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VERTICAL WAGE INEQUALITY IN HIGH-TECH MANUFACTURING COMPANIES IN POLAND[1]

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Purpose: The research objective, which was to identify and assess the impact of technological advancement of manufacturing enterprises on the development of vertical wage inequality.
Design/methodology/approach: In order to determine vertical wage inequality, the quotient between the remuneration of managers (individual CEO or average board members) and the average remuneration of operational employees was used. The study was conducted on a sample of manufacturing companies with different levels of technological advancement. Comparisons were made using descriptive statistics and the Kruskal-Wallis test.
Findings: The analyses carried out allowed the research hypothesis to be verified. According to the results, there are no grounds for rejecting it. Companies with the highest technological advancement had the lowest vertical wage inequality. Thus, technological advancement should be considered to have an impact on vertical wage inequality.
Research limitations/implications: A difficulty and limitation of the study of vertical wage inequality is obtaining full wage information. This is due to the nature of this type of data. They are confidential and subject to civil and data protection laws. Ultimately, wage information is provided in an aggregated and anonymised manner. Despite this, analysis of vertical wage inequality should continue, especially taking into account how it is affected by the implications of the development of artificial intelligence.
Social implications: The study indicates which group of manufacturing enterprises the state should support in order to reduce excessive vertical wage inequality.
Originality/value: The originality of the research stems from the fact that it takes into account the impact of technological advancement on vertical wage inequality. In addition to the CEO-employee relationship, the research analysed the relationship including board members.
Keywords: vertical wage inequality, manufacturing companies, technological advancement of companies.
Category of the paper: Research paper.

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1. Introduction

Vertical wage inequality is a common phenomenon in society (Ratio between CEO…). Most research on it focuses on the relationship between the remuneration received by the CEO and employees. There is a lack of research in the literature that considers board members other than the CEO (Walker et al., 2014, p. 35; Ruetschlin, 2014, p. 9, 1; Aggregated CEO-to…). The emergence of vertical wage inequality is caused by employers using different compensation schemes for management and operational employees. For management employees, mainly market-based systems are used, where the aim is to keep salaries comparable to those offered in the market. In contrast, when determining the remuneration of operational employees, a system that values their skills and knowledge, i.e. human capital, is often used (Armstrong, 2011, pp. 281-282). Highly skilled individuals are desirable employees in high-technology companies, where they are highly remunerated. This raises the question: does the level of technology affect the formation of vertical wage inequality? In order to answer this question, the research objective was to identify and assess the impact of technological advancement of enterprises on vertical wage inequality. The research hypothesis was that the lowest level of vertical wage inequality is found in companies with high technological advancement. This study used data on the salaries of CEOs, board members and employees working in manufacturing companies with different levels of technological advancement.

2. Specifics of employee remuneration in high-tech companies

A characteristic feature of high-technology manufacturing companies is the employment of operational staff with high levels of human capital. They are seen as a key resource in them and their skills are referred to as so-called intangible assets (Ratajczak-Mrozek, 2011, pp. 26-29; Schultz, 1961, pp. 1-17). Companies with complex manufacturing processes need highly skilled workers to develop, implement and operate technologically advanced solutions (Oi et al, 1999, pp. 2172-2184). This is due to the compatibility and complementarity of the level of technological advancement and human capital of employees (Zajączkowska-Jakimiak, 2006, pp. 47-69). Running a business where complex solutions are used without skilled production staff would not be possible (Jin et al., 2003, pp. 176-180). Their number is limited on the labour market. Therefore, attractive employment conditions are offered to attract them (Łysik, 2011, pp. 57-62). One of these is remuneration, which is set at a high level by valuing their skill level. This situation is in line with J. Mincer's model (Mincer, 1974, pp. 11-20). In contrast, in enterprises where the production technology is simple and uncomplicated, employees are most often remunerated on the basis of work outcomes. Although they may have high human

capital, this is not subject to the remuneration system. In addition, workers in low-technology jobs are easily replaceable, as their stock in the labour market is relatively large. All this results in low wages for workers in this group of enterprises. (Hansen et al., 2014, pp. 449-470)

In the case of managers, their remuneration is mainly influenced by determinants related to the reduction of agency costs and the managerial authority held (Bathala et al., 1995, pp. 59-69; Tosi et al., 1989, pp. 169-189). Although adequate human capital is required of them it does not play the same role as for operational staff. This state of affairs leads employers to set the remuneration of managers at similar levels in a given economic sector or in comparable entities (Aluchna, 2003, pp. 156-175).

In the social sciences, the relationship between the level of remuneration of operational staff and technology has been confirmed. H. Entorf and F. Kramarz analysed the impact of computer technology on the level of wages in the enterprises of sole proprietors. The authors diagnosed that the introduction of computer-based new technologies contributed to an increase in employees' wages (Entorf et al., 1997, pp. 1489-1509). B.H. Hall and F. Kramakz studied the effect of increased technology and innovation on wages using data from developed countries. They diagnosed that there is a positive correlation between the increase in R&D expenditure and wages (Hall et al., 1998, p. 106). B.P. Cozzarin diagnosed on the basis of data on Canadian manufacturing companies that technological change has an impact on employee wages. Higher wage growth was observed for process innovations than for product innovations (Cozzarin, 2015, pp. 243-249). F. Bogliacino and his team conducted an analysis using sectoral data from France, Germany, Italy, Spain and the United Kingdom. The authors diagnosed a positive impact of modern technological solutions (innovation and offshoring) on the wages of high-skilled workers and a negative impact on low-skilled workers (Bogliacino, 2018, pp. 778-808).

The literature search carried out confirms the impact of advanced technology - through the valuation of the human capital of operational workers - on their wage growth. Thus, technology, through its impact on wages, also becomes a determinant of their inequality.

3. Methodology

The subject of the study was vertical wage inequality in manufacturing companies listed on the Warsaw Stock Exchange. The choice of these companies was dictated by the positive economies of scale brought by the implementation of technological solutions in production processes (Olender-Skorek, 2017, pp. 38-49; Mączyńska et al., 2020, pp. 9-21). The development of the relationship between CEO remuneration and average employee remuneration and average board member remuneration and average employee remuneration was analysed. The necessary data on remuneration were obtained from reports published by

companies, including financial statements and reports on the remuneration of board members and supervisory boards. For CEOs, information on their individual remuneration was used. For board members and employees, average remuneration was used. In the study, board members are understood to be those on the board of directors who do not serve as CEO. The research sample consisted of 80 manufacturing companies, which were divided according to the level of technology used. Four groups of companies with technological advancement were obtained: high (hereinafter: HT), medium-high (hereinafter: MHT); medium-low (hereinafter: MLT) and low (hereinafter: LT). The division was carried out using information on the dominant activity of a given enterprise's PKD, which was obtained from the REGON Internet Database and the classification of technological advancement published by the Central Statistical Office in the statistical yearbook "Science and Technology in 2022" (Science and Technology). The temporal scope of the research covered the period from 2016-2022, which made it possible to obtain, respectively, for the group: HT-40, MHT-149, MLT-187, LT-104 observations. Statistical tests and methods were used in the study. To examine vertical wage inequality, a wage quotient was used, where the manager's salary (CEO or board member) was divided by the employee's salary. A similar method was used by S. Kiatpongsan and M.I. Norton (Kiatpongsan et al., 2014, p. 588). Vertical inequality was calculated for data from each enterprise and then compiled using descriptive statistics. A Kruskal-Walis test was used to determine whether there were differences between given groups of companies and whether these differences were statistically significant.

4. Result and discussion

The study analysed the vertical wage inequality between managers, i.e. CEO or board members, and employees. The results of this analysis are presented in Table 1.

Table 1.
Inequality of wages in manufacturing companies, taking into account their technological advancement

Specification	HT		MHT		MLT		LT	
	CEO-E	BM-E	CEO-E	BM-E	CEO-E	BM-E	CEO-E	BM-E
N	40		104		149		187	
Mean	9,70	8,27	18,84	14,25	14,22	9,73	25,22	11,63
Median	9,14	6,99	10,78	7,37	11,76	7,89	14,01	8,45
Coefficient of variation	0,53	0,59	1,74	1,97	0,84	0,98	1,25	0,74
Skewness	0,95	1,13	7,47	7,41	3,90	6,56	2,61	1,57
Kurtosis	1,74	1,22	68,42	67,89	27,65	65,70	6,14	2,65
Shapiro-Wilk test								
Statistic	0,929	0,907	0,603	0,853	0,369	0,372	0,72	0,57
Sig.	0,015	0,003	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001

CEO - Chief Executive Officer; BM - members of the board of directors; E – employees.

Source: own compilation based on data from financial statements.

The interpretation of the results obtained was based on the median. In each group of manufacturing companies, there was a vertical wage inequality on the line: CEO - employees and members of the board of directors - employees. The highest level of salary inequality between the CEO and employees was diagnosed in LT enterprises with 14.01, while the lowest in the HT group with 9.14. The difference between the median from LT and HT was 4.87 points. In the other groups of enterprises, i.e. MHT and MLT, CEO earnings were 10.78 and 11.76 times higher than the average employee salary, respectively. The set of enterprises most differentiated in terms of the described inequality was the MHT entities, the calculated coefficient of variation was 1.74. On the other hand, the lowest differentiation was diagnosed among HT enterprises, the value of the coefficient of variation was 0.53.

The highest inequality in remuneration between board members and employees was found in LT enterprises, the estimated median was 8.45. In turn, the lowest level of this relationship was found in HT enterprises, the calculated median was at 6.99. The difference between the indicated extreme values was 1.46 points. In the other two groups of companies, the median inequality between board members and employees was 7.37 in MHT and 7.89 in MLT, respectively. MHT companies were the most heterogeneous group; the coefficient of variation was estimated at 1.97. In HT entities, the variation was the smallest; the calculated coefficient of variation was 0.59.

The study carried out an analysis of the significance of differences for each described wage inequality. For this purpose, the non-parametric Kruskal-Wallis test was used, which is an alternative to the parametric one-factor analysis of variance. The choice of this test was driven by two diagnoses. Firstly, the groups of companies compared differed in size. Secondly, the Shapiro-Wilk test performed on the data from the individual enterprise groups was below 0.05 - thus, it was necessary to reject the null hypothesis that the distribution was normal and accept the alternative hypothesis that the distribution was extremely asymmetric.

First, a test was carried out for the inequality between CEO remuneration and average employee remuneration. The value of the Kruskal-Wallis test was equal to 19.522; $p < 0.001$, thus diagnosing the basis for rejecting the null hypothesis that there are no significant differences in CEO-employee pay inequality in companies with different levels of technological advancement. This means that at least one group of companies differs significantly from another in terms of this relationship. To detect between which groups of companies these differences occur, multiple comparison tests were used. The results are presented in Table 2.

Table 2.

Multiple comparisons (two-sided) on CEO-employee pay inequality

Specification	Test Statistic	Significant
HT-MHT	-56,124	**0,023**
HT-MLT	-56,515	**0,019**
HT-LT	-107,070	**<0,001**
MHT-MLT	-,390	0,980
MHT-LT	50,946	**0,004**
MLT-LT	50,556	**0,003**

Statistical significance $p < 0.05$.

Source: own compilation based on data from financial statements.

The analysis of the results allows us to conclude that only between MHT and MLT companies there is no statistically significant difference in the inequality between CEO remuneration and average employee remuneration. Differences that are significant occurred between HT companies and all others, i.e. MHT ($p = 0.023$), MLT ($p = 0.019$) and LT ($p =< 0.001$). The median salary inequality in HT companies was lower than in the other groups of companies. There were also statistically significant differences between MHT and LT enterprises ($p = 0.004$) and MLT and LT enterprises ($p = 0.003$). The median wage inequality in LT enterprises was higher than in the other enterprise groups.

In the case of the test for the inequality between the median remuneration of board members and the median remuneration of employees, the value of the Kruskal-Wallis test was 5.842, while $p = 0.120$. The result obtained indicates, with a composite statistical significance of $p < 0.05$, that there are no grounds to reject the null hypothesis that there are no significant differences in the inequality of remuneration along the board member-employee line in companies with different levels of technological advancement. This means that no group of companies differs significantly in this relationship from another.

The research conducted is original to that already done in the social sciences. The results confirm the assumption that high technology is a determinant of wage inequality. Its impact should be assessed favourably, as the lowest level of vertical wage inequality on the CEO-employee and board member-employee lines was diagnosed in HT companies and the highest in LT.

5. Conclusion

This study attempted to identify and assess the impact of technological advancement of manufacturing enterprises on vertical wage inequality. The analyses carried out allowed us to conclude that there are no grounds for rejecting the research hypothesis. The results of the study unequivocally indicated that the inequality between CEO remuneration and average employee remuneration, as well as the average remuneration of board members and average employee remuneration, was lowest in the group of highly technologically advanced enterprises. Moreover, for the first relationship, its level in the HT group was significantly different from the levels in the other groups of companies. The highest level of both inequalities was diagnosed in the group of low technological advancement enterprises. Identical to the CEO-employee salary inequality in the HT group, the level of this relationship in the LT group of entities differed significantly from the levels in HT, MHT and MLT enterprises. Based on the results obtained, it is assessed that isolated technology has a positive effect on vertical wage inequality.

The results from the analysis can serve as a guideline for policy makers in which direction to pursue the state's economic policy. It is recommended to promote and support entrepreneurship oriented towards highly technological advancement production. To this end, the legislator can use fiscal policy tools and/or monetary policy tools. In addition, the legislator should ensure that human capital can be developed and that there is a steady flow of skilled labour into the labour market. It can achieve this by introducing appropriate educational policies.

Studies that use wage data are difficult to implement. This is primarily due to the legal protection of salary information and the need to rely on aggregate data. Nevertheless, this is an area where many problems have not been posed and solved, especially in terms of the impact on the socio-economic aspects of the implementation and development of artificial intelligence.

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