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# Corporate cash-pool valuation: a Monte Carlo approach

## Abstract

### **Purpose:**

The paper analyzes a special corporate banking product, the so-called cash-pool, which gained remarkable popularity in the recent years as firms try to centralize and manage their liquidity more efficiently.

### **Design/methodology/approach :**

A Monte Carlo simulation was applied to assess the key benefits of the firms arising from the pooling of their cash holdings.

### **Findings:**

The main conclusion of the analysis is that the value of a cash-pool is higher in the case of firms with large, diverse and volatile cash-flows having less access to the capital markets, especially if the partner bank is risky but offers a high interest rate spread at the same time. It is also shown that cash pooling is not the privilege of large multinational firms as the initial direct costs can be easily regained within a year even in the case of SMEs.

### **Originality/value:**

The novelty of this paper is the formalization of a valuation model. The literature emphasizes several benefits of cash-pooling such as interest rate savings, economy of scale and reduced cash-flow volatility. The presented model focuses on the interest rate savings complemented with a new aspect: the reduced counterparty risk toward the bank.

**Keywords:** corporate cash management, banking transaction services, cash-pool, Monte-Carlo simulation, net interest spread, counterparty risk

**JEL-Codes:** G15, G21, G32

## 1. Introduction

General *corporate cash management* is one of the elementary topics of corporate finance. It is discussed in almost all basic corporate finance textbooks (e.g. Brealey and Myers, 2005). Cash management issues of multinational corporations, corporate groups require even more complex solutions; therefore international management books discuss the topic even more in detail (e.g. Siddaiah (2010) or Madura (2010)). Cash management in the literature is usually presented as a sub-topic of *liquidity management*, mostly as a part of *working capital management*. The most important issues discussed under these keywords are: (1) cash flow planning, its efficiency, accuracy, and important techniques; (2) control on cash, cash collection and disbursement, the usage of cash; (3) optimal cash management theories and models, see Baumol (1952) and Miller-Orr (1966).

The literature of efficient cash management models also concentrates on the issues of fast collection and slow disbursement, and on the optimal utilization of the cash. However, before a company can structure the processes of optimal collection and disbursement, it has to optimize its intragroup payment activity first. It is always a controversial question whether the company should apply a centralized or a decentralized cash management approach. Most of the authors argue for centralized cash management as it leads to higher level of consolidation, which implies lower financing requirements and offers more investment opportunities. Moreover, it has the advantage of the economy of scale and a better negotiation position towards commercial banks (see e.g. Madura, 2010, pp 600). Textbooks and related articles often add that due to a centralized cash management extra costs can also be avoided, corporate treasurers can get greater control over corporate cash holdings (Fanning, 2015), and reporting and banking relations can be simplified (Kilkelly, 2011). However, centralization has several disadvantages, too. Flexibility decreases, as the reaction time of the units is reduced, which can easily cause demotivation and organizational resistance (Oxelheim and Wihlborg, 2008). Regulatory and tax issues may also cause several inconveniences and delays which may lead to higher transaction costs (Siddiah, 2010, pp 314).

Banks offer several products to serve companies in their centralized cash management processes, and these products have gained top priorities in the current banking product palette. Recently, separate *cash/transaction management divisions* have been set up in most commercial banks. There are numerous reasons why these areas have gained such a serious attention inside banking organizations. On the one hand, due to the strict capital requirements, the role of non-credit type services and their stable fee revenues have become more important to all commercial banks. On the other hand, these services are also essential to anchor clients to the bank. Moreover, the implementation of SEPA (Single Euro Payments Area) and the continuous developments in the general IT infrastructure also offer the opportunity to merge even cross-border cash flows easily and cost efficiently. Finally, as products become more and more complex, they require special know-how which automatically supports the establishment of specialized departments.

Section 2 presents those services that support the centralized cash management. In Section 3 the basic factors of benefits and costs of cash-pooling are summarized from the corporate point of view. In Section 4 a model and the corresponding simulations are presented which gives an estimate of the value added coming from the interest savings and the reduced counterparty risk of a simple cash-pool set up under different parameters. In Section 5 results are discussed, while in Section 6 conclusions are derived.

## 2. Banking services for centralized cash management

Centralized cash management simplifies and reduces intercompany transfers and cash movements. This is why *payment netting systems* were born, where payment deadlines are standardized, and all claims are settled periodically based on the principle of netting (Siddiah, 2010). The netting of payments is not exclusively a banking service. Several financial institutions offer similar products, or even the company can develop its own IT solution. If there is some cross sale within the group, netting can produce considerable savings in the transaction costs and the FX conversion fees<sup>1</sup> by reducing internal banking transfers. It can also reduce the financing needs and expenses (Kilkelly, 2011). Payment netting systems optimize internal corporate transactions and settlements; however, do not optimize and centralize the cash management of the company. It is offered by another product group: the so-called cash-pool systems.

One of the modern centralized cash management products offered by almost all commercial banks is the *cash-pool*. In today's terminology, all structured processes where bank accounts of a group of corporations are combined are regarded technically as cash-pools. In a cash-pool system, accounts of different companies (even of different legal entities) are introduced into a single bank account structure settled in a cash-pool agreement. It centralizes all balances of the sub-accounts into a central master account. Amounts are consolidated, and deposit and credit interest rates are calculated and charged accordingly. Companies participating in a cash-pool sign an agreement which settles the framework and the structure of the cash-pool and all relevant conditions. Participating companies also sign a contract with the commercial bank that manages the accounts under the agreed banking terms and conditions. Commercial banks offer a wide range of cash-pool solutions; however, structures can be grouped into two main standard types: (1) *cash concentration* (or also called *physical cash-pool*) and (2) *notional cash-pool*. Which type of cash-pool is more common in a given region or country mainly depends on the tax, accounting, and other legislations.

The objective of a *cash concentration* is to concentrate all liquid assets of the group physically to reduce the external financing need of the whole company and to use the collected cash elements in an optimal way, especially to exploit the economy of scale (Dolfe and Koritz, 1999). The simplest and most widespread form of cash concentration is the so-called zero-balancing cash-pool. Usually, the parent company holds the "master account", and

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<sup>1</sup> FX risk hedging solutions are described in (Dömötör and Havran, 2011).

the “sub-accounts” (called “pooling accounts”) are connected to the master account in the pre-defined hierarchy. The surplus on the pooling accounts is regularly transferred to the master account; and vice versa, if the balance of the sub-account is negative, then the necessary amount to offset the negative balance is transferred automatically from the master account. To handle the intraday negative balances, banks usually set up an intraday overdraft facility on the sub-accounts. At the end of the day, the master account shows the total net balance of all accounts in the cash-pool system. Technically, the company owning the master account handles the transactions among the sub-account holder companies as bilateral intercompany loans. The bank calculates and settles the interest based on the balance of the master account and charges only the master account holder. The determination, the booking, and the settlement of the intercompany interest charges and incomes are the task of the central corporate treasury.

A *notional cash-pool* does not require real cash movement and transfers. It is essentially a tool of interest optimization where interests are calculated on the netted amount of all combined accounts (Dolfe and Koritz, 1999). Besides these basic solutions, many other combinations and special cash pooling solutions exist on the market. For example, pooling can comprehend not only one but more currencies (multi-currency pooling), it can be based on cross-border transactions (cross-border cash pool) or on combined solutions. For detailed descriptions of these products see (Walter and Kenesei, 2015).

Finally, banks do not necessarily transfer money – effectively or virtually – from one account to the other to assist the centralized cash management of a company. Sometimes the collection and the processing of the information on account movements can also create a value added. The so-called “information management” or “information pooling” service comprehends only the collection and the provision of the data on the accounts of the participating firms in a structured form.

### **3. Benefits and costs of cash pooling**

The most important source of benefits is the *interest savings*. If some of the pool accounts are in negative while others show positive balances, then the positive accounts finance the negative ones, and hence, the net interest spread can be saved. The second source of benefits arises from the *economy of scale*, as transaction fees and management efforts can be saved and even improvements in banking conditions can be achieved. The third benefit is due to the *reduced volatility* of the net accumulated cash flow due to the diversification. As volatility is lower, forecasting errors are also reduced; and it allows companies to release the surplus liquidity permanently from their working capital. Finally, we complete the list with a special source of benefits, which is not mentioned in the literature: the *reduced counterparty risk* which has two sides. One is due to the lower potential exposure of the firms to the default of the bank. The other is due to the effect of credit risk diversification of the participating firms which can be reflected in a lower interest rate spread applied in a cash-pool system relative to the individual spreads.

Besides benefits, additional costs of cash pooling should also be considered. External costs among others include the *direct installation costs* of the new banking service. Account maintenance and reporting requirements also imply expenses from the company's side. In the case of cross-border, multicurrency cash pools special regulatory and tax issues may arise which implies further *advisory and legal expenses*. There are also some *internal costs* to consider: for example the costs of internal reporting monitoring, banking calculations, and handling the documentation. Finally, we should not forget about the potential negative effects of organizational conflicts and resistance which might appear during and after the implementation.

In this paper, we analyze and model the most important elements of and motivations behind cash pooling: the interest savings and the reduced counterparty risk at corporate group level<sup>2</sup>; and compare these benefits to the direct installation costs. We assume that net cash-flows follow a normal distribution, which can be a good starting point, as we believe that numerous independent effects are aggregated into this measure. However, when a particular firm wants to evaluate the benefits of a cash-pool system, first of all, it has to analyze its cash-flows and cash account balances and define its specific distribution which can serve as a basis for the Monte Carlo simulation.

#### 4. Model and simulation

The net cash-flow of two uniform firms is supposed to come from a normal distribution,  $N(\mu, \sigma, \rho)$ , each day, where  $\mu$  is the mean,  $\sigma$  is the standard deviation and  $\rho$  is the linear correlation between the two stochastic variables. For the sake of simplicity, all these parameters are assumed to be fixed over time. Hence, the net cash account position of firm  $i$  ( $i=1, 2$ ) on day  $t$ ,  $X_t^i \in \mathcal{R}$  which equals the cumulated net cash-flows in the period of  $[0, t]$  follows an Arithmetic Brownian motion (ABM). If the net account position is positive, then it is a deposit ( $D$ ); and if it is negative, then it is a credit ( $C$ ):

$$(X_t^i)^+ = D_t^i \quad (1)$$

$$|(X_t^i)^-| = C_t^i \quad (2)$$

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<sup>2</sup> We set aside the issue of how to share the benefits and costs (e.g. the counterparty risk of the participating firms against each other) of a cash pool system among the units of the group.

Let us integrate these two uniform firms into a cash-pool. If their original positions were of opposite sign, then these positions offset each other, and the aggregate deposit and credit are reduced accordingly. Otherwise, if the original positions' signs were the same or at least one of them was zero, then the aggregate position is the sum of the original ones, and there is no reduction in the overall deposit or credit, see Table 1.

Table 1: Illustration of the netting of the cash account positions

	$X_t^1$	$X_t^2$	$X_t = X_t^1 + X_t^2$	Reduction in the deposit
1	+15	-5	+10	+5
2	+3	-8	-5	+3
3	+4	+2	+6	0
4	-5	-1	+6	0
5	0	+7	+7	0
6	-9	0	-9	0

Source: the authors

As Table 1 shows, the reduction in the aggregate deposit,  $\Delta D_t$  is always positive or zero.

$$\Delta D_t = (D_t^1 + D_t^2) - D_t^{1+2} \geq 0 \quad (3)$$

The same applies to the reduction in the aggregate credit,  $\Delta C_t$ , as well:

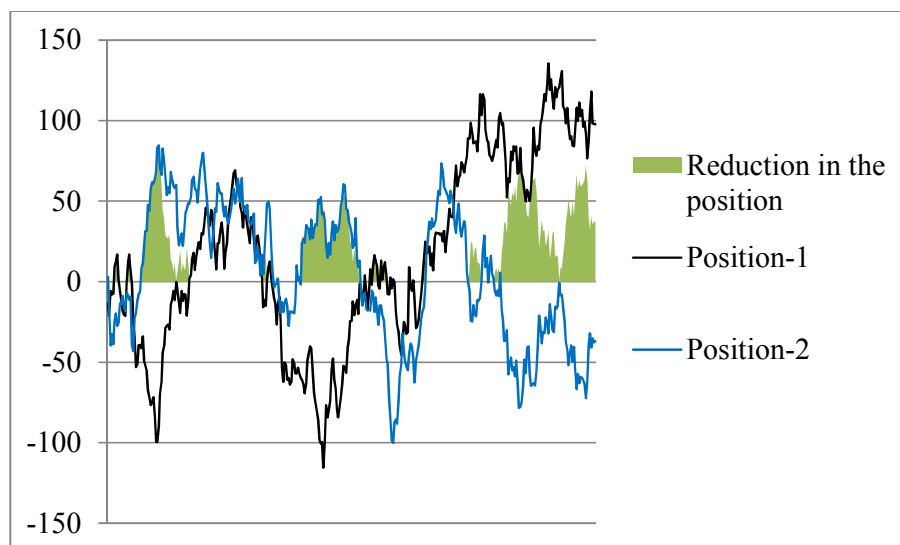
$$\Delta C_t = (C_t^1 + C_t^2) - C_t^{1+2} \geq 0 \quad (4)$$

It is obvious that the reduction in the deposit just equals the reduction in the credit. Let us call this amount as the *reduction in the position*,  $\Delta X_t$ :

$$\Delta C_t = \Delta D_t = \Delta X_t \quad (5)$$

Figure 1 illustrates how  $\Delta X_t$  may evolve over time if the initial account position in  $t=0$  is zero.

Figure 1: Illustration of the reduction in the account position due to cash-pooling over one year (a hypothetical random scenario)



Source: the authors

Let us denote the interest rate on the credit with  $c$  and the interest rate on the deposit with  $d$ . The benefit of the cash-pool  $B_t$  comes from two sources. Firstly, the firms benefit from the reduction of the position because of the net interest spread ( $c-d$ ), as the interest rate on the credit is higher than the interest rate on the deposit. Secondly, due the reduced position the firms have a lower counterparty risk exposure to the bank, as well. Let us denote the probability of default of the bank with  $p$ . In case of default, the loss is assumed to be 100% (loss given default = LGD = 100%). For the sake of simplicity,  $c$ ,  $d$  and  $p$  are all supposed to be fixed and are expressed on a daily basis. Therefore, the benefit of the firms coming from the cash-pooling at a given day is:

$$B_t = c\Delta C_t - d\Delta D_t + p\Delta D_t \quad (6)$$

Using (5), (6) and the notation of  $s = c - d > 0$  (interest spread) we get

$$B_t = (s + p)\Delta X_t \quad (7)$$

where only  $\Delta X_t$  is stochastic. The *total benefit realized over one year* ( $B$ ) can be calculated by adding up the daily benefits, provided that we disregard the compounding of the interests within a year, which is a common practice in the management of the bank accounts.

$$B = (s + p) \sum_{t=1}^{365} \Delta X_t = (s + p)X \quad (8)$$

where  $X$  is the *total reduction in the position over one year*. To evaluate the ex-ante benefits coming from a two-element cash-pool during one year, we have to calculate the expected value of  $B$  which is

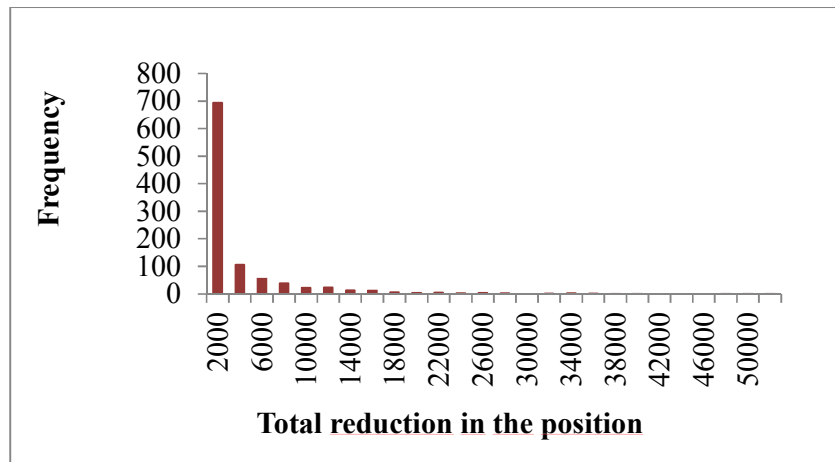


$$E(B) = (s + p)E(X) \quad (9)$$

Therefore, the key element of the valuation is the calculation of the expected total reduction in the position  $E(X)$ . One possible way of the calculation is, for example, the use of a Monte Carlo simulation as follows.

The individual accounts of two uniform firms were supposed to follow an Arithmetic Brownian motion. We defined the *base case* as a scenario of  $\mu = 1$ ,  $\sigma = 10$  and  $\rho = 0$ . We conducted a Monte Carlo simulation for one year where the number of repetitions was 10 000. For each repetition, we calculated the sum of daily reductions in the position ( $X$ ) which turned out to follow a highly asymmetric distribution shown in Figure 2.

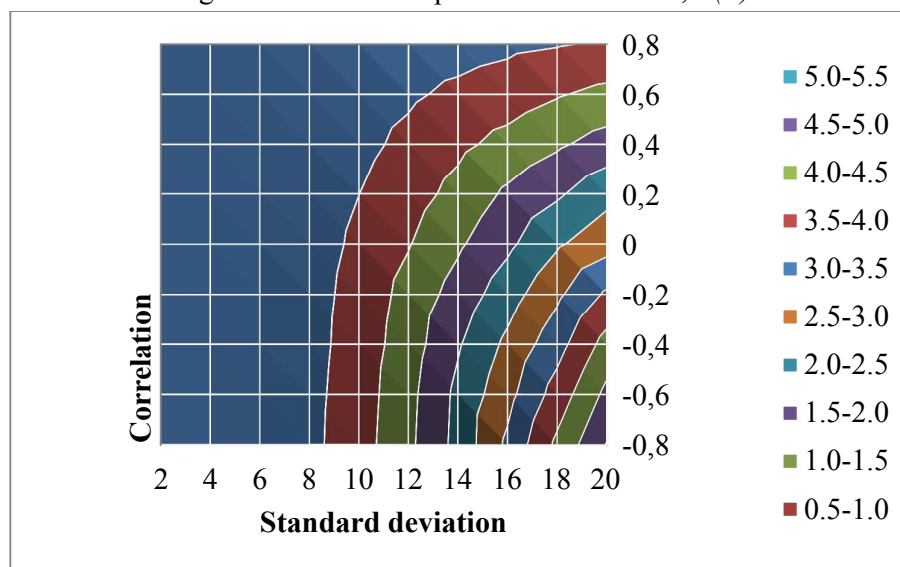
Figure 2: The distribution of the total reduction in the position over one year ( $X$ ) in the base case



Source: the authors

In the base case, the expected value of  $X$  was around 3000. If the yearly net interest spread is 3% and the yearly probability of default is also 3% (this corresponds to a rating category of “non-investment grade”), then  $s + p = 0.017\%$ . In this case, the expected benefit of one-year operation is around  $B = 3000 \cdot 0.017\% = 0.5$  which equals approximately half of the daily net cash income of one firm.

The simulation shows that this benefit depends more on the standard deviation ( $\sigma$ ) and the correlation ( $\rho$ ) than on the expected value of the daily cash inflow ( $\mu$ ). Therefore, we performed a sensitivity analysis on  $\sigma$  and  $\rho$ . Figure 3 presents the contour map of the bivariate benefit function:

Figure 3: Contour map of benefit function,  $E(B)$ 

*Source: the authors*

The benefit is increasing in the standard deviation and is decreasing in the correlation, as expected. It follows that cash-pooling is more valuable for more volatile and diverse firms. The correlation has a natural lower limit of -1 (in principle this would give the maximal cash-pool value), but this lower limit is unrealistic to be approached in normal business conditions. However, the standard deviation is not limited, and the value of the cash-pool is very sensitive to this parameter.

## 5. Results

According to (9), the benefits of the cash-pool over a year can be calculated as  $(s + p)E(X)$  where  $s$  is the net interest spread and  $p$  is the probability of default of the bank (both  $s$  and  $p$  are fixed and expressed on daily basis); whereas  $E(X)$  is the expected value of the reduction in the net cash account position of the firms participating in the pool sum up over the whole year which is the sum of the green area in Figure 1.

To get a general impression whether a cash pool implementation is worth for a company, first the base case is discussed. In the base case ( $\mu = 1$ ,  $\sigma = 10$  and  $\rho = 0$ ) the benefits of the cash-pool were around 0.5 day's expected income of one firm. Given that experts' estimations set the initial direct costs of a simple cash-pool implementation at around 5000 Euros, one-year benefits cover the initial costs only for those firms which have a daily expected net cash-flow higher than 10 000 Euros, that is more than 3.65 million Euros per year. In this calculation, we are referring to the net cash-flow (incomes minus costs) which is a proxy for the net profit. Supposing that the profit margin is around 10%, the payback period will remain under one year, only if the net sales of a firm are over 36.5 million Euros. As firms with a net cash-flow under 50 million Euros per year are considered as small or medium enterprises

(SMEs), we can conclude that the implementation of a cash-pool system can be a highly profitable project even for SMEs. Moreover, we can see in Figure 3 that if the volatility of the cash-flow increases, the value of the cash-pool increases sharply, as well. For example, if we double the volatility from 10 to 20, then the cash-pool becomes six times more valuable (around 3 days of the expected daily net cash-flow). Hence, in the case of high volatility even smaller firms (around net sales of 10 million Euros per year) may profit from cash-pooling.

The application of the valuation formula  $(s + p)E(X)$  in a real business situation may seem quite simple for the first sight as the interest rate spread ( $s$ ) and the probability of default of the bank ( $p$ ) are relatively easy to estimate. Standard spreads as the main factor of attractiveness of a cash-pool system are posted on the bank's webpages (non-standard firms can get special offers from the bank); in the developed financial markets it is ranging between 0.5%-6% with an average of 3% (Worldbank Databank, 2015), and may also be dependent on the general level of risk-free interest rate in the given economy, and other macroeconomic determinants (Dbouk and Kryzanowski, 2010). The probability of default of a given bank can be estimated from the rating of the bank, or from the bond prices issued by the bank or from the corresponding CDS spreads. Default rates in the banking sector are usually somewhere between 0%-4%, as it can be seen from the data of the rating agencies (Standard and Poors, 2014).

However, it is interesting to examine how these two parameters characterizing the bank side ( $s$  and  $p$ ) are interrelated. According to the empirical literature interest rate spreads depend mostly on the regulatory environment, the market position of the bank and the riskiness of the bank's portfolio.<sup>3</sup> It means that big, stable banks with significant market power and with low default probability usually operate with higher interest rate spread. Therefore  $s$  and  $p$  tend to be negatively correlated (Ho and Saunders, 1981; Wong, 1997; Saunders and Schumacher, 2000; Pasiouras et. al., 2007; Ionnidis et al., 2010; Tan 2012). It follows from this, that in normal conditions the value of a cash-pool is practically independent of the bank's characteristics. In the case of big and powerful banks the company benefits from the high interest spread but less from the reduced default risk; while in the case of small and risky banks it is the opposite case: the gain on the spread is low, and we can rather benefit from the reduced default exposure. The sum of the two component ( $s+p$ ), hence the value of a cash-pool can be maximal in the case of a bank with a high spread, which is due to its market power and not to its low risk.

Once we have estimation for  $s$  and  $p$ , which are the parameters reflecting the bank's position, we have to determine the expected reduction in the exposure over one year  $E(X)$  which is characterizing the firms' side, as it depends on the cash holding of the firms: its timing, magnitude, volatility and the correlation between them. This is the most difficult part of the evaluation process, as the expected reduction in the exposure cannot be calculated intuitively. This is why one has to turn to some simulation techniques as it was presented in this paper.

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<sup>3</sup> Most of the empirical articles deal with the interest rate margin which is not the same but closely correlated to the interest rate spread.

We know from the financial literature that corporate cash holdings depend mostly on the growth opportunities (+), the volatility of the cash-flow (+), and the access to the capital market (-). Due to this latter factor firms with high credit ratings can afford to keep relatively lower cash. Other, but less relevant determining factors can be the ownership structure, the liquidity of the assets<sup>4</sup>, the leverage, the bank debt, etc. (Oplet et al., 1999; Ozkan and Ozkan, 2004). Excess cash holdings can be the sign of investment related agency problems, as well (Huang et. al. 2015).

To sum it up, cash-pooling is more beneficial for heterogeneous and rather negatively correlated firms with large and volatile cash-flows. Large corporate cash holding can be due to significant and unforecastable growth opportunities, high volatility of the corporate cash-flows and to less accessible capital markets (for example because of the low credit rating or the underdevelopment of the capital market). On the other hand, interest rate spreads and the counterparty risk of the bank are also important factors which may show some variability across countries and over time, but can be easily estimated in a given situation. Cash pooling creates more value in case of using the services of banks with high interest rate spread and high default risk at the same time, which eventually can be explained by their significant market power. But practically, when evaluating the benefits of a cash-pool, the bank's characteristics are much less relevant than that of the participating firms.

## 6. Conclusion

We analyzed a special corporate banking product, the so-called cash-pool which gained remarkable popularity in the recent years as firms try to manage their liquidity more efficiently. We formulated a valuation model and applied a Monte Carlo simulation to assess the two most important benefits arising from a cash-pool: the interest rate savings and the reduction in the counterparty risk. We conclude that the value of a cash-pool is higher in the case of firms with large, diverse and volatile cash-flows having less access to the capital markets, especially if the partner bank is risky but offers a high interest rate spread at the same time. It is also shown that cash pooling is not the privilege of large multinational firms anymore as the initial direct costs can be easily regained within a year even in the case of SMEs, especially if the corporate cash holding is highly volatile.

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<sup>4</sup> For measuring the liquidity of the assets see: Gyarmati et al. (2010).

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Table 1: Illustration of the netting of the cash account positions

	$X_t^1$	$X_t^2$	$X_t = X_t^1 + X_t^2$	Reduction in the deposit
1	+15	-5	+10	+5
2	+3	-8	-5	+3
3	+4	+2	+6	0
4	-5	-1	+6	0
5	0	+7	+7	0
6	-9	0	-9	0

*Source: the authors*