

Analysis of the Impact of Special Economic Zones on Macroeconomic Indicators in Poland

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Abstract

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A Special Economic Zone (SEZ) is a designated geographical area with specific economic regulations and incentives to promote foreign investment and boost economic growth. The present study aims to analyse the impact of SEZs on the macroeconomic indicators of Poland. This study investigates the relationship between Poland's Special Economic Zones and the Polish economy from 1998 to 2020, employing a vector autoregressive model using ordinary least squares regression to analyse time series data on annual SEZ tax exemptions (TEx_SEZs) and macroeconomic indicators, such as GDP, foreign direct investment, employment growth rate, and per capita income. The methodology includes descriptive analysis, correlation analysis, augmented Dickey-Fuller (ADF) tests for stationarity, an Engle-Granger two-step cointegration test to estimate the long-run equilibrium relationship, and Granger causality analysis to explore whether TEx_SEZs influence economic growth. The results of regression analysis indicates that the total tax exemption for Special Economic Zones (TEx_SEZs) does not directly contribute to economic growth, the employment growth rate, and per capita income in Poland, aligning with the non-causal relationship found between TEx_SEZs and GDP. However, the study shows that TEx_SEZs have a statistically significant and positive impact on Poland's foreign direct investment (FDI), implying that SEZ tax incentives can effectively attract FDI and stimulate economic growth. While the reliance of this study on secondary data and the limited depth of the analysis constitute limitations, future research should employ diverse datasets, case studies, and interviews to address these constraints and explore the socioeconomic and environmental impacts of special economic zones in Poland and other countries.

Key words

Special Economic Zone, macroeconomic growth, Poland.

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Introduction

Investment activities are one of the basic categories describing the state, functioning and development opportunities of any type of organisation, particularly business organisations. An analysis of the literature indicates that the concept of planning investment activities is multifaceted (Pujer, 2016). There are many ways of defining and describing it, including indicative parametric and non-parametric methods for describing organisational and economic investments (Patusiak et al., 2016, Dinu, 2015). Therefore, investment policy is one of the ways to achieve structural change. Among the many tools that have been used around the world over the years, Special Economic Zones (SEZs) have gained popularity. Over the past four decades, SEZs have emerged as state-created economic enclaves designed to attract domestic and foreign investors to foster regional economic growth (Pastusiak et al., 2018; Michałek, 2023). They allow indirect implementation of the state setting through the use of autonomous market units operating under competitive conditions (Dorożyński et al., 2021). There are many types of this instrument, albeit often unique due to the institutional characteristics of a country. An example of such an arrangement are the zones operating in Poland (Krynska, 2010). The reason for selecting Poland for the analysis is its highly extensive network of Special Economic Zones (SEZs) and its significant role in the Polish economy, particularly in terms of fostering local and national economic interactions. Regional development is the growth of a region's economic potential, accompanied by a steady improvement in the living conditions of its residents and increased competitiveness (Blau et al., 2020; Szczepańska-Woszczyna et al., 2022). On the other hand, territorial policy is defined in the literature as intentional and deliberate actions by the authorities to regulate certain areas of inter-territorial development (Mutalimov et al., 2021). The

prerogative of the zone is to create favourable conditions for the companies operating there, as well as the use of existing industrial plants and infrastructure while supporting the restructuring process of the industrial centre.

1. Literature review

In 1994, Poland introduced Special Economic Zones (SEZs), primarily located in underdeveloped regions. The main purpose behind creating these zones was to stimulate local economic growth by attracting capital investments, facilitating regional job opportunities, promoting exports, and revitalising outdated industrial areas. The envisioned objectives of SEZs encompassed enhancing the competitiveness of products and services while fostering technological progress (Lizińska and Marks-Bielska, 2013).

Countries worldwide have implemented zonal projects, irrespective of their socio-political system or economic development level. These projects have led to the emergence of diverse types of zones, characterised by various forms and classifications, operating within different macroeconomic environments. While their motivations, expectations, and operational models may vary, their shared objective is creating an attractive investment climate to lure domestic and foreign investors. These zones were established to bolster and stimulate economic development in specific regions and, in some cases, to address structural issues faced by those areas, as exemplified by Poland. A key anticipation of these projects was that foreign capital inflows would spur economic growth and initiate the exchange of knowledge, transfer advanced technologies and innovations, and facilitate access to world-class marketing and management systems. This approach aimed to create a conducive environment for fostering economic progress and development, with the

infusion of foreign expertise and resources playing a pivotal role in achieving these objectives (Nazarczuk and Cicha-Nazarczuk, 2021; Akhmetshina et al., 2017; Kanungo, 2016; Pakdeenurit et al., 2014; Palit, 2010).

Special Economic Zones (SEZs) were envisioned as a vital component of development policies designed to stimulate the advancement of underdeveloped regions. Their primary objective was attracting investors to areas deemed unprofitable or facing economic challenges (Wiedermann and Trojak, 2009). By offering various investment incentives, such as income tax exemptions, access to utility infrastructure, and support for investment implementation, these regions were expected to become more appealing to potential investors, particularly large industrial companies. Initially, SEZs were intended to be established selectively, with only a few designated zones, to foster local economic growth and address labour market challenges in those specific areas (Pastusiak, 2011).

The primary objectives of Special Economic Zones (SEZs), as stated in the law dated 20 October 1994 (Ustawa z dnia 20 października 1994 r. o specjalnych strefach ekonomicznych, 1994), are as follows:

- Fostering the advancement of particular economic sectors,
- Encouraging the development and implementation of novel technical and technological solutions within the national economy,
- Facilitating the expansion of exports,
- Enhancing the competitiveness of manufactured products and services rendered,
- Utilising existing industrial resources and economic infrastructure effectively,
- Generating new employment opportunities,
- Ensuring the sustainable utilisation of untapped natural resources.

A Special Economic Zone (SEZ) is a targeted policy designed to draw foreign direct

investment (FDI), stimulate employment opportunities, and bolster economic reforms. Particularly for developing economies, an SEZ holds the potential to act as a catalyst for progress by inviting foreign investors who can significantly enhance the productivity of local companies, boost revenues, and expand market shares through the introduction of cutting-edge technologies and the establishment of new enterprises (Dubinina, 2022).

The creation of Special Economic Zones results from the gradual integration of the global economy. Special Economic Zones are the result of integration by macro agreements (Gosek, 2022). Regional integration, involving the unity of nations in a common framework of economic, social and international policies, is carried out between countries undertaking international political tasks (Ficek & Gawlik, 2022). The first independent economic zone introduced a typical Special Economic Zones focused on export activities and basic services for entrepreneurs through tax exemptions. Thus, it can be said that these were tax-exempt areas. The first zones of this type were established in Central America and later in the Far East in the mid-1960s (Nazmi, 2015). Creating Special Economic Zones in many countries did not mean that the country establishing them would benefit from uniform economic zone conditions (Dargas-Draganik et al., 2022). Moreover, the size and specificity of the zones were often determined solely by economic conditions. If this zone arouses investor interest, it is likely that the area will expand and change from a “small area” to a “large area” (Aggarwal, 2019).

Due to their nature, zones can be divided into large and small zones and industrial and energy zones. A large zone covers a large area (Brezdeń and Szymytkie, 2019). Countries with such zones are mainly developing countries or countries with large areas of their own. The exceptions are Liechtenstein, Monaco and Hong Kong, where investment opportunities are strictly

regulated (Kuczynska-Chalada et al., 2020). A large zone usually covers the entire city and its residents. The largest group of countries (regions) are small zone countries. Zones usually cover from a few hectares to dozens of hectares. Most often, they are single zones located within closed economic enclaves. Such zones are industrial in nature and are not inhabited by people. Another type of economy is the so-called Specific Zone Industry (Lin, 2021). Selected industrial activities are carried out in the following countries: France, Germany, Mexico, USA, China, India, South Korea and Taiwan. This zone includes services supporting industry, banking and tourism. The last type of zone is performance-specific or zones for specific activities. The term 'zone' is somewhat overused in this case. This is because it is possible to find companies that have certain rights but at the same time meet strict conditions (Sleszynski and Wiedermann, 2020).

The relationship between economic policies and macroeconomic conditions has garnered significant attention as they serve as potential drivers of economic performance within a nation. Economic policies wield the power to influence various aspects of an economy, including investments in human capital, infrastructure, and other key areas. Hall and Charles (1999) assert that government policies can play a pivotal role in supporting specific industries during critical stages of their development (Hall and Charles, 1999). To facilitate foreign-invested manufacturing and services for export, countries establish Special Economic Zones (SEZs) that adopt liberal laws and economic policies. In essence, the creation of SEZs symbolises a political regime's commitment to achieving economic transformation in a non-market economy (Pan et al., 2016).

A study by Lipták, Klasová and Kovác focused on five crucial macroeconomic parameters that are deemed highly influential in driving institutional changes within economic policies. These parameters include

the gross domestic product, which was calculated based on market prices per capita in euros. Additionally, they considered inflation measured through the Harmonised Index of Consumer Prices and wages, which were evaluated as real income per individual in euros. To assess employment dynamics, they analysed the employment rate of the population aged between 20 and 64. Lastly, the researchers examined expenditures on research and development, computed per capita in euros. By investigating these key indicators, the study aimed to gain valuable insights into the implications of institutional change in the realm of economic policies (Lipták, Klasová and Kovác, 2015). In another study, the results show that SEZs have demonstrated a highly beneficial influence on the advancement of the least developed regions in Poland, whereas their impact on relatively more affluent areas was modest or even unfavourable (Ambroziak and Hartwell, 2018).

A study conducted in the context of Thailand reveals the establishment of Special Economic Zones (SEZs) in 10 border provinces in 2015 and 2016. However, the SEZ program did not attract significant investment into the zones as intended, and the analysis shows that it did not lead to macroeconomic development. Provinces with SEZs did not experience higher GDP growth compared to those without, and poverty reduction progress was not significantly different. These findings cast doubt on the effectiveness of Thailand's SEZs and suggest the need for more substantial cost advantages for firms within the zones compared to non-SEZ areas. Additionally, it suggests that investing in education and specialised training for workers could help offset increasing labour costs and boost productivity (Durongkaveroj, 2023). However, another study conducted in India provides a different perspective, namely that the establishment of Special Economic Zones (SEZs) had a significant impact on rural economies as it generated demand for substantial amounts

of land, leading to immediate changes in their economic and social landscape and exacerbating rural poverty. However, as time passed, the adverse effects of SEZs on rural poverty gradually diminished. Interestingly, the influence of SEZs on urban poverty differed from their impact on rural poverty. Moreover, districts with multiple SEZs experienced more pronounced effects than those with only one or two SEZs. On the whole, SEZs did have positive economic effects, but this transformation may also have heightened inequalities between rural and urban areas (Aggarwal and Kokko, 2022).

The literature review has provided a comprehensive overview of the existing research and scholarly works on the topic at hand. By synthesising and analysing the findings of various studies, it has become evident that there are common themes and divergent perspectives within the field. While some gaps in the literature have been identified, this review lays a solid foundation for the subsequent research and serves as a valuable resource for understanding the current state of knowledge in this area. Moving forward, building upon these insights will undoubtedly contribute to a deeper understanding and further advancements in the subject matter.

2. Methodology

Economic theories, when observed in different environments, experience shocks (positive or negative). Given the inevitable and varying economic environments, the methodology provides the evidence to support any result, thus reconciling the mismatch between economic theories and their ability to thrive in different environments which sometimes arises. Ultimately, the impact of tax changes on the size of the economy is an empirical question. Policymakers and researchers have always been interested in how potential changes in the tax system impact the overall economy. Evidence by Piketty, Saez and Stantcheva (2014) on tax rates and economic

growth between 1960 and 2010 from 18 OECD countries using regression analysis reveals that there is a weak correlation between growth in real GDP per capita and tax rate. In order to attract more FDI, countries introduce different tax incentives, such as tax holidays, investment allowances and exemptions. Shafiq et al. (2021) examined the impact of taxation on foreign direct investment in Pakistan using time series data (1985-2020), autoregressive distributed lag (ARDL) and error correction model (ECM) techniques used for empirical analysis. The study concludes that low taxes provide the impetus for foreign investment and the long-run relationship between taxes and FDI in Pakistan.

This study examined the relationship between special economic zones (“tax havens”) in Poland and the Polish economy using time series data from between 1998 and 2020. The vector autoregressive model was employed using the ordinary least squares regression method. Firstly, the author identified and gathered data on Special Economic Zones in Poland, specifically the annual total amount of tax exemptions (TEx_SEZs). Macroeconomic data for Poland were collected, including gross domestic product, foreign direct investment, employment growth rate, and per capita income over a specific period. The second step in the methodology was data analysis. Descriptive analysis was conducted on the collected data to understand the trends, patterns, and distributions of the variables. Correlation analysis examined the initial relationships between TEx_SEZs and macroeconomic indicators. The augmented Dickey-Fuller (ADF) test was used to test for unit roots, and the test results revealed per-capita income and foreign direct investment to be stationary while GDP, employment growth rate and TEx_SEZs are non-stationary. Non-stationary time series can cause a spurious regression (Gujarati, 2022), where a significant relationship is observed between variables, although no true relationship exists. The Engle-Granger two-step cointegration

test was employed to test whether a cointegrating relationship exists between the variables and estimate the long-run equilibrium relationship between them. The cointegration test results revealed that a cointegration relationship between the variables exists. The vector autoregression (VAR) model was used to model the relationship between Special Economic Zones and macroeconomic performance in Poland, considering factors such as data quality, control variables, and potential lagged effects. The mean residual test of model accuracy was performed to validate our regression results. In the final step of the methodology, Granger causality analysis was performed to investigate whether TEx_SEZs Granger-causes economic growth in Poland. The researchers utilised time series forecasting techniques (VAR model) to forecast the future value of FDI based on the presence and characteristics of TEx_SEZs.

Research Questions

1. What is the nature of the relationship between Special Economic Zones and macroeconomic indicators in Poland?
2. How do Special Economic Zones impact economic growth, foreign direct investment, employment growth rate and per capita income in Poland?

$$\begin{aligned} \text{GDP}_t &= \beta_1 + \phi_{11}\text{UEM}_{(t-1)} + \phi_{12}\text{FDI}_{(t-1)} + \phi_{13}\text{PCAP}_{(t-1)} + \phi_{14}\text{TEx_SEZs}_{(t-1)} + e_{1t} \\ \text{UEM}_t &= \beta_2 + \phi_{21}\text{GDP}_{(t-1)} + \phi_{22}\text{FDI}_{(t-1)} + \phi_{23}\text{PCAP}_{(t-1)} + \phi_{24}\text{TEx_SEZs}_{(t-1)} + e_{2t} \\ \text{FDI}_t &= \beta_3 + \phi_{31}\text{GDP}_{(t-1)} + \phi_{32}\text{UEM}_{(t-1)} + \phi_{33}\text{PCAP}_{(t-1)} + \phi_{34}\text{TEx_SEZs}_{(t-1)} + e_{3t} \\ \text{PCAP}_t &= \beta_4 + \phi_{41}\text{GDP}_{(t-1)} + \phi_{42}\text{UEM}_{(t-1)} + \phi_{43}\text{FDI}_{(t-1)} + \phi_{44}\text{TEx_SEZs}_{(t-1)} + e_{4t} \\ \text{TEx_SEZs}_t &= \beta_5 + \phi_{51}\text{GDP}_{(t-1)} + \phi_{52}\text{UEM}_{(t-1)} + \phi_{53}\text{FDI}_{(t-1)} + \phi_{54}\text{PCAP}_{(t-1)} + e_{5t} \end{aligned}$$

Where:

GDP_t = Gross domestic product at time 't'

UEM_t = Unemployment rate at time 't'

FDI_t = Foreign direct investment at time 't'

PCAP_t = Per capita income at time 't'

TEx_SEZs_t = Tax exemption for Special Economic Zones at time 't'

ϕ_{ij} = coefficients that represent the effect of the predictor variables on the target variable and on themselves (autoregressive terms).

$\beta_1, \beta_2, \beta_3, \beta_4$ and β_5 = intercept terms

$e_{1t}, e_{2t}, e_{3t}, e_{4t}$ and e_{5t} = stochastic error terms.

3. Do Special Economic Zones Granger-cause economic growth in Poland?

Research Objectives

1. To model the relationship between Special Economic Zones and macroeconomic performance in Poland.
2. To statistically evaluate the impact of Special Economic Zones on economic growth, foreign direct investment, employment growth rate and per capita income in Poland.
3. To ascertain if Special Economic Zones Granger-cause economic growth with feedback.
4. To forecast foreign direct investment in Poland based on Special Economic Zones in Poland.

Model Specification

In its simplest form, vector autoregression (VAR) models are used to model multiple time series variables that may be interdependent. The model assumes that each variable is a function of its own lagged values and the lagged values of the other variables in the system. The VAR model can capture short-term relationships between variables even when they are not cointegrated. The functional form of our model is specified as follows:

Definition and Justification of Variables

The variable GDP refers to the annual gross domestic product at market prices in Poland measured in millions of Polish zloty (PLN). Unemployment rate (UEM) is defined here as an estimate of annual national unemployment as a percentage of the total labour force. It refers to the share of the labour force that is without work but available for and seeking employment in Poland. FDI is defined as the

annual sum of direct investment equity capital inflows in Poland, measured in US dollars. Per capita income (PCAP) is Poland's annual gross national income, converted to US dollars using the World Bank Atlas method, divided by the midyear population. It is also known as GNI per capita, measured in US dollars. TEx_SEZs is the total tax exemption value for entrepreneurs and companies managing zones in Poland, measured in thousands of PLN.

Table 1. Data Table

Year	GDP (million PLN)	UEM (%)	FDI (USD)	PCAP (USD)	TEx_SEZs (thousand PLN)
1998	607,103	9.94	6,383,000,000	4360	30,560
1999	674,530	12.29	7,407,000,000	4440	123,469
2000	748,483	16.31	9,335,000,000	4670	241,526
2001	781,548	18.37	5,677,000,000	4710	407,912
2002	812,214	19.89	4,091,000,000	4900	496,954
2003	847,152	19.37	5,371,000,000	5500	611,424
2004	933,091	19.07	13,868,000,000	6260	600,185
2005	990,530	17.75	11,041,000,000	7330	587,816
2006	1,069,431	13.84	21,473,000,000	8420	868,164
2007	1,187,508	9.6	25,031,000,000	9930	1,084,333
2008	1,285,571	7.12	14,574,000,000	11,940	1,089,439
2009	1,372,025	8.17	14,025,000,000	12,490	1,221,559
2010	1,434,368	9.64	18,542,000,000	12,670	1,517,971
2011	1,553,641	9.63	18,212,000,000	12,820	1,829,753
2012	1,612,739	10.09	7,180,000,000	13,090	1,633,383
2013	1,630,126	10.33	1,029,000,000	13,230	2,289,140
2014	1,700,552	8.99	20,455,000,000	13,470	2,551,536
2015	1,798,471	7.5	15,598,000,000	13,250	2,561,422

Year	GDP (million PLN)	UEM (%)	FDI (USD)	PCAP (USD)	TE _x _SEZs (thousand PLN)
2016	1,853,205	6.16	17,750,000,000	12,660	2,728,838
2017	1,982,794	4.89	11,999,000,000	12,690	2,661,240
2018	2126506	3.85	19,204,000,000	14,180	2,775,982
2019	2,288,492	3.28	17,619,000,000	15,330	3,054,179
2020	2,337,672	3.16	19,151,000,000	15,300	2,869,783

Source: Polish Ministry of Development and Technology, World Development Indicators, Eurostat Database

Table 2. Summary Statistics (the summary statistics of the natural data of the variables in the linear model)

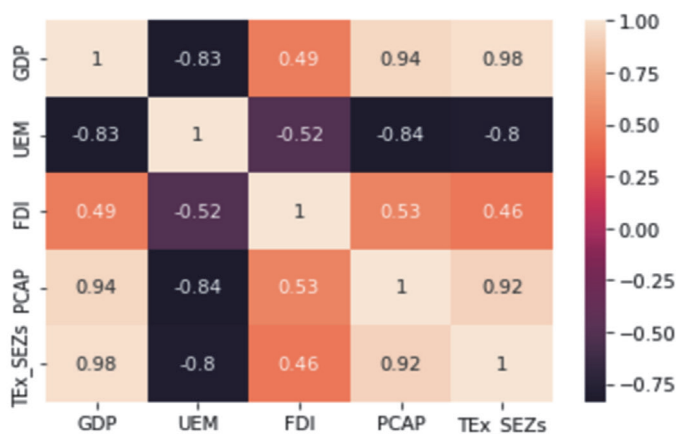
	GDP	UEM	FDI	PCAP	TE _x _SEZs
count	23	23	23	23	23
mean	1,375,120.0	10.8	13,261,520,000	10,158.2	1,471,155
std	533,702.1	5.3	6,471,568,000	3956.1	1,018,627
min	607,103.0	3.1	1,029,000,000	4360.0	30,560
25%	890,121.5	7.3	7,293,500,000	5880.0	594,000
50%	1,372,025.0	9.6	14,025,000,000	12,490.0	1,221,559
75%	1,749,512.0	15.0	18,377,000,000	13,160.0	2,556,479
max	2,337,672.0	19.8	25,031,000,000	15,330.0	3,054,179

Source: See Results Appendix

3. Research results

Following the analysis of data pertaining to the first research question: “What is the nature of the relationship between Special Economic Zones (SEZs) and macroeconomic indicators in Poland?”, the author provides correlation analysis used to test relationships between quantitative variables or categorical variables. A correlation coefficient is a means of assigning a value to the relationship. Correlation coefficients have

a value of between -1 and 1. A figure of 0 means no relationship between the variables at all, while -1 or 1 means a perfect negative or positive correlation. The most common correlation coefficient is the Pearson correlation coefficient, which is used to test for linear relationships between data. For the purpose of this research, the Pearson correlation coefficient will be used to test for relationships between our target vectors (GDP, UEM, FDI and PCAP) and feature (TE_x_SEZs).

Figure 1. Pearson correlation heatmap of the variables in our linear model

Source: own elaboration

Table 3. Correlation between the tax exemption for Special Economic Zones (TEx_SEZs) and selected macroeconomic variables (GDP, UEM, FDI & PCAP) in Poland

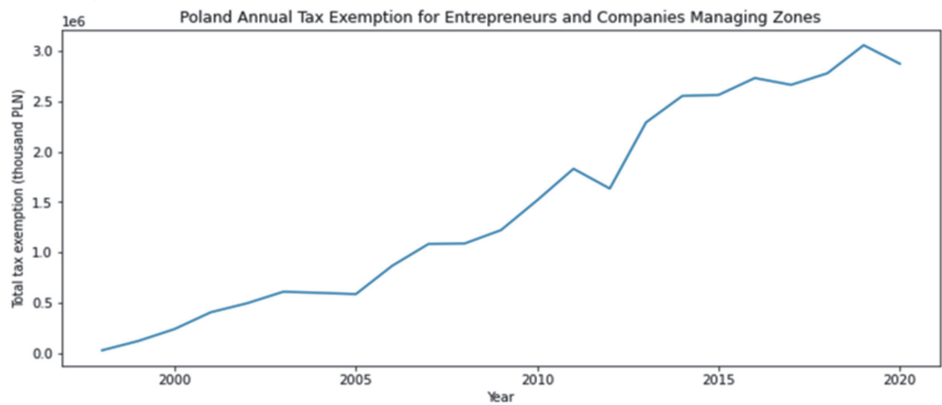
Feature matrix	Target vector	Correlation coefficient	Relationship
TEx_SEZs	GDP	0.98	Strong & Positive
TEx_SEZs	UEM	-0.8	Strong & Negative
TEx_SEZs	FDI	0.46	Moderate & Positive
TEx_SEZs	PCAP	0.92	Strong & Positive

Source: own elaboration

The Pearson correlation test results, as shown in Figure 1 and Table 3, indicate a strong correlation between three target variables (GDP, UEM and PCAP) and the predictor (TEx_SEZs) in the proposed model, while FDI exhibits a moderate correlation with TEx_SEZs. A Pearson correlation coefficient of 0.98 and 0.92 means a very strong and positive relationship

exists between GDP and TEx_SEZs and PCAP and TEx_SEZs, respectively, in Poland. However, a correlation coefficient of 0.46 between FDI and TEx_SEZs indicates a moderately positive relationship between both variables. The positive signs here indicate the nature (direct relationship) of the graph produced by the variables, as shown in Figures 2, 3, 4 and 5.

Figure 2. Annual total tax exemption for special economic zones in Poland



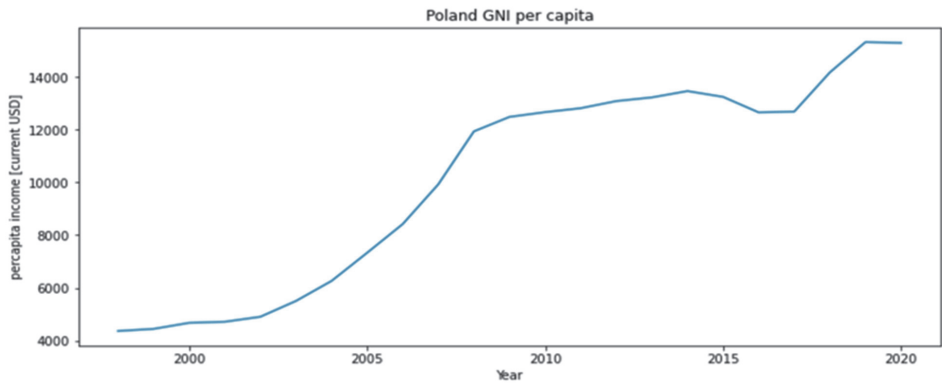
Source: own elaboration based on data obtained from the Polish Ministry of Finance (1998-2020)

Figure 3. Annual GDP at market prices in Poland



Source: own elaboration based on data obtained from Eurostat (1998-2020)

Figure 4. Annual gross national income per capita in Poland



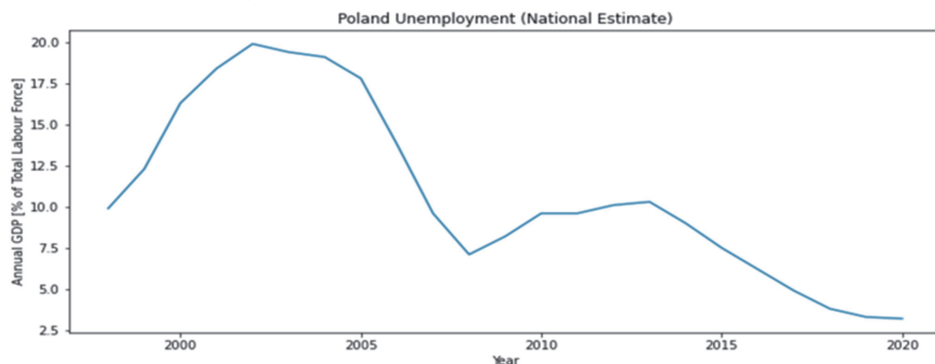
Source: own elaboration based on data obtained from World Development (1998-2020)

Figure 5. Annual foreign direct investment in Poland

Source: own elaboration based on data obtained from World Development (1998-2020)

On the other hand, the Pearson correlation coefficient between TEx_SEZs and UEM is -0.8, implying a strong negative correlation. The negative sign here indicates

the nature (inverse relationship) of the graph produced by both variables, as shown in Figure 6 compared to Figure 2.

Figure 6. Annual unemployment rate in Poland

Source: own elaboration based on data obtained from World Development (1998-2020)

The results of the research based on research question no. 2: “How do special economic zones impact economic growth, foreign direct investment, employment growth rate and per capita income in Poland?” are as follows:

Stationarity (Unit Root) Test

The augmented Dickey-Fuller (ADF) test was used to test for stationarity in the individual variable. The test aligns with the following hypothesis:

Null hypothesis (H0): The variable contains a unit root and is non-stationary.

Alternative hypothesis (H1): The variable is stationary and does not contain a unit root.

Decision Rule: If the calculated ADF test statistic is less than the critical values at the 5% significance level, the study rejects the null hypothesis of non-stationarity and accepts the alternative hypothesis of stationarity and otherwise. The results for the augmented Dickey-Fuller Test for Unit Roots are summarised as follows:

Table 4. Augmented Dickey-Fuller (ADF) Unit Root Test

Variable	Critical Value (5%)	t-statistic	Result
GDP	-3.1271	1.7375	Non-stationary
UEM	-3.1041	-2.0313	Non-stationary
FDI	-3.1271	-3.9025	Stationary
PCAP	-3.1271	-8.4127	Stationary
TE _x SEZs	-3.0054	-0.4930	Non-stationary
TE _x SEZs _{diff_1}	-3.0131	-7.1001	Stationary

Source: own elaboration

Engle-Granger Two-Step Cointegration Test

Two or more variables are said to be cointegrated if they have a long-run or an equilibrium relationship between them (Gujarati, 2022). To test for cointegration among the variables in our model, the author used the Engle-Granger two-step cointegration test on the variables (stationary variables and the first difference of the non-stationary variables in the series). The decision rule for the Engle-Granger two-step cointegration test is based on the p-value. A significance level (5% or 0.05) is typically chosen for the test. The decision rule is as follows:

If the p-value is less than the chosen significance level ($p\text{-value} < 0.05$), we reject the null hypothesis of no cointegration. This means there is evidence of cointegration among the variables.

The test statistic is -6.3848, and the p-value is 0.0000. Comparing these values with the critical values at the 5% significance level, it can be concluded that there is evidence of cointegration among the variables. The p-value is less than 0.05, indicating that the null hypothesis of no cointegration is rejected. Thus, it is concluded that there exists a long-run equilibrium relationship between the lagged values of TE_xSEZs (TE_xSEZs_{diff_1}) and GDP, UEM, FDI, and PCAP in Poland.

Regression Results

Vector autoregression (VAR) models are typically used in econometrics to model the dynamic relationships between multiple time series variables. They are used when:

- The variables are all time series data with interdependencies between them.
- The objective is to capture the relationship between variables and understand how changes in one variable affect the other variables.
- There is no prior theory specifying the direction of causality between the variables.

The decision rule for testing the statistical significance of a regression coefficient is to compare its p-value with a significance level, often set at 0.05. If the p-value is less than the significance level, we reject the null hypothesis that the coefficient is equal to zero and conclude that it is statistically significant. This means that there is strong evidence that the predictor variable has a non-zero effect on the response variable. On the other hand, if the p-value is greater than the significance level, it fails to reject the null hypothesis and concludes that the coefficient is not statistically significant. This means that there is not enough evidence to suggest that the predictor variable has a meaningful effect on the response variable.

**Table 5. Vector Autoregressive (VAR) Estimates with Lag Length 1:
TEx_SEZs_diff_1 Impact**

Dependent Variable	Coefficient	Std. error	t-statistic	Probability
GDP	0.038049	0.28575	1.332	0.183
UEM	-0.000001	0.000001	-0.984	0.325
FDI	11091.58291	4722.82962	2.349	0.019
PCAP	0.000350	0.000548	0.639	0.523

Source: own elaboration

The regression results for the proposed VAR model, shown in Table 7, display the impact of TEx_SEZs on the selected macroeconomic indicators (GDP, UEM, FDI, PCAP) in Poland. Of all the macroeconomic indicators explored in the model, the study can only reject the null hypothesis of statistical insignificance for FDI, given that its p-value (0.019) is less than 0.05 according to the decision rule. Thus, it can be concluded that TEx_SEZs have a statistically significant impact on FDI in Poland. The

regression coefficient (11091.58) indicates a positive relationship between TEx_SEZs and FDI, as can be seen from the sign of its coefficient and confirmed in the correlation analysis. The sign and magnitude of the coefficient of TEx_SEZs imply that, holding all other explanatory variables in the model constant, an increase of 1000 PLN in the total tax exemption for special economic zones (TEx_SEZs) will increase foreign direct investment (FDI) in Poland by US\$11,091.58.

Table 6. (FDI Forecast)

Year	Forecast (USD)
2021	13,271,306,600
2022	17,506,513,100
2023	16,690,797,300
2024	17,060,070,600
2025	17,155,843,600

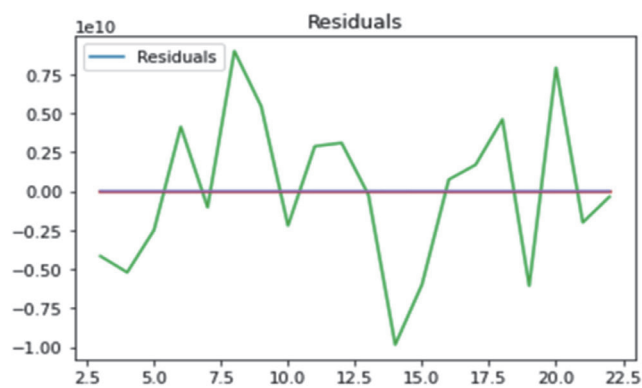
Source: own elaboration

Test for Model Accuracy Mean Residuals

The mean of the residuals should be approximately zero, indicating that the model

is, on average, predicting the correct values. The mean of the residuals can be checked by calculating the mean and comparing it to zero.

Figure 7. Plot of Residuals



Source: own elaboration

Table 7. Table of Mean Residuals

Variable	Mean residual
GDP	-0.000003666111
UEM	0.0000000000074
FDI	-0.01
PCAP	-0.000000000525
TEx_SEZs_diff_1	-0.000000286384

Source: own elaboration

In answering the third research question: “Do SEZs Granger-cause economic growth in Poland?” the Granger causality test was calculated.

Granger causality is a statistical concept used to determine the causal relationship between two time series variables. It is based on the idea that if one time series variable Granger-causes another, then the past values of the first variable provide useful information in predicting the future values of the second variable beyond what is already captured by its past values. The p-value indicates the significance level for the Granger causality between the variables, where a p-value below a chosen significance level (0.05) suggests evidence of Granger causality.

The Granger causality test result between GDP and TEx_SEZs with a p-value of 0.08

suggests weak evidence to reject the null hypothesis of no Granger causality.

In this case, with a p-value of 0.08, larger than the commonly used significance level of 0.05, there is no strong statistical evidence to conclude that TEx_SEZs Granger-causes GDP. This means that the past values of TEx_SEZs may not provide significant information to predict or explain the current or future values of GDP in a causal manner.

4. Discussion

The regression result suggests that the total tax exemption for Special Economic Zones (TEx_SEZs) does not directly contribute to economic growth, employment growth rate and per capita income in Poland. This finding aligns with the findings of Miranda

et al. (2022). The Granger causality test result also suggests weak evidence for the rejection of the null hypothesis of no Granger causality between TEx_SEZs and GDP. The weak statistical evidence of Granger causality implies that past values of TEx_SEZs may not be reliable predictors of GDP in a causal manner. This implies that the historical performance of TEx_SEZs alone may not provide substantial information for accurately forecasting or explaining GDP changes. The lack of a significant Granger causality relationship indicates that other factors beyond TEx_SEZs might significantly influence GDP in Poland. It suggests that the overall economic performance and growth of the country are influenced by a complex interplay of various factors, including but not limited to special economic zones. The non-causal relationship between TEx_SEZs and GDP suggests that policymakers should not solely rely on tax exemptions for special economic zones as a primary driver of economic growth. While special economic zones may attract foreign investment and promote regional development, other policies and factors must be considered in order to stimulate and sustain overall economic growth. The causality test result highlights the importance of ongoing policy evaluation and monitoring. Policymakers should regularly assess the effectiveness of policies related to special economic zones, including tax incentives, and make adjustments or refinements based on empirical evidence and analysis. This helps ensure that policies align with economic growth and development goals. This finding is in line with the suggestions given by Aggarwal and Kokko (2022).

On the other hand, TEx_SEZs have a statistically significant and positive impact on foreign direct investment (FDI) in Poland. This implies that providing tax incentives, such as tax exemptions on special economic zones, can be an effective policy tool to attract foreign direct investment. This can be beneficial for Poland's economy as it encourages foreign companies to invest in the

country, leading to increased capital inflows, job creation, and potential technology transfer. The positive relationship between TEx_SEZs and FDI implies that by implementing favourable tax policies for special economic zones, Poland can stimulate economic growth. Increased FDI can expand businesses, enhance productivity, and drive overall economic development. The impact of TEx_SEZs on FDI highlights the potential for regional development. By establishing special economic zones in specific regions, Poland can promote economic activities and investments in those areas. This can help to reduce regional disparities and create employment opportunities outside major urban centres. This result aligns with the study conducted in Thailand in that the government must prioritise implementing FDI-friendly policies and trade promotion within the SEZ, as they play a pivotal role in stimulating regional economic growth. Central to this development strategy should be the provision of favourable incentives and privileges to attract foreign direct investment (Romyen et al., 2019).

The result suggests that policymakers should consider the effectiveness of tax incentives, such as the total tax exemption on special economic zones, when designing policies to attract FDI. This information can assist in optimising the design and implementation of tax policies, ensuring they are targeted and tailored to encourage FDI inflows. The findings emphasise the importance of maintaining a competitive business environment to attract foreign investment. By offering tax exemptions on special economic zones, Poland can enhance its competitiveness compared to other countries and potentially position itself as an attractive destination for foreign investors.

Conclusions

Finally, this research sheds light on the complex relationship between tax exemptions for Special Economic Zones (TEx_SEZs)

and Poland's economic performance. The Granger causality test results indicate a non-causal relationship between TEx_SEZs and GDP, suggesting that historical performance of special economic zones may not be reliable predictors of changes in GDP. This highlights the need for policymakers to recognise that economic growth is influenced by a myriad of factors beyond TEx_SEZs. Consequently, it is imperative for policymakers to adopt a holistic approach when designing economic policies, taking into account various factors that contribute to overall economic development.

Conversely, the statistically significant and positive impact of TEx_SEZs on foreign direct investment (FDI) indicates the effectiveness of tax incentives in attracting foreign companies to invest in Poland. This finding underscores the importance of crafting targeted and competitive tax policies to stimulate FDI inflows, which can lead to increased capital investment, job creation, and technology transfer, ultimately fostering economic growth.

The contrasting results of the study highlight the complexity of policymaking in the context of Special Economic Zones. Policymakers must strike a balance between leveraging tax incentives to attract FDI while recognising the limitations of TEx_SEZs as the sole driver of economic growth. The research emphasises the need for continuous policy evaluation and evidence-based decision-making, allowing policymakers to adapt and refine tax policies to achieve sustainable economic development.

In conclusion, the findings of this study contribute valuable insights to the ongoing discourse surrounding Special Economic Zones and their impact on Poland's economy. By considering both the non-causal relationship between TEx_SEZs and GDP and the positive impact on FDI, policymakers can better shape policies that foster balanced economic growth and regional development. As Poland continues its quest for

economic prosperity, understanding the intricate dynamics of Special Economic Zones will be instrumental in charting a resilient and thriving economic future for the nation.

This study has several limitations to consider. Firstly, it relies on secondary data with potential biases and limited depth of analysis. Secondly, its findings may not be easily generalised beyond the Polish context due to variations in economic conditions and policies across countries. Moreover, the statistical analysis used might not capture all causal relationships, overlooking intricate pathways and omitted variables. The study lacks an in-depth exploration of the evolving policies governing TEx_SEZs in Poland. Additionally, it does not investigate the potential socio-economic and environmental impacts of these zones. Future research should employ diverse datasets, including case studies and interviews, conduct cross-country comparisons, and explore alternative econometric models to strengthen the findings.

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