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An empirical XGBoost algorithm to predicting which are the factors that most contribute to boosting women's entrepreneurship in the world?

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ABSTRACT

The purpose of this paper is to identify the most contributing factors to boosting women's entrepreneurship by exploiting World Bank datasets related to the project: Women, Business and the Law, from 1971 to 2021 in 190 countries, using Extreme Gradient Boosting a model of Machine learning, which is a boosting algorithm based on gradient boosted decision trees algorithm.
Across more than five decades of data from this project, the paper highlights the importance of empowering women, and found that specific factors are among the strongest motivators for women to take up entrepreneurship as a career choice, And insistence on preserving the extracted factors that boost their progress and contribute with strong participation in the success of institutions and company, due the impact of the latter on sustainable development in the world.

1. Introduction

In the last ten years, although it remains low generally, the proportion of women entrepreneurs and small business owners has increased in most countries of the world."A third of all entrepreneurs in the world are women. Their contribution to development is clear: as their business grows, they inspire, create jobs, and offer themselves, their families, and their communities a chance for a better, more inclusive future", (UNCTD, 2022). In the context of the family and women's tasks, women are half of society, and they have a role to play in creating a more prosperous world, but she will not excel if circumstances impede her. Due to the problems facing women's Business, popular organizations and centers in the world have taken the initiative to study the topic and launch their own projects, and institutes for researchers are establishing global indicators for measurements on women's entrepreneurship. On 27 March 2019, CFE (Center For Entrepreneurship in Moscow) organized Time to Unlock the Potential of Women Entrepreneurs, a high-level panel discussion examined why women entrepreneurs matter and what policy can do to leverage their talents, (OECD, 2019) and launched Women's Entrepreneurship Initiative (WE Initiative) aims at boosting women's entrepreneurship at the global, national and local scale through improved policy efforts, the initiative is based on four pillars:

(1) Provide comparable international data on business women's access to finance (SMEs and Entrepreneurs);

(2) Identifying best practices on priority topics (eg women tech entrepreneurs);

(3) Provide tailored policy guidance for countries and local regions through case studies;

(4) Develop a multi-stakeholder platform that brings together the public and private sectors; The Global Entrepreneurship and Development Institute constructed the female entrepreneurship index to measure a multidimensional aspect of female entrepreneurial development, (Terjesen & Lloyd, 2015) defined as "innovative, market expanding" this gender specific Index utilizes to capture the multi-dimensional aspects of entrepreneurial development. Female entrepreneurship generally encompasses a wide range of activities, and the Gender-GEDI Index is the world's first diagnostic tool to comprehensively identify and analyze the conditions that promote the

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development of high-potential female entrepreneurship. The initial 17 country empirical provides key insights across multiple regions and levels of national economic development. Thirty individual-level and institutional-level dimensions are paired together into 15 pillars that are further divided into three main sub-indices: Entrepreneurial Environment, Entrepreneurial Eco-System and Entrepreneurial Aspirations. (See,(Terjesen & Lloyd, 2015)) the Data and Methodology section for a more detailed explanation of the sources of all of these variables.) The initial analysis, focusing on 17 countries places the United States in first place followed by Australia, Germany, France and Mexico. Rounding out the top ten are the United Kingdom, South Africa, China, Malaysia, and Russia.

"It is important to note that there is room for improvement even among top-ranked countries on the Gender-GEDI Index, as the US achieves just 76 on the 100 point scale. In addition, even among the ten top-ranked countries there is a distinct gap between the US and Australia, which draw scores of 76 and 70, and the next four countries, and there is a further gap between 6th-ranked United Kingdom (which has a score of 51) and 7th-ranked South Africa, which pulls a score of 43", (GEDI, 2013).

The "GEM 2021/22 Women's Entrepreneurship Report offers a trend analysis of women's entrepreneurship in 50 countries, five global regions and three national income levels, focus on four key themes in the first half of the report, followed by a closer analysis of region and country-specific patterns in the second half. The four themes are:

(1) Gender differences in rates at various points in the entrepreneurial lifecycle, from intentions through to startup activity, new business, established business and business exit;

(2) Gender differences in COVID impacts, both positive and negative;

(3) Structural inequalities and women's participation in high-potential startups;

(4) Factors in the enabling environment that likely influence gender differences in entrepreneurial activity", (Amanda, & Benjamin, & Schott, 2022).

This report's highlights several compelling findings from GEM 21/22 data, from gender composition of high-potential startups to pandemic impacts and national expert ratings of the enabling environment for women entrepreneurs, one of the report's key findings is that women represent two out of every five early-stage entrepreneurs that are active globally, women tend to be somewhat less active globally than men when it comes to startup activity, but women entrepreneurs in upper-middle-income countries represent some of the most innovative, high-growth entrepreneurs globally, and are at parity with men with regard to international market focus.

From the foregoing, it turns out that there are different opinions that women are less active or in full swing with men in the field of entrepreneurship, there are those who focus on income gaps between countries, and there are those who see the issue of gender differences and factors influencing the life cycle of entrepreneurship.

Most of these studies were based on certain income levels or a limited number of countries ranging from 17 to 50, so the current study build on the basis of a somewhat more global and more general project. WBL, is an acronym for Project Women, Business and the Law is in the form of reports, in a series of annual world bank group studies that measure laws and regulations in 190 economies, in eight areas that affect women's economic participation: mobility, workplace, pay, marriage, parenthood, entrepreneurship, assets and pensions, the 2022's report includes empirical research on legal frameworks for available, affordable, high-quality childcare, as well as on the implementation of laws.

"Women, Business and the Law" measures global progress toward gender equality in 190 economies by identifying the laws and regulations that restrict and incentivize women's economic participation. Whether a 25 year-old starting her first job, a mother balancing work with caring for her children, or a woman on the verge of retirement, the eight indicators show the relationship between laws and women throughout their working lives, (WBL, 2022). Much research on entrepreneurial motivation has identified a number of influencing factors, (Arthur, Hisrich, & Cabrera, 2012) found that education is important in the entrepreneurial process. (Millman & Matlay, 2010) also found that there is a significant correlation between students' entrepreneurship intentions and education entrepreneurship, while both (Scheinberg & MacMillan, 1988) went to suggest on need for personal development, (Gelderen & Jansen, 2006) need for autonomy; (Krueger, 1993) need for independence; (Reynolds & Miller, 1988) need to improve social status and a drive to innovate and create new products or services, in the works of each (Lei Zhu, 2017) women

entrepreneurs are motivated to earn more income in both China and Vietnam, Vietnamese businesswomen value intrinsic rewards such as gaining personal satisfaction and freedom.

Among the areas that are classified by WBL, the aim of the current research is to identify the most contributing factors to achieving women's entrepreneurship in the world. The paper has the following structure: literature review, methodology and then empirical analysis conducted to support the study, and finally concluded with short recommendations, and future research.

2. Literature review

It was not until the 1980s that female entrepreneurship started to attract academic attention. The early studies often examined the differences between male and female entrepreneurs in terms of uncover the motivations behind female ownership of businesses. Although a number of research attempted to identify factors contributing to the success of women entrepreneurs, no consensus has been reached. In the entrepreneurial literature, the primary area of research has often been what motivates individuals to become entrepreneurs?

The early studies on women entrepreneurship in developed countries indicate that women are motivated to establish their own business to gain independence, achieve self fulfillment and escape the "glass ceiling", see ((Scott, 1986), (Buttner, 1993)), the biggest problem women face in finding employment is the issue of mobility, women in most society have got restricted mobility, Women's lives are almost confined to the four walls of the kitchen, confined to three Ks, kitchen, children, knitting. There are hardly any opportunities to cross these borders. There is no confidence in traveling at night or during the day, even to different regions and countries. Movement is less among women compared to male entrepreneurs. This indicates a low level of freedom of participation and movement, as well as an aspiration to become female entrepreneurs, (Ajay, Sapna, & Vinod, 2012).

(Das, 2000), this study profiles women entrepreneurs who own and manage small to medium sized enterprises in southern India. It examined the problems these women faced during the setting up and continued operation of their businesses. It also looked at their reasons for starting a business and the self-reported reasons for their success. The initial problems faced by these women seem similar to those faced by women in western countries. However, woman entrepreneurs in developing countries seem to differ in their reasons for starting and succeeding in business, and observed in her study that most common reasons for success of women entrepreneurs is personal qualities such as hard work and perseverance, some independent factors are family background, dream desire of status and economic independence, suggests that these factors vary according to parameters such as region, gender, age, family background, and work experience.

In the researcher's opinion, as indicated in the introduction, the organization "Women, Business and law" covers a kind of inclusiveness and is committed to informing research and policy discussions about the state of women's economic opportunities and empowerment, and demonstrates the progress made while emphasizing the work still to be done to ensure it. Over the past 12 years, Women, Business and the Law has expanded coverage to 190 economies and eight topics relevant to women's economic participation which are as follows:

2.1. Mobility

The Mobility indicator measures constraints on a woman's agency and freedom of movement, both of which are likely to influence her decision to enter the labor force and engage in entrepreneurial activity, (Htun, Mala, Francesca, & Jami, 2019). This indicator consists of four components that measure, whether a woman can choose where to live; travel outside her home; can apply for a passport; travel outside the country (measured relative to a man's liberty).

2.2. Workplace

The Workplace indicator analyzes laws affecting women's decisions to enter the labor market, including women's legal capacity and ability to work, as well as protections in the workplace against discrimination and sexual harassment. Antidiscrimination legislation is positively associated with women's employment and earnings, whereas sexual harassment can negatively influence women's career trajectories, (McLaughlin, 2017). This indicator has some

components that assess, whether a woman can get a job; whether the law prohibits discrimination in employment based on gender; whether there is legislation on sexual harassment in employment . . .

2.3. Marriage

The Marriage indicator measures legal constraints related to marriage and divorce. Legal discrimination against women, including limits on their ability to be head of household, has been found to be negatively correlated with labor force participation, (Goldin & Olivetti, 2013). This indicator has five components that measure the following; whether there is no legal provision that requires a married woman to obey her husband; whether a woman can be head of household, whether there is legislation specifically addressing domestic violence; whether a woman can obtain a judgment of divorce; whether a woman has the same rights to remarry as a man.

2.4. Pay

The Pay indicator measures laws affecting occupational segregation and the gender wage gap. Restrictions on certain jobs have been found to be correlated negatively with female employment, (Costa, 2009). This indicator has some components that assess, whether the law mandates equal remuneration for work of equal value; whether a woman can work at night, whether a woman can work in a job deemed dangerous; whether a woman can work in an industrial job.

2.5. Parenthood

The Parenthood indicator examines laws affecting women's work during and after pregnancy. Women are more likely to return to work if the law mandates maternity leave, (Berger, Lawrence, & Waldfogel, 2004). This indicator has some components that measure the following, whether paid leave of at least 14 weeks is available to mothers; whether the government administers 100 percent of maternity leave benefits; whether paid leave is available to fathers; whether there is paid parental leave; whether dismissal of pregnant workers is prohibited.

2.6. Entrepreneurship

The Entrepreneurship indicator measures constraints on women starting and running a business. Having access to a bank account is strongly correlated with women's labor supply, (Field, 2016). This indicator has four components that measure the following; whether the law prohibits discrimination in access to credit based on gender; whether a woman can sign a contract; whether a woman can register a business, whether a woman can open a bank account. (Berger, Lawrence, & Waldfogel, 2004).

2.7. Assets

The Assets indicator examines gender differences in property and inheritance law, including instances in which legal systems are supported by customary law and judicial precedent. Improving property and inheritance rights is positively associated with female earnings and employment as well as women's access to housing and land, (Gaddis, 2020), (Peterman, 2011). This indicator has five components that measure the following; whether men and women have equal ownership rights to immovable property; whether sons and daughters have equal rights to inherit assets from their parents; whether male and female surviving spouses have equal rights to inherit assets; whether the law grants male and female spouses equal administrative authority over assets during marriage; whether the law provides for the valuation of nonmonetary contributions.

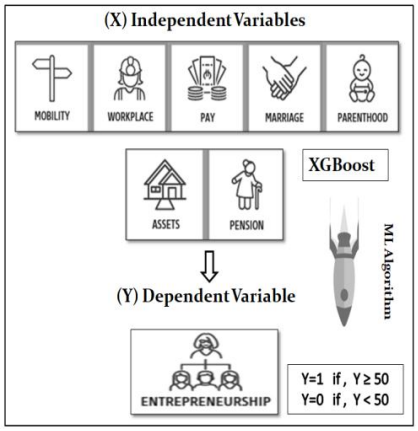
2.8. Pension

The Pension indicator assesses laws affecting the size of a woman's pension. Early retirement can widen the potential gender gap in pension levels and increase women's risk of poverty in old age, (Burn, 2020). This indicator has four components that measure the following, whether the age at which men and women can retire with full pension benefits is the same; whether the age at which men and women can retire with partial pension benefits is the same; whether the mandatory retirement age for men and women is the same; whether periods of absence from work due to childcare are accounted for in pension benefits.

3. Methodology

As a fairly new discipline, data science takes advantage of vast amounts of data at our disposal today and availability of advanced computational power. These factors make it possible the improvement of existing prediction methods and contribute to the development of new and better algorithms. In this paper, we introduce machine learning of the Extreme Gradient Boosting, (see (Chen & Guestrin, 2016), (Analytic Vidhya, 2018)) for prediction, using the data from the WLB's eight Indicators, which consists of 9691 observations, for 190 countries over 51 years where Entrepreneurship is the dependent variable that was transformed as shown in Figure 1.

Figure 1: Conceptual framework of the methodology



Source: Developed by the author using the World Bank Data.

(When: Y=1, it means a successful women's entrepreneurship, if the score of Entrepreneurship is greater than or equal to 50, and vice versa in the case of Y=0), and the independent variables are the remaining variables means: (Mobility, Workplace, Pay, Marriage, Parenthood, Assets, Pension). Indicator-level scores are obtained by calculating the un-weighted average of the questions within that indicator and scaling the result to 100. Overall scores are then calculated by taking the average of each indicator, with 100 representing the highest possible score. Recalling that the object is to detect what the most factors influence women's entrepreneurship using a binomial classifier XGBoost?

3.1. Experimental Setup

In machine learning, the ability of a model to predict categorical values based on a training dataset is called classification, (Musayev & enol, 2017). As the data were imbalanced, the class-weighting version of the XGBoost implementation was used, where the minority represented was over-represented in the algorithm training process in proportion to its' relative size from the observations. In order to evaluate the performance of given models, a series of experiments have been conducted. The models have been implemented with Python 3.7 programming language. Initially, we load the dataset and make an exploratory data analysis to extract best features for determining a major factor of successful women's entrepreneurship. Later, we modify data structure to prepare training on machine learning models. Finally, we apply XGBoost algorithm and record results of their performance for prediction. Using different performance metrics to evaluate the model, which are as follows:

- Accuracy of the model given in Eq. (4), which basically shows the number of successful predictions.

- Precision gives the percentage of the positive predictions that were correctly identified.

- Recall which is another performance metric is the percentage of correctly predicted positive cases.

- F1-Score measure metric is the harmonic average of the Precision Eq. (2) and Recall Eq. (3).

Calculation of F1-Score is given in Eq. (1):

$$F1 - Score = \frac{2 \times Precision \times Recall}{Precision + Recall} \quad (1)$$

$$\text{Precision} = \frac{TP}{FP+TP} \quad (2)\ ; \quad \text{Recall} = \frac{FN}{FP+TP} \quad (3);\ \text{Accuracy} = \frac{TN+FP}{FN+TP+TN+FP} \quad (4)$$

Where: True Positive= (TP), False Negative= (FN), True Negative=(TN), False Positive= (FP).

- Confusion Matrix**:** The confusion matrix provides statistics about correct and incorrect predictions. It makes a comparison of expected values within the test set with the predicted values in the training set.

- Feature Importance**:** is the process of automatically which contribute most to model prediction. A benefit of using ensembles of decision tree methods like gradient boosting is that they can automatically provide estimates of feature importance from a trained predictive model. (see more in (Brownlee, 2020).

4. **Results and Discussion**

The results were achieved using 10 fold cross-validation for XGB model, and are based on the average results obtained. 10-fold CV takes a 10 variable as an input, partition the dataset into 10 parts, cycles over the parts and for each cycle leaves the single portion out of training and use it as a test set. The Table 1. Shows the full set of results in tabular form, the specific task based on confusion matrix when, Y=1: (means a successful women's entrepreneurship). The confusion matrix provides with a visual insight into how our algorithm is performing.

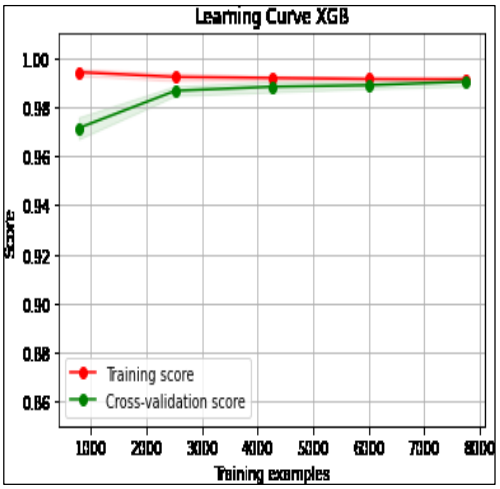
Table 1. Cross Validation Results for XGBoost Algorithm

Folds	Precision	Recall	F1-Score
Fold:1	0.9953	0.9930	0.9942
Fold:2	0.9918	0.9895	0.9906
Fold:3	0.9953	0.9965	0.9959
Fold:4	0.9976	0.9907	0.9941
Fold:5	0.9942	0.9930	0.9936
Fold:6	0.9942	0.9930	0.9936
Fold:7	0.9953	0.9918	0.9936
Fold:8	0.9953	0.9953	0.9953
Fold:9	0.9977	0.9977	0.9977
Fold:10	0.9977	0.9942	0.9959
Mean Accuracy : 0.9903%			
Std (+/-): +/- 0.0031%			

Source: Prepared by author, using python software.

The model achieved high results in each Fold, and in all tested measures (Precision, Recall, F1-Score, Accuracy), achieving a best mean accuracy: 0.9903% with Std:+/- 0.0031%, in order to evaluate overall performance, learning curve can be utilized to measure how many training sample is required to reach optimum performance. It is a visual indicator of how the performance is increased by adding new training samples and whether the classifier is adversely affected from a variance error or a bias error. Learning curve for our XGB algorithm is depicted on Figure 2.

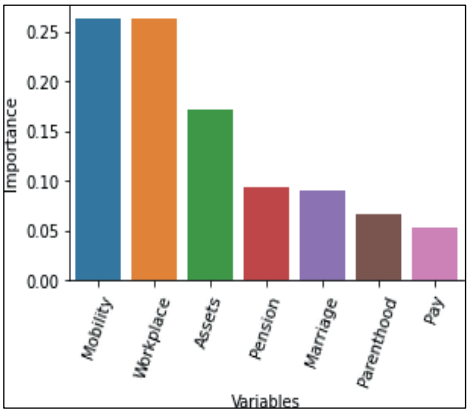
Figure 2: Learning Curve for XGBoost Algorithm



Source: Developed by the author, using Python software and World Bank Data.

The validation curve is a tool for finding good hyper parameter settings. Some hyper parameters (maximum tree depth in a decision tree, other regularization, etc.) We want the model to be complex enough to capture relevant information in the training data but not too complex to avoid overfitting. Gap between the two curves, determines the interpretation of the model in the bias-variance landscape. This classifier will not need any more training data, this form can be the most expressive and most convenient. Figure 2 shows the training curve for a classifier where training and validation scores converge to a good value. The most factors that contribute to predicting the success of women's entrepreneurship have also been identified on Figure 3.

Figure 3: Rank Features in order of Importance



With the corresponding percentages in Table 2.

Table 2. Contribution percentage of Features Importance.

Features Importance	Contribution percentage
Mobility	26.3597
Workplace	26.2435
Assets	17.2132
Pension	9.3682
Marriage	9.0022
Parenthood	6.5528
Pay	5.2603

Source: Developed by the author using according to Figure 3.

The results are summarized as follows:

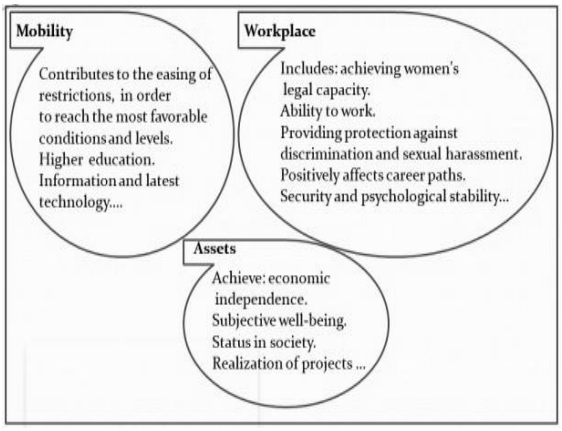
- The model achieved high results in each Fold, and in all tested measures (Precision, Recall, F1-Score, Accuracy), achieving a best mean accuracy: 0.9903% with Std:+/- 0.0031%, Table 1.

- The learning curve clearly displays that XGBoost shows better performance (A narrow distance shows low variance in the gap between the two curves), and only needs about 2500 training samples to reach the best accuracy. Figure 2.

- Notable the most features contributing to the model are Mobility, Workplace and Assets, the threshold used to obtain these results is 10%, Table 2.

Analyzing these results, extracted from the power of the model to predict factors, Mobility and the Workplace have a high ratio and close to about 26%, plus the assets factor is about 17%, while other factors are somewhat weak, and below the threshold chosen. Although a number of researches have attempted to identify contributing factors, for the most part no consensus has been reached, the results here agree and include some findings from previous studies, as (Ajay, Sapna, & Vinod, 2012) points in the field of Women entrepreneurship management, that women may be good entrepreneurs for the following reasons: economic independence, confidence, status in society, greater freedom of mobility, etc. And (Scott, 1986), (Buttner, 1993) show in developed countries indicate that women are motivated to establish their own business to gain independence, achieve self fulfillment. (Das, 2000), indicate that woman entrepreneurs in developing countries seem to differ in their reasons for starting and succeeding in business, and observed in her study that most common reasons for success of women entrepreneurs is personal qualities such as hard work and perseverance, some independent factors are family background, dream desire of status and economic independence.

Figure 4: The most important factors and other inclusive



Source: Developed by the author.

The WBL framework in (WBL, 2022), states about the compatibility of areas of law with the economic decisions align areas of law with the economic made by women as they go through different stages, and provides an update of the indicators, taking into account reformed laws and regulations where the indicators represent not only women's interactions with the law, but also these metrics (Mobility, workplace, ...) represent incentives for women to become successful entrepreneurs and employees. Accordingly, Mobility, workplace, and assets are major factors that include a lot of others, as the Figure 4 shows.

5. Conclusion

This modest study aims to contribute to the field of women's entrepreneurship, using the XGBoost algorithm with 10 folds (number of cross-validation sets), achieve better results with an average accuracy of 99%. Identifying the most important factors that stimulate women's entrepreneurship, based on a database of 190 countries over 51 years, is enough as a powerful model to extract: firstly, the importance of women's freedom Mobility and its impact on entrepreneurship increased by 26,36%. Secondly, 26.24 percent focused on the importance of security, stability and

protection in the workplace against all forms of discrimination. Thirdly, by 17,21% the importance of women in obtaining assets in a fair way, whether from work, inheritance and property rights, these are powerful motivators for women's entrepreneurship as well as other low-impact factors that are less than 10% as stated in the analysis of the results.

The world needs the creativity of all its members, educated and responsible, whether male or female, and especially females more than ever because of the long- standing marginalization of them . Decision makers should provide favorable conditions that focus on the contents of the obtained factors, the policies of countries that maintain these conditions will contribute to the provision of a greater number of women's projects that will generate economic gains and sustainable development.

What makes this research unique from the rest of the others mentioned here, is the development of a quantitative assessment to extract the important factors that include most of the elements affecting women's entrepreneurship, using the most powerful algorithms supported by bagging and boosting methods, As well as employing data that exceeded 9600 observations around the world and touched different economic levels.

6. Future research

Future studies can explore other external factors influencing women's entrepreneurship, explore what is the nature of the relationship between the factor of women's entrepreneurship and economic growth using a combination of various machine learning algorithms. We also hope that through these models, research will be directed to studies on the important factors that stimulate women's entrepreneurship at individual economic levels, comparing them separately in developing, emerging and developed countries.

Supplemental material

Code on Github: Code, and output details of the results XGBoost model's can be found on Github repository:

https://github.com/Fadila-2020/Code_Women_Etrepreneurship.git

Data accessibility statement

https://wbl.worldbank.org/en/all-topics

Declaration of conflicting interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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