A Direct Finance Deposit and Borrowing Method Built Upon the Web Implemented Bidding ROSCA Model

Adjunct Professor Kuen-Bao (Frank) Ling, National Taiwan University, Taiwan
President Yung-Sung Chien, SHACOM.COM INC., Taiwan
Finance Researcher Bing-Lun Hsieh, SHACOM.COM INC., Taiwan
Finance Researcher Yen-Tsen Chen, SHACOM.COM INC., Taiwan

ABSTRACT

ROSCA (Rotating Savings and Credit Association) works all over the world. In Taiwan, the bidding auction mechanism is implemented on the basis of ROSCA, developing into bidding ROSCA. The characteristics of bidding ROSCA, such as direct finance, combination of deposit and borrowing, and self-determined interest rate are important foundation for future financial services. Yung-Sung Chien (2002) devised a ROSCA business method that accommodates more participants by removing the bidding leader and by offering credit guarantee. This study is based upon such a strategy, using the concept of the overall fund balance to broaden the scopes of the bidding ROSCA, freeing which from the limit on participants, amount, and time to facilitate the bidding ROSCA and arrive at the deposit and borrowing interest rates that are actually determined by the market.

INTRODUCTION

This research will improve on the foundation of direct finance and combination of deposit and borrowing methods of the traditional ROSCA (bidding ROSCA), with an aim to overcome the constraints of the operation of the traditional ROSCA and expand the scope of use, as well as to utilize the computer and Internet technologies to create a brand new deposit and borrowing method.

Hence, this study has three purposes:
1. To create a direct finance method that enables the borrower and the lender to freely choose the roles they want to play in the system.
2. To improve the traditional ROSCA and break off the bounds of the original structure to transform it into a direct finance product that achieves greater efficiency with the use of computer and Internet technologies.
3. To create a friction-free trading environment that allows the participants to decide the interest rates autonomously so as to arrive at the real deposit and borrowing interest rates in the market.

LITERATURE REVIEW

This study plans to construct a deposit and borrowing method built upon the direct finance model. There are two facets for discussion of our research on academic papers. The first facet is related papers on the direct finance model, and the other is related papers on the ROSCA model.

Direct Finance

Tsai (2000) thinks that large corporations rely more and more on the direct finance model for their capital needs while mid-sized companies and small businesses do not. Tsai sees the act of businesses borrowing from banks as an example of indirect finance and the act of raising fund from issuing commercial papers in the money market as direct finance. As the percentage of the fund needs of large corporations filled by the secondary market gradually increases at the expense of other means of fund gathering, it stands to reason that large corporations are becoming more dependent on the direct finance model for their financing. Mid-size companies and small businesses do not exhibit this trend as
they are less likely to issue commercial papers on the secondary market due to the lack of credit worthiness. However, that does not prove that mid-sized companies and small businesses have less desire for direct finance means to satisfy their fund needs. As this study demonstrates, direct finance will exert an increasingly greater influence on the deposit and borrowing.

**Bidding ROSCA Model**

Huang (2001) constructed a web-based system that implemented the ROSCA model. The system shows the feasibility of a web-based ROSCA implementation through a set of methods that are complete, reliable, private, fair, verifiable, and able to validate eligibility. The reliability bidding process in the web-based ROSCA implementation has been verified and proven feasible, thus there are no technical issues with the web operated system.

Chien (2002) removes the bidding leader from the traditional ROSCA and places the financial institution in its place, utilizing computer systems and network technologies to enable web-based ROSCA. With no bidding leader, the total loan amount can be calculated in the following two formulae depending on when the interest is paid:

The required fund to the bid-winner for time period 1 = (Contribution amount x (Number of time periods – 1)) – premiums.

The required fund to the bid-winner for the remaining terms:

\[ A_n = (U - I_n) \times [(N + 1) - (n + 1)] + (U \times n) \] ………………………………………….(2.1) or

\[ A_n = (U \times [N - (n + 1)]) + [U \times (n - 1)] + \sum_{i=1}^{n-1} I_{ni} \] …………………………………………..(2.2)

The above method mitigates the risk of the bidding leader having moral hazard by putting the financial institution in charge of the operation, it also allows the ROSCA implementation to become standardized and expand its participant base; however, it does not remove or remedy any of the restrictions of the ROSCA model itself.

**DEPOSIT AND BORROWING STRATEGY IN DIRECT FINANCE**

There is an inherent disadvantage with either the traditional ROSCA model or the web ROSCA model: each bidding pool is strictly limited by several factors. All the bidders of the ROSCA must all comply with the same criteria before actual bidding may begin. These criteria include: first, the number of bidders must be equal to the number of time periods for the pool; second, under the same bidding pool, each bidder must use the same time frame for submitting and winning bids as well as paying the same contribution amount.

To mitigate the above mentioned limitations and inefficiencies, this study will construct a direct finance system that is built upon the web implemented ROSCA model and based on the concept of fund balance to demonstrate the efficiency improvements under the direct finance model.

This study utilizes the improved structure proposed by Chien (2002) that adds the concept of fund balance to create a new method of deposit and borrowing within the direct finance model.

The traditional ROSCA is a direct finance implementation with numerous major limitations and restrictions that has a fund balance at equilibrium. This study seeks to assimilate the different types of ROSCA and apply the concept of fund balance throughout the entire transaction. At the end of each time period in the study, the different needs for funds for each member can be calculated (the bidders have borrowing needs, and the non-bidders have deposit needs). The optimal fund balance is where the funds deposited is exactly equal to the funds borrowed, and therefore at zero, which is a type of direct finance. However, the probability for the fund balance to be exactly zero is very low; thus the fund balance would likely be greater or less than zero. If the fund balance is greater than zero, the system would generate interest expense; if the fund balance is less than zero, the system would receive interest payment. Thus, this study assumes that the fund balance has to be less or equal to zero. To calculate the fund balance, the system takes all the deposits from all the non-winning participants, subtracts that number by the total loan amount of all the winning bids at that time period.
There are six steps in determining the fund balance that will satisfy the need for funds for as many participants as possible: steps 1 and 2 will calculate the fund balance when there are no winners. If the balance is less or equal to zero, then the balance for this time period is at equilibrium; otherwise, if the fund balance is greater than zero, the system will proceed to step 3. Steps 3 and 4 calculates the minimum number of bid winners that will allow the fund balance to be less or equal to zero to determine the final outcome for this time period. Steps 5 and 6 will take the results from the calculations to determine the loan amount to be received by the bid winners and the required deposit for the non-winners. The steps will be discussed in detail below.

**Step 1: Calculate the Fund Balance Assuming No Bid-winner**

First, the system calculates the current fund balance with no winning bids. In step 1 we only calculate the total deposit amount from all the participants. The amount is calculated depending on when the interest is realized. The three formulae below are used.

Interest paid first: \( U - IH_n \) .................................................. (3.1) or \( U - IX_n \) .................................................. (3.2)

Interest paid after: \( U \) .................................................. (3.3)

where
\( U \) = the upper limit for the bids
\( IH_n \) = the maximum bid at the \( n \)th time period for the specific participant
\( IX_n \) = the required deposit amount calculated from the base interest rate for the \( n \)th time period.

The base interest rate mentioned above means a reserved bid for the auction. It can be provided according to the market term deposit rate.

The three formulae used in the situation of interest paid first are distinguished by the participant who bids or not. The above mentioned interest paid first means that the total loan amount received by the winning bid has already had the entire interest deducted, similar to a zero coupon bond. Whereas interest paid after refers to the winning bidder will receive the entire loan amount at auction close, and the interest payment will be included into the repayment installments, similar to a normal loan or mortgage.

**Step 2: Determine if the Fund Balance for the Previous Time Period X + The Current Fund Balance \( B_0 \) is Less or Equal to Zero**

If the fund balance for the previous time period \( X \) plus the fund balance for the current time period \( B_0 \) is less or equal to zero (\( B_0 + X \leq 0 \)), then no one has won the bid at the current time period, which means that all the participants must deposit the required amount into the system; conversely, if the fund balance is greater than zero, then the system will enter step 3.

**Step 3: Ranking the Borrowing Interest Rate**

If the fund balance calculated in step 2 is greater than zero, then the system would rank the bidders by the corresponding borrowing interest rate calculated through the bid. We can use formulae below to calculate the effective borrowing interest rate for any participant at the \( n \)th time period. First we use the formula (3.4) to calculate the average deposit interest rate \( r \) for all the prior time periods; next we use the formula (3.5) to calculate the effective borrowing interest rate \( R \) for the current time period. The formulae are as follows.

\[
\sum_{i=1}^{n-1} (U - I_i) \times (1 + r)^{(N-i)} = U \times (n - 1) \] .................................................. (3.4)

\[
\sum_{i=1}^{n-1} (U - I_i) \times (1 + r)^{(N-i)} + \sum_{j=1}^{N-n} U \times \left( \frac{1}{1 + R} \right)^j = A_n \] .................................................. (3.5)
where
\( U \) = the upper limit for the bids
\( N \) = the total number of time periods for the auction
\( n \) = the current time period, and \( n \leq N \)
\( I_i \) = the amount deposited by the participant at the \( i^{th} \) time period where \( i < n \)
r = the average deposit interest rate from the 1\( \text{st} \) time period to the \( i^{th} \) time period where \( i < n \)
\( R \) = the effective interest rate
\( A_n \) = the total loan amount for the winning bid at the \( n^{th} \) time period (please see formulae 3.7 and 3.8)

Once the effective borrowing interest rates for all the participants at the current time period are calculated, the system then ranks the rates from the highest to the lowest.

**Step 4: Determine the Least Number of Bid-winners that Will Allow the Fund Balance to Be Less or Equal to Zero**

This step relies on trial and error to determine the number of bidders \( n \) that will allow the combined fund balance for the current time period and the previous time period to be less or equal to zero.

\[
\text{Min} \left\{ n \mid B_n + X \leq 0 \right\} \quad \text{………………………………………………………………………………. (3.6)}
\]

where
\( B_n \) = the fund balance of the current time period when the winning number of bids = \( n \)
\( X \) = the fund balance for the previous time period

The possible total loan amount of the \( n \) winning bids can be calculated based on interest realization in the following two formulae.

Interest paid first: \( A_n = (U - I_n) \times (N - n) + U \times (n - 1) \) \quad \text{……………………………………… (3.7)}

Interest paid after: \( A_n = U \times (N - n) + U \times (n - 1) + \sum_{i=1}^{n-1} I_i \) \quad \text{……………………………………… (3.8)}

where
\( A_n \) = the total loan amount for the winning bid at the \( n^{th} \) time period
\( U \) = the upper limit for the bids
\( N \) = the total number of time periods for the bidding auction
\( n \) = the current time period, and \( n \leq N \)
\( I_n \) = the winning bid for the participant at the \( n^{th} \) time period
\( I_i \) = the amount deposited by the participant at the \( i^{th} \) time period where \( i < n \)

The average interest rate for the \( n \) winning bids can be determined. Next we can calculate the required deposits for each non bid-winner (depositor). Again, based on when the interest is realized, we have two formulae.

Interest paid first: \( (U - IA_n) \times (1 + R_a)^{(N-n)} = U \) \quad \text{……………………………………………… (3.9)}

Interest paid after: \( U \times (1 + R_a)^{(N-n)} = U + IA_n \) \quad \text{……………………………………………… (3.10)}

where
\( U \) = the upper limit for the bids
\( N \) = the total number of time periods for the bidding auction
\( n \) = the current time period, and \( n \leq N \)
\( IA_n \) = the required deposit calculated from the average interest rate for the \( n^{th} \) time period
\( R_a \) = the average borrowing interest rate
We can use $IA_n$ and the following two formulae to calculate the amount required for deposit for the non-winners.

Interest paid first: $U - IA_n$ .......................... (3.11)
Interest paid after: $U$ ........................................ (3.12)

where
$U = \text{the upper limit for the bids}$
$IA_n = \text{the required deposit calculated from the average interest rate for the } n^{th} \text{ time period}$

**Step 5: Settlement of Bid-winners.**

For the bid winners (borrowers), calculating how much they will receive from the winning bid will depend on when the interest is realized (Formulae (3.7) and (3.8)).

The winning bidders will need to repay the loan in the forthcoming time periods, the formula to calculate how much the winners will need to repay are as follows:

Interest paid first: $U$ ........................................ (3.13)
Interest paid after: $U + I_n$ ................................ (3.14)

where
$U = \text{the upper limit for the bids}$
$I_n = \text{the winning bid for the participant at the } n^{th} \text{ time period}$

**Step 6: Settlement of Non Bid-winners**

If the current time period has winning bids, we can use formulae (3.11) and (3.12) to calculate the amount required for deposit for the non-winners.

If there were no winning bids for the current time period, but the participant did submit a bid, the required deposit amount would be calculated as the formulae (3.1), (3.2), and (3.3).

**SIMULATION ANALYSIS**

In this section this study assumes that we have A, B, C, D, E, F, six participants participating in the direct finance model for simulation analysis. The bidding criteria and bidding cash flow are listed as follows in Tables 1 and 2.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Term (Year)</th>
<th>Interval (Month)</th>
<th>Total Time Periods</th>
<th>Maximum Bid</th>
<th>Entry Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>$15,000</td>
<td>January 1st</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>$10,000</td>
<td>January 15th</td>
</tr>
<tr>
<td>C</td>
<td>5/6</td>
<td>0.5</td>
<td>20</td>
<td>$15,000</td>
<td>February 1st</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>0.5</td>
<td>24</td>
<td>$10,000</td>
<td>January 1st</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>$15,000</td>
<td>January 15th</td>
</tr>
<tr>
<td>F</td>
<td>0.25</td>
<td>0.5</td>
<td>6</td>
<td>$10,000</td>
<td>October 1st</td>
</tr>
</tbody>
</table>

Table 1: Participant Bidding Criteria
The fund balance for this time period is ($148,108), which is until the last time period, December 1st. The effective interest rate for participant A is higher than the effective interest rate for participant D, so participant D is now a depositor. Using participant A’s effective monthly interest rate of 0.9248%, the required deposit to repay $15,000 on the first of every month for 12 months is $8,092. The total loan amount is $156,200, and participant A would need to repay $15,000 on the first of every month for 12 months. Through calculation of (3.4) and (3.5), the effective interest rate for participant A is higher than the effective interest rate for participant D, and the system will award the bid to participant A. The total loan amount is $156,200, and participant A would need to repay $15,000 on the first of every month for 12 months. December 1st. Because participant A won the bid, participant D is now a depositor. Using participant A’s effective monthly interest rate of 0.9248%, the required deposit amount for participant D is calculated to be $8,092. The fund balance for this time period is ($148,108), which is $8,092 - $156,200. The above is summarized in the following Table 3.

### Table 2: Bidding Cash Flows

<table>
<thead>
<tr>
<th>Bid</th>
<th>January 1st</th>
<th>January 15th</th>
<th>February 1st</th>
<th>February 15th</th>
<th>March 1st</th>
<th>March 15th</th>
<th>April 1st</th>
<th>April 15th</th>
<th>May 1st</th>
<th>May 15th</th>
<th>June 1st</th>
<th>June 15th</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>150,200</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
</tr>
<tr>
<td>B</td>
<td>800</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
<td>9,700</td>
</tr>
<tr>
<td>C</td>
<td>700</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
<td>14,500</td>
</tr>
<tr>
<td>D</td>
<td>800</td>
<td>8,092</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>E</td>
<td>700</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
<td>14,300</td>
</tr>
<tr>
<td>F</td>
<td>800</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
</tr>
</tbody>
</table>

As Table 2 shows, on January 1st, the first time period, there were 2 participants participating in the bidding, A and D. Each submitted a bid of $800. The fund balance would be $23,400 ($14,200 + $9,200 = $23,400) if there were no winners. As this number is greater than zero, the system would need a winner for the auction. Through calculation of (3.4) and (3.5), the effective interest rate for participant A is higher than the effective interest rate for participant D, and the system will award the bid to participant A. The total loan amount is $156,200, and participant A would need to repay $15,000 on the first of every month for 12 months until the last time period, December 1st. Because participant A won the bid, participant D is now a depositor. Using participant A’s effective monthly interest rate of 0.9248%, the required deposit amount for participant D is calculated to be $8,092. The fund balance for this time period is ($148,108), which is $8,092 - $156,200. The above is summarized in the following Table 3.

### Table 3: Comparison of Borrowing Interest Rates (January 1st)

<table>
<thead>
<tr>
<th>Participant</th>
<th>Term (Year)</th>
<th>Interval (Month)</th>
<th>Total Time Periods</th>
<th>Maximum Bid</th>
<th>Effective Interest Rate (monthly)</th>
<th>Total Loan Amount</th>
<th>Required Deposit Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>$15,000</td>
<td>0.9248%</td>
<td>156,200</td>
<td>8,092</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>0.5</td>
<td>24</td>
<td>$10,000</td>
<td>0.7064%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regarding January 15th, the second time period, there were three participants who submitted bids, B, D, and E, with bids of $300, $600, and $700 respectively. Suppose all three participants fail to win the bid, the fund balance for this time period would be $33,400 ($9,700+$9,400+$14,300=$33,400). Then add this number to the fund balance for the previous time period of -$148,108, the accumulated fund balance for this time period comes to $114,708. As the accumulated fund balance is less than zero, no participant will win the bid. Similarly, the accumulated fund balance continues to be less than zero for the third and fourth time periods on February 1st and February 15th, no one would win the bid for those two time periods, either.
As for the fifth time period, March 1\textsuperscript{st}, participants C and D submitted bids for $900 and $500, participant A has already won a bid, and thus is ineligible. Again, assuming participants C and D do not win the bid, the fund balance for this time period is $38,600 ($14,100+$9,500+$15,000=$38,600). Adding this number to the fund balance of the previous time period of -$28,408, and the accumulated fund balance for March 1\textsuperscript{st} comes to $10,192. As the accumulated fund balance is greater than zero, a bid winner is needed for this time period. Through calculations of formulae (3.4) and (3.5), the effective interest rate offered by participant C is higher than the effective interest rate offered by participant D, and the system awards the bid to participant C, with the total loan amount of $269,700 and repayment of $15,000 on the first of the month beginning in April until the time period ends in December.

For participant D, the required deposit amount is calculated through the effective interest rate offered by participant C (1.2618% monthly), and it comes to $7,880. The fund balance for this time period can then be calculated. The required deposit amount for participant D $7,880 – the total loan amount for participant C $269,700 + the repayment for participant A $15,000, and the fund balance comes to -$246,820. Table 4 lists the required deposit amount and the effective interest rates for the bids submitted by each participant.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Term (Year)</th>
<th>Interval (Month)</th>
<th>Total Time Periods</th>
<th>Maximum Bid</th>
<th>Effective Interest Rate (monthly)</th>
<th>Total Loan amount</th>
<th>Required Deposit Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>5/6</td>
<td>0.5</td>
<td>20</td>
<td>$15,000</td>
<td>1.2618%</td>
<td>269,700</td>
<td>7,880</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>0.5</td>
<td>24</td>
<td>$10,000</td>
<td>0.3889%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION

In a world where lenders and borrowers still rely on the indirect finance model, the advantages of the direct finance model are undeniable. This study utilizes the traditional ROSCA model to create a new direct finance method. Using the accumulated fund balance concept to determine the auction outcome at a particular term, the method improves upon the ROSCA model by removing the limitations on the number of participants, time, and contribution amount, and closely approaches the realization of a truly direct finance model.

Furthermore, this study also provides the ROSCA model a new way to calculate interest rates, allowing the participants to obtain a fair and mutual beneficial interest rate under varying conditions. Below lists the main accomplishments of this study.

1. Direct finance deposit and borrowing method: this study creates a new method by using the principles of the traditional ROSCA model. It allows the borrowers and the lenders to interact without an intermediary, thus minimizing controls on interest rates.
2. Introduces the concept of accumulated fund balance. The traditional ROSCA model is severely limited by the number of participants, time, and contribution amount, making implementation extremely difficult. This study combines different types of ROSCA along with participants of varying requirements together, and automatically determines the outcome of the auction based upon the accumulated fund balance at each term. Once the outcome is determined, the system then calculates the total fund won by the winner, and the required deposit amount for the non bid-winners. This not only removes the limitations of the traditional ROSCA model, it also greatly improves the efficiency for the platform operators that implement this method.
3. Reflection of market rates. As an explicit benefit of the direct finance model, both the lender and the borrower obtain the most favorable interest rates. As such, the interest rates determined through the method can best reflect the interest rates for the current market conditions. And, as this method combines all ROSCA with different conditions, it eliminates the probability for those illogical bids that adversely affect the traditional ROSCA bidding to affect the new method.
REFERENCES


