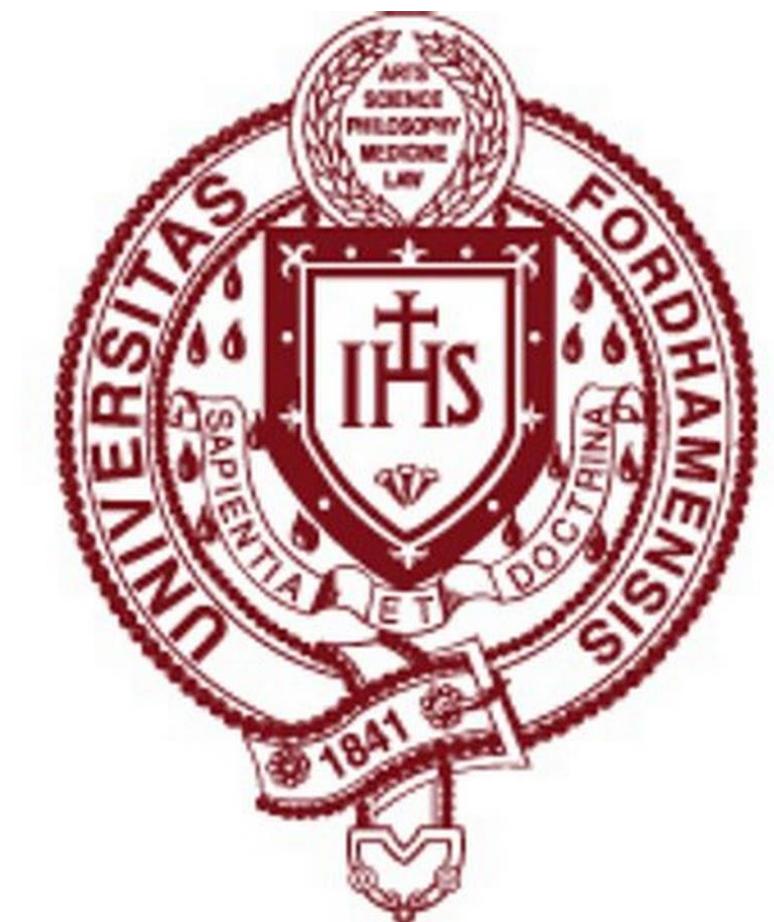


Recipes for Female Success: Becoming a CEO

Alona Bilokha¹; Mingying Cheng¹; Iftekhar Hasan^{1,2,3}
abilokha@fordham.edu, mcheng21@fordham.edu, ihasan@fordham.edu

¹Fordham University, ²Bank of Finland, ³University of Sydney



Abstract

In this paper, we focus on the determinants of female leadership in the corporate setting. We employ machine-learning algorithms to identify the most important predictors of first-time female chief executive officers (CEOs). With a comprehensive dataset of 130 characteristics of thousands of executives, we find that female executives who are well-connected in social networks and have diverse professional experience, including board exposure, are more likely to become CEOs. Interestingly, advanced education and international experience may have the opposite effect.

Our study provides a novel approach to analyzing career determinants of women in corporate America, contributing to the ongoing discussion on leadership and gender.

Introduction

Motivation: Although the number of female leaders is on the rise, women remain underrepresented in the upper echelons of the corporate world (Adams and Ferreira, 2009; Adams and Kirchmaier, 2016). Out of all S&P 500 companies, only 32 had female chief executive officers (CEOs) as of January 2022, representing about 6% of the companies in the index (Catalyst, 2022).

Research Questions: What defines a leader? How **first-time female CEOs** are different from all other female candidates who were not appointed CEOs?

Main Contribution: By utilizing the universe of female executives in the U.S., we apply machine-learning algorithms to examine the determinants of leadership from a gender perspective by analyzing characteristics of female executives and identifying the ones that can predict the likelihood of becoming a CEO.

1. We obtain a set (the most comprehensive to our knowledge) of over 100 characteristics across broad categories of education, professional experience, board participation, social networks, affiliations, awards, and other experiences.
2. We approach the CEO selection process from a gender perspective, focusing on the determinants of success specifically for female executives. With the recent progress in decreasing glass ceiling obstacles for women, our paper brings a unique perspective to the study of female career success.
3. We use 10 machine learning models combined with interpretable AI to offer data-driven insights about what matters most for female success in reaching the top leadership positions in corporate America.

Data

Sample: Our sample consists of 273,110 observations with 342 female executives who became first-time CEOs in public firms and a control group of 272,768 observations for female board members who were never employed as CEOs in U.S. publicly traded firms between 2001 to 2018.

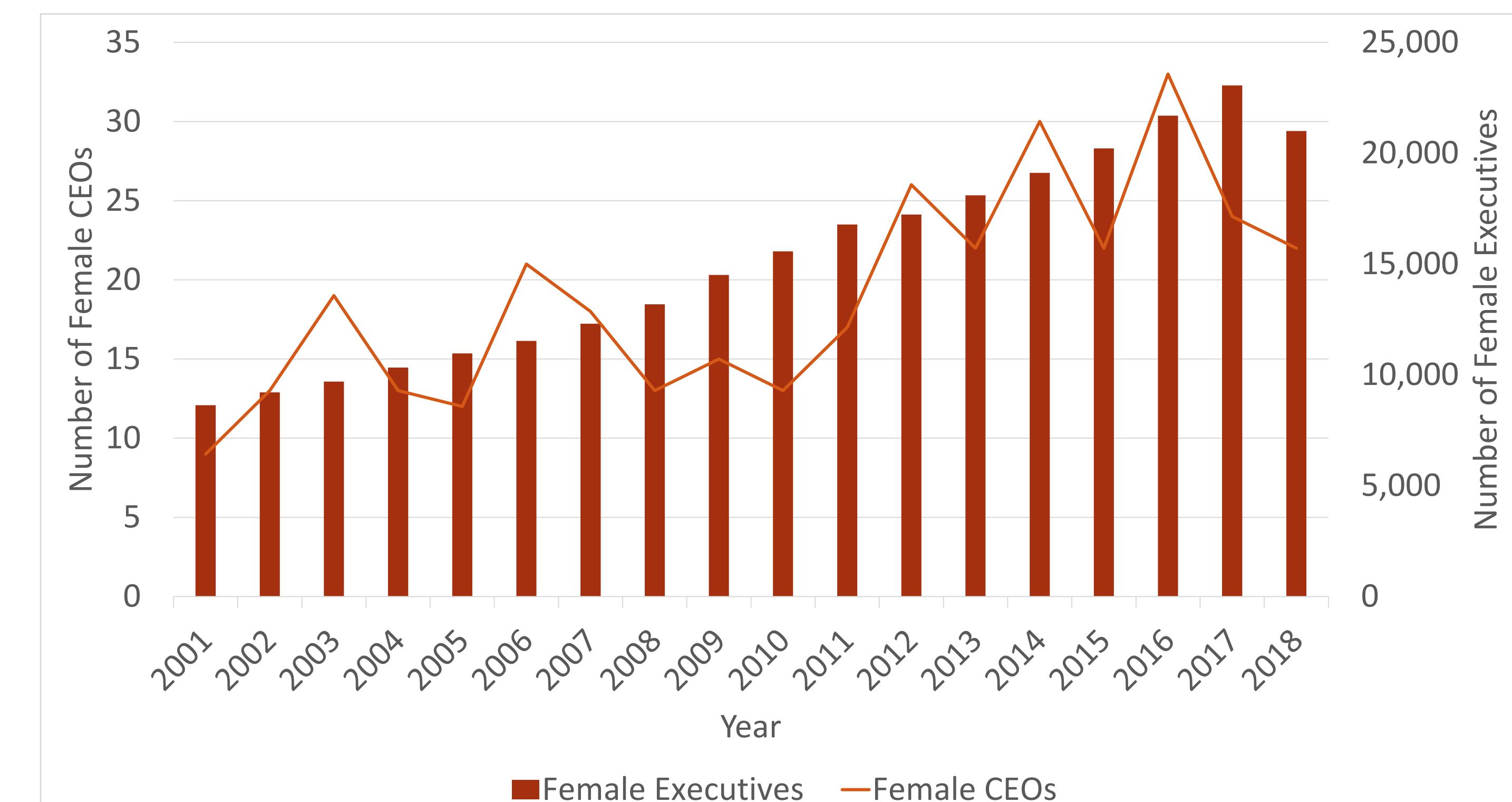


Figure 1. Sample Distribution by Year

Variables: We use 130 predictors and group them into 8 categories:

- **Education:** graduate/honors/Ivy degree, women's college, JD/MD etc.
- **Professional experience:** across industries, firms, types (finance, law, etc.)
- **Upper management experience:** CFO, COO, CTO, executive VP, President
- **Board experience:** number of boards and roles, including committees
- **Social network:** degree, closeness, betweenness, and eigenvector
- **Affiliations:** academic, art, business, foreign, health, humanities, etc.
- **Awards:** business, government, humanity, law, leadership, military, etc.
- **Other:** foreign nationality, mentor, volunteer, author, trustee, etc.

Methodology

Machine learning techniques can easily handle a large number of predictors and prevent overfitting by implementing cross-validation (Athey and Imbens [2019]).

Model training:

- 75/25 split for training/test data: 2001-2015 to train, 2016-2018 to test
- Subsampling method - synthetic minority over-sampling technique (SMOTE) and undersampling of majority class - during the model training in order to increase the predictive ability
- Cross-validation using rolling window of 5 years for training and 3 years for validation resulting in 8 total windows across training sample
- Tune length of 10 for each model on each window

Model interpretation:

SHAP values - theory of cooperative games by Nobel Laureate (2012) Lloyd Shapley in 1950s; machine learning application by Lundberg and Lee (2016); average marginal contribution of a feature to the outcome across all possible sequences.

Results & Interpretations

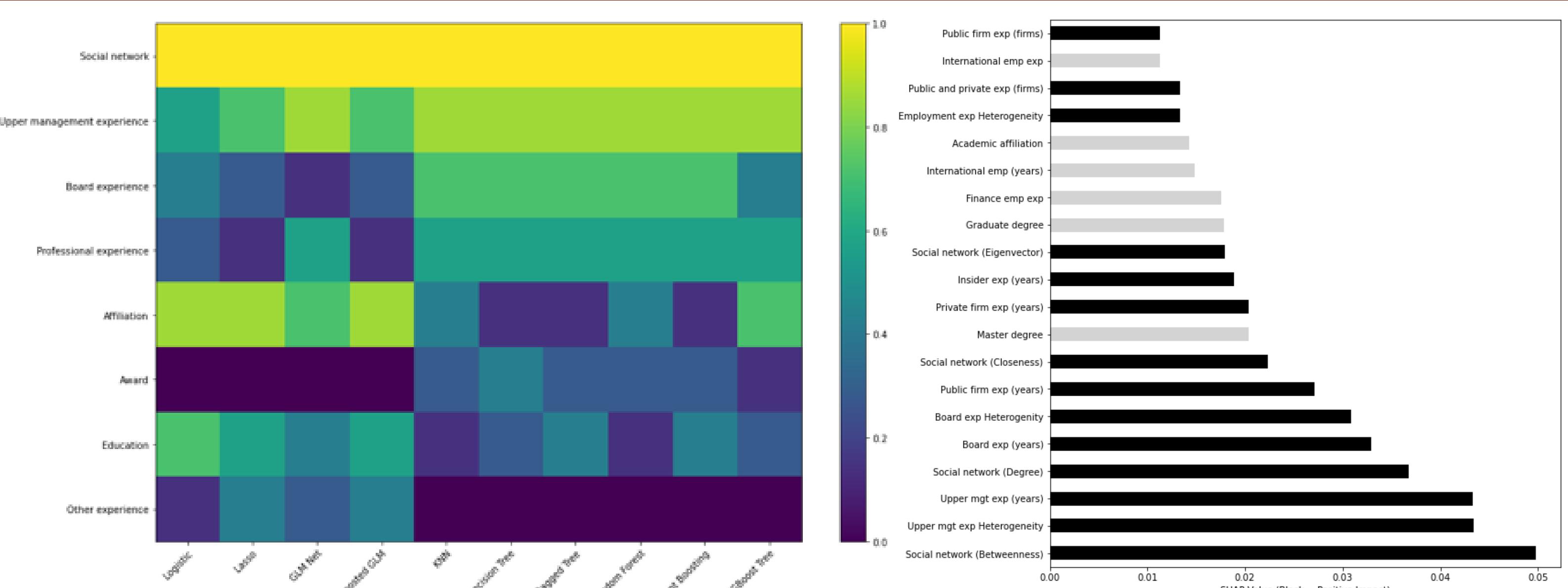


Figure 2. Feature Importance by Group

Figure 3. SHAP Values for Top 20 Variables

Results interpretation:

Most important predictors:

- Social network
- Upper management and board roles
- Heterogeneity of professorial experience

Positive predictors:

- **Social network:** Betweenness - extent to which a node lays between others and allows pass-through communications within the network (gatekeeper position); Degree - total number of direct ties an individual has; Closeness - how close an individual is to others in the network; Eigenvector - extent of connection to well-connected individuals
- **Upper management experience:** Heterogeneity - number of roles (CFO, COO, CTO, President) multiplied by the number of years of upper management experience; years
- **Board experience:** Heterogeneity - number of boards served multiplied by number of years; years
- **Professional experience:** Public firm (years), private firm (years), number of firms; Heterogeneity - number of firms times number of years

Negative predictors:

- **Advanced education:** master, graduate degree; academic affiliation
- **Professional experience:** finance, international employment

Implications:

- Fostering professional networks
- Promoting women to upper management positions
- Facilitating board appointments

Conclusions

This is the first paper to consider a comprehensive set of characteristics of female executives and identify the most important factors of success in becoming a first-time CEO. By constructing a comprehensive dataset of first-time female CEOs and their peers who did not make it to the very top of the corporate ladder between 2000 and 2018, we utilize machine-learning techniques to uncover patterns in the data and build predictive models to identify the most important factors for female success in becoming a CEO. We contribute to the prior literature on the anecdotal and interview-based characteristics of female CEOs by providing data-driven evidence of why some women better compete with their peers and become CEOs.

References

- Adams, R. B. & Ferreira, D. (2009). Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics*, 94(2), 291-309.
Adams, R. B. & Kirchmaier, T. (2016). Women on boards in finance and STEM industries. *American Economic Review*, 106(5), 277-81.
Athey, S. & Imbens, G. W. (2019). Machine learning methods that economists should know about. *Annual Review of Economics*, 11, 685-725.
Catalyst. Women CEOs of the S&P 500. (July 12, 2022).
Lundberg, S. M. & Lee, S. I. (2017). A unified approach to interpreting model predictions. In *Advances in Neural Information Processing Systems*, 4765-4774.