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Longitudinal Trends in Financial Metrics
within Female-Led Software Firms

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Abstract

Investigating the domain of female leadership within the Romanian software industry, this analysis focuses on activities delineated by the NACE code 6201, pertaining to custom software development (client-oriented software). Several stringent selection criteria were applied. Most importantly, companies must have 100% female ownership and employ at least three people. Of the 26,108 firms operating under this code, only 2,067 have at least three employees. Of these, just 112 are totally owned by women – that is less than six percent of all firms. The research studies the ongoing trends in principal financial indicators among Romanian software companies led solely by females from 2019 to 2023. This paper looks into how many staff members there are against each company's performance based on different metrics like profit or turnover which have been analysed systematically over time periods used for analysis so far, giving us a chance to find out if there is any significant relationship between the number of workers employed by different businesses and their respective gains made within specified durations also looking closely at comparative growth rates between profits earned versus sales revenue generated annually while taking into consideration average yearly turn over as well as profit growth changes observed during such period under review.

Keywords: Female Leadership, Romanian Software Industry, Female Ownership, Women-Led Firms, Women Entrepreneurship.

JEL Classification: M12, J16, L86, L26, L25.

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1. Introduction

Recently, female leadership in business has attracted more attention than ever. This is especially true with regard to gender diversity and its effect on organisational performance. In fact, research indicates that businesses whose top management consists of a higher percentage of women tend to realise better financial results (Noland et al., 2016).

Currently, the widest gaps between male and female entrepreneurs exist within the Information Technology (IT) sector where for every woman entrepreneur there are over two men. This huge difference points out the persistent difficulties faced by women in technological entrepreneurship combined with an absence of adequate literature studying the intersectionality between gender equity and tech startups (Wilson & Patón-Romero, 2022). The situation is even worse in developing countries where cultural and structural impediments are more pronounced, thus exposing female founders to many challenges while starting or running their businesses (Corrêa et al., 2024).

Even though they encounter such obstacles like any other group involved in innovation activities across different industries. New evidence shows that women entrepreneurs play a significant role when it comes to innovating within their firms. The study by Madison et al. (2022) conducted among small-and medium-sized enterprises (SMEs) located in emerging markets found that contrary to popular belief about male superiority regarding creativity levels among genders: companies with at least one female leader were likely to achieve better innovative results than those led solely by males. These findings suggest that promoting female entrepreneurship may yield positive effects not only at individual level but also on broader ecosystems.

Yet still there exist numerous barriers against the entry into this field for girls who have trained themselves from school age all through their career journey upwardly as adults working professionals within IT industry settings. Canedo et al. (2019) highlight continuous sexism coupled with inadequate mentorship opportunities, which discourage females from entering performing well throughout computer science related professions. Software development projects suffer similar issues since workplaces do little to improve the conditions under which their employees work.

The issue gets complicated due to lack of participation among women developers involved in Open Source Software (OSS) projects. Trinkenreich et al. (2022) argue these situations deny women valuable chances for career growth as well as skills acquisition while depriving OSS initiatives off different viewpoints necessary towards innovative thinking processes. Most difficulties experienced by females working in such environments stem from social interactions characterised by unequal status amongst peers coupled with pervasive noninclusivity communication patterns fuelled masculine attitudes towards femininity.

In Romania's software sector specifically, there is hardly any presence of female leadership – less than six percent entirely belong to companies owned by three or more persons.

Table 1. Factors Encouraging Female Entrepreneurship in the Tech Sector

Determinant	Description	Reference
Mentorship Programmes for Female Entrepreneurs	The knowledge, connections, and confidence of female entrepreneurs can be improved by mentorship programmes, which in turn leads to better business results.	(Wanberg et al., 2006)
Female Networking Groups in Business Performance	Women's networking groups are vital because they provide support, resources, and collaboration opportunities that can improve the business performance of female-owned businesses.	(Ibarra, 1993)
Government Policies and Female Entrepreneurship	By fostering a conducive business environment for women entrepreneurs, government policies and incentives encourage more female-owned businesses to be started and nurtured.	(Minniti & Naudé, 2010)
Access to Capital in Female-Led Firms	Capital access is important for the success of female-led companies. Women experience more significant hurdles in obtaining funding than men do.	(Brush et al., 2018)
Gender Diversity in Team Performance	Diversity of gender within teams can enhance their performance, creativity, and problem-solving abilities which are essential for the achievement of tech companies.	(Hoogendoorn et al., 2013)
Cultural Barriers to Female Entrepreneurship in Tech	Cultural attitudes towards gender roles significantly impact women's participation in tech entrepreneurship, requiring systemic changes to increase representation.	(Ahl, 2006)

Determinant	Description	Reference
Flexible Work Policies for increased Female Participation in Tech	Flexible work policies, including remote work and flexible hours, have the ability to increase the participation of women in the tech industry by providing a better work-life balance.	(Chung & Van der Lippe, 2020)

Source: structured by co-authors based on literature review.

2. Problem Statement

One persistent problem in fields like Computer Science, Engineering, Mathematics, and Physics is the lack of female students. This imbalance often leads to the marginalisation of women as employees and entrepreneurs in these areas. Many studies point to gender stereotypes and patriarchal structures as key reasons for this disparity (Kovaleva et al., 2022).

Our research fills a gap in understanding the financial performance of female-led enterprises in Romania's software industry. Despite the increasing focus on gender diversity in leadership roles, there is surprisingly little research on the financial outcomes of female-led tech firms. In Romania, only about 6% of software development organizations with more than three employees are totally women-owned. Given this remarkable underrepresentation, there is a pressing need to explore how these women-led organizations perform from a financial point of view over time. The research will focus precisely on companies that are 100% female-owned and have a minimum of three employees. It is intended to provide a detailed analysis of the component of an industry that holds a small scale but presents meaningfulness.

3. Research Questions / Aims of the Research

A major question we try to answer is if there is a significant relationship between the number of employees and profits made by companies. We want to find out whether higher numbers of personnel mean better financial results, thus indicating how crucial human resources are for an organisation's performance.

Our study also looks into another important thing which examines what happens when you increase or decrease the workforce: does it affect turnover in any way? This analysis aims at revealing revenue generation abilities influenced by the size of staff within firms thereby giving insight on their operational efficiency and market success. We do this through comparing growth rates for profit versus sales – are they moving up together or not? Knowing about such relationships might help us find other things that influence financial outcomes, too. Also worth investigating here would be whether there has been a steady increase in annual average turnover from 2019-2022 so as to assess these companies' income expansion trajectory over time.

Last but certainly not least, let us look into trends concerning yearly mean profit during the same period mentioned above; did average profits show consistent rise? Such inquiries matter because they speak volumes about overall wellbeing/viability female-led businesses possess.

4. Research Methods

4.1 Sample Selection

The sampling process was rigorous to ensure that the findings were trustworthy and applicable. The most important criterion was to identify firms owned by female entrepreneurs in custom software development, classified under NACE code 6201. This code relates to client-oriented software development activities which gives a narrow focus on a specific part of the market.

To guarantee sample specificity and relevance, these criteria were set:

- Companies must be entirely (100%) owned by women.
- Each company should employ at least three employees.
- The firms should be legally registered in Romania and the indicated NACE code used in operation. There are several reasons for this. First, by focusing on 100% women-owned firms, the impact of male partners on the challenges faced and successes achieved by the women entrepreneurs is removed. Second, the employee requirement gives the scale of operations that ensures reliable financial data, as it considers bigger businesses.

As such, the final methodology to be discussed is the Romanian companies being targeted, which has specific NACE coding that provides consistency in industry classification and the legal and economic environment.

surrounding them.

The data collection encompassed all Romanian companies meeting these criteria, derived from public records provided by state institutions such as the National Agency for Fiscal Administration (ANAF) (https://static.anaf.ro/static/10/Anaf/Informatii_R/doc_WS_Bilant_V1.txt).

4.2 Data Collection Instruments and Statistical Methods

The ANAF database contains public financial statements that were used for data collection. Profit, turnover, and total employees are some of the key financial indicators included in these statements. The official nature of this data source, as well as its compliance with legal reporting requirements, ensures accuracy and reliability.

For statistical analysis, several methods were employed to study relationships between variables comprehensively and identify significant trends:

Spearman's Rank Correlation Coefficient: This nonparametric measure was applied to determine how strong or weak the relationship is between employee numbers on one hand, and profit or turnover on another. It can deal with complex

nonlinearities better than other methods, which makes it suitable for dealing with statistical data.

Percentage Change Calculations: To capture growth dynamics over time, year-over-year percentage changes were calculated for profit, turnover, and employee numbers. Moreover, changes from baseline year (2019) to the following years (2020-2022), as well as cumulative change over entire study period were taken into consideration.

Trend Analysis: The aggregate annual totals of all companies for each variable were analysed to detect overall trends across industries. At industry level this approach helped smooth out firm level individual fluctuations providing clearer picture of patterns rather than at specific firm levels where noise may obscure signals due lack of sufficient observation points per firm within short periods when firms are not very different in size so that they exhibit similar responses to macroeconomic shocks resulting from business cycle phases during which firms operate simultaneously but do not necessarily always have identical characteristics like age cohort membership status etc., thus making it impossible to distinguish between them using only cross-sectional data collected at a single point in time without longitudinal studies being conducted first before any conclusions could be drawn about causal relationships involving different entities operating under diverse conditions prevailing at various times throughout history until now because otherwise they will just end up confirming preconceptions held by researchers who designed those experiments instead of yielding new insights into reality surrounding us here today.

4.3 Relevance of Methods

Statistical methods are chosen based on their capabilities in handling particular features of the data and research questions. Spearman's correlation is most appropriate here because it deals with ordinal data and aims at measuring nonlinear relationships. Percentage changes calculated together with trend analyses give clear, understandable measures of growth and performance over time which are critical for answering our research questions.

This will allow us to directly answer if workforce size affects profitability and turnover by looking at how many employees there are in relation to financial outcomes. Trend analysis also provides a wider view about these findings within industry dynamics, thus giving deeper insight into the financial paths taken by female-led software firms in Romania.

4.4 Calculation and Data Analysis Methods

Spearman's rank correlations were utilised to review the relationships between profit values, number of employees, and turnover for each company in a given year. These correlations were applied over the whole study period as well as within every single year under examination. Year-over-year percentage changes and percentage

change between first and last years of the analysed period (2019-2022) were used to calculate these financial metrics' percent variations two ways.

In order to identify general trends, the total values for each variable were computed across all companies for any particular year, which then determined changes in cumulative totals. In the cases where the cited value for calculating the percent changes was equal to zero, the percent change from zero was assigned a value of one hundred percent.

The calculations were conducted using MS Excel and JASP v0.18.3. The specific formula used to determine the percentage change was as follows:

$$\text{Change\%} = \text{IF}(\text{reference_year_value}=0, 1, (\text{current_year_value} - \text{reference_year_value}) / \text{ABS}(\text{reference_year_value}))$$

In this formula, the term "reference_year_value" represents the value of the variable for the year used as the basis for comparison. This value serves as a benchmark against the measured changes in the variable. "Current_year_value" is the value that the variable takes in the year for which a percentage change has to be computed. This is the current measure of the variable, against which a comparison has to be found and the change has to be evaluated in that respect from a base year.

The "ABS" function returns the absolute value of its argument. The effect is that no matter whether the value chosen is positive or negative, the result formula will always turn out to be a nonnegative number. Taking the absolute value guarantees that the magnitude of the change will still be correctly captured by the formula, unbiased by the sign of the change.

The "IF" logical function is used to handle situations whereby the reference value evaluates to zero. Had the formula been used as it is, in such scenarios it would return a division by zero error, which is undefined mathematically and may cause the system to yield wrong results or throw an error. In handling this, the "IF" function checks whether the "reference_year_value" is zero. In case the condition is satisfied, then the function returns 1 for the formula, meaning 100%. This approach gives a graceful avoidance of the division by zero and points to a meaningful interpretation in order to be shown that any non-zero value in the current year represents a change of 100% with respect to the zero reference value.

This formula was utilised to calculate changes in profit. For changes in the number of employees and turnover, the same formula was applied, with the exception of the absolute value function, as turnover and the number of employees cannot be negative in value.

Hypothesis 1: There is a significant correlation between the number of employees and companies' profit.

The Spearman correlation analysis was used to see if there is any relationship between the number of employees and profit in the companies from the sample. The findings revealed a significant positive correlation ($\rho = 0.371$, $p < 0.01$) for the entire sample and for every year studied. Yearly analysis showed that the correlation coefficients varied from 0.186 in 2021 to .500 in 2019 with regard to the time periods

studied which were all significantly different at least at the alpha level .05 except for one period, that is, year two thousand twenty-one where it was not statistically different at the alpha level five percent or less ($p > .05$).

Hypothesis 2: *There is a significant correlation between the number of employees and companies' turnover.*

To test this hypothesis, a Spearman correlation was calculated between the number of employees and companies' turnover. The analysis revealed a significant positive correlation ($\rho = 0.647$, $p < 0.01$) when considering the overall sample and across all years. Within individual years, the correlation coefficients varied, ranging from 0.482 in 2021 to 0.781 in 2019, all of which were statistically significant ($p < 0.05$).

Table 2. Correlations across all years

Variable	Turnover	Profit
1. Turnover	—	
2. Profit	0.753**	—
3. Employees	0.647**	0.371**
* $p < 0.05$; ** $p < 0.01$		

Source: computations performed by the co-authors.

Table 3. Highest and lowest within-year correlations (correlations between values of individuals companies within a single year)

Variable	Turnover lowest	Turnover highest	Profit lowest	Profit highest
1. Turnover	—	—		
2. Profit	0.709**	0.806**	—	—
3. Employees	0.482**	0.781**	0.186	0.500**
* $p < 0.05$; ** $p < 0.01$				

Source: computations performed by the co-authors.

4.5 Analysis of Profit and Turnover Growth Rates

Throughout the period of 2019 through 2022, the total profit of all companies in the dataset exhibited a major increase of 149%. At the same time, the total number of employees across these companies increased by only 29%. A closer look at annual growth rates shows that total profit growth rates ranged from 30% to 46%, whereas employee growth rates fluctuated between two percent (2%) and thirteen percent (13%). These findings imply that while the overall workforce size modestly expanded, company profits grew rapidly, which may indicate improvements in operational efficiency or higher levels of market demand.

Table 4. Annual total profit and total number of employees' growth rates, for individual years and for the whole period

	2020	2021	2022	2019-2022
Profit growth	32%	30%	46%	149%
Employee number growth	2%	13%	11%	29%

Source: computations performed by the co-authors.

Table 5. Percent of companies experiencing growth and decline of profit and the number of employees

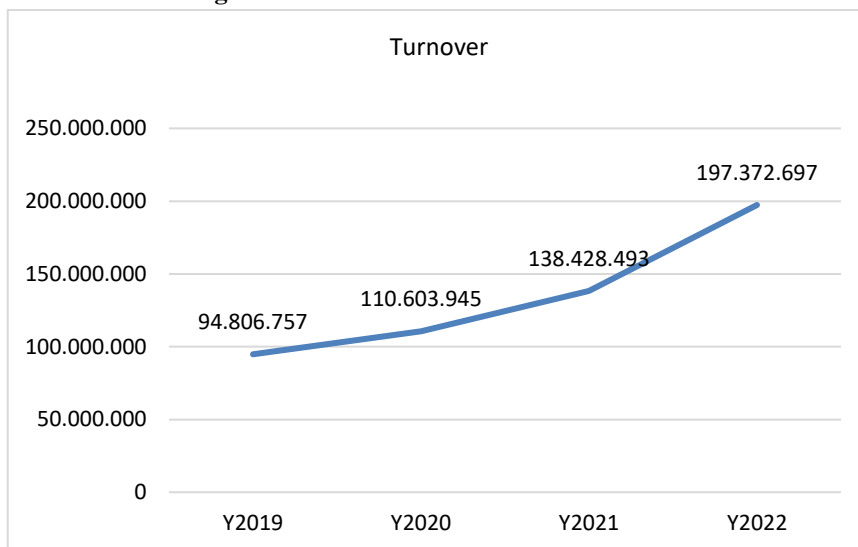
% of companies reporting	2020	2021	2022	2019-2022
Profit increase	55%	67%	59%	69%
Profit decline or stagnation	45%	33%	41%	31%
Employee number growth	42%	47%	46%	58%
Employee number decrease or stagnation	58%	53%	54%	42%

Source: computations performed by the co-authors.

4.6 Analysis of Annual Average Turnover Trends

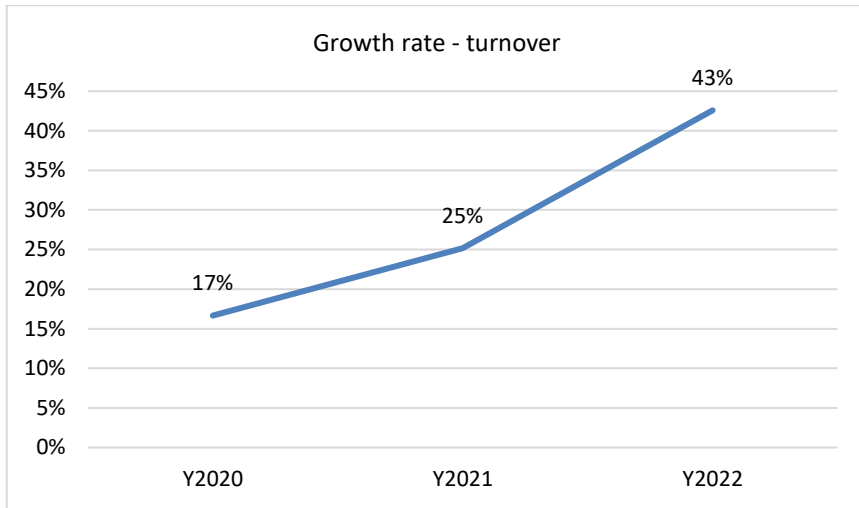
Between 2019 and 2022, the total turnover of all companies in the dataset increased by 108%. When analysing individual companies, 83% experienced an increase in their turnover, while 17% reported a decrease during the same period.

Figure 1. Total Turnover from 2019 to 2022



Source: computations performed by the co-authors.

Figure 2. Growth Rate of Turnover



Source: computations performed by the co-authors.

Table 6. Percentage of Companies Reporting Increase and Decrease in Turnover

% of companies reporting	2020	2021	2022	2019-2022
Turnover increase	66%	70%	75%	83%
Turnover decrease or stagnation	34%	30%	25%	17%

Source: computations performed by the co-authors.

Table 6 provides a detailed breakdown in the percentage of companies reporting changes in turnover each year. The majority of companies experienced an increase in turnover, with the highest percentage (83%) observed over the entire period from 2019 to 2022.

5. Findings

The research displayed a significant positive relationship between the count of employees and both profit and turnover. More precisely, the Spearman correlation coefficients were 0.371 for profit and 0.647 for turnover, in all the years and for the entire sample. This means that female-led software organisations that have more employees are inclined towards a greater degree of profitability and greater revenues compared to those with fewer workers, which underlines the meaningfulness it holds in nurturing financial performance.

The comparative growth rates of profit against those of turnover underwent rigorous examination. The findings show a considerable increase in overall profits among all firms within this dataset over the study period by 149% while the total number of staff only rose by 29%. Between thirty percent (30%) to forty-six percent (46%) were recorded annually as profit growth rates compared to two percent (2%) to thirteen percent (13%) for the number of people employed indicating operational

efficiencies may have improved or market demand increased towards services offered by these companies.

Furthermore, there was an identification within this research about trends showing a consistent annual average turnover increasing every year along with the corresponding profits. Total revenue went up from one hundred eight percent between twenty nineteen through twenty-two, where eighty-three percent experienced an increase while seventeen had declines followed closely behind is analysis indicating annual average gain steadily rising upwards over time such that sixty-nine reported growth during the same interval.

6. Conclusions

The research places light over the financial feasibility and development potential held by female-led software companies in Romania, despite their insufficient representation in this industry. The study also shows a steady increase in both annual average turnover and profit from 2019 to 2022. This suggests that Romanian women-led software firms have achieved long-term financial growth during the studied period. High percentages of companies reporting increases in turnover as well as profits reflect overall good financial health of these organisations. Such sustained growth indicates their resilience and capacity to respond to market demands which is remarkably impressive considering wider economic hardships coupled with highly competitive nature of software industry.

On the other hand, it is important to note that even if these positive trends are to emerge, a dramatic gender gap is on display within the industry: less than 6% are women-owned firms of all software development companies with more than three employees. This underrepresentation thus exposes the need for programs and initiatives aimed at supporting and promoting women entrepreneurship and leadership lines occupied by women in technology fields. More women should be encouraged to take up leadership roles or own businesses since such moves would greatly influence innovation levels as well as financial performance across industries involved.

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