

**NeuroEvolution of Augmenting Topologies for predicting financial distress:  
Evidence from Tunisia**

**Senda Belhaj Slimene**

IHEC (Institut des Hautes Etude Commerciale : High Commercial Studies Institute) of Carthage

Victor Hugo Street, Carthage Presidence, Carthage, Tunis, Tunisia

senda.belhaj.slimene@gmail.com

**Chokri Mamoghli**

IHEC (Institut des Hautes Etude Commerciale : High Commercial Studies Institute) of Carthage

Victor Hugo Street, Carthage Presidence, Carthage, Tunis, Tunisia

mamoghli@yahoo.fr

**Contact Person**

Senda Belhaj Slimene

senda.belhaj.slimene@gmail.com

## **Abstract**

This paper introduces a novel approach “NeuroEvolution of Augmenting Topologies (NEAT)” based on Neural Networks and Genetic Algorithms to early predict financial distress of Tunisian companies. Our sample covers the period of the Jasmin Revolution that led to an increase of the number of bankruptcies, making early provisions even more difficult. We used the financial statements, balance sheets as well as income statements of 350 Tunisian companies spread over the period starting from 2010 to 2013. These financial statements allowed us to calculate 29 financial ratios for each company, inspired from the existing literature.

The dependent variable is a binary variable taking two values: 0 for non-failed firms and 1 for failed firms. Firms are considered in distress when they are unable to meet its financial commitments for more than 90 days; this is the definition of distressed banks given by the central bank of Tunisia. Our sample covers companies from three different sectors relative to industry, commerce and services. R software was used to perform the empirical part of our study.

Furthermore, we aim to identify the factors that explain financial distress. Two methods of variable selections were applied: Random Forest and Adaboost algorithm. This step allows the prediction of the failed companies as well as the identification of the explanatory variables that have the highest threshold value in predicting bankruptcies. We obtained a list of 12 financial ratios that were used as inputs for the model NEAT.

To evaluate the performance of our approach, we will compare our results to those of two conventional ones based on discriminant analysis and Probit regression. The predictions were made using data two years prior to the potential bankruptcy. The percentage of correct classification as well as type 1 error and type 2 error will be recorded for both models; this is important since these two types of errors lead to different consequences, as discussed by Beaver (1966). Type 2 error results from misclassifying a non-failed firm, which results in an opportunity cost. However, type 1 error occurs when misclassifying a failed firm which results in the non-repayment of its debt, leading to losses for banks and investors (Angelini et al (2008), Joos et al (1998)).

We further evaluate the performance of our sample by testing it on the financial ratios of 2010, i.e. three years prior to the potential financial distress. The same procedure was made using the discriminant analysis and Probit regression.

Our model slightly outperforms the discriminant analysis as well as the Probit regression in term of good classification. However, we observe a considerable difference in type 1 errors meaning it's more accurate in predicting failed firms whose bankruptcy has considerable impacts since those firms can go into bankruptcy.

Results also shows that ratios related to debt level and the profitability of firms hold the highest threshold value. Although we focused on financial variables, future studies might be done including not only financial ratios but also variables regarding governance or macroeconomics.

**Keywords:** Bankruptcy prediction; Neural Networks, Genetic Algorithms, Adaptive Boosting; Decision trees; linear discriminant analysis; credit scoring; non-performing loans