. This is achieved by implementing a stochastic intensity rate that depends on a common macroeconomic parameter with the short rate process. Neither Lando (1998) nor Das/Tufano (1996) are truly successful in generating sufficient variability of time series must be validated empirically. Empirical analyses, however, tend to identify a significant negative correlation between credit spreads and the short rate[78]. But neither is it empirically proven that a negative correlation exists nor is it clear whether this correlation at all influences the valuation of credit risks.

Corporate models are conceived with view of the availability of input data. Their quality depends exclusively on the quality of the input data and the validity of the statistical correlations. The progress that these models offer lies in the measurement of all risks of a financial institution on the basis of the value-at-risk (VaR) methodology. However, these models are criticized for not having sufficient theoretical backup and for not guaranteeing freedom from the lack of arbitrage[79]. The KVM model may enjoy increased forecast accuracy for credit risks, but this is not guaranteed because it cannot be accessed by the public. The same holds for CreditView. Undeniably, CreditMetrics and CreditRisk attract the same general points of criticism as company ratings, even so CreditRisk's performance can hardly be judged - but because it is based on a continuous default risk it is certainly more flexible. Corporate models put their focus on the inclusion of

[70] See among others Delianedis/Geske (2003), Hull/Predescue/White (2005) or Elizalde (2005b).

[71] Asset correlations refer to the correlation between debt obligations (reference entities), see chart 2 p. 11.

[72] See Hull/Predescue/White (2005), p. 17

[73] Zhou (1997b) also indicates that "the empirical application of a diffusion approach has yielded very disappointing results." p. 1.

[74] See Elizalde (2005b), p. 12.

(75) See among others Duffie/Lando (2001), Giesecke (2005) or Jarrow/Protter (2004).

[76] Davydenko (2005), p. 2.

[77] The constant intensity parameters as well as the recovery rate parameters are still too restrictive in the Jarrow/Turnball (1995) model to contrast in a significant manner to structural models.

[78] See Hüttemann (1997), p. 91. However, it is also mentioned that this negative mentioned correlation is highly improbable from a theoretical point of view.

[79] See also Cossin (1997).

concentration risks based on statistical default data that make up an essential part of the risk in a credit portfolio[80]. Nevertheless, it must be concluded that it is extremely difficult to make statements on credit default behavior that is statistically valid because credit defaults happen only rarely.

In conclusion, it can be stated that the models for credit risk valuation have only been developed theoretically and their future success in credit risk modelling lies in their empirical applicability and their ability to replicate and predict credit spreads and default probabilities. Doubtlessly, greater transparency of credit risk is the key to effective management.

5. CONCLUSION

The hedging of credit risk in M&A transactions gains a new perspective with credit derivatives - negotiable bilateral contracts that allow financial institutions to manage their credit exposure. The traditional approach in derivatives has been to consider credit as a non-traded risk that can only be managed with credit limits and collateral. Credit derivatives can offer both the protection buyer and seller of risk considerable advantages over traditional alternatives and, both as an asset class and a risk management tool, represent an important innovation for global financial markets with the potential to revolutionize the way that credit risk is originated, distributed, measured, and managed .

Financial institutions use credit derivatives to hedge their credit risk, i.e. the distribution of financial losses due to unexpected changes in the credit quality of a counterparty in a financial agreement, aiming to protect themselves against defaults and downgrades. As a result, the P&L of the hedged position will not change at default time and the financial institution is protected against the possible decrease in the risky investment of an M&A deal, if the credit spread of its counterparty widens. Moreover, credit spread swaps isolate the spread component. This is of direct interest to protection seekers. It also provides flexibility to manage portfolios because transferring credit risk helps in developing funding strategies as well as new M&A transaction possibilities. Protection against rating downgrades provides the possibility to control or get rid off exposures contingent on ratings as well as cluster risks. Without this protection, it might be impossible to hold assets subject to a minimum target rating constraint. Credit derivatives guarantee that the minimum target rating holds through the horizon of the reference assets and thus hedge the credit risk exposure which financial institutions face particularly in the M&A business[81]. This shows clearly how credit derivatives help to minimize the credit risk in M&A transactions and protect against a downgrade of financial institutions or, in the worst case, their bankruptcy. Also the systemic stability within the banking system can only be secured if credit risk is limited[82].

Despite their immense importance in the funding of M&A transactions, credit derivatives still suffer from one core problem: the empirical lack of proper risk valuation methods. As long as there is compliance in the counterparty swap, the problem is solved, but low financial transparency coupled with the existence of information asymmetries between risk seller and buyer

[80] In this context the Modigliani/Miller (1958) capital structure theory is worth mentioning, especially among others the assumption that firms must be in a homogeneous business risk class. If the firms have varying degrees of risk, the market will value the firms at different rates. The earnings of the firms will be capitalized at different costs of capital.

[81] See also Bessis, J. (2002), p. 130.

[82] See Dermine, J. (1999), p. 3.

creates the potential for unanticipated, incorrectly priced and poorly managed concentrations of risk. Moreover, credit derivatives may promote new forms of moral hazard within the banking system as the linkage between origination and management of credit risk becomes more attenuated[83].

The diversity of credit risk valuation models shows that a market standard must still be accomplished. A greater number of empirical researches are necessary to gather the data required to develop robust credit models. However, empirical studies prove to be extremely difficult because credit risk data particularly for credit risks that are not quoted on the stock exchange is not easily available. As a consequence, in M&A transactions over one billion dollars, credit derivatives do not play the role that they could compared to the overall credit derivatives business[84].

Hence one solution would be to quote ever more credit risks on the stock exchange and to obtain the necessary credit risk information from independent rating agencies. Another approach would be to find valuations for illiquid credit risks that are not quoted on the stock exchange to which all market participants can agree, i.e. they compromise on basic principles of credit risk evaluation. Without a doubt, the development of accurate and robust credit risk valuation methods would represent a major break-through for the use of credit derivatives in leveraged M&A transactions.

On balance, credit derivatives have generated a positive development in reducing credit risk in M&A transactions and also for the global financial system in total, facilitating enhanced risk transfer and dispersion. The exponential growth (chart 1) in the credit derivatives market has significantly increased liquidity in the secondary credit market and allowed the efficient transfer of risk to other sectors that lack direct origination capabilities. The benefits of the market are clearly illustrated by the experience of the global banking industry, which, despite record defaults of nearly USD 250 billion since 2000, continues to enjoy more robust asset quality due to credit derivatives than during the recession of the early 1990s[85]. As empirical research has shown, the risk reduction potential of transactions is one of the crucial variables in explaining M&A success from the viewpoint of a financial institution[86]. Further advances will undeniably boost the importance of credit derivatives and its potential in reducing credit risk in M&A transactions.

In the M&A business, an improved standardisation within the derivatives market due to the introduction of robust credit risk valuation methods would further increase market transparency and turn credit derivatives into the cheapest (decrease in the bid-offer spread), quickest, most efficient, flexible and convenient risk management instruments that financial institutions have at hand to protect themselves against credit risks.

(83) Worth mentioning in this context is also that the improper use of credit derivatives can generate new risks, among others liquidity, counterparty, transaction or operational risks, see Brosnan,/ Barton (1996), pp. 5.

(84) See Bernadette/Minton/Williamson (2005), p. 20.

(85) See Fitch (2003), p.14.

(86) See Beitel/Schiereck/Wahrenburg (2004), p. 4. See also Houston/James/Ryngaert (2001).

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BANKING SECURITY: PREPARED FOR BIOMETRICS?

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1. NEW SECURITY THREATS TO BANKING

Trust is the basis of the banking sector's success. Most financial transactions require the customer to empower third parties like banks to handle, administrate and supervise their financial property. Therefore, banks have been an attractive target to fraudsters since the beginning of modern financial management in the Renaissance. Traditionally, the characteristic of these attacks has been the use of physical violence to gain control over the customers' values.

The success of eCommerce and electronic banking has raised new security issues that were not known in traditional banking business. The virtual nature of transactions and the increasing automatization of financial processes have generated so-called virtual crime. For the last years we have seen a growing number of phishing, card fraud other identity theft incidents. Like all new developments, the new telecommunication media used for virtual transactions do also imply the potential for fraudulent use, and must be secured against fraud.

According to the United States Federal Trade Commission, identity theft and the misuse of the data was the issue of 40% of all frauds reported in the United States from 2002 to 2004. 46% of these cases were related to bank accounts, credit cards and other financial transfers [1]. The yearly amount of loss due to credit card fraud reaches USD 4 billion [2].

On the one hand, financial institutions seek after methods and technologies to enhance virtual transaction security. On the other hand, innovative technologies also provide the measures to enhance physical security in the banking sector.

The implementation of biometric technologies in banking processes has been discussed for years but in practice, only few installations have been successfully introduced. In the present article, an introduction to biometric technologies is provided. Potential application fields and selected examples of biometrics in banking security will be described, and the success perspectives will be discussed.

2. INTRODUCTION TO BIOMETRICS

The term biometrics derives from the Greek words "bios" (life) and "metron" (measure). In a broader sense, biometrics can be defined as the measurement of body characteristics or biological statistics [3]. With this non-technological meaning this term has been used in medicine, biology, agriculture and pharmacy. Criminal prosecution, identity management and police records have used biometric data like facial pictures, body height and finger prints for a long time [4]. However, the rise of new technologies to measure and evaluate physical or behavioral characteristics of living organisms automatically has given the word biometrics a second meaning. Research on computer-based, automated recognition started in the 1960s, and the first commercial use, a fingerprint application at a bank, took place in 1968 [5]. In the present article, the term "biometric technologies" refers to automated methods of recognizing a person based on physiological or behavioral characteristics [6].

Traditional authentication methods are based on knowledge, e.g. a PIN or a password, or possession, e.g. a key or a smart card. Any person knowing the secret or possessing the key can use an identity. A system that is based on knowledge or possession is not able to verify if a user is actually the person he/she claims to be. Therefore, traditional PIN and password solutions are not sufficient for identification purposes [7].

Biometric methods are based on physiological or behavioural characteristics. Since they take advantage of mostly unchangeable characteristics, they are more reliable than traditional methods of authorization. Automated systems based on biometrics to recognize persons enable fast, user-friendly and highly secure identification and verification processes. The most-used biometric data are individual physiological characteristics such as the fingerprint, the facial image and the iris image. In comparison to these physiological characteristics, the signature and the voice do also include behavioural aspects [8].

3. WHY BIOMETRICS ARE A TOPIC OF ECONOMIC INTEREST

At least since 11 September 2001, the international community supports the development and implementation of biometric technologies. The strategic environment is influenced by political actors like the United States of America, the European Union, and Japan. Triggered by security concerns and international terrorism, public interest in these technologies has increased constantly over the last years. The needs to improve border protection, issue more secure identification documents and enhance security at public places have strengthened the development and market penetration of biometric products. Biometric technologies are of particular business interest because they are widely applicable, connected to political and security-related interests and have a strong interdependency with other security technologies. Forecasting the international and national biometric markets is difficult considering the high diversity of analysis results in international studies. Market studies forecast strong world market growth at an annual rate of 30 to 60% [9].

Biometric technologies are hardly applicable without an appropriate surrounding infrastructure. Although biometric technologies may be demonstrated in stand alone solutions, they are usually part of larger systems and combined with other technologies that are necessary to exploit the advantages of biometrics. For example, storage and processing mediums such as servers and smart cards are required to store the biometric data, as well as appropriate front end, middleware and back end structures. Radio Frequency Identification (RFID) is another key technology that supports the growth of the biometric markets because it enables the contactless communication of storage medium and reading device. The pure biometric recognition itself has no immediate value.

4. BIOMETRICS IN BANKING

The usage of biometric technologies in the banking sector has been discussed for years because the potential application fields seem to be very promising.

Since the first installation in 1968, banks have evaluated biometric technologies for their security purposes. According to the International Biometric Group, the revenue generated with biometrics in the financial service industry will reach USD 405.5 million in 2008. A large portion of this revenue will be generated in the banking sector. Growth is primarily supported by the various authentication requirements in existing applications for bank employees and customers.

However, until today the implementation of biometric technologies in the banking sector has not been successful on a large scale. Most applications focus on employee authentication, e.g. access control to security areas, vaults, etc. The few existing customer applications focus on access to safe deposit boxes and other stand alone approaches. Whereas in the public sector, biometric identification solutions have become state of the art, complex biometric intra-bank identification systems for different purposes have hardly been installed, and larger systems involving a group of banks are even more difficult to realize than proprietary banking security solutions.

We can identify several reasons for this: First, the banking sector is not very open to new technologies because bank fear to scare conservative customers. Second, banking systems are highly complex and require intense standardization. The more banks are involved and the more customer-centered the desired approach, the higher standardization and integration efforts will be. Consequently, customer-oriented solutions are still in the early stage of development and evaluation [10]. Third, the number of system users in closed, proprietary systems is relatively low, and the users change not very often, which eases system administration and maintenance. Biometric trials in banking security were characterized by:

- Focus on access control
- Focus on employees
- Proprietary solutions
- Small and stable user groups
- High unit costs

The further market development is hindered by some barriers. Although standardization issues are under discussion, it turns out to be a difficult task to agree on worldwide technological standards for biometrics in banking. Implementing a biometric solution, banks and security providers still take the risk to invest in a “wrong” technological approach or solution. International biometric standardization has made large improvements during the last years. Biometric standardization initiatives have started to create standards to implement biometrics in the financial services industry [11]. The increasing number of phishing and identity frauds puts pressure on banks to implement transaction authorization processes that are more secure than the traditional PIN card methods, and we will see a growing number of trials in the next years. Concerning technology, the most biometric technologies are suitable for certain banking applications, and there will not be a single technology dominating the market. Recent surveys show that customers are willing to use biometrics in banking. According to a survey among UK banking customers, one third of banking customers would use biometrics to improve transaction security [12].

It is suggested to differentiate the application fields of biometrics by internal banking applications and customer-oriented applications.

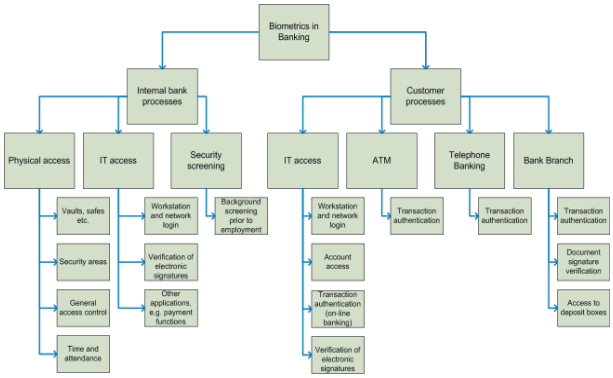

Fig. 1: Potential application fields of biometrics in banking

5. INTERNAL BANK PROCESSES

Physical access

Considering internal bank processes, physical access control for employees used to be the first application field of biometrics, and it is still the most important today. The extent and characteristics of employee access control may vary from access to high security areas and vaults to general access control in the branch. Time and attendance control may be combined with access control.

There are different possibilities for data storage and processing. If the biometric reference data is stored and processed decentrally in the reading device, the user does not need an additional storage medium. During verification the user gives the biometric feature to the reading device, which matches the captured data with the stored reference data. This solution is the most simple because it does not require high integration effort.

Since reading devices may be stolen and biometric data may be compromised, many approaches focus on data storage at additional security mediums that are under the user's control, e.g. smart cards. The user applies the card to the reading device; the live data is captured and compared to the reference data stored on the card. Thus, the biometric data cannot be stolen from the reading device. The data on the card is secured with cryptographic methods. Contactless smart cards (RFID) are the most preferred solution for access control today [13]. Another possibility is to store the reference data in a database. Data storage on secure storage mediums should be preferred considering the data protection perspective. Fingerprint, iris recognition and face recognition are likely to be the most used technologies in employee access control.

In practice only few banks such as Volksbank Reutlingen have implemented biometric access control. The solution in Reutlingen was established in 2005 and is based on fingerprint recognition. It includes access to security areas but not general access control. The biometric reference data is stored decentrally in the reading devices at the entrance to the security areas, which results in the disadvantages described above [14].

Today's trials mostly represent proprietary solutions in single bank branches. Large scale access control solutions for banks with numerous subsidiaries and thousands of employees will raise more complex and cost-intensive system development and integration issues. A higher level of interoperability is required because at different locations the system may have to interoperate with different processes, interfaces and routines. It is expected that biometric access control solutions become more attractive to banks if the market prices and unit costs of cards and readers drop further due to economies of scale and learning curve effects.

IT access

The second application field of biometrics in internal bank processes is IT access control. Access to workstations and networks such as desktops, notebooks and company networks may be secured with biometric technology. For example, Citibank evaluates fingerprint verification for employee PC log-in [15]. Access control may also be performed on the application level, e.g. if employees work with sensitive data and programs.
Biometric technologies may also be used to verify electronic signatures. According to German law, the qualified electronic signature is equivalent to a written signature (SigG § 6). Today the user of an electronic signature verifies him/herself against a signature card with a PIN. This verification process is based on possession of the card and knowledge of the secret PIN. A biometric verification could close the gap between the holder and the signature card.

Additonal benefits may be provided by interfaces to other applications such as payment functions, e.g. at company stores, canteens etc. If employees use their employee ID card for payments, the money value is usually stored on the card and could be secured with biometric methods.

Biometric IT access is still in an early implementation stage at banks. We will see an increasing number of implementations in future with the goal to strengthen the protection of sensitive data. Loss, exchange or theft of passwords will no longer be possible, and the number of support cases will diminish. Administrators can always verify who is logged in the system. When used in cashless payment, biometric solutions will create more trust and support the introduction of cashless transactions.

However, the costs of biometric data management may be higher than access management based on password and PIN management. Banks should consider whether the additional security is worth extra costs or wait until the market prices fall further.
The most promising technologies for these applications will be fingerprint and signature recognition because the sensors can easily be integrated into the IT equipment and the technologies do work under difficult sourrounding conditions.

Security screening

In the United States most employees in financial services must undergo a background check prior to employment. A fingerprint is taken on ink basis and

matched against official AFIS or other databases where ink-based fingerprint pictures of criminals or wanted people are stored [16]. This process can be conducted faster, cleaner, more reliable and more convenient with modern electronic fingerprint recognition technology. The quality of digitally enroled fingerprints is better compared to scans of ink-based fingerprints.

6. BIOMETRICS IN CUSTOMER APPLICATIONS

Use cases involving the customer are more complex and more difficult to realize in comparison with internal bank processes because:

- The user community is not concentrated at a certain location like bank employees
- Additional hard and software is necessary to perform biometric verification
- Applications need to comply with various IT infrastructures, customization may be required
- Users are not willing to spend a significant amount of money for biometric solutions

Due to these reasons, the use of biometrics by banking customers lags behind biometric solutions in internal bank processes. Nevertheless, some application fields seem to be very promising:

IT access

Workstation and network login applications for customers are only partly comparable to the IT access in banks. The introduction of centralized biometric solutions using data bases and smart cards for login is too complex compared to the benefits. Customer IT access should be reasonable to choose decentralized verification solutions. For example, a computer or laptop may have an integrated fingerprint reader or a comparable external device, e.g. at the USB hub or included in the mouse. Fingerprint and signature recognition are most suited for this approach because the sensors may easily be integrated in the computer or workstation and work under the most conditions.

More effort should be spent for Account access and transaction authorization. Online banking is among the most important eBusiness applications, and it is the most attractive fraud target. Therefore, online banking should be secured appropriately. Many banking customers have experienced fraud attacks to PIN-TAN online banking, e.g. phishing and other identity theft. To increase the security of online banking, access to accounts and transaction authorization could be bound to biometric verification. An appropriate solution requires a secure storage medium for the reference data, e.g. a smart card, and a device that is able to read and process the data and perform secure communication. The most promising technologies are fingerprint and signature recognition.

Like in internal bank processes, biometrics could also be used for verification of electronic signatures.

The integration of biometric IT access control into customer processes is a challenging task for the industry. The technological diversity of hard and software at the customers' side requires solutions that are scalable and adjustable but also highly standardized. A

significant barrier is the need for additional hard and software at the customer's workstation, e.g. smart card readers and biometric sensors. It cannot be assumed that customers are willing to take the costs. Banks will also have to invest in a new service and maintenance structure to support the customers new hard and software.

The costs of biometric solutions for homebanking are still too high compared with the actual additional value. This inproportion will change the higher the damage due to fraudulent attacks in the banking business is, and the lower the equipment costs in future will be. It is also likely that future end devices will have integrated sensors and readers.

Another difficult issue is inconvenience. Debit and credit cards are not likely to be used to store the biometric reference data of the banking customer because banks do not wish to enable the user to read banking cards with home devices. Customers will have to use an additional signature card including biometrics, or even two additional cards if the biometric data cannot be stored on the signature card.

As soon as these issues have been solved, biometric technologies will provide convenient and secure verification solutions for large and widespread user populations. Banks should have high interest in supporting their customers with secure banking solutions to re-establish trust in online transactions.

ATM

Authorization of transactions at Automated Teller Machines used to be one of the first application fields of biometrics in banking discussed by a broad professional community. The idea was to store the biometric data on a debit or credit card [17]. Biometrics may also be used to authenticate customers at other self-service stations like kiosks and deposit boxes.

From 1999 to 2002, the TeleTrusT association accomplished the BioTrust project which was concerned with the evaluation of biometric technologies in the banking sector. The results demonstrated that biometric solutions at ATMs are complicated by the high organizational and technical effort to integrate biometrics in the existing ATM infrastructure [18]. The technological possibilities could not meet the expectations, and the costs for a complex biometric ATM transaction solution are still too high to be considered a practicable alternative to tradition PIN solutions.

For customer convenience, banks must agree on standards to guarantee that customers can use one card for verification at ATMS of different banks. The most intensive efforts to standardize and implement biometrics in banking have been made in Japan. The Japanese Bankers Association and major Japanese banks work on the establishment of standards for biometrics in banking to enable banking customers to use ATMs of different banks with only one card, using the same biometric authentication method [19]. Several tests and trials have been conducted in Japan. For example, the Bank of Kyoto, the Juroku Bank and Japan

Post have equipped 2.000 ATMs with fingerprint recognition. Other banks like the Bank of Tokyo-Mitsubishi evaluate vein recognition for authentication [20]. Vein recognition uses the human vein patterns at the palm or back of hand to verify the identity of a person.

The results of the BioTrusT study show that the use of biometrics in ATMs will not be profitable in the mid-term future. Prior to implementation in the field, more trials have to be conducted [21]. There are several barriers that prevent the use of biometrics for customer self service banking. ATMs are integrated in bank networks that are highly complex and linked to other banks' networks. Integration to these networks requires high standardization and interoperability, which is typical for a mature technology. Moreover, integration requires investments in hard and software and causes costs for integration, biometric enrolment, user and administrator training, equipment of existing terminals etc. Eventually, costs may be higher than the benefits.

Depending on the damage by fraudulent attacks and the market prices for biometric solutions, the calculation may change in future. The integration of contact chips to debit and credit cards and the EMV standards will further accelerate the use of ID technologies in banking.

Telephone banking

The use of voice recognition technology for automated customer verification in telephone banking is supported by the success of the call center business and the need to automatize banking processes to cut costs. In comparison to automated PIN-TAN verification, voice recognition has the potential to make telephone banking more secure. Another iadvantage is that banks do not have to handle calls from customers that have lost or forgotten their PIN or password anymore.

One barrier to the quick success of biometric telephone banking is system training. Since the system needs to train to the customer's voice, the user has to enrol at the bank to prove his/ her identity. According to the International Biometric Group, voice recognition technologies will be implemented for account access in automated telephone banking or call centers. The decisions of the large credit card institutes will strongly influence the further development of biometrics in the financial sector by setting standards [23]. It is expected that biometric telephone banking has a successful future.

Bank branch

Biometric customer applications in bank branches focus on transaction authentication. Transactions in the bank branch can be authorized by the customer with a biometric characteristic [24]. Fingerprint, face and signature recognition seem to be most practical for this application field. Another area of interest is document signature verification. A large percentage of identity fraud in banking is caused by falsified signatures on cheques, remittance slips etc. Signature pads can be used to capture and verify the signature directly in the branch. If the document has been signed manually, signature recognition technology may compare the written signature to stored reference data of the hol-

der. Access to safe deposit boxes and safes is one of the most popular customer-focused applications of biometrics in banking.

Customer-focused biometric applications in bank branches are easier to implement than ATM or home-banking applications because the customers come to the point of installation. This minimizes the necessary investments in hard and software as well as the integration efforts. Access to deposit boxes has been the first biometric application in banking, and it is likely to play an important role in the market in future. Considering signature recognition at teller transaction, there is a large intersection with existing technologies such as signature scanning and verification at checks, which may create cost synergies and also diminish inhibitions by bank responsibles to introduce the new technology.

7. THE FUTURE OF BIOMETRICS IN BANKING

We have seen that the perspectives of biometrics in banking are promising and biometric technologies will find their way to standard bank processes. Employee and customer-oriented applications will both play a role but due to their complexity, many customer-focused applications will be implemented later than applications in internal banking processes. The implementation of customer-focused applications is still hindered by certain barriers such as costs and logistics efforts.

In general there has been a clear tendency to more complex and integrated solutions for the last years. Most of the commonly used biometric characteristics are suited for usage in banking. There is no single technology, solution or product that serves all requirements in banking security. The reasonable choice of technologies and solutions depends on the area of use, and on the targets the user pursues.

Although banks are conservative and risk averse in their approach to new technologies, the increasing standardization, growing experiences with biometrics in other application fields like electronic ID documents, and the growing damage caused by ID theft and other fraud will facilitate the widespread use of biometrics in banking.

It will be the security industry's task to develop and implement countermeasures to protect eBusiness and maintain the banking customer's trust. Biometric technologies may be the enabler to prevent identity fraud in banking in future.

(1) EMV (Europay, MasterCard, Visa) is a standard for chip-based payment with debit and credit cards which was developed to improve security in card payment, compared to the existing magnet stripe standards [22].

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FORECASTING OF CURRENCY EXCHANGE RATES USING ARTIFICIAL NEURAL NETWORKS

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1. INTRODUCTION

Since the breakdown of the Bretton Woods System of fixed exchange rates in 1971-1973 and the implementation of the floating exchange rate system, researchers have been motivated to predict the movements of currency exchange rates[1]. In today's global economy, forecasting the exchange rates is a crucial aspect for managers of multinational companies, borrowers, fund managers, corporate treasurers and specialised traders. The current daily trading volume on the global money market is estimated to reach up to 1,5 trilion of USD[2]. Though this huge volume market and the profit opportunities sourcing from trading or speculating on such a big market, the prediction of exchange rates is one of the most difficult tasks in forecasting nowadays. The exchange rates are inherently noisy, non-stationary and chaotic . These characteristics suggest that there is no complete information that could be obtained from the past activities on the market to fully recognise the dependency between past and future exchange rates.

The factors affecting exchange rates consist of:

- economic factors- such as interest rates, inflation, GDP growth;
- political factors- such as war, political crisis, disturbances etc.;
- psychological factors – e.g. expectations which may lead to speculative trading.

The interaction between the above factors is complex, making forecasting of exchange rates very difficult. That is why, very often researchers instead of predicting the exact future spot exchange rate between two currencies, try to estimate the downward or upward trend of future exchange rates. In other words, the focus of the forecast is on the dynamics of appreciation or depreciation of the currency.

The Author in this article will compare both forecasting approaches on the example of exchange rates between American dollar and Polish zloty during the period of beginning 1997 to the end of the second quarter of the year 2005. According to a survey made by Perz P. and Znamirowski P. from Warszawska Grupa Inwestycyjna S.A., 70% of 500 Polish big companies are influenced by the movement of exchange rates[4]. The main interest of the author of this article is to create the effective exchange rate prediction models and to use them in the field of forecasting the business bankruptcy risk[5].

2. FACTORS AFFECTING THE EXCHANGE RATES

An exchange rate measures the value of one currency in units of another currency. To forecast the exchange rate changes in the future it is necessary to consider factors which influence it. In the literature following factors are listed[6]:

Relative inflation rates

Changes in relative inflation rates can affect international trade, which influences the demand and supply of currencies and therefore affects exchange

(1) More about Bretton Woods System and other types of exchange rate systems: Madura J.: International Financial Management, 5th edition, South Western College Publishing, Ohio 1998, p. 175-197.

(2) Dunis Ch., Williams M.: Modelling and trading the EUR/USD exchange rate-do neural networks perform better? Liverpool Business School papers, February 2002, p. 2.

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(4) More about this research: Perz P., Znamirowski P.: Zarzadzanie ryzykiem kursowym w przedsiebiorstwie, Rynek Terminowy, nr 22, 2003, p. 35-43.

(5) More about bankruptcy models: Korol T., Prusak B.: Upadłosc przedsiebiorstw a wykorzystanie sztucznej inteligencji, CeDeWu, Warszawa 2005.

(6) Madura J.:op. cit., p. 105-139; and Ossowski J.: Analiza czynnikowa kursu dolara na polskim rynku walutowym – ujecie kwartalne, Prace Naukowe Katedry Ekonomii i Zarzadzania

rates. A higher inflation rate in Poland than in the US will cause the increase of the import of cheaper American products to Poland (ceteris pari-bus[7]). This will result in higher demand for USD. At the same time a higher relative inflation rate in Poland will lead to the reduction of supply of USD as the export of Polish products will decrease in such ircumstances. The higher demand and smaller supply of USD will lead to the appreciation of USD against PLN. The opposite situation (higher relative inflation rate in the US) should lead to the depreciation of USD against PLN as the demand for USD should reduce due to higher prices of American products, and at the same time the supply of USD should explode.

Relative interest rates

Changes in relative interest rates affect invest-ment in securities, which influences the demand and supply of currencies. Higher relative interest rates in Poland will lead to higher supply of USD in exchange for PLN, as investments in securities in Poland will be more profitable for investors (ce-teris paribus). On the other side the demand for USD should reduce due to less profitable securities in the US. The increase of supply of USD and the decrease of demand for USD will cause depreciation of USD against PLN. Higher relative interest rates in the US will lead to appreciation of USD against PLN, because US investors will reduce their activities in Poland, so the supply of USD will decrease. At the same time, the demand for USD will increase because of higher level of interest in having USD.

Gross Domestic Product

The country characterising with high growth of GDP should attract foreign investors, who will want to use the profit opportunities in such economy. So, a booming economy in Poland would lead to higher supply of USD in exchange for PLN (ceteris paribus). This would lead to depreciation of USD.

Export

As export is one of the elements of GDP the as-sumption will be connected to the above one. Aditionaly, increasing Polish export means that the amount of USD to be exchanged for PLN is increasing, so USD will depreciate (ceteris paribus).

Import

Increasing Polish import as the opposite to the increasing export will lead to appreciation of the USD due to higher demand for USD (ceteris paribus).

Income level

Higher GDP accompanies high income level. But high income societies tends to increase the de-mand for imported goods. In this assumption, the growth of income level in Poland will lead to ap-preciation of USD against PLN (ceteris paribus) due to higher demand for USD.

Przedsiebiorstwem, tom II, 2003, Politechnika Gdanska, p. 25-42.

(7) In reality the actual demand and supply of currency depends on several factors simultaneously. The point of holding all other factors constant is to logically present the mechanics how each individual factor influences the exchange rates. Each factor assessed one at a time will allow to describe separate influence of each factor on exchange rates. Then, all factors can be tied together to the forecasting model.

Government controls

The governments may influence the exchange rate in many ways, including: the imposition of foreing exchange barriers, the imposition of foreign trade barriers, intervening (buying or selling currencies) in the foreign exchange markets, affecting macro variables such as inflation, interest rates and income levels.

Expectations

Exchange rates react to any news that may have a future effect. Financial flow transactions are very responsive to news, since the decisions to hold securities denominated in a particular currency are often dependent on anticipated changes in curren-cy values. If particular news affects anticipated currency movements, it will affect the demand for currencies and the supply of currencies for sale. Because of such speculative transactions, exchange rates can be very volatile.

3. THE RESEARCH ASSUMPTIONS

The method of forecasting

In this research work the author has chosen the artificial neural network (ANN) method to predict the exchange rates. In literature ANN is considered as very effective method of forecasting. ANN is more effective than traditional methods in describing the dynamics of non-stationary time series data due to its unique non-parametric, noise-tolerant and adaptive properties[8].

The most commonly used neural network architecture is the multilayer feedforward network. It consists of an input layer, an output layer and one or more intermediate layer-hidden layer.

The input layer is a layer where neural network receives its data. The number of nodes-neurons in this layer depends on the number of inputs to a model and each input requires one neuron.

The hidden layer lies between the input and output layers. There can be many hidden layers. They are analogous to the brain's interneurons, a place where the hidden correlations of the input and output data are captured. This allows the network to learn, adjust, and generalize from the previously learned facts to the new input. Unlike any other classical statistical methodology, this gives the system intuitive predictability and intelligence[9].

During training the network responds to new input by producing an output that represents a forecast. The network collects the in-sample output values in the output layer.

The entry dataset and the research approaches

The Author has conducted many research approaches, creating over 50 different exchange rate prediction models[10]. In this article only two of the most interesting approaches will be presented, resulting with three different ANN models.

[8] Kamruzzaman J., Sarker R.: ANN based forecasting of foreign currency exchange rates, Neural Information Processing- Letters and Reviews, vol. 3, no. 2, 2004, p. 50; and Gradojevic N., Yang J.: The application of artificial neural networks to exchange rate forecasting-the role of market microstructure variables, Bank of Canada, Working Papers, no. 23, 2000, p. 2-6.

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[10] These approaches differed by type of entry data (dynamics of economical value, relative value, nominal value etc.), by the type of ANN model – multilayer feedforward models, recurrent models, generalized feedforward models, and by the number of hidden and output nodes in the model.

In both presented approaches the entry dataset were the following economical values:

- X1 - Polish export
- X2 - Polish import
- X3 - the balance of Polish trade
- X4 - the change of export
- X5 - the change of import
- X6 - GDP of Poland
- X7 - inflation rate in the US
- X8 - inflation rate in Poland
- X9 - interest rate in the US
- X10 - interest rate in Poland
- X11 - nominal income level in Poland
- X12 - dynamics of real income level in Poland
- X13 - the spot rate of EUR/USD (1 USD = number of units of EURO)
- X14 - the dynamics of the change of exchange rate EUR/USD

The above data was given as a quarterly value. There were 14 entry neurons representing the above factors in the entry layer of each model.

In the first approach there were two models: "A" and "B". In both models there was one output neuron. In model "A" output neuron was representing the forecast of future exchange rate of PLN/USD (100 USD = number of units of PLN). In model "B" the output neuron was representing the forecast of future trend of exchange rate changes (dynamics of exchange rate changes in relation to quarter before).

In the second approach there was one model "C" with two output neurons:

— future exchange rate of PLN/USD (100 USD = number of units of PLN),
— future trend of exchange rate changes (dynamics of exchange rate changes in relation to quarter before).

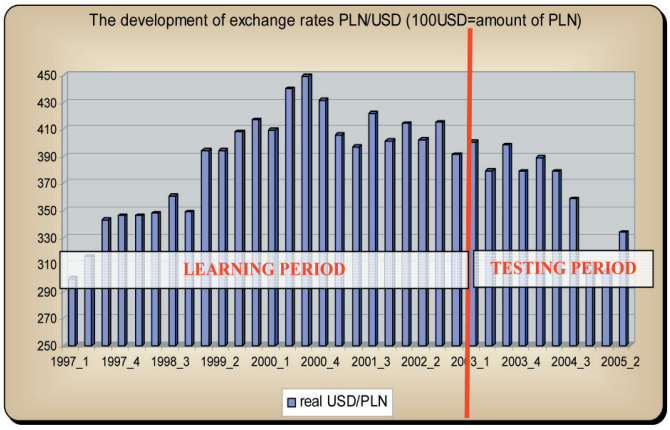
All three models were characterized by 4 hidden neurons in one hidden layer.

The dataset in both approaches was divided into learning and testing sets. The learning sets were I, II, III and IV quarter of 1997, 1998, 1999, 2000, 2001 and 2002. The testing sets were I, II, III and IV quarter of 2003, 2004, and I, II quarter of 2005.

4. THE ANN MODELS OF PREDICTING EXCHANGE RATES OF USD/PLN

As it was written before, the exchange rates depend not only on economical factors which are relatively easy to predict but also on factors unpredicted as political circumstances and/or psychological effects. That is why, before rating the effectiveness of created ANN models it is necessary to analyze the development of real exchange rates between USD and PLN. A high volatile currency will be much harder to forecast than a stabilized currency. Russian rubble and Swiss Franc can be given as two extremely different examples of currencies to predict. The effectiveness of the forecast will depend also stricly on the volatility of the currency. The development of exchange rates of PLN/USD in Poland during the years 1997-2005 is presented in figure 1.

Figure 1. Development of exchange rates PLN/USD in Poland.



Source: Self-study.

During the research period (first quarter 1997 – second quarter 2005), Polish zloty was the strongest at the end of first quarter of 1997 (100 USD = 300 PLN) and it was the weakest at the end of third quarter of 2000 (100 USD = 449 PLN). In other words, it can be said that USD appreciated against PLN in this period of time by 49,66%. In general during the years 1997-2005, there can be seen three trends:

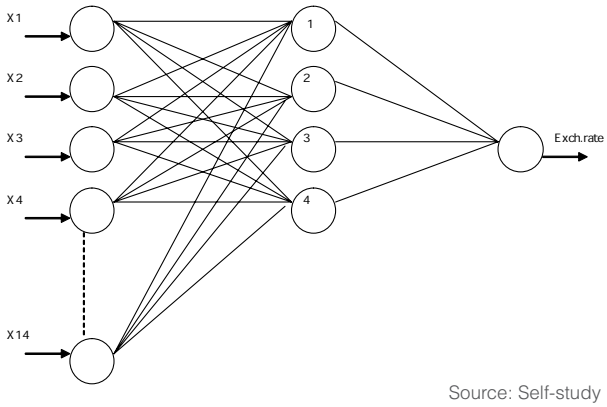
- from first quarter of 1997 to third quarter of 2000 – PLN was continuously depreciating,
- from first quarter of 2001 to first quarter of 2003 – PLN was on stable level, moving more or less from 410PLN to 390 PLN for 100 USD,
- from first quarter of 2004 to second quarter of 2005 – PLN was continuously appreciating against USD (304 PLN for 100USD).

The Year 2003 characterized the quite volatile movements of depreciation and appreciation of PLN. Summarizing it can be said that the starting and ending point of the research period characterizes with similar exchange rates, but in between these starting and ending points of research USD was appreciating and depreciating against PLN to the level of even 50%.

First approach

In the first research approach the author has created two different prediction models: "A" and "B". The task of model "A" is to predict the future exchange rate of PLN/USD.
The architecture of this model is presented in figure 2.

Figure 2. Architecture of ANN model – "A".

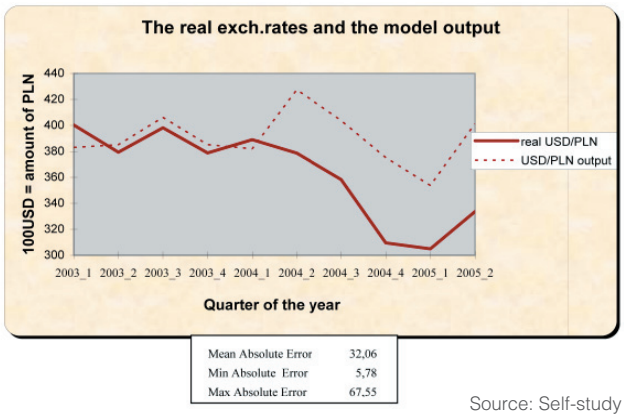


Source: Self-study

The above model consists of 14 input neurons (from X1 to X14), each representing the entry data described in previous point 3. There is one hidden layer with 4 neu-

rons. The forecast is given in one output neuron which is representing the future predicted exchange rate of PLN/USD. The real and the forecasted exchange rates (output of the model) during the testing phase (first quarter of 2003 to second quarter of 2005) are presented in figure 3.

Figure 3. The effectiveness of the ANN model "A".



Source: Self-study

From the above figure it can be assumed that from the first quarter of 2003 up to first quarter of 2004 the forecasted exchange rates are very similar to real exchange rates of PLN/USD. Model "A" precisely predicted appreciation and depreciation of PLN during that period. The minimum absolute error of the model "A" is 5,78 PLN per values from 300 to 449 PLN (per 100 USD).

A high inefficiency of the forecast is noted in second quarter of 2004. Model predicted that 100USD should be worth 427 PLN, while it was worth only 378PLN. This error[11] could have been caused by external factors e.g. political disturbances (unstable situation in Iraq) etc.

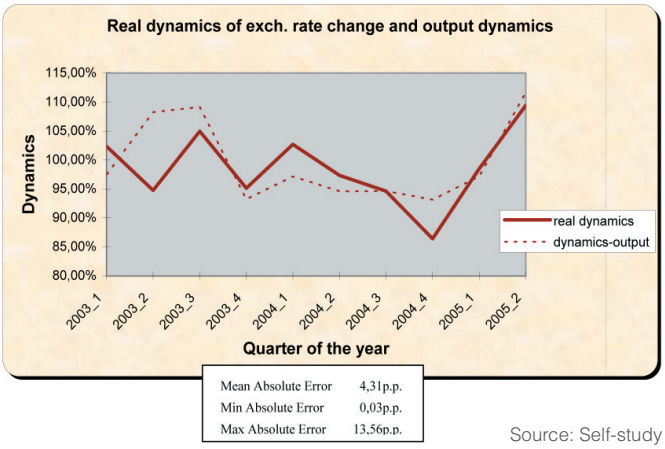
What is worth to note is that in spite of differences between the real and predicted exchange rates starting from third quarter of 2004 to the end of second quarter of 2005, the trend of appreciation and depreciation of the forecasted curriencies is very similar to the real trend. If the model had not made the wrong estimation of exchange rates in the second quarter of 2004, probably the predicted exchange rates during the whole research period would have been very similar as they were in 2003.

This similar trend of appreciation and depreciation of researched currencies have made the author of this article to develop a second model – model "B", which would predict the dynamics of change of exchange rates instead of spot rate. Very often the forecat of the changes of currency is more important for managers not a precise spot rate.

The architecture of ANN model "B" is the same as model's "A" presented in figure 2. The only difference is that the output neuron of the model represents the dynamics of exchange rates PLN/USD instead of spot rate. The real and the forecasted dynamics of exchange rates (output of the model) during the testing phase are presented in figure 4.

[11] Depreciation instead of appreciation of USD.

Figure 4. The effectiveness of the ANN model "B".



Source: Self-study

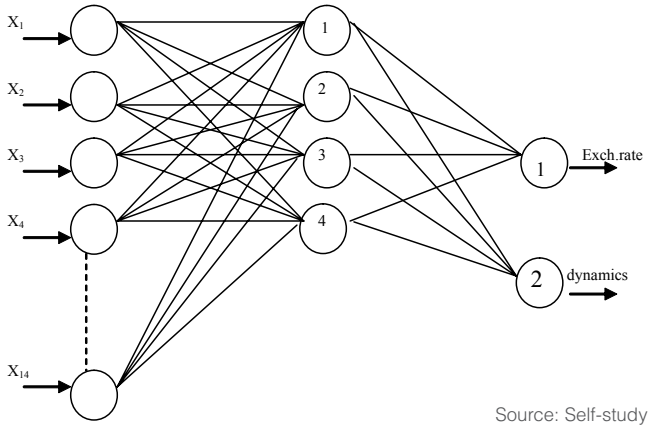
The Author has calculated dynamics of exchange rate change in given quarter of the year in respect to the quarter before. In this case 100% dynamics means that exchange rates are constant, values above 100% represent the appreciation of USD against PLN and below 100% dynamics means the depreciation of USD against PLN to the quarter before.

The highest forecast error is in second quarter of 2003 and it equals 13,56 percentage points. In this quarter model "B" predicted that exchange rate PLN/USD should increase by 8,26% (108,26% dynamics), while it decreased by 5,3% (94,7% dynamics). In two quarters of 2005 predicted and real dynamics are almost identical, which states for very high effectiveness of the model "B". The minimum error of this ANN model is only 0,03 percentage point. The mean absolute error of the forecast in a whole testing phase is 4,31 percentage points.

Second approach

In second research approach the architecture of ANN model compared to previous ones differs in the output layer. In model "C" this layer consists of two neurons. One is predicting future exchange rate of PLN/USD, and the second is forecasting the future trend of exchange rate changes (dynamics of exchange rate changes in relation to quarter before). In other words, the task of model "C" is to predict at the same time what models "A" and "B" predicted individually.

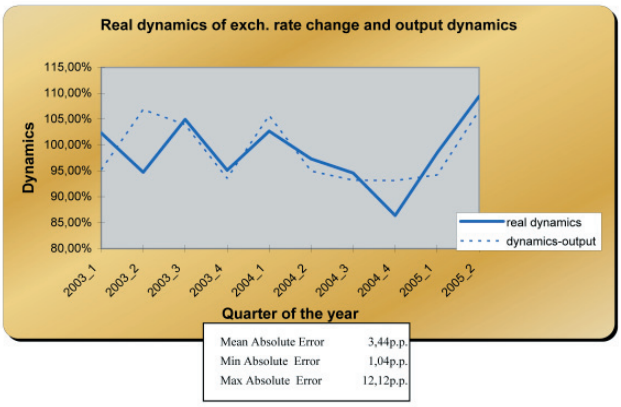
Figure 5. Architecture of ANN model – "C".



Source: Self-study

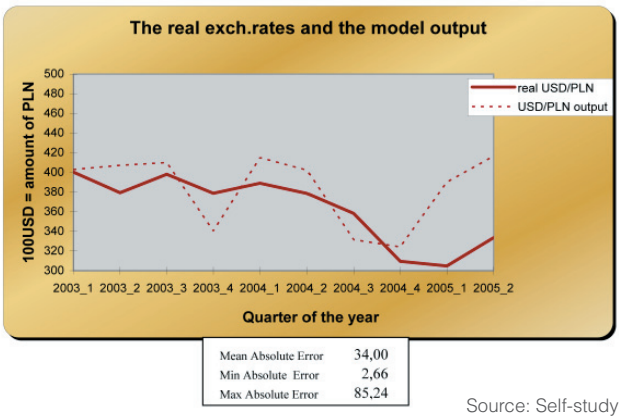
The effectiveness of the above ANN model is presented in figure 6 and 7. Figure 6 presents the real and the forecasted dynamics of exchange rates and figure 7 presents the real and the forecasted exchange rates during the testing phase.

Figure 6. The effectiveness of the ANN model "C" - dynamics.



Source: Self-study

Figure 7. The effectiveness of the ANN model "C" – exchange rates.



Source: Self-study

Comparing effectiveness of the model "C" with models "A" and "B" it can be stated that:

– model "C" forecasting dynamics of exchange rates characterizes with slightly smaller the mean absolute error and the maximum error than model "B" during a whole testing phase. The maximum error was 1,44 percentage points smaller. Although the minimum absolute error in model "C" was bigger for a whole one percentage point;
– model "C" forecasting the spot rate has made much bigger the mean absolute error and the maximum error than model "A" during a whole testing phase. These errors were respectively bigger for: 1,94 PLN and 17,69 PLN (per 100 USD).

To conclude: although ANN model "C" is slightly better in forecasting the dynamics of exchange rates than model "B", it is worse in predicting the future spot rate than model "A". Based on these results it can be said that model "B" performs best among presented ANN models and it can be recommended for forecasting PLN/USD exchange rates.

Reviewed by Professor Dr. Patrick Moore
University of Applied Sciences Stralsund

5. LITERATURE

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MERGER ARBITRAGE IN HEDGE FUNDS, RISK AND RETURN: CRITICAL ISSUES

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Abstract

The hedge fund industry is growing in size and new strategies are being developed by fund managers to achieve profits. One of the strategies which take advantage of merger and acquisition activities is called Merger or Risk Arbitrage. This is a market neutral strategy and takes advantages of present corporate mergers. In spite of good success rate, the uncertainty of M&A deals poses potential risk. Also there is unavailability of credible data on hedge funds as they are not under very strict government regulations. Hence, it is very important for rich individuals and institutional investors to be well aware of potential risks before investing into the hedge funds involved in this merger arbitrage. Present study will try to explain these risks, their measurement and comparison with stock index.

1. INTRODUCTION

Over past several years, business world is witnessing growing trends in merger and acquisitions (M&A). There are several reasons behind this becoming favourite of big and medium size business, including domestic and multinational companies. One of them is operating efficiently higher, synergy and economies of scale (centralising multiple services to ensure critical linkages).

Given below a graph showing number of M&A deals from 1985 to 2005 with corresponding deal values

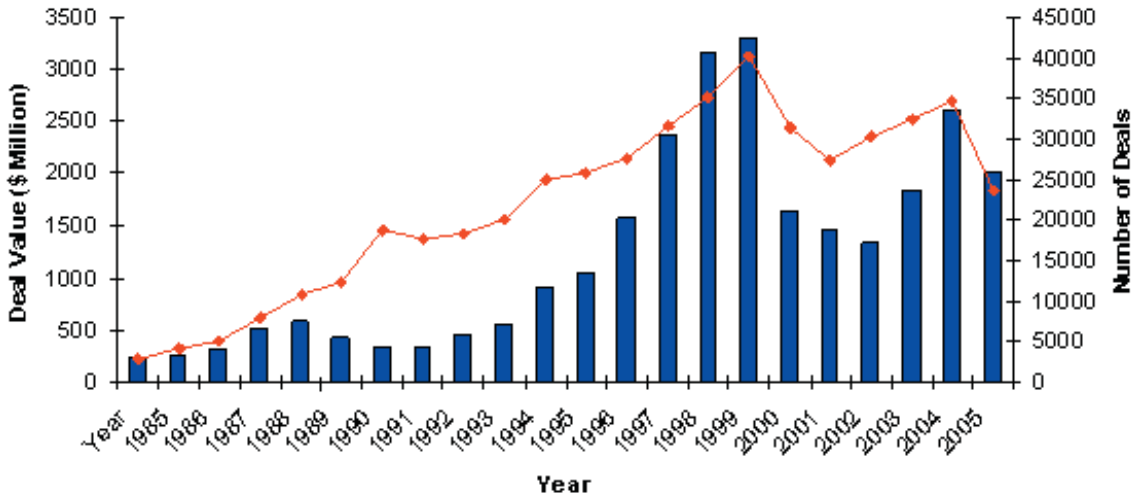


Chart 1.1: Global Announced M&A Activity from 1/1/1985 to 9/5/2006*, Source: Thomson Financial as of September 5, 2006, *Excluding Withdrawn deals and Open Market Repurchases.

One of the offshoots of M&A activities is "Merger (Risk) Arbitrage" strategy employed by many hedge funds. The real challenge in practise of this strategy is to estimate risks and return. Present study will give background information about hedge funds and then will talk about merger arbitrage strategy. The present study would present factors governing risk and return in merger arbitrage strategy. The focus would be to estimate risk, return as well as correlations with some index like S&P. A detailed list of due diligence process for hedge fund manager and investors would be provided.

2. HEDGE FUNDS

Definition[1]: "A hedge fund can be broadly defined as a privately offered fund that is administered by a professional investment management firm (or ‚hedge fund manager'). The word ‚hedge' refers to a hedge fund's ability to hedge the value of the assets it holds (e.g., through the use of options or the simultaneous use of long positions and short sales). However, some hedge funds engage only in ‚buy and hold' strategies or other strategies that do not involve hedging in the traditional sense. In fact, the term ‚hedge fund' is used to refer to funds engaging in over twenty five different types of investment strategies".

One of the over twenty five strategies practised by fund managers is Merger Arbitrage. It is also known as Risk Arbitrage.

3. MERGER ARBITRAGE

The term "Merger Arbitrage" is defined by many authors on the subject including Mitchell M. and Pulvino T. (2000) and Cornelli F. (1998). "Merger Arbitrage, which is also known as Risk Arbitrage refers to an investment strategy whereby an attempt is made to profit from what is known as an arbitrage spread."

As there are more M&A activities, arbitrage will also rise. Given below is a chart 1.2 showing estimated assets and net asset flow into merger arbitrage activities from1990 to 2003. Although the source of date for M&A deals in chart 1.1 differs from chart 1.2, there seem to be an agreement over trends of these two charts.

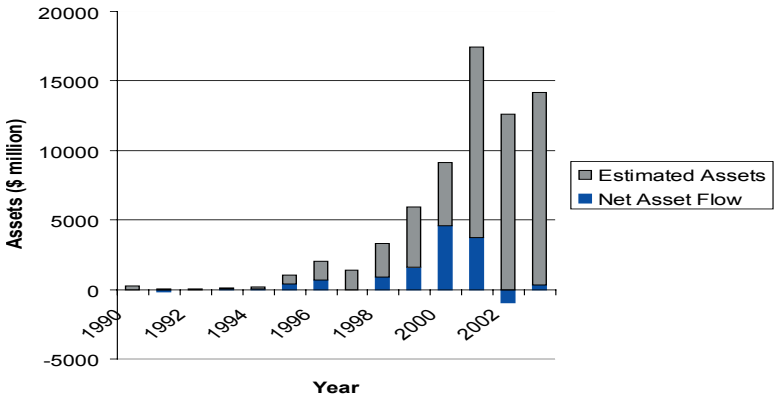


Chart 1.2: Assets value of Merger Arbitrage Strategy by year from 1990 -2003, Source: HFR Industry report

(1) Managed Funds Association, Hedge Fund FAQ 1 (2003).

4. MECHANISMS OF MERGER ARBITRAGE

In order to understand the risks and returns associated with Merger Arbitrage, we need to know about the different processes which dominate when a fund manager see an opportunity in M&A.

To understand how a hedge fund manager can make profit out of merger activity, here are examples of different scenarios. In one situation a company is acquired by another, and in other situation which is also known as merger of equals, two companies merging to form a bigger one. So in the modern day business terminology one is referred as leading company (the acquirer) which is purchasing another company (the target). A fund manager looks for deals which are going to take place. To make money out of these, the stocks of two merging companies are simultaneously bought and sold to create a risk less profit. Merger Arbitrage is the investment in both companies (the acquirer and takeover candidate) of an announced merger. But as profit is without any potential risks, there is an uncertainty about the merger is completed, which is reflected in the difference between the takeover bid price and the current price of the takeover candidate. In one of the way to make profit, a hedge fund manager may buy the takeover candidate, short stock of the acquirer, and expect the prices of the two companies to converge. But the risk is merger actually not consuming.

In order to quantify the above explanation, a firm targeted for acquisition receives an offer equivalent to $30 for each of its outstanding shares. For simplicity, suppose that prior to the announcement of the deal the stock of both the target and acquiring firms sold for $20 a share. After the merger plans are publicly revealed, assuming the investors react to the announcement by bidding the price of the target firm's stock up to $28. At this time, the arbitrageur must judge whether the deal appears sufficiently likely to go through that purchasing the target firm's stock in order to capture the $2 price spread is justified. If it does appear so, the exact strategy employed depends upon the nature of the acquiring company's offer. With a cash tender offer (cash deal), the arbitrageur has only to purchase the stock of the target firm in order to lock in the price differential. For stock deal shares are exchanged, however, the post-announcement value of the exchange offer will vary with the price of the acquiring firm's stock. Thus, in order to lock in a particular spread, the stock of the acquiring firm will have to be sold short in appropriate quantities at the same time that the target firm's stock is purchased. In the present example, as $28 is spent for a share of the target firm, one and a half shares of the suitor company will be shorted at the assumed price of $20. If the merger is then consummated, the investor can cover the short sale with the exchanged value of the target share.

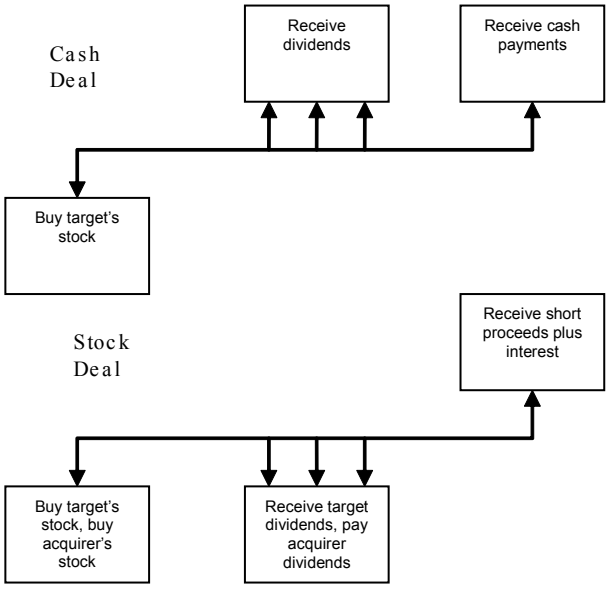


Figure 1.1: Cash flows in cash merger deal and stock merger deal, Source: Pulvino, T., Arbitrage in equity markets

Once company announces a bid to acquire a target, share prices quickly reflect the terms of the proposed acquisition, adjusted for the chance that the deal will close, financing costs, and other factors. The target company is usually purchased at a premium to the level the company's shares traded at prior to the bid effort. For this reason, merger arbitrage traders may try to anticipate a takeover attempt. Although share prices quickly reflect takeover news, traders may try to acquire positions quickly, before prices fully reflect the takeover proposal.

5. ISSUES RELATED TO RISK/RETUN ETIMATION

After a review of mechanism of merger arbitrage, we can have a look at factors which determine potential risks and thereafter good or bad returns. These factors are involved in other financial instruments too, but they have special role in merger arbitrage process due to focus on more profits.

5.1 MERGER ARBITRAGE SPREAD

Basically, "Arbitrage Spread" anticipates the price resolution of the target's shares and indicates the market pricing of the target conditional on the announced bid price. The present available literature is not able to precisely determine the characteristics of this spread and its determinants and its relation to subsequently realized returns.

To understand these issues, Jindra and Walking (1997) modelled the arbitrage spread and subsequently tested the implications of this model on a sample of 362 cash tender offers from 1981 to 1995. These are calculated based on bid price by first bidder and market price one day after announcement of the tender offer. According to Jindra and Walking, "The arbitrage spread is found to be positively related to the size of bid premium, friendly managerial attitude about the offer and existence of rumours about the offer but negatively related to the target size and pre-offer run up".

Another study given below is a qualitative representation of variation in the arbitrage spread by Mitchell and Pulvino (2001).

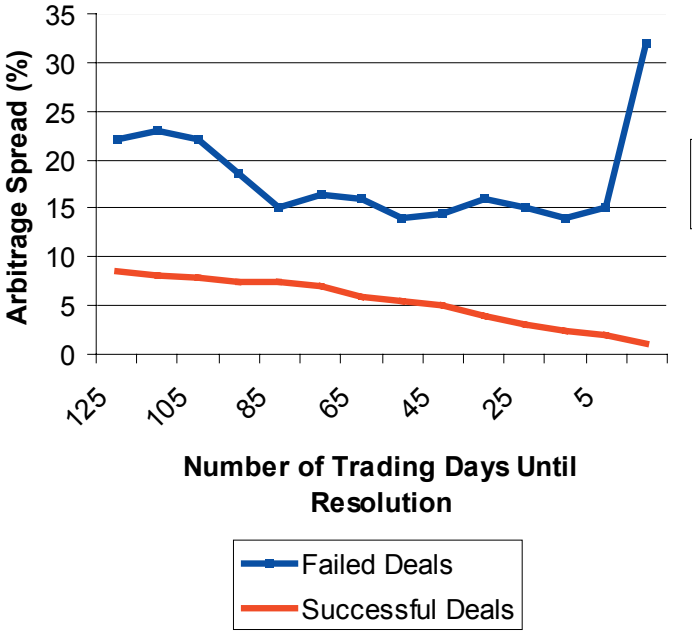


Chart 1.3: Median gross arbitrage spread (excluding dividends and short rebate) for failed and successful stock mergers, 1963-1998 (for qualitative representations only), Source: Mark Mitchell and Todd Pulvino, The Journal of Finance (December 2001), p. 2139

The chart above shows the evolution of the median arbitrage spread between announcement and consummation or failure for both successful and failed mergers. For failed mergers, the spread remains relatively wide during the life of the merger. When a deal fails, the median spread widens dramatically, increasing from 15% to more than 30% on the termination announcement day. A very different pattern exists for merger arbitrage investments in successful transactions. In successful deals, the arbitrage spread decreases, continuously as the deal resolution date approaches. Upon successful consummation of the merger, the spread collapses to zero.

The fact that spread are much wider for unsuccessful transactions than for successful ones suggest that the arbitrage community accurately identifies risky deals and incorporates the risk into target and acquirer stock prices well before announcement of deal failure. At the same time, the sudden widening of the arbitrage spread just before deal failure suggests that the arbitrage community, while it does a good job identifying the risky deals, is generally surprised by merger failures.

5.2 DURATION OF DEAL CLOSING AND TIMING

Success of merger arbitrage is also dependent on another factor known as duration between announcement and deal actually closing. It is similar to comparative advantage principle. For example of the risk of the deal not closing on time or at all, the target company's stock will sell at a discount to its value at the merger's closing and this discount increasing with the expected length of time until closing and the perceived risk of the deal.

"Recent merger[2] of AT&T with BellSouth which was long-awaited and valued at $67 billion to create the largest telecom company in the U.S., thought to be present chance for arbitrageurs, to capture easy money. Though with big deal size, it was not on the list of favourites for arbitrageurs. With many investors

[2] http://www.thestreet.com/pf/stocks/brokerages/10271978.html

calculating 6% returns by the time the deal closes in about a year, other opportunities were more attractive". „If some other arbitrage investor wants to waste his time on a single-digit return, that's fine. I'm focusing on other things," one opinionated investor said".

So if the gain out of arbitrage opportunities in mergers are measured to be same as that from treasury bonds than there is no way to invest into more risky strategy like merger arbitrage. The more duration of deal closing the less return it yields and lesser attractive for potential investors. According to arbitrageurs when the arbitrage opportunity is small, best time is to lock in before the merger announcement.

Summing up following factors should be given due considerations before investing:

- The spread between price being paid and closing price of merger
- Duration between deal announcement and actually closing
- Whether there is any drift from initial conditions of merger
- Any future bids to play against initial bid
- In the event of bid not consuming, degree of loss.

6. RISKS IN MERGER ARBITRAGE

Merger arbitrage is subjected to idiosyncratic risks, i.e. "The risk of price change due to the unique circumstances of a specific security, as opposed to the overall market. This risk can be virtually eliminated from a portfolio through diversification also known as unsystematic risk". Thus we can enlist risks associated with merger arbitrage as follows:

- Deal risk
- Portfolio risk
- Event risk
- Liquidity risk

Deal risk is also classified as shown in figure:

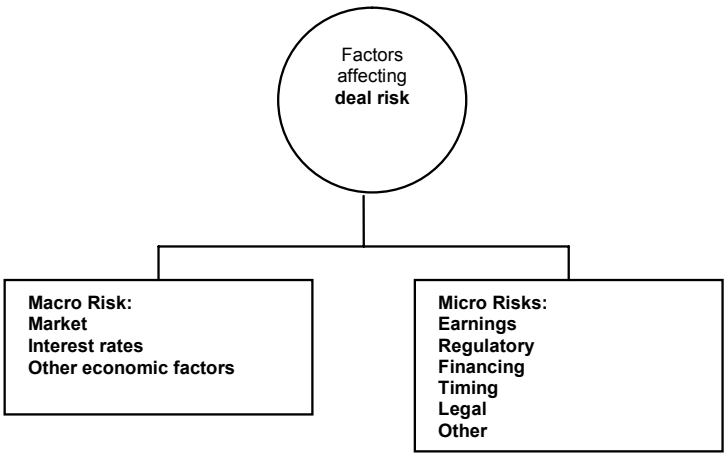
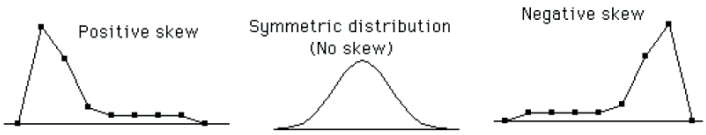


Figure 1.2: Potential risks in Merger Arbitrage, Source: Hedges on Hedge Funds

6.1 ROLE OF VAR

VaR is a methodology used to measure the systematic risk in a portfolio of assets, the risk that cannot be diversified away. VaR represents a quantitative method to compare risks across asset classes, the basis of which is an analysis of historical volatility of assets.

Risk their estimation by traditional methods for merger arbitrage as it is negatively skewed, "Negatively[3] (positively) skewed trading strategy is one whose profit and loss (P&L) over some specified horizon has a negatively (positively) skewed probability distribution" and thus its return distribution may look like in figure 1.1.



The reason for it, one can make a diversified merger hedge fund across many transactions that results into small market neutral profits over the long term. But in the extraordinary situation of a stock market sell-off or global liquidity squeeze, causing many mergers to fail, will result into wide losses across the merger arbitrage hedge fund's holdings.

Value-at-risk (VaR) is the standard tool for assessing market risk in trading portfolios. But most of its implementations are poorly equipped to warn of skewed trading strategies. Merger Arbitrage is a very negatively skewed strategy as shown in table 1.1

	Annualized Return	Annualized Standard Deviation	Skewness	Kurtosis
Merger Arbitrage	10,86	3,81	-2,27	9,75
Convertible Arbitrage	11,28	4,20	-1,67	5,50
Distressed Securities	11,18	5,37	-1,57	9,81
Event Driven	12,79	6,62	-0,57	5,15
Fixed Income Arbitrage	6,31	4,18	-3,28	17,29
Macro	16,03	9,47	0,53	0,97
Equity Market Neutral	6,85	3,79	-0,01	0,65
MSCI Europe	4,63	15,55	-0,76	1,14

Table 1.1: Risks due to skewness and kurtosis, Source: Ross S., The role of hedge fund in institutional portfolio

The more negative that skewness number, the more fund manager should be concerned and it is very difficult for VaR to recognize skewness arising from strategy like merger arbitrage

Again in the case of merger arbitrage, in order to use VaR, one has to fit a distribution to the stock price. Even after assuming a distribution is assumed, its mean should equal the stock's current value which is easier. What is more difficult is deciding what negatively skewed distribution to use and how to calibrate it to the current circumstance.

VaR tends to look at the historic volatility of the stock, which obviously changes once a merger is announced. I think it would be more appropriate to model the target company after the acquirer after the announcement if you want a daily VaR number, as the stock will track the acquirer more closely than it's former self (except of course for changes in spread).

7. PERFORMANCE & RETURN OF MERGER ARBITRAGE

Many authors have analyzed performance of merger arbitrage. The central to this kind of analysis is to predict whether the announced merger will happen. This will be treated separately into Decision Process section of this paper.

"In merger arbitrage sources of return depend on these factors[4]:

– The locked-up initial spread

[3] http://mathworld.wolfram.com/Skewness.html

[4] Yang T. et al, Merger arbitrage: Evidence of profitability

– The probability that the proposed merger will succeed
– The return for the risk arbitrager if the merger effort fails,"

After the merger announcement locked-up initial spread is known and later subjected to changes. Hence, its prediction together with success of proposed merger (and over what time period), as well as plausible results and/or price movements, especially target price movements is a major issue and challenge for the risk arbitrage industry.

Todd Pulvino has made an extensive literature survey and based on that he presented following data about annualized returns from various deals carried out from1971 to1995.

Transaction Type	Authors	Sample Size	Annualized Return
Cash Tender Offers	Dukes, Frolich, Ma (JPM 1992)	761(1971-1985)	220% raw
Cash Tender Offers	Jindra and Walking	361(1981-1995)	102% excess
Cash Tender Offers	Bhagat, Brickley, and Loewenstein (JF 1987)	295(1962-1980)	18% excess
Cash and Stock	Larcker and Lys (JFE 1987)	131(1977-1983)	51,9% excess
Cash and Stock	Karloyi and Shannon (1998)	37(1997)	26% raw
Cash and Stock	Baker and Savasoglu (1999)	2125(1978-1996)	11,5% excess
Hedge Fund	Agrawal and Naik (1999)	(1994-1998)	9,5% excess
Hedge Fund	Ackermann et al. (JF 1999)	(1988-1995)	Superior Sharpe Ratios

Table 1.2: Historical data of merger and annualized return, Source: Pulvino Todd

Based on CISDM hedge fund index if we compare the growth of $100 invested in merger arbitrage with S&P index, the following output is obtained as shown below.

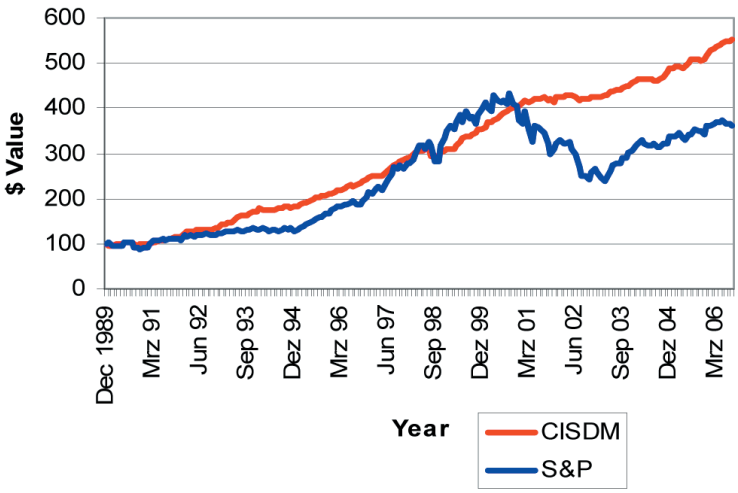


Chart 1.4: Growth of $100 from 1989 to 2006, Source: CISDM Merger Arbitrage Index and S&P Data

7.1 EFFECT OF LEVERAGE IN RETURN

"Leverage[5] may be best understood as the creation of exposure greater in magnitude than the initial dollar amounts posted to an investment. It is a significant factor in the risk and return profiles of various hedge fund strategies". There are various means of employing leverage such as by borrowing, deployment of proceeds from short sales, or one of the popular means, through the use of derivatives.

In the hedge fund world the most common measures of leverage are gross leverage and net leverage. Gross leverage is: (longs + absolute value of shorts) / portfolio equity. Net leverage is: (longs + shorts) / portfolio equity. While these ratios have value as relative measures between hedge funds trading the same strategies, as

Schneeweis T., Martin G. et al, The impact of leverage on hedge fund risk and return

standalone measures they provide little insight. Other tools must be used to analyze the true risk of leverage in a hedge fund - the volatility and financing risks.

Basically for hedge funds derivatives[6] are primary tool for achieving leverage such as:

- Forwards, Futures and Options
- Interest Rate Swap
- Total Return Swap
- Credit Default Swap
- Tranche Products

"According to Pulvino, Hedge fund portfolios are able to withstand shocks caused by inadequate diversification if they are not too highly leveraged. Because correlations cannot be predicted with certainty, managing leverage is important. He stated that:

High Leverage + Lack of Diversification = Disaster.

This equation holds even if underlying investments are sound."

7.2 Correlation

"In the world of finance[7], a statistical measure of how two securities moves in relation to each other. Correlations are used in advanced portfolio management."

If correlation coefficient, which ranges between -1 and +1 is 1 then its "Perfect positive correlation" and implies that as one security moves, either up or down, the other security will move in lockstep, in the same direction and vice versa for "Perfect negative correlation".

Data from Zurich Hedge Fund Indices given below shows correlation as computed for hedge funds from January 1998 through December 2000. The data reveals that merger arbitrage is not in perfect correlation.

	Annualized Return (%)	Standard Deviation (%)	Sharpe Ratio	Correlation with S&P
EACM	11,4	5,0	1,2	0,55
HFR	13,1	4,7	1,6	0,49
CSFB	11,8	4,7	1,3	0,53
Zurich	13,8	3,9	2,1	0,47
Average	12,5	4,6	1,6	0,51

Table 1.3: Correlation of Merger Arbitrage Hedge funds with S&P, Source: "The Zurich Hedge Fund Indices" (Spring 2001 Edition)

8. DECISION PROCESS

In merger arbitrage, it is very important to gather useful information about the future M&A deals and to apply this at right time. The more systematic and rigorous process is, the more successful strategy would be. We have classified the factors deciding investment opportunity into two categories:

8.1 QUALITATIVE

Thus arbitrageurs have to anticipate future mergers and follow the merger announcements very closely. It would also involve evaluating the risks associated with the same. A possible key analysis to determine

[6] Martin G., Getting Exposure: Hedge Funds, Leverage and Derivatives

[7] http://www.investopedia.com/terms/c/correlation.asp

feasibility of merger consummation can be given as:

- Reviewing the deal terms,
- Probability of merger consummation (business rationale, contingencies, votes, etc.),
- Timing of deal closure,
- Potential return if deal closes and downside risk (assuming deal break).

The merger arbitrageur is a speculator. He advises fund manager for a possible merger in future. However, unlike a currency speculator concerned with overall economic trends, the fund manager in an attempted takeover cares only about the factors affecting the outcome of the proposed deal through their willingness to gamble on the terms of the merger.

8.1.1 APPROACH

Research Process, First Stage: A good return from investments into merger arbitrage strategy of hedge funds depends upon the M&A process of companies involved. So, it is natural that success of this strategy is dependent upon the outcome of acquisition proposal. So from both investors and fund manager's point of view, there are almost same set of guidelines but with slight differences.

Guidelines for fund Manager:

- Sales growth
- Company's net income and earnings per share
- Acquiring company's finances
- Size of the acquirer and comparing with the target
- Offered stock price for target company

All information gathered is useful to estimate the profitability of merger for both acquirer and acquired companies. An overall assessment of the financial merits is evaluated and an approximation has to be made about the consequence of the deal. Information gathering is followed by computation of merger multiples to EBITDA, EBIT and net income. Generally, a fund manager looks for healthy companies being purchased at reasonable multiples without excessive premiums.

Research Process, Second Stage: The second stage of the research should be to participate in the management conference calls; review the Wall Street research, SEC filings and the merger agreement. In our review of the merger agreement, we look for any unusual conditions to the merger such as due diligence, financing, business or regulatory conditions. We are basically looking for solid merger agreements with minimal conditions. We also examine regulatory issues that could affect the timing or the ultimate approval of the transactions. We have very well outside antitrust counsel and we have an in-house lawyer to look at any legal issue that may affect the outcome of a transaction. Generally, the focus of our research is to eliminate deals that are riskier and have a lower probability of being completed. We look at the remaining lower risk deals on a return basis and we try to focus on deals with lower risk and higher potential returns.

8.1.2 DUE DILIGENCE

A fund manager invests the money of investors into a strategy based upon some predictions. But to be on the safer side, he is recommended to perform some due diligence, before arriving on a decision. Thus, the process of investment decisions in merger arbitrage strategy depends on a thorough analysis of merger deals taking place. Usually an analysts specialising in screening of new deals recommends it to fund manager. Once a deal is announced, fund manager should perform a detailed financial analysis. Primarily they should examine the followings:

Questionnaire:

1. What is the spread? What is the annualized return?
2. What are the regulatory issues/hurdles?
3. Is financing in place?
4. Is due diligence complete?
5. What is the downside if the deal breaks?

Also to look at are kind of deals as described earlier i.e. standard cash tender offer to more complex transactions involving collar mergers.

After collecting basic information, a final analysis is required which is performed to understanding the issues that can make or break a merger. This fundamental analysis plays an important role. The main reason that an arbitrageur focuses on fundamental research is to determine a fair value for the target company. In merger arbitrage, fundamental analysis helps determine a fair value for the target company. If an initial bid for a company is below the target‘s intrinsic value, or the price at which similar transactions have gone through, the arbitrageur knows that there may be room for a higher bid. On the other hand, if a bid is richly priced relative to recent deals in the target company‘s industry, there may be room for the acquiring company to lower its offer, should any problems arise.

A second reason for fundamental analysis of the target is that the arbitrageur will own the target stock outright if the deal falls through. If a deal breaks, the arbitrageur must decide whether to stay long the target stock, or to sell it because there is no longer a merger agreement that insures a takeover price.

Summing it, merger arbitrage investing should follow a disciplined, research based methodology in the investment of announced mergers and acquisitions. A very rigorous analysis and astute judgement comprise the science and art of successful arbitrage investing. But it has been seen that historically a strategy yielding good profits for some duration may prove to be disaster in another. So strategy should be reviewed on regular basis.

8.2 QUANTITATIVE

Quantitative analysis of merger arbitrage includes check on volatility, Jensen’s alpha, information ratio, sharp ratio. So calculating these factors is part of decision process.

SUMMARY AND CONCLUSIONS

In this paper we looked at the issues related to risk and return of merger arbitrage, a hedge fund strategy adopted by many fund managers. While many of the key issues within the same including role of VaR, hedge fund index risk and return profiles were seen, there are a few distinct difficulties with approximating the risk/return of merger arbitrage. First and foremost, the deal risk, which is out of control of fund manager. But the effect of this risk is tremendous which can force the investment into red. Other factors like antitrust laws etc also play a great role, even if the company's' shareholders agree for a merger.

There is a need for a VaR model which can simulated the strategy by keeping in mind these external factors. Although, there are several indices which provide data on merger arbitrage hedge funds, their reliable is still under question. The hedge fund industry in itself can't be strictly regulated. Hence, there is reliability on data from different indices. It is however acknowledged by most fund manager that the hedge fund indices guide in some way with whatever data they represent.
For the time being, the researchers need to continue to look at the methods to evaluate risk/return of merger's stock price spreads.

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