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Disparities in employment and education across European Union member states

Abstract

The article focuses on disparities in education and employment. The main aim is to evaluate scope and scale of disparities in education and employment among the EU Member States. The spatial scope of the research covers 27 EU Member States. The time scope of the research covers the period 2016–2023 (selected four years, in particular: 2016, 2019, 2020, 2023). The following hypothesis was verified during the research: Disparities in education and employment between EU countries are widening. The study was carried out using two selected methods of multivariate comparative analysis, namely Hellwig taxonomic measure of development (TMD) and standard deviations' method of grouping linearly ordered objects.

The significance of balanced development was stressed numerous times in the EU documents. The EU Action Plan for European Pillar of Social Rights emphasized the need to achieve high employment rate, reduce gender employment gap, lower early school leavers from education and training rate, promote tertiary education attainment and adult participation in learning. The necessity to solve the problem of young people NEET was also underlined.

The conducted research confirmed the truth of the hypothesis assuming increasing disparities in employment and education across EU countries. The largest employment and education disparities are between the Scandinavian countries and Romania, Greece, Italy, Spain. The Scandinavian countries are distinguished by high employment rates, really low gender employment gaps, extremely high enrollment in higher education and life-long learning, relatively low NEET rates. As for the countries that make up the G1 group, their situation is due to coupled problems such as low employment rates, high NEET rates, relatively high unemployment rates, as well as large gender employment gaps and extremely low intensity of adult participation in training.

The persistence and rise of disparities in education and employment between EU Member States is a serious problem for the EU, as this situation makes it difficult to create a more cohesive and convergent European Union. Therefore, active actions should be advocated to promote education and greater professional activity in those EU countries that struggle most with the problem of low employment and education.

Keywords: disparities, employment, education, European Union, EU Member States.

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Dysproporcje w zatrudnieniu i edukacji pomiędzy państwami członkowskimi Unii Europejskiej

Abstrakt

Artykuł koncentruje się na problemie dysproporcji w zatrudnieniu i edukacji. Głównym celem jest zbadanie zakresu i skali dysproporcji z zakresu zatrudnienia i edukacji między państwami członkowskimi UE. Zakres przestrzenny prowadzonych badań to 27 państw członkowskich UE. Zakres czasowy prowadzonych analiz to okres 2016–2023 (wybrane cztery lata, a w szczególności: 2016, 2019, 2020, 2023). W trakcie badań weryfikowano hipotezę, zakładającą, że: Nierówności z zakresu edukacji i zatrudnienia występujące między krajami UE pogłębiają się. Badanie przeprowadzono z wykorzystaniem dwóch wybranych metod wielowymiarowej analizy porównawczej, a mianowicie taksonomicznej miary rozwoju Hellwiga (TMD) oraz metody odchyleń standardowych jako metody grupowania obiektów uporządkowanych liniowo.

Znaczenie zrównoważonego rozwoju było wielokrotnie podkreślane w dokumentach unijnych. W Planie Działania UE na rzecz Europejskiego Filaru Praw Socjalnych podkreślono potrzebę osiągnięcia wysokiego wskaźnika zatrudnienia, zmniejszenia różnic w zatrudnieniu kobiet i mężczyzn, obniżenia wskaźnika osób przedwcześnie kończących edukację i szkolenia, promowania zdobywania wyższego wykształcenia i uczestnictwa dorosłych w uczeniu się. Podkreślono również konieczność rozwiązania problemu młodzieży NEET.

Przeprowadzone badania potwierdziły prawdziwość hipotezy zakładającej narastanie dysproporcji w zatrudnieniu i edukacji między państwami UE. Największe różnice w zatrudnieniu i edukacji występują między krajami skandynawskimi a Rumunią, Grecją, Włochami i Hiszpanią. Kraje skandynawskie wyróżniają się wysokimi wskaźnikami zatrudnienia, bardzo niską genderową luką w zatrudnieniu, wyjątkowo wysokim poziomem uczestnictwa w szkolnictwie wyższym i kształceniu ustawicznym oraz stosunkowo niskimi wskaźnikami NEET. Sytuacja państw tworzących skupienie G1 wynika z wielu powiązanych problemów, takich jak niski poziom stopy zatrudnienia, wysoki poziom wskaźnika NEET, stosunkowo wysoka stopa bezrobocia, a także duża genderowa luka w zatrudnieniu oraz bardzo niska intensywność kształcenia ustawicznego.

Utrzymywanie się oraz wzrost dysproporcji w obszarze edukacji i zatrudnienia pomiędzy państwami członkowskimi UE stanowi poważny problem dla UE, gdyż taka sytuacja utrudnia tworzenie bardziej spójnej i konwergentnej Unii Europejskiej. Dlatego też należy postulować aktywne działania na rzecz promocji edukacji i większej aktywności zawodowej w tych krajach UE, które najbardziej borykają się z problemem niskiego zatrudnienia i wykształcenia.

Słowa kluczowe: dysproporcje, zatrudnienie, edukacja, Unia Europejska, państwa członkowskie UE.

JEL: D63, I24, O57.

INTRODUCTION

The article focuses on education and employment in European Union Member States. The main aim is to evaluate scope and scale of disparities in employment and education across the EU Member States with the implementation of selected methods of multivariate comparative analysis. The following hypothesis was verified during the research: Disparities in education and employment among EU countries

are widening. The studied research problem is actual and of vital importance due to the fact that increasing instability in the global economy in the 21st century – resulting from both economic and non-economic factors – is causing cascading and accumulating problems for the EU, disrupting and disturbing the process of balanced development of the economies of the EU. Hence, the need to reduce disparities, repeatedly emphasized in EU documents, still persists and requires the development of a new approach.

Literature review

Considerable evolution of the perception of socioeconomic disparities and inequalities is observed. Rawls (1994), Sen (1995), Piketty (2014) addressed the inequality problem in equity theory. They argued that equity sets in motion a mechanism to reduce inequality by facilitating access to goods and services through an increase in the economic powers of the state (Rawls, 1994; Sen, 1995; Piketty, 2014). Atkinson (2018) states that inequality is not inevitable; on the contrary, it results from conscious behavior. Milanovic (2016) studied trends in global income disproportions (both between and within nation-states) and stated that economic history of the world was actually history of inequality, the inequality which resulted from both economic and political factors. According to Boushey (2021), huge disparities created during the last 50 years have made economy less efficient and less resilient to shocks; reducing disparities can, therefore, form the right key to ensuring future prosperity. CASE listed the following global and regional drivers of multidimensional inequality: a. Dominant narratives and corresponding policies; b. Values, norms, practices and structures perpetuating discrimination and intolerance, especially discrimination against women; c. Financialization, including power of capital and global elites; d. Power of global corporations and lack of effective regulation; e. Lack of financial transparency and ineffective global tax governance; f. Distorted structure of global trade; g. Climate change and environmental degradation; h. Conflict, global displacement and international migration policies; i. Distorted technological development, scientific progress and innovation; j. Lack of effective global governance (CASE at LSE, 2024). Breunig and Majeed (2020) analyzed how both inequality and poverty influence economic growth. Franzini and Raitano (2013), as well as Neidhöfer (2019) studied correlation between inequality and its intergenerational transmission. Gajardo (2016) focused on the impact of disparities on development. Links between digital technology and e-commerce development and economic disparities exemplified by China were studied by Liu, Qian, Gu and Li (2024). Association between economic complexity and income disproportions was analyzed by Hu and Hoang (2020).

Income differences between and within subregions in Europe from 1980 to 2021 were studied by Neef and Sodano (2022). The problem of large income disparities

in Europe was also surveyed by Yanatma (2024), as well as Faggian, Mechelangeli and Tkach (2018). The research on relation between income disproportions and socioeconomic development in the EU was conducted by Litwiński (2019). Pawlas (2016) studied disparities in socioeconomic development in the EU from 2003 to 2014. The impact of the COVID-19 pandemic on disparities in the EU was surveyed by Eurofound (2023), as well as Palomino, Rodriguez and Sebastian (2020). Brunori (2017) analyzed the perception of inequality of opportunity in Europe.

The issue of disparities and need for more balanced growth and development has been stressed in the EU (earlier: the European Communities) treaties (The Treaty of Rome, 1957, Article 2; Single European Act, 1987, Article 130a, 130b, 130, 130c, 130Q; Treaty on European Union, 1992, Article 3, 3A, 103; Article 1; Treaty of Amsterdam, 1997; The Treaty of Lisbon, 2007, Article 2, 163). Moreover, the importance of disparities' reduction was included in the Europe 2020 Strategy (European Commission, 2010). The need to promote human capital development and increase employability was indicated in *A New Skills Agenda for Europe. Working together to strengthen human capital, employability and competitiveness* (European Commission, 2016). *A Roadmap for Recovery. Towards a More Resilient, Sustainable and Fair Europe,* was the EU's first response to the outbreak of COVID-19 pandemic and possible increase of disparities caused by it (European Council, 2020). Once again, the issue of economic and social differences and the need to reduce the disproportions were raised in the European Pillar of Social Rights and the Action Plan dedicated to it (European Commission, 2021).

The reviewed theories and prior research indicated the significance of the problem of disparities and rising inequalities due to its effect on processes of economic development, impact on poverty reduction, social cohesion, political stability, economic policy and international cooperation. The increased emphasis on education and employment in the EU documents, strategies and plans indicated the need for a more thorough examination of disparities in education and employment across the EU Member States.

Research methods and input data

Disparities among EU Member States can be studied in regard to several areas including income, employment, education, health. Due to a limited scope of the article, the conducted research was limited to employment and education disparities across the EU Member States. The first step was to select the set of diagnostic variables. Initially the decision was taken to describe situation in the EU Member States with the use of eight diagnostic variables:

X1 – employment rate,

X2 – unemployment rate,

X3 – gender employment gap,
X4 – early school leavers from education and training,
X5 – tertiary education attainment,
X6 – young people neither in employment, nor in education or training,
X7 – adult participation in learning in the last four weeks,
X8 – individuals who have basic or above basic overall digital skills (the so called Digital Skills Indicator 2.0, i.e. a composite indicator, based on selected activities related to internet or software use that individuals aged 16–74 perform in five specific areas (a. Information and data literacy, b. Communication and collaboration, c. Digital content creation, d. Safety, and e. Problem solving).

Variables X1, X2 and X3 described the employment situation. Variables 4, 5, and 7 allowed for comparison of the situation in the area of education. Variable 7 combined both areas, i.e. education and employment. Variable X8 described the digital skills which seemed important having in mind the gradual advancement of digital economy. Finally, however, variable X8 was excluded due to the fact that it was not possible to collect complete data set (statistical information regarding Digital Skills Indicator 2.0 was available for 2021 and 2022 only). Therefore, the multivariate comparative analysis was based on seven variables (X1–X7). It should be stressed here that the EU Action Plan for European Pillar of Social Rights highlights the importance of EU Member States achieving better results in all the above-mentioned variables.

The study was carried out using two selected methods of multivariate comparative analysis, i.e. Hellwig taxonomic measure of development (TMD) and standard deviations' method of grouping linearly ordered objects. Methods of multivariate comparative analysis allow for comparison of objects described by many variables. Hellwig TMD method makes it possible to hierarchize the studied objects (i.e. to rank 27 EU Member States according to their education and employment situation). The application of the standard deviations' method allows for the division of the studied objects into four clusters containing similar objects (i.e. the division of the 27 EU Member States into four groups containing similar objects in regard to education and employment situation).

After selecting the set of diagnostic variables, the character of each of the variables was determined. Three variables were considered stimulants (X1 – employment rate, X5 – tertiary education attainment and X7 – adult participation in the last four weeks) while the remaining four were variables were considered destimulants (X2 – unemployment rate, X3 – gender employment gap, X4 – early school leavers from education and training, as well as X6 – young people neither in employment, nor in education or training). Variables were standardized and development model was constructed – a model unit, where diagnostic of variables were determined according to the rule, where: $z_{0j} = \max_i (z_{ij})$ for stimulants or $z_{0j} = \min_i (z_j)$ for destimulants. The distance of *i*-unit from the

development model was calculated using Euclid's measure: $d_i = \sqrt{\sum_{j=1}^{m}(z_j - z_p)^2}$

TMD was calculated according to the formula (Hellwig 1968; Pluta 1986):

$$\text{TMD}_i = 1 - \frac{d_i}{d_o} \quad , i=1,2,.., n,$$

where: $d_0 = \bar{d}_o + 2S_0$, and $\bar{d}_0 = \frac{1}{n}\sum_{i=1}^{n} d_i$, $S_0 = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_i - \bar{d}_o)^2}$, while: $\text{TMD}_i \in [0; 1]$.

Then, the analyzed EU Member States were hierarchized according to TMD (the higher the position of a state, the better the situation in regard to education and employment).

Finally, cluster analysis was implemented in order to identify groups of EU Member States with a similar level of employment and education. The application of the standard deviations' method of grouping linearly ordered was us to divide 27 EU Member States into four groups (clusters), according to the following classification rule (Pawlas, 2018):

$$G_1 : s_i < \bar{s} - S(s),$$

$$G_2 : \bar{s} > s_i \geq s_i - S(s),$$

$$G_3 : \bar{s} + S(s) > s_i \geq \bar{s},$$

$$G_4 : s_i \geq \bar{s} + S(s),$$

where: $\bar{s}$ – arithmetic mean of synthetic variable (in this study: arithmetic mean of TMD), while S – standard deviation of synthetic variable (in this study: standard deviation of TMD), s_i – value of the synthetic variable of the object i (in this study: TMD value in i EU member State). G4 brings together EU countries with the most favorable situation in the area of education and employment, while group G1 gathers EU countries with the worst situation in the two analyzed areas.

The research was conducted for the selected years from 2016 to 2023: 2016 was the 1st year taken into consideration due to the fact that A New Skills Agenda for Europe was introduced by the EU in 2016, 2019 (the last pre-pandemic year), 2020 (the first year of COVID-19 pandemic), 2023 (the last year for which complete data set was available). Statistical information used for the research was taken from EUROSTAT database. Input data are presented in tables 1 and 2.

Table 1. Input data – year 2016 and 2019

Economy	2016							2019						
	X1	X2	X3	X4	X5	X6	X7	X1	X2	X3	X4	X5	X6	X7
Belgium	67.7	7.9	9.3	8.8	45.6	12.2	7.0	70.5	5.5	8.0	8.4	47.5	11.2	8.2
Bulgaria	67.0	8.6	6.8	13.8	33.8	22.4	2.2	74.3	5.2	8.1	13.9	32.5	16.7	2.0
Czechia	76.7	4.0	16.0	6.6	32.8	11.1	8.8	80.3	2.0	15.0	6.7	35.1	9.8	8.1
Denmark	76.0	6.0	6.9	7.5	46.7	8.4	28.0	78.3	5.0	7.2	9.9	49.4	9.6	25.3
Germany	77.6	3.9	8.1	10.3	33.2	10.0	8.5	79.6	3.0	8.0	10.3	35.5	8.6	8.2
Estonia	77.0	6.8	6.8	11.4	43.3	13.3	15.3	80.5	4.5	6.0	11.2	44.0	9.7	19.6
Ireland	71.3	8.4	12.2	6.0	54.6	14.5	6.5	75.0	5.0	12.5	5.1	55.4	11.4	12.6
Greece	55.9	23.9	19.5	6.2	42.7	21.9	4.0	60.8	17.9	20.7	4.1	43.1	17.5	3.9
Spain	63.9	19.6	11.5	19.0	40.1	18.1	9.4	68.0	14.1	11.9	17.3	44.7	14.9	10.6
France	70.7	10.1	6.1	8.8	43.7	13.6	18.8	72.3	8.4	5.9	8.2	47.5	12.4	19.5
Croatia	61.4	13.1	9.6	2.8	29.3	19.5	3.0	66.7	6.6	10.5	3.0	33.1	14.2	3.5
Italy	61.4	11.7	19.9	13.8	26.2	24.4	8.3	63.5	9.9	19.4	13.3	27.8	22.3	8.1
Cyprus	68.7	13.0	9.7	7.6	53.4	18.0	6.9	75.7	7.1	11.6	9.2	58.8	14.1	5.9
Latvia	73.0	9.7	2.8	10.0	42.8	13.3	7.3	77.3	6.3	3.7	8.7	45.7	10.2	7.4
Lithuania	75.2	7.9	1.9	4.8	58.7	10.7	6.0	78.2	6.3	1.6	4.0	57.8	10.9	7.0
Luxembourg	70.7	6.3	11.0	5.5	54.6	6.8	16.8	72.8	5.6	9.1	7.2	56.2	6.5	19.1
Hungary	73.7	5.0	9.7	12.4	33.0	12.0	6.3	77.6	3.3	11.0	11.8	33.4	11.0	5.8
Malta	71.1	4.7	25.5	15.6	32.0	9.4	7.8	75.6	4.1	22.0	14.2	39.9	8.5	11.8
Netherlands	77.9	7.0	10.5	8.0	45.7	6.9	18.8	81.0	4.4	8.9	7.5	51.4	6.3	19.5
Austria	74.8	6.5	7.8	6.9	40.1	9.3	14.9	76.8	4.8	8.8	7.8	42.4	8.6	14.7
Poland	68.2	6.3	13.4	5.2	44.6	14.0	3.7	72.6	3.3	14.6	5.1	47.0	11.4	4.9
Portugal	69.5	11.5	6.5	14.0	34.6	12.8	9.6	75.5	6.7	6.9	10.6	36.2	9.2	10.5
Romania	60.3	7.2	17.7	18.5	25.6	24.3	1.2	65.1	4.9	19.2	15.3	25.8	20.9	1.3
Slovenia	69.5	8.0	6.5	4.9	44.2	9.3	11.6	75.9	4.4	6.5	4.6	44.9	7.5	11.2
Slovakia	71.8	9.6	9.2	7.4	31.5	15.1	2.9	75.6	5.7	7.7	8.3	40.1	13.7	3.6
Finland	72.4	8.9	3.2	7.9	46.1	11.2	26.4	76.2	6.8	3.3	7.3	47.3	9.1	29.0
Sweden	80.8	7.1	4.1	7.4	51.0	6.7	29.6	81.7	6.9	5.2	6.5	52.5	5.9	34.3

Legend: X1 – employment rate, X2 – unemployment rate, X3 – gender employment gap, X4 – early school leavers from education and training, X5 – tertiary education attainment, X6 – young people neither in employment, nor in education or training, X7 – adult participation in learning in the last four weeks.

Source: EUROSTAT (2024a; 2024b; 2024c, 2024d; 2024e; 2024f; 2024g).

Table 2. Input data – year 2020 and 2023

Economy	2020							2023						
	X1	X2	X3	X4	X5	X6	X7	X1	X2	X3	X4	X5	X6	X7
Belgium	69.7	5.8	8.1	8.1	47.8	11.3	7.4	72.1	5.5	7.6	6.2	50.2	9.6	11.1
Bulgaria	72.7	6.1	8.3	12.8	33.3	18.2	1.6	76.2	4.3	7.3	9.3	35.0	13.8	1.4
Czechia	79.7	2.6	15.3	7.6	35.0	11.0	5.5	81.7	2.6	13.9	6.4	34.9	10.1	9.9
Denmark	77.8	5.6	7.0	9.3	49.8	10.2	20.0	79.8	5.1	5.6	10.4	52.7	8.6	30.5
Germany	78.2	3.7	7.5	10.1	36.6	9.6	7.7	81.1	3.1	7.7	12.8	41.0	8.8	8.3
Estonia	79.1	6.9	4.4	8.5	41.5	11.1	16.6	82.1	6.4	2.4	9.7	47.3	9.6	23.2
Ireland	72.1	5.9	12.7	5.0	58.1	14.1	11.0	79.1	4.3	9.9	4.0	63.7	8.5	12.3
Greece	58.3	17.6	19.4	3.8	43.9	18.5	4.1	67.4	11.1	19.8	3.7	45.1	15.9	3.4
Spain	65.7	15.5	11.4	16.0	44.8	17.3	11.0	70.5	12.2	10.3	13.7	50.6	12.3	15.8
France	72.1	8.0	5.7	8.0	48.8	13.4	13.0	74.4	7.3	5.5	7.6	51.5	12.3	14.9
Croatia	66.9	7.5	11.2	2.2	34.7	14.6	3.2	70.7	6.1	7.8	2.0	38.9	11.8	6.4
Italy	61.9	9.3	19.7	14.2	27.8	23.5	7.1	66.3	7.7	19.5	10.5	29.2	16.1	11.6
Cyprus	74.9	7.6	12.0	11.5	59.8	15.3	4.7	78.9	6.1	9.0	10.5	66.1	13.8	11.0
Latvia	76.9	8.1	3.7	7.2	49.2	11.9	6.6	77.5	6.5	3.1	7.7	47.4	10.0	10.7
Lithuania	76.7	8.5	1.7	5.6	59.6	13.0	7.2	78.5	6.9	1.5	6.4	59.5	13.5	10.7
Luxembourg	72.1	6.8	7.1	8.2	62.2	7.7	16.3	74.8	5.2	6.8	6.8	61.9	8.5	16.2
Hungary	77.5	4.1	11.2	12.1	33.2	12.3	5.1	80.7	4.1	9.2	11.6	32.2	10.9	9.6
Malta	76.0	4.9	18.9	13.0	40.1	9.7	10.8	81.7	3.1	14.2	10.0	43.4	7.5	16.5
Netherlands	80.8	4.9	8.4	7.0	54.0	6.3	18.8	83.5	3.6	7.8	6.2	54.3	4.7	26.4
Austria	74.8	6.0	8.4	8.1	41.6	9.9	11.7	77.2	5.1	7.8	8.6	44.0	9.4	17.1
Poland	72.8	3.2	14.8	5.3	47.7	12.5	3.8	77.9	2.8	11.8	3.7	49.2	9.1	8.7
Portugal	74.2	7.0	5.7	9.1	39.0	11.0	9.8	78.2	6.5	5.6	8.0	39.2	8.9	13.4
Romania	65.2	6.1	19.3	15.6	26.4	20.6	1.0	68.7	5.6	19.1	16.6	22.8	19.3	6.7
Slovenia	74.8	5.0	5.9	4.1	46,9	7.9	8.4	77.5	3.7	6.1	5.4	40.0	7.8	19.9
Slovakia	74.6	6.7	7.3	7.6	39.7	14.4	2.8	77.5	5.8	7.7	6.4	41.1	11.2	10.5
Finland	75.5	7.7	3.3	8.2	49.6	9.8	27.3	78.2	7.2	0.2	9.6	43.1	9.2	26.1
Sweden	80.2	8.5	5.3	7.7	52.2	6.9	28.6	82.6	7.7	4.7	7.4	58.0	5.7	38.8

Source: EUROSTAT (2024a; 2024b; 2024c, 2024d; 2024e; 2024f; 2024g).

RESULTS AND DISCUSSION

The first step was to conduct an introductory descriptive statistical analysis in regard to each variable. Table 3 presents the results of the preliminary descriptive statistical analysis.

Table 3. Results of preliminary descriptive statistical analysis (years 2016, 2019, 2020, 2023)

Variable	X1	X2	X3	X4	X5	X6	X7
Variable character	S	D	D	D	S	D	S
YEAR 2016							
Mean	70.526	8.989	10.081	9.300	41.107	13.674	10.726
Standard deviation	5.909	4.379	5.517	4.131	8.884	5.143	7.726
Range	24.9	20.0	23.6	16.2	33.1	17.7	28.4
Minimum value	55.9	3.9	1.9	2.8	25.6	6.7	1.2
Economy min.	Greece	Germany	Lithuania	Croatia	Romania	Sweden	Romania
Maximum value	80.8	23.9	25.5	19.0	58.7	24.4	29.6
Economy max	Sweden	Greece	Malta	Spain	Lithuania	Italy	Sweden
YEAR 2019							
Mean	74.348	6.211	10.122	8.870	43.519	11.559	11.689
Standard deviation	5.366	3.260	5.277	3.617	8.801	4.072	8.274
Range	20.9	15.9	20.4	14.3	33.0	16.4	33.0
Minimum value	60.8	2.0	1.6	3.0	25.8	5.9	1.3
Economy min.	Greece	Czechia	Lithuania	Croatia	Romania	Sweden	Romania
Maximum value	81.7	17.9	22.0	17.3	58.8	22.3	34.3
Economy max	Sweden	Greece	Malta	Spain	Cyprus	Italy	Sweden
YEAR 2020							
Mean	73.378	7.022	9.767	8.737	44.567	12.667	10.041
Standard deviation	5.523	3.168	5.154	3.447	9.487	4.104	7.092
Range	22.5	15.0	18.0	13.8	35.8	17.2	27.6
Minimum value	58.3	2.6	1.7	2.2	26.4	6.3	1.0
Economy min.	Greece	Czechia	Lithuania	Croatia	Romania	Nether-lands	Romania
Maximum value	80.8	17.6	19.7	16.0	62.2	23.5	28.6
Economy max	Nether-lands	Greece	Italy	Spain	Luxembourg	Italy	Sweden
YEAR 2023							
Mean	76.844	5.763	8.589	8.193	46.011	10.626	14.485
Standard deviation	4.674	2.237	5.009	3.238	10.452	3.186	8.310
Range	17.2	9.6	19.6	14.6	43.3	14.6	37.4
Minimum value	66.3	2.6	0.2	2.0	22.8	4.7	1.4
Economy min.	Italy	Czechia	Finland	Croatia	Romania	Nether-lands	Bulgaria
Maximum value	83.5	12.2	19.8	16.6	66.1	19.3	38.8
Economy max	Nether-lands	Spain	Greece	Roma-nia	Cyprus	Romania	Sweden

Legend: S – stimulant, D – destimulant

Source: own calculations.

Already the results of the preliminary statistical analysis showed large disparities between EU Member States in all the variables included in the study. The highest employment rates were observed in Sweden (2016 and 2019) and the Netherlands (2020, 2023), while the lowest employment rates characterized Greece (2016, 2019 and 2020) and Italy (2023). The average employment rate for the EU27 increased by over 6 p.p., while the range was reduced by over 7 p.p. from 2016 to 2023. The unemployment rate was lowest in Germany (2016) and the Czech Republic (2019, 2020 and 2023). The highest unemployment rate was noted for Greece (2016, 2019 and 2020) and Spain (2023). The average unemployment rate for the EU27 amounted to 9% in 2016 and 5.8% in 2023. What is more, the range of unemployment rate was reduced by over 10 p.p. in the analyzed period of time (from 20 in 2016 to 9.6 in 2023). Gender employment gap was the highest in Malta (2016, 2019), Italy (2020) and Greece (2023). The lowest level of gender employment gap was noted in Lithuania (2016, 2019, 2020) and Finland (2023). The average gender employment gap was slightly reduced in the analyzed period of time (from over 10% in 2016 and 2019 to 8.6 in 2023). At the same time the range of gender employment gap was reduced by 4 p.p. (from 23.6 to 19.6). The indicator of early school leavers from education and training measures the share of the population aged 18 to 24 with in majority lower secondary education who were not involved in any education or training (EUROSTAT, 2024b). The problem of leaving education system too early was most serious in Spain (2016, 2019, 2020) and Romania (2023); it practically did not exist in Croatia. The range of the indicator of early school leavers from education and training amounted to 16.2% in 2016, and 14.6% in 2023, so the reduction in range was marginal only. Tertiary education attainment measures the share of the population aged 30–34 years who have successfully completed university or university-like (i.e. tertiary-level) education. The highest tertiary education attainment level was characteristic for Lithuania (2016, 56,7%), Cyprus (2019 and 2023 – 58.8% and 66.1% respectively), and Luxembourg (2020 – 62.2%). The average value of tertiary education attainment increased by almost 5 p.p. (from 41.1% to 46.0%) in the analyzed period of time; the range of this indicator, however, increased even more – by 10 p.p. (from 33.1% to 43.3%). Young people neither in employment, nor in education or training (NEET) is the next variable taken into consideration; this indicator measures the share of the population aged 15 to 29 who is not employed and not involved in education or training. The lowest level of NEET indicator was noted in Sweden (2016, 2019 – 6.7% and 5.9% respectively) and the Netherlands (2020, 2023 – 6.3% and 4.7% respectively), while the highest value of NEET indicator was characteristic for Italy (2016, 2019, 2020 – 24.4%, 22.3% and 23.5% respectively) and Romania (2023 – 19.3%). The average value of NEET indicator was reduced by 3 p.p. and its range decreased by 3.1 p.p. in the analyzed period of time. The indicator of adult participation in learning measures the share of people aged 25 to 64 who stated that they received formal or non-formal education and training in the four

weeks preceding the survey in the total population of the same age group, excluding those who did not answer to the question regarding participation in education and training (EUROSTAT, 2024). Sweden was the absolute leader in regard to adult participation in learning (the value of this indicator in Sweden amounted to 28.4% in 2016, and it was even higher in the years to come, so that in 2023 it equaled 37.4%). Minimum values of adult participation in learning (less than 1.5%) were noted in the case of Romania (2016, 2019, 2022) and Bulgaria (2023).

The next step was to calculate the TMD and develop a ranking of the EU27 countries by its value. Finally, the standard deviations' method was applied in order to divide the 27 EU Member States into four groups (clusters) gathering EU Member States with a similar level of employment and education. The results of multivariate comparative analysis with the application of Hellwig TMD method are presented in table 4, while the results of cluster analysis are shown in table 5.

Table 4. Ranking of EU Member States according to TMD (years 2016, 2019, 2020, 2023)

Position	2016		2019		2020		2023	
	Economy	TMD	Economy	TMD	Economy	TMD	Economy	TMD
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	Sweden	0.830	Sweden	0.787	Netherlands	0.728	Netherlands	0.715
2	Denmark	0.768	Finland	0.715	Sweden	0.712	Sweden	0.683
3	Finland	0.709	Netherlands	0.706	Finland	0.685	Denmark	0.617
4	Netherlands	0.691	Denmark	0.684	Denmark	0.662	Slovenia	0.580
5	Luxembourg	0.683	Luxembourg	0.657	Luxembourg	0.647	Ireland	0.574
6	Austria	0.644	Slovenia	0.621	Slovenia	0.616	Luxembourg	0.568
7	Lithuania	0.642	Estonia	0.619	Estonia	0.603	Estonia	0.565
8	Slovenia	0.614	Lithuania	0.600	Lithuania	0.573	Finland	0.539
9	Estonia	0.611	Austria	0.600	Austria	0.557	Austria	0.508
10	France	0.609	Ireland	0.584	France	0.551	Poland	0.490
11	Ireland	0.546	France	0.569	Ireland	0.550	Latvia	0.481
12	Latvia	0.539	Latvia	0.546	Latvia	0.545	Lithuania	0.474
13	Germany	0.525	Belgium	0.505	Belgium	0.509	Portugal	0.470
14	Belgium	0.519	Germany	0.497	Portugal	0.509	Malta	0.469
15	Czechia	0.488	Portugal	0.485	Germany	0.496	Belgium	0.464
16	Poland	0.478	Poland	0.471	Poland	0.467	France	0.455
17	Cyprus	0.474	Czechia	0.470	Slovakia	0.437	Slovakia	0.445
18	Hungary	0.457	Cyprus	0.467	Czechia	0.434	Cyprus	0.413
19	Portugal	0.430	Slovakia	0.448	Cyprus	0.419	Czechia	0.407
20	Slovakia	0.422	Hungary	0.413	Malta	0.388	Germany	0.396

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
21	Bulgaria	0.310	Malta	0.351	Hungary	0.387	Croatia	0.357
22	Croatia	0.295	Croatia	0.347	Croatia	0.363	Hungary	0.355
23	Malta	0.282	Bulgaria	0.302	Bulgaria	0.289	Bulgaria	0.293
24	Spain	0.227	Spain	0.223	Spain	0.192	Spain	0.213
25	Italy	0.167	Italy	0.093	Greece	0.096	Greece	0.103
26	Greece	0.117	Romania	0.087	Romania	0.084	Italy	0.102
27	Romania	0.105	Greece	0.084	Italy	0.067	Romania	0.024

Source: own calculations.

Sweden was the unquestioned leader in regard to synthetic measure of TMD in 2016 and 2019, while the Netherlands took the lead in 2020 and 2023. Sweden, Denmark, Finland and the Netherlands formed the four countries with the highest TMD levels in 2016, 2019 and 2020 (they constituted a 4-element G4 cluster in these years). In 2023, however, the situation was slightly changed: Finland was no longer inside a G4 cluster.

Table 5. Result of grouping EU countries into clusters by level of synthetic TMD measure (years 2016, 2019, 2020, 2023)

2016		2019		2020		2023	
Economy	Cluster	Economy	Cluster	Economy	Cluster	Economy	Cluster
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sweden	G4	Sweden	G4	Netherlands	G4	Netherlands	G4
Denmark	G4	Finland	G4	Sweden	G4	Sweden	G4
Finland	G4	Netherlands	G4	Finland	G4	Denmark	G4
Netherlands	G4	Denmark	G4	Denmark	G4	Slovenia	G3
Luxembourg	G3	Luxembourg	G3	Luxembourg	G3	Ireland	G3
Austria	G3	Slovenia	G3	Slovenia	G3	Luxembourg	G3
Lithuania	G3	Estonia	G3	Estonia	G3	Estonia	G3
Slovenia	G3	Lithuania	G3	Lithuania	G3	Finland	G3
Estonia	G3	Austria	G3	Austria	G3	Austria	G3
France	G3	Ireland	G3	France	G3	Poland	G3
Ireland	G3	France	G3	Ireland	G3	Latvia	G3
Latvia	G3	Latvia	G3	Latvia	G3	Lithuania	G3
Germany	G3	Belgium	G3	Belgium	G3	Portugal	G3
Belgium	G3	Germany	G3	Portugal	G3	Malta	G3
Czechia	G2	Portugal	G3	Germany	G3	Belgium	G3
Poland	G2	Poland	G2	Poland	G3	France	G3
Cyprus	G2	Czechia	G2	Slovakia	C2	Slovakia	G3

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Hungary	G2	Cyprus	G2	Czechia	G2	Cyprus	G2
Portugal	G2	Slovakia	G2	Cyprus	G2	Czechia	G2
Slovakia	G2	Hungary	G2	Malta	G2	Germany	G2
Bulgaria	G2	Malta	G2	Hungary	G2	Croatia	G2
Croatia	G2	Croatia	G2	Croatia	G2	Hungary	G2
Malta	G1	Bulgaria	G2	Bulgaria	G2	Bulgaria	G2
Spain	G1	Spain	G1	Spain	G1	Spain	G1
Italy	G1	Italy	G1	Greece	G1	Greece	G1
Greece	G1	Romania	G1	Romania	G1	Italy	G1
Romania	G1	Greece	G1	Italy	G1	Romania	G1

G1 – the worst situation in terms of education and employment; G4 – the highest level of employment and education.

Source: own calculations.

At the other extreme, the situation looked as follows: the lowest value of TMD was noted for Romania (2016 and 2023), Greece (2019) and Italy (2020). A 4-element G1 cluster was formed by Romania, Greece and Italy together with Spain in 2019, 2020 and 2023. In 2016 the G1 cluster included one more EU Member State, i.e. Malta. It should be emphasized that the range of the value of the synthetic indicator TMD considerably increased – in 2016, the TMD for Romania accounted for 12.6% of the value of the TMD of Sweden, and in 2023, the TMD of Romania accounted for only 3% of the TMD of the Netherlands.

The conducted research allowed for the confirmation of the hypothesis assuming that disparities in education and employment across the EU Member States are widening (e.g. in 2016 the value of synthetic measure TMD was 7.9 times higher for the highest-ranked Sweden than for the lowest-ranked Romania, while in 2023 the value of synthetic measure TMD for the leading Netherlands was 29 times higher than for the 27th Romania).

The obtained results coincide with the conclusions regarding the issue of disproportions of various character across EU countries drawn by Brunori (2017), Faggian, Mechelangeli and Tkach (2018), Litwiński (2019), Neef and Sodano (2022), Eurofound (2023), Yanatma (2024). The obtained results also fall in line with EU recommendations regarding the need to take more active actions to eliminate disparities of various nature within the EU (both across EU countries and at the regional level within the EU). It is worth noting here a significant rise in education and employment disparities across the EU Member States following the COVID-19 pandemic. The persistent and even growing education and employment disparities between EU Member States in the analyzed period of time constitute a significant barrier to achieving greater coherence and convergence

in the EU. Reducing the education and employment disproportions can be perceived as a challenge for the EU. The European Commission is aware of the challenge. Therefore, The Action Plan setting out concrete initiatives aiming at turning the European Pillar of Social Rights into reality by 2030 was introduced (European Commission, 2021). Moreover, the European Commission underlined the importance of education, skills and employment in the process of twin digital and green transition the EU's facing (European Commission, 2023).

CONCLUSIONS

Socioeconomic disparities include – among others – financial, income, wealth, political, gender, participation, employment, education, generation, territorial differences. The EU aims at reducing disparities of various character (this objective is underlined in EU treaties and other EU documents). The study focused on employment and education disparities across the EU Member States. The EU Action Plan for European Pillar of Social Rights emphasizes the significance of high employment rate, reduction of gender employment rate, strengthening education and training by reducing the rate of early school leavers from education and training, promoting tertiary education attainment, as well as adult participation in learning. Moreover, the need to solve the problem of young people neither in employment, nor in education or training is stressed in the aforementioned Action Plan.

The conducted research and analyses allowed for a positive verification of the hypothesis assuming deepening educational and employment disparities among the EU Member States. The largest employment and education disparities have been found between the Scandinavian countries and Romania, Greece, Italy and Spain. Scandinavian countries are distinguished by high employment rates, a really low gender employment gap, extremely high enrollment in higher education as well as life-long learning, and relatively low NEET rates. As for the countries that make up the G1 group, their situation is due to coupled problems such as low employment rates, high NEET rates, relatively high unemployment rates, as well as large gender employment gaps and extremely low intensity of adult participation in training.

The obtained results fall in line with the goals of the current European agenda and have clear policy implications. The persisting and growing disparities in the area of education and employment across the EU Member States constitute a serious problem for the EU due to the fact that such a situation makes it difficult to create a more cohesive and convergent European Union. Differences in education and employment across the EU Member States may lead to deepening disproportions in the level of development of EU economies (both education and employment are considered important factors of economic development). Moreover, rising employment and education disparities may adversely affect social stability in the

EU. Therefore, it is necessary to postulate active actions to promote education and greater professional activity in those EU countries that are most struggling with the problem of low employment and education. It seems that the disparities in education and employment across the EU Member States partly result from cultural differences. Hence, changes are difficult and take time. The process of regional integration within the EU is all the more important, as it allows for the exchange of experiences and good practices, which may turn out to be a driving force for positive changes in countries like Romania, Greece, Spain, Italy.

Research limitations were related to limited access to statistical information. Moreover, due to the limited volume of the study, it was necessary to abandon some of the more in-depth analyses. Subsequent studies should focus on a more detailed analysis of disproportions across EU Member States in terms of living conditions, health and healthcare, gender, generation. Subsequent studies should also include an assessment of the course of implementation of the EU's Action Plan for the European Pillar of Social Rights.

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Horizontal gender segregation and gender pay gap (GPG) in the light of social value of work and sustainable development. Case for Poland[2]

Abstract

The persistence of horizontal gender segregation and the gender pay gap (GPG) poses a significant challenge to achieving the Sustainable Development Goals (SDGs). Success in reaching these goals requires considering both the economic and social aspects of work. In ongoing academic discourse, the topic of social value is increasingly addressed, and it serves as the background for the analyses in this article. The article aims to answer the question of the level of feminization and GPG in professions with varying levels of social value. The hypothesis is that professions with high social value are more feminized and have a lower pay gap compared to those with low social value. The study uses a mixed-method approach, integrating survey data from 2020 with statistical data from the Polish Central Statistical Office (GUS), focusing on professions classified at the third level of the ISCO-08 classification. This combination provides a detailed analysis of gender segregation and the GPG concerning the social value of work. The findings suggest that, in order to reduce pay inequalities, it is important not only to reduce horizontal segregation but also to support and recognize professions with a high level of social value.

Keywords: occupational wage differential, wage gap, social value of work, gender segregation.

Horyzontalna segregacja zawodowa i luka płacowa ze względu na płeć w świetle społecznej wartości pracy i zrównoważonego rozwoju. Przykład Polski

Abstrakt

Utrzymywanie się horyzontalnej segregacji zawodowej oraz luki płacowej ze względu na płeć stanowi istotne wyzwanie w realizacji Celów Zrównoważonego Rozwoju (SDGs). Osiągnięcie tych

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celów wymaga uwzględnienia zarówno ekonomicznych, jak i społecznych aspektów pracy. W ostatnich latach w dyskursie akademickim coraz częściej porusza się temat społecznej wartości pracy, który stanowi tło analiz zawartych w niniejszym artykule. Celem artykułu jest odpowiedź na pytanie jaki jest stopień feminizacji i międzypłciowej luki płacowej w zawodach o różnym poziomie społecznej wartości. Postawiona hipoteza zakłada, że zawody o wysokiej wartości społecznej są bardziej sfeminizowane i cechują się niższym poziomem międzypłciowej luki płacowej w porównaniu do zawodów o niskiej wartości społecznej. W badaniu zastosowano metodę mieszaną, łączącą dane ankietowe z 2020 roku oraz dane statystyczne Głównego Urzędu Statystycznego (GUS), koncentrując się na zawodach sklasyfikowanych na trzecim poziomie klasyfikacji ISCO-08. Połączenie tych dwóch źródeł danych umożliwia szczegółową analizę segregacji płciowej i luki płacowej w odniesieniu do społecznej wartości pracy. Badanie wykazało, że w zawodach o wyższej wartości społecznej luka płacowa jest niższa, ale jednocześnie większość tych zawodów jest silnie sfeminizowana. Wyniki te rzucają nowe światło na ustalenia Strawińskiego (2018), który wskazywał, że najmniejsze różnice w wynagrodzeniach występują w zawodach o niemal zrównoważonym udziale kobiet i mężczyzn.

Słowa kluczowe: zrównoważony rozwój, luka płacowe ze względu na płeć, społeczna wartość pracy, horyzontalna segregacja zawodowa.

JEL: J310, J710.

Introduction

The persistence of horizontal gender segregation and the gender pay gap (GPG) represents a significant barrier to achieving the Sustainable Development Goals (SDGs), particularly Goal 5: Gender Equality and Goal 8: Decent Work and Economic Growth. The effective achievement of these goals depends on acknowledging the importance of both the economic and social dimensions of human work. Therefore, in recent years, there has been increasing discussion about the social value of various types of activities. I apply the concepts of social value to the field of work study addressing the topic of horizontal gender segregation and gender pay gap in the context of the social value of work. The main aim of the article is to answer the question of what the feminization and gender pay gap (GPG) are in professions with different levels of social value, with the hypothesis that professions with a high level of social value are more feminized, and the GPG is lower than in occupations with a low level of social value. In this context, the social value of work can serve as the background or framework for explaining the relationship between horizontal gender segregation and the gender pay gap, that has been analyzed in many studies (Blau, Kahn, 2017; Burchell et al., 2014; Brynin, Perales, 2016; Council of the European Union, 2017; Rabu, 2023, p. 497; Strawiński et al., 2018).

In the article I used a mixed-method approach that integrates self-reported survey data with statistical data from Polish Central Statistical Office (GUS). The survey was conducted in 2020 and includes responses from individuals across 30 different occupations. The statistical data focuses on occupations categorized at

level 3 of the ISCO-08 classification, which provides a detailed analysis of the workforce, which in itself is original, as few studies worldwide take this level of classification into account (Strawiński et al., 2018, p. 387). The combined use of these two data sources offers a comprehensive insight into gender segregation and GPG within detailed occupational groups with respect to social value of work.

Gender pay gap in current research

Gender equality has gained significant relevance in modern discourse, though its origins stretch back much further. One of its first formal acknowledgments came with the 1957 Treaty of Rome, which established the European Economic Community (EEC) and recognized wage equality as a key principle (Preti, di Bella, 2023). Over time, the European Union introduced policies and action plans focused on promoting equal opportunities in education, employment, and working conditions. Key treaties, such as the Treaty of Maastricht and the Treaty of Amsterdam, further reinforced gender equality by embedding it into the core objectives and policies of the EU (Preti, di Bella, 2023). At the international level, additional efforts were made, including the creation of the W20 group in 2015 at the G20 summit, with a mission to empower women and ensure their active participation in the G20 process (di Bella, Suter, 2023, p. 61). The European Union's commitment to gender equality also aligns with the Sustainable Development Goals (SDGs), particularly in ensuring equal opportunities in the labour market without gender discrimination. The International Labour Organization (ILO) similarly emphasizes gender equality within its Decent Work agenda, which promotes sustainable, productive, and fair employment for both men and women. In 1999, the ILO developed gender equality policies aimed at improving institutional frameworks, implementing gender mainstreaming, and promoting gender balance across all workforce levels (Annovazzi et al., 2018, p. 271). Despite progress toward gender equality, significant pay disparities persist across occupations and industries. Studies highlight that the gender pay gap continues due to factors like occupational segregation, discrimination, and the underrepresentation of women in high-paying sectors.

One of the significant contributors to the overall gender pay gap is horizontal gender segregation, when men and women are distributed unequally across industries and job types. Studies, such as those conducted by the International Labour Organization, reveal that the global gender pay gap stands at 16%, with women earning on average 84 cents for every dollar earned by men (ILO, 2018). However, this gap is even wider in certain high-paying sectors like finance, technology, management, engineering, construction, medicine, and law where women are underrepresented and continue to face both vertical and horizontal

barriers to economic advancement (Rabu, 2023, p. 497). Moreover, a lot of women work in low-paid occupations in caregiving, secretarial, and pre-primary education positions (Council of the European Union, 2017). Burchell *et al.* (2014) report that in European Union 18% of women are employed in mixed-gender occupations, 69% work in predominantly female roles, and 13% are in male-dominated fields. In comparison, 15% of men are in mixed occupations, 59% are in male-dominated roles, and 26% are employed in female-dominated jobs. This segregation not only reinforces the gender pay gap but also perpetuates social norms that define 'appropriate' roles for women and men (Bettio et al., 2009). Gender differences in occupation and industry remain significant contributors, explaining the gap (Bettio et al., 2009; Blau, Kahn, 2017; Goldin, 2014; Levanon, Grusky, 2016). Blau and Kahn found that occupational differences alone account for one-third of the gender wage gap, and when combined with industry, they explain half of it (2017, p. 827). Thus, a large part of the wage gap is due to the different types of jobs men and women hold. Most papers argue that the relationship between occupational segregation and the gender wage gap is linear, meaning that female occupations pay less than male occupations (Buligescu, Borghans, Fouarge, 2020, p. 87). Few other papers find a non-linear relationship between sex composition and wages where the highest wages for both men and women are earned in mixed or integrated occupations (Buligescu, Borghans, Fouarge, 2020, p. 87). Whether the relationship is linear or not, studies show that GPG is high in masculinized occupations.

Besides, the wage difference may also result from varying levels of education or experience. Traditional human capital factors account for only a small portion of the wage gap, largely because educational levels between men and women have become more similar (ILO, 2018). The American Association of University Women found that, even after controlling for factors such as education and experience, women earn between 78% and 82% of what men earn in similar roles (AAUW, 2018). It shows that there are some psychological and social factors influence the gender pay gap.

Research conducted in Poland reveals that occupational segregation and wage disparities are closely linked to gendered roles in the labour market. A study focusing on 98 occupational groups at the three-digit level of the ISCO-08 classification found significant unexplained wage gaps, particularly in male-dominated occupations (Strawiński et al., 2018, p. 389). Interestingly, wage differences were smallest in female-dominated and mixed-gender occupations, suggesting that wage discrimination is less prevalent in these sectors. Strawiński *et al.* (2018) hypothesized that these gaps may result not only from discrimination but also from factors difficult to capture in econometric models, such as physical job demands and cultural expectations.

The importance of norms, psychological traits, and non-cognitive skills were analysed by Blau and Kahn (2017). They found that women are less likely than

men to engage in negotiation and competition and are more risk-averse. Gender differences in these traits were proposed as an explanation for women's lower wages and their underrepresentation in higher-level positions. Blau and Kahn (2017) cite several studies that have examined these factors, with results showing that while the role of psychological traits is smaller than the effects related to occupation and industry, they still account for over 25 percent of the overall gender wage gap. According to Benerjee social norms and stereotypes are also significant factors influencing the gender pay gap and unexplained portion of the gender wage gap must be considered carefully within the broader context of cultural and social factors (Banerjee, 2014).

The gender pay gap has far-reaching consequences not only for individuals but also for economies at large. The World Economic Forum (WEF) estimates that closing the gender pay gap could add $12 trillion to the global economy by 2025 (WEF, 2019). The gap also results in a lifetime earnings deficit for women, limiting their financial autonomy and exacerbating issues related to savings and retirement (WEF, 2019). The gender wage gap has significantly decreased during the last three decades. Brynin and Perales (2016, p. 163) link the narrowing of the gender wage gap as the result of the growth in female skills, to the spread of egalitarian gender ideologies and mainstreaming policies. Blau and Kahn (2017) note that since the 1970s, women in the USA have decreased (though not fully eliminated) their dominance in administrative support and service roles, such as teaching and nursing, and made notable progress in entering management positions and traditionally male-dominated professions. While significant progress has been made in addressing the gender pay gap, particularly in high-income countries, the pace of change remains slow. The 2024 Global Gender Gap Report indicates that at the current rate, it will take 134 years to achieve full gender parity (WEF, 2024). However, countries that have implemented gender-responsive policies, such as Iceland and Finland, have made substantial progress, closing over 80% of their gender gaps.

The theories of gender pay gap

The research highlights various factors influencing the gender pay gap (GPG), explained by theories from economics, sociology, and psychology. The key theories are: Personal Prejudice Theory (Discrimination Theory), Human Capital Theory, Statistical Discrimination, Monopsony Theory, Compensating Wage Differentials, Devaluation, Theory Crowding Model and Occupational Segregation Theory.

Gary Becker's Personal Prejudice Theory (1957, expanded in 1971) explains gender wage discrimination as stemming from personal biases against women (Becker, 1971). It identifies three forms of discrimination in the labour market namely,

customer discrimination, employee discrimination and employer discrimination. Some customers prefer male workers, leading employers to segregate women into lower-paying jobs with minimal customer interaction (Becker, 1971; Sielska, 2017, pp. 433–440; Sielska, 2019, p. 31). Another form of bias occurs when male employees resist working alongside female colleagues, prompting employers to compensate male workers with higher wages. This employee-driven discrimination increases labour costs, leading employers to avoid hiring women in certain roles to maintain workplace harmony (Sielska, 2019, p. 31). Besides employers' personal prejudices lead them to prefer hiring men (Sielska, 2019, p. 31). The theory has been criticized for assuming that discrimination will disappear in the long run as employers maximize profits. However, critics like Hamermesh and Rees argue that this oversimplifies the complexity of workforce diversity (Słoczyński, 2008).

Gary Becker also developed Human Capital Theory, later expanded by Jacob Mincer, which is central to discussions on the gender pay gap (GPG). The theory suggests that wage differences between men and women are due to variations in skills, education, experience, and investments in human capital. Becker and Mincer argue that women tend to invest less in human capital due to career breaks like maternity leave, leading to lower wages (Becker, 1962). This theory highlights individual choices, overlooking the broader social and structural barriers that limit women's access to education and training. For example, women may face limited opportunities for education or career advancement due to cultural expectations and discriminatory workplace policies (Mazur-Łuczak 2010, p. 22). Additionally, it fails to acknowledge the impact of unpaid care work, which disproportionately falls on women and is not considered part of human capital (England, 2010).

The theory of statistical discrimination, introduced by Kenneth Arrow and Edmund Phelps, posits that employers make decisions based on perceived averages of gender groups. They assume, that women are less likely to remain in the workforce long-term, leading to lower wages for women as a group (Arrow, 1973; Phelps, 1972). While this theory helps explain how stereotypes about women's productivity contribute to wage gaps, it overlooks the socialization processes that shape these stereotypes in the first place. It also fails to recognize the role of societal expectations and pressures on women to conform to traditional roles (Zachorowska-Mazurkiewicz, 2016).

Joan Robinson's Monopsony Theory (1933) explains wage discrimination through the lens of market power (Kuropatwa, 2014, pp. 57–61). Robinson argued that employers, especially in less populated or rural areas, have significant power in setting wages due to the lack of alternative employment options. Women, with fewer mobility options due to caregiving responsibilities, are often willing to accept lower wages. Though the theory highlights structural market imbalances, it does not adequately address how societal expectations about gender roles limit women's employment choices, particularly in terms of their caregiving responsibilities (Sielska, 2017).

An interesting explanation of gender wage inequality is presented by the theory of Compensating Wage Differentials, according to which women are paid less because they prefer jobs with more favourable working conditions or greater flexibility, often found in lower-paying fields (Goldin, 2014). The major flaw in this theory is that it ignores the societal pressures and expectations that force women to prioritize caregiving over career advancement. The lack of support for working mothers further skews this trade-off, limiting women's opportunities in high-paying, demanding fields (Perales, 2013).

Social and cultural factors contributing to wage disparities between male- and female-dominated occupations play a crucial role in Paula England's Devaluation Theory (1992). This theory posits that jobs traditionally performed by women, such as caregiving or teaching, are systematically undervalued compared to male-dominated professions, even when they require similar levels of skill and education. The undervaluation of women's work stems from long-standing societal biases that devalue care work and other nurturing roles associated with women (Perales, 2013). As a result, female-dominated occupations tend to offer lower wages than male-dominated ones. Paula England's Devaluation Theory focuses on cultural biases and social norms that devalue jobs held by women. This is related to the roles of men and women in society and the belief (based on stereotypical thinking) that women should take care of housework and child-rearing, which require lower competences than professional work (Goldin, 2021).

The topic of unpaid care and domestic work as one of the key factors influencing gender inequalities in employment and wages is extensively explored in the research of Claudia Goldin – Nobel Prize laureate in economy in 2023. She points out that the traditional division of social roles, in which women take on the majority of household and caregiving responsibilities, has negative consequences for their position in the labour market. Women are more likely to choose industries and positions that offer greater flexibility and allow them to balance work with family life, which often correlates with lower earnings. Additionally, women more frequently work part-time or in less demanding positions, which impacts their income and career advancement. Employment gaps (e.g., maternity leave) and lower availability for work result in women being less likely to reach top managerial positions. According to Goldin, one of the main barriers for women in the labour market is the lack of flexibility in employment structures (Goldin, 2014).

A lot of indicated aspects of inequality are present in Horizontal Gender Segregation Theory. A pioneer of occupational segregation theory was Barbara Bergmann (1974), who believed that the reason women earn lower wages is due to their work in lower-paying professions. Her theory was later developed by George Johnson and Frank Stafford (2002). Both economists explored the influence of various factors on occupational segregation, as: the degree of employer discrimination against certain groups in specific occupations, employee preferences,

human capital, and societal pressure stemming from institutional constraints or social norms (Kuropatwa, 2014, p. 62). Horizontal Gender Segregation Theory is a concept that seeks to explain the division of men and women into different occupational fields, often described as "masculine" or "feminine" jobs. The main premise of horizontal segregation is that societal norms and stereotypes drive this separation, impacting both job choices and opportunities. Feminine traits, such as nurturing and caregiving, are typically associated with jobs in health care, education, and social services, while masculine traits, such as physical strength and technical skills, are linked to jobs in engineering, construction, and manufacturing (Gromkowska-Melosik, 2013). According to this theory occupations dominated by women tend to be undervalued, both socially and economically, which leads to lower wages in comparison to male-dominated fields, even when the skills required are similar (Levanon et al., 2009; Czeranowska, 2024, p. 176). Horizontal segregation not only affects the types of jobs that men and women enter, but it also has long-term implications for career advancement. In feminized industries, there are fewer opportunities for promotion and career progression compared to male-dominated industries. As a result, women are often limited in their ability to achieve higher pay and leadership positions.

While these economic theories offer valuable insights into the gender pay gap (GPG), the social dimensions of the issue require deeper explanation. None of these theories develop the concept of the social value of work, even though it seems to be very important characteristic of the work referring to sustainable development discourse. So far, there is only one study that has addressed the issue of the social value of work in various professions in the context of pay inequalities and fair compensation. The results of this research have been included in the report "A Bit Rich", where social value of work was calculated for six professions. The conclusion was that: high-paid occupations, as city bankers, advertising executives, and tax accountants generated social costs, while low-paid occupations: nursery workers, hospital cleaners, and recycling workers contributed to the growth of social value (Lawlor et al., 2009, pp. 30–35). The aspect of the social value of work can provide an interesting background for analysing inequalities in the labour market.

Methodology of research

The aim of this article was to analyse the wage structure and pay inequalities in professions with varying levels of social value. The hypothesis tested was that professions with a high level of social value are more feminized and that the gender pay gap (GPG) is smaller in these professions compared to those with lower levels of social value. To achieve this goal, a triangulation method of data

sources was applied. The ranking of socially valuable professions was based on original research conducted within the project no. 2013/09/D/HS4/02701, funded by the National Science Centre. Survey data were collected between April 2019 and May 2020. A total of 490 employees participated in the study. They were asked, among other things, to assess the social value of work in 30 selected professions, chosen to represent all ten major occupational groups in the ISCO-08 classification. Occupations were defined at the ISCO-08 classification's third, fourth and fifth level, which provides a fairly detailed level of disaggregation (for more information see: Andrałojć, 2023b). The resulting ranking of socially valuable professions is presented in Figure 1.

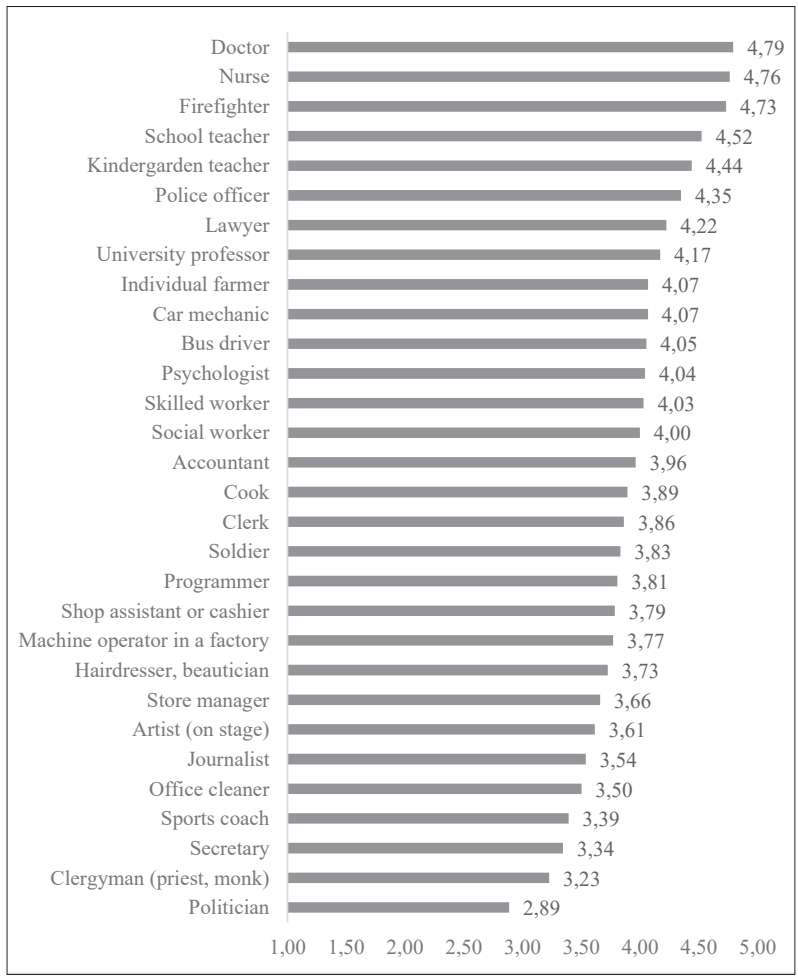

Figure 1. Social value of work by occupations

Source: (Andrałojć, 2023b).

In the next phase of the research, the gender distribution and the pay gap in these individual professions were analysed. Data showing the employment structure by gender in the studied occupations and the GPG index were taken from the Polish Central Statistical Office (GUS) datasets, collected biennially in the "Structure of Wages and Salaries by Occupations" (SWSO) surveys for 2020. These studies account for the third level of occupational disaggregation. One of the strengths of the SWSO survey is its high reliability in wage data, which is directly reported by accounting departments, including the number of hours worked, and the large size of its dataset. Moreover, previous research shows that the range of the estimated gender pay gap at the ISCO third-digit occupational level is significantly broader than estimates obtained at a more aggregated level. Analyses conducted at the aggregated level may lead to underestimating the gender pay gap in occupations, as they do not adequately account for segregation effects (Strawiński et al., 2018, p. 383). The key for mapping between the studied occupations in social value ranking and the ISCO-08 classification, average earnings, GPG indicator and the participation of women in the employment structure is presented in Table 1.

Finally, 27 occupations' groups were analysed in this research. Three professions were excluded. First soldier, which is classified in group 10 in the ISCO-08 classification, was not covered by the SWSO report. The other two professions, police officer and clergyman, are highly specific, and in the ISCO-08 classification, they were included in very broad and diverse groups at the third level, making gender structure and GPG analysis at this level not reliable.

Table 1. The key for mapping between the studied occupations and the ISCO-08 classification, average earnings, GPG and feminization, year 2020, SWSO

Lp.	Occupation	ISCO-08 code and title for third level of coding	Average gross monthly earnings in pln 2020	GPG 2020	Feminization (% of employed women) 2020
1	*2*	*3*	*4*	*5*	*6*
1	Clerk	335 – Regulatory government associate professionals	5891.36	17.90	83.13
2	Politician	111 – Legislators and senior officials	9543.87	19.40	42.74
3	Accountant	331 – Financial and mathematical associate professionals	5506.33	19.90	87.24
4	Store manager	142 – Retail and wholesale trade managers	5324.64	20.00	63.36
5	Doctor	221 – Medical doctors	10909.24	5.70	59.65
6	Nurse	222 – Nursing professionals	6299.02	3.20	96.75
7	University professor	231 – University and higher education teachers	7774.87	10.10	47.25

1	*2*	*3*	*4*	*5*	*6*
8	Kindergarden teacher	531 – Child care workers and teachers' aides	3450.85	3.40	87.23
9	School teacher	234 – Primary school and early childhood teachers	5802.04	5.60	87.23
10	Programmer	25 – Information and communications technology professionals	10210.88	18.50	19.86
11	Lawyer	261 – Legal professionals	10916.09	10.00	61.77
12	Psychologist	263 – Social and religious professionals	5972.56	13.30	80.91
13	Clergyman (priest, monk)	-	-	-	-
14	Journalist	264 – Authors, journalists and linguists	7193.84	15.3	61.17
15	Artist (on stage)	265 – Creative and performing artists	6467.91	7.9	48.28
16	Police officer	-	4786.08	-	-
17	Social worker	341 – Legal, social and religious associate professionals	4786.08	-1.4	91.42
18	Sports coach	342 – Sports and fitness workers	4529.63	9.5	42.31
19	Secretary	412 – Secretaries	4491.54	0.1	97.69
20	Cook	512 – Cooks	3366.05	5.4	67.49
21	Hairdresser, beautician	514 – Hairdressers, beauticians and related workers	3016.06	21.1	96.43
22	Shop assistant or cashier	522 – Shop salespersons	3574.27	17.9	74.28
23	Firefighter	541 – Protective services worker	3409.20	6.0	15.54
24	Individual farmer	61 – Market-oriented skilled agricultural workers	4194.18	4.8	34.19
25	Skilled worker	711 – Building frame and related trades workers	4128.45	-6.0	1.30
26	Car mechanic	723 – Machinery mechanics and repairers	5396.64	13.4	1.34
27	Machine operator in a factory	81 – Stationary plant and machine operators	5013.46	24.8	28.97
28	Bus driver	833 – Heavy truck and bus drivers	3915.09	-22.7	1.66
29	Office cleaner	911 – Domestic. hotel and office cleaners and helpers	3242.51	3.6	92,32
30	Soldier	-	-	-	-

Source: author's own elaboration on the basis of SWSO, Polish National Statistical Office.

Analysis and discussion

The Spearman correlation coefficient between feminization and average gross monthly earnings for the 27 professions included in the study was -0.14 and was not statistically significant. This could indicate a lack of correlation between these categories. However, when examining the distribution of these variables presented in Figure 2, it can be observed that in professions with the highest share of women (black line on the chart), average earnings are lower than in professions with a smaller proportion of women in the employment structure. Examples of feminized professions with low earnings include secretary, nurse, hairdresser, beautician, office cleaner, social worker, kindergarten teacher, and shop assistant. It is also worth noting that in highly masculinized professions, earnings were relatively low as well (e.g., skilled worker, car mechanic, bus driver, firefighter). The exception was programmer – a highly masculinized profession with high average earnings. Other highly paid professions, such as lawyer, doctor, and university professor, had a balanced gender employment structure. These results correspond with the theory of horizontal labour market segregation – women work in lower-paid professions, while men predominantly work in higher-paid ones, which explains a significant portion of the overall gender pay gap in the labour market.

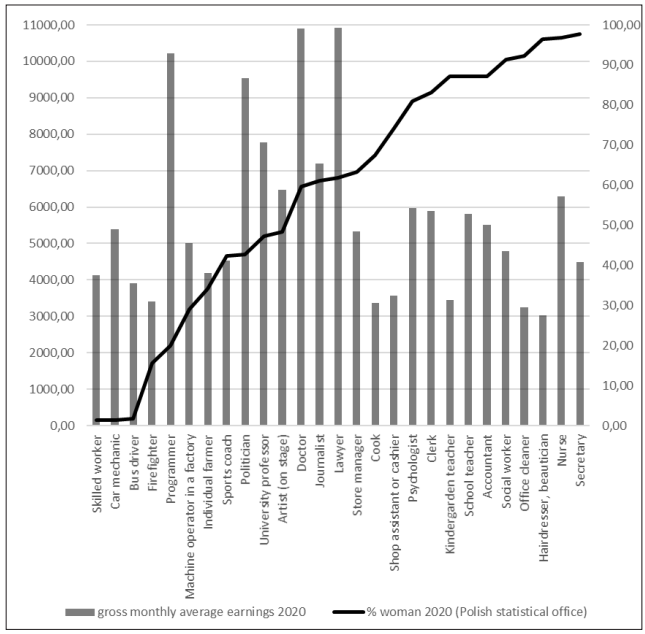

Figure 2. Relationship between monthly average earnings and feminization (%of women in employment)

Source: author's own elaboration on the basis of SWSO, Polish National Statistical Office.

Women tend to work in professions that are not highly paid, despite the fact that the work performed in these professions is socially valuable. Examples include preschool and childcare workers, whose earnings in 2020 averaged 60% of the national average, as well as teachers and nurses (whose earnings were only slightly above the national average) (Andrałojć, 2023b). In general, professions with high social value, which should gain importance in the context of achieving sustainable development goals, are still not properly valued by the market, meaning that wage levels in these professions remain relatively low (Andrałojć, 2023a; Andrałojć, 2023b). According to respondents, the most undervalued professions include nurse, firefighter, police officer, preschool teacher, school teacher, social worker, and cleaner. The research found a very strong and statistically significant relationship between the assessment of the social value of work and the adequacy of wages—the more socially valuable a profession is perceived to be, the greater the opinion that the profession is undervalued by the labour market (Andrałojć, 2023b). Looking at the analyzed professions, it can be observed that the top professions rated as socially valuable were female-dominated (e.g., doctor, nurse, school teacher, kindergarten teacher), with the exception of firefighter (Figure 3). In contrast, the least socially valuable occupations were mainly male-dominated (with the exception of secretary and office cleaner). This trend is shown in Figure 3, although the Spearman's rho correlation coefficient was very low and statistically insignificant at -0.1.

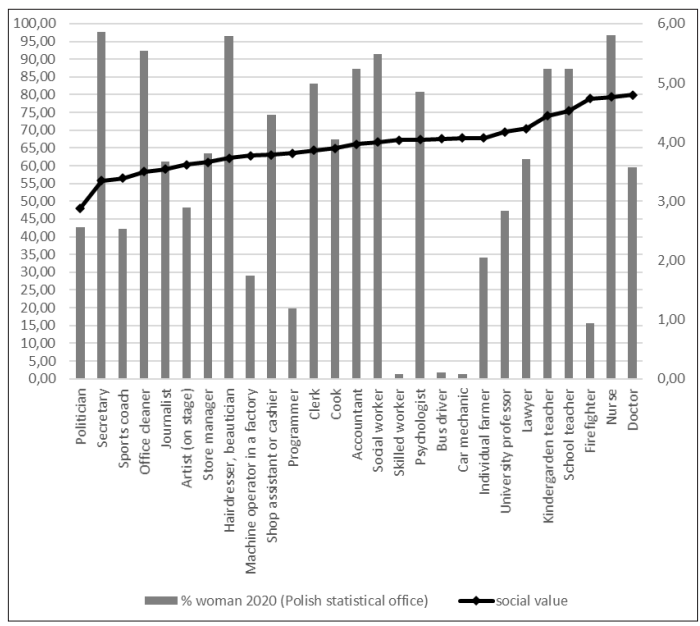

Figure 3. Feminization and social value of work in different occupations

Source: author's own elaboration.

Taking into account social value of work and GPG the correlation, measured by Spearman coefficient was negative: -0.31, but it was not statistically significant. These results indicate that there is no strong, statistically significant relationship between these indicators, but there is a noticeable trend suggesting that a higher level of social value in a given profession is associated with a lower level of income inequality between genders. Taking a closer look at the distribution of variables, which is presented graphically in Figure 2 it can be observed that in the group of professions with the highest social value ratings (e.g., doctor, nurse, firefighter, school teacher, preschool teacher), the gender pay gap was lower than in professions with lower social value ratings (politician, journalist, store manager, hairdresser and beautician, or machine operator in a factory). It is also worth noting that in the group of professions with relatively high or medium levels of social value, there were some professions where the GPG was negative, meaning that, on average, women earned more than men (bus driver, skilled worker, social worker).

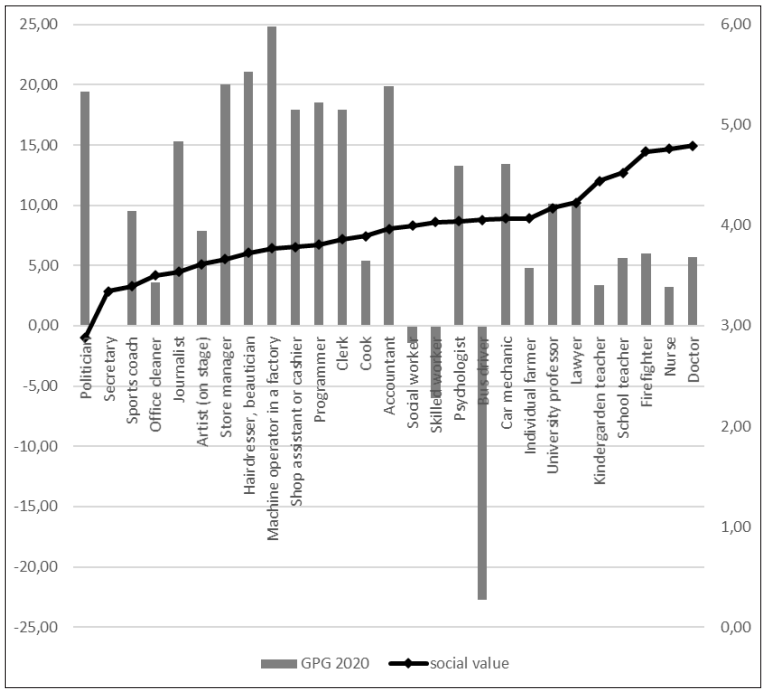

Figure 4. GPG and social value of work in different occupations

Source: author's own elaboration.

It is worth noting that in the group of 27 analysed professions, a trend was observed indicating a positive relationship between the average wage level and

the gender pay gap (GPG), with a Spearman correlation coefficient of 0.29. This means that in professions with higher average wages, pay inequalities were greater. Additionally, when considering all 127 professions covered by the SWSO report, the correlation coefficient was 0.31, and it was statistically significant at the 0.01 level. An even stronger positive relationship was observed between men's average earnings in a given profession and the GPG, with a Spearman coefficient of 0.43, also significant at the 0.01 level. This indicates that the higher the wages in a given profession, the greater the level of pay inequality between women and men, particularly in professions where men earn significantly more on average.

Conclusion

The theories and studies referenced in this article suggest that cultural norms and value systems, which shape beliefs about the social value of work, can be an important factor in discrimination in the labour market. The article highlights that in professions with higher social value, the gender pay gap (GPG) is lower than in professions with lower social value. It is important to note that most of these professions are female-dominated. Therefore, it is not only necessary to reduce horizontal segregation but also to promote and support socially important work that aligns with the goals of sustainable development. As the sustainable economy develops, work in socially useful professions may gain more importance, which could lead to increased wages in these fields and, consequently, a reduction in the GPG.

This conclusion sheds a slightly different light on the findings of Strawiński (2018), who indicated that the smallest gender pay gaps are observed in occupational groups with nearly balanced participation of men and women (masculinization index between 0.41 and 0.50). He suggests that reducing the degree of segregation between men and women in various professions could help reduce wage differences between these two groups (Strawiński, 2018). While such actions are valid, they may not be the only solution to reducing the pay gap. The varying degrees of feminization and masculinization in professions may remain to some extent. Both women and men, having specific skills and predispositions, may perform better in certain professions. Therefore, alongside efforts to achieve balanced gender employment ratios in different professions, it is essential to give greater recognition to work in professions with a high level of social value. Such conclusion correspond to come extant with Horizontal Gender Segregation Theory, according to which feminized occupation tend to be undervalued, both socially and economically (Levanon et al., 2009; Czeranowska, 2024) taking into account social value of work as an important aspect of sustainable development may contribute to reduce pay inequality. Awareness of the social value causes that

people focus in their work not only on economic aspects – that is, earning money – but also on the socially important outcomes of their work and deeper meaning of work performed.

Further research could consider conducting analysis at an even lower level of occupational aggregation to obtain more detailed information about specific occupational groups. It would be interesting to combine these analyses with the social roles women play, such as being mothers. It could be assumed that the stronger the role of women in childcare (compared to men), the greater the occupational segregation and the GPG. Moreover, it would be worth examining the distribution of income among women and men in various professions. One could assume that in cases where women play a dominant role in childcare, the variation in wage levels could be greater than for men. Even if the average wages of women and men were comparable, it would not necessarily indicate an absence of "hidden" discrimination, particularly women with children. Expanding the scope of research further, the topic of the social value of unpaid work, such as childcare, and its appropriate recognition in both social and economic dimensions could be explored. After all, the topic of gender discrimination in the labour market goes back not only to the social roles that both women and men play, but to what extent these roles are considered valuable.

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The better you fit the job, the better you are suited to the team. The case of Poland[2]

Abstract

In the person-environment fit literature there is limited research on the effect that compatibility between an employee and his or her job exerts on the compatibility between the employee and the team he or she works in. This study sheds light on this relationship by revealing two mechanisms through which Person-Job (PJ) fit influences Person-Group (PG) fit. In the first mechanism, this influence is mediated by self-esteem and supervisor satisfaction, while in the second one, by interpersonal justice and social cohesion. Personality traits and gender are moderators. Both mechanisms are tested for demand-ability fit and need-supply fit, as well as for internal and external forms of team fit. The study uses conditional process analysis and data provided from a survey of 826 Poles with MA or BA degrees at productive age, i.e. 25–45 years old. The results show that meeting the needs of team members for *Autonomy* has a stronger impact on their positive behaviour than satisfying their expectations regarding *Promotion*. Employees who are given greater independence have better relationships with both their supervisor and their teammates.

Keywords: PJ fit, PG fit, supervisor.

Im lepiej pasujesz do swojej pracy, tym lepiej pasujesz do zespołu. Przypadek Polski

Abstrakt

W literaturze dotyczącej dopasowania osoba-środowisko istnieje niewiele badań na temat wpływu, jaki zgodność między pracownikiem a jego pracą wywiera na zgodność między pracownikiem a zespołem, w którym pracuje. Niniejsze badanie rzuca światło na tę relację, ujawniając dwa mechanizmy, poprzez które dopasowanie Osoba-Praca (PJ) wpływa na dopasowanie Osoba-Grupa (PG). W pierwszym

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mechanizmie wpływ ten jest pośredni przez poczucie własnej wartości i zadowolenie przełożonego, podczas gdy w drugim przez sprawiedliwość interpersonalną i spójność społeczną. Cechy osobowości i płeć są moderatorami. Oba mechanizmy są testowane pod kątem dopasowania popyt-możliwości i dopasowania potrzeba-podaż, a także pod kątem wewnętrznych i zewnętrznych form dopasowania zespołu. W badaniu wykorzystano analizę procesów warunkowych i dane pochodzące z ankiety przeprowadzonej wśród 826 Polaków z tytułem magistra lub licencjata, w wieku 25–45 lat. Wyniki pokazują, że zaspokajanie potrzeb członków zespołu w zakresie autonomii ma silniejszy wpływ na ich pozytywne zachowanie niż zaspokajanie ich oczekiwań dotyczących awansu. Pracownicy, którym przyznano większą niezależność, mają lepsze relacje zarówno ze swoim przełożonym, jak i członkami zespołu.

Słowa kluczowe: dopasowanie pracownik-praca, dopasowanie pracownik-zespół, przełożony.

JEL: M54, M12, J53.

Introduction

The question of how well employees match their job has become the basis of the Person-Environment (PE) fit theory. According to this theory, employees are well suited to the environment in which they work, if their professional expectations are consistent with the requirements of a given position, opportunities related to the work itself, rules applicable in the team and the entire organization, as well as with the management style of their superiors (Kristof-Brown et al., 2005). These four areas of PE fit theory (job, team, superiors, organization) are important issues not only in the management literature but have also become the subject of research by economists who investigate human resources issues within personnel economics (Lazear, Shaw, 2007).

In their research review, Kristof-Brown and her colleagues (2005) emphasize the disproportion in the number of studies on PE fit areas. A similar conclusion can be drawn from the literature review by DeRue and Hollenbeck (2007). Two of such areas, Person-Group (PG) fit and Person-Supervisor (PS) fit, have been studied less frequently than Person-Job (PJ) fit and Person-Organization (PO) fit. The latter has enjoyed considerable interest. There is a clear gap in research on PG fit, especially given the growing importance of teamwork in many enterprises (Lazear, Shaw, 2007, Table 1B).

In their latest reviews of the fit literature, De Cooman (2022) and Vleugls (2024) point to the need for a change in research in this area. They suggest a greater focus on the interrelationships between different forms of fit. Vleugels (2024) points out that one of the most important challenges facing fit scholars is to focus on the differentiation of the conceptualization of PE fit. It emphasizes that the possibility of an employee's development in the work environment does not depend solely on his or her personal characteristics (such as personal values, goals, needs or personality traits), nor on the work environment itself (i.e. job demands and supplies, organizational culture), but on the extent to which personal attributes and attributes of the work envi-

ronment are consistent. De Cooman (2022), discussing changes in the fit literature, returns attention that this conformity may be existing on different hierarchical levels, such as the vocation (person-vocation fit), organization (person-organization fit), work unit (person-group fit), job (person-job fit) and individual (person-supervisor and person-person fit). Fit scholars suggest that employees may combine different forms of fit into one multidimensional fit, and this requires a methodological change. Moving away from examining individual fit forms and focusing on a construct that would be a weighted sum of different types of fit occurring at different hierarchical levels (Darrow, Behrend, 2017; Follmer et al., 2018). It is possible that employees experience different levels of fit. It is therefore necessary to examine more closely the interplay of different types of fit. However, as Vleugels (2024) draws attention to the fact that fit scholars rarely undertake this task in a single empirical framework. An example of such a study is the work of Chi *et al.* (2019), in which the authors show that person-group fit weakens the impact on the decision to resign from work, resulting from the initial mismatch between the needs of employees and the organization's offer. The second impact of person- group fit was about weakening the negative relationship between demands-abilities misfit and task performance.

The search for optimum fit comes from and remains in the traditional understanding of fit. Is it still relevant in a world where flexible and remote work arrangements play an increasingly important role? Vleugels (2004) suggests that fit scholars should focus on person-skill fit, which is concentrated on technical skills needed for a given job position. He believes that the mechanisms of social dependencies have lost their importance. Scholars dealing with remote and hybrid work models confirm the first part of Vleugles' opinion, but strongly disagree with the second part. Grey (2023) emphasizes that the successful application of remote and hybrid work models goes beyond technology. Trust and good relationships are the foundation of successful teamwork and collaboration and their importance is growing in virtual teams, but as Gifford (2022) points out, they are more difficult to achieve because communication via electronic media does not provide as many opportunities to build relationships as face-to-face communication.

More project-based teamwork and an increased organizational reliance on self-managing teams have led to an increased interest in person-group fit. Scholars have focused on how team dynamics influence employee perceptions of team fit (Klaic et al., 2018). It has been noted that well-cooperating teams develop a collective sense of fit (Seong, Choi, 2021). The negative impact of remote work has also been observed. The lack of face-to-face contact often leads to a decrease in morale and engagement (Golden, Veiga, 2005).

The research presented in this paper addresses the problem of linking employee fit to the work environment at two different levels: individual and team.

The positive true score correlations between types of fit presented by Kristof-Brown *et al*. (2005, Table 5) in their literature review indicate that the relationship

between PJ and PG fit is weaker (the estimated true score correlation is equal to 0.49) than relationships between PJ-PO and PO-PG (the estimated true score correlations are equal to 0.72 and 0.54, respectively). This suggests indirect effects between PJ fit and PG fit, i.e. it is likely that mediated effects are present.

This study is aimed to investigate the mechanisms through which PJ fit influences PG fit and, more specifically, to identify the mediators and moderators of this relationship. It is believed that the relationship between an employee and the supervisor may help to explain the impact of PJ fit on PG fit. Two effects seem to be significant, namely the influence of the employee's personality on his/her assessment of the manager's management style and the influence of the respect shown to the employee by the supervisor on how closely the employee feels connected with his/her team. This prompts the aforementioned hypothesis regarding there being two mechanisms.

In the first mechanism a good PJ fit strengthens self-esteem, and this, in turn, allows the employees to more widely accept the management style of their supervisor i.e. they feel greater satisfaction with their supervisor. The acceptance of superiors increases an individual's PG fit. Self-esteem in a job and satisfaction with the supervisor are the mediators (in the causal chain) in the first mechanism.

The second mechanism is based on interpersonal justice (or respect from supervisors) and social cohesion serving as mediators in the causal chain. A person's good fit with his or her job increases the sense of interpersonal justice. Such individuals feel that their superiors give them the same respect as they give to others. A person treated with respect feels closer to the team. His or her sense of belonging becomes stronger, which motivates him or her to pursue the team's goals. This person's fit with the group (PG fit) increases.

These indirect effects of PJ fit on PG fit described in both mechanisms can be strengthened or weakened by moderators, such as personality traits or gender.

The mechanisms are tested for four conceptualizations of fit, two of which are types of PJ fit, i.e. demands-abilities fit and needs-supplies fit, and the other two are types of PG fit, i.e. internal fit in a team and external fit in a team. The justification for choosing two forms of PJ fit are the conclusions formulated by Kristof-Brown and her colleagues (2005) in their review, whereas the two forms of PG fit are based on the proposition made by DeRue and Hollenbeck (2007). Kristof-Brown *et al.* (2005) suggest that the use of multiple conceptualizations of PJ fit can produce more robust results because they reflect the many aspects of an employee's compatibility with the job. A similar suggestion is made by DeRue and Hollenbeck (2007) claiming that the complex nature of working teams is better explained by research that investigates both, the match between a job and an employee's personality (internal PG fit) as well as between the employee and the tasks of the team (external PG fit)

The demand-abilities fit, understood as an individual's skills meeting the job requirements, was introduced by Muchinsky and Monahan (1987), while the needs-

supplies fit, was proposed by Kristof (1996) who defined this form of PG fit as satisfying the needs of an employee by environmental supplies. In their definitions of internal and external PG fit, DeRue and Hollenbeck's (2007) distinguished between employee-to-team match in relation to interpersonal relationships (internal PG fit) and employee-to-team match with respect to the tasks to be performed by the team (external PG fit).

A survey of 826 employees in Poland provided the data used in this study. The participants were between 25 and 45 years of age, i.e. employees of mobile working age. All of the respondents have completed a tertiary level of education, which made it possible to assume that they have a similar environment at the workplace. This, in turn, made it easier to focus on the relationship between PJ fit and PG fit, including the role of PS fit.

The hypotheses leading to the achievement of the research goal are verified using mediation analysis proposed by Hayes (2013). Mediation analysis allows us to identify a model that describes the mechanism by which PJ fit (X) influences PG fit (Y).

This research sheds light on several gaps in empirical research on the match between an employee and his or her work environment. First of all, the relationship between PJ fit and PG fit is analyzed in depth. The findings reveal the transmission mechanisms through which PJ fit influences PG fit, as well as the role of PS fit in these mechanisms. The mediation models include two aspects of the relationship between the employee and the supervisor: how the employee's personality affects his or her satisfaction with the supervisor and how the manager's respect towards an employee makes that employee feel more attached to the team. The literature on PE fit should be expanded to include research findings related to the PJ fit-PG fit relationship and the role of PS fit in this relationship. This research sheds light on this issue and includes Satisfaction with supervisor and Interpersonal justice as mediators of the said relationship. Both of these variables are closely related to PS fit. Given the relative lack of research focused on the validation of multidimensional approaches, this study examines multiple conceptualizations. It incorporates two ways in which a person matches a job. The first one relates to the match between the employee's needs and the opportunities to satisfy those needs provided by the organization, whereas the second relates to the match between the requirements of a given job and the employee's abilities. The study also focuses on two methods of determining how well the employee matches the team, by investigating whether the employee follows the internal rules and whether he/she accepts the tasks that the team performs externally. The application of these four conceptualizations of fit makes the findings much more robust.

An investigation into the role that personality characteristics play would broaden the knowledge of how an employee fits into the work environment. This study evaluates the importance of self-esteem, as a mediator, which transmitted the impact of PJ fit on PG fit.

The rest of this paper covers five sections and ends with conclusions. Theoretical support of the hypotheses is discussed in Section 2. For a discussion of the sample and methods, see Section 3. A presentation of the findings is in Section 4. The indication of those aspects of the study which reduce the possibility for generalization of the results as well as the direction of research in the future are issues that are covered in Section 5. The paper ends with a summary in Conclusions.

Literature review

The aim of this study is to determine the causality between the fit of an employee to the job he/she performs (PJ fit) and his/her fit to the team (PG fit) in which he or she works. One of the methods commonly used to assess causality is mediation analysis. Mediation analysis enables us to investigate the effect of an independent variable (predictor, X) on a dependent variable (outcome, Y) via a third variable called a mediator (M) or intervening variable (a more elaborate model containing several mediators in the sequence is also possible). It should be emphasized that mediation is correlational in nature, i.e. the variables in the mediation analysis must be related to each other. However, correlation does not imply cause and effect, and that is what I need to establish. Using mediation analysis in my study makes sense because this method is considered an effective way to test theory-based mechanisms (MacKinnon, 2008). Hypotheses about causality mechanisms generate a pattern of predictions (MacKinnon, Pirlott, 2015). If my pattern of predictions turns out to be correct, it is a confirmation that my theory is correct.

Therefore, in this study, the hypotheses regarding the mechanisms linking PJ fit with PG fit will be preceded by an indication of the theoretical basis for the expected relationships.

According to Rosenberg's (1965) definition, self-esteem is a general assessment of one's own competences. In contrast, Korman (1976) addressed the issue of employee self-esteem. He pointed out that workplace experiences can strengthen an individual's self-evaluation. Employees who value their competences are more likely to show favorable behaviour towards their organization. Such employees experience greater satisfaction with having their needs met by their organization. Korman's suggestions have become the basis for the self-esteem concept of how an employee perceives him or herself in the organization in which he or she works. Based on their literature review, Pierce and Gardner (2004) established a common definition of this concept. Organization-based self-esteem means that the employee feels needed and valued by the organization in which he/she works. The literature review by these two researchers points to links between organization-based self-assessment and work outcomes.

There is another conclusion that emerges from the review of empirical research which is relevant to this study. General self-esteem is significantly related

to organization-based self-esteem (Pierce, Gardner, 2004, p. 599). This conclusion suggests that the results obtained from mediation models with a variable describing overall self-esteem will also apply to organization-based self-esteem.

Pierce and Gardner (2004, p. 606) cite numerous works showing that organization-based self-esteem is strongly related to most aspects of job satisfaction, including satisfaction with superiors.

Supervisors organize the work environment. Their management style defines how subordinates react, how they perceive their roles in the team (Durham et al., 1997) and what they expect in their mutual cooperation (Grean, Scandura, 1987). A supervisor who receives positive feedback from employees serves as the foundation of a well-functioning team (Manz, Sims, 1987). So, if an employee positively evaluates the supervisor, who is crucial for the team, it is also easier for that employee to adapt to the team. Satisfaction with the supervisor helps to increase PG fit.

Given the findings and suggestions presented in the literature I hypothesize that the mechanism through which PJ fit affects PG fit is as follows:

Hypothesis 1: *A good PJ fit strengthens the individual's self-esteem; an employee who has confidence in his or her competences is keener to accept the supervisor's requirements and, as a consequence, feels greater satisfaction with the supervisor; this, in turn, improves the match between the employee and the team (PG fit).*

The first mechanism is presented in Figure 1.

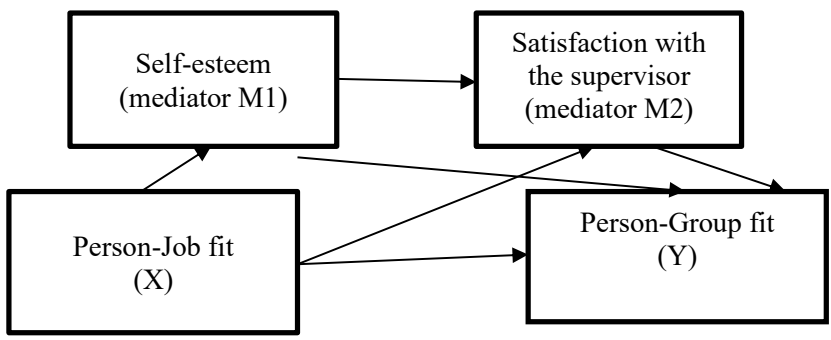

Figure 1. Mediation model of the first transmission mechanism in which PJ fit affects PG ft through two mediators in sequence: M1=Self-esteem and M2=Satisfaction with the supervisor

Source: author's work.

Interpersonal justice is defined as a measure showing the extent to which superiors treat their subordinates with due respect and courtesy (Greenberg, 1993). Colquitt and Zipay (2014) reviewed the literature on justice, fairness, and employee reactions which shows that the issue of justice is important to

employees because of uncertainty. The more people are uncertain, the more they need justice. One of the types of uncertainty in the workplace is about the status of the employee. Tyler and Lind (1992) note that an individual is very sensitive to signals that confirm his or her status in the group he or she belongs to. If the supervisor treats the employee with respect, this is interpreted as a signal that the employee is important to the team.

Good PJ fit reduces uncertainty about employee status. An employee who is well suited for his or her job (PJ fit), is appreciated by the supervisor, who manifests this by treating the employee with respect, which signals that the employee is of certain status.

Interpersonal justice is an important factor in shaping mutual relations between team members. Employees treated with respect by their superiors feel more connected to the team members. Strong ties with colleagues increase their social cohesion. As Brawley *et al.* (1987) points out, members of a team with good social cohesion like to work together and also to spend time together as colleagues or even friends.

The more team members are related to each other, the more likely they will accept their goals and tasks as well as the roles assigned to them by their superiors (Cartwright, 1968; Dorfman, Stephan, 1984; Casey-Cambell, Martens, 2009).

Therefore, based on the effects of interpersonal justice and the outcomes of social cohesion described in the literature, I hypothesize that the second mechanism through which PJ fit affects PG fit is as follows:

Hypothesis 2: *A good PJ fit contributes to the fact that an employee is treated with respect by his or her superior; interpersonal justice (respect from supervisors) strengthens social cohesion, which improves the employee's PG fit.*

The second mechanism is presented in Figure 2.

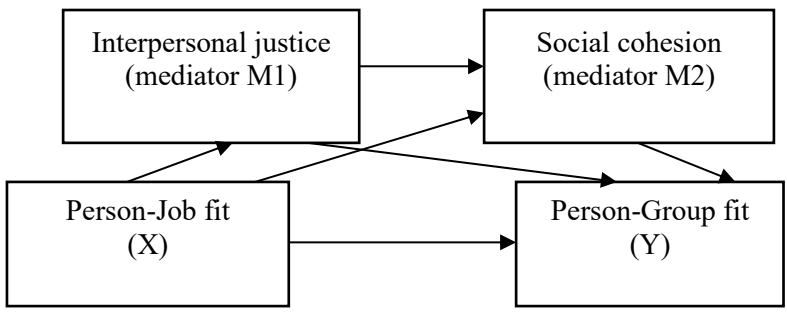

Figure 2. Mediation model of the second transmission mechanism in which PJ fit affects PG fit through two mediators in sequence: M1=Interpersonal justice and M2=Social cohesion

Source: author's work.

METHODOLOGICAL APPROACH

A questionnaire survey conducted in Poland in November 2016 by a professional polling agency provided the data for this study. The interviewers interviewed 826 survey participants directly using computer-assisted personal interviewing (CAPI). The participants were employed, aged 25–45 (i.e. in mobile working age), and have graduated from university (i.e. obtained a master's or bachelor's degree). Participants were consciously selected (using age range and higher education as selection criteria) from a national random-quota sample. The sample selected in this manner was representative of the target research group by age, gender, and place of residence. The project survey included 277 items which aimed to examine the resourcefulness of Polish families.

As to the demographic characteristics of the participants, women constituted 59 percent of the total sample, while men 41 percent. Respondents who did not have children (49%) prevailed. The distribution of participants by place of residence was fairly even, about 24% lived in the countryside and in towns, both smaller and larger; 10% of the participants lived in Warsaw. The participants differed significantly in terms of the economic sector in which they worked, dominated by the private sector (62% of participants) as well as the size of the company. The vast majority were employed in small and very small enterprises (64%) and only 9% in large ones.

The items in the questionnaire survey were used to construct variable measures. A description of variable measurement is included in Table 1. All measures are based on items recognized in the literature and used in questionnaire studies. The relevant literature is listed in Table 1.

Person-Job fit is an antecedent variable, or an independent variable X. Two basic conceptualizations of the Person-Job fit are used to check whether the relationships in the mediation models are statistically significant for both PJ fit conceptualizations: *Demand-Abilities PJ fit* and *Needs-Supplies PJ fit*.

Person-Group fit is a consequent variable, or a dependent variable Y. With regard to this variable, two conceptualizations were also used – *Internal PG fit* and *External PG fit* – to check the robustness of the results obtained from mediation models.

Four mediators will be applied to the models. The first two – *Self-esteem* and *Satisfaction with the supervisor* – will be used in models checking the statistical significance of the relationships contained in the first mechanism describing the impact of PJ fit on PG fit. The next two – *Interpersonal justice* and *Social cohesion* – will be intervening variables in models explaining the second mechanism.

Based on the results of research contained in the literature, four personality traits were selected as moderators. These are: *Extraversion, Conscientiousness, Neuroticism, Not open to experience*. *Gender* is the fifth moderator tested in the models. Finally, age is a control variable.

Table 1. Measures of variable

Antecedent variable X (or Person – Job fit)	Item
Two basic conceptualizations of the Person-Job fit	
Demand-Abilities PJ fit (adapted from Saks and Ashforth, 2002)	How much you disagree or agree with the statement: Your knowledge, skills and abilities are appropriate to those required for the job
Needs-Supplies PJ fit (adapted from Chuang et al., 2016)	How much you disagree or agree with the statements: Your present job satisfies your needs for: skills improvement autonomy and responsibility promotion opportunities and career development
Consequent variable Y (or Person – Group fit)	
Internal PG fit (based on DeRue and Hollenbeck, 2007)	I agree with other team members about the effort required to complete our tasks
External PG fit (based on DeRue and Hollenbeck, 2007)	I agree with other team members about how much we should compete with other teams
Mediators	
Self-esteem by Robins et al. (2001)	I have high self-esteem
Satisfaction with the supervisor – adapted from Chuang et al. (2016)	The way my manager manages is in line with my expectations
Interpersonal justice (respect from supervisors) – based on Colquitt and Zipay (2015)	Supervisors treat me with the same respect as others
Social cohesion – based on Brawley et al. (1987)	I feel strongly connected with the people I work for
Control variable	
Age	25–45

All variables measured on 5-point scale, 1=strongly disagree……5=strongly agree; except Big 5 measured on 7-point scale, 1=strongly disagree……7=strongly agree
These variables are used in mediation models.

Source: author's work.

The research uses the conditional process analysis, developed by Hayes (2013a), to find the indirect relationships between PJ fit and PG fit. Mediation models, which can be estimated using the Hayes method (2013a), describe the mechanisms through which the effect of a variable X (PJ fit in this study) is transmitted to a variable Y (PG in this study) via the mediator M.

The computational tool proposed by Hayes (2013) – PROGRESS in SPSS – was used in this study. The PROGRESS allows us to investigate not only a simple causal chain of events, such as $X \rightarrow M \rightarrow Y$, but also to consider a more elaborate model containing several mediators in the sequence: $X \rightarrow M1 \rightarrow M2 \rightarrow ...$

→ *Mk→Y*, as in Figure 1, where there are two mediators: M1=*Self-esteem* and M2=*Satisfaction with the supervisor* and in Figure 2, where the mediators are M1=*Interpersonal justice* and M2=*Social cohesion*.

RESULTS AND DISCUSSION

The results of the mediation analysis, which allow me to verify the hypotheses 1 and 2, are presented in Tables 2 and 3. These results contain values for direct and total indirect effects of PJ fit on PG fit, taking into account mediators. These values are calculated according to the formulas for model 6 given in Figure 3. These formulas with the names of the X and Y variables and mediators M are given in the notes under Table 2 and Table 3. Tables 2 and 3 also include the lower (Boot LLCI) and upper (Boot ULCI) limits of the 95% confidence interval for each effect. If both Boot LLCI and Boot ULCI are positive or negative at the same time it means that the effect is statistically significant. In this case, the effect value is bolded.

The results presented in Tables 2 and Table 3 show that PJ fit influences PG fit both directly and indirectly (see the effect values bolded). The effects, in general, are stronger for needs-supplies PJ fit than for demand-ability PJ fit. These findings support the suggestion of Kristof-Brown *et al.* (2005, p. 288) that the relationship between demand-abilities fit and job attitudes is weaker because it reflects the satisfaction of environmental needs to a greater extent, while the impact of needs-supplies fit on job attitudes is stronger because this type of fit is concentrated on meeting individual needs. Theories of need fulfillment (e.g., Locke, 1976) are the basis for this suggestion. They show that meeting the needs of an employee increases his/her positive engagement at work. Thus, needs-supplies fit reflects the satisfaction of personal needs more directly than demand-abilities fit.

Direct and indirect effects are significant is because they show that the impact of PJ fit on PG fit is partially mediated by the mechanisms presented in hypotheses 1 and 2. The existence of significant indirect effects confirms the predictions expressed by Kristof-Brown *et al.* (2005) that mediated and moderated effects are likely to occur in the relationship between PJ fit and PG fit.

An in-depth analysis of the transmission mechanisms reveals both mediation and moderation effects (see respectively Table 2 and 3 for mediation analysis and Tables 4 and 5 for moderation analysis). Due to the fact that total indirect effects (mediation effects) are stronger for needs-supplies PJ fit than for demand-ability PJ fit, the analysis of results in Table 2 and Table 3 focuses on the values of total indirect effects for needs-supplies PJ fit.

Analyzing the results in Table 2 mediation effects (or total indirect effects) are similar for internal fit in teams and external fit considering the first transmission

mechanism where PJ fit influences PG fit through two mediators: *Self-esteem* and *Satisfaction with the supervisor*:

↑PJ fit → ↑Self-esteem → ↑Satisfaction with the supervisor → ↑PG fit

Table 2. Direct and indirect effects of Person-Job fit (PJ fit) on Person-Group fit (PG fit) through the mediators: *Self-esteem* and *Supervisor satisfaction* (the first mechanism – hypothesis 1)

Antecedent variable X = PJ fit	Consequent variable Y = PG fit											
	Y=Internal PG fit						Y=External PG fit					
	Direct effect of X on Y			Total indirect effect of X on Y			Direct effect of X on Y			Total indirect effect of X on Y		
	Effect	LLCI	ULCI	Effect	Boot LLCI	Boot ULCI	Effect	LLCI	ULCI	Effect	Boot LLCI	Boot ULCI
X=Demand--Ability PJ fit	**.1891**	.1216	.2566	**.1464**	.0994	.1988	**.0929**	.0236	.1623	**.1340**	.0850	.1862
Needs-Supplies PJ fit												
X=Need for improving skills	**.1868**	.1218	.2519	**.1816**	.1380	.2301	**.1202**	.0536	.1868	**.1809**	.1364	.2282
X=Need for autonomy	**.2511**	.1848	.3174	**.1783**	.1342	.2242	**.1427**	.0739	.2114	**.1816**	.1314	.2341
X=Need for promotion	**.2290**	.1691	.2889	**.1649**	.1248	.2112	**.1335**	.0714	.1956	**.1780**	.1311	.2319

Total indirect effect of X on Y = Ind1 + Ind2 + Ind3, where:
Ind1: X → Self-esteem → Y
Ind2: X → Supervisor satisfaction → Y
Ind3: X → Self-esteem → Supervisor satisfaction → Y
Ind1, Ind2, Ind3 are statistically significant
The results in Table 3 come from Hayes PROCESS for SPSS and SAS, model 6: with two mediators in the sequence (see Fig.3).
Number of participants: N=826
Bold values indicate effects that are significant at the level of 5%
The level of confidence is: 95

Source: author's estimation.

The values of the total indirect (mediation) effects are respectively: (0.1464 and 0.1334); (0.1816 and 0.1809); (0.1783 and 0.1816); (0.1649 and 0.1780), see Table 2, the values bolded. The small difference in values for total indirect effects of PJ fit suggests that the mediators *Self-esteem* and *Satisfaction with the supervisor* are equally important for individuals when assessing how much they agree with

other team members on the amount of work required for their tasks (internal PG fit) as well as how much they should compete with other teams (external PG fit). In general, by increasing an individual's self-esteem and satisfaction with the supervisor, a good PJ fit contributes to better PG fit. The significance of *Satisfaction with the supervisor* sheds light on the role of Person-Supervisor fit (PS fit), which is a dimension of PE fit. It also explains why Kristof-Brown and her colleagues (2005, Table 5, p. 308) found the weakest correlations between PS fit and other fits. Given that *Satisfaction with supervisor*, the variable used in this study, is closely related to Person-Supervisor fit, the obtained results indicate that Person-Supervisor fit is a mediator in the PJ fit-PG fit relationship.

When it comes to the second transmission mechanism in which PJ fit affects PG fit through two other mediators, *Interpersonal justice (or Respect from supervisors)* and *Social cohesion* (see Table 3):

↑PJ → ↑Interpersonal justice (or Respect from supervisors) → ↑Social cohesion → ↑PG fit

The total indirect effects of PJ fit are stronger for internal PG fit than external PG fit, but only in the case of needs-supplies fit, with the following values of total indirect effects for particular needs: (0.1614 and 0.1214 – the total indirect effects for internal and external PG fit, respectively, see the need for improving skills); (0.1792 and 0.1378 – the total indirect effects for internal and external PG fit, respectively, see the need for autonomy); (0.1348 and 0.1032– the total indirect effects for internal and external PG fit, respectively, see the need for promotion), see Table 3, the values bolded.

If we compare how important it is for different needs to be satisfied (needs-supplies fit), we discover that *Autonomy* is more important than *Promotion* in obtaining a good PG fit. Satisfying the need for promotion, which results in increased respect from superiors (and, as a consequence, increased social cohesion), is the least important (the total indirect effects: 0.1348 and 0.1032, see Table 3, the values bolded) while satisfying the need for autonomy is the most important (the total indirect effects: 0.1792 and 0.1378, see Table 3, the values bolded) for both internal and external PG fit. The findings suggest that if the need for autonomy is satisfied the sense of respect from superiors and the sense of social cohesion are greater, which produces a better PG fit than if the need for promotion is met. The dominant indirect impact of satisfying the need for autonomy on PG fit confirms the conclusions of Adler and Borys (1996). Their research indicates that if team members can make significant decisions about their team's functioning, they are more likely to accept the tasks they are to perform.

In summary, the findings from the mediation analysis, presented in Tables 2 and 3, confirm hypotheses 1 and 2 regarding the existence of the two transmission mechanisms through which PJ fit affects PG fit.

Table 3. Direct and indirect effects of Person-Job fit (PJ fit) on Person-Group fit (PG fit) through the mediators: *Interpersonal justice (or Respect from supervisors)* and *Social cohesion* (the second mechanism – hypothesis 2)

Antecedent variable X = PJ fit	Consequent variable Y = PG fit											
	Y=Internal PG fit						Y=External PG fit					
	Direct effect of X on Y			Total indirect effect of X on Y			Direct effect of X on Y			Total indirect effect of X on Y		
	Effect	LLCI	ULCI	Effect	Boot LLCI	Boot ULCI	Effect	LLCI	ULCI	Effect	Boot LLCI	Boot ULCI
X=Demand--Ability PJ fit	**.1761**	.1067	.2454	**.1595**	.1172	.2073	**.1008**	.0264	.1755	**.1262**	.0880	.1682
Needs-Supplies PJ fit												
X=Need for improving skills	**.2071**	.1408	.2734	**.1614**	.1211	.2047	**.1797**	.1087	.2507	**.1214**	.0832	.1595
X=Need for autonomy	**.2502**	.1797	.3208	**.1792**	.1314	.2310	**.1864**	.1104	.2625	**.1378**	.0885	.1891
X=Need for promotion	**.2592**	.1996	.3187	**.1348**	.0982	.1746	**.2083**	.1437	.2728	**.1032**	.0702	.1429

Total indirect effect of X on Y = Ind1 + Ind2 + Ind3, where:
Ind1: X → Interpersonal justice → Y
Ind2: X → Social cohesion → Y
Ind3: X → Interpersonal justice → Social cohesion → Y
Ind1, Ind2, Ind3 are statistically significant.
The results in Table 3 come from Hayes PROCESS for SPSS and SAS, model 6: with two mediators in the sequence (see Fig3)
Number of participants: N=826
Bold values indicate the effects that are significant at the level of 5%
The level of confidence see Table 2

Source: author's estimation.

This study also tested age as a control variable in the mediation models, however, age was statistically insignificant, and therefore, the results are not presented.

The study has some limitations. The variables are obtained by measuring the participants' perceptions of fit which reflect the subjective match between the person and his or her job and team. Perceived fit can be influenced by the personal characteristics of participants included in the survey. The study tries to limit these shortcomings by including personality traits and gender as moderators.

This study is based on data on employees with a university degree or equivalent and the results are limited to this sub-population. On the other hand, it allows us

to assume that the working conditions of the survey participants are similar and therefore do not significantly affect the answers provided.

The fit research is conducted most often in a uniform work environment, for example, the articles discussed in the surveys of the fit literature developed by Herkes *et al.* (2020) concern fit in health care, while a systemic review by Wightman and Christensen (2024) includes articles devoted to person-environment fit in the public sector. Some empirical work is carried out on the basis of data concerning a selected enterprise or several enterprises in one sector, e.g. the paper by Zhang, Seong and Hong (2022) concerns Person-Group fit in the public sector firm in Korea. There are no studies covering the entire population of employees in a given country. The fit literature builds knowledge about person-environment fit focusing on the results confirmed in various work environments.

Taking into account this specificity of research, the study presented in this paper sheds light on the relationships between different fit forms, not from the perspective of employees of one sector or one enterprise, but of a group of highly qualified employees.

This study uses cross-sectional data, which means that changes in the relationship between PJ fit and PG fit over time are not shown. This is always a drawback. However, the lack of statistical significance of *Age* in the models used in the study alleviates this drawback. Unfortunately, since there is no longitudinal data on PE fit, cross-sectional data is the only option.

In the future, research should be undertaken to expand the list of moderators, taking into account fairness at the workplace and personality characteristics such as innovation and achievement-orientation. There is a need for further studies on the moderators of the relationship between PJ fit and external PG fit.

It is certainly worth following the advice of Vleugels (2004) that scholars should undertake research on person-skill fit, which focuses on technical skills needed for a given job position.

In the context of remote and hybrid work models, the importance of working time flexibility and flexibility of the form and place of work should be examined as factors influencing the perception of the employee's fit to the work environment.

CONCLUSION

The findings from the mediation and moderation analyses reveal that there are direct and indirect effects of PJ fit on PG fit. Two transmission mechanisms through which PJ fit influences PG fit were identified. In the first one, a good PJ fit increases PG fit through *Self-esteem* and *Satisfaction with the supervisor*, while in the second mechanism through *Interpersonal justice* (or *Respect from supervisors*) and *Social cohesion*. Both mechanisms are stronger for the needs-supplies form of PJ fit.

By increasing an individual's self-esteem and satisfaction with the supervisor, a good PJ fit improves both forms of PG fit (i.e. internal and external PG fit).

The findings suggest that if the need for autonomy is satisfied, the sense of respect from supervisors and the sense of social cohesion are greater, which produces a better PG fit than if the need for promotion is met. The dominant indirect impact of satisfying the need for autonomy on PG fit suggests that when team members have greater freedom in planning and carrying out their tasks, they are more likely to accept them than when tasks are imposed upon them. Autonomy generates positive behaviour among team members and improves their collaboration with their supervisor and their teammates.

The results offer recommendations for management practices. Fit is very important for employees because it influences their decisions and behaviour in the workplace. To maximize the benefits of teamwork it is necessary to match the employee to the job. Autonomy can have a stronger indirect effect on PG fit than promotion.

The obtained results do not lose their significance in remote and hybrid work models. Research on strategies that foster hybrid team performance emphasizes that supervisors must provide all team members with a sense of self-worth, build trust and psychological safety (Hincapie, Costa, 2024). The leader's leadership style is a critical factor that impacts team cohesiveness significantly (Baker et al., 2024).

The mechanisms of social dependencies between PJ fit and PG fit, which this study was devoted to, are still relevant in the world of virtual work.

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Couriers and drivers – women or men? Opinions on gender in platform work "via apps" in Poland

Abstract

The article examines gender-related perceptions and stereotypes of platform-based courier and driver jobs, focusing on factors such as physical aptitude, safety concerns, work flexibility, and anonymity. The theoretical background to the empirical research was the theory of statistical discrimination. The main purpose was to provide the views of Polish residents on gender diversity in the context of platform work as couriers for delivering meals from restaurants or shopping and taxi drivers. The following hypothesis was set: clients might be guided by stereotypes in their opinions given to platforms workers. The methods used were critical analysis of the scientific achievements of literature and a diagnostic survey, using the questionnaire technique. The paper explores the concept of digital labour platforms (DLPs) focusing on offline service delivery and provides a concise overview of statistical discrimination theory. It also examines the results of a survey conducted among adult inhabitants of Polish cities. The findings indicate that while certain gendered perceptions remain strong, attitudes seem to be not far away from gender neutrality.

Keywords: digital labour platforms, gender inequality, work "via apps", couriers, drivers.

Kurierzy i kierowcy – czy płeć ma znaczenie? Opinie na temat kobiet i mężczyzn w pracy platformowej w Polsce

Abstrakt

Przedmiotem badań w artykule uczyniono stereotypy związane z płcią w kontekście pracy kurierów i kierowców świadczących usługi za pośrednictwem platform cyfrowych (DLP), koncentrując się na takich aspektach, jak predyspozycje fizyczne, kwestie bezpieczeństwa, elastyczność pracy oraz anonimowość. Teoretycznym punktem odniesienia dla badań empirycznych była teoria dyskryminacji statystycznej. Głównym celem było przedstawienie opinii mieszkańców Polski na temat kobiet i mężczyzn w kontekście pracy platformowej, tj. jako kurierzy dostarczający posiłki

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z restauracji lub zakupy oraz jako kierowcy taksówek. Postawiono następującą hipotezę: klienci platform mogą kierować się w swoich ocenach pracowników stereotypami dotyczącymi płci. Zastosowane metody badawcze obejmowały krytyczną analizę dorobku literatury naukowej oraz metodę sondażu diagnostyczny z wykorzystaniem techniki ankietowej. W artykule omówiono pojęcie cyfrowych platform pracy z akcentem na usługi realizowane offline i przedstawiono krótką charakterystykę teorii dyskryminacji statystycznej. Dokonano analizy wyników badania ankietowego przeprowadzonego wśród dorosłych mieszkańców polskich miast. Można stwierdzić, że choć pewne stereotypy płciowe nadal są obecne, postawy respondentów nierzadko bywają neutralne.

Słowa kluczowe: cyfrowe platformy usług pracy, nierówności płci, praca przez aplikację, kurierzy, kierowcy.

JEL: J16, J39, J49.

INTRODUCTION

Discussions about female and male traits and skills often revolve around a mixture of theories from various fields. Economics typically provide insight into how gender differences, real or perceived, impact economic outcomes like labour market participation, wage gaps or occupational choices. A distinct approach has been adopted in this paper. Setting the analysis in the context of perceived sex-based differences, this article addresses the topic of digital labour platforms (DLPs) with focus on opinions on those that provide offline services – couriers and drivers. To date such a study has not been conducted in Poland; only related themes have been covered in relation to China (Kwan, 2022), Argentina (Micha et al., 2022) and India (Ghosh et al., 2022), among others. According to those authors, DLPs can perpetuate existing gender biases, leading to an undervaluation of female work who face lower earnings and worse conditions compared to their male counterparts. The emphasis here is not on inequality as a result of certain processes but on its underlying determinants. The research problem addressed concerns the extent to which gender stereotypes influence customer perceptions of platform workers. This approach provides new insights, thereby filling a gap in the existing literature. The main objective is to diagnose and present the views of Polish residents on the gender diversity in the context of platform work as: couriers for delivering meals from restaurants or shopping and drivers in the light of the theory of statistical discrimination. Such background seemed to be noteworthy in the context of the research problem raised since the theory relies on stereotypes about average group characteristics. The hypothesis stated here was that platform clients might be guided by stereotypes in their opinions given to platforms workers. The hypothesis was verified through an analysis of the structure of responses to a survey that included, among other items, questions concerning participants' opinions on this issue. Existing studies confirm that various biases may influence customers satisfaction evaluations and produce discriminatory judgments for minority and female employees (Hekman

et al., 2010). There are also studies suggesting that female or minority drivers receive lower ratings from passengers (i.e. Greenwood et al., 2018; Micha et al., 2022). Thus, it can be assumed that opinions of the platforms' influence the positioning of the workers and finally – their incomes. The motivation to explore the topic stemmed from the desire to examine whether similar premises can be observed in the Polish market, especially in view of the growing popularity of services purchased via platforms and noticeable on the streets of Polish cities couriers and drivers. The data presented here provide a unique opportunity to explore opinions on platform workers with regard to their gender. The methods used were critical analysis of the scientific achievements of literature and a diagnostic survey, using the questionnaire technique. The article examines the results of a survey conducted among adult inhabitants of Polish cities.

The paper is organised as follows. Following the introduction, the first section concerns the concept of the DLPs with a focus on services delivered offline. The next part examines briefly the statistical discrimination theory. This is followed by a separate section describing the methodology and the subsequent section presenting the results. The final part encompasses the conclusions, discussion and limitations of the study.

Literature review – Platform work with a focus on offline digital labour platforms

Platform work can be described as on-demand work facilitated by digital (internet) platforms which, by means of algorithms, intermediate between two groups of independent users: workers and clients (customers), both registered on a given platform. The organisation of the process of transaction is quite characteristic of this business model. In outline: the work is structured around discrete tasks, in contrast to traditional employment models characterized by ongoing work relationships. All services are ordered by clients via smartphone apps (possibly via websites), and the algorithm suggests workers who could possibly perform the task. Payment is often per task/project, rather than a salary or hourly wage (Farrell, Greig, 2016; Ostoj, 2020; Ostoj, 2021). Many DLPs operate globally, therefore the workforce registered even on one platform is notably diverse, encompassing individuals from various demographic backgrounds, skill levels, and geographic locations (Vallas, Schor, 2020). This diversity is also facilitated by the low barriers to entry for many types of work.

There are two basic groups of DLPs (ILO, 2021; Vallas, Schor, 2020; Schmidt, 2017). The first group, online platforms, utilize advanced internet and mobile technologies, making services accessible to both customers and workers internationally or even globally. The tasks are performed remotely via platforms

such as Amazon Mechanical Turk, Clickworker, TopCoder, Upwork (and many others), and include a wide range of services from relatively simple activities such as video transcription or annotating images to more complicated services such as translation, software development or graphic design. The second group – offline platforms, employ mobile and geolocation technologies to connect local workers with clients in need of physical, location-specific jobs. They usually embrace such services as taxi, delivery, care provision, house cleaning, and odd jobs. The examples of platforms are Uber, Deliveroo, Glovo, Task Rabbit, Hilfr, Rappi, or Handy. The main focus of the paper is on the two prominent sectors within offline platforms, namely delivery and taxi services. Delivery platforms connect couriers with customers who need to transport things, ranging from groceries and restaurant meals to packages and personal items. In turn, taxi platforms connect passengers looking for transportation with nearby drivers. Both delivery and taxi platforms use a proprietary algorithm to match workers with clients; the algorithm considers factors like proximity, worker availability and their ratings, estimated time of arrival and probably many other factors that are not made public by the platforms.

DLPs provide customers with several benefits, including 24/7 availability, upfront and competitive prices, or fast service delivery. The situation is more complex from the perspective of the workers. Based on the analysis of the subject literature, it becomes feasible to categorize the attributes of platform work into two categories – advantages and disadvantages. Within each category, a specific subset of the characteristics inherent to offline services can be identified (Table 1).

Table 1. Pros and cons of platform work

	Advantages	Disadvantages
Related to both online and offline work	• The opportunity to earn additional or higher income. • A more flexible work schedule. • The ability to organize and manage one's own workload without external oversight. • Greater independence in decision-making. • Minimizing exposure to bias or unfair treatment. • Avoiding repetitive and monotonous routines.	• Unpredictable and often insufficient earnings. • Lack of social safety nets. • Algorithmic delegation of tasks and evaluation of work, with reduced human supervision. • The need to be available and vigilant almost constantly. • No access to guidance, mentorship, or support from colleagues and supervisors. • Covering work-related costs.
Related to entirely offline services	• Involving continuous movement and varying locations (ideal for individuals who thrive in non-static environments).	• Involving direct interactions with clients. • Dealing with heavy traffic in cities. • Exposure to harsh weather conditions.

Source: (Pal, Kumar, 2024; Faisal, 2024; Verdin, O'Reilly, 2022).

Platform work (Table 1) offers advantages such as flexibility, autonomy, greater anonymity, and avoidance routine but, it comes with challenges including i.a. unstable income, lack of social protection, and algorithmic management. Offline work, while providing face-to-face interaction and physical activity, also requires dealing with urban traffic and weather conditions. The reflection on the content of the Table prompts an inquiry into whether certain characteristics might play any role in the context of gender issues and what the potential consequences might be. However, it is essential to base the approach on established scientific theory.

Statistical discrimination theory – an overview in the context of present day

Statistical discrimination theory relies on stereotypes about the average group characteristics to make decisions under uncertainty (Becker, 1957; Baumle, Fosset, 2005; Bertrand, Duflo, 2016). It was developed by K. Arrow (1971) and E. Phelps (1972) and explains how group inequality can arise and persist even when decision-makers (like employers or consumers) are rational and non-prejudiced. The authors suggest that discrimination occurs because those agents have imperfect information about the productivity of individuals. Instead of making decisions based on complete information, they rely on statistical averages or historical data about the group to which a person belongs. For example, if a group (a minority, a gender) has historically been less productive, employers might assume that all of its members are less productive, leading to discrimination in the form of differences in job opportunities or wages between the groups (Thijssen et al., 2021). The theory also covers scenarios where discrimination arises from differences in the reliability or "noise" of signals (like test scores) that applicants send to employers. Even if two individuals from different groups have identical above-average signals, the one from the group with a higher historical mean might be favored because their signal is seen as more reliable, even if those groups are otherwise identical in terms of actual ability. In short, employers might use group characteristics as proxies for individual productivity. Thus, employment decisions are not taken entirely on the basis of individual characteristics but rather on the basis of (perceived) group features. The process appears to be reinforced if decision-makers are prejudiced or irrational. In the context of gender issues, such discrimination may result from socially shared stereotypes about male and female traits and skills legitimated by various ideologies (di Stefano, 2019; Sielska, 2023). The problem has been also developed i.e. within the framework of the hypothesis of sex segregation in the labour market. Due to the role attributed to women and

men and the belief in different sets of gender-specific characteristics, women are often perceived (even by themselves) as being better in roles requiring empathy, communication, and nurturing while men are seen as better in STEM fields and physical work. Because of traditional caregiving roles, occupations offering flexible hours or the possibility to combine work with family responsibilities are also often more appealing to women. Men are seen as responsible for earning income to support their families, which is why earning potential and job stability are significant factors. Such opinions about females and males might serve as proxies for individual characteristics leading to various forms of discrimination.

On the surface, adopting the statistical discrimination theory may be controversial in combination with the DLPs issues, as it originates from the 1970s, whereas the platforms emerged in the 21st century. Furthermore, there is no negotiation in such business model, since the rates are predetermined and current decisions are made by algorithms, not humans. No formal hiring decisions are made either, it is sufficient that the potential platform workers meet certain conditions and registers on a platform. Therefore, human mistakes or stereotyping seem unlikely. However, the inadequacy of this theory becomes apparent. First of all, the algorithms employed are not transparent and are designed in alignment with the preferences of the platform owners, with no assurance that they are free from discrimination (Orwat, 2020), including gender bias. Secondly, the algorithms consider customer opinions, which may already be influenced by stereotypes existing in a society. With such reasoning and applying the theory of statistical discrimination to the situation of women and men working as couriers or drivers for the DLPs may explain differences in customer choices and ratings which can appear. The theory suggests that platform clients, having incomplete information about individual drivers or couriers, may make decisions based on stereotypes or statistical averages related to the group to which the person belongs. Although it is not possible to decide on worker gender (or any other characteristic such as nationality, race etc.) at the assignment stage, platform workers are rated after each completed task. In the light of the theory, customers might base their evaluations not solely on the actual experience but also on biases derived from general beliefs about the group. For example, if men have historically been more commonly employed as drivers or couriers, clients might, consciously or unconsciously, assume that men are more competent or better suited for this job. As a result, a female driver receives lower ratings than a male driver for the same quality of task performed. These ratings influence further matching process, namely drivers with better ones might get more ride requests or be matched with higher-rated passengers. The system can create anxiety, as consistently low ratings could reduce their earnings or even lead to deactivation. More lucrative assignments for men not only may affect the gender differences in earnings, but also job security for

women. Moreover, groups of taxi or delivery drivers perceived as doing a better job may also be rewarded informally in the form of tips, reinforcing inequality.

With regard to the stereotypes and features of platform work delineated in the preceding section, the question arises as to whether the profession of delivery person or taxi driver can be considered more suitable for one gender than the other. Attention has been paid to gender-related issues stemming from the theory, as well as to offline platform-based work. The aspects of physical strength and conditioning, flexibility and anonymity were selected for more in-depth study. The question of income in the context of gender and the role of the man as the breadwinner was dropped. Although platform work is low paid, it is often seen as complementary work, so it is difficult to grasp the context of gender differences.

Research methods

The study was conducted employing a diagnostic survey method, with the use an internet-based questionnaire technique. It was outsourced to an organisation with access to a comprehensive research panel allowing for the selection of a representative sample of the adult Polish population residing in urban areas, ensuring diversity and representativeness in terms of gender, age, and education. The survey was conducted in December 2023. The sample (401 respondents) included 51.1% women and 48.9% men. By age: 9.5% were aged 18–24; 19% were aged 25–34; 41.6% were aged 35–54, and 29.9% were aged 55–70. By place of residence: 47.6% were residents of large cities with more than 50,000 inhabitants; 52.4% were residents of cities with up to 50,000 inhabitants. The survey of rural residents was abandoned due to anticipated poor recognition of the phenomenon. The structure of the sample in terms of the level of education was as follows: 43.6% of people with higher education, 25.9% with post-secondary or secondary vocational education, 17.7% with general secondary education, 11% with vocational education and 1.7% with lower secondary, primary or incomplete primary education.

A concise introduction at the outset of the questionnaire was incorporated to differentiate between workers operating "via apps" and "traditional" couriers and taxi drivers. Given that the survey focused on gathering gender-related opinions rather than experiences, the criterion to exclude individuals who had never ordered services through such platforms was omitted. A subset of findings derived from an analysis of responses to two separate questions devoted to couriers and drivers is presented. Each question was structured in a closed format, allowing respondents to select only one answer from the provided options. Responses here were expressed on a five-point Likert scale: from 1 – *I completely disagree, to 5*

– *completely agree.* The questions were as follows: *In your opinion, is there any link between gender and the job of a courier delivering meals/shopping ordered via platforms, such as Pyszne.pl, Glovo, Wolt? In your opinion, is there any link between gender and the job of a driver providing passenger transport services ordered via platforms, such as Uber, Bolt, FreeNow? The responses suggested were: a) more suitable for men because of physical predispositions, b) more suitable for men because it can be dangerous (contact with awkward customers), c) gender is irrelevant, d) more suitable for women because it allows for greater flexibility and the possibility of combining work with domestic responsibilities, e) more suitable for women because of greater anonymity.* It is noteworthy that the neutral answer is general in nature. This was intended to counterbalance to the other four responses in which references to stereotypes are made.

RESULTS FROM THE SURVEY

The structure of the answers obtained shows a complex picture of platform workers in the context of gender differences in the eyes of Polish city dwellers (Table 2).

Table 2. Opinions on courier and driver job in the context of gender (in %)

	Couriers			Drivers		
Statement about the job*	1-2	3	4-5	1-2	3	4-5
More suitable for men due to physical predispositions	27.2	23.7	49.2	39.1	24.2	36.7
More suitable for men because it can be dangerous	26.0	18.2	55.9	24.7	23.4	51.9
Gender is irrelevant	26.6	27.7	45.6	21.4	31.7	46.9
More suitable for women because it allows for greater flexibility	51.6	27.4	21.0	49.2	22.9	27.9
More suitable for women because of greater anonymity	45.1	34.7	20.2	46.6	32.4	21.0

* 1 – Completely disagree, 2 – Rather disagree, 3 – Undecided, 4 – Rather agree, 5 – Completely agree.

Source: own elaboration based on research results.

Physical aptitude was the first issue considered (Table 2). Nearly half of the respondents (49.2% – combining the responses of those who rather agree and completely agree) lean towards the view that the courier job may be more suitable for men due to predispositions. This proportion suggests that a considerable number of people perceive the physical demands of the work – such as carrying items or cycling long distances – as potentially more challenging for women.

More than 27% reject the idea that this job is more suited to men, indicating they believe the predisposition is not a significant factor. On the topic of taxi drivers, it becomes evident that 36.7% of respondents declare the view that men might be more suitable for the job of a driver. Although this is a significant percentage, it is less than half, which indicates that a majority either disagrees or is undecided about this notion.

The potential dangers arising primarily from difficult customer interaction were then examined. More than half of the respondents (55.9%), agree to some extent with the statement that the job of a courier delivering meals or shopping might be more proper for men for this reason. 26.0% of people disagree with the statement, suggesting that they do not believe gender matters in the context of perceived risks. 18.2% of the respondents remain undecided. Similar proportions are observed regarding driving jobs. Almost 52% of individuals "completely" or "rather agree" that the job is more suitable for men. This perspective could stem from traditional views on gender roles or perceptions of men being more capable of handling dangerous situations. The significant portion (23.4%) of the respondents indicates uncertainty. The relatively small group likely believes that gender is not a relevant factor in safety concerns in this profession.

The third statement aimed to gather opinions while ensuring respondents felt comfortable answering without requiring them to give a reason. The distribution of responses regarding the couriers reflects a lack of consensus among respondents. Namely, 27.7% are undecided, 26.6% disagree to some extent and 45.6% agree to some extent. The response pattern to the statement concerning drivers reveals a slightly different trend. 21.4% disagree with the statement that gender is irrelevant, indicating a minority perceives gender as relevant in this role, though the proportion is smaller than agreement levels. Nearly 47% agree to some extent (28.9% "Rather agree", 18.0% "completely agree"), showing that almost half of the respondents see gender as irrelevant. 31.7% are undecided, representing the largest group, which suggests that many respondents consider the issue to be situational or lack a strong opinion.

Yet another statement addressed the matter of flexibility. The response structure to the remark that courier work is more suitable for women because it allows for combining work with household duties indicates a predominant disagreement among the respondents. More than half of them (51.6%) reject the idea that courier work is inherently more suitable for women due to its flexibility. 27.4% are undecided while minority (21%) aligns with the view that flexibility in courier work makes it better suited for women. There are slight variations in the response patterns to analogous question regarding to drivers. Namely, almost 50% disagree to some extent that driving work is more proper for women because of flexibility. 27.9% agree that this feature of the job may make it more suitable for women, while 22.9% are undecided. It seems that the responses referring to both

couriers and drivers demonstrate that gender stereotypes linking women to flexible work and domestic responsibilities are not strongly supported by the majority in Poland, though the undecided group highlights that these perceptions may linger.

Anonymity is the last issue raised here. The overall structure reveals skepticism toward the argument that anonymity specifically makes courier work more appropriate for women. 45.1% of the respondents disagree with the statement while the largest group (34.7%) comprises undecided. A smaller group (20.2%) completely or rather agrees, showing limited support for the notion that platform anonymity significantly benefits women in courier work. In the context of job as a driver, nearly half of respondents (46.6%) do not view platform-based anonymity as a key factor in making driving work more suitable for females. A fairly large group (32.4%) lacks a clear stance or sees the relationship between anonymity and gender-based discrimination as unclear or situational. A smaller group (21.0%) shows support for the idea that anonymity in platform-based driving services is particularly beneficial for women.

The analysis indicates that gender stereotypes are present in perceptions of courier and driver jobs, but they are not forceful nor universally accepted. The higher percentage of undecided respondents suggests that societal perceptions of gender roles in these professions may be more nuanced or context-dependent, meriting deeper investigation into underlying factors.

CONCLUSIONS

While some stereotypes persist in Poland, especially with regard to physical demands and safety, societal views indicate a more gender-neutral perceptions of these jobs. They can be also manifested differently depending on the profession. Stereotypes about physical strength and job safety are more pronounced for couriers than drivers. Driving seems to be perceived as more gender-neutral, while courier work still carries traditional perceptions. The notion that women should do flexible jobs is not widely supported, however, some still hold this view. Anonymity is not considered a key gender-related factor. The analysis of respondents' answer patterns suggests that only some of the commonly held gender stereotypes are present in Polish society. Thus, the hypothesis set out in the article is only partially confirmed. The results also differ from those cited from similar studies conducted in other countries, where the findings were more conclusive. Nevertheless, it should be emphasized that only opinions were surveyed and not specific decisions regarding the ratings they gave to the workers or the tips handed. On the one hand, this may be considered a limitation of the study, because it makes direct comparisons and broader discussion more difficult; on the other

hand, it is important to acknowledge that platform work remains a relatively recent phenomenon in Poland – while it is relatively well-known in urban areas, not all individuals have necessarily engaged with such services. Yet, this does not preclude the possibility of having a formed opinion on the subject. Future research could refine the sample by focusing exclusively on platform service users and incorporating questions related to decision-making rather than solely opinions. Yet, this approach may require further time until the phenomenon becomes more recognisable in the Polish labour market.

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Management of the enterprise wage fund in the context of the EAF Model

Abstract

This study aims to develop and verify in empirical applications an economic model for determining the real level of employee remuneration, human capital utilization, and managerial efficiency within enterprises. Amidst ongoing debates concerning wage structures and compensation systems, this research introduces the Economic Activity Function (EAF) as a tool for analyzing labor productivity and wage distribution.

A mixed-methods approach was employed, combining a literature review to establish the role of the economic constant a = 0.08 [1/year] in compensation analysis with an empirical case study of Komfort-Eko Ltd. Utilizing financial statement data, key indicators—including the Management Index (M) and the Labour Productivity Index (Q)—were calculated to assess wage fund allocation efficiency.

Findings reveal that the EAF framework enables the estimation of crucial managerial indicators, serving as a valuable instrument for evaluating corporate performance and optimizing remuneration structures. By forecasting labor productivity for subsequent periods, businesses can predict remuneration levels, including bonus allocations, thereby enhancing financial planning and employee motivation.

The implications of this study extend to policymakers and business leaders, providing a robust analytical framework for evaluating management quality, labor productivity, and remuneration fairness. The predictive capabilities of the EAF model facilitate financial scenario planning and decision-making, ultimately contributing to a more structured and data-driven approach to corporate wage management.

Keywords: EAF model, Management Index, Labor Productivity Index, wage fund.

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Zarządzanie zakładowym funduszem płac w kontekście modelu EAF

Abstrakt

Niniejsze badanie ma na celu opracowanie i weryfikację w zastosowaniach empirycznych modelu ekonomicznego umożliwiającego określenie rzeczywistego poziomu wynagrodzeń pracowników, stopnia wykorzystania kapitału ludzkiego oraz efektywności zarządzania w przedsiębiorstwach. W kontekście toczącej się debaty na temat struktury wynagrodzeń i systemów płacowych, wprowadzone zostaje pojęcie Funkcji Aktywności Ekonomicznej (EAF) jako narzędzia analizy wydajności pracy i dystrybucji wynagrodzeń.

W badaniu zastosowano metodologię mieszaną, obejmującą przegląd literatury w celu ustalenia roli stałej ekonomicznej a = 0,08 [1/rok] w analizie systemu wynagrodzeń oraz studium przypadku przedsiębiorstwa Komfort-Eko Sp. z o.o. Na podstawie danych ze sprawozdań finansowych obliczono kluczowe wskaźniki, w tym Wskaźnik Zarządzania (M) i Wskaźnik Wydajności Pracy (Q), celem oceny efektywności alokacji funduszu płac.

Wyniki badań wskazują, że model EAF umożliwia oszacowanie kluczowych wskaźników zarządczych, stanowiąc istotne narzędzie oceny efektywności przedsiębiorstwa oraz optymalizacji struktury wynagrodzeń. Prognozowanie poziomu wydajności pracy na kolejne okresy pozwala na przewidywanie wysokości wynagrodzeń, w tym funduszu premiowego, co usprawnia planowanie finansowe i motywację pracowników.

Implikacje badawcze obejmują zarówno decydentów politycznych, jak i liderów biznesu, dostarczając im rzetelnego narzędzia analitycznego do oceny jakości zarządzania, produktywności pracy oraz sprawiedliwości systemu wynagrodzeń. Możliwości prognostyczne modelu EAF ułatwiają planowanie scenariuszowe oraz podejmowanie decyzji strategicznych, przyczyniając się do bardziej ustrukturyzowanego i opartego na danych podejścia do zarządzania płacami w przedsiębiorstwach.

Słowa kluczowe: Model EAF, wskaźnik zarządzania, wskaźnik produktywności pracy, fundusz płac.

JEL: J24, J31, M11.

INTRODUCTION

The aim of this study is to develop and verify in empirical applications an economic model for determining the real level of employee remuneration, human capital utilization, and managerial efficiency within enterprises. To this end, the study will examine the existence and practical applicability of a constant magnitude in economic processes, with particular emphasis on its role in the management of a company's wage fund. The scope of the analysis includes both theoretical and empirical considerations, integrating economic modeling with business management practices. The primary research hypothesis is that a fundamental economic constant governs key financial variables, including wages, prices and profit rates, thereby serving as a crucial reference point for discount and interest rates, and that its inclusion in decision-making models allows for more effective management of the compensation fund, improved efficiency in the use of human capital, and more accurate strategic decisions in firms.

The motivation for addressing this research topic stems from the ongoing debate regarding the existence of invariant economic parameters, as well as the need for robust theoretical frameworks that improve managerial efficiency. While F. Neal and R. Shone (1976) contended that economic systems lack fixed constants analogous to those found in the physical sciences, subsequent empirical studies have provided compelling evidence to the contrary. This paper seeks to contribute to this discourse by presenting findings that substantiate the presence of a stable economic magnitude with tangible implications for business operations. The relevance of this research is underscored by the necessity for decision-makers to rely on scientifically grounded methodologies rather than arbitrary heuristics in financial management.

Literature Review

A growing body of empirical research suggests that economic processes exhibit a degree of regularity that can be captured through a constant magnitude influencing key financial indicators. This constant plays a pivotal role in determining the equilibrium dimensions of wages, prices, and profit rates, thereby informing strategic financial decisions. Its significance extends to the formulation of economic models that facilitate optimal corporate governance, provided that decision-makers adopt a scientific rather than discretionary approach to managerial problem-solving.

In particular, the constancy of the average rate of capital multiplication over a given period has been identified as a critical determinant in medium-term return analyses. The estimation of this parameter has enabled the development of the Economic Activity Function (EAF), a model designed to evaluate the efficiency of corporate management and wage fund allocation. By integrating this constant into decision-making frameworks, firms can enhance their capacity for long-term financial stability and sustainable growth. This study provides validation of the existence of a stable economic magnitude influencing business processes and managerial decision-making. By bridging theoretical economics with practical business applications, this research underscores the imperative of scientifically informed decision-making in contemporary economic environments.

The first studies related to the detection of a constant magnitude of periodic returns were based on large samples and involved the analysis of data on returns on stocks listed on the US (NYSE) over a period of about 80 years (Garrison, 2006; Dobija, 2007, pp. 89-114). The authors of these studies showed that the real rate of return on US stocks is ex ante 8%. These studies have shown that average annual stock returns, i.e. periodic capital gains in entrepreneurship, are specific and strongly correlated with a fixed quantity. In the past, this type of research has

manifested itself in the assessment of the "risk premium". This quantity, defined as the difference between the real return and the return on US Treasury bills, is a component of the CAPM model (Goetzmann, Ibbotson, 2006), which has lost much of its appeal in the current era (Chatterjee, Lubatkin, Lyon, Schulze, 1999). The novelty of the presented approach to the study of the "risk premium" was the disclosure of the constant magnitude with which the "risk premium" is associated. This is related to the recognition that, in an efficient market, periodic profits are, among other things, the result of natural forces. After all, employees receive a fair wage, depreciation of fixed assets increases costs, so it is the forces of nature that are also the source of periodic increases in invested capital. For this reason, a = 0.08 [1/year] is estimated as the real rate of return in an efficient market.

Further studies conducted by many authors, such as B. Kurek (2012), I. Gorowski and Kurek (2020), W. Koziol (2011), A. Mikos and Koziol (2020), M. Dobija and Renkas (2007, 2022, 2023), J. Renkas (2013, 2021, 2022), B. Oliwkiewicz (2020), I. Cieslak (2008), A. Jonkisz-Zacny (2017) and others, took into account the indispensable use of the magnitude a = 0.08 [1/year] in justifying the theses of the conducted studies. There was widespread amazement at the results of estimating the average value of this quantity, which always oscillated around a value very close to 8%.

B. Kurek (2012), on the other hand, studied the size of periodic profits in business units and their relationship with a constant. He conducted the study on a sample of financial statements of companies belonging to the Standard & Poor's 1500 index over a period of 20 consecutive years, determining the real rate of return on capital invested in entrepreneurship. He took into account the components of the index, i.e. the companies included in the Standard & Poor's 1000, Standard & Poor's 900, Standard & Poor's 600, Standard & Poor's 500, Standard & Poor's 400 indexes. The total number of observations was 22,952. The results of B. Kurek's statistical tests confirm the hypothesis of an average ex-post risk premium of 8.33%, which corresponds to an ex-ante risk premium of 8%. The test was performed at a confidence level of 0.999, giving a confidence interval of 8.25-8.89%, with a mean of 8.57%. Statistical inference was considered to be completely safe due to the low relative random error (3.75%). B. Kurek was concerned with the rate of capital multiplication in entrepreneurship. Therefore, unlike R.G. Ibbotson and W.N. Goetzmann, who looked for a risk premium in setting their targets, B. Kurek examined the real rate of return and confirmed the magnitude of a = 0.08 [1/year].

The magnitude of a = 0.08 [1/year] is also evident in the human capital account, as M. Dobija (2007) was the first to show. He confirmed this by calculating the minimum wage for a 17-year-old starting work in the USA. He made the calculations on the basis of three different quantities: 0.07 [1/year], 0.08 [1/year] and 0.09

[1/year]. The test rejected a constant value of 0.07 [1/year] and 0.09 [1/year], and using a value of 0.08 [1/year] guaranteed the closest approximation to the legal minimum wage in the USA.

W. Koziol (2011) carried out another of the studies on the magnitude of "a" based on the human capital account, analysing the wages of a large number of employees of the company ABM Solid SA and statistically confirming its magnitude at a = 0.08 [1/year], showing that the wages of workers are at 8% [1/year] in relation to the value of their human capital.

A study of actual salary expectations of job seekers in Ukraine (Renkas, 2021) also confirmed the empirical fact that there is a 100% correspondence between expected wages and those determined by the theoretical model (N = aH, where: N – the amount of the annual basic salary, a – the percentage of the payment of the employee's human capital at 0.08 [1/year], H – the value of the employee's human capital determined as the sum of the capitalised costs of living expenses, professional education and work experience) is ensured only by the use of a = 0.08 [1/year] in the theoretical model. The use of 0.07 or 0.09 for the capitalisation of costs showed a significant deviation in the percentage of compliance of the wages compared. The survey was based on the wage expectations of 3,920 jobseekers and is valuable in that those under unemployment pressure do not have exorbitant wage expectations but rather reckon with the ongoing cost of living.

The magnitude of a = 0.08 [1/year] has also been repeatedly confirmed in studies of statutory minimum wages in the USA (Dobija, 2011; Dobija, Renkas, 2021; 2022; 2023). Using a rate of return of a = 0.08 [1/year] in the model when analysing minimum wages in the USA resulted in 100% agreement between the statutory minimum wage and the theoretically calculated minimum wage for a young person with no vocational training or work experience. The authors of the study have repeatedly shown that rates other than 8%, such as 7.5% or 8.5%, are fundamentally different from the legal minimum wage in the US economy, which is considered fair.

Throughout history we also find traces of the manifestation of the magnitude a = 0.08 [1/year] in economic life. According to A. Pikulska-Robaszkiewicz (1999, pp. 41–42), in the Roman Republic the interest rate on loans was limited by law to 1/12 of the capital, i.e. 8.33% per annum. By maintaining this limit, Emperor Justinian freed contracts from unreasonable, ruinous interest. This decision was a reasonable compromise between humanitarianism and the necessary needs of circulation, which revealed the operation of the natural rate of capital multiplication. Later, the introduction of a similar limit on interest in maritime loans allowed the development of maritime trade. All this showed that economic development took place after the natural rate of capital multiplication was allowed to operate, i.e. the value of a = 0.08 [1/year].

Studies have also shown that, in addition to the above-mentioned extremely important areas of the constant, it determines the rate of the passage of time in the Earth's living system and sets the lower limit of biomass growth (Dobija, Renkas, 2023). It has also been revealed in the estimation of fair prices for agricultural products (Kurek, 2011; Renkas, 2019), as well as in studies on the evaluation of the natural level of depreciation of fixed assets (Jonkisz-Zacny, 2017). All the above-mentioned areas, in which the constant of potential capital growth a = 0.08 [1/year] was found, confirm the necessity of its inclusion in economic accounts.

It is noteworthy that the use of the constant a = 0.08 [1/year] leads to fair values. This constant has made it possible to develop models of the growth in the value of human capital (Renkas, 2022), so that in terms of wages we can speak of fair wages.

The constant a = 0.08 [1/year] presented above has its practical applications in many economic fields. An example of the practical use of the constant magnitude a = 0.08 [1/year] is its use in the algebraic representation of the costs and results of the manufacturing process, which led to the idea of the Economic Activity Function (EAF). This is a functional description of the production process, which naturally begins with the representation of the products and services produced in terms of the selling price as a function of the cost of production.

It is worth noting that the econometric models popular in economics, called production functions (such as R. Solow's model (Romer, 2000, pp. 23–53)), are characterised by the fact that the factors of production are measured in natural units rather than monetary units. However, the production process, which culminates in a market exchange, can be described taking into account the fact that production factors are concentrated in a product according to the principles of cost accounting. Therefore, the idea of the Economic Activity Function (EAF) is derived from cost accounting, from its algebraic description. In this description we can find all the necessary variables, and the data from the financial statements become an indispensable source of information.

METHODOLOGY

The starting point for developing the Economic Activity Function (EAF) is to represent the production process in realization prices as a function of production costs:

$$P = S + Z \tag{1}$$

where: P – value of manufactured products in a given year at realization prices, S – cost of manufactured products, Z – gross profit in the current reporting period.

If we take the cost (S) out of parentheses on the right side of the equation, we get the equation:

$$P = S\ (1 + Z/S) = S\ (1 + z) \tag{2}$$

where: z – cost-effectiveness (Z/S).

The magnitude of z = Z/S represents cost-effectiveness and in the literature (Goronzy, 1968; Certo, Kalm, LePine, 2020) is presented as a function of two variables: return on assets (ROA = Z/A) and a ratio that determines the turnover of assets relative to costs (A/S).

In turn, costs of manufacturing products (S) include W – labour costs and B – other (non-labour) costs, provided for by technology and the management process, so the above equation takes the form:

$$P = (W + B)\ (1 + z) \tag{3}$$

Taking the labour cost variable W out of parentheses, one gets:

$$P = W(1 + B/W)\ (1 + z) \tag{4}$$

As is well known, asset turnover is represented by the magnitude of S/A, from which can be derived the formula for asset turnover relative to non-wage costs:

$$b = B/A \tag{5}$$

where: B – non-wage costs, b – asset turnover ratio relative to non-wage costs.

This is how the amount of consumption of assets in relation to costs, less the amount of wage costs, is obtained. Then the variable B = bA, and formula (4) takes the form:

$$P = W(1 + bA/W)\ (1 + z) \tag{6}$$

where: A – assets at historical prices.

Labour costs W are derived from the human capital of the employed. M. Dobija presents a detailed study in this regard. He was the first to emphasized (Dobija, 1998) that the rate of return known for the profits made on the stock market (8%) should also apply when settling accounts with employees (the concept of a fair wage based on the value of the human capital of the employed applies here). M. Dobija concluded that the employer should pay the same percentage on the use of the employee's capital that applies as the average rate of return on investments, i.e. 8%.

Accordingly, in the algebraic treatment of company costs in the part of presenting the general wage fund, on the grounds of the fair wage model (Dobija, 1998; Renkas, 2022), the value of a = 0.08 [1/year] has its original application. Namely, using the relationship that N = aH (where: N – the total amount of accrued base wages for

the employees of the enterprise, a – the percentage of payment of human capital of employees at 0.08 [1/year], H – the value of the employee's human capital) and W = uH (where, W – the total fund of accrued wages in the enterprise (including bonus wages), u – the general percentage of payment of human capital), after appropriate substitutions in the denominator of equation (6), the formula (7) is obtained:

$$P = W(1 + bA/uH)\ (1 + z) \tag{7}$$

The difficulty of estimating the H variable can be avoided by calculating it from the transformed formula H = N/a. In this case, the value of the variable H can be measured using reporting data, which includes information on the basic wages of employees (N). As a result of converting the H variable into the N/a figure, the production model looks as follows:

$$P = W(1 + bAa/uN)\ (1 + z) \tag{8}$$

Using in turn the approximate equation: $1 + x \approx e^x$, the Economic Activity Function of the enterprise is derived from equation (8):

$$P = W(1 + bAa/uN)\ (1 + z) \cong W\ e^{bAaz/uN} = WQ \tag{9}$$

where: $Q = e^{bAaz/uN}$ and represents itself an unmeasured quantity, determining the level of labour productivity in the company.

The quantity Q is labour productivity, under which is understood the labour cost multiplier, determining the value of production. At the same time, it is the value of production, per unit of labour costs (Q = P/W). It is a function of a number of important variables that are well known in productivity management theory. This quantity at the macro level (Q = GDPR/W, where: GDPR – real GDP, W – wage fund in the economy) is also applicable to exchange rate theory (Jedrzejczyk, 2013). The parity of labour productivity determines the real exchange rate, and the disparity determines the need to take into account the size of Q in conversions. Also, the size of Q at the macro level has found wide application in the theory of integrating currency areas (Dobija, 2014).

In turn, the Economic Activity Function presented above finds its important application in the management of wages in the enterprise. A particularly important part of this management is the analysis and evaluation of the impact of labour productivity and the level of management in the enterprise on the formation of the size of employee compensation. For this purpose, it is necessary to carry out some transformations. Based on the Economic Activity Function (9), a production model is introduced with a synthetic Management Index M:

$$P = W\ e^{bAaz/uN} = W\ e^{AMa/N} \tag{10}$$

where: M – synthetic index determining the level of management.

The index M integrates the influences of all the previously presented variables related to decision-making. Namely, these are the variables of asset turnover (b), level of paid labour (u) and profitability (z). These variables are directly related to the day-to-day decisions of the business unit's management, so they add up to the Management Index M = M(b,u,z). This index can be determined based on information from the company's reporting system. This system generates the necessary data for its measurement.

Accordingly, the following relationships are obtained:

$$P = WQ = W\, e^{AMa/N} = W\, e^{TM} \tag{11}$$

where: T – labour equipment index.

The placement of the magnitude A in the exponent of a power indicates the enormous impact of assets on the impact of minimum action management. A similar effect is exerted by the Management Index M. On the other hand, the labour cost variable W refers to the magnitude a = 0.08 [1/year] and should not be set arbitrarily. The important fact is that the above model makes it possible to determine the real level of use and remuneration of human capital in the enterprise.

As a result of appropriate transformations of the EAF model, formulae are obtained for determining the Labour Productivity Index Q, the Management Index M and the general fund for the payment of labour in the enterprise (W) as a function of the data characterising the economic performance of the enterprise, as well as the bonus fund in accordance with the results obtained:

$$M = \frac{N ln Q}{Aa} \tag{12}$$

$$Q = \frac{P}{W} \tag{13}$$

$$Q = \frac{P}{W} \tag{14}$$

where: P – products produced for the year at realisation prices, A – carrying value of assets, M – management index, N – total amount of basic wages, W – total wage fund in the enterprise (W = N + hN), h – bonus as a percentage of basic wages.

As is well known, the structure of remuneration in an enterprise most often consists of a basic remuneration (remuneration set as payment for work performed in accordance with established labour standards) and additional, bonus remuneration (for work performed above the established standards), which depends on the financial results achieved by the enterprise. The size of the bonus

remuneration, as a forecast amount for the next year, can be calculated on the basis of the Economic Activity Function (EAF) presented above. This model makes it possible to determine the real level of usage and payment of human capital in the production process and also makes it possible to estimate and predict the size of the bonus fund, which is subject to distribution among employees in accordance with the bonus system established in the enterprise.

The total wage fund (W), and therefore the fixed and variable part of it, can be represented by the following formula:

$$W = uH = aH + hH \tag{15}$$

where: W – the total wage fund in the enterprise, u – the actual level of labour payment (u = a + h), a – fixed magnitude (0.08 [1/year]), h – the percentage of premium (bonus as a percentage of basic wages), H – the value of human capital of employees.

RESULTS

Using the above formula and the presented model of the Economic Activity Function, we will present an example of the process of analysing and evaluating the level of labour payment, planning the level of wages, measuring the level of Management Index M and Labour Productivity Index Q in a model manufacturing enterprise. The formula for labour productivity shows that its level is influenced by three basic factors: the value of assets, the level of wages and the Management Index M. The ratio of the value of assets to the value of human capital expresses the level of technical armament of labour. From the point of view of the decision-making process, the influence of management on the level of wages in the company is fundamental. If other factors remain unchanged (e.g. the value of assets), a corresponding increase in the level of wages will reduce the Labour Productivity Index and vice versa.

Therefore, an important condition for improving labour productivity in an enterprise is an increase in the level of management, which is expressed by the Management Index M. Although not in every case the increase in the level of Management Index M leads to an increase in the Labour Productivity Index Q, since it also depends on other factors (for example, on the value of assets). It is also worth noting that when analysing individual companies, we are dealing with different economic conditions of labour productivity. In a more thorough analysis, it is worthwhile to examine not only the magnitudes of individual variables, but also to analyse their significance.

Based on formulas (12), (13) and (14), Table 1. Calculation of Management Index M, Labour Productivity Index Q, and level of labour payment based on sample

financial data presents sample calculations of Management Index M and Labour Productivity Index Q based on the financial data of a sample company, along with a forecast for the next year. On the basis of the obtained indexes, the planned percentage of bonuses in relation to base wage in the following year was also calculated.

Table 1. Calculation of Management Index M, Labour Productivity Index Q, and level of labour payment based on sample financial data

Financial data	2023	2024
Realized production (P)	64,125,000.00	65,030,000.00
Value of assets (A)	56,904,000.00	56,936 000.00
Basic wage (N)	9,552,000.00	9,576,000.00
Labour payment fund (W)	11,011,000.00	11,173,540.00
Management Index (M)	3.70	3.70
Labour Productivity Index (Q)	5.82	5.82
Percentage of premium, [%]	15.27	16.68
Bonus wage	1,459,000.00	1,597,540.00

Source: own study.

The last column of Table 1. Calculation of Management Index M, Labour Productivity Index Q, and level of labour payment based on sample financial data shows the planned budget for the next year. The plan includes a few percent increase in production along with a small increase in costs. The Management Index M is not expected to decrease, as it includes profitability and asset turnover. Achieving the projected financial results will pay a bonus of 1,597,540, which is 16.68% on the amount of base wages. This bonus is a good incentive for employees to meet the projected budget. Such motivation will promote increased labour productivity in the future. Also important is the fact that in this way several variants of the development of the financial situation in the enterprise can be predicted.

The Economic Activity Function (EAF) presented above was used for analyse the financial data of Komfort-Eko Ltd. This enterprise is located in Rivne (Ukraine) and is engaged in the production of filters for wastewater treatment plants and their installation. Also, Komfort-Eko Ltd. provides various construction services. Table 2. Results of calculations of Management Index M, Labour Productivity Index Q and level of labour payment for Komfort-Eko Ltd. presents the results of calculating the Management Index M, Labour Productivity Index Q and the level of labour payment, which were determined on the basis of the data of the company's financial statements for 2022. For comparison, and in order to draw important conclusions about the management of Komfort-Eko Ltd., the next column shows the results of the calculation of individual variables for the year 2023.

Table 2. Results of calculations of Management Index M, Labour Productivity Index Q and level of labour payment for Komfort-Eko Ltd.

Financial data	2022	2023
Realized production (P), [UAH]	9,582,500.00	11,630,000.00
Value of assets (A), [UAH]	5,105,900.00	5,310,200.00
Basic wage (N), [UAH]	342,200.00	380,700.00
Labour payment fund (W), [UAH]	369,952.00	427,260.00
Management Index (M)	2.73	2.96
Labour Productivity Index (Q)	25.90	27.22
Percentage of premium, [%]	8.11	12.23
Bonus wage, [UAH]	27,752.00	46,560.00

Source: based on Komfort-Eko Ltd. financial statements.

The information presented in Table 2. Results of calculations of Management Index M, Labour Productivity Index Q and level of labour payment for Komfort-Eko Ltd. shows that in 2023 the company achieved an increase in the Management Index M. This shows that the level of management improved, which translated into better financial results. It is important to highlight the fact that the EAF model helps to show that it was the improvement in management performance that contributed to the better results and not, for example, a significant increase in the scale of production. In other words, we are not observing a quantitative improvement, but a qualitative one. This has also contributed to an increase in the Labour Productivity Index Q.

Achieving the results shown in Table 2. Results of calculations of Management Index M, Labour Productivity Index Q and level of labour payment for Komfort-Eko Ltd. in 2023 allowed to manage the bonus fund in the amount of UAH 46,560. This serves as an additional incentive for employees to achieve the company's goals for the following year. This example confirms the usefulness of the presented EAF model in the analysis of future scenarios of the company's financial development. In turn, trend analysis of the change in the Management Index M makes it possible to assess the effectiveness of management decisions.

Discussion, limitations and directions for further research

Using the Economic Activity Function (EAF), it is possible to analyse the level of the Management Index M and the labour remuneration system in each enterprise. These formulae express a general relationship: the higher the level of Labour Productivity Index Q in a unit, and if the upward trend of Management Index M is maintained, the higher the level of labour remuneration.

Comparing the above formal description of production with existing models of production and economic growth, such as those developed by J. Robinson (1953), R.G. Wright, W.A. Ruch and R.F. Gonzalez (1975), Y.M. Ebadi and R.J. Paul (1985) and others, it can be seen that the model presented is not one-dimensional, as the formula P = WQ might suggest. Paul (1985) and other authors, it can be confirmed that the model presented is not one-dimensional, as the formula P = WQ might suggest, since the Labour Productivity Index Q is a function of several variables, namely the technical equipment of the labour force (A/H), the turnover of assets, the return on assets (ROA) and the level of labour compensation. This leads to the presentation of the Labour Productivity Index Q as a synthetic measure for evaluating a company's operations, as indicated by the formula quoted above.

Since the level of compensation is inversely proportional to Q, the premise that the Labour Productivity Index Q cannot fall sets a limit to the increase in the wage bill. Therefore, the size of the total wage fund, as well as bonus wages, in an economic unit is determined by (and dependent on) the achieved level of the Labour Productivity Index Q or the management index M. The economic activity function clearly confirms the links between these indices in the labour process. The Labour Productivity Index Q can be increased by improving the technical equipment of labour (A/H) and by increasing the efficiency of management (variables b and z).

Particularly noteworthy is the variable u, which reflects the level of labour remuneration in the enterprise. The analysis of the economic activity function presented shows that a slight increase in the Labour Productivity Index Q can be achieved as a result of a reduction in labour costs. However, this will immediately lead to a decrease in demand (Say's law) and then it will already be more difficult to maximise asset turnover and the market rate of return z. In addition, it is worth noting the placement of the indicator of the level of labour compensation (u) in formula (9). This variable appears in the numerator, since W = uH, and in the denominator. This indicates the existence of its optimal size. This fact is already known from the thermodynamic theory of human capital, according to which a worker's basic wage should not be less than 8% of the value of his individual human capital (Renkas, 2022). Therefore, the question of a fair wage level requires an appropriate theory, in particular one based on the human capital account. The basic thesis in this case is the correspondence between the level of remuneration of labour and the value of its performance.

The above examples do not exhaust the possibilities of carrying out the various types of financial simulations allowed by the model of the Economic Activity Function presented. Moreover, it is even advisable to prepare several alternative scenarios that will allow the most favourable course of action to be chosen.

The possibility of forecasting provided by the concept of the economic activity function and the awareness of the existence of the magnitude a = 0.08 [1/year] is conducive to the expansion and improvement of the system of employee motivation in the company. It makes it possible to carry out an analysis of future scenarios of the development of the financial situation and to present the size of the bonus fund depending on the degree of implementation of the established plan. It also allows continuous monitoring of the trend in the change of the Management Index M, which indicates the effectiveness of the actions and decisions taken by management.

Of course, the Economic Activity Function (EAF) model presented has limitations that need to be taken into account in its practical application. First, in its current form, the model does not take into account possible changes in external economic conditions, such as inflation, changes in the labour market or global financial crises. It is applied to a stable economic unit that is not currently exposed to a crisis situation. In addition, the model is based on the assumption that an increase in the Labour Productivity Index Q and the Management Index M automatically leads to an increase in wages, which may not always reflect market reality, where other factors such as remuneration policy or socio-political factors may start to have a greater impact on wage levels.

Also, the approach to the Labour Productivity Index (Q) as a function of several variables (technical equipment of the workforce, turnover of assets) may lead to some simplifications that are not always accurate for certain industries where other indicators may be more relevant.

Further research could focus on developing the model of the economic activity function with additional variables that better capture the complexity of modern enterprises. Examples include variables related to new technologies, automation and the digitalisation of work, which have a significant impact on the Labour Productivity Index Q and the Management Index M.

In addition, research may focus on the inclusion of non-standard forms of employment and flexible remuneration systems in the model to better adapt it to modern economic conditions. An analysis of the impact of macroeconomic factors, such as inflation or monetary policy, on the relationships represented in the model could provide valuable insights into labour cost management.

It would also be worthwhile to carry out empirical studies to verify the application of the model in different sectors of the economy. Comparing the effectiveness of the model in companies with different technological levels and in different phases of the business cycle could provide new data on the effectiveness of the Management Index M and the Labour Productivity Index Q.

A further step could also be to develop the theory of fair pay based on the human capital account and test it in practice in different companies to confirm its effectiveness in increasing employee motivation.

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FinTech as a key factor in financing SMEs growth in the digital age[3]

Abstract

This article examines the role of financial technology (FinTech) in addressing the challenges faced by small and medium-sized enterprises (SMEs) in accessing finance. It begins by examining the historical context of financial innovation and its impact on economic growth and stability. The financial crisis of 2007–2008 highlighted the need for alternative financing solutions, leading to the emergence of FinTech as a disruptive force in the banking sector. The article discusses the various barriers to SME finance, including high costs, information asymmetry and lack of collateral, and how FinTech solutions have addressed these challenges. Through the application of digital financial services and innovative business models, FinTech has facilitated faster, easier and cheaper lending and capital raising processes for SMEs. It has also reduced information asymmetry through the use of alternative data sources and advanced analytics. The article also highlights the role of large technology companies in providing digital financial products and services, alongside traditional financial institutions and FinTech startups. In addition, it emphasises the wider impact of FinTech on SMEs, including improving operational efficiency, facilitating international expansion and fostering

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innovation. Overall, FinTech is presented as a critical enabler of SME growth and economic development in both domestic and international markets.

Keywords: FinTech, innovation, SMEs, growth, digital economy.

FinTech jako kluczowy czynnik finansowania rozwoju MŚP w erze cyfrowej

Abstrakt

Niniejszy artykuł analizuje rolę technologii finansowej (FinTech) w rozwiązywaniu wyzwań stojących przed małymi i średnimi przedsiębiorstwami (MŚP) w zakresie dostępu do finansowania. Rozpoczyna się od zbadania historycznego kontekstu innowacji finansowych i ich wpływu na wzrost gospodarczy i stabilność. Kryzys finansowy z lat 2007–2008 uwypuklił potrzebę alternatywnych rozwiązań finansowych, co doprowadziło do pojawienia się FinTech jako przełomowej siły w sektorze bankowym. W artykule omówiono różne bariery w finansowaniu MŚP, w tym wysokie koszty, asymetrię informacji i brak zabezpieczeń, a także sposób, w jaki rozwiązania FinTech sprostały tym wyzwaniom. Dzięki zastosowaniu cyfrowych usług finansowych i innowacyjnych modeli biznesowych, FinTech ułatwił szybsze, łatwiejsze i tańsze procesy udzielania pożyczek i pozyskiwania kapitału dla MŚP. Zmniejszyła również asymetrię informacji dzięki wykorzystaniu alternatywnych źródeł danych i zaawansowanej analityki. Artykuł podkreśla również rolę dużych firm technologicznych w dostarczaniu cyfrowych produktów i usług finansowych, obok tradycyjnych instytucji finansowych i startupów FinTech. Ponadto podkreślono szerszy wpływ FinTech na MŚP, w tym poprawę wydajności operacyjnej, ułatwienie ekspansji międzynarodowej i wspieranie innowacji. Ogólnie rzecz biorąc, FinTech jest przedstawiany jako kluczowy czynnik umożliwiający wzrost MŚP i rozwój gospodarczy zarówno na rynkach krajowych, jak i międzynarodowych.

Słowa kluczowe: FinTech, innowacje, MSP, wzrost, gospodarka cyfrowa.

JEL: G23, G28, O16.

Introduction

Innovation is undoubtedly the driving force behind modern economies. It touches all aspects of their functioning, including the financial sector. Financial innovation in the digital age is known as FinTech and refers to an ever-growing segment of the market. Financial technology refers to the use of technology to deliver financial services and products to consumers. This can refer to banking, insurance, investment, in fact anything to do with finance. According to Allied Market Research, growth in online banking and mobile platforms will generate $110.57 billion in 2020 and is expected to reach $698.48 billion by 2030, growing at a compound annual growth rate (CAGR) of 20.3% from 2021 to 2030. However, the success of FinTech among individuals – consumers – is not the whole story. Businesses, especially SMEs, are also adopting FinTech, and the main role they seem to be fulfilling is to bridge the equity gap that is so characteristic of this business sector. This article aims to provide an insight into the impact of

digitalisation and FinTech solutions on the functioning of small and medium-sized enterprises.

Innovation in economic theory

Innovation in economic theory has been the subject of many academic studies. One of the most frequently cited authors is Schumpeter, in whose theory profits resulting from the creativity and innovation of entrepreneurs should be regarded as the basic factor in the development of capitalism, and the theory of economic growth built by Schumpeter introduced innovation into the group of factors influencing economic growth and microeconomic choices (Schumpeter, 1934). The essence of Schumpeterian innovation is non-innovation (as opposed to imitation, which involves the diffusion of innovation) (Marcinkowska, 2012).

The strand of innovation research that seeks to link innovation, competitiveness and growth is relevant to this thesis. Based on Schumpeter's theory of growth, Aghion *et al.* (2013) reflect, among other things, on the relationship of the inverted U-function between competition and growth identified by Schumpeter. This theory suggests that in an environment with low levels of competition, innovation implies less growth than when competition is high. This level of concentration was confirmed by Apergis *et al.* (2016) in a study of EU bank panel data from 1996 to 2011, which concluded that the EU banking sector has a pattern of monopolistic competition due to the mergers and acquisitions that have taken place since the 2008 crisis. This view was also highlighted by Bos *et al.* (2013), who studied the US banking sector to understand the relationship between competition and innovation. Through the model used, these authors positively verified the relationship represented by the inverted U. This had to do with the concentration of capital in US banks, which led to a decline in competition and actually reduced the level of innovation. This is particularly relevant as financial markets have become increasingly concentrated, reducing the level of competition. In this case, innovation brings lower levels of growth because innovators are likely to have fewer incentives to act, banks will be unwilling to invest in innovation (Marecki, Wojcik-Czerniawska, 2021, p. 285).

Based on Schumpeter's theory, Michalopoulos *et al.* (2009) developed a model that explains the joint evolution of financial and technological innovation. This duo is a consequence of the organisational development of firms and the emergence of stakeholders other than the entrepreneur. According to the researchers, growth is a consequence of the entrepreneur's decision, but it is supported by his continuous collaboration with financiers. This means that innovators introduce new processes and products because they are forced to do so by financiers. Successful financiers will be in the best position to assess the progress of an in-

novation but will only be interested if the financial innovation in question allows for a monopoly ration. The authors of this study concluded that as innovation becomes naturally obsolete, "technological innovation and economic growth will grind to a halt if financiers do not innovate" (Michalopoulos et al., 2009, p. 36).

Innovation in financial services of the digital economy – FinTech

Financial innovation in the traditional sense has been the subject of research by Lerner and Tufano (2011), who in their paper identified a historical view of innovation, listing interest rates and Eurobonds among financial innovations. On the other hand, the benefits and risks of innovation in the banking sector were examined by Beck *et al.* (2016). Using data from 32 countries between 1996 and 2010, the authors found that innovation was associated with both faster growth and volatility, as well as poorer performance. The literature also includes studies on the impact of the financial crisis on innovation. The author of the study (Thakor, 2011) states that "first, the more competitive the financial system (the lower the cost of entry), the stronger the incentives for financial innovation and the greater the amount of innovation. Second, the more innovative the financial system, the more vulnerable it is to financial crises" (Thakor, 2011, p. 144). A reference to Schumpeter's inverted U theory can be found here.

In turn, financial innovation (and in particular innovative post-derivative instruments) became the prime 'suspect' in the 2007–2008 financial crisis (Barre, Davis, 2008).

Innovation is seen as a driver of competitiveness for firms and economies. The development of information and communication technologies (ICTs) has helped to transform economic models and improve the quality of life around the world (Huynh et al., 2020). The 21st century is the age of ICT development. The Internet is growing and new solutions are emerging: cloud computing and mobile platforms. The digitalisation of business processes and operating models was considered one of the most effective ways to transform the international market even before the emergence of COVID-19 (Kotarba, 2018).

There is no doubt that it was the financial crisis of 2007–2010 that became the executioner of Schumpeter's 'creative destruction' in financial markets. Confidence in the banking sector declined. At the same time, confidence in the 'wisdom of the crowds', i.e. in platform solutions and the companies using these solutions, has grown. The financial innovations of banks and other financial institutions became less important (and were seen as less innovative) than those of companies such as Amazon, Google or Facebook. A report by the World Economic Forum (WEF, 2017) showed that banks lag significantly behind technology giants in the development of technologies such as cloud computing, artificial intelligence

and big data analytics. Digital technologies, including blockchain, have become the cornerstone of modern innovation in finance (Wojcik-Czerniawska, 2022).

The financial crisis caused problems with access to capital, due to restrictions on lending and investment by banks and traditional sources of funding. These restrictions resulted from a combination of bank-led decisions, new and stricter regulations (such as Basel II and III), and a decline in new investment from both companies and individuals. However, there was still a need for capital.

The continuing rapid development of digital and, in particular, mobile digital technologies has created a number of new opportunities for the financial sector. The new services and solutions for the financial sector have come to be known as FinTech. FinTech is: "a field or sector resulting from the symbiosis of digital platforms and artificial intelligence in financial services, generally at odds with traditional financial services" (Lacasse et al., 2016, p.1). In the literature, FinTech is referred to as a 'digital ecosystem', combining artificial intelligence (AI), the Internet of Things (IoT), digital platforms and the Wi-Fi generation. This new ecosystem is the birthplace of new payment and remittance solutions, deposits and loans, and new forms of currency (cyber and virtual). Lacasse *et al.* (2016) conclude that fintech solutions will have a significant impact on the transformation of financial services. The Financial Stability Board (FSB) defines FinTech as financial innovation enabled by technology that can have a significant impact on financial markets and institutions. Innovation can result in new business models, applications, processes or products used in the delivery of financial services (Marecki, Wójcik-Czerniawska, 2020).

Digital transformation has undoubtedly had significant implications for the banking sector. Sharma (2015) outlines the key challenges associated with the digital solutions being implemented. The author lists the following:

– the regulatory environment, which requires companies to change their IT solutions to comply with regulations;
– higher consumer expectations, as new technologies have increased their demand for better, faster and cheaper services;
– lower risk appetite as a direct result of the crisis;
– the development of the FinTech sector, with new business models and large players forcing banks to respond.

This assessment of the impact of digital transformation on the banking sector confirms the assumptions of the Shumpeterian idea of 'creative destruction'. It shows that new technologies at the service of human innovation are building a new era for financial services.

At its core, FinTech is being used to help businesses, entrepreneurs and consumers better manage their financial operations, processes and lives through the use of specialised software and algorithms.

Table 1. Taxonomy and classification of Fin Tech companies

Category	Fintech sector/ business model	Sub-sectors/business models included in each sector
1	*2*	*3*
Retail sales (consumers, households, SMEs)	Digital loans	P2P/business loans (off-balance sheet), P2P/consumer loans (off-balance sheet), P2P/real estate loans (off-balance sheet), on-balance sheet business loans, on-balance sheet consumer loans, on-balance sheet real estate loans, cash advances to customers or buy now/pay later, debt securities/bonds, invoice trading, cash advances to merchants and community microfinance
	Digital capital raising	Equity crowdfunding, real estate crowdfunding, revenue/profit sharing crowdfunding, donation-based crowdfunding, rewards-based crowdfunding and community shares.
	Digital payments	Digital remittances (cross-border P2P[4]), digital transfers (domestic P2P), money transfers (P2P, P2B[5], B2P[6], B2B[7]), e-money issuers, mobile money, merchant acquiring providers, access points (PoS[8], mPoS[9], online PoS), bulk payment solutions, top-ups, payment gateways and aggregators, payment API centres and clearing and settlement providers.
	Insuretech	Usage-based insurance, performance-based insurance, on-demand insurance, claims and risk management solutions, comparison portals, customer management, digital brokers or agents, IoT[10] (including telematics), P2P insurance and technical service providers (TSPs).
	Digital banking and savings	Neobank / fully digital native bank, marketplace bank, digital micro-savings solutions, digital money market / fund, agency banking (cash deposit and withdrawal services), banking as a service (BaaS) and savings as a service (SaaS).
	Wealthtech	Digital wealth management, financial comparison sites, retirement planning, personal finance management/planning, robo-advisors and social commerce
	Exchange services	Central order exchange, decentralised exchange models (dex), derivatives platforms, institutional brokerage services, OTC[11] services, P2P markets, retail brokerage services and trade automation.
	Digital storage	Co-managed trust services, e-money wallets, hardware cryptocurrency wallets, hosted cryptocurrency wallets, external trust services and non-hosted cryptocurrency wallets.

[4] P2P – peer-to-peer.

[5] P2B – person-to-business.

[6] B2P – business-to-partners – B2P refers to the business interactions and transactions that occur between companies and their partners or affiliates.

[7] B2B – business-to-business.

[8] PoS – Point of Sale.

[9] mPoS – mobile Point of Sale.

[10] IoT – Internet of Things.

[11] OTC – over-the-counter.

1	*2*	*3*
Market supply	Sharing technology with businesses	API12 management, digital accounting, electronic invoicing, blockchain in the enterprise and financial management and business analytics.
	Regtech	Profiling and due diligence, risk analysis, dynamic compliance, regulatory reporting and market monitoring.
	Alternative credit and/or data analysis	Alternative credit rating agency, credit scoring, biometric analysis, psychometric analysis and sociometric analysis
	Digital identity	Security and biometrics, KYC13 solutions and fraud prevention and management

Source: (CCAF, World Bank and World Economic Forum, 2022, p. 24).

SMEs and digital technologies

The main benefit of the development of digital technology is to streamline the production process and increase productivity (Karim et al., 2022). In addition, digital technology as a source of information and communication in the current era has increased the dependence on technology for all human activities (Wiyono, Kirana, 2021). The adoption of digital technology is strongly correlated with global financial growth. Digitalisation plays a key role in managing business stability and creditworthiness. Digital resources can be an effective tool for managing business processes. Especially after months of government support for businesses during the COVID-19 pandemic, it is clear that there must be a broad plan to implement consistent digital technologies in SMEs to level the development playing field for businesses of all sizes (Gudovskaya, Linin, 2021). Fintech plays a leading role in the fourth industrial revolution, which integrates new technological developments into business processes and changes the way modern companies operate.

There is no doubt that the main pain point for small and medium-sized pre-enterprises, which hinders their creation, growth or viability, is the problem of access to finance. SMEs most often choose internal funds or loans from friends and family as a form of financing because of the difficulties in accessing loan capital. A survey of SMEs in 135 countries found that access to finance was reported as the most serious obstacle to the day-to-day running of businesses (Ayyagari et al., 2017).

In emerging markets, about 131 million (41 per cent) SMEs suffer from a lack of access to finance. Creating opportunities for SMEs in these markets is one of

[12] API – Application Programming Interface.

[13] KYC solutions – Know your customer (KYC) is the process financial institutions (FIs) use to verify their customers' identities and inform compliance risk assessments. KYC is a foundation of anti-money laundering and countering the financing of terrorism (AML/CFT) compliance in jurisdictions worldwide.

the most important ways to accelerate economic development and reduce poverty. The estimated size of the so-called SME financing gap in developing countries is $5 trillion, or about 1.3 times the value of loans to this group of enterprises.

The supply-side barriers to SME finance, where FinTech solutions have shown the greatest impact in closing the finance gap, are as follows (WBG, 2022):

A. High cost of borrowing and servicing relative to revenue

Traditional methods of SME finance have relied on building strong relationships through face-to-face contact. Coupled with information asymmetries, this increased the unit cost of financing and reduced the ability of SMEs to access finance. In addition, the relatively high transaction costs associated with using capital markets for SME financing (public issuance of securities) meant that these forms of SME financing had to be considered unrealistic in most cases. Loans to these companies are also, by definition, smaller than loans to large companies. In addition, the formal requirements in terms of the underwriting process, operational, legal and credit risk monitoring of a loan are the same for SMEs as for large companies (if not higher). As a result, SME lending is riskier and less profitable for lenders given the smaller loan amounts, higher risk and the same level of formality for each loan.

FinTech solutions aim to facilitate these processes. Automated processes and products using DFS (Digital Financial Services) help to reduce transaction costs and make lending and capital raising much faster and easier by automating customer onboarding, underwriting, due diligence and collections. Products include: receivables financing such as factoring, reverse factoring and trade receivables financing; secured revolving credit lines; and platform financing – P2P lending and equity crowdfunding.

B. Information asymmetry

Information asymmetry, caused by a lack of available financial and credit data, is a major obstacle for SMEs in accessing finance. The lack of available information is traditionally replaced by higher collateral requirements.

Several FinTech solutions have been developed to address the information asymmetry barrier to SME finance. These solutions rely on the use of alternative data sources, big data analytics, artificial intelligence and machine learning to provide additional sources of information for SME credit risk assessment. Information from payment processors (i.e. credit card clearing companies and payment systems), e-commerce platforms and digital banks can also provide data to help measure cash flows and revenues and calculate the SME's ability to repay the loan. The use of these new data sources and advanced analytical techniques has made it possible to provide financing to SMEs that were previously unable to obtain financing from financial institutions.

C. Lack of collateral

Lack of collateral is also a common reason for SMEs' inability to access credit. A modern secured transactions framework has been developed, which allows lenders to develop loan products secured on movable assets owned by SMEs (rather than on real estate as in the past). Several FinTech solutions have emerged to support the introduction and use of movable assets (equipment, inventory, receivables, payment instruments and cash on deposit) as collateral, mainly through asset-based lending products: factoring, reverse factoring, secured revolving credit lines, trade receivables financing and tokenised assets. In addition, the digitisation of platforms to present and record transactions, connectivity to independent sources of information to help verify the existence and eligibility of collateral (i.e. payment processors, tax authorities, bank accounts, etc.), the Internet of Things to help monitor the maintenance, sale and replenishment/replacement of collateral, and smart contracts to automate the settlement of contracts are making asset-based finance products more accessible to both SMEs and financiers.

The impact of FinTech solutions on SME access to finance

Through the application of various technological innovations, digital financial services have become an important enabler for bridging the SME finance gap (SME, 2018). Technological innovations serve as the basis for the development of new business models and digital financial products, which include digital loans and other credit products, as well as raising equity capital through crowdfunding platforms. Digital financial services make the process of lending and raising capital faster, easier and cheaper. In addition, the use of alternative data sources, coupled with big data analytics, artificial intelligence (AI) and machine learning (ML), reduces information asymmetry by providing additional sources of information for assessing SME credit risk. These new data sources and advanced analytics make it possible to provide financing to businesses with no credit history or collateral, which were previously unable to obtain financing from financial institutions. The use of digital documentation, combined with the automation of many processes, helps to register the business and verify its identity, thereby increasing its chances of accessing finance (WBG, 2022).

Digital financial services are typically provided by new players, such as fintechs, large technology companies and neo-banks. However, traditional financial institutions are also starting to offer them. There are hybrid solutions in the market, where banks and other financial organisations partner with FinTech companies to use their products. Although FinTech companies are mainly young players that

have been in the market for less than a decade, large technology companies such as Alibaba, Tencent, Facebook, Amazon and Google are starting to offer digital financial products and services. Compared to FinTech start-ups, the main advantages of large technology companies are their huge customer base and the large amount of customer resources and data available. The availability of digital financial services can also encourage informal businesses to join the formal economy, leading to increased economic activity.

Fintech solutions and digital tools help to remove supply-side barriers and increase access to finance for SMEs.

Table 2 illustrates how fintech solutions address supply-side barriers.

Table 2. Key products facilitating digital finance and financial barriers for SMEs

Fintech solution	Impact	Key barriers/restrictions
1	*2*	*3*
Factoring	Factoring is a financial product that allows a financial institution to provide financing to an SME supplier by purchasing its receivables or invoices ('receivables'). In factoring transactions, the SME supplier is the customer of the financial institution	– No security – Asymmetry of information – High cost of service in relation to revenue
Reverse factoring	Reverse factoring is a financial product whereby a financial institution provides SMEs with immediate liquidity by discounting the liabilities of a large buyer. In reverse factoring transactions, the large buyer is the customer of the financial institution.	– No security – Asymmetry of information
Secured revolving credit lines	Secured revolving lines of credit (known as asset-based lending or ABL – asset-based lending) is a loan product used to provide working capital to mature or advanced SMEs, using their receivables and inventory as collateral.	– No security – High cost of service in relation to revenue
Tokenised assets	Asset tokenisation refers to the process of issuing a blockchain token that digitally represents a tangible or intangible asset, for trading, discounting or financing as collateral	– No security – High cost of service in relation to revenue
P2P/lending market	Peer-to-peer (P2P)/marketplace lending is a business model that uses online platforms to match potential lenders with borrowers. The term marketplace lending is sometimes used to distinguish business models where institutional investors rather than individuals are the lenders. However, the terms are also widely used as synonyms.	– Asymmetry of information – High cost of service in relation to revenue

1	2	3
Equity crowdfunding	The basic premise of crowdfunding is to enable small companies to reach a large number of potential investors and offer investment in their companies. Crowdfunding is made possible by taking advantage of technological advances and regulatory exemptions that reduce the cost of public share issues and increase the promotional potential of offerings.	– High cost of service in relation to revenue
Digitisation of business processes	Refers to the digital transformation of accounting, inventory, purchasing, invoicing, sales and delivery methods, practices and documentation, including the development of customer portals and e-commerce applications.	– Asymmetry of information – High cost of service in relation to revenue
Digitisation of banking processes	It refers to the automation of banking processes from onboarding to marketing, product applications, insurance, risk management, disbursements and servicing. Eliminating manual processes increases self-service rates, reduces processing costs and overall lowers service costs, while reducing errors and enabling the use of customer data across products.	– High cost of service in relation to revenue – Lack of available information
Electronic invoicing	Refers to the digital evolution of invoices that have the same legal force as their paper counterparts but are generated, approved, transmitted, received, rejected or accepted and/or archived or recorded electronically for tax, accounting, billing and commercial or financial purposes	– Asymmetry of information
Digital payments	Refers to transfers of value that are made using digital or electronic data transfer devices and channels. Digital payments include payments initiated by debit or credit card, mobile phone, computer, tablet or mobile digital device	– Asymmetry of information – High cost of service in relation to revenue – No security
Credit risk assessment using alternative data	It refers to the use of alternative data such as mobile phone call records, utility and bill payments, digital payment transactions, social media, industry/sector data and more in the development of credit risk models to assess SME borrowers' willingness and ability to repay.	– Asymmetry of information
E-commerce	Buying and selling goods or services using the internet via computers or other digital devices including mobile. E-commerce levels the playing field for SMEs, enabling them to showcase their products online on a par with larger companies. The platforms provide rich data on cash flow, inventory and business performance of active SMEs.	– Asymmetry of information – High cost of service in relation to revenue

1	*2*	*3*
Open banking	It refers to practices or regulations that aim to make traditional financial institutions share their customers' data (with customer consent) with third parties - including fintech companies - in a secure, standardised way to level the playing field between smaller firms and large financial institutions.	– High cost of service in relation to revenue

Source: (CCAF, World Bank and World Economic Forum, 2022, p. 24).

FinTech in SMEs worldwide

Long underserved by traditional financial services providers, SMEs have new options with the rise of FinTech offerings.

Consumer adoption of FinTech services has increased from 16% in 2015, the year EY's first Global Fintech Adoption Index was published (Ernst&Young, 2017), to 33% in 2017 and 64% in 2019. Over this period, EY has seen waves of innovation, including new ways to make payments, manage money and access finance. EY now measures 19 different offerings to customers, up from 10 in 2015.

As FinTechs expand their offerings, they are maturing as businesses, expanding their global reach – and spurring new competition. As FinTech technology continues to grow in popularity, banks, insurers and financial institutions are responding with FinTech offerings of their own.

In a 2019 report. E&Y presented the results of a study on the use of FinTech solutions by SMEs (Ernst&Young, 2019). FinTechs are now offering a range of innovative services to SMEs. They are using FinTechs to address their financial needs, including securing working capital, hedging currency risk and managing cash flow.

The report (Ernst&Young, 2019) presents the results of a study in five countries – two developed markets (UK and US) and three emerging markets (China, Mexico and South Africa). Among these countries, China leads the way with a 61% adoption rate of FinTech solutions in SMEs, followed by the US with 23%. The other three countries are the UK (18%), South Africa (16%) and Mexico (11%).

For the purposes of the survey, SME adopters of FinTech solutions were defined as companies that had used FinTech services in the last six months in all four categories:

– banking and payments
– financial management,
– financing
– insurance.

The global adoption rate is 25%, leaving plenty of room for growth.

One reason to expect a rapid increase in FinTech adoption by SMEs is their willingness to share data. Seventy per cent of MSPs are willing to share their banking data selectively and securely with other financial services companies if it would help them get a better deal. By comparison, only 46% of consumers are willing to share data in such circumstances.

This willingness of SMEs to share data creates significant opportunities for FinTech companies to develop products based on open APIs. Open APIs are at the heart of the open banking phenomenon in markets around the world.

In the UK, which introduced open banking in 2018, 94% of SME FinTech companies are willing to share data with other financial services companies, and 63% are willing to share data with non-financial companies if it means gaining access to a better offer. This suggests that the efficiencies created by open banking in the SME sector are significant, with products and services based on open APIs bringing real value to SMEs in the UK (Ernst&Young, 2019).

Many FinTechs in the UK are using open banking and open data to serve their SME customers in a personalised and timely way, helping them to understand, manage and grow their businesses. FinTechs offering financial management services can use open banking data to provide rich insights into the cash flow and financial health of SMEs.

Many SMEs are already accustomed to digital data-sharing, such as sending their financial information to a cloud accounting provider. With the proliferation of open APIs, providers can more effectively offer a range of services to SMEs, such as overdraft protection, bookkeeping, expense management, factoring and supply chain management.

Open APIs stimulate the development of new financial management tools. For example, fintechs can provide SMEs with the ability to dynamically and automatically hedge the currency risk of a transaction directly at the point of sale (Wojcik-Czerniawska, 2019).

Open APIs can make it much easier for SMEs to access credit. With access to open data, lenders – whether they are established banks or FinTech companies – can make informed decisions quickly, in some cases reducing the 'time to answer' and 'time to cash' for an SME loan to just a few minutes. In the UK, we see various product marketplaces, as well as standalone offerings, using open banking to 'turbo-charge' the implementation and underwriting processes. The aim is to provide faster and better access to credit for SMEs.

Unlike consumers, who often choose fintechs based on attractive rates and fees, SMEs are more interested in features and functionality (Ernst&Young, 2019). When asked to list the top three reasons why they would choose a FinTech over a bricks-and-mortar financial institution, 66% globally cited breadth of

functionality and features, 55% cited 24/7 service availability, and 54% cited ease of setting up and using the service. In contrast, 39% cited rates and fees as one of the most important factors. The top three global drivers for SMEs to adopt FinTech solutions are also the same in the UK market.

Summary

Technological disruption is becoming increasingly common. Digitalisation, one form of this disruption, is impacting businesses in a myriad of unpredictable ways, enabling them to be more flexible and adaptable. Through fintech – the delivery of financial services through various forms of technology – businesses are equipped with the tools and services they need to grow and expand internationally. Fintech helps in two main ways – reach and connectivity – by increasing 'mobility and agility'.

Technological innovation in financial services (FinTech) is changing the way consumers think about financial products. FinTech can support economic growth and reduce exclusion in access to financial services. FinTech plays an incredibly important role in the SME ecosystem. First and foremost, it provides them with access to finance: Fintech offers new ways for SMEs to raise capital through crowdfunding platforms, peer-to-peer lending or online factoring. This in turn enables them to grow faster, invest in innovation and increase production or employment. Improving access to finance supports economic growth by stimulating business activity. FinTech technologies can also improve the operational efficiency of SMEs by automating accounting processes, managing payments or analysing data. This saves them time and money, allowing them to focus on growing their business and introducing innovative products and services. FinTech opens up new commercial opportunities for SMEs, both in domestic and international markets. E-commerce platforms, payment solutions or online accounting make it easier for businesses to expand into new markets, contributing to increased turnover and economic growth. The implementation of modern FinTech solutions allows SMEs to adapt more quickly to market changes and create innovative products and services, and can also help to increase customer confidence in SMEs by providing greater transparency in financial transactions and better data protection.

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Investment method in the Mexican pension system: consequences for economic growth and social inequalities

Abstract

The aim of the article is to present and analyze the application of the investment method in Mexico's pension system and to assess its impact on economic growth, financial stability, social inequalities, and the level of pension benefits. Specifically, the article discusses how the diversity and efficiency of investment strategies implemented within the investment method by AFORE pension funds influence economic outcomes and social disparities. By comparing the investment performance of Mexican pension funds with international benchmarks, the study explores how effective asset management contributes to economic growth through capital accumulation and impacts inequalities by affecting retirement income distribution. The pension reform in Mexico, introduced in 1997, shifted the system from a pay-as-you-go to a defined contribution model managed by private funds (AFORE). While high investment returns can promote economic growth and reduce social inequalities by enhancing pension adequacy, poor investment decisions pose risks of financial instability, potentially exacerbating income disparities among retirees. Using empirical data, the article evaluates the effectiveness of the investment method used by AFORE in achieving balanced economic and social outcomes.

Keywords: pension system, investment method, AFORE, Mexico, financial stability.

Metoda inwestycyjna w systemie emerytalnym Meksyku: konsekwencje dla wzrostu gospodarczego i nierówności społecznych

Abstrakt

Celem artykułu jest przedstawienie i analiza zastosowania metody inwestycyjnej w systemie emerytalnym Meksyku oraz ocena jej wpływu na wzrost gospodarczy, stabilność finansową, nierówności społeczne oraz poziom świadczeń emerytalnych. W szczególności omówiono, w jaki sposób różnorodność i efektywność strategii inwestycyjnych realizowanych w ramach metody inwestycyjnej

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przez fundusze emerytalne AFORE wpływa na wyniki gospodarcze i nierówności społeczne. Dokonując porównania wyników inwestycyjnych meksykańskich funduszy emerytalnych z międzynarodowymi punktami odniesienia, w artykule przeanalizowano, jak efektywne zarządzanie aktywami może przyczyniać się do wzrostu gospodarczego poprzez akumulację kapitału oraz wpływać na nierówności społeczne poprzez oddziaływanie na dystrybucję dochodów emerytalnych. Reforma emerytalna w Meksyku, wprowadzona w 1997 roku, przekształciła system repartycyjny w system zdefiniowanej składki zarządzany przez prywatne fundusze (AFORE). Wysokie stopy zwrotu z inwestycji mogą wspierać wzrost gospodarczy oraz zmniejszać nierówności społeczne poprzez poprawę adekwatności świadczeń emerytalnych, jednak błędne decyzje inwestycyjne grożą destabilizacją finansową, mogąc nasilać dysproporcje dochodowe wśród emerytów. Na podstawie danych empirycznych dokonano oceny skuteczności metody inwestycyjnej stosowanej przez fundusze AFORE w osiąganiu zrównoważonych rezultatów ekonomicznych i społecznych.

Słowa kluczowe: system emerytalny, metoda inwestycyjna, AFORE, Meksyk, stabilność finansowa.

JEL: G23, G28, H55, J32.

Introduction

The pension system in Mexico has undergone significant reforms over the past decades, transforming from a defined benefit (DB) system to a defined contribution (DC) system. The key reform occurred in 1997 with the introduction of private pension funds known as *Administradoras de Fondos para el Retiro* (AFORE). This reform aimed to enhance the financial stability of the pension system and adapt it to the country's changing demographic and economic conditions, ultimately influencing economic growth and affecting social inequalities (Martínez, Rodríguez, 2020; OECD, 2019).

The primary objective of this article is to present and analyze the application of the investment method in Mexico's pension system, assessing its implications for economic growth, financial stability, pension adequacy, and social inequalities. Specifically, the article addresses the following issues (Gómez Hernández, González, 2021; CONSAR, 2018):

– The characteristics and application of the investment method by AFORE.
– The efficiency of investment strategies implemented under this method.
– Comparative analysis of Mexican pension funds' investment outcomes with international benchmarks.
– The impact of the investment method on economic growth through capital accumulation and its consequences for income distribution and social inequalities among retirees.

The investment method implemented by pension funds significantly influences the pension system's financial stability and the broader economic environment. High returns achieved through effective management can lead to increased economic growth by generating additional investment capital and potentially

reducing social inequalities through improved pension benefits. Conversely, poor investment decisions carry risks of financial instability, exacerbating economic downturns and deepening income disparities among retirees. Therefore, a detailed understanding and critical evaluation of the investment method applied by AFORE is crucial for identifying balanced strategies that simultaneously promote economic growth and reduce social inequalities (Martínez, Rodríguez, 2020; World Bank, 2023).

The article is divided into several main sections. The first part includes a literature review, discussing previous studies on pension systems and investment strategies. Next, the research methods are described, including data sources and analysis techniques. The research results are presented in the following section, and then their implications and risks associated with investments are discussed. The article concludes with a summary of the main findings and recommendations for pension policy (de Mesa, Mesa-Lago, 2016).

In 1997, Mexico underwent a significant pension system reform, transforming it from a pay-as-you-go (PAYG) system to a system based on individual pension accounts managed by private funds (AFORE). This reform aimed to increase the efficiency of managing pension funds and provide better investment returns for future retirees (Martínez, Rodríguez, 2020; OECD, 2019).

The effectiveness of the pension system largely depends on the investment strategies used by pension funds. High investment returns can significantly increase the value of accumulated funds, which directly translates into higher pension benefits. Therefore, pension funds must employ well-thought-out and effective investment strategies that ensure financial stability and adequate benefits for retirees (Gómez Hernández, González, 2021).

The main objective of this study is to understand the investment methods used by AFORE and their effects. The specific research questions include (Martínez, Rodríguez, 2020; OECD, 2019):

– What investment strategies are used by AFORE?
– What are the investment results of these strategies?
– What factors influence the investment efficiency of pension funds?
– What are the implications of these results for the financial stability of the pension system in Mexico?

The following sections of the article will address these questions through the analysis of empirical data and comparison with other pension systems worldwide.

Literature Review

Pension systems play a crucial role in providing financial security for individuals after they retire from active employment. In the academic literature,

two main types of pension systems are distinguished: defined benefit (DB) systems and defined contribution (DC) systems.

In DB systems, the amount of pension benefits is predetermined and typically depends on the length of service and the level of earnings during the period of active employment (Blake, 2006). The employer bears the investment risk, meaning they are obliged to provide specified benefits regardless of the investment performance of the pension funds. Examples include traditional pension systems in many European countries.

In DC systems, the amount of contributions is fixed, while future benefits depend on the investment performance of the accumulated funds (Barr, Diamond, 2008). The investment risk is borne by the participants, meaning the level of pensions can vary depending on market performance. Examples include the 401(k) systems in the United States or AFORE in Mexico.

Many countries are transitioning from DB to DC systems due to the growing financial burdens associated with aging populations (OECD, 2019). There is an increasing importance of private pension funds as a complement to public pension systems (Holzmann, Hinz, 2005). Financial education is playing a growing role in preparing participants of DC systems to better manage their savings.

Pension reforms worldwide aim to increase the financial stability of pension systems and adapt them to changing demographic conditions. Key reforms include:

– Chilean model: Introduced in 1981, it is based on private pension accounts managed by private funds. This model has become a blueprint for many other countries in Latin America (Soto, 2007).
– Reform in the United Kingdom: In the 1980s and 1990s, personal pension plans were introduced, increasing the role of private savings in the pension system (Barr, Diamond, 2008).
– Reform in Poland: In 1999, a three-pillar system was introduced, consisting of a mandatory public pillar, a mandatory private pillar, and voluntary pension savings (Chłoń-Domińczak, 2002).

In this context, the pension reform in Mexico (1997) involved transitioning from a pay-as-you-go system to a system based on individual pension accounts managed by private funds (AFORE) (Mesa-Lago, 2008). The introduction of *Sistema de Ahorro para el Retiro* (SAR) in 1997 did not eliminate the existing *Seguro de Retiro, Cesantía en Edad Avanzada y Vejez* (RCV). Instead, both systems were designed to coexist and complement each other, providing a more stable pension savings structure for Mexican workers. The reform aimed to increase the efficiency of managing pension funds and provide better investment returns. The reform was a response to the financial problems of the old system, which was burdened with high costs and low efficiency (Tapia, Yermo, 2008).

Pension funds employ various investment strategies aimed at maximizing investment returns while managing risk. These strategies include:

– Investments in equities: Long-term investments in equities can yield high returns but are also associated with higher risk (Dimson, Marsh, Staunton, 2002).
– Investments in bonds: Bonds are more stable and secure but generally offer lower returns compared to equities (Fabozzi, 2007).
– Diversification: Funds seek to diversify their investment portfolios to reduce risk by investing in different asset classes and geographical regions (Markowitz, 1952).
– Alternative investments: Some pension funds invest in real estate, commodities, or hedge funds to further diversify the portfolio and increase returns (Brown, Garlappi, Tiu, 2010).

The literature review shows that the effectiveness of investment strategies depends on many factors, such as global market conditions, monetary policy, and the skills of fund managers (Holzmann, Hinz, 2005; World Bank, 2023).

Studies on the Mexican pension system focus on assessing the effectiveness of AFORE funds and their impact on the financial stability of the pension system. Key findings from the studies include:
– Investment efficiency: Studies indicate that AFORE funds achieve varied investment results depending on the investment strategies and the skills of fund managers (Tapia, Yermo, 2008). Gómez Hernández and González (2021) analyze the investment results of AFORE funds, emphasizing that these funds achieved varied results over the years, with the best results in 2015 and 2017. The authors suggest that investment flexibility and the ability to diversify investment portfolios are key success factors for AFORE funds.
– Investment risks: The risk associated with investments in equities and other more volatile financial instruments can affect the stability of the pension system, especially during financial crises (OECD, 2019).
– Financial stability: A study by Aguila (2011) found that the 1997 reform significantly improved the financial stability of the pension system, although challenges related to the adequacy of benefits remain.
– International comparisons: Comparative analyses show that Mexico's pension system, despite its challenges, is relatively efficient compared to other Latin American countries (World Bank, 2023).

Research Methods

The main aim of this study is to evaluate the effectiveness and impact of the investment method applied by AFORE pension funds in Mexico, focusing particularly on its implications for economic growth and social inequalities. To achieve this goal, the study adopted a mixed-method approach, integrating both quantitative and qualitative analyses. Such an approach enables comprehensive

assessment and deeper insight into the dynamics of pension investments, fund performance, and their broader socioeconomic impacts.

Data Sources and Collection

Quantitative data used in the research includes statistical records on investment performance, asset allocation, and return rates of selected AFORE pension funds spanning the period 2014–2023. Primary quantitative data were obtained from annual reports published by the National Commission for the Retirement Savings System (CONSAR, 2023), supplemented by international datasets from OECD (2023) and the World Bank (2023). These sources allowed for robust comparative analysis and validation of domestic performance indicators against international benchmarks.

Qualitative data comprised document analysis of pension system reports, regulatory guidelines, and policy evaluations published by CONSAR, the OECD, the World Bank, as well as academic literature on pension economics and investment management. This qualitative analysis provided context and explanatory depth, facilitating the interpretation of quantitative findings.

Analytical Techniques

Quantitative analysis primarily employed descriptive and inferential statistical methods. Annual return rates of selected AFORE funds were systematically compared to established benchmarks, allowing for assessment of investment efficiency and relative fund performance. Furthermore, the research applied regression analysis to identify key factors influencing investment outcomes, including asset diversification, fund size, and macroeconomic conditions (such as interest rates and economic growth rates).

Qualitative analysis followed a structured approach to document review, utilizing thematic content analysis to extract critical insights from secondary sources. Particular attention was given to identifying strategic and regulatory factors that influenced fund performance and resilience during major economic disruptions, notably the 2008 financial crisis and the COVID-19 pandemic.

Scope and Limitations

The timeframe selected (2014–2023) was chosen to encompass a period of significant economic volatility, allowing for an evaluation of fund resilience and adaptive strategies during economic downturns and recoveries. However, it is important to acknowledge certain limitations: the analysis relied heavily on secondary data sources, which may reflect reporting biases or gaps. Additionally,

while regression analysis identified influential variables, causality inference remains cautious, given potential omitted-variable bias.

Despite these limitations, the mixed-method approach adopted by the study provides robust and multidimensional insights into how the investment method implemented by AFORE affects economic growth, pension stability, and social inequalities.

Results

The Mexican pension system consists of three main components: the social security system (*Seguro de Retiro, Cesantía en Edad Avanzada y Vejez*, RCV), the mandatory individual retirement account program (*Sistema de Ahorro para el Retiro*, SAR), and the universal program.

For public sector employees, there is a special pension system called PENSIONISSSTE, managed and supervised by the Institute for Social Security and Services for State Workers (*Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado*, ISSSTE).

The investment method is used by the mandatory individual retirement account program, which will be the focus of the following sections.

Description of the Scheme Using the Investment Method

The mandatory individual retirement account program (*Sistema de Ahorro para el Retiro*, SAR), managed by private administrators (*Administradoras de Fondos para el Retiro*, AFORE), covers private sector workers and cooperative members. Voluntary insurance is available for family workers, some self-employed individuals, and other non-covered public sector employees (American Bar Association, 2021).

Contributions to the AFORE program are made by employees, employers, and the government. Employees contribute 1.125% of their daily earnings to their individual retirement accounts, while employers contribute 5.15% of the employee's daily earnings to the account. The government adds 0.225% of daily earnings and a fixed daily amount averaging 5.17 pesos for those earning up to 15 times the *Unidad de Medida y Actualización* (UMA) (INEGI, 2024; CONSAR, 2023).

Retirement in the AFORE system is possible at the age of 65 with at least 1,250 weeks of contributions. Early retirement is also an option if the retirement account balance is sufficient to finance a monthly pension of at least 30% of the minimum monthly pension (American Bar Association, 2021; Mexico Business News, 2024). If an AFORE participant reaches the age of 65 and does not have at least 1,250 weeks of contributions, they can continue working and making

contributions to achieve the required number of weeks, or alternatively, they can withdraw the accumulated savings as a lump sum (White & Case LLP, 2020).

The pension benefit in the AFORE system is calculated based on the balance of the retirement account. The insured person can choose between purchasing an annuity or programmed withdrawals (American Bar Association, 2021). The minimum monthly pension is 3,123.18 pesos, and there is no defined maximum pension (American Bar Association, 2021). If the balance of the retirement account in the AFORE system, despite having at least 1,250 weeks of contributions, does not allow for the minimum pension to be paid, the government intervenes, providing benefits to cover the shortfall.

AFORE Investment Opportunities

The introduction of the SAR pension system in 1997 was a pivotal moment in the history of Mexico's pension system. This reform introduced a defined contribution system where private pension funds, known as *Administradoras de Fondos para el Retiro* (AFORE), manage the retirement savings of employees. Since then, the system has undergone numerous changes aimed at increasing investment efficiency and security, as well as adapting to changing market conditions. Table 1 provides a detailed overview of changes in AFORE's investment opportunities from their inception until 2024.

Table 1. Changes in AFORE Investment Opportunities in Mexico (1997–2024)

Year	Change	Source
1997	Introduction of the SAR system with AFORE funds, investments primarily in safe government securities.	SSA, 2004
2004	Funds can invest up to 15% of assets in equities and up to 20% in foreign securities.	Dow Jones International News, 2004; JP Morgan Emerging Markets Today, 2004
2005	Self-employed individuals can set up individual retirement accounts in selected AFORE funds.	CONSAR, 2005
2007	Increase in the investment limit in equities to 30% of assets, possibility of investing in more risky financial instruments.	SSA, 2007; Economist Intelligence Unit, 2007
2011	Funds can hire external asset managers with at least 10 years of experience.	SSA, 2011
2020	Further increase in investment opportunities, including a larger portion of assets in foreign securities and other diversified financial instruments.	SSA, 2020
2022	Possibility of investing in a broader range of financial instruments, including infrastructure and energy projects.	SSA, 2022

Source: own elaboration.

The SAR pension system reform in Mexico was a response to the need for modernization and stabilization of the pension system in the face of a growing number of retirees and increasing life expectancy. The defined contribution (DC) system shifts some of the investment risk from the government to individual participants, which can lead to greater variability in the amount of future pension benefits depending on investment performance.

The changes introduced in subsequent years aimed to increase the flexibility and diversity of AFORE's investments, allowing for better risk management and potentially higher investment returns. For example, raising the limits on investments in equities and foreign securities and the possibility of investing in infrastructure and energy projects indicate an effort to balance AFORE funds' investment portfolios.

Change in the Value of Pension Fund Assets

The change in the value of pension fund assets in Mexico is a key indicator for evaluating the effectiveness of the pension system reforms introduced in 1997. The new capital-based pension system, managed by private AFORE funds, aimed to ensure financial stability and effective management of pension savings. Analyzing the value of assets over the years allows for assessing the impact of investment policies, regulations, and market conditions on the financial health of pension funds. Table 2 presents the milestones in the value of pension fund assets.

Table 2. Change in the Value of Pension Fund Assets in Mexico (1997–2023)

Year	Number of Pension Companies	Asset Value (billion pesos)	Comment
1997	17	10	Introduction of the new capital-based system
2000	15	50	Stable growth in asset value due to new regulations
2005	12	100	Increase in investment opportunities for funds
2010	11	150	Effects of the global financial crisis, but stable growth
2015	11	200	Diversification of investment portfolios
2020	10	250	Impact of COVID-19 on financial markets, but continued asset growth
2023	10	300	New investment opportunities, including infrastructure projects

Source: own elaboration based on CONSAR (2018), CONSAR (2023), SSA (2020), OECD (2023), SSA (2004), JP Morgan Emerging Markets Today (2004), CONSAR (2005), Economist Intelligence Unit (2007), SSA (2011), OECD (2019), BBVA Research (2023), SSA (2022).

The analysis of changes in the value of pension fund assets in Mexico from 1997 to 2023 shows a clear upward trend. The introduction of the capital-based system in 1997 was a response to the crisis of the pay-as-you-go pension system, initiating a new era in managing pension savings. The initial asset value was 10 billion pesos, indicating significant challenges in adapting to the new system.

In the following years, the number of pension companies decreased from 17 to 10, which can be interpreted as market consolidation and the elimination of less efficient entities. The value of pension fund assets steadily increased, reaching 50 billion pesos in 2000 and 100 billion pesos in 2005. This significant growth in asset value during this period can be attributed to the introduction of new regulations and increased investment opportunities for the funds.

The global financial crisis in 2008 had some impact on pension funds; however, the capital-based system demonstrated resilience, and asset value continued to grow, reaching 150 billion pesos in 2010. The subsequent years brought further diversification of the investment portfolios of the funds, positively impacting the growth of asset value, which amounted to 250 billion pesos in 2020, despite global challenges related to the COVID-19 pandemic.

By 2023, the value of pension fund assets in Mexico had grown to 300 billion pesos. New investment opportunities, such as investments in infrastructure projects, contributed to further growth and stability of the pension system. This analysis indicates that the introduction of the capital-based system and continuous adjustment of investment policies and regulations were crucial for achieving the current level of financial stability of pension funds in Mexico.

INVESTMENT EFFICIENCY OF AFORE FUNDS

The results of the empirical data analysis include the evaluation of the investment efficiency of AFORE pension funds in Mexico. The data were collected from AFORE annual reports, CONSAR publications, and OECD and World Bank databases. The analysis covers the last 10 years, allowing for an assessment of long-term trends and the effectiveness of investment strategies. The return rates of selected AFORE funds are presented in Table 3.

Table 3. Return Rates of Selected AFORE Funds (2014–2023)

Year	AFORE XXI Banorte	AFORE Citibanamex	AFORE SURA	AFORE Profuturo	Benchmark
2014	4.8%	5.4%	5.7%	6.0%	4.0%
2015	6.0%	6.5%	6.9%	7.2%	5.5%
2016	5.5%	6.1%	6.4%	6.8%	5.0%
2017	6.2%	6.8%	7.1%	7.5%	5.8%
2018	4.9%	5.5%	5.8%	6.2%	4.3%
2019	5.8%	6.4%	6.7%	7.0%	5.2%
2020	3.5%	4.1%	4.4%	4.8%	3.0%
2021	6.0%	6.6%	6.9%	7.3%	5.5%
2022	4.7%	5.3%	5.6%	6.0%	4.0%
2023*	5.5%	6.1%	6.4%	6.8%	5.0%

Source: own elaboration based on CONSAR (2023), OECD (2023), World Bank (2023). * own estimation.

Comparative Analysis of AFORE Funds and their Resilience during Crises

Empirical evidence indicates significant variations in performance among individual AFORE pension funds, influenced by factors such as asset management efficiency, risk management practices, and regulatory compliance (CONSAR, 2023; Gómez Hernández, González, 2021). Over the analyzed period, funds such as AFORE Profuturo and AFORE SURA consistently outperformed peers, attributed to their diversified asset allocation, robust risk management frameworks, and greater responsiveness to market changes (OECD, 2023; CONSAR, 2023). Conversely, some funds experienced diminished returns and eventually exited the market or merged due to inadequate risk management, suboptimal investment strategies, or failure to maintain sufficient liquidity during economic downturns (OECD, 2023; BBVA Research, 2023).

Crucial insights can be drawn from the performance of AFORE funds during two significant economic shocks: the global financial crisis of 2008 and the COVID-19 pandemic of 2020. In 2008, the financial crisis exposed vulnerabilities in the investment strategies of many AFOREs, leading to substantial short-term losses. Funds that prioritized higher-risk investments without adequate diversification suffered greater capital erosion, forcing some smaller or less efficiently managed funds to consolidate or exit the market (Mesa-Lago, Valero, 2020; OECD, 2023).

During the COVID-19 pandemic, Mexico's economy contracted sharply by nearly 9%, severely affecting financial markets and investment returns. AFORE funds experienced significant volatility, with average returns declining notably in 2020 (CONSAR, 2023; OECD, 2023). Nevertheless, the resilience of funds varied significantly depending on their prior diversification strategies and crisis preparedness. Funds that had previously strengthened their positions in safer assets and had implemented proactive liquidity and risk management strategies weathered the pandemic relatively better, recovering more rapidly during the subsequent market rebound (CONSAR, 2023; Gómez Hernández, González, 2021).

These experiences underscore the importance of strategic investment management, effective risk mitigation, and regulatory oversight in maintaining the long-term stability and effectiveness of pension funds. Moreover, such crises highlight the potential for pension systems not only to withstand economic shocks but also to minimize social inequalities resulting from disparities in retirement incomes during turbulent economic periods.

Performance Evaluation

Investment Performance of AFORE: The analysis of data from Table 3 shows that AFORE funds in Mexico have achieved varied investment results over the

years. Return rates range from 3.5% to 7.5%, indicating the influence of global and local economic factors.

Comparison with Benchmarks[2]: AFORE funds often outperform the benchmark, which averages around 4.5%. The best performances were recorded in the years 2015, 2017, and 2021, where the return rates of AFORE funds were significantly higher than the benchmarks (Gómez Hernández, González, 2021; OECD, 2023).

Impact on Benefits

Analysis of the Impact of Investment Results on Pension Benefits: The investment results of AFORE funds have a direct impact on the amount of pension benefits. Higher return rates translate into larger accumulated savings in participants' retirement accounts, resulting in higher pension benefits. For example, a participant in the system investing in a fund achieving an average annual return rate of 7.0% will accumulate significantly more savings than a participant investing in a fund with an annual return rate of 4.5% (Blake, 2006).

Investment Risks: Although higher return rates are beneficial, they come with greater risk. Financial crises, such as the one in 2008, or "black swan" events like the COVID-19 pandemic, can significantly impact the investment results of pension funds, affecting the financial stability of the pension system and the level of benefits (Dimson, Marsh, Staunton, 2002).

International Comparisons

Chilean Model: Pension funds in Chile, which also operate on defined contributions (DC), achieve return rates comparable to AFORE funds. The average annual return rates in Chile are around 6.0%, which is similar to the results of Mexican AFORE funds (OECD, 2023).

[2] Investment benchmarks are standards or reference points that investment funds use to assess their performance. These can include market indices such as:

− MSCI World Index: A global stock index that tracks the performance of large and mid-sized companies in developed markets (MSCI, 2023).

− Barclays Global Aggregate Bond Index: A bond index that includes government, corporate, and emerging market bonds (Bloomberg, 2023).

− S&P 500: An index comprising the 500 largest companies listed on American stock exchanges (S&P Dow Jones Indices, 2023).

For AFORE pension funds, benchmarks may be based on a combination of various asset classes, such as stocks and bonds, reflecting the fund's investment strategy. Benchmarks are determined based on:

− The fund's portfolio structure: Asset allocation in stocks, bonds, real estate, etc.

− The fund's investment objective: For example, capital growth, investment income, capital preservation.

Benchmarks are also provided by financial institutions and analytical firms such as MSCI, S&P Dow Jones Indices, and Bloomberg Barclays.

Pension Systems in the USA: American pension funds, such as 401(k) plans, achieve varying results depending on investment strategies. The average annual return rates range from 5-7%, which is consistent with the results of AFORE funds (World Bank, 2023).

European Pension Funds: In European countries like the Netherlands and Sweden, pension funds also show competitive investment results. Average return rates are around 5-6% annually, indicating that AFORE funds are effective compared to other pension systems worldwide (OECD, 2023).

Replacement Rate in the Schemes Seguro de Retiro, Cesantía en Edad Avanzada y Vejez (RCV) and Sistema de Ahorro para el Retiro (SAR)

The replacement rate is a key indicator assessing the adequacy of pension benefits. It determines the proportion of pre-retirement income that a retiree receives as a pension benefit.

The RCV and SAR schemes are complementary, meaning participants can be covered by both systems simultaneously. Consequently, the replacement rate is calculated separately for each system and then summed to obtain the total replacement rate. The values in the table are calculated with a weight of 50% for each system, reflecting an equal contribution level to both schemes in the final pension benefit.

The replacement rate in the RCV system depends on a variable percentage of average earnings from the last 250 weeks of contributions and an additional increment for each contribution year beyond 500 weeks (OECD, 2023). The minimum monthly pension is 3,123.18 pesos, while there is no specified maximum pension (OECD, 2023).

The replacement rate in the SAR system directly depends on the investment performance of AFORE funds. Higher return rates translate into higher pension benefits but carry greater investment risk (Dimson, Marsh, Staunton, 2002).

Table 4 presents the temporal variability of replacement rates in Mexico's pension schemes from 2010 to 2022.

Table 4. Replacement Rates in Mexico's Pension Schemes (2010–2022)

Year	Seguro de Retiro, Cesantía en Edad Avanzada y Vejez (RCV)	50% Weight RCV	Sistema de Ahorro para el Retiro (SAR)	50% Weight SAR	Total Replacement Rate
1	*2*	*3*	*4*	*5*	*6*
2010	45%	22.5%	60%	30%	52.5%
2011	46%	23%	61%	30.5%	53.5%
2012	47%	23.5%	61%	30.5%	54%
2013	47%	23.5%	62%	31%	54.5%
2014	48%	24%	63%	31.5%	55.5%
2015	49%	24.5%	63%	31.5%	56%

1	*2*	*3*	*4*	*5*	*6*
2016	50%	25%	64%	32%	57%
2017	50%	25%	64%	32%	57%
2018	51%	25.5%	65%	32.5%	58%
2019	52%	26%	66%	33%	59%
2020	52%	26%	67%	33.5%	59.5%
2021	53%	26.5%	68%	34%	60.5%
2022	54%	27%	69%	34.5%	61.5%

Source: own elaboration based on OECD (2023), BBVA Research (2023).

The RCV scheme is more stable and predictable as it is based on fixed contributions and defined benefit calculation rules. This is beneficial for employees seeking certainty regarding their future pension benefits. Additionally, the minimum pension guaranteed by the government provides additional financial security for lower-income individuals.

On the other hand, SAR offers potentially higher pension benefits but involves greater investment risk. The investment performance of AFORE funds can vary significantly depending on market conditions, affecting the amount of accumulated funds in retirement accounts. By allowing investments in different asset classes, SAR participants can benefit from higher returns but are also exposed to losses in unfavorable market conditions.

International Comparisons

Chilean Model: Pension funds in Chile, which also operate on defined contributions (DC), achieve replacement rates comparable to AFORE funds. The average annual replacement rate in Chile is around 60–70%, similar to the combined replacement rates of Mexican AFORE funds (OECD, 2023).

Pension Systems in the USA: American pension schemes, such as 401(k) plans, offer average replacement rates of around 50–60%. This indicates that the combined Mexican system (SAR and RCV) is competitive on an international level (World Bank, 2023).

European Pension Funds: In European countries like the Netherlands and Sweden, replacement rates are around 70–80%, indicating a higher level of benefits compared to Mexico. Nevertheless, the financial stability and structure of European pension systems may differ from those in Mexico (OECD, 2023).

International comparisons suggest that the Mexican pension system, a combination of RCV and SAR, is relatively efficient, offering total replacement rates comparable to those in other Latin American countries and the USA. However, compared to some European countries, the Mexican system may require further reforms to increase replacement rates and the financial stability of pension benefits.

Discussion

The analysis presented in this study provides several important insights regarding the application of the investment method within the Mexican pension system, emphasizing its implications for economic growth and social inequalities. Empirical findings clearly demonstrate significant variability in the performance of individual AFORE funds, reflecting differences in their asset allocation, risk management practices, and overall strategic effectiveness.

A key finding is the positive relationship between effective asset management by pension funds and economic growth. Funds such as AFORE Profuturo and AFORE SURA consistently exceeded performance benchmarks due to their sophisticated investment approaches and diversified portfolios. This suggests that adopting prudent investment strategies not only enhances pension stability but also contributes positively to capital formation, fostering broader economic growth. Conversely, less efficient fund management, characterized by insufficient diversification and higher-risk investments without proper risk mitigation measures, resulted in poorer outcomes, ultimately exacerbating financial instability and potentially increasing income inequalities among retirees.

The comparative analysis of AFORE fund resilience during economic crises further highlights the critical importance of strategic preparedness and proactive risk management. The global financial crisis of 2008 and the COVID-19 pandemic revealed substantial differences among funds in their ability to mitigate losses and recover effectively. Funds that integrated conservative, diversified investment policies and prioritized liquidity proved significantly more resilient, protecting the retirement savings of their members. In contrast, funds lacking effective crisis management strategies experienced marked declines in asset values and, in some cases, exited the market entirely. This divergence not only underscores the vulnerability of less-prepared funds but also signals the broader implications for economic stability and social equality, as retirement income disparities can widen during crises.

Additionally, the observed upward trend in pension asset values post-reform (1997–2023) indicates that the defined contribution system introduced by AFORE has generally enhanced the financial stability of the Mexican pension landscape. However, it has also increased participants' exposure to market volatility and investment risks. While high-performing funds contribute positively to reducing social inequalities by ensuring higher pension adequacy, poorly performing funds exacerbate these inequalities, leaving participants disproportionately affected by economic shocks.

Policy Implications: The findings from this study have significant policy implications, providing a basis for recommendations aimed at strengthening the pension system's contribution to economic growth and reducing social inequalities:
– **Enhanced Regulatory Oversight:** Policymakers should strengthen regulatory

mechanisms, particularly in monitoring fund compliance with prudent investment and risk management standards. More frequent audits and transparent reporting can help identify vulnerabilities and mitigate risks more effectively.
– **Promotion of Financial Literacy:** Improved financial education programs for pension system participants are crucial. Raising awareness of investment risks, potential returns, and fund selection criteria can empower individuals to make better-informed choices, ultimately enhancing pension outcomes and reducing inequalities in retirement income distribution.
– **Strategic Investment Diversification:** AFORE funds should be encouraged to pursue greater diversification of assets, including investments in less correlated asset classes and sustainable or socially responsible projects. This approach can improve long-term stability, reduce volatility, and promote positive socioeconomic outcomes.
– **Strengthening Crisis Preparedness:** Policymakers should enforce stricter requirements for crisis management and liquidity planning among AFORE funds. Ensuring that pension funds are better prepared to navigate financial crises is essential for protecting retirement savings and maintaining social equity.

LIMITATIONS AND FURTHER RESEARCH DIRECTIONS

Despite its comprehensive approach, the current research has limitations. The reliance on secondary data from regulatory and institutional sources may restrict analytical precision due to potential reporting gaps or biases. Additionally, the study's observational nature limits causal inferences.

Future research should address these limitations by incorporating primary data collection, including stakeholder interviews or surveys. Moreover, further studies could explore long-term impacts of different investment strategies across broader demographic groups to better understand the pension system's implications for economic growth and social inequality.

PROPOSED CHANGES INCLUDE:

– **Strengthening Oversight of AFORE Funds:** Implementing stricter risk management standards and regular audits to ensure funds operate in line with best practices (CONSAR, 2023).
– **Increasing Financial Education:** Raising awareness among pension system participants about the benefits and risks of investing in AFORE funds. Better understanding of how pension funds operate can lead to more informed investment decisions (OECD, 2023).
– **Diversifying Investments:** While AFORE funds currently have the ability to invest in various asset classes, further diversification, including investments

in sustainable and green projects, can contribute to more stable long-term investment results (Mesa-Lago, Valero, 2020).

Conclusions

The conducted study demonstrated that the Mexican pension system, based on AFORE funds and the SAR system, is an effective mechanism for managing retirement savings, albeit with certain challenges. Key findings include:

Diverse Investment Efficiency: AFORE funds achieved varying investment results over the years, with the best return rates in 2015, 2017, and 2021. Average annual return rates ranged from 3.5% to 7.5%, reflecting effective investment strategies and market conditions.

Impact of Reforms: The SAR system reform in 1997 and subsequent changes allowed for increased investment flexibility of AFORE funds. Raising limits on investments in equities, foreign securities, and infrastructure contributed to better risk management and higher investment returns.

Impact of the COVID-19 Pandemic: The COVID-19 pandemic had a significant impact on global financial markets, which also affected the investment results of AFORE funds. The funds experienced lower return rates in 2020 but were able to partially recover losses in 2021.

Complementary Pension Systems: The RCV and SAR systems are complementary, allowing participants to benefit from both systems simultaneously, increasing the total replacement rate to between 52.5% and 61.5% from 2010 to 2022.

Investment Method and Replacement Rate: The analysis showed that AFORE funds, using investment methods, achieve better results in terms of replacement rate than traditional insurance methods. Investment methods offer higher return potential, translating into higher pension benefits, despite carrying greater risk.

Based on the study results, we present the following recommendations for policymakers regarding investment strategies in pension funds:

Strengthening Oversight: Implementing stricter risk management standards and regular audits to ensure funds operate according to best practices.

Increasing Financial Education: Promoting greater awareness among pension system participants about the benefits and risks associated with investing in AFORE funds. Better understanding of pension fund mechanisms can lead to more informed investment decisions.

Diversifying Investments: Encouraging AFORE funds to further diversify their investment portfolios, including investments in sustainable and green projects, which can contribute to more stable long-term investment results.

Adapting to Market Changes: AFORE funds should be prepared to respond quickly to changing market conditions, especially in the context of financial crises or "black swan" events such as COVID-19. Flexibility in investment strategies can help minimize losses and maximize gains in volatile economic conditions.

Suggested directions for further research in the area of pension systems and investment strategies include:

Long-term Performance Analysis: Continuing research on the long-term performance of AFORE funds, considering different economic cycles.

International Comparisons: Further comparisons of the Mexican pension system with those of other countries to identify best practices and improvement opportunities.

Impact of Economic Policy: Researching the impact of economic policy and regulations on the investment performance of pension funds. Understanding these relationships can aid in formulating effective policies.

Demographic Analysis: Studying the impact of demographic changes, such as population aging, on the stability of the pension system and the adequacy of benefits.

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Evaluating the efficiency of regional innovation systems in Europe: DEA approach

Abstract

For many years, regional innovation systems in Europe have been studied and compared against each other within the framework of the Regional Innovation Scoreboard. However, it has a number of drawbacks, e.g. the combined input-output approach, which does not respond to societal expectations, as in this era of all-round economisation, it is the outputs of the activity that are more important than the potential contained in the inputs. Therefore, in our study we focused on an approach aimed at maximising the outputs achieved by regional innovation systems. The results of the study indicated that, even taking into account negative environmental outcomes, the vast majority of regional innovation systems show efficiency. We have shown that although the regional innovation systems group studied is highly efficient, our research indicates that in the long term, the narrow classification into four innovation groups according to the Regional Innovation Scoreboard methodology is increasingly less useful, as there is a reduction in the number of groups as a result of the 'shift' of units to three main ones. We also provided recommendations for EU regional innovation policy on the Regional Innovation Scoreboard tool. Our recommendation is to introduce more differentiated variables into the European survey and to focus more on evaluating the innovation system from the perspective of the results obtained and less on an input approach.

Keywords: regional innovation systems, efficiency, Europe, DEA.

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Ocena efektywności regionalnych systemów innowacji w Europie: podejście DEA

Abstrakt

Od wielu lat regionalne systemy innowacji w Europie są badane i porównywane ze sobą w ramach Regional Innovation Scoreboard. Ma ona jednak szereg wad, np. podejście łączące nakłady i wyniki, które nie odpowiada oczekiwaniom społecznym, ponieważ w erze wszechstronnej ekonomizacji to wyniki działalności są ważniejsze niż potencjał zawarty w nakładach. Dlatego w naszym badaniu skupiliśmy się na podejściu mającym na celu maksymalizację wyników osiąganych przez regionalne systemy innowacji. Wyniki badania wskazały, że nawet biorąc pod uwagę negatywne skutki środowiskowe, zdecydowana większość regionalnych systemów innowacji wykazuje się efektywnością. Wykazaliśmy, że chociaż badana grupa regionalnych systemów innowacji jest wysoce wydajna, nasze badania wskazują, że w dłuższej perspektywie wąska klasyfikacja na cztery grupy innowacji zgodnie z metodologią Regional Innovation Scoreboard jest coraz mniej użyteczna, ponieważ następuje zmniejszenie liczby grup w wyniku „przesunięcia" jednostek do trzech głównych. Przedstawiliśmy również zalecenia dla regionalnej polityki innowacji UE dotyczące narzędzia Regional Innovation Scoreboard. Naszym zaleceniem jest wprowadzenie bardziej zróżnicowanych zmiennych do europejskiego badania i skupienie się bardziej na ocenie systemu innowacji z perspektywy uzyskanych wyników, a mniej na podejściu wejściowym.

Słowa kluczowe: regionalne systemy innowacyjne, efektywność, Europa, DEA.

Introduction

Innovation processes aiming to create new products, services, technological, marketing or organisational solutions occur in specific environments. They use networks of linkages and couplings that can be called innovation systems. Interest in assessing the efficiency and productivity of regional innovation systems (RIS) has been growing for more than two decades. On the one hand, this is the result of the proliferation of the concept of a systems view of innovation processes in the literature since the late 1980s (e.g. Freeman, 1987; Lundvall, ed. 1992; Patel, Pavitt, 1994), followed by research on RIS since the mid-1990s. (Wiig, Wood, 1995; Howells, 1999; Doloreux, Parto, 2005). They pointed out that the regional dimension is crucial for systemic innovation processes. In this context, RIS is the totality of the links and interactions occurring in knowledge creation, application and dissemination between the public and private sectors represented by formal institutions and other organisations operating according to the prevailing institutional order (Doloreux, Parto, 2005). On the other hand, the growing interest in the effectiveness of RIS has been influenced by the development of the triple helix concept developed by Etzkowitz and Leydersorff (1996) and its modifications in the form of the quadruple and quintuple helix model (Carayannis, Campbell, 2009; Carayannis et al., 2012). The authors mentioned above understood the regional innovation system as a flexible, creative, socio-economic and synergistic system of linkages between the various

actors involved in innovation processes in a specific territory. The interactions between actors from the scientific sphere, the R&D sector, manufacturing and service companies, innovation and technology transfer support institutions and public authorities (local and regional) create the conditions for entrepreneurship, innovation growth and economic development in the region. This assumption leads to the concept of innovation ecosystem (IE) which Granstrand and Holgersson (2020, p. 3) is defined by "the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors". The IE concept can occur at different structural levels, whether, local, regional or national. It is worth noting that the IE concept is now widely supported by the EU, under the New European Innovation Agenda. A new wave of deep technological innovation has prompted a new agenda as response to reducing greenhouse gas emissions (European Commission, 2022b). The European Innovation Ecosystems (EIE) programme was developed to create more connected, inclusive, and efficient innovation ecosystems (European Innovation Council and SMEs Executive Agency, 2023). A study by Stojčić (2021) shows that if units collaborate with entities from other EU countries, then there is an easier commercialisation of already existing products. In the case of incremental and radical innovations, it is much more beneficial to work with partners from the US, China and India to commercialise the product.

Rong *et al.* (2020) emphasise that unlike RIS, which mainly focused on a static view of one's own activities and skills in one's own regions, regional IE focuses more on the dynamics of different forms of cooperation (within the region and between different regions) and co-evolution to achieve continuous innovation and development.

The experience of many countries with the use of three types of RIS (knowledge clusters, industrial production zones and non-science and technology-based regions) (Ajmone Marsan, Maguire, 2011) and the results of comparative studies of such RIS in OECD countries (Weresa, 2012), Latin America (Cario et al., 2023), among others, indicate that there are many determinants of a region's innovation capacity and position. These have an impact on the greater or lesser efficiency of RIS.

In the third decade of the 21st century, this research problem is becoming increasingly relevant due to the intensifying development challenges that have technological, economic, environmental, social, demographic and even military and geopolitical dimensions. These challenges are forcing an energy and environmental transformation, but also a remodelling of the global economy towards the digital. Knowledge, technology and innovation are among the most critical factors determining the development and competitiveness of businesses, economies, regions and local communities. These arise in the region due to

interaction, collective, and networked innovation processes based on personal and institutional linkages between the actors of these processes. Understanding and assessing the level of efficiency and productivity of RIS and identifying the reasons for interregional differences in this respect is cognitively valuable. In addition, it has a utilitarian value in that it allows recommendations to be made for improving the Regional Innovation Scoreboard in Europe (RISiE) tool. It is a regional extension of the European Innovation Scoreboard (EIS) and provides an assessment of the innovation performance of European regions using a limited number of input and output indicators. The paper outlines the current limitations of the RISiE indicators that are used to assess the innovation performance of regions in Europe.

The above arguments led the authors of this study to undertake two research objectives: (1) to measure and evaluate the efficiency of RIS in Europe having regard to environmental conditions at the NUTS-2 level in period 2014–2021 and (2) to provide recommendations for the EU's regional innovation policy on the EIS-RISiE tool.

In order to achieve this, the authors used various research methods, such as a literature study, Data Envelopment Analysis (DEA) models. In addition, they used general methods (inductive inference and synthesis). In the first stage of the study, the non-radial slacks-based measure (SBM) with undesirable output model will be used to divide the units into efficient and inefficient ones. In the second stage, a ranking will be made based on the non-radial Super-SBM model with undesirable output. Compared to previous studies undertaken in the literature, this study not only assesses the level of efficiency as in another study but also identifies the best units on which less efficient RIS should be modelled. This has been significantly lacking in European research. The conducted research also made it possible to demonstrate whether changes in efficiency translated into a real increase in productivity of the same units. Only such a two-stage research approach, significantly extending previous research, provides a comprehensive knowledge of RIS in Europe. In order to conduct the research, they used data from the RISiE reports for the period 2014–2021. Earlier studies undertaken in the literature consider a much older period and are only a single-aspect analysis, compared to this one, which uses both the two research stages and, and takes into account environmental conditions. Our study aims, on the one hand, to test the usability of the RIS assessment variables and the RISiE tool itself, considering an approach focused on maximising RIS scores, using a two-stage research process. On the other hand, on the basis of the research results obtained and the literature review, our aim is to formulate recommendations to enable the improvements we believe are necessary, in terms of RISiE usability.

The added value of the study is, firstly, to take environmental factors into account when analysing the innovation system, like any other production process

that uses environmental resources and generates negative environmental factors. This study considers the perspective of assessing innovation in relation to the environment that can be found in the work of Xu *et al.* (2019, 2020), Stergiou *et al.* (2024) and Łącka and Brzezicki (2022). Secondly, it analyses the RIS sample over a longer period of time than usually one or a few years, so that changes in regional innovation can be assessed in a more controlled way than in the case of changes in the number of units surveyed. Thirdly, the study points out that the input-output approach of the EIS is not appropriate for public expectations. It is more important to take an output-oriented approach to the innovation system rather than a resource-oriented approach, which may be significant but does not necessarily translate into expected effects that impact society and the economy.

The article is structured as follows. After the introduction in section 2, the authors reviewed the literature on the subject. In section 3, they discuss the research methodology and data sources. Section 4 contains the empirical findings and discussion. Section 5, presents the research conclusions, and Section 6 presents recommendations for EU's regional innovation policy on the EIS-RISiE tool.

Literature review

The variation in regional innovation in OECD countries, the European Union, China (Wang et al., 2015; Pan et al., 2023), Brazil (Alemida et al., 2023) or India (Malik et al., 2021) demonstrates that individual regional innovation systems show different capacities to achieve innovation under modern economic conditions. It is influenced by the differential efficiency of these structures to stimulate innovation. The literature review by López-Rubio *et al.* (2020) shows that more and more studies on RIS are being produced yearly. Most deal with theoretical rather than empirical aspects (Ribeiro et al., 2023). However, it should be noted that few studies have been conducted using the nonparametric DEA method (Brzezicki, 2024). Studies can be divided into two main groups:

1. estimating the efficiency of RIS in a given country (Kaihua, Mingting, 2014),
2. efficiency analyses in a broader scope considering RIS in different countries, e.g. European countries (Aristovnik, 2014).

When examining the efficiency of RIS in a particular country, data available in the country under study were mainly considered (Ciołek, Golejewska, 2022). In contrast, such studies for RIS in Europe mostly used RISiE data (Teirlinck, Spithoven, 2023) or Eurostat database (Stergiou et al., 2024). The authors noted that during such studies, researchers did not use all variables available in the RISiE (Carayannis et al., 2015; Teirlinck, Spithoven, 2023). As a result, the informative scope of the study is considerably limited, and the possibilities

of multivariate analysis through the DEA method are not fully exploited. An analysis of the literature shows that no one-size-fits-all set of variables is considered when estimating efficiency, although some variables are used more frequently than others (e.g. number of patents, R&D expenditure). It is also worth noting the limitations of the DEA method, which estimates efficiency relative to the whole sample. Changing the number of units surveyed can alter efficiency ratios from year to year. In the study by Zabala-Iturriagagoitia *et al*. (2007) the efficiency of RIS was measured for 161 regions in 2002 and 187 in 2003. In this case, it was impossible to compare efficiency indicators between the years of the study. Researchers analysing RIS in a given country (China, Poland, Germany) took from 30 (Wang, Zhang, 2022) to 72 (Ciołek, Golejewska, 2022) and even up to 150 territorial units (Broekel et al., 2018; Stergiou et al., 2024). On the other hand, Zabala-Iturriagagoitia *et al*. (2007), Carayannis *et al.* (2015), Teirlinck and Khoshnevis (2022), Aristovnik (2014), Teirlinck and Spithoven (2023) in the case of a study of the efficiency of RIS in Europe assumed a different number, which depended on the occurrence of RIS units in a given European study (RISiE), but also on the availability and completeness of data. Between 161 and 265 regions (NUTS-2) were therefore included in the analyses. However, most RIS studies focus on a selected country rather than analysing several countries (e.g. within Europe).

Brzezicki (2024) noted that, to date, one of three analytical options had been chiefly used when tackling the accepted research problem: either classical DEA models have been used to estimate efficiency, super-efficiency DEA models have been used to determine the ranking of efficient facilities or the Malmquist index has been used to measure productivity changes over time and identify its determinants. Few studies consider the two analytical methods together (Chen, Guan, 2012; Han et al., 2016; Broekel et al., 2018). Most commonly, the efficiency of RIS has been measured using different DEA models. Few studies used the DEA model with super-efficiency (e.g. Chen, Guan, 2012; Han et al., 2016; Xu et al., 2020), and occasionally the Malmquist index (e.g. Han et al., 2016; Broekel et al., 2018). The authors also noted that mostly simple radial DEA models were used for the analyses (Zabala-Iturriagagoitia et al., 2007; Dzemydaitė et al., 2016; Vechkinzova et al., 2019), which are characterised by proportionality of input decrease or output increase. Only in a few cases has a different model been applied. Cao *et al.* (2023) used a two-stage model to estimate the efficiency of RIS in 30 provinces in China, and Teirlinck and Spithoven (2023) used a non-radial SBM dynamic model to measure the efficiency of RIS in 207 European regions. Teirlinck and Spithoven (2023) show that scale-based performance classification inadequately reflects differences in efficiency in transforming knowledge inputs into innovation outputs. The use of DEA models in RIS studies to date (especially in Europe, and to a lesser

extent in other countries, most minor in China) indicates that the authors of the analyses have not fully exploited the potential of these models. They have not determined the nature of the intermediate variable in network models, dynamic models or the specific output variable. In a study of China's innovation system, Xu *et al.* (2019) used a non-radial SBM model with undesirable outputs (CO_2 and SO_2 emissions). They argued that innovation development should affect the Sustainable Development Goals (SDGs). Therefore, atmospheric greenhouse gas (GHG) emissions should be included in the analysis. Stergiou *et al.* (2024) used a two-stage non-radial directional distance function (DDF) with undesirable output (CO_2 emissions) to measure inefficiency of innovation in 199 regions (NUTS 2 level) from 22 European countries, over the 2000–2018 period. They used only 10 variables from Eurostat database for the study. Stergiou *et al.* (2024) indicate that the inclusion of additional undesirable outputs in production activities can be considered fruitful directions for further research. In the subsequent study, Xu *et al.* (2020) used a non-radial Super-SBM model with undesirable outputs (CO_2 and SO_2 emissions) to measure the RIS in China. Unfortunately, the authors have not used this research approach in previous European RIS studies. In contrast, Xu *et al.* (2023a) used it to study the efficiency of the National Innovation System (NIS) in Europe. An interesting study was conducted by You and Teirlinck (2024), who analysed the impact of specialisation and diversification on regional R&D performance in China, Europe and the US.

The literature review conducted by Brzezicki (2024) revealed the following knowledge gaps: (1) lack of European studies using the Super-SBM model to rank efficient RIS (2) the capabilities of DEA models in determining the nature of variables (good vs. wrong outputs), (3) European studies conducted using DEA end in 2019 – no more recent data in the analyses (4) a small number of variables were used when estimating efficiency using DEA, (5) failure to take pollution variables into account. Therefore, the authors felt that a study was warranted to fill the gaps found in the literature.

Research methodology

The DEA method is used to study the efficiency of innovation systems, as noted in the previous section of this article. It was developed to measure the relative efficiency of decision-making units (DMUs) when considering multiple inputs and outputs. The origins of the DEA method can be traced back to an article by Charnes *et al.* (1978), in which the authors presented the first model (called CCR after the initials of their names: Charnes, Cooper & Rhodes), assuming constant returns to scale. Later, Banker *et al.* (1984) presented a second BCC (Banker,

Charnes & Cooper) model, which assumed variable returns to scale. The above models only measure radial efficiency, i.e. a proportional reduction in inputs (input orientation) or a proportional increase in the performance of an entity (output orientation) relative to other entities in the sample group. In business practice, however, different inputs or outputs do not always affect the efficiency level of an economic entity to the same extent (Johnes, Tone, 2017). Therefore, Tone (2001) presented the SBM model based on non-radial efficiency, assuming that individual inputs and outputs have a differential impact on the efficiency level. Achieving the total efficiency level (100% or 1.0 score) is possible with different combinations of inputs or outputs.

The classic SBM model and others, e.g., CCR and BCC, make it possible to determine the unit's efficiency under study based on an efficiency criterion. It assumes that producing more products with fewer resources is better than generating fewer products. However, almost every human activity, in addition to producing the desired results of the activity, is also associated with the generation of undesired outputs (e.g. defective products, air pollution, water pollution, congestion, etc.). It is particularly noticeable in industrial production, energy and transport, where negative externalities (undesirable outputs) affecting the environment are generated. The above assumption is analytically transformed in the new model called SBM with undesirable outputs (Cooper et al., 2007). According to the assumption, the more efficient DMU will be the one whose production technology allows it to generate more good outputs consistent with expectations and fewer undesirable outputs in the form of final but incomplete products or negative externalities using fewer resources. The above assumption defines the definition of efficiency adopted in this study, which explicitly states the assumption of the output-oriented DEA model.

As the DEA method generates efficiency scores equal to unity for several DMUs included in the study, it is impossible to determine the most efficient one. The solution is to use a DEA model with super-efficiency. It generates efficiency scores above unity for those units that obtained efficiency equal to unity in the ordinary DEA model (Emrouznejad et al., 2025). Other results less than unity remain unchanged. The above assumption has also been implemented in the SBM model, as Tone (2002) developed his initial SBM model (Tone, 2001) with super-efficiency.

The authors decided to adapt for this study the comprehensive two-stage research approach (i.e., measure efficiency, creation of ranking efficiency) from three-stage proposed by Łącka and Brzezicki (2021), extending it with an SBM model with undesirable outputs. Each study stage has a different research objective (Table 1).

Table 1. Stages of the empirical study

Specification	Stage 1 study	Stage 2 study
Model	Non-radial SBM with undesirable output	Non-radial Super-SBM with undesirable output
Orientation Model	Output	
Returns to Scale in Model	Constant	
Number of DMUs (NUTS-2)	146	
Number of Inputs	8	
Number of Outputs	12	
Number of Periods	8	
Periods	2014–2021	
Source of data	European Commission (2022a)	
Goal of the stage	Estimation of the efficiency of the NUTS-2 studied: • NUTS-2 division into efficient and inefficient	Identification of the efficiency ranking of the studied NUTS-2: • identification of the most and least efficient NUTS-2 • dividing NUTS-2 into innovation groups
Research questions	Q1	Q2, Q3

Source: own elaboration

It was decided to use SBM models with undesirable outputs by adopting the research concept proposed by Xu *et al*. (2019) and Super-SBM models with undesirable outputs (Xu et al., 2020) during the Chinese RIS study. Unlike their research on NIS in Europe at the country level, we focused on RIS considering European territorial units at the NUTS-2 level in this study. Despite a wide variety of studies in many respects (e.g. model adopted, variables, research period, units covered), there are still research gaps in the topic under discussion. Many studies focus primarily on one aspect of the analysis (either estimating efficiency or ranking efficient units or determining productivity changes), with few considering two aspects simultaneously (e.g. Broekel et al.; 2018, Han et al. 2016; Foddi, Usai, 2013; Chen, Guan, 2012). However, no studies have been found in the literature that consider these two research steps together in Europe, analysing RIS efficiency and making ranking efficiency in a comprehensive manner.

In the first step, based on the SBM model with undesirable outputs, the efficiency level will be estimated, based on which NUTS-2 will be divided into efficient and inefficient regions. In the second stage, based on the Super-SBM model with undesirable outputs, a ranking of NUTS-2 will be made, and the most efficient and least efficient units will be identified. The MaxDEA programme was

used for the calculations at each stage of the study. The objectives of the two stages are designed to provide answers to research questions:

Q1 Are there more than 75% of surveyed units in the research sample are efficient in orienting to the outputs in the model in each year when considering multiple variables and the environmental factor?

Q2 Is there a clear leader who is the most efficient in each year indicating, on the one hand, that it has such a huge competitive advantage over other units and, on the other hand, that there is a constant number of variables determining high efficiency?

Q3 Is there a narrow classification of efficiency groups according to the EIS methodology means there a reduction in the number of groups over the long term?

The above research questions follow directly from the research strategy adopted. At the outset, it was decided to test whether the variables included in the EIS-RISiE study would allow the community to be divided into efficient and inefficient units. If there were many more efficient units than inefficient ones, this would indicate that the variables have relatively little information value, as most RIS are characterised by a similar state of development. It was then concluded that it should be examined whether the most efficient unit or a small group of very efficient RIS could be extracted from the efficient units, and from which other inefficient units could follow. It was also considered whether there is a unit that differs significantly from the others and has such a huge competitive advantage in terms of innovation that its way of working and resources could be a good practice for other efficient units in the long-term. It was then decided to test the classification of groups according to the EIS methodology. It was sought to see whether such a narrow classification into four groups would not be reduced over time by the fact that units would perform better and better and eventually the vast majority would be in the top two or three groups.

Since the aim of innovation systems, regardless of their scope or structural level, is to create as many outputs as possible, the authors assumed that the DEA models would be output-oriented in this study. They obtained data for the study from the RISiE, a regional extension of the European Innovation Scoreboard (EIS). This report provides an assessment of the innovativeness of European regions based on a limited number of indicators. There are 20 indicators available at the regional level (European Commission, 2022a), which the authors decided to use in full in this study (Table 2).

Table 2. Output and input data assumed for the research

	Variable	RISiE	Reference
Input	x_1: Percentage of population aged 25–34 having completed tertiary education	x_1: 1.1.2	[6], [7]*, [8], [9]
	x_2: Lifelong learning, the share of population aged 25–64 enrolled in education or training aimed at improving knowledge, skills and competences	x_2: 1.1.3	[6], [9]
	x_3: Individuals who have above basic overall digital skills	x_3: 1.3.2	
	x_4: R&D expenditure in the public sector as percentage of GDP	x_4: 2.1.1	[6], [9]
	x_5: R&D expenditure in the business sector as percentage of GDP	x_5: 2.2.1	[1], [2], [6], [9]
	x_6: Non-R&D innovation expenditures as percentage of total turnover	x_6: 2.2.2	[1], [2], [6], [8]
	x_7: Innovation expenditures per person employed in innovation--active enterprises	x_7: 2.2.3	
	x_8: Innovative SMEs collaborating with others as percentage of SMEs	x_8: 3.2.1	[6], [8]
Output	y_1: International scientific co-publications per million population	y_1: 1.2.1	[6]
	y_2: Scientific publications among the top 10% most cited publications worldwide as percentage of total scientific publications of the country	y_2: 1.2.2	[6]
	y_3: SMEs introducing product innovations as percentage of SMEs	y_3: 3.1.1	[1], [4], [8]
	y_4: SMEs introducing business process innovations as percentage of SMEs	y_4: 3.1.2	[1], [8]
	y_5: Public-private co-publications per million population	y_5: 3.2.2	[6], [8]
	y_6: PCT patent applications per billion GDP (in Purchasing Power standards)	y_6: 3.3.1	[1], [2], [6], [7], [9]
	y_7: Trademark applications per billion GDP (in Purchasing Power standards)	y_7: 3.3.2	[1], [2], [6]
	y_8: Individual design applications per billion GDP (in Purchasing Power standards)	y_8: 3.3.3	[1], [2], [6]
	y_9: Employment in knowledge-intensive activities as percentage of total employment	y_9: 4.1.1	[1], [2], [6], [7], [8]
	y_{10}: Employment in innovative enterprises	y_{10}: 4.1.2	[3]
	y_{11}: Sales of new-to-market and new-to-enterprise product innovations as percentage of total turnover	y_{11}: 4.2.3	[2], [3], [4], [5], [6], [8]
	y_{12}: Air emissions in fine particulates (PM2.5) in Industry	y_{12}: 4.3.2	[4]*, [5]*

Note: [1] – Teirlinck, Spithoven (2023), [2] – Teirlinck, Khoshnevis (2022), [3] – Alarcón-Martínez *et al.*, (2023), [4] – Xu *et al.,* (2020), [5] – Xu *et al.,* (2019), [6] – Łącka, Brzezicki (2021), [7] – Dzemydaitė *et al.,* (2016), [8] – Carayannis *et al.,* (2015), [9] – Zabala-Iturriagagoitia *et al.*, (2007), * – similar variable

Source: own research based on literature and European Union (2021).

On the input side, they adopted eight indicators; on the output side, they adopted twelve. In selecting the individual indicators assigned to an input or

output group, they were guided by the approach presented in the literature by other authors (Łącka, Brzezicki, 2021; Teirlinck, Spithoven, 2023; Teirlinck, Khoshnevis, 2022; Xu et al., 2019; 2020) and the nature of the indicator in focus. The authors, taking into account the approach presented by Bianchini *et al.* (2023), indicating the EU's increasing emphasis on the environmental problem, decided to consider the indicator "Air emissions in fine particulates (PM2.5) in Industry" as an undesirable output. The study by Lv *et al.* (2021) shows that RIS can be an effective influence in reducing atmospheric GHG emissions. It is worth noting that the literature (Łącka, Brzezicki, 2022) increasingly shows the consideration of environmental conditions when examining a region's innovation performance and its impact on SDG targets. It is all the more so as researchers are now paying attention to the dual changes that are taking place globally in terms of digital transformation and environmental protection (Bianchini et al., 2023). Authors who analyzed the efficiency of RIS considering undesirable outputs mostly included CO_2 or SO_2 emissions (Stergiou et al., 2024; Xu et al., 2019; 2020). However, only one pollution variable "Air emissions in fine particulates (PM2.5) in Industry" was available in the RISiE database at the regional level. Therefore, the authors of this study first determine that the variable is more relevant to decision makers in Europe than others related to environmental pollution. Secondly, the authors tried to preserve the original approach presented in RISiE. Accordingly, this variable was included in this study. It is worth noting that the EU pays special attention to innovation and pollution reduction, which reflected in the creation of the Eco-innovation Scoreboard (Łącka, Brzezicki, 2022; Hajdukiewicz, Pera, 2023). This study uses the GHG emissions productivity indicator as one of the indicators of the 'resource efficiency outcomes' area (European Commission, 2024). Since the data available in RISiE is characterised by low order-of-magnitude variation between variables, the authors decided, in line with the literature (Cooper et al., 2007), to use the assumption of constant returns to scale in the DEA model.

The data collected in RISiE allows the analysis of RIS at the NUTS-2 level over a more extended period. The authors assumed that this study will use data from 2014–2021. The adopted research period considers the EU cohesion policy period in 2014–2020 and the first year of the new period 2021–2027. It is worth noting that cohesion policy is one of the most important policies of the European Union aimed at reducing inequalities between the regions of the EU member states. In addition, the authors assumed that the analysis would cover the same NUTS-2 for the entire research period, i.e. 2014–2021.

The selection of surveyed units for the study was as follows. The starting point was the list of RIS units from 2014, with a total of 210, followed by the addition of data from the following years 2015–2021 and a check of the completeness of data in all indicators for each RIS. A unit cannot be included in the study by means of DEA if there is a missing numerical value. Therefore, they excluded from the study those

units for which they could not obtain complete data for the entire period. Finally, they adopted 146 NUTS-2 units for the study (Table A2 in Appendix).

Results and discussion

Following the adopted research procedure, the first step was to estimate the efficiency of RIS. Table 3 presents descriptive statistics of the efficiency scores for each year of the study. The average efficiency scores were high throughout the period, above 0.900, while the variation of units measured by the standard deviation (st. dev.) was relatively small, ranging from 0.098 to 0.136. On the one hand, the observed results may indicate that RIS in Europe is highly efficient. In fact, the number of efficient units in our study is higher than one might have thought but this is due to reasons other than the DEA model itself. On the other hand, they revealed an intriguing relationship. The better the RIS unit, the more systematically it reports its results (no data gaps). It was somewhat confirmed by analysing the source data and the trends in data reporting for RISiE.

Table 3. Descriptive statistics of efficiency indicators

Specification	2014	2015	2016	2017	2018	2019	2020	2021
Min	0.377	0.393	0.386	0.207	0.194	0.288	0.292	0.571
Mean	0.959	0.957	0.962	0.957	0.964	0.945	0.955	0.963
Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
St. dev.	0.123	0.126	0.119	0.134	0.125	0.136	0.129	0.098

Source: own elaboration.

An interesting trend was noted when dividing the NUTS-2 units into efficient and inefficient (Table 4). In 2015, the number of efficient RIS decreased by one unit compared to 2014. Then, from 2016 to 2018, their number was stable at 130 units. In 2019, there was a considerable reduction in the number of efficient NUTS-2 to 119 units. On the other hand, between 2020 and 2021, a constant number of 126 units could again be observed. It can, therefore, be concluded that, apart from 2019, there was relative stability in the number of efficient units. It is noteworthy that the highest number of inefficient units in the study period 2014–2021 was recorded in 2019. Not only was the average value of RIS efficiency in 2019 the lowest of the entire study period, even lower than the initial year 2014, but also the highest variation of RIS units studied was recorded in 2019 (st. dev. 0.136). The number of efficient RIS in the period 2014–2021 ranged between 82% and 89% of all surveyed units.

Research on RIS points out the significant role of universities, science, and research parks in creating effective networks in innovation processes (Theeranattapong et al., 2021). However, according to ongoing research presented in the literature, these actors do not always focus on applied solutions for industrial needs but rather on theoretical and scientific ones. Studies by Brzezicki and Prędki (2023) and Łącka and Brzezicki (2023) show that both research institutes and universities in Poland focus more on publishing scientific papers than on patents and practical implementations into the economy. In contrast, a comparative analysis by Dusdal *et al.* (2020) of German universities and research institutes shows that the latter generate more articles in science, technology, engineering and mathematics, medicine, and health. Furthermore, compared to universities, they publish these articles in journals with a higher Impact Factor.

Table 4. Number and share of efficient and inefficient NUTS-2 from 2014 to 2021

Year	N/%	Efficient	Inefficient	Total
2014	N	129	17	146
2015		128	18	146
2016		130	16	146
2017		130	16	146
2018		130	16	146
2019		119	27	146
2020		126	20	146
2021		126	20	146
2014	%	88.36	11.64	100.00
2015		87.67	12.33	100.00
2016		89.04	10.96	100.00
2017		89.04	10.96	100.00
2018		89.04	10.96	100.00
2019		81.51	18.49	100.00
2020		86.30	13.70	100.00
2021		86.30	13.70	100.00

Notes: N – number of NUTS-2 units.

Source: own elaboration.

The increase in the number and share of inefficient units in 2020–2021 compared to 2014–2018 may result from the impact of the COVID-19 pandemic on the economy of the EU and its regions. The pandemic shocked the global and EU economies and companies' innovation activities (Santos et al., 2021). On the one hand, the conditions for innovation processes deteriorated due to supply

and demand shocks in specific sectors and regions. On the other hand, pandemic crises (health, social and economic) have led to spectacular growth in some industries and technologies and a significant acceleration of innovation processes. Nevertheless, some of the RIS in EU countries and other parts of the world could not achieve the same efficiency as in previous periods (Miranda Junior et al., 2022). The coronavirus pandemic provided the impetus to reflect on the functioning of innovation systems worldwide, e.g., in developing countries during and in the post-pandemic world (Singh, Joseph, 2024). Fig. 1 presents the spatial division of NUTS-2 into efficient and inefficient regions in the two extreme years of the study. The graphical depiction of the distribution of units shows that in 2014 and 2021 (apart from a few exceptions), there was no definite accumulation of inefficient units in one country or territorial area.

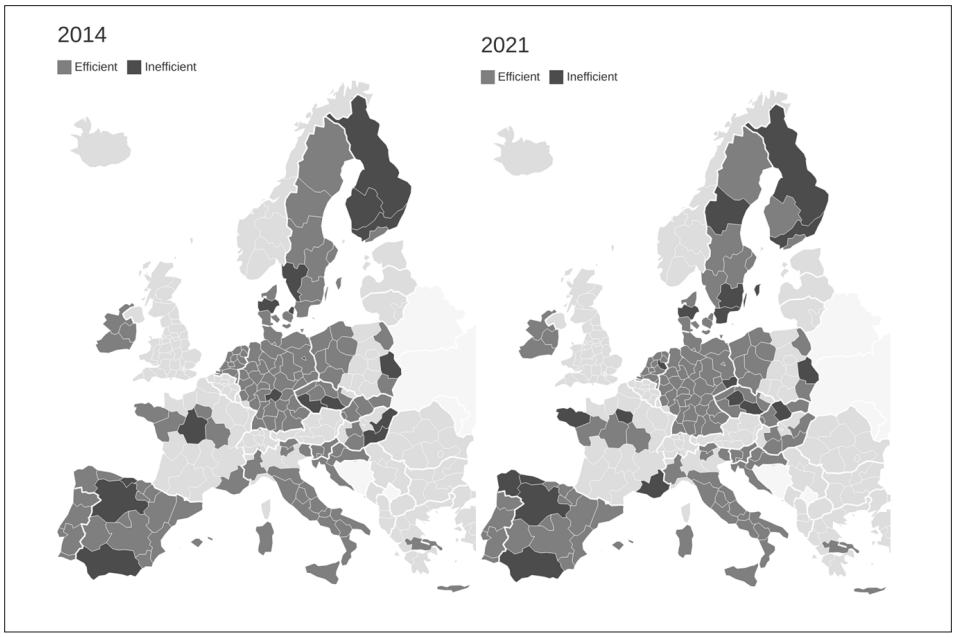

Fig. 1 Spatial division of NUTS-2 into efficient and inefficient in the two extreme years of the survey

Source: own elaboration.

The mentioned exceptions (at least 2 NUTS-2 inefficient units) concern Finland (2014, 2021), the Czech Republic (2014, 2021), Hungary (2014) and Spain (2014, 2021). Furthermore, it was noted that there are no significant differences between the two survey years for efficient and inefficient units. The changes in efficiency mainly concern single RIS. Notably, some units remained inefficient in the two years of the survey, while others either gained efficient

status in 2021 or, on the contrary, became inefficient. For example, FI19 and SE23 were considered inefficient in 2014 and efficient in 2021. The reverse was true for, among others, SE21 and SE22, which were initially deemed efficient in 2014 but inefficient in 2021. The change in status did not apply to FI1D, FI1C, ES61, ES41 and PL81, among others, which were inefficient in the two extreme years of the study.

The following research used the Super-SBM model with undesirable outputs to perform a RIS innovation ranking. The results of ranking the ten most and least efficient NUTS-2 from 2014 to 2021 are presented in Table 5. The research did not reveal a straightforward leader who was the most efficient each year. However, the EL64 unit emerged as the leader in 2016, 2018, 2020 and 2021, and ITG2 in 2014–2015. Several units were noted to be among the ten most efficient RIS in different years. Although a single RIS has proved most effective in some years, not in all, so H2 has been positively verified. In contrast, the least efficient unit in 2014–2018 was HU32; in 2019–2020, it was PL81. The situation changed in 2021 when the FRH0 was ranked last. Unit PL81 is located in the area of Eastern Poland, which has long shown a lower level of development than the rest of the country. For many years, central, regional and local governments have been taking many pro-development and pro-innovation activities in this area of Poland. They aim to accelerate the region's development. Unfortunately, it still shows a certain distance concerning the other regions of Poland.

The authors decided that the results obtained with the Super-SBM model with undesirable outputs had compared with those obtained by RIS in RISiE. As it turned out, the results differed, and a negative correlation was obtained between them. It means that the better the RIS score in RISiE, the weaker the level of efficiency is achievable. The difference is due to the method used to estimate the efficiency in RISiE and the DEA method. In the case of RISiE, all variables are considered together – whether they relate to inputs or outputs of RIS functioning. In contrast, in the case of the present analysis using the DEA method, the authors distinguished between variables on inputs and outputs of RIS operation. When estimating efficiency, we focused on the level of outputs obtained. It should be noted here that when evaluating the performance of an entity, whatever it may be (company, institution, territorial unit, etc.), the outputs of its work are more important than the inputs devoted to producing outputs. It is not always the case that more significant inputs contribute to more significant outputs of an entity. Therefore, the authors agree with the findings presented by Teirlinck and Spithoven (2023), who point out that the evaluation scale in RISiE inadequately reflects differences in efficiency in transforming knowledge inputs into innovation outputs. Furthermore, the authors argue for the extension of RISiE to include an indicator estimating the level of efficiency of individual RIS – a point also highlighted by Teirlinck and Spithoven (2023) in their study.

Table 5. Ranking of the ten most and least efficient NUTS-2 from 2014 to 2021

	2014		2015		2016		2017		2018		2019		2020		2021	
No	U	Eff.	U	Eff.	U	Eff.	U	Eff.	U	Eff.	U	Eff.	U	Eff.	U	Eff.
1	ITG2	3.074	ITG2	3.011	EL64	3.498	CZ04	5.078	EL64	4.794	ITH1	1.774	EL64	2.642	EL64	2.729
2	EL43	2.143	EL64	2.038	ITG2	3.140	EL64	3.900	EL43	2.006	CZ04	1.760	ITH1	1.854	EL43	1.917
3	EL64	2.043	EL43	1.958	EL43	2.382	ITG2	2.256	DE22	1.701	EL43	1.678	PT15	1.723	PT15	1.793
4	CZ04	1.622	CZ04	1.644	ITG1	1.566	EL43	2.024	ES53	1.620	ES53	1.667	DEE0	1.608	SI03	1.727
5	ITG1	1.524	ITG1	1.544	ES53	1.543	DE22	1.791	ITH1	1.590	DEE0	1.453	EL43	1.569	ITH1	1.499
6	ITF6	1.508	ES53	1.455	CZ04	1.467	ITH1	1.696	ITG2	1.555	HR03	1.452	ES53	1.542	CZ04	1.346
7	DE93	1.430	ITH1	1.401	DE22	1.415	ITF5	1.600	CZ04	1.546	PT15	1.404	DE93	1.485	ITG2	1.327
8	ES53	1.401	ITF5	1.342	ITH1	1.379	ES53	1.542	ITF5	1.346	ITF2	1.379	ITG2	1.474	HR03	1.291
9	ITH1	1.381	FRC1	1.316	ITF5	1.318	PT15	1.470	DK05	1.331	ITG2	1.346	SI03	1.463	SI04	1.283
10	FRC1	1.356	DE22	1.305	DE93	1.291	ITF3	1.284	HR03	1.284	ES23	1.289	CZ04	1.385	ES62	1.276
137	FRB0	0.670	DK01	0.642	ES61	0.750	CZ02	0.698	FI19	0.776	SE33	0.656	SI04	0.690	ES11	0.698
138	CZ03	0.655	FI1C	0.638	FI1C	0.650	PT16	0.688	SE23	0.764	FI1D	0.638	FI1D	0.666	ES41	0.694
139	DK01	0.649	FRB0	0.632	DK01	0.636	FI1D	0.682	SI04	0.738	SI04	0.626	SE33	0.619	SE32	0.690
140	FI1C	0.629	FI1D	0.618	FRB0	0.622	FRH0	0.558	PT16	0.721	PL84	0.611	FRH0	0.615	FRL0	0.688
141	FI1D	0.606	HU23	0.547	HU23	0.599	CZ06	0.555	FI1D	0.686	SE12	0.556	SE12	0.590	DED2	0.666
142	ES13	0.566	CZ06	0.523	ES13	0.565	FRB0	0.528	SE33	0.473	PL63	0.541	FRB0	0.561	PL81	0.662
143	CZ06	0.529	SE33	0.522	CZ06	0.544	PL81	0.499	FRB0	0.450	FRB0	0.507	PL63	0.518	CZ02	0.647
144	HU33	0.438	HU33	0.476	HU33	0.477	SE33	0.404	PL81	0.430	HU33	0.480	HU33	0.438	ES12	0.623
145	PL81	0.418	PL81	0.427	SE33	0.429	HU33	0.378	HU33	0.358	HU32	0.344	HU32	0.391	CZ06	0.613
146	HU32	0.377	HU32	0.393	HU32	0.386	HU32	0.207	HU32	0.194	PL81	0.288	PL81	0.292	FRH0	0.571

Notes: U – DMU, Eff. – efficiency, No – Rank position.

Source: own elaboration.

Since the average values of the efficiency scores in the SBM model with undesirable outputs in each year were high (above 94%), it was not possible to divide NUTS-2 into four groups according to the methodology used in RISiE (i.e. Innovation Leaders – 125% of the average value, Strong Innovators – between 100% and 125% of the average, Moderate Innovators – between 70% and 100% of the average and Modest Innovators – below 70% of the average). Only applying the Super-SBM model with undesirable outputs allowed the authors to divide the NUTS-2 surveyed into four groups. The results are presented in Fig. 2. The difference between Fig. 1 and Fig. 2 needs to be explained at this point. The application of the SBM model with super-efficiency and undesirable outputs allowed the RIS units to be divided in more detail. The efficient units in Fig. 1 were divided into two groups, i.e. Innovation Leaders, and were partly allocated to the Strong Innovators group when their efficiency values were close to 125% of the average for the whole research sample (at least above 107% of the average). The inefficient units in Fig. 1 were also divided into two groups, i.e. Moderate Innovators and Modest Innovators.

The first point worth noting when looking at Fig. 2 is that the RIS is significantly less differentiated in 2021 than in 2014. It is likely that we may be dealing with a convergence effect of innovation in European regions.

Fig. 2 Spatial division into NUTS-2 innovation performance groups in the two extreme years of the survey

Notes: Group 1 – Innovation Leaders, Group 2 – Strong Innovators, Group 3 – Moderate Innovators, Group 4 – Modest Innovators.

Source: own elaboration.

Comparison of data for 2021 with data from 2014 showed that some entities, such as Italian regions (e.g. Sicily, Sardinia), not only improved their situation compared to 2014 (group 4), but also ranked up to group 2. A more spectacular change can be seen in the Czech region located in the north-west of the country. It improved its efficiency so much that, in 2014, it was in group 4 and was promoted to group 1 in 2021. However, not every region retained its competitive advantage in terms of innovation, because, for example, the Lublin Voivodeship (in Poland) in 2014 was ranked at the top of the efficiency ranking, but in 2021, unfortunately, it was only in group 3. A comparison of the number of efficiency groups in 2014 versus 2021 shows a reduction of one.

Table 6 shows the number of RIS in each efficiency group. The highest number of units is in group 2, followed by group 3.

Table 6. Number and share of individual NUTS-2 efficiency groups 2014–2021

		Efficiency groups				
Year	N/%	1	2	3	4	Total
2014	N	10	93	39	4	146
2015		8	104	29	5	146
2016		8	82	53	3	146
2017		9	68	64	5	146
2018		7	90	44	5	146
2019		9	110	23	4	146
2020		12	107	23	4	146
2021		7	112	27	0	146
2014	%	6.85	63.70	26.71	2.74	100.00
2015		5.48	71.23	19.86	3.42	100.00
2016		5.48	56.16	36.30	2.05	100.00
2017		6.16	46.58	43.84	3.42	100.00
2018		4.79	61.64	30.14	3.42	100.00
2019		6.16	75.34	15.75	2.74	100.00
2020		8.22	73.29	15.75	2.74	100.00
2021		4.79	76.71	18.49	0.00	100.00

Notes: 1 – Innovation Leaders, 2 – Strong Innovators, 3 – Moderate Innovators, 4 – Modest Innovators, N – number of regions

Source: own elaboration.

When comparing the efficiency results in the following years, it is worth noting that the most remarkable change (shifts between groups 2 and 3) occurred in these groups. In the case of group 2 (Strong Innovators), it was observed that

there was a significant decrease in efficiency in two periods (2016 and 2017) compared to the previous year. In the other periods, there was an upward trend. In contrast, the fewest units were recorded in group 4 (Modest Innovators) and group 1 (Innovation Leaders). Interestingly, in 2017, the number of units in group 2 and group 3 were similar, at 68 and 64, respectively.

In addition, similar units were observed in these groups (1 and 4) (the most negligible variation between years in the group). When comparing year-on-year performance results, the authors noted that the most significant variability occurred in group 3. According to Xu *et al*. (2023b), economic development, investment in human capital and regional openness can increase innovation efficiency in most EU regions. In contrast, industrial structure, urbanisation, and infrastructure hinder improving European innovation efficiency. The results of our study partially coincide with those of Stergiou *et al*. (2024), who indicated that improving the efficiency of knowledge generation results in a reduction of greenhouse gas emissions. The shifts between efficiency groups in our study are due, on the one hand, to more efficient generation of good RIS outputs and, on the other, to attention to reducing undesirable outputs in terms of environmental pollution.

CONCLUSIONS

The appropriately designed research process and the research results obtained through it made it possible to answer the defined research questions. The results of the first research stage allowed the first research question (Q1) to be answered. The authors' research into the efficiency of regional innovation systems in Europe has shown as between 82% and 89% of NUTS-2 were efficient throughout the study period. Their share was the highest between 2015 and 2018.

The second research stage allowed the second (Q2) and third (Q3) research questions to be answered. The research showed that between 2014 and 2021, there was no clear leader with the highest efficiency each year. Based on the Super-SBM model with undesirable outputs, the authors prepared a ranking of the ten most and ten least efficient units in the period studied. It shows that no single region can be identified as the efficiency leader in innovation. It was possible to establish that leadership in this respect over the most prolonged period (2016, 2018, 2020 and 2021) was achieved by the EL64 unit. Among the most inefficient NUTS-2 units, HU32 showed this status for the longest time, between 2014 and 2020.

The research showed that European regions belonged to different innovation groups, with the Innovation Leaders group being the least numerous. The Strong Innovators and Moderate Innovators groups (the most numerous) had the most

prominent changes and shifts between groups. The authors noted that in 2021, no individuals were described as Modest Innovators. This indicates, on the one hand, that the innovation of the RIS has improved and, on the other hand, that the narrow classification of groups according to the EIS methodology results in a reduction in the number of groups in the long term.

Although this study filled a gap in the literature, it also has limitations. Firstly, the study excluded NUTS-2, for which it was impossible to obtain complete data for the entire study period, i.e. 2014–2021. Future studies should cover all NUTS-2 included in the different editions of RISiE. In order to do this, DEA models that consider uncertain data (e.g. fuzzy data, interval data) should be used. Secondly, the authors only analysed the past period based on historical data. Therefore, historical analysis can be considered in the future, and a prediction of future performance can be made. Thirdly, the study did not consider external factors affecting the obtained RIS efficiency results. It should be done by using methods (e.g. CNLS with contextual variables) and procedures (e.g. two-stage analysis) that take so-called environmental variables into account in the study when estimating efficiency. Fourthly, it is necessary to analyse changes in productivity between the years of the study. Another interesting research direction is the analysis of urban innovation and subsystems within RIS, e.g. sectoral innovation systems. It would build on research already undertaken in this area (Cano et al., 2023).

Recommendations for RIS policy on the EIS-RISiE tool

The authors' analyses of quantitative efficiency (based on RISiE database data) indicate that many RIS in the European Union are characterised by efficiency. However, this presented approach using RISiE data on inputs and outputs has many cognitive limitations. This is due to the numerous shortcomings of the RISiE. Firstly, this report lacks indicators capturing the quality of interactions between individual institutions, actors or people, or even data on cooperation between closer and further RIS (network effects), which can synergise to increase the efficiency and effectiveness of a particular RIS. Secondly, considering the sustainable development promoted in the EU, RISiE lacks more variables showing the environmental impact of innovations (only one variable is related to air pollution of fine dust from industry). Thirdly, among the RISiE data, no variables show the particular specialisation of the RIS or the adopted strategy for innovation development in the region. Consequently, RIS is assessed through the prism of the whole research sample rather than a subsample, which would have allowed the researchers to obtain more detailed analysis results. It is worth noting that in recent years, RIS efficiency issues have gained

importance in the context of the development of intelligent specialisations that will provide the region with long-term development and competitive advantage (Czyżewska-Misztal, Golejewska, 2016; Lopes et al., 2020). The drive to implement the proposed concepts in specific territories stems from the search by national and regional authorities for effective mechanisms for creating and diffusing innovation. The authors noted that some of the recommendations are gradually being implemented by the EU, albeit in a different way to RISiE. At the end of 2024, 148 regions in Europe have been awarded the title of Regional Innovation Valleys (RIV). The RIV initiative aims to create interconnected regional innovation valleys across the EU, by leveraging strategic areas of regional strength and smart specialisations (European Innovation Council and SMEs Executive Agency, 2023). Fourthly, RISiE lacks data at a lower level of aggregation for cities. It is, therefore, impossible to determine the strength of the impact of urban agglomerations on the efficiency of a given RIS, although the literature, using selected EU RIS as an example, indicates that metropolitan areas significantly influence innovation systems at a higher structural level (Fischer et al., 2001). Fifthly, RISiE does not provide information on the number of R&D institutions and innovation firms in an RIS. Their number and structure affect a given RIS's efficiency. The data in this respect would allow these units' economies of scale to be considered. Sixthly, there is no data on ICT in RISiE, and the dynamic development of these technologies can currently be seen. They are also an essential part of the network of relationships in innovation processes.

These arguments point to certain shortcomings of the RISiE methodology in a rapidly changing socio-economic environment and the increasing number of challenges facing RIS. In the context of the EU, it is worth highlighting actions the Community took, such as, among other things, the earmarking of EU funds for R&D activities and the promotion of human capital flows through Erasmus+ programmes. The information on this would make it possible to check the impact of the "EU effect" on individual RIS. Currently, there is a lack of such data in RISiE. The authors therefore recommend expanding the set of information collected to assess innovation activity in regional innovation systems in EU countries.

RISiE reports only include "hard" data characterising the institutional and formalised innovation system. They do not contain "soft" data, which could at least roughly show the "positive innovation climate" in the environment of innovation processes and the openness of society to the transfer of formal and tacit knowledge in interpersonal interactions. Introducing this type of data into the research on regional innovation and the operation of RIS would make it possible to assess the social potential for innovation, the barriers to knowledge and technology transfer and the areas of necessary support.

Attachments

Table A1. List of acronyms

Acronyms	Clarify
BCC	Banker, Charnes & Cooper model DEA
CCR	Charnes, Cooper & Rhodes model DEA
DEA	Data Envelopment Analysis
DMU	Decision-Making Unit
EIS	European Innovation Scoreboard
EU	European Union
GHG	Greenhouse Gas Emission
NIS	National Innovation System
NUTS	EU established in 2003 a common classification of territorial units for statistics called NUTS at three structural levels (hierarchical system). NUTS-2 is regions
R&D	Research and Development
RIS	Regional Innovation Systems
RISiE	Regional Innovation Scoreboard in Europe
SBM	Slacks Based Measure model DEA
Super-SBM	Slacks Based Measure model DEA with super efficiency

Table A2. Overview of NUTS-2 included in the RIS study

No.	Country	Code	No.	Country	Code	No.	Country	Code	No.	Country	Code	No.	Country	Code
1	Belgium	BE10	31	Germany	DE73	61	Spain	ES23	91	Italy	ITF1	121	Poland	PL81
2	Czechia	CZ01	32	Germany	DE80	62	Spain	ES24	92	Italy	ITF2	122	Poland	PL82
3	Czechia	CZ02	33	Germany	DE91	63	Spain	ES30	93	Italy	ITF3	123	Poland	PL84
4	Czechia	CZ03	34	Germany	DE92	64	Spain	ES41	94	Italy	ITF4	124	Portugal	PT11
5	Czechia	CZ04	35	Germany	DE93	65	Spain	ES42	95	Italy	ITF5	125	Portugal	PT15
6	Czechia	CZ05	36	Germany	DE94	66	Spain	ES43	96	Italy	ITF6	126	Portugal	PT16
7	Czechia	CZ06	37	Germany	DEA1	67	Spain	ES51	97	Italy	ITG1	127	Portugal	PT17
8	Czechia	CZ07	38	Germany	DEA2	68	Spain	ES52	98	Italy	ITG2	128	Portugal	PT18
9	Denmark	DK01	39	Germany	DEA3	69	Spain	ES53	99	Hungary	HU21	129	Slovenia	SI03
10	Denmark	DK02	40	Germany	DEA4	70	Spain	ES61	100	Hungary	HU23	130	Slovenia	SI04
11	Denmark	DK03	41	Germany	DEA5	71	Spain	ES62	101	Hungary	HU32	131	Slovakia	SK01
12	Denmark	DK04	42	Germany	DEB1	72	France	FR10	102	Hungary	HU33	132	Slovakia	SK02
13	Denmark	DK05	43	Germany	DEB2	73	France	FRB0	103	Netherlands	NL11	133	Slovakia	SK03
14	Germany	DE11	44	Germany	DEB3	74	France	FRC1	104	Netherlands	NL12	134	Slovakia	SK04
15	Germany	DE12	45	Germany	DED4	75	France	FRG0	105	Netherlands	NL13	135	Finland	FI19
16	Germany	DE13	46	Germany	DED2	76	France	FRH0	106	Netherlands	NL21	136	Finland	FI1B
17	Germany	DE14	47	Germany	DED5	77	France	FRL0	107	Netherlands	NL22	137	Finland	FI1C
18	Germany	DE21	48	Germany	DEE0	78	Croatia	HR02	108	Netherlands	NL23	138	Finland	FI1D
19	Germany	DE22	49	Germany	DEF0	79	Croatia	HR03	109	Netherlands	NL31	139	Sweden	SE11
20	Germany	DE23	50	Germany	DEG0	80	Croatia	HR05	110	Netherlands	NL32	140	Sweden	SE12
21	Germany	DE24	51	Ireland	IE04	81	Croatia	HR06	111	Netherlands	NL33	141	Sweden	SE21
22	Germany	DE25	52	Ireland	IE05	82	Italy	ITC1	112	Netherlands	NL34	142	Sweden	SE22
23	Germany	DE26	53	Ireland	IE06	83	Italy	ITH1	113	Netherlands	NL41	143	Sweden	SE23
24	Germany	DE27	54	Greece	EL43	84	Italy	ITH2	114	Netherlands	NL42	144	Sweden	SE31
25	Germany	DE30	55	Greece	EL64	85	Italy	ITH4	115	Poland	PL41	145	Sweden	SE32
26	Germany	DE40	56	Spain	ES11	86	Italy	ITH5	116	Poland	PL42	146	Sweden	SE33
27	Germany	DE50	57	Spain	ES12	87	Italy	ITI1	117	Poland	PL43			
28	Germany	DE60	58	Spain	ES13	88	Italy	ITI2	118	Poland	PL51			
29	Germany	DE71	59	Spain	ES21	89	Italy	ITI3	119	Poland	PL61			
30	Germany	DE72	60	Spain	ES22	90	Italy	ITI4	120	Poland	PL63			

Source: own elaboration based on European Commission (2022a).

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Social and financial inequalities in the availability of public transport in selected capitals of Polish voivodeships[2]

Abstract

The aim of the article was to determine the scale of the impact of the financial barrier in public collective transport (hereinafter: PCT) in selected local government units and to compare selected voivodeship cities – metropolitan centers in terms of the mobility policy applied in the financial aspect.

The study aims to identify differences in transport accessibility based on the relationship between ticket prices and residents' incomes and to examine the potential effects of eliminating fees for public transport use on reducing social inequalities.

Moreover, the aim was to benchmark selected voivodeship cities – metropolitan centres, in terms of the applied tariff policy within the framework of public transport (hereinafter: PCT) in comparison with the disposable income of the population.

The research problem was the affordability of public collective transport in selected LGUs. 9 out of 10 largest Polish cities in terms of population. So far, none of them has implemented unconditional free public transport. Therefore, there is a financial barrier, which in the case of the lowest-earning residents, makes it difficult to meet current life needs.

The analysis was carried out in mid-2024 based on data from the turn of 2023/2024 and selected, from 2022, mostly from public statistics, including the Central Statistical Office (Polish: GUS). Polish and foreign literature and industry press were used. The own study was based on information from LGUs and their communication companies. Finally, the analyzed cities were categorized in terms of the adopted criteria.

It can be stated that the lack of fees for using PCT will translate into a reduction in social inequalities in a given LGU. The scale of this change cannot be determined *ex-ante*, and therefore the effectiveness of such a policy cannot be estimated. As part of the benchmarking, the studied group can be divided into three categories in terms of financial accessibility: highly accessible

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(Gdańsk, Kraków, Poznań), with average financial accessibility (Lublin, Szczecin and Wrocław) and with low financial accessibility (Białystok, Bydgoszcz and Łódź).

Keywords: mobility, city, exclusion, ticket, cost.

Nierówności społeczne a finansowa dostępność transportu publicznego w wybranych stolicach polskich województw

Abstrakt

Celem artykułu było określenie skali wpływu bariery finansowej w publicznym transporcie zbiorowym (dalej: PCT) na wybrane jednostki samorządu terytorialnego oraz porównanie wybranych miast wojewódzkich – ośrodków metropolitalnych pod względem stosowanej polityki mobilności w aspekcie finansowym.

Celem badania była identyfikacja różnic w dostępności transportu na podstawie relacji cen biletów do dochodów mieszkańców oraz zbadanie potencjalnych skutków zniesienia opłat za korzystanie z transportu publicznego na zmniejszenie nierówności społecznych.

Ponadto celem był benchmarking wybranych miast wojewódzkich – ośrodków metropolitalnych, pod względem stosowanej polityki taryfowej w ramach publicznego transportu zbiorowego (dalej: PCT) w zestawieniu z dochodami rozporządzalnymi ludności.

Problemem badawczym była dostępność finansowa publicznego transportu zbiorowego w wybranych JST. 9 z 10 największych polskich miast pod względem liczby ludności. Do tej pory żaden z nich nie wdrożył bezwarunkowego bezpłatnego transportu publicznego. Istnieje zatem bariera finansowa, która w przypadku najgorzej zarabiających mieszkańców utrudnia zaspokojenie bieżących potrzeb życiowych.

Analizę przeprowadzono w połowie 2024 r. na podstawie danych z przełomu 2023/2024 r. i wybranych, z 2022 r., wykorzystując głównie statystyki publiczne, w tym GUS. Przeprowadzono przegląd literatury polskiej i zagranicznej oraz prasy branżowej. W badaniu własnym wykorzystano informacje pochodzące od JST i ich firm telekomunikacyjnych. Na koniec dokonano kategoryzacji analizowanych miast ze względu na przyjęte kryteria.

Ostatecznie stwierdzono, że brak opłat za korzystanie z PCT przełoży się na zmniejszenie nierówności społecznych w danej JST. Skali tej zmiany nie można określić *ex ante*, a co za tym idzie, nie można oszacować efektywności takiej polityki. W ramach benchmarkingu badaną grupę podzielono na trzy kategorie pod względem dostępności finansowej: wysoko dostępną (Gdańsk, Kraków, Poznań), o średniej dostępności finansowej (Lublin, Szczecin i Wrocław) oraz o niskiej dostępności finansowej (Białystok, Bydgoszcz i Łódź).

Słowa kluczowe: mobilność, miasto, wykluczenie, bilet, koszt.

JEL: H71, H72, H75, H76, L98, O18, R48.

Introduction

In the EU transport policy, we can find specific expectations regarding public transport. These include the construction of sustainable, intelligent and resilient urban mobility systems based on an active public sector and its capabilities to meet needs in this matter (Mercik, 2023, p. 710). This leads

to a basic conclusion: this transport should (theoretically) be available to all residents of a given area.

The research problem will be the affordability of public collective transport (hereinafter PCT) in selected LGUs. 9 out of 10 largest Polish cities in terms of population were used for further analysis. So far, none of them has implemented unconditional free public transport. Therefore, there is a financial barrier, which in the case of the lowest-earning residents, makes it difficult to meet current life needs. This was considered a significant research problem and relatively little analysed in Polish-language literature, within the framework of domestic economic conditions. It was assumed that the social severity of the financial barrier is the greater the higher the ticket fee paid by a potential user of individual transport is in relation to their income.

The aims of the article are to identify differences in transport accessibility based on the relationship between ticket prices and residents' incomes and benchmark selected provincial cities – metropolitan centres with a population of 300-800 thousand in terms of the affordability of public transport. Białystok (292 thousand people) and Kraków (806 thousand people) were included in the range, obtaining nine entities subject to further study. Finally, the analysed cities were categorized in terms of the adopted criteria.

The analysis was carried out in mid-2024 based on data from the turn of 2023/2024 and selected, from 2022, mostly from public statistics, including the Central Statistical Office (Polish: GUS). Polish and foreign literature and industry press were used. The own study was based on information from LGUs and their communication companies.

Urban public transport and social inequalities – definitions

Inequalities are associated with the poorer economic geographic areas of the world, countries known as developing. However, the problem affects every part of the globe, differing only in its spatial scale (Hatzenbuehler et al., 2024). An example is the eastern provinces of Poland, classified in the European nomenclature as less developed regions (Dz.U. UE 2019/C 162/03). People are moving to the largest cities and their metropolitan areas, which is confirmed by subsequent censuses and studies of population migration (GUS, https). This leads to the conclusion that these areas are subject to special challenges related to inequalities that have their basis in the current and past financial situation of these people.

When looking for synonyms for "inequality", terms such as asymmetric, disproportionate, uneven, non-uniform, irregular, etc. come to mind. When inequality concerns society, it is defined by access to specific, expected goods,

uneven levels of need satisfaction, measured, for example, by individual life satisfaction and/or consumption (Kałamucka, 2023, pp. 118–122). It should therefore be stated that inequalities concern diverse aspects of life (Pliszka, 2005, pp. 451–454). The implications are transferred to opportunities (or lack thereof) in terms of work, education, access to health care or, more broadly, the living conditions of individuals and social groups; they are associated with being born in a specific place (Suter, 2000, pp. 6589–6594). The basis for inequality may be a lack of understanding of the needs of people who experience certain aspects of urban mobility differently than people with various types of disabilities (e.g. physical, intellectual, cognitive, sensory) (Mwaka et al., 2024). Social inequalities affect many areas of human life, but they are most often associated with income differentiation. Social inequalities are noticeable in every area of life and have an impact on the material and non-material existence of a person (Krot, Lewicka, 2016, pp. 233–244; Velho et al., 2016, pp. 24–35). Exclusion related to poverty can be activated and maintained, among others, by the lack or deficiency of mobility in physical space (Kenyon, 2006, pp. 1–120). At the same time, these inequalities have an impact on human mobility; financial access to public transport is a limitation. There is a feedback loop here: well-managed human and social mobility can contribute to reducing inequalities (Hackl, 2018, pp. 150–162).

The Polish legislator defined public collective transport as "generally available regular passenger transport performed at specified intervals and on a specified communication line, communication lines or communication network" (Art. 4 ustawy z dnia 16 grudnia 2010 r. o publicznym transporcie zbiorowym, Dz.U. 2023 poz. 2778). In addition, the same article of the Act includes a definition of public transport. These are universally available services in the scope of public collective transport performed by a public collective transport operator for the purpose of current and uninterrupted satisfaction of the transport needs of a given community in a given area, which in this case is the borders of a LGU (Dz.U. 2023 poz. 2778). The implementation of this goal is limited by the financial considerations of a given commune and (in the case of payment) the disposable income of the population.

Another concept that combines the two above is the "affordability" of public transport. It is understood as the conscious possibility of incurring expenses related to urban mobility using public transport. The financial costs of travel are assessed – their impact on the budgets of individuals and households (Carruthers, Dick, Saurkar, 2005, pp. 1–2). The affordability of public transport can be measured by the nature of travel and its structure: whether a given person travels exclusively out of duty (work, school, medical care) or for pleasure (e.g. to the cinema, theatre, sporting event). The affordability of transport is higher the lower the percentage of travel costs in total expenses. Each city applies a different pricing policy, which is an interesting material for comparison.

AFFORDABILITY OF PUBLIC TRANSPORT IN SELECTED POLISH CITIES

The affordability of public transport services is one of many problems within the macro-problem of social inequality. As mentioned in the introduction, each of the cities studied applies a ticket fee. In this case, the affordability of transport will be compared to the financial capabilities of society. A single-ride ticket (or – in the absence of such an option – its time equivalent in the form of a 45/60-minute ticket) cost in 2024 from PLN 3.80 (Bydgoszcz) to PLN 6 (in Krakow and Poznań), which in a "round trip" gives amounts from PLN 7.60 to PLN 12. Theoretically, these are not significant – in relation to the disposable budget of households in Poland – amounts, but they can be a barrier for people with the lowest incomes. For example, from January 1, 2025, the income criteria for social assistance will increase to a maximum of: PLN 1,010 (currently – PLN 786) for a person running a household alone and PLN 823 (currently – PLN 600) for a person in a family (Dz.U. 2024 poz. 1044). Referring this to the average number of working days per month treated as activity (in 2024: 21 days/month) it should be stated that the monthly cost of PCT in the cities studied would range (for PLN 3.80 and PLN 6 per ticket; taking into account one return trip): from PLN 159.6 to PLN 252, which would constitute 20%–32% of the budget of a single-person household and 26%–42% per person in a multi-person household. In the case of a single-person household, on the lowest statutory salary, which from mid-2024 amounts to PLN 3,262 net (full-time job), this gives a share of disposable income from 5% to 7.7%. Mobility within the LGU may therefore be limited by the affordability of PCT.

In the case of people who use public transport regularly and treat it as their so-called "first choice", a more adequate comparison will be the cost of monthly tickets, which is presented in the table below (Table 1). The cost of purchasing a ticket was compared to the average monthly gross salary. It should therefore be remembered that the availability of a monthly ticket measured by its price will be lower, because citizens have a net salary.

Table 1. Summary: monthly ticket prices, average monthly gross salary and the relation between the price of a monthly ticket within the PCT to the above-mentioned salary in selected Polish cities in 2024

City	Price of a monthly ticket, without discounts, for all day lines in PCT) in PLN (as of 01/07/2024)	Average gross monthly salary (in PLN; at the end of 2023)	The relationship between the price of a monthly ticket and the average monthly gross salary
1	*2*	*3*	*4*
Białystok	130.00	7089.31	1.83%
Bydgoszcz	108.00	7478.19	1.44%
Gdańsk	117.00	8915.97	1.31%

1	*2*	*3*	*4*
Kraków	90.00	9223.73	0.98%
Lublin	128.00	7443.57	1.72%
Łódź	168.00	7548.10	2.23%
Poznań	149.00	8303.38	1.79%
Szczecin	140.00	7933.31	1.76%
Wrocław	110.00	8334.84	1.32%

Source: own study based on public transport websites in the surveyed cities, as well as data from (the Central Statistical Office, https).

Kraków is the leader of the list, with a burden of less than 1% in relation to the average gross monthly salary. Moreover – comparing the retail price of a monthly ticket for an individual customer to the social benefit threshold under the income criterion in the scope of social assistance for a single-person household – the purchase cost constitutes 11.5% of the amount of the income threshold of social assistance and is also the lowest in the above list. At the opposite end of the spectrum is Łódź with a price of PLN 168 for a monthly personal ticket. Its purchase is an expense of around 2.23% of the average monthly salary according to the Central Statistical Office for a given LGU; comparing the cost of purchasing a ticket to the income criterion in the scope of social assistance for a single-person household gives 21.4%. Such a high share, with limited disposable income, may therefore clearly affect the ability to use PCT.

Based on data from the Central Statistical Office, it is worth tracking the number of households that benefited from community social assistance benefits in a given year. The Central Statistical Office included such a household in the statistics only once, without taking into account the number of benefits and the number of people in a given household (and therefore the actual number of beneficiaries). The data was compared with the number of households according to the National Census of 2021. According to the legislator, "a household using community social assistance is one that has received financial assistance, in kind or in the form of services through a social welfare center" (Dz.U. 2016 poz. 930). The condition for granting assistance is the occurrence of one of the problems listed in Article 7 of the above Act. In the case of cash benefits, the basic condition for their granting is the income criterion, which was mentioned in the earlier part of the article.

The above table shows the scale of the problem of access to PCT. The above percentage of households may have limited possibilities, e.g. in terms of performing work and adapting qualifications to the spatial needs in a given LGU. Paying for public transport contributes to a decrease in the efficiency of using human capital in a given LGU, negatively affecting the labor market.

Table 2. Share of households covered by social assistance (according to income criterion; 2022) in all households in LGUs (NSP2021)

City	Number of households covered by social assistance support based on income criteria (according to data for 2022)	Number of households based on the 2021 National Census	Share of households covered by social assistance based on income criterion in the total number of households in a given commune
Białystok	4,551	111,569	4.1%
Bydgoszcz	3,833	129,662	3.0%
Gdańsk	4,874	193,377	2.5%
Kraków	8,934	320,708	2.8%
Lublin	4,619	127,631	3.6%
Łódź	10,977	289,269	3.8%
Poznań	11,471	220,993	5.2%
Szczecin	5,028	155,886	3.2%
Wrocław	5,398	280,635	1.9%

Source: own study based on: (Central Statistical Office, Local Data Bank, Number of households covered by social assistance support based on income criterion, and Number of Households according to NSP2021, https).

Is the lack of individual payment for the use of PCT a panacea for social inequalities in terms of mobility?

It is therefore appropriate to consider a situation in which the cities studied waive individual fees for access to PCT. Would the number of passengers served increase? The answer seems obvious: yes. For example, research by foreign authors, e.g. on the unified (and lower than before) tariff for Lisbon introduced in 2019, showed an increase in the use of public transport (Silver et al., 2023). By how much? – we cannot measure this ex-ante. It should be emphasized that the affordability of public transport is an important, although one of many, factors encouraging or discouraging the use of this means of transport in the territory of LGUs (Kwarciński, 2013, pp. 230–236; Goliszek, Połom, 2016, pp. 16–27). To some extent, the answer to this type of question is illustrated in the table below (Table 3). It presents the relationship between the number of passengers and the population.

The largest number of passengers per year, relative to the number of inhabitants, is carried by operators in Poznań, followed by Kraków. It is worth mentioning that Poznań was in 3rd place from the end in terms of the relation between the price of a monthly ticket and the average monthly gross salary; a higher relation was only observed in Białystok and Łódź. In Białystok, there were 204 passengers

per resident in 2023, which was the lowest result). Therefore, a correlation can be observed between the price of a monthly ticket and the number of passengers transported annually by PCT. However, it should be noted that in cities such as Poznań, Wrocław, Kraków or Gdańsk, the number of passengers is inflated by tourists and students; the latter – due to the relatively large and recognizable universities located there. It should therefore be stated that the course of the curve responsible for the relation between ticket prices and the level of PCT use will be different for individual urban centres. Thus, the impact of reducing the price of transport on the increase in the number of passengers will not be uniform for the cities studied.

Table 3. The number of public transport passengers in relation to the population of LGUs (in 2023, in millions of people)

City	Population (2023 in millions)	Number of public transport passengers (2023 in millions)	Number of passengers compared to the population in a given city
Białystok	0.29169	59.50	203.99
Bydgoszcz	0.32643	90.20	276.32
Gdańsk	0.48737	158.20	324.60
Kraków	0.80620	351.90	436.49
Lublin	0.32957	107.00	324.67
Łódź	0.65202	177.50	272.23
Poznań	0.53844	251.70	467.46
Szczecin	0.38907	150.00	385.54
Wrocław	0.67374	194.50	288.69

Source: own study based on public transport websites in the surveyed cities, as well as data from (the Central Statistical Office, Local Data Bank, https).

Conclusions and recommendations

It can be stated that the lack of fees for using PCT will translate into a reduction in social inequalities in a given LGU. The scale of this change cannot be determined *ex-ante*, and therefore the effectiveness of such a policy cannot be estimated. Free PCT is not an ideal solution. Such an approach may intensify unfavourable social behaviours, e.g. taking over pedestrian traffic (I can ride 2 stops "for free"), or lead to the creation of induced traffic (trips that would not have been made before). Moreover – referring to the first part of the article - the lack of payment could be combined with social assistance and thus intensify the association that PCT is for "poor people", and no one wants to be qualified as such (Mazur, 2024, https). In January 2024, 94 communes in Poland were

covered by free transport addressed to everyone or only to residents. However, it should be emphasised that these were smaller communes (maximum several dozen thousand inhabitants) with a poorly developed bus network and a small number of connections per day, which is not really able to replace private transport, as is the case in the largest cities in Poland.

However, the question remains open whether the provincial cities that are the subjects of the study cannot afford to bear the costs of this transport. After all, the goal is the greater good – ensuring mobility for citizens. Additionally, there are environmental benefits and benefits related to attracting external human capital.

As part of the benchmarking, taking into account, among others, the income of the population, the prices of individual types of tickets, the effect in the form of the number of passengers using PCT – the studied group can be divided into three categories in terms of financial accessibility: highly accessible, with average financial accessibility and with low financial accessibility. The first category included Gdańsk, Kraków and Poznań. These are large agglomerations with relatively high (compared to the other entities in the study) income per capita. The efficiency of functioning and spatial accessibility of public transport and relatively low or average prices of single and season tickets ultimately translated into quite high results in this ranking. The second category included Lublin, Szczecin and Wrocław. The lowest category includes: Białystok, Bydgoszcz and Łódź. In each of them, ensuring individual mobility requires the involvement of a relatively larger part of the budget of individuals than in the case of other cities. At the same time, Białystok has the greatest potential related to the possibility of increasing the number of PCT users in relation to reducing ticket prices. In recent years, the number of passengers has been decreasing, while public transport ticket prices have been increasing. Analyzing this relationship, it can be clearly stated that a radical reduction in the price of a ticket with the promise of a future freeze (and then liquidation) of fees would encourage people to abandon the use of individual transport. A good example is the "German ticket for 9 euros" (Rozynek, 2024, pp. 80–90), which led to an increase in the use of public rail transport precisely by lowering the financial barrier. According to estimates by the German government, as a result of the implementation of the 9-euro ticket, 52 million people used public transport between June and the end of August 2022 alone and it was possible to reduce air pollution emissions by approximately 1.8 million tons of CO_2 emissions (Michalak, 2022).

Due to transport subsidies for entities performing these tasks and the costs for local government units associated with this, scientists most often analyze the possibility of limiting the amount of budget subsidies for public transport without discouraging potential passengers (demand) and maintaining the supply of services. The goal – most often – is to limit the satisfaction of the need for mobility by car in LGUs (Bąkowski, 2015, pp. 3–9). Here, therefore, there is room

for deepening research on the ability of LGUs' budgets to take over the entire burden of financing public transport.

Based on the above and the experience of other Polish cities, the formation of transport tariffs should refer to a greater extent to the actual financial possibilities of potential users. A good example is Białystok, which introduced no fees for children and studying youth (Dz.U. Woj. Podlaskiego z 2019 r. poz. 5074). Similar forms of support for disabled people, those looking for (unemployed) or taking up a job would be advisable (e.g. free of charge for the first three months of starting employment). Such evolutionary changes in the formation of tariffs and exclusions from fees would allow for an increase in the affordability of PCT in the largest Polish cities and would be an important step towards ensuring free public transport.

The problem of the relatively low use of PCT is also stereotypes, e.g. associations with poverty, lack of professional success. In addition, people with discounts, i.e. pupils, students, and retirees, use public transport. Those who would use a full-price ticket strive to purchase an individual means of transport - a private car. This is the result of the dominant thinking for many generations that one's own house and car are the synonyms of success and luxury. This is confirmed, for example, by the study by the Lindorff company entitled "The material situation of Poles" from 2017, in which 64% of respondents indicated a car as a synonym for wealth (Arak, 2024). J. Gierczak ventured to make a far-reaching statement that the lack of a car disqualifies a person socially. At the same time, he pointed out that this approach is independent of the intellectual level of the people surveyed (Gierczak, 1994, p. 12). The growing number of wealthy Poles (income above PLN 120,000 gross per year) does not help in changing stereotypes. Despite the pandemic and unfavourable changes in taxes, the 2024 KPMG report indicated that the number of such people increased by as much as 51% between 2021 and 2022 (KPMG, 2024). To sum up, social (including pro-ecological) and political (legal) actions are necessary to change transport habits towards greater use of PCT (Kasperska, 2011, p. 1108).

The elimination of the financial barrier to using public transport would not translate into a change in the mobility habits of the urban population in the short term. However, it would have a major impact on decisions at the time of using up a private vehicle, or especially on younger users and their future. The implementation of free public transport is a solution that could contribute to solving, or at least reducing the scale of the impact of other problems, starting with air quality, noise, traffic congestion, the need to build new parking lots, wider roads, etc. These effects are difficult to assess and compare with the costs of maintaining PCT and probably for this reason, there is no change in the concept of mobility in cities.

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Right-wing vs. left-wing: comparative analysis of pension systems in Paraguay and Venezuela in the context of extreme political ideologies

Abstract

The pension systems in Latin America have experienced significant transformations influenced by political ideologies. Paraguay and Venezuela present contrasting cases, with right-wing and left-wing policies, respectively. This paper analyzes how these ideologies shaped pension reforms in both countries, focusing on their outcomes and sustainability.

This article aims to compare the pension systems of Paraguay and Venezuela to understand how extreme political ideologies impact social security policies. It identifies strengths and weaknesses of both systems, and evaluates broader implications for economic stability and social equity.

A comparative analysis is conducted using both qualitative and quantitative data from government reports, international organizations, and academic sources. The analysis includes case studies and historical data to highlight differences in the systems and the political contexts behind them.

Right-wing policies in Paraguay emphasize privatization, leading to inequality and potential financial instability, while Venezuela's left-wing policies focus on state control and redistribution, resulting in financial challenges and reduced public trust. This paper contributes to the understanding of how political ideologies affect social security systems, offering insights for policymakers and researchers.

Keywords: pension systems; political ideologies; Paraguay; Venezuela; comparative analysis.

Prawica kontra lewica: analiza porównawcza systemów emerytalnych w Paragwaju i Wenezueli w kontekście skrajnych ideologii politycznych

Abstrakt

Systemy emerytalne w Ameryce Łacińskiej przeszły znaczące transformacje, pod wpływem różnych ideologii politycznych. Przypadki Paragwaju i Wenezueli stanowią kontrastujące przykłady, z od-

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powiednio prawicowymi i lewicowymi politykami. Niniejszy artykuł analizuje, jak te ideologie wpłynęły na reformy emerytalne w obu krajach, koncentrując się na ich wynikach i zrównoważonym rozwoju.

Celem artykułu jest porównanie systemów emerytalnych Paragwaju i Wenezueli w celu zrozumienia, w jaki sposób skrajne ideologie polityczne wpływają na polityki zabezpieczenia społecznego. Identyfikuje mocne i słabe strony obu systemów oraz ocenia szersze implikacje dla stabilności ekonomicznej i sprawiedliwości społecznej.

Przeprowadzono analizę porównawczą z wykorzystaniem zarówno danych jakościowych, jak i ilościowych pochodzących z raportów rządowych, organizacji międzynarodowych oraz badań naukowych. Analiza obejmuje studia przypadków i dane historyczne, które ukazują różnice w systemach oraz konteksty polityczne, które je kształtowały.

Polityki prawicowe w Paragwaju kładą nacisk na prywatyzację, co prowadzi do nierówności i potencjalnej niestabilności finansowej, podczas gdy lewicowe polityki w Wenezueli koncentrują się na kontroli państwa i redystrybucji, co skutkuje wyzwaniami finansowymi i spadkiem zaufania publicznego. Artykuł wnosi wkład w zrozumienie wpływu ideologii politycznych na systemy zabezpieczenia społecznego, oferując cenne wnioski dla decydentów i badaczy.

Keywords: systemy emerytalne; ideologie polityczne; Paragwaj; Wenezuela; analiza porównawcza.

JEL: H55; P16; O57.

Introduction

Contemporary pension systems in Latin American countries constitute a crucial element of social policy, reflecting both historical conditions and current political trends. Particularly interesting for analysis are the pension systems of Paraguay and Venezuela, which differ not only structurally but also ideologically. Paraguay, dominated by extreme right-wing political influences, and Venezuela, under the rule of extreme left-wing politics, offer a unique opportunity for a comparative analysis of the impact of different ideologies on the shaping of pension policy (Datz, 2012; Madrid, 2003).

The purpose of this article is to examine how extreme political ideologies, both right-wing and left-wing, have influenced the development and functioning of pension systems in Paraguay and Venezuela. Through a comparative analysis, the article seeks to understand how these ideologies shape political decisions and what consequences they have for the stability and efficiency of pension systems (Kay, 2011).

Although there is extensive literature on the impact of political ideologies on social policy, there is a lack of detailed analyses comparing specific cases of countries with vastly different political orientations. This study aims to fill this gap by offering a new perspective on understanding the role of ideology in shaping pension systems (Mesa-Lago, 2008; Müller, 2003).

The research methodology is based on a comparative analysis of available data concerning the pension systems in Paraguay and Venezuela. The methods employed include both qualitative and quantitative approaches, allowing for a comprehensive evaluation of the subject matter (Barrientos, 2004).

The article is organized as follows: After the introduction and literature review, where previous research on the topic is discussed, the methodology section presents the details of the research methods used. The next part of the article contains the research findings, which are thoroughly discussed and compared in the context of the impact of extreme political ideologies. The article concludes with a discussion of the findings and recommendations for future social policy and further research in this area.

Literature review

Literature review on pension systems in Latin America

The literature on pension systems in Latin America reveals significant differences in approaches to pension reforms, particularly in the context of the impact of political ideologies on the shaping of these systems. There is broad consensus in the literature that political conditions and the ideological preferences of the ruling parties play a crucial role in the direction of pension reforms in the region (Madrid, 2003; Kay, 2011).

Pension reforms in Latin America

During the 1980s and 1990s, many Latin American countries underwent substantial pension system reforms, which were partially driven by the influence of neoliberal policies promoted by international financial institutions such as the International Monetary Fund (IMF) and the World Bank (Kay, 2011). These reforms often involved the privatization of pension systems, aimed at increasing the efficiency of pension fund management as well as reducing fiscal burdens on the state (Madrid, 2003).

In this context, Paraguay became an example of a country that adopted a pension model strongly inspired by neoliberal ideology, resulting in the creation of a system based on private pension accounts managed by private investment funds (Barrientos, 2004). On the other hand, Venezuela, under the leadership of Hugo Chávez, took the opposite direction, aiming for the renationalization of the pension sector and the creation of a state-run pension system that would reflect the values of the extreme left, such as social justice and income redistribution (Müller, 2003).

The impact of political ideologies on pension systems

The ideological differences between the right and the left have a significant impact on the shaping of pension policy. The right, with its emphasis on the free

market, private property, and a limited role for the state, leans towards pension models that promote individual responsibility and private savings for retirement (Madrid, 2003). In practice, this translates into the privatization of pension systems, as observed in Paraguay, where neoliberal reforms have found fertile ground (Kay, 2011).

Conversely, left-wing governments, as in the case of Venezuela, strive to strengthen the state's role in providing social security, which translates into highly centralized pension systems. The goal of such systems is to ensure universal access to pension benefits, regardless of individual savings ability, in line with left-wing values of social justice and redistribution (Mesa-Lago, 2008).

Clash of ideologies: Paraguay vs Venezuela

Paraguay and Venezuela represent two extreme cases in the context of pension reforms, influenced by diametrically opposed political ideologies. Paraguay, where the extreme right dominates, introduced reforms aimed at privatizing the pension system and limiting the role of the state. In contrast, Venezuela, dominated by the extreme left, sought to centralize the pension system and increase state control over pension funds (Datz, 2012).

Comparing these two cases allows for an understanding of how extreme political ideologies can influence the shaping of pension systems and what consequences these changes may have for society. The literature highlights that while privatization can increase the efficiency of pension systems, it can also lead to social inequalities. On the other hand, centralization can provide greater social justice but often at the expense of economic efficiency (Barrientos, 2004; Müller, 2003).

Research methods

Methodology

The methodology of this study is based on a comparative analysis of the pension systems in Paraguay and Venezuela, considering the impact of extreme political ideologies on the shaping of these systems. Both qualitative and quantitative approaches were employed to provide a comprehensive view of the issue under examination.

Description of research materials

The study is based on the analysis of secondary data, including government documents, reports from international organizations such as the International

Monetary Fund (IMF) and the World Bank, as well as academic literature on pension systems in Latin America. Specifically, reports and publications on pension reforms in Paraguay and Venezuela were utilized, which constitute the primary data sources for this research (Kay, 2011; Madrid, 2003).

Methods of analysis

The research was conducted using comparative analysis and case study methods. Comparative analysis allows for the juxtaposition of two different approaches to pension policy – the neoliberal model adopted in Paraguay and the left-wing approach in Venezuela – and the assessment of their impact on the structures and efficiency of the pension systems.

a. **Qualitative Analysis**: The qualitative analysis involved a detailed examination of the content of government documents, legislation, and political guidelines that shaped pension reforms in both countries. The focus was on understanding how political ideologies influenced decisions regarding the structure of the pension systems and identifying key differences between them.
b. **Quantitative Analysis**: The quantitative analysis was based on processing statistical data concerning the level of pension security, the financing of pension systems, as well as demographic indicators affecting the efficiency of these systems. Data were analyzed regarding the number of people covered by the pension systems, the amount of benefits, the level of poverty among retirees, and the financial stability of the systems.

Research hypotheses

The following hypotheses were proposed in the study:

– Hypothesis 1: A pension system based on neoliberal principles, such as in Paraguay, leads to greater financial efficiency but may increase social inequality.
– Hypothesis 2: A pension system based on left-wing principles, such as in Venezuela, increases social justice but at the expense of financial stability and system efficiency.

Methodological limitations

It should be noted that the study relies primarily on available secondary data, which may limit the completeness of the analysis. Additionally, the lack of access to current and accurate data from Venezuela, due to the ongoing economic and political crisis, poses a significant challenge to accurately assessing the efficiency of the pension system in that country. Despite these limitations, the applied methodology allows for an insightful examination and comparison of the pension systems under study.

Results

Pension system in Paraguay (as of october 1, 2024)

The pension system in Paraguay is characterized by a complex structure that has evolved over the years, adapting to changing demographic, economic, and political conditions. Paraguay has two main pension programs: the Mandatory Social Insurance (*Seguro Social Obligatorio*) and the Social Assistance System for the Elderly (*Pensión Alimentaria para Adultos Mayores*). The Paraguayan pension system also includes several special schemes for various professional groups, such as public sector employees, teachers, police, military personnel, railway workers, dockworkers, bank employees, and micro-entrepreneurs. These special schemes provide additional benefits and conditions tailored to the specific needs of these professional groups (Social Security Administration, 2020).

Mandatory social insurance

The Mandatory Social Insurance covers public and private sector employees, including municipal workers, employees of state-owned enterprises, seasonal workers, and domestic workers. The program is also available to self-employed individuals on a voluntary basis. Pension contributions amount to 9% of gross monthly earnings paid by employees, 14% by employers, and 1.5% by the government, which also covers administrative costs and those related to healthcare and work accident benefits. Self-employed individuals pay 12.5% of the monthly minimum wage plus 0.5% for administrative fees (Social Security Administration, 2020).

The old-age pension amounts to 100% of the average monthly earnings from the last 36 months before retirement and is paid upon reaching the age of 60 and accumulating at least 1,250 weeks of contributions. A partial pension, amounting to 60% of the average monthly earnings plus 4% for each year of contributions beyond 15 years, is available to individuals aged 65 with at least 750 weeks of contributions. An early pension, amounting to 80% of the average monthly earnings plus 4% for each year beyond 55, is available to individuals aged 55 with at least 1,500 weeks of contributions. The minimum monthly pension is 33% of the monthly minimum wage, and the maximum is 300 times the daily minimum wage (OECD, 2014). As of October 2024, the minimum wage in Paraguay was 2,798,309 guaraníes, approximately equivalent to 385 US dollars (WageIndicator.org, 2024).

Retirement age and contribution requirements are the same for both genders, in line with Paraguay's gender equality policy (World Bank Gender Data Portal, 2024).

Management of the pension system

The Social Security Institute (*Instituto de Previsión Social*, IPS) is the main institution managing the Mandatory Social Insurance, responsible for collecting contributions, paying out pension benefits, and providing healthcare benefits to insured individuals. The IPS also operates its own clinics and hospitals, making it a central component of Paraguay's social security system (IPS, 2024).

Social Assistance System for the Elderly

The Social Assistance System for the Elderly (*Pensión Alimentaria para Adultos Mayores*) is aimed at Paraguayan citizens aged 65 and older who do not receive other pension or annuity benefits. This program is fully funded by the government. The benefit amounts to at least 25% of the monthly minimum wage and is granted based on a needs assessment using the Quality of Life Index for Older Adults (*Indice de Calidad de Vida para Adultos Mayores*, ICV-AM) (Ministerio de Desarrollo Social, 2024).

The Ministry of Social Development (*Ministerio de Desarrollo Social*, MDS) oversees and administers the social assistance program for the elderly, following its transfer from the Ministry of Economy and Finance under Law No. 7232/2024. This transfer aimed to increase the efficiency and transparency of the program. The MDS collaborates with local governments to ensure proper procedures for the registration and verification of beneficiaries (Ministerio de Desarrollo Social, 2024).

Challenges and reforms

The pension system in Paraguay faces numerous challenges, such as an aging population, insufficient funding, and political and administrative inconsistencies. In response to these challenges, Paraguay plans to implement structural reforms that may include raising the retirement age, adjusting contribution levels, and improving the efficiency of pension fund management. One of the main goals of the reforms is also to integrate the special pension systems for various professional groups, which could contribute to improving the efficiency and fairness of the system (OECD, 2014; LatinAmerican Post, 2023).

Pension system in Venezuela (as of october 1, 2024)

The Venezuelan pension system is a complex structure consisting of two main components: the Basic Component (*componente básico*) and the Income-Related Component based on defined benefits (*prestaciones definidas*). The system also includes special programs for workers in difficult conditions (*trabajadores en condiciones difíciles*), as well as programs for farmers (*agricultores*) and temporary workers (*trabajadores temporales*).

Social insurance

The main pension program in Venezuela is Social Insurance (*Seguro Social*), which covers public and private sector employees, cooperative members, domestic workers, seasonal workers, and temporary workers. Self-employed individuals can join the system voluntarily. Pension contributions amount to 4% of an employee's monthly earnings, while the employer pays between 9% and 11% of the gross wage, depending on the level of occupational risk, and 4% for public sector employees. Self-employed individuals pay contributions equal to 13% of their declared monthly income. The government subsidizes the system by allocating at least 1.5% of total monthly wages to cover administrative costs and finance the deficit (SSA, 2024).

Benefits under the Social Insurance program include the old-age pension (*Pensión por Vejez*), which amounts to 100% of the legal monthly minimum wage. The minimum retirement age is 60 years for men and 55 years for women, with a minimum requirement of 750 weeks of contributions. As of July 2024, the minimum pension was 1,800,000 bolívares soberano, equivalent to approximately 0.05 USD (TimeCamp, 2024).

Gran Misión en Amor Mayor social program

Gran Misión en Amor Mayor is a social program aimed at elderly individuals who do not meet the contribution requirements for social insurance. To qualify for this program, men must be at least 60 years old, and women must be at least 55 years old. Beneficiaries must have been residents of Venezuela for the past 10 years, and their household income must be below the legal monthly minimum wage. The program provides benefits equal to the monthly minimum wage, which is 1,800,000 bolívares soberano (TimeCamp, 2024).

Additionally, the Venezuelan government grants various allowances, such as War Bonds (*Bonos de Guerra*), aimed at compensating for the loss of purchasing power of pension benefits due to high inflation and economic crisis. In October 2024, the War Bonds amounted to 3,294 bolívares (approximately 90.7 USD) for public employees, 3,330 bolívares (approximately 91.7 USD) for retirees, and 1,640 bolívares (approximately 45.2 USD) for individuals receiving pensions from the IVSS (La República, 2024; Bloomberg Línea, 2024).

Pension system management institutions

The Venezuelan pension system is managed by several institutions, the most important of which are the Venezuelan Institute of Social Insurance (*Instituto Venezolano de los Seguros Sociales*, IVSS), responsible for managing pension funds, registering insured individuals, collecting contributions, and paying benefits.

The Treasury of Social Security (*Tesorería de Seguridad Social*, TSS) manages the social insurance funds, ensuring financial stability and efficient management. The Superintendency of Banking Sector Institutions (*Superintendencia de las Instituciones del Sector Bancario*, SUDEBAN) oversees financial institutions, including pension funds, to ensure compliance with regulations and financial stability (SSA, 2024).

Challenges and anticipated changes

The Venezuelan pension system faces serious problems, such as system financing, which is burdened by hyperinflation and declining oil revenues, a key issue for the country's economy (OECD, 2014). Inflation has drastically reduced the real value of pensions, forcing the government to regularly raise minimum wages and pensions, further straining the state budget. The aging population also increases the number of beneficiaries of the pension system, leading to greater financial strain (Orinoco Tribune, 2024).

Anticipated reforms include increasing contributions from workers and employers, introducing additional funding sources such as taxes dedicated to the pension system, and better integrating the system with the labor market to cover more workers, including the self-employed and informal workers (Iwry, John, Gale, 2024). Strengthening the institutions managing the pension system, such as the IVSS and TSS, will also be a key element of the reforms, aiming to improve management efficiency and oversight of pension funds (SSA, 2024).

Comparative analysis of the impact of ideology: the influence of extreme right and extreme left on pension systems in Paraguay and Venezuela

The pension systems in Paraguay and Venezuela reflect the ideological differences between the extreme right-wing and extreme left-wing governments that have influenced social policy in these countries. A comparative analysis of both systems reveals how these different approaches have affected the structure, efficiency, and financial stability of pension systems.

Extreme right in Paraguay: privatization and individual responsibility

Paraguay, dominated by extreme right-wing governments, particularly during the rule of the Colorado Party, implemented policies based on neoliberal principles that promote privatization and limit the role of the state. The Paraguayan pension system reflects these principles by strongly emphasizing private pension savings and individual responsibility for one's financial future.

As part of the reforms carried out in Paraguay in 2003, individual pension accounts were introduced, aimed at improving the financial stability of the system and reducing the risk of insolvency. Private pension funds have gained a key role in managing pension assets, with the goal of increasing efficiency and investment returns (OECD, 2014). The extreme right in Paraguay viewed these reforms as a way to limit state influence on the economy and encourage individual financial responsibility.

However, in later years, significant problems arose related to financial viability and political difficulties in implementing this reform. This resulted in a gradual shift away from individual pension accounts. The reform failed to achieve its intended goals, such as improving the financial stability of the pension system and increasing public trust in private pension funds (Calvo, Bertranou, Bertranou, 2010).

As a result of these problems, Paraguay decided to return to the pay-as-you-go (PAYG) system, which now dominates. The current system is primarily managed by the state-run *Instituto de Previsión Social* (IPS), which administers contributions and pays out pension benefits (LatinAmerican Post, 2023). Private pension funds still play a limited role, mainly in the context of voluntary pension savings, but they no longer have a key role in the mandatory pension system.

Extreme left in Venezuela: state interventionism and redistribution

In contrast, in Venezuela, extreme left-wing governments, starting with Hugo Chávez, implemented policies of strong state interventionism in the economy, aimed at wealth redistribution and ensuring universal access to social security. The Venezuelan pension system was organized around the idea of social solidarity, where the state plays a central role in providing minimum benefits for all citizens.

The Gran Misión en Amor Mayor program, created in 2011, reflects the extreme left's approach to pension policy. This program provides minimum pension benefits for individuals who were unable to meet the contribution requirements for social insurance. The goal was to guarantee a dignified life for the elderly, regardless of their previous income levels (Díaz, 2018).

However, the extreme left's approach to pension policy in Venezuela, based on extensive state interventionism, led to serious financial problems. The Venezuelan pension system suffers from chronic underfunding, caused by declining oil export revenues and hyperinflation. State control over the pension system failed to ensure its financial stability, and the value of pension benefits dramatically decreased, failing to cover even the basic living needs of retirees (Orinoco Tribune, 2024).

Comparison of efficiency and financial stability

Comparing the two systems, it is clear that the extreme right in Paraguay focused on financial efficiency and individual responsibility, leading to greater

system flexibility but at the cost of increasing social inequalities. On the other hand, the extreme left in Venezuela emphasized universal access to benefits and redistribution, aimed at reducing inequality but leading to financial destabilization of the system and a dramatic decline in pension value.

Both approaches had their strengths and weaknesses, but neither proved fully effective in ensuring the long-term stability and adequacy of pension systems. In Paraguay, privatization increased the pressure on individual savings, while in Venezuela, excessive centralization and state interventionism led to financial disaster. These extreme ideologies have shown that both excessive reliance on the market and excessive state control can lead to serious problems in managing pension systems.

Interpretation of results: political differences and their impact on society

The comparative analysis of the pension systems in Paraguay and Venezuela reveals how ideological differences between the extreme right and extreme left have influenced the shaping of pension policy and its consequences for society. The results of the study indicate significant differences in the approach to managing pension systems, which had a substantial impact on various aspects of social life, including financial stability, inequality levels, and the well-being of citizens.

Financial stability and system efficiency

In Paraguay, extreme right-wing governments led to the implementation of pension reforms aimed at increasing system efficiency through privatization and enhancing individual responsibility. The introduction of individual pension accounts and the greater role of private pension funds were intended to improve the financial stability of the system. However, the results indicate that while this system proved more flexible and efficient from a fund management perspective, it also contributed to increased social inequalities. People with lower incomes had difficulty accumulating sufficient funds for retirement, leading to a situation where many lacked adequate financial security in old age.

In Venezuela, where extreme left-wing governments focused on state interventionism and redistribution, the pension system aimed to provide universal access to minimum pension benefits. This policy sought to reduce social inequalities by guaranteeing a minimum income for all citizens of retirement age. However, the results show that while this approach may have initially reduced inequality, it led to severe financial problems. Hyperinflation and declining oil export revenues significantly weakened the value of pension benefits, which in turn increased poverty among retirees and undermined the stability of the entire system.

Impact on social inequality

One of the key aspects of the differences between the extreme right and extreme left is their approach to social inequality. In Paraguay, the approach based on privatization and individual responsibility contributed to greater disparities in financial security among the elderly. Higher-income individuals had greater ability to save effectively for retirement, while lower-income individuals were at higher risk of insufficient funds in old age. This system favored the deepening of social inequalities, which can lead to long-term social problems such as the marginalization of lower-income groups and increased social tensions.

In Venezuela, where extreme left-wing policies focused on redistribution and universal access to pension benefits, the pension system aimed to reduce inequality by guaranteeing a minimum income for all retirees. While this approach theoretically should lead to greater social equality, in practice, it turned out that the system was unable to provide an adequate standard of living for retirees. Hyperinflation and economic inefficiency led to a situation where minimum pension benefits were insufficient to cover basic living needs, which increased poverty and worsened living conditions for a large portion of society.

Citizen well-being and social stability

The differences in political ideology between Paraguay and Venezuela also had a direct impact on the well-being of citizens and social stability. In Paraguay, the emphasis on privatization and individual responsibility for pension savings may have led to greater motivation to save and manage personal finances. However, the lack of sufficient security for lower-income individuals increased the risk of poverty among retirees, which in turn could lead to social discontent and potential tensions.

In Venezuela, universal access to pension benefits was seen as a way to guarantee a minimum level of well-being for all citizens. However, economic problems such as hyperinflation and declining oil revenues undermined the effectiveness of this system, leading to widespread poverty among retirees and a general deterioration in living conditions. This, in turn, may have contributed to social unrest and political destabilization.

Discussion

Comparative analysis of the pension systems in Paraguay and Venezuela reveals how ideological differences between the extreme right and extreme left influence the structure and functioning of pension systems, as well as their social and economic consequences. The research findings indicate that both extreme privatization and

emphasis on individual responsibility in Paraguay, as well as centralization and redistribution in Venezuela, have led to problems that undermined the stability and efficiency of pension systems in both countries.

Evaluation of results in the context of previous studies

The findings of this study confirm previous research on the impact of ideology on social policy in Latin American countries (Kay, 2011; Mesa-Lago, 2008). In the case of Paraguay, reforms inspired by neoliberal principles of privatization and reducing the role of the state aimed to increase system efficiency by introducing individual pension accounts. However, as predicted by some researchers (Calvo, Bertranou, Bertranou, 2010), these reforms did not meet expectations, leading to increased social inequality and difficulties in maintaining the financial stability of the system. As a result, Paraguay reverted to the pay-as-you-go (PAYG) system, highlighting the limitations of privatization reforms in the context of developing countries.

In Venezuela, the extreme left's approach, focused on redistribution and centralization, aimed to ensure universal access to social security. However, the findings show that this policy, despite its ambitious goals, led to serious financial problems in the pension system, especially in the context of hyperinflation and declining oil revenues (Orinoco Tribune, 2024). These problems highlight the challenges faced by state interventionism during a deep economic crisis.

Comparison with other Latin American countries

When comparing the situation in Paraguay and Venezuela with other countries in the region, it can be observed that many Latin American countries, such as Chile and Argentina, have also experimented with various pension system models, ranging from privatization to renationalization (Datz, 2012). Chile, one of the first in the region to implement pension privatization, is now also struggling with problems related to the low efficiency of private pension funds and growing inequalities. Argentina, on the other hand, returned to a state-run system after unsuccessful privatization reforms, indicating a broader trend in the region where pension systems based on individual accounts are facing increasing criticism.

Political implications

The findings of this study have significant implications for social policy, suggesting that neither extreme privatization nor full centralization can provide long-term stability and fairness in pension systems. In the context of Paraguay, the extreme right-wing policy, which focused on individual responsibility, led to issues with inequality and system stability, forcing the government to revise its approach and return to a more state-managed pension model.

In contrast, in Venezuela, extreme centralization and emphasis on redistribution without adequate financial mechanisms led to a severe crisis in the pension system, highlighting the risks associated with excessive reliance on state control in the face of economic challenges.

Research opportunities

Hybrid pension systems analysis

Conduct a comparative analysis of hybrid pension models in other countries, identifying successful elements that could be adapted to the contexts of Paraguay and Venezuela.

Political culture and pension systems

Investigate the influence of political culture—such as compromise orientation and polarization levels—on the implementation and success of pension reforms.

Conclusions

In conclusion, the study found that pension systems based on extreme ideologies, whether right-wing or left-wing, face significant challenges in ensuring long-term stability and social equity. In both cases, solutions rooted in extreme ideologies led to financial and social problems, suggesting the need for a more balanced approach to managing pension systems. The practical implications of these findings include the need to rethink pension policies to achieve a better balance between individual responsibility and the role of the state in social security. A limitation of the study is its reliance primarily on available secondary data and the difficulty in accessing current data from Venezuela, which may affect the comprehensiveness of the analysis. Future research should focus on more detailed empirical analyses and comparative studies involving other countries in the region to better understand the impacts of different approaches on pension reform. De-ideologizing pension systems is crucial for creating stable, equitable, and efficient structures that serve citizens across political cycles.

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