The Use of System Dynamics Models to evaluate the Credit Worthiness of firms

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ABSTRACT

Evaluating new bank loans has been considered as one of the main dilemmas that banks managers have to deal with in order to reduce the probability of default. The lending process is a series of activities involving two main parties whose association ranges from the loan application to the successful or unsuccessful repayment of the loan. This paper describes the construction of a flight simulator which uses the ideas of System Dynamics and the Viable Systems Methodology. The Decision Support Tool thus formed uses systemic approaches to measure a firm's performance and can provide a risk assessment in the sense of evaluating performance under different (what- if) scenarios. The credit worthiness from this model can then be evaluated against the usual estimate based only on financial ratios.

1. Introduction

The Credit Industry in Jordan has expanded over the last few years, due to intense competition and the increasing number of credit card issuers, new loans product and new banks. More and more, small firms can have credit without serious check of their credit status due to the weakness in the existing risk assessment approaches. This expansion policy has increased the default rate and number of bankruptcy cases. These problems require different ways of thinking, different ways to help the credit officers in the banks to understand the credit worthiness of firms.

2. A need for a new methodology to measure a firm's performance and to work as a credit assessment tool.

2.1 Existing credit scoring techniques

Nowadays, the global banks are trying to decrease the default loans by using various types of applicant or customer credit risk management systems and by using new tools and methods to improve the evaluation of the quality of credit decisions. Banks

and bank consultants have attempted to sell such sophisticated credit risk management systems that aim to devise risk management strategies and to alter the borrowing and lending practices by bank loan officers and the financial institutions in order to limit their risk exposure (Cebenoyan, Strahan 2004).

Typical of such a model which takes into account both interest rate risk and credit risk is one by Mari and Reno. They illustrate a strong procedure which could be useful for estimating models for bank loans for different economic sectors. It is assumed that banks have historical data and default probabilities. A defect is that there is no feedback involved and they do not look at possible future scenarios. (Mari and Reno 2004)

A number of credit scoring models that classify consumer loan applications have been developed to aid traditional Judgmental methods.
One such method uses neural networks. The existing customers are segmented by dividing the customers into two groups (good and bad credit customers) and proposing management strategies for each group (Kim, Sohn 2004). Such a credit scoring system has an effect on the lending decision and the companies. It lowers information costs between borrowers and lenders and increases the portfolio share of small business loans (Frame 2001). Others evaluate the effectiveness of decision support system (DSS) for the credit process. This helps in the analysis of balance sheets, cash flow analysis, calculation of financial ratios, sensitivity analysis, future projections and risk evaluation (Kanugo, Sharma, Jain 2001). The final goal is to achieve a better lending decision. Taking into consideration the basic principals of financial analysis, and risk management and there is persuasive evidence that a good DSS improves this decision-making process.

Some researchers just look at loan profitability. They argue that each of the incoming loan applications offers the bank a unique risk-adjusted rate of return. This return is actually the profit for the bank; the expected profitability of each potential loan depends on both the applicant's observable default-risk and the offered contractual interest rate (Deshmukh, Greenbaum, Kanatas 1983). The credit officers evaluate the risk-adjusted rate of return, the future lending opportunities and the volume of loans already made in order to take their decision to either approve or deny the loan application. The analysis of comparative financial statement in the form of a study of the relationships between the items in the statement can be really effective. Such a comparative analysis can be expressed by mathematical ratios between the variables or the items in the statement. There are over 41 financial ratios used by the analysts. Most financial ratio measures seem to discriminate well between good and bad credit risks based on their mean value. Before attempting a comparative analysis of data in financial statement, we must make sure that the financial statements are reasonably adequate for the purpose, they should be complete, should also be of recent data, or at least limited to the period they cover.

The credit officer is interested in the relative competitive position of each customer as reflected by financial ratios. He should be able to exercise judgment in limiting the amount of credit extended to each customer. Furthermore, he can advise customers of ways and means of bettering their credit standing through improving their efficiency in capital management.

2.2 Need for a New Methodology

Although mathematically derived credit scoring tools are a definite improvement over subjective judgmental and intuitive methods to evaluate the credit application loans, most of the commonly used systems are assumed to act independently and their methodology uses curve-fitting or a regression technique. Some problems are that often Balance Sheets can be 'adjusted' to portray a rosier picture of the financial health of the company than is actually exists so the financial ratios are rendered in appropriate. Also they give a static picture whereas we live in a dynamic world. They also just provide a snapshot whereas it would be much more useful if a holistic picture of the company was assembled which would reflect the company's ability to survive of the period of the loan. Far too often decisions are taken on data based on past events which have no bearing on future events (Moscardini, Lawler, Loutfi 1998) Also, these models do not include the effect of delays in the system. In all aspects of life, there are delays – some serious and some not. These delays can have non-linear effects which are a breeding ground for Chaotic behaviour i.e. behaviour where small changes in some parameters can result in massive changes in the financial position of the company. Furthermore, many of these tools do not explain how and why they have identified a potential "good" or "bad" loan application which might restrict the use of such systems and techniques.
A second need is that although a company could be profitable today, its organisational structure may be poor and therefore it would not be able to withstand any major changes in its environment. The Viable Systems Model posits an organisational structure which must exist in order for an entity to be viable (i.e. able to survive)
It is an interesting challenge to see how the VSM can be combined with System Dynamics to produce a much more realistic picture of a company's credit worthiness.

A new methodology should be flexible enough to permit dynamic runs which allow for delays and non-linearities and predict the company's behaviour towards possible shocks in its environment.

2.3 System Dynamics as part of the new methodology

We propose that System Dynamics satisfies the previous requirements for a new methodology. In our case, the advantages of System Dynamics are as follows:

- It can produce dynamic models which give a significant advantage over traditional modelling techniques in understanding the pattern of behaviour.
- It allows easy insertion of delays and non-linearity, which is always important in the case on credit analysis, this allows System Dynamics models to introduce better picture of the real financial position of the firms.
- It allows one to measure soft relationships using graphs. Such a technique for representing non-measurable features coupled with advanced modelling software as Powersim Studio interface eases significantly the modelling task; it also allows one to easily simulate different scenarios.
- It allows one to model with little data because the "cause" and "effect" relationships are mostly defined, this gives a strong potential for using System Dynamics models.

- It allows the user to examine behaviour under “what if scenarios “which provides a risk assessment of the company’s future prospects.

Sterman (Sterman, 2000) gives an insight that the real value of an SD model should be to eliminate problems by changing the underlying structure of the system rather than anticipating and reacting to the environment. This allows the model to interact with the environment and gives/alerts feedback for structure changes

We have built a simple example of a generic System Dynamics model of a small retail firm composing its main operational factors that can be changed through implementing new strategies. The System Dynamics model will evaluate the firm’s performance according to these new strategies. The main goal will be to test if this firm really needs to obtain a bank loan to continue its operation regularly and whether it will be viable enough to repay its debts in the future. It therefore evaluates the credit worthiness of the firm over time (trend analysis). .
Some financial ratios are still used in the model but they are not used as the primary basis for approving a loan or rejecting loan application. They are just one of the building blocks in the construction of a firm’s total financial picture.

2.4 VSM as part of the new methodology

The VSM will be used as a diagnostic tool to ascertain if the company has in place the organisational structures that are needed for viability. This would investigate the communication channels, the different parts of the organisation and the levels of recursion that exist. These facts will be discovered by appropriate questions linked to a decision tree where answers to one question then lead to other questions. The emphasis of this paper is on the System Dynamic aspect but the combination of System Dynamics with Cybernetics is very interesting

We also have constructed an interface build on the SD and VSM model that allow the credit officer (analyst) to anticipate the financial consequences of the firm’s loan plan and strategies. This is a prototype flight simulator which will help them (the lenders) to understand the firm’s past performance, its financial structure, and its managerial philosophy and strategy. It also provides the basis for reasonable expectations about the firm’s capacity for repaying debt.

3.0 The Case Study and the System Dynamics Model

The System Dynamics model was designed for a small retail firm. It is assumed that this firm usually purchases finished products from wholesalers or directly from manufacturers for resale to a consumer. The operating cycle can involve cash or accounts payable used to purchase inventory (a finished product) which then is sold directly to the public on credit or cash.
It is hoped that a credit analyst in the bank will find it much easier to understand and evaluate the credit worthiness of firms applying for a loan by using our interface based on SD model. (This interface was built using Powersim Studio).
First, he will use the firm’s financial statements as an input to the interface by connecting the interface with a excel sheet, and implementing the major policies in the firm in order to calculate the main financial ratios.

Second, using the interface parameters, the analyst can evaluate the firm's performance under different scenarios. In our case-study, we analyse the impact of new loans on the previous financial ratios and estimate the firm's future strategies if the bank approves its loan application?

A simple example of a generic SD model will be shown in this section. This simple model helps the modeller to understand the complexity and unpredictability through the modelling of

- interdependencies between the main variables in the small firm
- relationships (including non-linear) between policy levers and affected variables.
- Delays between causes and effects.

3.1 Stock and Flow Diagram

Generally, three fundamental financial statements represent the financial position of any firm, balance sheet, cash flow statement and the income statement. The Balance sheet is a detailed list of assets, liabilities, and owner's equity, showing a firm's financial position at a given date. Assets modelled are cash, account receivable, inventory (in our case, finished product), while the liabilities are accounts payable, long term debt and bank credit. An Income statement is a summary of a firm's income and expenses over a given period of time while cash flow statement reflects a summary of a firm's operating, financing and investing activities (cash receipts and payments) over a specific period of time. Figure 1 shows the Income statement structure which consists of the main variables included in the income statement provided by the firm.

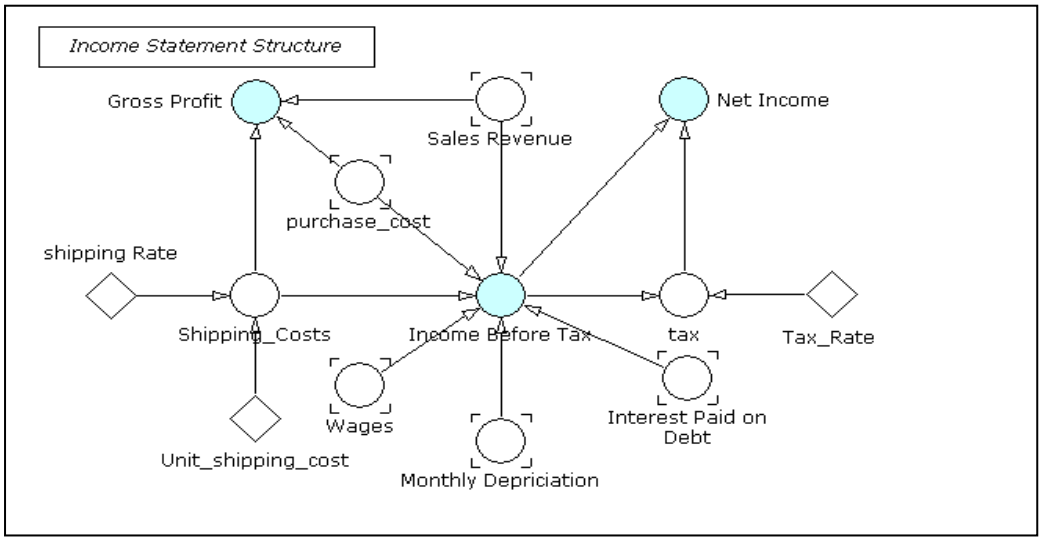

Figure 1: Income Statement Structure

Figure 2 shows the structure of the cash, bank credit and account receivables.

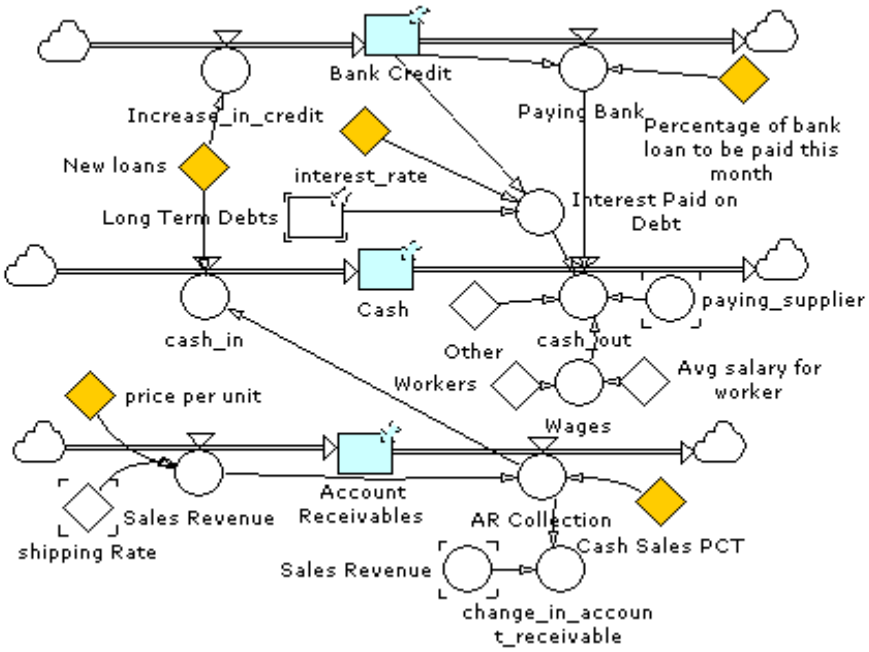

Figure 2

Figure 3 shows the structure of the account payable and inventory.

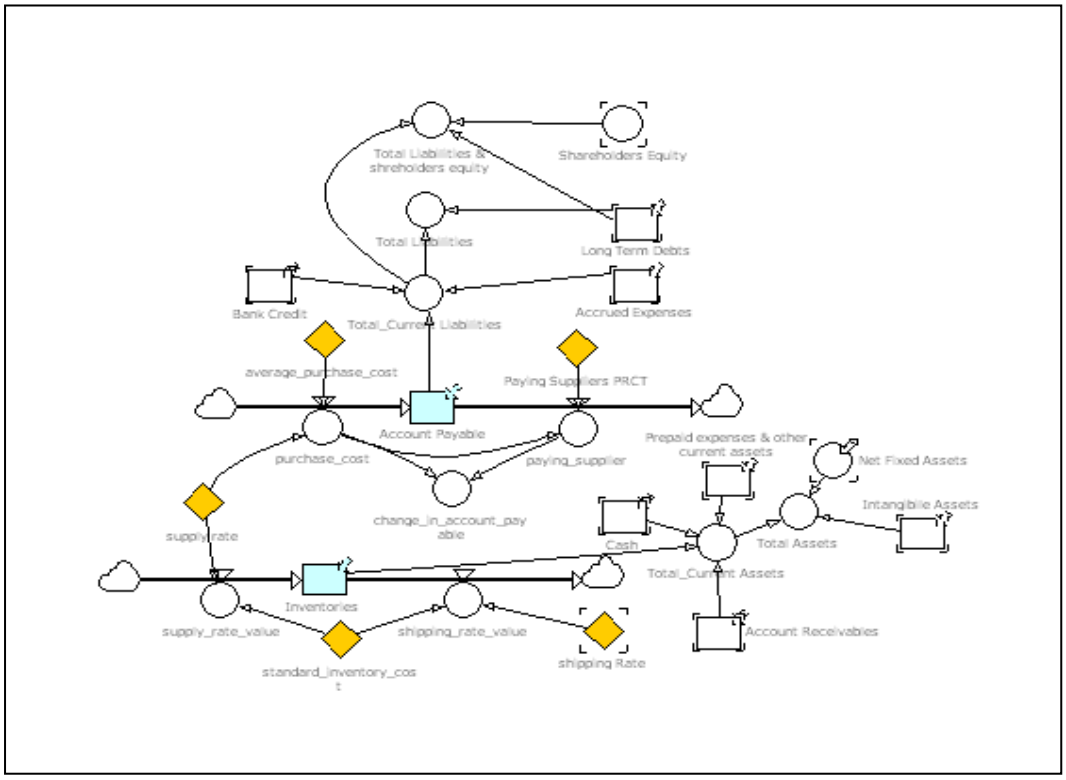

Figure 3: The Account Payable and Inventory structure

In the interface, the credit officer will be able to test the effect of new loan on the firm. The variables in “orange” represent the parameters that the credit officers can change through the simulation to test their different scenarios. At the same time he will be able to switch pages to the calculation of financial ratios to evaluate the firm’s performance.

Figure 4 represents the major financial ratios used in our study; ratios can be grouped into four main categories, each of which represents an aspect of a firm’s financial well-being. In our study we will focus on the main ratios in each category. The main categories are:

1. Liquidity ratios : include Current ratio, quick ratio
2. Activity ratios: include Account Receivables turnover ratio, Account payables turnover ratio
3. Leverage ratios: include debt to equity ratio and debt to assets ratio
4. Profitability ratios: include return on assets, return on equity and net profit margin.

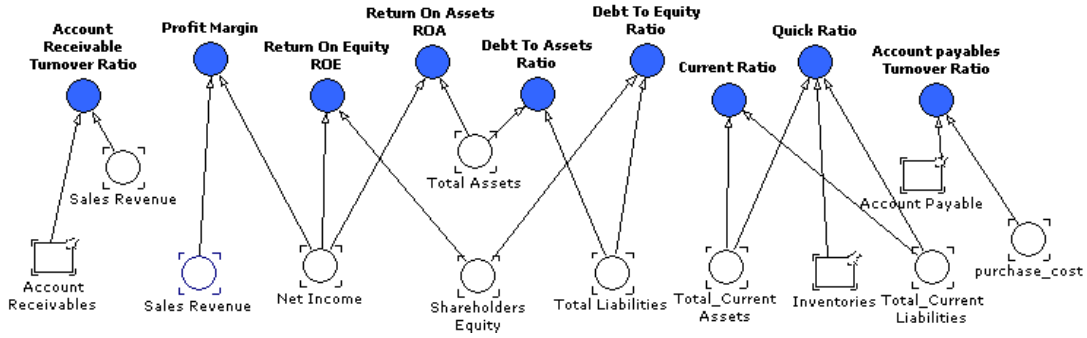

Figure 4

4.0 Run the Simulation

Figure 5 represents the final step in the firm’s analysis evaluation; the following interface is a sample of comprehensive parameters that can be changed through the simulation .it is based on the previous System Dynamics model which allows the analyst to:

- Use the firm’s financial statements as an input to the interface to calculate the financial ratios for the current financial situation and before obtaining the new loan.
- Allow the analyst or the user to measure the firm’s performance under different what if scenarios through the changes in its financial ratios when implementing these scenarios.
- Allow the credit officer to analyse the firm’s loan application through simulating the impact of the requested loan on the firm’s future performances.

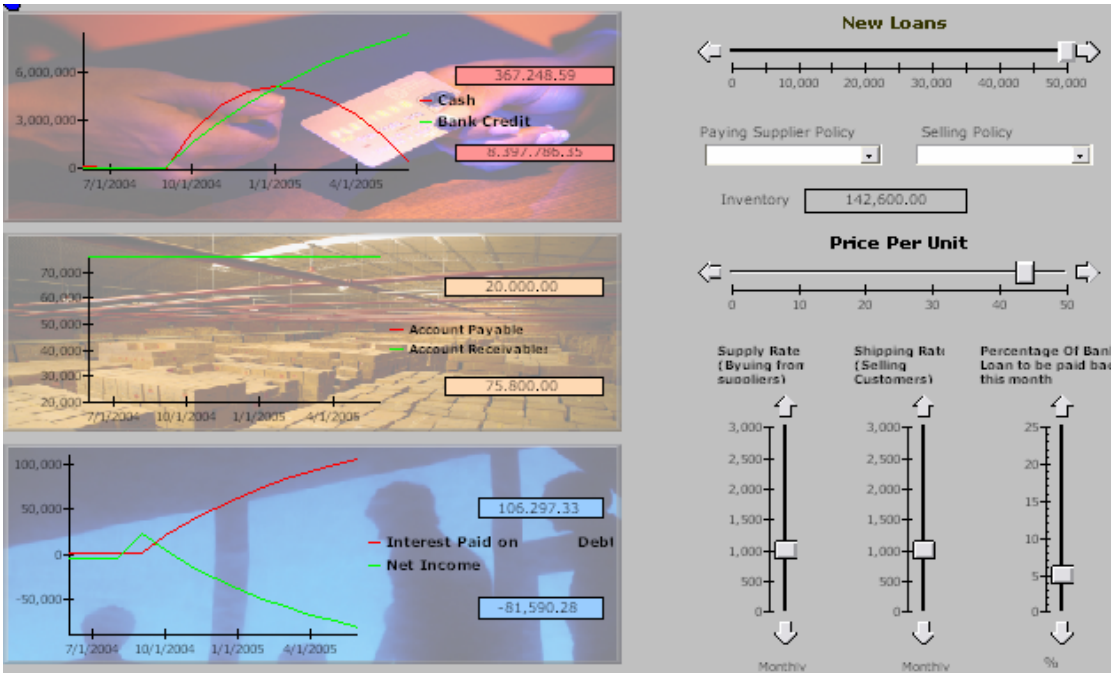

Figure 5: The System Dynamics simulation interface

5.0 Conclusions

The common ways of analysing the creditworthiness of firms provide the banks with static snapshots of the real world, but the analysts usually are not able to communicate the time dimension of the models of the small firms. The advantages of introducing this system dynamics methodology into the financial analysis are obvious. The credit officers will then not just regurgitating dry financial analysis methods, but will actively interact with models of the firms and experiencing a real insight into the firm's financial position. The credit officer can now answer to him self the question what if, what will happen to the firm's performance if the bank approved its loan request?

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