Predicting the management performance of firms

ECON3225

Tse Chun Hei Vincent
Patrick van Ewijk
Yeung Yan Chun
Chang Ching Yin

Introduction

The GDP of all countries in the world together was estimated to be 84.71 trillion USD in 2020. In this competitive economic workfield companies want to be managed as efficiently as possible, and answering a question of how this would be possible is of high interest. Either directly or indirectly, a manager has an impact on the growth of a company (Andersson & Tell, 2019).
Not only growth is associated with managers however. In recent scandals, like the Wells Fargo account scandal (where managers created a too high sales pressure for employees) , the behaviour of managers is considered as one of the factors why the problem occurred (Glazer, 2016). Whenever managers motivate their employees in a wrong way, a company could end up in an unfavourable situation.

Finally, recent research shows that firms that are managed in a better way, are more accurate about their predictions of their own economic growth and about their macro-economic growth (Bloom et al, 2021).

Hence, knowing whether a firm is managed well or not seems to be a question of great importance for many different parties. In this research, we'll not be considering the question of what causes a firm to be managed in a good way. Instead, it will be questioned how we can predict whether a firm is managed in a good way or not. Besides, we will focus on the question which factors seem to be important for predicting the management performance of a firm. It seems that these questions could be especially helpful for investors, who just want an indication whether a firm is managed well for their portfolio decisions.

Literature review

We analysed several studies regarding the management of firms, as we were wondering about correlations between our regressor and the management score. Although these studies are usually based upon the "classic" methods (Ordinary Least Squares) and we are purely interested in prediction, still we argue this research is useful and worth comparing with our results.

Fraction of managers & non-managers with a degree

A recent study, based on German Employer and WMS data, considered the effect of several regressors on the management performance of the company (Bender et al., 2018). It was concluded here that a high education of employees, and especially managers, is associated with a higher management performance. Wolniak and Pascarella (2005) associated a higher degree of employees with higher job satisfaction. A more recent paper, regarding both training and education of specifically managers, concludes the same (Mosadeghrad, 2014). One may suspect that this could be seen in the management scores.

Country of location and origin

Recently, a study focused on the differences between cultures in countries (Cheng & Groysberg, 2020). Here the study also focuses for a part what this means for managers. It turns out that in eastern Europe employees are generally more focused on authority. Further, American firms are generally more focused on results and the purpose of their practices.
Although management performance is not mentioned in this paper, those claims could indicate a higher association between plants located in the US (or from origin in the US) and the management performance, whereas the opposite could be true for plants in eastern Europe. In a somewhat older study, Hofstede investigated the differences in management between several countries, based upon 5 criteria (1993). Hofstede reasons that a country whose vision is individualistic, has not a too large difference between the rich and poor in society and has not too strong uncertainty avoidance leads to a management structure. According to Hofstede, this fits all Anglo countries. The transaction costs on the job market in those countries are historically lower and the core element in the organisation is the manager.

Number of employees within the plant
Bloom (2014) showed in a research that firms with more employees are associated with higher management scores. Intuitively, the author argues that the variables firm size and better management could influence one another. Larger firms have more means to search and get better managers. On the other hand, whenever a firm is managed in a good way, it is expected that the firm is more likely to grow (and has more incentive to hire employees).

Competition & Ownership
Bloom and Van Reeven found that a larger degree of market competition has a statistically significantly positive effect on the management performance for firms in Europe and the United States (2007). Besides, it is found in this paper that the ownership of a company seems to matter. Whenever a company is family-owned and has a CEO based on primogeniture, the company is ceteris paribus expected to have a lower management score.

Data and method
The source of the dataset used in this research is www.worldmanagementsurvey.org (WMS). The dataset itself covers a period of 2004-2010, and it contains information about the management of companies in the manufacturing industry. By a survey through phone calls the data is collected. More than 9000 companies are examined. To avoid the confirmation bias, the survey uses a blind method.

The survey itself consists of 3 sections of questions: Management, Organisation and Human Resources. Here the scores reflect the power and quality of managers within the company.
The survey questions are, for instance, related to whether the company uses modern techniques and what the reasons are for introducing these techniques.
For the sake of our research, we are interested in the average score over all the questions in the survey.

Besides the management score, the dataset also included corresponding information of the company. That is, the log of the number of employees, a dummy variable whether the company is an exporting company, the number of competitors (both in 2004 and at the moment the company received the survey), a dummy variable whether the country of origin of the plant is the same as the location of the plant (domestic plant), the fraction of managers and non- managers with a degree, the country of origin (and location) of the plant, the rigidity of employment, the industry code, the year the survey was conducted and the gdp of the city where the plant is located (based on ppp).

Data preparation
The dataset contained many missing values. In order to solve this, we applied a combination of dropping several variables and imputing other continuous variables. In this report, we decided to use a Multiple imputation by chained equations (MICE) approach for this. This approach uses the distribution of the observed data and is described as an effective tool to impute missing values (Wulff & Jeppesen, 2017).
Finally, only companies with a management score outside the following range are removed.

$$(Q_1 - 1.5 * IQR, Q_3 + 1.5 * IQR)$$

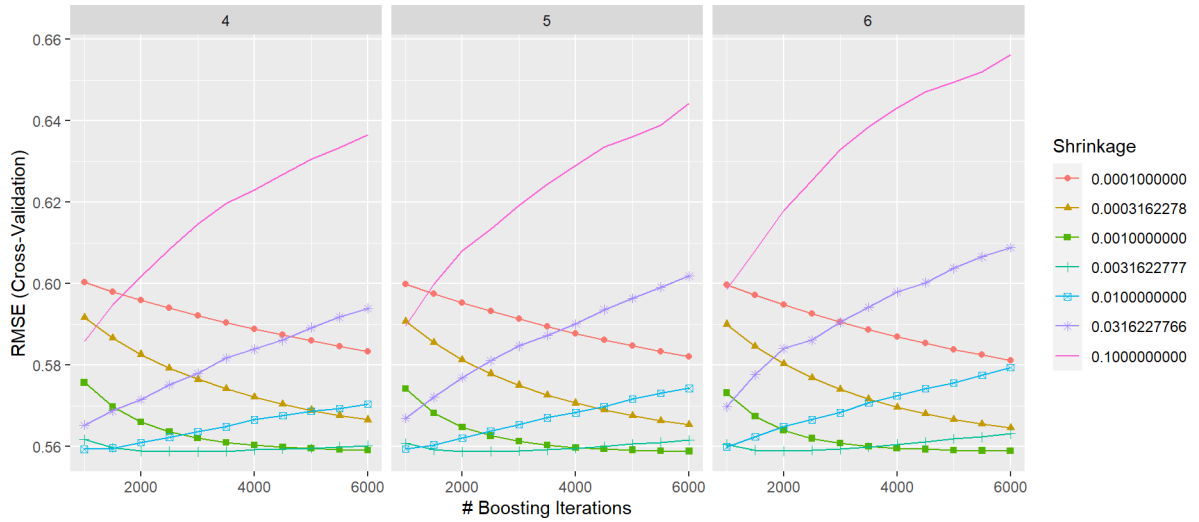
Here Q_1 represents the first quartile, Q_3 the third quartile and IQR the interquartile range.

Finally, the dataset contained 3241 observations and 10 variables describing the company information (year, industry code, and number of competitors in 2004 were dropped).

1/4th of the data will be used as a testing set for evaluating the model performance and 3/4th of the data will be used as a training set for fitting the model.

Model

The model consists of a boosting approach. First, using 10-fold cross-validation, we fine-tuned the model however. The process is shown below.



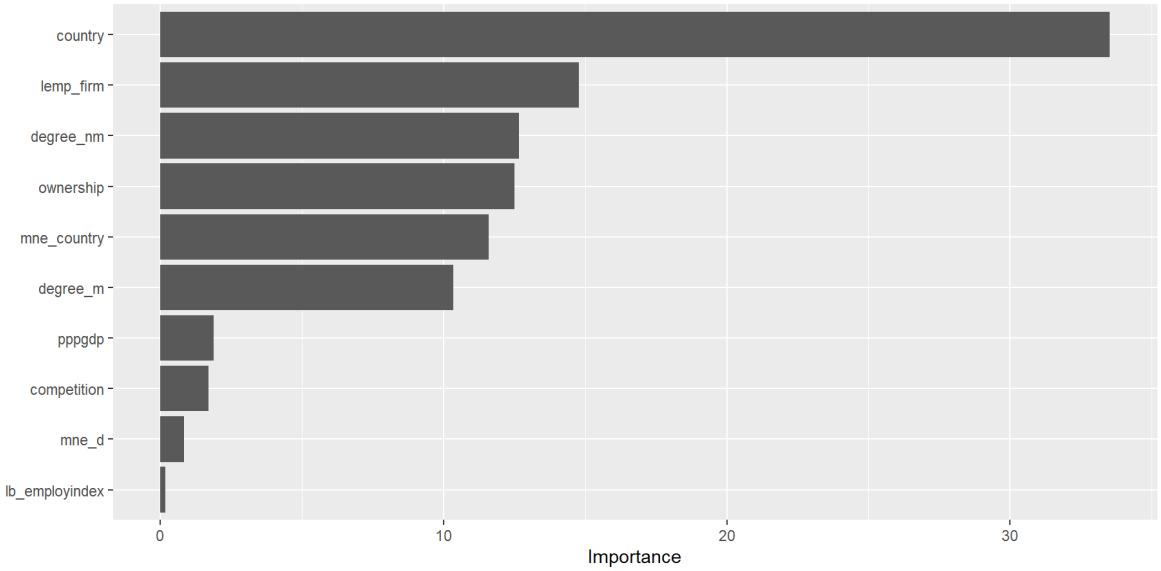
In total 3 graphs are shown. These correspond to an interaction depth of 4,5 and 6. For each graph, the x-axis corresponds to the number of boosting iterations and the y-axis corresponds to the square root of the mean squared error (using cross validation).

The estimated optimal parameters of the grid we considered are: 2000 regression trees, an interaction depth of 5 and a shrinkage of 0.003162278. This corresponds to the green-blue line at 2000 boosting iterations in the graph in the middle. Using these parameters, boosting is applied.

Results

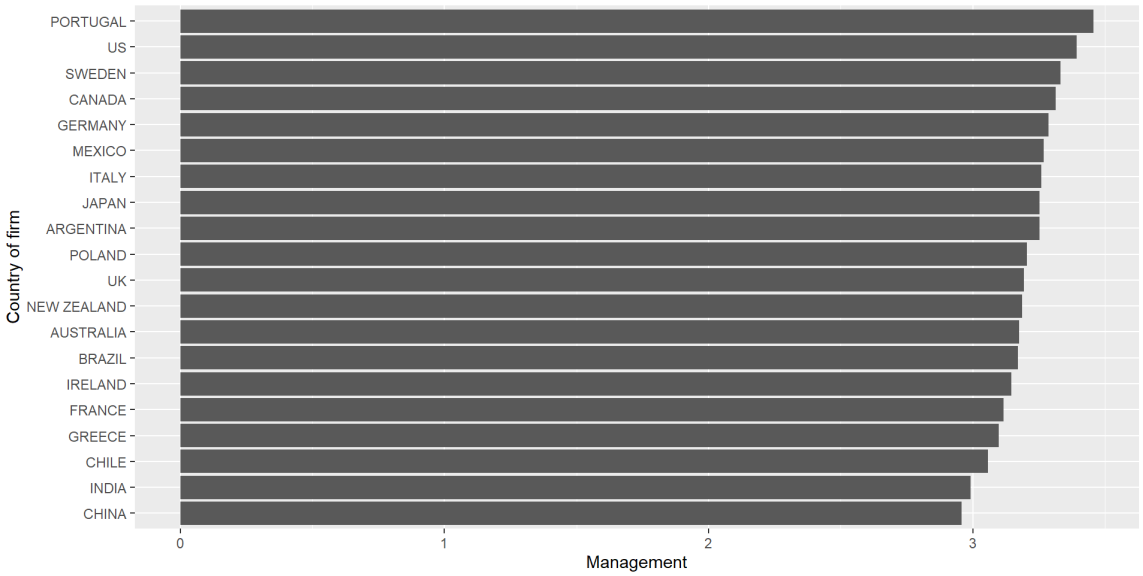
The test mse of the considered model equals 0.2943. Although this does not look bad at first sight, one must realise that the management score is measured on a scale up to 5 and we deleted the extreme values. The test R squared equals 0.1967.

Below the relative importance is shown, which is a measure for variable importance in the boosting model. It should be noted that the importance sums to 100 and it keeps track of how much the MSE changes whenever a variable is included or not in the tree.



As could be seen in the graph, the country seems the most important regressor. Moreover, the number of employees in a firm, the education of managers and non-managers in the firm, the ownership of the firm and the country of origin also seem to be important. This corresponds to the existing literature. Finally, the GDP of the city in which the firm is located, the fact that a firm is a domestic firm, the rigidity of employment and the number of competitors don't seem to be that important. The latter observation seems to be in contrast to an earlier study of Bloom in our literature research.

We decided to present the partial dependence curves as well, to investigate certain correlations and come up with possible theories about this correlation. As illustrated in our introduction, we don't discuss any causal effects; so these theories are just possible theories. We don't go into detail about exogeneity of the regressors.
The partial dependence curve of the country of the firm is shown below. The others are included in the Appendix.



One could indeed see that US firms seem to be associated with a higher management score as the literature suggests. This does not hold true for the other Anglo countries however (firms in New Zealand, Australia and UK are generally not associated with a high management score).

Interesting is the association of Chinese firms with a low management score. One possible story that could partially explain this fact is that there used to be a shortage of managers in China (Farrell & Grant, 2005). As the data covers a period of 2004-2010, it could be that this is a reason for the low management score.

The partial dependence graphs in the appendix seem generally to agree with the considered literature research. Family owned firms with a CEO from the family are associated with a lower management performance, firms with a high number of employees are in general linked to a high management performance, a high percentage of managers and non-managers in the company is associated with a high management performance and a country which is from origin from the US is generally linked to a higher management performance.

Conclusion

In this report, the prediction of the management score has been studied. We fitted a model and the test R squared is 0.197. This is lower than what we hoped to find. Nevertheless, one has to be rational. As can be seen on the WMS website, researchers are still publishing papers related to management performance and keep investing in gathering new and more data.
Concluding, maybe one has to admit that management is not easily predictable. Despite this fact, we argue that our results are not useless. We couldn't find a paper yet that was purely interested in predicting management performance and in this sense this is a unique report.

Discussion, limitations and recommendations

Our results regarding the correlation of individual variables with the management performance seems, in general, to correspond with literature. Exceptions are the importance of the competition of the firm in the market (which has a low relative importance compared to other regressors in contrast to other studies in literature) and the association between plants in Anglo countries and high management performances. Although not part of our research question, future research could focus again on the effect of those variables.
It should be mentioned that the most recent data from the dataset is from 2010. One could argue if correlations that were present in the past still apply to the present.
Further, it should be mentioned that the current dataset only contains a limited number of variables. Variables that captured the diversity within the company might be of interest for future research for instance, as research indicated that diversity influences organisational performance (Cho & Mor, 2017). Still we are sceptical about a drastic improvement in the test R squared, as in general we would expect that many more factors are needed to give an accurate prediction of the management performance.

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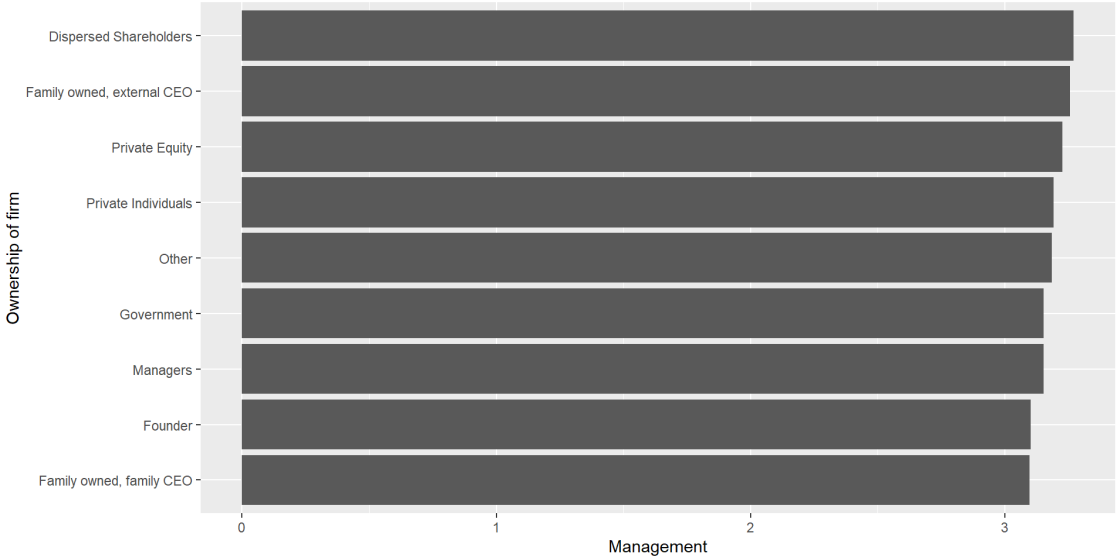
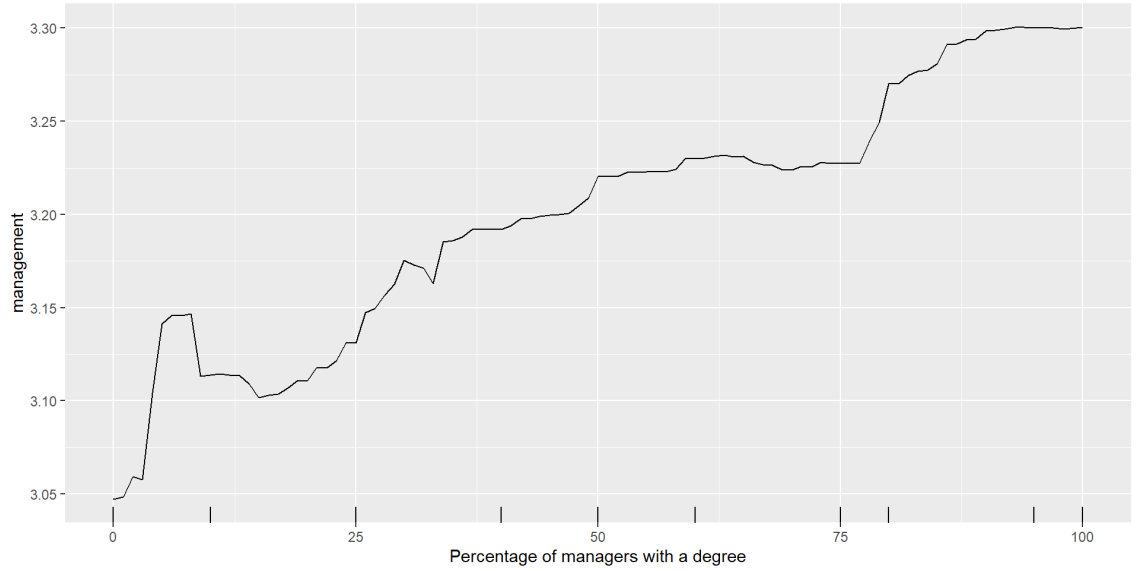
Appendix

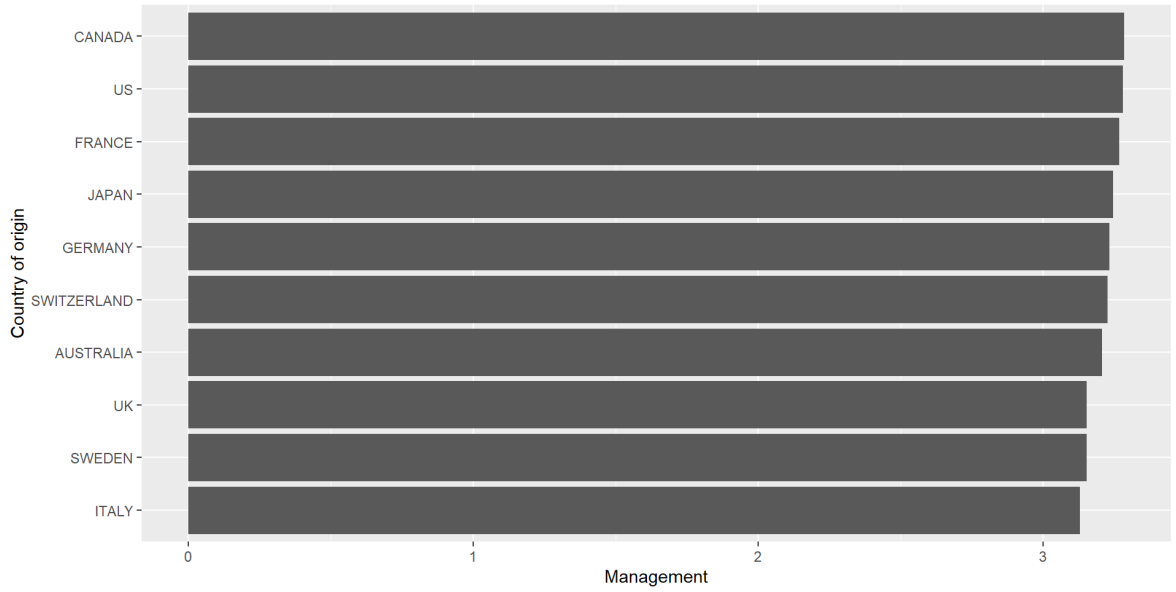
Partial dependence curve- Ownership of firm



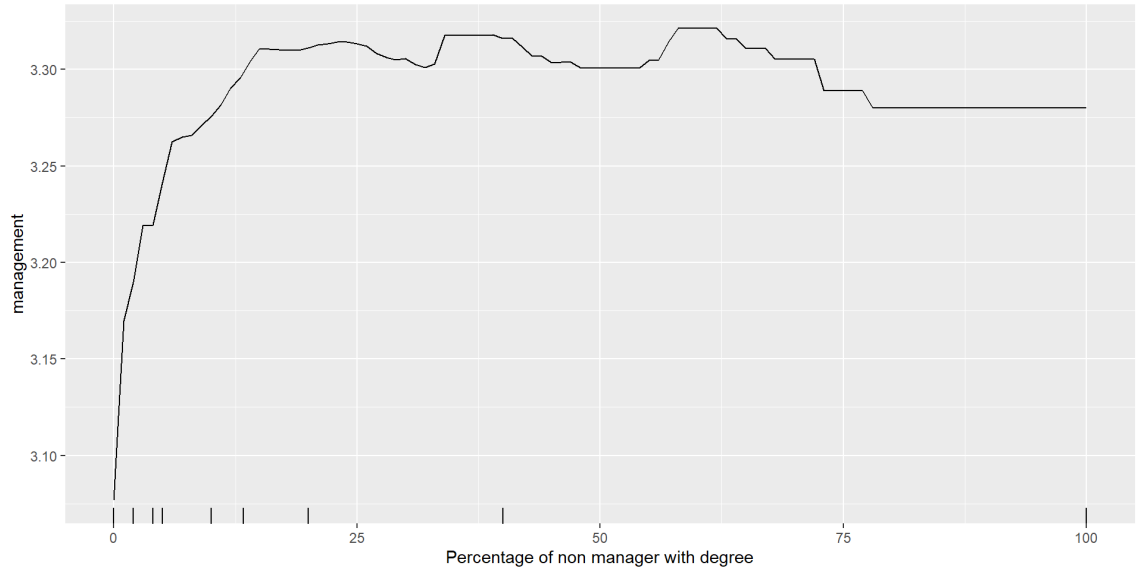
Partial dependence curve- percentage of managers with a degree



Partial dependence curve- country of origin



Partial dependence curve- Percentage of non-managers with a degree



Partial dependence curve- Log number of employees