ISSN: 2029-4913/eISSN: 2029-4921

VILNIUS TECH
Vilnius Gediminas Technical University

TECHNOLOGICAL and ECONOMIC DEVELOPMENT of ECONOMY

2026
Volume 32
Issue 3
Pages 813–839
https://doi.org/10.3846/tede.2026.23408

THE EXTENSIVE AND INTENSIVE MARGINS OF EMPLOYMENT RESULTING FROM POLAND'S SEZ POLICY

Camilla JENSEN ✉

Department for Social Science & Business, Roskilde University, Roskilde, Denmark

Article History:
- received 4 October 2023
- accepted 10 January 2025
- first published online 9 March 2026

Abstract. The paper evaluates Poland's Special Economic Zones (SEZ) policy with a focus on the emergence of market-based business clusters. A structural model of regional growth is estimated to measure and assess the impact of the SEZs as a 'helping hand' on the extensive and intensive margins of employment. Literature on business clusters suggest it would require them to grow on both margins simultaneously to be viable; attracting more firms and making each firm dependent on the success of its regional peers. However, the policy went through different phases and the priorities of policy-makers as well as zone managers shifted over time. For the designated Zone Management Companies (ZMCs) the results have been modest for the extensive margin. The main outcome of the policy has been on the intensive margin, in part, this result is expected due to the large firm bias inherent in the policy and the selection bias owing to the prior location of state-owned enterprises.

Keywords: Special Economic Zones (SEZs), comparative institutions, substitutions by design, panel data analysis, regional policy, foreign direct investment.

JEL Classification: C19, H25, L53, O25, P48, R58.

✉Corresponding author. E-mail: ***camje@ruc.dk***

1. Introduction

Though much research has been conducted on special economic zones in both developed and developing countries (World Bank, 2010; Zeng, 2015), little is known empirically about the long-term outcome of building sustainable clusters through these types of regional policy interventions and designs (Goodin, 1996). The case investigated in this paper concerns the specific policy design and management structure behind the Special Economic Zones (SEZs) in Poland. The program was already initiated at the beginning of the transition process (1994), started up in 1998, completely changed mandate in 2008 (from a supply- to demand-led design), and was eventually concluded or mainstreamed by 2018. Presently, the policy has been overshadowed by the Polish Investment Zone (Ministry of Economic Development and Technology [MEDT], 2020). This new policy covers all of Poland and inherits the management structure behind the original policy design of the SEZs.

The primary purpose of the Polish zones programme has been to alleviate emerging unemployment during the transition to a market economic system (Ambroziak, 2016; Cizkowicz et al., 2017; Jensen, 2018). Later the focus shifted towards attracting foreign investors and

providing co-investment structures for EU regional funds. SEZs as a vehicle for specialisation and exporting took more importance as the transition progressed (Nazarczuk & Uminski, 2018). However, in later years some Polish zone managers have started to emphasise traditional cluster building factors – such as attracting new firms and entrepreneurs regardless of where they come from.

With a longitudinal panel dataset available from the Polish Local Data Bank [PLDB] (n.d.), the paper evaluates the policy on two general dimensions of such cluster building efforts.

1.1. Research questions

The research question of central interest is whether the SEZ policy leads to a sustainable form of cluster formation. This is assessed or measured on the extensive and intensive margins of employment. Margins that could result from or be altered by the SEZ policy. The aim is to study this question at the most detailed intervention level it is possible to observe in a longitudinal panel design with publicly available data.

A secondary question is whether the response to the policy was heterogenous across the 14 zone management companies (ZMCs).

1.2. Background

Poland has relied on alleviating problems of lacking local 'captains of regional development' through a design of zone administrations that traversed traditional regional boundaries and governance systems. When the design shifted in the late 2000s from being supply- to demand-led in terms of where a firm could be located (Jensen, 2004; Cieślik, 2005; Gwosdz et al., 2008), the policy catapulted itself from being marginal towards becoming central in sustaining and aiding existing patterns of enterprise restructuring and new firm development.

Other important success criteria have been key to how the zones' development has been aided by both foreign direct investment inflows and structural funds received from the European Union. For example, the ability of each zone administration to grow could be a measure itself of relative success and failure. Legnica and Kamienna Gora are only involved in the administration of 17 subzones each (by 2016), whereas the largest zones administration (in terms of the number of areas drawn to it), Lodz, is involved in the management of 61 subzones in the same year.

However, administrative size and the reach of each zone's respective management structures should not be the most important evaluation criteria in assessing whether the resulting clusters are sustainable. Therefore the paper focuses on investigating the impact the governance structure and design of the policy has had on the intensive (size of firms attracted in terms of employment) and extensive (number of firms attracted) margins of employment. Where the mainstream literature often overlooks the dynamic relationship between small and large firms (Hart, 2000; Audretsch, 2002; Nelson, 2008; Jensen & Goldberg, 2014). Given the emphasis that policy-makers and ZMC managers put on generating or sustaining employment quickly, the policy may include an inbuilt bias of favouring large firms and foreign investors (see also Appendix A for a more in-depth introduction to the policy design, specific rules, regulations and geographical location of each individual ZMC).

Undoubtedly, while countries and regions today experience an ever-greater reliance on a few firms (superstar exporters, see Freund & Pierola, 2015) for their national economies, such overt reliance on the intensive margin of employment as a means of seeking a sole avenue for growth can reduce long-term regional resilience and lead to other types of risk exposures, such as a narrow specialization pattern and high dependency levels on individual firms and activities (Twinam, 2020).

For a more in-depth introduction to the specific policy design case and the location of the zones, the reader is referred to Appendix B.

1.3. Structure of the paper

The next Section offers a short review of the appreciative-theoretical (non-mathematical) and empirical literature on viable cluster building. Throughout the literature review, several hypotheses are offered in extension to the research questions stated above. Section 3 then analyses descriptively the available data at the level of the ZMCs to identify seemingly successful areas in terms of space governed, investment, and employment attracted by each of the companies. Each major region in Poland has a successful ZMC. This suggests that geography alone cannot explain the relative performance of the new regional administrative units.

Data at the gmina level is introduced in Section 4 along with a theoretical modelling framework and the econometric strategy of the paper related to the hypothesis testing is explained in depth. The results and a number of robustness checks are presented in Section 6. Section 7 synthesises the findings in a common discussion and offers a conclusion of the results.

2. Literature review – viable clusters and the role of SEZ policy

The dynamic aspect of regional growth via the attraction of new firms (the extensive margin of firm growth) and the growth of existing firms (the intensive margin of firm growth) is the focus of the study here and thus also the focus of this brief literature review.

Together, the extensive and intensive margins of employment could constitute what the theoretical appreciative (non-mathematical) literature suggests is viable cluster building (Delgado et al., 2010, 2014). See Fritsch and Storey (2014) for an extensive review, Porter (1998, 2000) for an introduction and Feldman (2014) linking clusters to entrepreneurship variables. See also Delgado et al. (2010, 2014) on determinants or drivers of strong or viable clusters and Verdú and Tierno (2019) on clusters, innovation, and entrepreneurship ecosystems.

All the appreciative literature focus on the attraction and generation of new firms or the entrepreneurship variable (see also Frenken et al., 2015). Entrepreneurship is equivalent to the extensive margin of employment growth. However, the overshadowing strength of business clustering according to the literature is always industry strength with a focus and/or complementarity driving a process of deep knowledge specialization (Baptista & Swan, 1999; Porter, 1998, Baldwin et al., 2010; Twinam, 2020). In this perspective, the intensive margin (questions about firm size and how firms complement one another) has thus far only been a minor consideration in the empirical literature. Longitudinal and dynamic studies have focused on firm turnover rates via entry and exit (Frenken et al., 2015). In the theoretical appreciative

literature, in contrast the question about the intensive margin is at the core (see also further below). However, the difference in focal perspective may also be related to the fact that there is not necessarily one common definition of what constitutes a cluster let alone a viable cluster. Porter (1998, 2000) (closest today to the authority Marshall is considered to be for the industrial district in his time) defines a cluster as:

"a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities"

The intensive margin (average firm size or the growth of individual firms inside the cluster) is also one of the central ideas of the industrial district or cluster. What drives the cluster and sustains it are the intricate linkages, relationships, and bonds created between firms, their products, processes, managers, and people (Rialland, 2009). The (average) intensive margin of firms in clusters relate to Marshall's original idea of *external economies*. Catapulted to the literature on entrepreneurial ecosystems of the 2010s (which is perhaps a timelier wording for the same or similar phenomena as an industrial district or a business cluster) translates into *network economies* (Zaratiegui, 2004). What distinguishes the more modern literature on ecosystems is also how digitalization (and globalization) is reshaping the conceptualization and place-specificity of a cluster, which can drive knowledge specialization across space even further (see Li et al., 2023; Giuliani, 2017).

Some clusters are identified as being driven by a single or a few single lead firms. Other clusters are identified as communities of very small firms. This relationship hinges strongly on the type of industries, the historical epoque, the country and the inherent ownership, and collaborative traditions (industry culture) of the individual cluster example (Stich et al., 2023). Therefore, some clusters see their employment hinging mostly on a few large firms, though other research has found that employment growth is more strongly associated with smaller average firm size (Glaeser et al., 2010).

In relation to the literature on viable cluster building, it is hypothesized in the context of an economy such as Poland, (moving away from a state directed towards an entrepreneur-driven economic system) that:

H1: *Areas with SEZs attract more new firms and generate more employment than other areas.*

H1.1: *Part of the reason why SEZs generate more employment is because the responsiveness of employment to firm growth is higher in areas where the SEZ policy is implemented. (Where a higher intensive margin could be because of a few very large firms (economies of scale) or because of external economies across firms or both.)*

No papers were found that conduct longitudinal empirical analysis of SEZ policies related to these general questions about the long run sustainability of business clusters. Surprisingly few studies have investigated institution-building in relation to SEZ and/or privatization policies in transition countries (see i.e. Blaszczyk, 2001 on this aspect of institution building for privatization in the Polish context, or more generally see also Parker & Kirkpatrick, 2005). Several papers on the SEZ policy in the developed country context have addressed questions related to employment outcomes alongside the question of the counterfactual (the overall

employment response or employment outcome of the policy) (see i.e., Billings, 2009, Gobillon et al., 2010, Chaudhary & Potter, 2018). Several studies in the context of the Polish SEZ policy have addressed this question as referenced in the introduction. Additionally, in the Polish context, some structural factors related with clusters have been identified and touched upon, particularly related to the specialisation of Polish clusters, SEZs, urbanisation and exporting (Nazarczuk et al., 2018, 2024). In the broader SEZ literature the focus has been more on the differential, or heterogenuous responses, to the policy, owing to different aspects of the intervention design than long run outcomes for cluster building (Ottaviano, 2010; Neumark & Young, 2021). For example, Bondonio and Greenbaum (2007, 2014) focus on heterogeneity in response to different instruments, whereas other studies take a focus on heterogeneity in the treated firms (Mayer et al., 2012) or the treated neighbourhoods (Briant et al., 2015; Howell, 2019; Fujishima et al., 2022). Differences have been found, due to the role of time and the enrolment of new intervention areas into an existing policy, including the feedback impact it has on existing or old intervention areas (Givord et al., 2018; Jensen, 2018; Neumark & Young, 2021), the tax design itself (i.e., Layser, 2018, 2020), and the political affiliation of the governors determining the allocations (Frank et al., 2022).

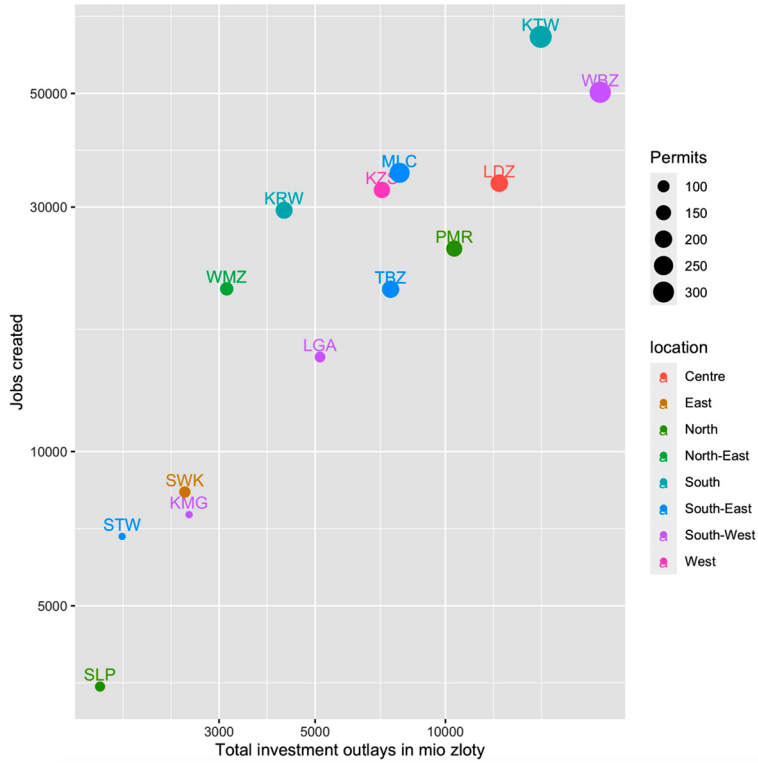
In the present study, which has character of a quantitative, economy-wide study, there are limited possibilities to observe heterogeneity at the intervention level other than conventional control factors for data collated at the traditional administrative-spatial levels of the economy. The main factor we can observe is the political implementation of the ZMC governance structure. A secondary hypothesis is therefore added:

H2: *The policy response is heterogenuous across the ZMC companies and irrespective of other traditional location factors that can be controlled (i.e. structural factors such as geography, skill structures, specialisation structures, wages, physical infrastructure etc.)*

The literature review here identified a significant gap in the SEZ literature, as hardly any effort has been made to connect the SEZ literature with the broader theoretical and empirical literature on what makes clusters viable and sustainable long-term (see also Patrick et al., 2017).

3. Stylised facts about the development of each ZMC

In this Section aggregated data is used at the level of the ZMCs to establish several stylised facts about their relative performance. The descriptive statistics in Appendix Table A1 also summarises the data available at the ZMC level. The initial exploratory plot in Figure 1 shows that no regional geography in Poland has the most successful zones except for the South, which stands out now with a first tier: Walbrzych (WBZ) in the South-West and Katowice (KTW) in the South. These two ZMCs are now the largest, they are followed by a second tier of more moderately sized ZMCs and a last third tier of least developed ZMCs. The 2nd tier, however, is varied in terms of geography: Lodz (LDZ) in the Centre, Krakow in the South, Mielec (MLC) and Tarnobrzeg in the South-East, Pomeranian (PMR) in the North, Warminsko-Mazurska (WMZ) in the North-East, Kostrzyn-Slubice (KZS) in the West and finally Legnica (LGA) in the South-West.



Note: Ticker symbols: KMG – Kamienna-Gora, KTW – Katowice, KRW – Krakow, KZS – Kostrczyn-Slubice, LDZ – Lodz, LGA – Legnica, MLC – Mielec, PMR – Pomeranian, TBZ – Tarnobrzeg, SLP – Slupsk, STW – Starachowice, SWK – Suwalki, WBZ – Walbrzych, WMZ – Warminsko-Mazurska.

Figure 1. Relative performance of the ZMCs (2017 data)

While the first tier is concentrated towards the South, the second tier contains a broader representation of Poland, except for the Easternmost part of Poland which is only represented in the third tier with the Suwalki (SWK) ZMC (and where 2 of the original 17 ZMCs were closed at an early stage of the policy). Other than Suwalki, the 3rd tier of lagging performers also counts each of the three other corners of Poland: Slupsk (SLP) in the North, and Starachowice (STW) and Kamienna-Gora (KMG) in the South-West and South-East respectively.

Next, the econometric analysis turns to the gmina or sub-zone level, where the focus is on general area development concerning attraction and development of firms and employment.

4. Data and methodology for the analysis at the gmina level

The detailed employment and firm population data at the gmina (commune) level is from the Local Data Bank published online by the Central Statistical Office in Warsaw (https://bdl.stat.gov.pl/BDL/start). The variables drawn from the Local Data Bank (PLDB, n.d.) are listed in Table 1. The data on sub-zones (policy dummies) and the year that the sub-zones fell under

each ZMC have been collected directly from the ZMCs themselves (see also Jensen, 2018), complemented with official lists having been published since 2012[1].

The subsequent analysis is conducted exclusively at the level of gminas, which is the most detailed geographical data available in the Local Data Bank (PLDB, n.d.). However, this data is connected to the level of the ZMCs by using information contained in the SEZ coding. This coding includes both a dummy for when the policy is active in each gmina and information about the ZMC company that governs each area (generating the Zone dummies of which there are 14).

Regional interventions can be difficult to investigate with panel data, because traditional and new regional administrations are often collinear or overlap entirely. The longitudinal nature of the data here solves this problem, because each gmina comes into the SEZs and ZMCs at different points in time.

Table 1. Data at the gmina level – all gminas including cities (source: Statistics Poland, n.d.)

Statistic	N	Mean	St. Dev.	Min	Median	Max
Employment, no. of places (1995–2021)	67,419	3,819.6	25,535.0	0	713	1,579,966
All firms, no. of (1995–2023)	72,471	1,651.8	9,796.0	0	460	552,771
Foreign owned firms, no. of (1995–2023)	72,471	19.0	246.0	0	2	25,974
State owned firms, no. of (1995–2023)	72,471	0.5	5.9	0	0	586
New firms, no. of (2009–2023)	37,485	160.3	881.2	0	53	46,599
New foreign firms, no. of (2009–2023)	37,485	0.9	17.8	0	0	1,527
Size Class: SMEs, no. of (2002–2023)	54,934	75.5	394.4	0	22	17,091
Domestic migration, no. of persons (1995–2023)	72,413	175.2	563.0	0	81	30,710
Foreign migration, no. of persons (1995–2023)	72,471	5.0	30.3	0	1	1,857
Net enrollment secondary school, percentage (2003–2018)	52,326	68.2	40.8	0.0	87.1	200.0
Commercial infrastructure, new buildings in dam3 (2005–2023)	47,481	40.7	160.4	0.0	8.4	6,347.9
University infrastructure, new buildings in dam3 (2005–2023)	47,481	1.1	8.5	0.0	0.0	598.2
Retail infrastructure, no. of permanent marketplaces (1995–2023)	72,471	0.6	1.7	0	0	66
Roads, surfaced communal in km (2001–2022)	54,895	397.8	298.6	0.0	320.0	2,274.7
Wages, av. monthly gross salary in zloty (2002–2022)	52,447	3,234.7	1,138.7	0.0	3,069.3	11,361.5
Areas with Zones Policy, no. of (1995–2023)	72,471	0.1	0.3	0	0	1
Area of gmina, ha (1995–2003)	72,194	12,581.3	7,926.9	224	11,173	98,992

[1] The Polish government publishes an annual report on the performance of each ZMC including detailed locational information for the gmina level. See for example Ministry of Economy (2016).

Table 1 shows the size of a typical gmina being around 1,650 firms and with employment at around 4,000. However, considering the distribution of economic data in gminas is positively skewed, averages are drawn up by the outliers due to economic agglomerations, and it may be more valid to look at the medians for what is typical for a gmina. Many gminas are rural, some are urban, and some are fractions of cities, which is why there are large differences. The intricacy of the data at the gmina level is ideal for the analysis, not least, because it is found, only at this level, that there are more frequent occurrence of areas without the zones policy (2nd last row in Table 1) relative to areas with the zones policy. This is not true when we go to higher levels of regional aggregation (such as powiats, voivods and nuts2 regions). Because at these levels it becomes increasingly impossible to differentiate in space for the influence of the policy. At the gmina level we observe only around 10% of areas have the policy intervention in place (here reported with Table 1 as an average across time and space).

5. Theory and econometric strategy

A partial Equation from Puga's model (1999) of regional employment is adopted to investigate the research questions. The advantage of Puga's model is that it is mathematically simpler to implement than later models in the theoretical literature on agglomeration economies. This is partly because this literature has developed in line with the Melitz revolution in international economics on heterogenuous firms (see Baldwin et al., 2010). To implement such models necessitates firm-specific data, but at the trade-off of lacking availability for longitudinal research designs (see i.e., Combes & Gobillon, 2015; Gobillon & Magnac, 2016).

Initially it is assumed that the extensive margin (number of firms) is exogenous to ZMCs efforts, and that labour supply is perfectly elastic at the given wage[2].

The base model takes outset in the regional labour demand model from Puga (1999). In this model capital is represented with intermediate goods, where u is the share of intermediates in final output. A higher share of own regional value added ($1 - u$) increases labour demand locally and must be thought of as a fixed effect in terms of how diversified (low u) or specialised (high u) firms are in the region. Additionally, a higher number of firms n increases labour demand. The opportunity cost of sourcing from other firms (affected by producer prices and trade cost among other) c will lead the firm to internalize and produce more on its own.

$$L_{it}^{id} = \left(1-u\right) n_{it} c_{it} \frac{1}{w_{it}} - K_{it} r\left(w_{it}\right). \tag{1}$$

Whereas the cost of own value added through higher wages w decreases labour demand.

Total labour demand of the gmina or city i may also be affected by the conditions in agriculture and services (however, services are not considered separately in Puga, 1999).

In Puga's model, industrial labour demand L_{id} is affected negatively by land endowment K devoted to agricultural production and the returns to agriculture r. However, Equation (1) cannot be estimated directly with a linear model. Here, only each part is transformable using logarithmic transformation. One solution is to rearrange Equation (1) so that *total* labour

[2] If the contrary hypothesis holds it could be more appropriate to model with a 2SLS, where also the extensive margin (ability to attract new firms) depends on the ZMCs effort.

demand instead is estimated as a function of the first part (as shown with logarithmic transformation in Equation (2) below).

$$Log L_{it}^{td} = \log(1-u) + \log n_{it} + \log c_{it} - \log w_{it}. \quad (2)$$

Data availability determines the adaptation of the model to the application here. Total employment (dependent variable), number of firms *n*, trade cost when proxied with physical infrastructure *c* and wages *w*, are variables readily available from the local databank[3]. Structural factors such as urbanisation, diversification or specialisation of firms, and the influence of agriculture on industry will be absorbed by the fixed effects. It is an assumption of the simple model that these factors are constant over time.

Number of firms is further broken down by ownership (all, foreign and state) in the Local Data Bank (PLDB, n.d.). Equation (2) is expanded below in Equation (2.1) with an extra term for both foreign and state-owned firms, which is to be read as a deviation from all firms. For example, if it is positive (or negative) and significant, it implies that foreign (state) firms on average generate more (less) employment relative to all other firms and over time.

Producer prices and trade cost by region affecting *c* are not directly observable. However, infrastructure (using the variable 'surfaced communal roads' in the Data Bank) is adopted as a proxy for *c* in this study. A dummy for the SEZ policy or for each of the ZMCs can then be added to Equation (2.1) (not shown) in order to investigate the hypothesis that SEZs are effective tools for generating more employment, Individual ZMC companies may be more successful relative to others. In this case the response to the policy is heterogenuous across the ZMCs.

The final Equation for the intensive margin (where the intensive margin of employment is captured with the coefficient estimate on the number of firms variables) take the following form:

$$\log \text{Employment}_{it} = \alpha_i + \tau_T + \beta_1 \text{SEZ gmina}_{it} + \beta_2 \log \text{All Firms}_{it} + \beta_3 \log \text{Foreign Firms}_{it} + \beta_4 \log \text{State Firms}_{it} + \beta_5 \log \text{Roads}_{it} + \beta_6 \log \text{Wages}_{it} + \epsilon_{it}. \quad (2.1)$$

The testing of H1 (H1: Areas with SEZs attract more new firms and generate more employment than other areas.) is conducted by including an interaction term between the policy variables (i.e. SEZ gmina in (2.1)) and the 'All firms' variable. A partial confirmation of H1 is implied by this interaction coefficient being significant and positive: $\beta > 0$. Its existence and positive sign signify that the employment generation effect in a cluster runs through the number of firms variable. External economies could lead to a higher intensive margin. But very large outlier firms may also drive up the intensive margin.

Part of the impact will also be implied through the ability of the cluster to attract more firms. This part of H1 is tested by the other Equation adopted in the paper. Equation (3) accounts for measuring the number of firms attracted to each area and the direct response of this extensive margin on the policy. In Puga (1999), new firm growth is determined by a positive constant (regional-structural factors) and the relative profitability of entrepreneurs

[3] However, infrastructure and wages are only available at the powiat level and therefore take the same value for all gminas located within a powiat (like a county in the UK). Where powiats will typically consist of 3–19 gminas, but with some city powiats consisting of one or several gminas.

operating out of different regions. The model describes profitable entrepreneurship or firm growth as dependent on two opposing forces. Demand and cost linkages drive profitability rates upwards, whereas labour and product market competition drive profitability rates downwards. These relationships are translated with Equation (3) into proxies available from the Local Data Bank (PLDB, n.d.). These variables are educational attainment, university, retail, commercial, and transport infrastructure as the positive profitability drivers (positive sign expected) and wages as the negative profitability driver (negative sign expected).

Based on reviews of the empirical literature on entrepreneurship (as referenced in the literature review), important variables have been included that have been found to positively affect regional entrepreneurship such as migration and schooling levels (see also Neffke et al., 2018; Shi et al., 2022; García-Machado et al., 2023; Jagódka & Snarska, 2023). In this context the SEZ variable is a natural policy factor in relation to Puga's modelling framework – because SEZs seek to foster demand and cost linkages through the emulation of pure market-based cluster building efforts – i.e., ZMCs act as a 'helping hand' to ignite these processes. The following Equation is estimated to account for the extensive margin (a confirmation of H1 implying that $\delta 1 > 0$):

$$\begin{aligned}\log \text{New Firms}_{it} = {} & \gamma_i + \tau_T + \delta_1 \text{SEZ gmina}_{it} + \delta_2 \log \text{Migration Domestic}_{it} + \\ & \delta_3 \log \text{Migration Foreign}_{it} + \delta_4 \log \text{Netenroll}_{it} + \delta_5 \log \text{Univinfra}_{it} + \\ & \delta_6 \log \text{Comminfra}_{it} + \delta_7 \log \text{Retailinfra}_{it} + \delta_8 \text{Roads}_{it} + \delta_9 \log \text{Wages}_{it} + \epsilon_{it}.\end{aligned} \tag{3}$$

All Equations are estimated with inclusion of two-way fixed effects (hence individual intercepts in the equations for each gmina i and time or year t)[4]. Both Equations, seeking to measure the intensive and extensive margins, are estimated first on the full regional dataset using the SEZ dummy as shown above in 2.2 and 3. Then re-estimated on the part of the dataset that includes gminas subjected at some point in time to the SEZ policy – in the current period or at a future point in time.

Where the coefficients for the policy should be interpreted in the context of:

- Across all gminas: how a gmina responds to treatment across all gminas and over time
- SEZ gminas only: how a gmina responds to treatment across all treated gminas and over time

Only when using the SEZ gminas subset is there the implied control for the normal selection bias of being in and out of treatment (see also King & Nielsen, 2019; Matyas, 2017). However, control is not implied in other aspects of selection and timing, such as the first investor taking the best plot etc. In relation to selection bias, control is made of the most important selection variable found in earlier literature on Polish SEZs: the (prior) location of state firms (Jensen, 2018).

[4] In practise, it is the FWLS version of Equations (2) and (3) that is estimated. This representation is not shown with the equations here. The FWLS equivalent is the same, but with each term including an interaction term on the reciprocal of the square root of the variable Area (thereby also adjusting for the possibility or potential error influence that some gminas change size over time). This source of heteroscedasticity in the data owes to agglomeration economies which for political reasons tend to shrink the size of administrative borders in the areas that have such economic agglomerations (see also Jensen & Mina, 2019). When the source of heteroscedasticity is known, the more efficient estimator addresses the source of the problem rather than using the generic solution of clustered robust standard errors (see also King & Roberts, 2015). The disadvantage of FWLS is that it is sensitive to outliers. It performs best for large samples. Independent hereof, the appropriateness of the method also rests on the validity of the chosen weighting scheme (see also Romano & Wolf, 2017).

6. Econometric results

The Equations for the extensive (Equation (3) in Table 2) and intensive margins (Equation (2) in Table 3) of employment and growth in firm populations were estimated for all gminas (*all gminas* in the Tables) in all years, where the full panel applied is available (see also Table 1). Since the Equations for the extensive margin has more variables and many of the variables capturing firm entry have more limited availability, the time series in Table 2 is somewhat shorter than in Table 3. The same Equations were then estimated for only that sub-sample of gminas, which at some points are involved in the SEZ policy (where individual gminas come into the policy gradually over the period of study, *SEZ gminas* in the Tables).

Table 2 shows results for three different variations on the dependent variable of *n* or firm entry: *New firms* in Columns 1–2, *New foreign firms* in Columns 3–4 and finally *SMEs* (sized

Table 2. The extensive margin of firm growth and employment

	Dependent variable					
	New Firms		New Foreign Firms		SMEs	
	All gminas (1)	SEZ gminas (2)	All gminas (3)	SEZ gminas (4)	All gminas (5)	SEZ gminas (6)
Gmina in treatment (SEZ dummy)	–0.113***	0.015**	–0.058***	0.174***	0.001	0.012***
	(0.008)	(0.007)	(0.013)	(0.021)	(0.004)	(0.003)
Domestic migrants	0.057***	0.101***	–0.015*	–0.110***	0.035***	0.058***
	(0.005)	(0.011)	(0.008)	(0.032)	(0.003)	(0.005)
Foreign migrants	0.017***	0.021***	0.001	0.015*	0.009***	0.006***
	(0.002)	(0.003)	(0.003)	(0.009)	(0.001)	(0.002)
Net enrollment secondary school	0.063***	0.096***	0.053***	0.089***	0.022***	0.017***
	(0.007)	(0.012)	(0.010)	(0.034)	(0.003)	(0.005)
University infrastructure	0.0002	0.002	0.003	0.020***	0.002**	–0.00004
	(0.002)	(0.003)	(0.003)	(0.007)	(0.001)	(0.001)
Commercial infrastructure	0.005***	0.003*	0.004**	–0.007	0.002**	0.003***
	(0.001)	(0.002)	(0.002)	(0.005)	(0.001)	(0.001)
Retail infrastructure	0.063***	0.051***	0.109***	0.109***	0.004	0.017***
	(0.009)	(0.015)	(0.014)	(0.042)	(0.004)	(0.006)
Surfaced roads	0.030***	0.014	0.171***	0.225***	–0.001	–0.001
	(0.009)	(0.013)	(0.014)	(0.038)	(0.004)	(0.006)
Wages	–0.094***	–0.018	0.147***	0.006	–0.043***	0.002
	(0.020)	(0.016)	(0.030)	(0.046)	(0.011)	(0.009)
Observations	34,894	6,800	34,894	6,800	44,819	8,734
R^2	0.969	0.981	0.642	0.620	0.989	0.994
Adjusted R^2	0.967	0.979	0.614	0.589	0.989	0.994
Residual Std. Error	0.021 (df = 32378)	0.016 (df = 6292)	0.032 (df = 32378)	0.044 (df = 6292)	0.012 (df = 42299)	0.009 (df = 8222)

9–249 employees) in Columns 5–6. A potential problem with the *New firms* variable is that it does not capture entrepreneurship in a transition economy context in the way it is meant to (i.e. high growth potential firms) (see also Jensen & Goldberg, 2014). Different variations for this dependent variable therefore serve as robustness checks. However, the results across the three different dependent variables are similar for most of the model factors and, ultimately, the performance (equation fit) was nearly as good for the *New firms*. The *New foreign firms* also show differentiated results, meaning it is worth paying attention to. The most correct and conservative variable is considered to be the *SMEs* variable, considering it best represents all high growth potential firms (i.e. not sole entrepreneurships or survival-oriented types of small businesses).

The control factors take expected signs and are of reasonable sign and significance and will therefore not be commented upon further. Traditional factors better explain entrepreneurship in Poland compared to the SEZ policy. Based on Table 2, we cannot conclude that the SEZ policy has been able to generate more new firms in comparison to other areas and irrespective of traditional factors of location choice. However, area selection may be important, as noted previously when comparing the interpretations across the full sample of all gminas and the sub-sample of SEZ gminas.

Within SEZ gminas, the policy has generated a higher extensive margin once the policy has been activated. The measured effect for the extensive margin with this model is highest for the *New foreign firms* variable. Once the policy is activated within the treated areas, the response on foreign firm entry has been 17.4% higher than in years without the policy. The same response is much lower for the other dependent variables: 1.5% for the *New firms* variable and 1.2% for *SMEs*. Overall, the result of the policy for generating entrepreneurship or growing through the extensive margin has been modest according to these results.

Next in Table 3 are reported results for the intensive margin. As discussed in the literature review, the intensive margin is equally, if not more important, in the assessment of whether clusters are viable. Because the coefficient estimates the interaction term between the policy variable (SEZ dummy) and the *All firms* (n) variable, it reveals whether there is a difference when using the policy: does it deepen the collaborations and co-dependencies in the way we would expect in a business cluster?

The main variables of interest are, henceforth, the policy specific variables again, as reported in the first and law row of the main section of Table 3 (regression coefficients).

According to the results in Column 1, Table 3 (without the interaction term between the *SEZ dummy* and the *All firms* variable), and even when controlling for the (prior) presence of *State firms*, the policy has a small negative impact on employment over the period studied here (which is longer than the periods that have been previously studied in the literature). As expected, employment shows a strong positive response to the extensive margin of employment: the number of firms in each area. A 1% increase in the firm population results in a 0.67% increase in employment. If the increase is in the foreign firm population, we can add around 0.02%, while if the increase is in the state firm population, we must deduct around 13–15%.

However, it is the comparison between Columns 1 and 2, in Table 3, that shows the main conclusion for the intensive margin. Once we take into account the interaction between the response of number of firms and the SEZ policy (where the interaction effect is small but

Table 3. The intensive margin of employment and firm growth

	Dependent variable		
	Employment		
	All gminas (1)	All gminas (2)	SEZ gminas (3)
Gmina in treatment (SEZ dummy)	–0.027**	0.273***	–0.061
	(0.011)	(0.082)	(0.063)
All firms	0.672***	0.671***	0.664***
	(0.020)	(0.020)	(0.035)
Foreign firms	0.023***	0.024***	0.070***
	(0.007)	(0.007)	(0.012)
State firms	–0.135***	–0.145***	0.015
	(0.009)	(0.010)	(0.011)
Surfaced Roads	0.071***	0.070***	0.022
	(0.012)	(0.012)	(0.017)
Wages	–0.381***	–0.381***	–0.119
	(0.055)	(0.055)	(0.091)
All firms x Gmina in treatment (SEZ dummy)		–0.041***	0.006
		(0.011)	(0.008)
Observations	49,862	49,862	9,729
R^2	0.918	0.918	0.949
Adjusted R^2	0.914	0.914	0.946
Residual Std. Error	0.044 (df = 47341)	0.044 (df = 47340)	0.033 (df = 9216)

Note: *p < 01; **p < 0.05; ***p < 0.01.

negative, suggesting that on average the policy generated clusters do not show any signs of stronger viability for the intensive than other clusters), the average employment impact of the policy in the treated areas jumps to around 31%[5] higher employment in treated areas relative to all other areas.

This change in results could be driven by the endogeneity that exists between the intensive margin and different subgroups of firms. This was possible to investigate in part using the knowledge from prior research (see i.e., Jensen, 2018); that it is often the (prior) location of state firms that drives the enrolment of each gmina or area into the policy (measured with the SEZ dummy).

As a robustness check of the results in Table 3 was conducted an instrumental variable regression in Table 4. (Notice that the location of the policy variables of interest are opposite in Table 4 due to the IV regression compared to the order they are presented in Table 3.) In Table 4 the SEZ dummy is instrumented by the State firms variable and, therefore, is reported last. The results shown vindicate the intensive margin or relative firm size as the decisive fac-

[5] Note that we need to take the exponent to the coefficient estimate and deduct 1 when interpreting a dummy where the dependent variable is log transformed.

tor behind the employment outcome in business clusters created or helped by the policy. (Notice that the result for the instrument in Column 2 can be driven by the sensitivity of the econometric method (FWLS) to outliers whereby the abnormally high negative coefficient estimate is obtained – see also Footnote 4. The result can also in part be driven by the massive layoffs from the state-owned firms in some areas, but which the SEZ policy effectively counteracts.). However, once we shift to the part of the dataset where we compare the treated areas before and after treatment (Column 3 in Table 4), the explanatory power for the intensive margin result shifts towards the foreign firms variable. Within the gminas that are affected by the policy at some point in time, it is the arrival of foreign firms that is important for employment outcomes – but it is not relative to all the other gminas. Relative to all the other gminas is the intensive margin, which in this case signifies (because the SEZ helping hand does not grow the extensive margin more) that the policy exhibits a large firm bias.

Table 4. IV regression for the intensive margin of employment and firm growth

	Dependent variable		
	Employment		
	All gminas (1)	All gminas (2)	SEZ gminas (3)
All firms	0.836***	0.672***	0.661***
	(0.026)	(0.021)	(0.036)
All firms x Gmina in treatment (SEZ dummy)		0.604***	–0.024
		(0.043)	(0.022)
Foreign firms	–0.011	0.011	0.074***
	(0.009)	(0.008)	(0.012)
Surfaced Roads	0.079***	0.080***	0.018
	(0.012)	(0.012)	(0.018)
Wages	–0.438***	–0.370***	–0.123
	(0.059)	(0.057)	(0.091)
IV: SEZ dummy fitted on State firms	0.902***	–4.611***	0.171
	(0.068)	(0.331)	(0.165)
Observations	49,862	49,862	9,729
R^2	0.907	0.912	0.949
Adjusted R^2	0.902	0.907	0.946
Residual Std. Error	0.047 (df = 47342)	0.046 (df = 47341)	0.033 (df = 9217)

Note: *p < 01; **p < 0.05; ***p < 0.01.

7. Conclusions and discussion

The objective of the paper is to evaluate the relative impact of the policy design of reforming regional governance structures in Poland, as related to post-socialist Poland's special economic zones policy. The objective has been to assess why and how the policy is able to sustain employment through the enactment of a policy that emulates the market process of

business clusters. The paper hypothesises that the policy is able to do so – through growing clusters on the extensive and intensive margins of employment.

The first hypothesis (H1) test only finds limited confirmation in the panel. Relative to all other areas, gminas with the SEZ policy implemented did not generate more entrepreneurship than in other areas. But in a within comparison among the gminas affected by the policy, it is found that the policy did result in a pattern of generating more new firms. That is once the policy started to take effect in each gmina.

The other important aspect of H1 was that the policy will lead to a greater response on regional employment through the intensive margin. This idea takes theoretical outset in Marshall's idea of external economies, Porter's concept of value-added chains of interconnected firms, or the network economies associated with the more modern idea of the entrepreneurial ecosystem. The testing of this idea also found limited confirmation in the panel. Instead, the result showed that the policy may have an inherent large firm bias, which opposes the idea that a growing business cluster in itself leads to more employment across all firms in the business cluster.

It is concluded that, in the mix of attracting foreign investors and restructuring former state firms, the generation of entrepreneurship from the bottom-up has been an aspect of the policy that has been relatively ignored or deemed less important. Contrasting this is a large firm bias, which is often inherent in these types of interventions. Overall, the results show that the best performing zones, in terms of numbers and size, are those that were able to attract larger sized investors, more foreign investors, and grow these firms more. Some individual ZMCs also stand out as being successful on the intensive margin for these reasons.

The Polish experience with SEZs therefore demonstrates the need for paying relatively more attention to attracting new firms or start-ups and as the transition progresses. In this aspect the Polish policy was less successful - relative to maintaining employment and activities in existing firms (Cieślik, 2005; Cizkowicz et al., 2017; Jensen, 2018; Nazarczuk & Uminski, 2018). Many administrative barriers including size requirements could make it more difficult for entrepreneurs or newcomers to benefit from the incentive packages. Policy-makers therefore need to pay more attention to establishing rules and requirements that allow for attracting a more diverse ecosystem of firm populations.

From the outset, the policy sought to target large investments, foreign investors, and foremost those that could offer Polish regions significant employment prospects. Entrepreneurship is only an aspect of the policy that has been added later as an afterthought. While cluster and spillover theory would predicate that the attraction of large firms will lead to these processes occurring organically on their own or secondarily, the analysis suggests that so far this, on average, has not been the case.

The policy and its impact cannot be understood as independent of the overall general transition process in Poland. But while the elements of transition and privatisation strategy are often emphasised in the transition literature (Birdsall & Nellis, 2003), some of the real workings of importance may have been in the regional design and the emergence of new structures for regional governance. Perhaps Poland has avoided falling into the trap of excessive urbanisation and economic agglomeration that often plagues the capitalist economies nowadays. The real counterfactual of what would have happened without the policy can never be fully answered.

Disclosure statement

The author has no competing interests to declare.

References

Ambroziak, A. A. (2016). Income tax exemption as a regional state aid in special economic zones and its impact upon development of Polish districts. *Oeconomia Copernicana*, *7*(2), 245–267.

Audretsch, D. B. (2002). The dynamic role of small firms: Evidence from the US. *Small Business Economics*, *18*, 13–40. https://doi.org/10.1023/A:1015105222884

Baldwin, J. R., Brown, W. M., & Rigby, D. L. (2010). Agglomeration economies: Microdata panel estimates from Canadian manufacturing. *Journal of Regional Science*, *50*(5), 915–934. https://doi.org/10.1111/j.1467-9787.2010.00675.x

Baptista, R., & Swann, G. M. P. (1999). A comparison of clustering dynamics in the US and UK computer industries. *Journal of Evolutionary Economics*, *9*, 373–399. https://doi.org/10.1007/s001910050088

Billings, S. (2009). Do enterprise zones work? An analysis at the borders. *Public Finance Review*, *37*(1), 68–93. https://doi.org/10.1177/1091142108321238

Birdsall, N., & Nellis, J. (2003). Winners and losers: Assessing the distributional impact of privatization. *World Development*, *31*(10), 1617–1633. https://doi.org/10.1016/S0305-750X(03)00141-4

Blaszczyk, B. (2001). *Secondary privatization in Poland* (*part II*): *Evolution of ownership structure and performance in national investment funds and their portfolio companies* (CASE Network Reports No. 48). SSRN. https://doi.org/10.2139/ssrn.1432403

Bondonio, D., & Greenbaum, R. T. (2007). Do local tax incentives affect economic growth? What mean impacts miss in the analysis of enterprise zone policies. *Regional Science and Urban Economics*, *37*(1), 121–136. https://doi.org/10.1016/j.regsciurbeco.2006.08.002

Bondonio, D., & Greenbaum, R. T. (2014). Revitalizing regional economies through enterprise support policies: An impact evaluation of dimeple instruments. *European Urban and Regional Studies*, *21*(1), 79–103. https://doi.org/10.1177/0969776411432986

Briant, A., Lafourcade, M., & Schmutz, B. (2015). Can tax breaks beat geography? Lessons from the French enterprise zone experience. *American Economic Journal*: *Economic Policy*, *7*(2), 88–124. https://doi.org/10.1257/pol.20120137

Chaudhary, N., & Potter, J. (2018). Evaluation of the local employment impacts of enterprise zones: A critique. *Urban Studies*, *56*(10), 2112–2159. https://doi.org/10.1177/0042098018787738

Cieślik, A. (2005). Regional characteristics and the location of foreign firms within Poland. *Applied Economics*, *37*(8), 863–874. https://doi.org/10.1080/00036840500061087

Cizkowicz, P., Cizkowicz-Pekala, M., Pekala, P., & Rzonca, A. (2017). The effects of special economic zones on employment and investment: A spatial panel modelling perspective. *Journal of Economic Geography*, *17*(3), 571–605. https://doi.org/10.1093/jeg/lbw028

Combes, P.-P., & Gobillon, L. (2015). The empirics of agglomeration economies. In *Handbook of regional and urban economics* (Vol. 5, pp. 247–348). Elsevier. https://doi.org/10.1016/B978-0-444-59517-1.00005-2

Delgado, M., Porter, M. E., & Stern, S. (2010). Clusters and entrepreneurship. *Journal of Economic Geography*, *10*(4), 495–518. https://doi.org/10.1093/jeg/lbq010

Delgado, M., Porter, M. E., & Stern, S. (2014). Clusters, convergence, and economic performance. *Research Policy*, *43*(10), 1785–1799. https://doi.org/10.1016/j.respol.2014.05.007

Dorozyński, T., Świerkocki, J., & Urbaniak, W. (2018). Determinants of investment attractiveness of Polish special economic zones. *Entrepreneurial Business and Economics Review*, *6*(4), 161–180. https://doi.org/10.15678/EBER.2018.060409

Dorozyński, T., Świerkocki, J., & Urbaniak, W. (2019). FDI inflows to special economic zones in Poland. Regional approach. *Journal of Management and Financial Sciences*, (27), 87–103. https://doi.org/10.33119/JMFS.2017.27.5

Feldman, M. P. (2014). The character of innovative places: Entrepreneurial strategy, economic development, and prosperity. *Small Business Economics*, *43*(1), 9–20. https://doi.org/10.1007/s11187-014-9574-4

Frank, M. M., Hoopes, J. L., & Lester, R. (2022). What determines where opportunity knocks? Political affiliation in the selection of opportunity zones. *Journal of Public Economics*, *206*, Article 104588. https://doi.org/10.1016/j.jpubeco.2021.104588

Frenken, K., Cefis, E., & Stam, E. (2015). Industrial dynamics and clusters: A survey. *Regional Studies*, *49*(1), 10–27. https://doi.org/10.1080/00343404.2014.904505

Freund, C., & Pierola, M. D. (2015). Export superstars. *Review of Economics and Statistics*, *97*(5), 1023–1032. https://doi.org/10.1162/REST_a_00511

Fritsch, M., & Storey, D. J. (2014). Entrepreneurship in a regional context: Historical roots, recent developments, and future challenges. *Regional Studies*, *48*(6), 939–954. https://doi.org/10.1080/00343404.2014.892574

Fujishima, S., Hoshino, T., & Sugawara, S. (2022). *Heterogeneous effects of place-based policies and a practical treatment assignment rule*. SSRN.

García-Machado, J. J., Sroka, W., & Nowak, M. (2023). PLS-SEM model on business demand for technological services and R&D and innovation activities. *Technological and Economic Development of Economy*, *29*(1), 1–22. https://doi.org/10.3846/tede.2023.17968

Givord, P., Quantin, S., & Trevien C. (2018). A long-term evaluation of the first generation of French urban enterprise zones. *Journal of Urban Economics*, *105*, 149–161. https://doi.org/10.1016/j.jue.2017.09.004

Giuliani, E. (2017). Industrial clusters in global networks. In H. Bathelt, P. Cohendet, S. Henn, & L. Simon (Eds.), *The Elgar companion to innovation and knowledge creation* (pp. 360–371). Edward Elgar Publishing. https://doi.org/10.4337/9781782548522.00031

Glaeser, E. L., Kerr, W. R., & Ponzetto, G. A. M. (2010). Clusters of entrepreneurship. *Journal of Urban Economics*, *67*(1), 150–168. https://doi.org/10.1016/j.jue.2009.09.008

Gobillon, L., Magnac, T., & Selod, H. (2010). Do unemployed workers benefit from enterprise zones? The French experience. *Journal of Public Economics*, *96*(9–10), 881–892.

Gobillon, L., & Magnac, T. (2016). Regional policy evaluation: Interactive fixed effects and synthetic controls. *Review of Economics and Statistics*, *98*(3), 535–551. https://doi.org/10.1162/REST_a_00537

Goodin, R. E. (1996). Institutions and their design. *The theory of institutional design* (pp. 1–53). https://doi.org/10.1017/CBO9780511558320.002

Gomułka, S. (2014). Transformacja gospodarczo-społeczna Polski 1989–2014 i współczesne wyzwania [Poland's economic and social transformation 1989–2014, and contemporary changes]. *Nauka*, (3), 7–16.

Gwosdz, K., Jarczewski, W., Huculak, M., & Wiederman, K. (2008). Polish special economic zones: Idea versus practice. *Environment and Planning C*: *Government and Policy*, *26*(4), 824–840. https://doi.org/10.1068/c0209p

Hart, P. E. (2000). Theories of firms' growth and the generation of jobs. *Review of industrial Organization*, *17*, 229–248. https://doi.org/10.1023/A:1007887626165

Howell, A. (2019). Heterogeneous impacts of China's economic and development zone program. *Journal of Regional Science*, *59*(5), 797–818. https://doi.org/10.1111/jors.12465

Jagódka, M., & Snarska, M. (2023). Regional disparities as a result of differences in human capital and innovativeness on the example of Poland. *Technological and Economic Development of Economy*, *29*(2), 696–716. https://doi.org/10.3846/tede.2023.18536

Jensen, C. (2004). Localized spillovers in the Polish food industry: The role of FDI in the development process? *Regional Studies*, *38*(5), 533–548. https://doi.org/10.1080/0143116042000229302

Jensen, C., & Goldberg, I. (2014). *Demand-driven innovation policies in the European Union* (CASE Research Paper, No. 468). Centre for Social and Economic Research. https://doi.org/10.2139/ssrn.2394551

Jensen, C., & Winiarczyk, M. (2014). *Special economic zones – 20 years later* (CASE Research Paper No. 467). Centre for Social and Economic Research. https://doi.org/10.2139/ssrn.2394547

Jensen, C. (2018). The employment impact of Poland's special economic zones policy. *Regional Studies*, *52*(7), 877–889. https://doi.org/10.1080/00343404.2017.1360477

Jensen, C., & Mina, A. (2019). Did transition bring cleaner air? Effects of ownership, territorial and technology policy on air pollution. *Ecological Economics*, *165*, Article 106276. https://doi.org/10.1016/j.ecolecon.2019.03.017

King, G., & Roberts, M. E. (2015). How robust standard errors expose methodological problems they do not fix, and what to do about it. *Political Analysis*, *23*(2), 159–179. https://doi.org/10.1093/pan/mpu015

King, G., & Nielsen, R. (2019). Why propensity scores should not be used for matching. *Political Analysis*, *27*(4), 435–454. https://doi.org/10.1017/pan.2019.11

KPMG. (2009). *A guide to special economic zones in Poland*. Warsaw, Poland.

KPMG. (2012). *Special Economic Zones – Edition 2012*. Warsaw, Poland.

Kolko, J., & Neumark, D. (2010). Do some enterprise zones create jobs? *Journal of Policy Analysis and Management*, *29*(1), 5–38. https://doi.org/10.1002/pam.20477

Layser, M. D. (2018). A typology of place-based investment tax incentives. *Washington and Lee Journal of Civil Rights and Social Justice, 403*, 403–463. https://doi.org/10.2139/ssrn.3381394

Layser, M. D. (2020). How place-based tax incentives can reduce geographic inequality. *Tax Law Review*,*74*(1), 1–68. https://doi.org/10.2139/ssrn.3516469

Li, Y., Kenney, M., Patton, D., & Song, A. (2023). Entrepreneurial ecosystems and industry knowledge: Does the winning region take all? *Small Business Economics*, *61*, 153–172. https://doi.org/10.1007/s11187-022-00681-y

Matyas, L. (Ed.). (2017). *The econometrics of multi-dimensional panels*. Springer. https://doi.org/10.1007/978-3-319-60783-2

Mayer, T., Mayneris, F., & Py, L. (2012). *The impact of urban enterprise zones on establishments' location decisions*: *Evidence from French ZFUs* (Banque de France Working Paper No. 458). SSRN. https://doi.org/10.2139/ssrn.2346227

Ministry of the Economy. (2009). *Informacja o realizacji ustawy o specjalnych strefach ekonomicznych* [Information about the implementation of the Act on Special Economic Zones] (2008, December 31). Warsaw. https://orka.sejm.gov.pl/Druki6ka.nsf/wgdruku/2030/$file/2030.pdf

Ministry of the Economy. (2016). *Informacja o realizacji ustawy o specjalnych strefach ekonomicznych* [Information about the implementation of the Act on Special Economic Zones] (2015, December 31). Warsaw. https://orka.sejm.gov.pl/Druki8ka.nsf/0/B01837BE236B7D1DC1257FC5003BADB1/%24File/555.pdf

Ministry of Enterprise and Technology. (2018). *Informacja o realizacji ustawy o specjalnych strefach ekonomicznych* [Information about the implementation of the Act on Special Economic Zones] (2017, December 31). Warsaw. https://orka.sejm.gov.pl/Druki8ka.nsf/0/6178DA8C683C4543C12582A3003728F2/%24File/2591.pdf

Ministry of Economic Development and Technology. (2020). *Polish investment zone – Current summary of operations*, *support during the pandemic*. https://www.gov.pl/web/development-technology/polish-investment-zone--current-summary-of-operations-support-during-the-pandemic

Ministry of Economic Development and Technology. (2023). *Informacja o realizacji ustawy o specjalnych strefach ekonomicznych* [Information about the implementation of the Act on Special Economic Zones] (2022, December 31). Warsaw. https://orka.sejm.gov.pl/Druki9ka.nsf/0/49B7462B1889DC55C12589C1002F50C8/%24File/3306.pdf

Najwyzsza Izba Kontroli. (2010). *Informacja o wynikach kontroli funkcjonowania i rozszerzania obszaru działania specjalnych stref ekonomicznych w latach 2006–2008* [Operation and expansion of the area of operation of special economic zones (SEZ) in 2006–2008]. https://www.nik.gov.pl/kontrole/P/08/130/LBI/

Najwyzsza Izba Kontroli. (2012). *Pomoc publiczna udzielona w latach 2006–2010 przedsiębiorcom działającym w specjalnych strefach ekonomicznych* [Public aid granted in 2006–2010 to entrepreneurs operating in special economic zones]. https://www.nik.gov.pl/kontrole/wyniki-kontroli-nik/kontrole,9267.html

Nazarczuk, J. M., Umiński, S., & Gawlikowska-Hueckel, K. (2018). The role of specialisation in the export success of Polish counties in 2004–2015. *Entrepreneurial Business & Economics Review*, *6*(2), 91–109. https://doi.org/10.15678/EBER.2018.060205

Nazarczuk, J. M., & Umiński, S. (2018). The impact of special economic zones on export behaviour: Evidence from Polish firm-level data. *E+M Ekonomie a Management*, *21*(3), 4–22. https://doi.org/10.15240/tul/001/2018-3-001

Nazarczuk, J. M., Umiński, S., & Márquez-Ramos, L. (2024). Exporting activity in rural regions: Does it differ from urban regions? Evidence from Poland. *Technological and Economic Development of Economy*, *30*(3), 712–732. https://doi.org/10.3846/tede.2024.20505

Neffke, F., Hartog, M., Boschma, R., & Henning, M. (2018). Agents of structural change: The role of firms and entrepreneurs in regional diversification. *Economic Geography*, *94*(1), 23–48. https://doi.org/10.1080/00130095.2017.1391691

Nelson, R. R. (2008). What enables rapid economic progress: What are the needed institutions? *Research Policy*, *37*(1), 1–11. https://doi.org/10.1016/j.respol.2007.10.008

Neumark, D., & Young, T. (2021). Heterogeneous effects of state enterprise zone programs in the shorter run and longer run. *Economic Development Quarterly*, *35*(2), 91–107. https://doi.org/10.1177/0891242420982341

Official Journal of Law. (2018). *Act of 10th May 2018 on support for new investments*. https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20180001162/T/D20181162L.pdf

Ottaviano, G. I. (2010). 'New' new economic geography: Firm heterogeneity and agglomeration economies. *Journal of Economic Geography*, *11*(2), 231–240. https://doi.org/10.1093/jeg/lbq041

Parker, D., & Kirkpatrick, C. (2005). Privatisation in developing countries: A review of the evidence and the policy lessons. *Journal of Development Studies*, *41*(4), 513–541. https://doi.org/10.1080/00220380500092499

Patrick, C., Ross, A., & Stephens, H. (2017). Designing policies to spur economic growth: How regional scientists can contribute to future policy development and evaluation. In R. Jackson & P. Schaeffer (Eds.), *Regional Research Frontiers*: *Vol. 1. Advances in Spatial Science* (pp. 119–133). Springer. https://doi.org/10.1007/978-3-319-50547-3_7

Polish Local Data Bank. (n.d.). Retrieved on September 15, 2024, from https://bdl.stat.gov.pl/BDL/start?p_name=indeks

Porter, M. E. (1998). Clusters and the new economics of competition. *Harvard Business Review*, *76*(6), 77–90.

Porter, M. E. (2000). Location, competition, and economic development: Local clusters in a global economy. *Economic Development Quarterly*, *14*(1), 15–34. https://doi.org/10.1177/089124240001400105

Puga, D. (1999). The rise and fall of regional inequalities. *European Economic Review*, *43*(2), 303–334. https://doi.org/10.1016/S0014-2921(98)00061-0

Rialland, A. I. (2009). *Cluster dynamics and innovation* (Marintek Report). Norwegian Marine Technology Research Institute. Trondheim, Norway.

Romano, J. P., & Wolf, M. (2017). Resurrecting weighted least squares. *Journal of Econometrics*, *197*(1), 1–19. https://doi.org/10.1016/j.jeconom.2016.10.003

Shi, Z., Wu, Y., Chiu, Y.- ho, Shi, C., & Na, X. (2022). Comparing the efficiency of regional knowledge innovation and technological innovation: A case study of China. *Technological and Economic Development of Economy*, *28*(5), 1392–1418. https://doi.org/10.3846/tede.2022.17125

Statistics Poland. (n.d.). *Local Data Bank*. https://portal.geo.stat.gov.pl/en/home/data/local-data-bank/

Stich, C., Tranos, E., & Nathan, M. (2023). Modeling clusters from the ground up: A web data approach. *Environment and Planning B*: *Urban Analytics and City Science*, *50*(1), 244–267. https://doi.org/10.1177/23998083221108185

Twinam, T. (2020). *Trade shocks and growth*: *The impact of the quartz crisis in Switzerland*. SocArXiv twscm. Center for Open Science.

Verdú, F. M., & Tierno, N. R. (2019). Special issue: Clustering and innovation: Firm-level strategizing and policy. *Entrepreneurship and Regional Development*, *31*(1–2), 1–6. https://doi.org/10.1080/08985626.2018.1537143

World Bank. (2010). *Special Economic Zones*. *performance*, *lessons learned*, *and implications for zone development*. The World Bank.

Zaratiegui, J. M. (2004). Marshallian industrial districts revisited. Part II. *Problems and Perspectives in Management*, *2*(3), 43–58.

Zeng, D. Z. (2015). *Global experiences with special economic zones*. *Focus on China and Africa* (Policy Research Working Paper No. 7240). World Bank Group. http://documents.worldbank.org/curated/en/810281468186872492/pdf/WPS7240.pdf

APPENDIX

Appendix A. Complementary tables and figures

Table A1. Comparative Statistics on ZMC Performance and Resources, 2017

Zone (tickers)	Name	Area (ha)	Land dev. (%)	Permits (No.)	Jobs created (No.)	Equity (mio PLN)	Infrastructure (mio PLN)	Investments (mio PLN)	Location
KMG	Kamienna-Gora	540.8	44.3	60	7.530	11.5	20.9	2,557.3	South-West
KRW	Krakow	949.7	68.4	189	29.580	17.6	150.2	4,240.4	South
KTW	Katowice	2,614.4	66.3	329	64,481	9.2	55.2	16,605.1	South
KZS	Kostrczyn-Slubice	2.201.3	56.3	180	32,400	27.2	104.4	7,133.4	West
LDZ	Lodz	1,754.6	63.0	209	33,401	24.9	53.5	13,318.7	Centre
LGA	Legnica	1,341.1	25.6	86	15,294	36.0	54.4	5,131.8	South-West
MLC	Mielec	1,724.0	75.9	268	34,992	5,291.8	140.5	7,838.1	South-East
PMR	Pomeranian	2,246.3	68.7	173	24,893	376.0	466.5	10,481.6	North
SLP	Slupsk	910.2	38.8	79	3,478	30.9	23.9	1,592.3	North
STW	Starachowice	708.0	63.7	56	6,829	16.7	10.1	1,790.9	South-East
SWK	Suwalki	663.0	63.9	92	8,336	20.0	36.5	2,500.1	East
TBZ	Tarnobrzeg	1,868.2	76.8	195	20,740	5.291.8	197	7,470.7	South-East
WBZ	Walbrzych	3,774.5	50.8	315	50,268	407.0	268.8	22,789.5	South-West
WMZ	Warminsko-Mazurska	1,364.7	68.9	118	20,778	34.4	5.8	3,124.6	North-East

Table A2. The extensive margin of firm growth and employment (by ZMC)

	Dependent variable					
	New firms		New foreign firms		SMEs	
	All gminas (1)	SEZ gminas (2)	All gminas (3)	SEZ gminas (4)	All gminas (5)	SEZ gminas (6)
Kamienna Gora (KMG dummy)	0.018	0.083***	0.284***	0.371***	0.012	0.023*
	(0.041)	(0.031)	(0.064)	(0.088)	(0.018)	(0.013)
Krakow (KRW dummy)	0.014	0.144***	0.048	0.280***	0.006	0.017**
	(0.027)	(0.020)	(0.042)	(0.058)	(0.011)	(0.008)
Katowice (KTW dummy)	–0.155***	–0.035*	–0.020	0.211***	0.028**	0.039***
	(0.026)	(0.020)	(0.041)	(0.057)	(0.011)	(0.008)
Kostrzyn-Slubice (KZS dummy)	–0.105***	0.019	–0.134***	0.096*	–0.007	0.002
	(0.023)	(0.017)	(0.036)	(0.050)	(0.011)	(0.008)
Lodz (LDZ dummy)	–0.113***	0.015	–0.188***	0.021	0.015	0.031***
	(0.039)	(0.030)	(0.061)	(0.084)	(0.012)	(0.009)
Legnica (LGA dummy)	–0.077	0.069**	–0.184**	0.092	–0.009	0.001
	(0.047)	(0.035)	(0.073)	(0.100)	(0.020)	(0.014)
Miclec (MLC dummy)	–0.062**	0.073***	–0.068	0.166**	0.031**	0.042***
	(0.032)	(0.024)	(0.049)	(0.068)	(0.013)	(0.009)

End of Table A2

	Dependent variable					
	New firms		New foreign firms		SMEs	
	All gminas (1)	SEZ gminas (2)	All gminas (3)	SEZ gminas (4)	All gminas (5)	SEZ gminas (6)
Pomeranian (PMR dummy)	–0.169***	–0.042**	–0.239***	–0.013	–0.033***	–0.021***
	(0.022)	(0.017)	(0.035)	(0.049)	(0.010)	(0.008)
Slupsk (SLP dummy)	–0.141***	–0.010	–0.255***	–0.007	–0.050***	–0.039***
	(0.036)	(0.027)	(0.056)	(0.078)	(0.017)	(0.012)
Starachowice (STW dummy)	0.037	0.169**	0.025	0.215	0.084***	0.098***
	(0.088)	(0.066)	(0.137)	(0.189)	(0.023)	(0.017)
Suwalki (SWK dummy)	–0.132***	–0.004	0.028	0.266***	0.008	0.020**
	(0.026)	(0.020)	(0.041)	(0.058)	(0.014)	(0.010)
Tarnobrzeg (TBR dummy)	–0.110***	0.026	0.109**	0.314***	0.004	0.017*
	(0.032)	(0.024)	(0.050)	(0.069)	(0.013)	(0.009)
Walbrzych (WBZ dummy)	–0.130***	–0.0004	0.076*	0.360***	–0.002	0.007
	(0.029)	(0.022)	(0.045)	(0.063)	(0.012)	(0.008)
Warminsko-Mazurska (WMZ dummy)	–0.164***	–0.034*	–0.036	0.190***	–0.021*	–0.012
	(0.026)	(0.020)	(0.040)	(0.056)	(0.012)	(0.009)
Domestic migrants	0.056***	0.097***	–0.015*	–0.112***	0.035***	0.058***
	(0.005)	(0.011)	(0.008)	(0.033)	(0.003)	(0.005)
Foreign migrants	0.017***	0.020***	0.0005	0.013	0.009***	0.006***
	(0.002)	(0.003)	(0.003)	(0.009)	(0.001)	(0.002)
Net enrollment secondary school	0.063***	0.097***	0.053***	0.090***	0.022***	0.016***
	(0.007)	(0.012)	(0.010)	(0.034)	(0.003)	(0.005)
University infrastructure	0.0004	0.002	0.004	0.022***	0.002**	0.0001
	(0.002)	(0.003)	(0.003)	(0.007)	(0.001)	(0.001)
Commercial infrastructure	0.005***	0.003	0.004**	–0.008	0.001**	0.003***
	(0.001)	(0.002)	(0.002)	(0.005)	(0.001)	(0.001)
Retail infrastructure	0.061***	0.043***	0.107	0.100**	0.004	0.014**
	(0.009)	(0.015)	(0.014)	(0.042)	(0.004)	(0.006)
Surfaced roads	0.029***	0.015	0.172***	0.242***	0.0003	0.004
	(0.009)	(0.014)	(0.014)	(0.039)	(0.004)	(0.006)
Wages	–0.091***	–0.015	0.150***	0.006	–0.042***	0.003
	(0.020)	(0.016)	(0.030)	(0.046)	(0.011)	(0.009)
Observations	34,894	6,800	34,894	6,800	44,819	8,734
R^2	0.969	0.981	0.643	0.623	0.989	0.994
Adjusted R^2	0.967	0.979	0.615	0.592	0.989	0.994
Residual Std. Error	0.021 (df = 32365)	0.016 (df = 6279)	0.032 (df = 32365)	0.044 (df = 6279)	0.012 (df = 42286)	0.009 (df = 8209)

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

Table A3. The intensive margin of firm growth and employment (by ZMC)

	Dependent variable		
	Employment		
	All gminas (1)	All gminas (2)	SEZ gminas (3)
Kamienna Gora (KMG dummy)	–0.262***	–1.573***	–1.749***
	(0.056)	(0.442)	(0.324)
Krakow (KRW dummy)	0.050	0.606″	0.352
	(0.035)	(0.309)	(0.227)
Katowice (KTW dummy)	–0.041	0.698***	0.303*
	(0.034)	(0.245)	(0.181)
Kostrzyn-Slubice (KZS dummy)	–0.020	0.119	–0.255
	(0.034)	(0.295)	(0.217)
Lodz (LDZ dummy)	–0.036	0.580″	0.241
	(0.034)	(0.232)	(0.172)
Legnica (LGA dummy)	–0.049	–0.520	–0.766*
	(0.059)	(0.531)	(0.393)
Mielec (MLC dummy)	–0.007	0.347	0.078
	(0.040)	(0.276)	(0.203)
Pomeranian (PMR dummy)	0.010	0.566***	0.207
	(0.033)	(0.214)	(0.158)
Slupsk (SLP dummy)	0.007	0.491	0.014
	(0.054)	(0.524)	(0.385)
Starachowice (STW dummy)	0.039	0.506	0.321
	(0.066)	(0.389)	(0.286)
Suwalki (SWK dummy)	–0.154***	–0.419	–0.768***
	(0.045)	(0.274)	(0.202)
Tarnobrzeg (TBR dummy)	0.002	0.618*	0.534**
	(0.039)	(0.323)	(0.238)
Walbrzych (WBZ dummy)	–0.009	0.104	–0.223
	(0.033)	(0.258)	(0.190)
Warminsko-Mazurska (WMZ dummy)	–0.067*	0.264	–0.307
	(0.035)	(0.332)	(0.245)
All firms	0.671***	0.671***	0.666***
	(0.020)	(0.020)	(0.036)
Foreign firms	0.023***	0.025***	0.078***
	(0.008)	(0.008)	(0.012)
State firms	–0.134***	–0.146***	0.014
	(0.009)	(0.010)	(0.011)
Surfaced Roads	0.073***	0.072***	0.022
	(0.012)	(0.012)	(0.018)
Wages	–0.386***	–0.380***	–0.091
	(0.055)	(0.056)	(0.094)

End of Table A3

	Dependent variable		
	Employment		
	All gminas (1)	All gminas (2)	SEZ gminas (3)
All firms x Kamienna Gora (KMG dummy)		0.174***	0.199***
		(0.058)	(0.043)
All firms x Krakow (KRW dummy)		–0.075*	–0.041
		(0.041)	(0.031)
All firms x Katowice (KTW dummy)		–0.096***	–0.042*
		(0.031)	(0.023)
All firms x Kostrzyn-Slubice (KZS dummy)		–0.019	0.033
		(0.039)	(0.029)
All firms x Lodz (LDZ dummy)		–0.081***	–0.028
		(0.030)	(0.022)
All firms x Legnica (LGA dummy)		0.068	0.099*
		(0.075)	(0.056)
All firms x Mielec (MLC dummy)		–0.048	–0.011
		(0.036)	(0.027)
All firms x Pomeranian (PMR dummy)		–0.073***	–0.023
		(0.028)	(0.020)
All firms x Slupsk (SLP dummy)		–0.064	0.003
		(0.069)	(0.050)
All firms x Starachowice (STW dummy)		–0.064	–0.036
		(0.053)	(0.039)
All firms x Suwalki (SWK dummy)		0.036	0.085***
		(0.038)	(0.028)
All firms x Tarnobrzeg (TBR dummy)		–0.085*	–0.072**
		(0.044)	(0.032)
All firms x Walbrzych (WBZ dummy)		–0.015	0.027
		(0.034)	(0.025)
All firms x Warminsko-Mazurska (WMZ dummy)		–0.045	0.035
		(0.044)	(0.033)
Observations	49,862	49,862	9,729
R^2	0.918	0.918	0.950
Adjusted R^2	0.914	0.914	0.947
Residual Std. Error	0.044 (df = 47328)	0.044 (df = 47314)	0.032 (df = 9190)

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

Appendix B. The institutional design and set-up behind the Polish SEZ Policy

SEZs have been active in Poland since 1995. Over the period 1995–1997, the government established 17 zones that were designed to operate not longer than until 2017. In 2001 some zones were phased out and others merged reducing the number to 14.

The maximum area eligible for public support under the scheme has also increased several times from the first ceiling of 6.3k ha to 25k ha in 2015. Initially, the Polish SEZs were established to attract new investment to mitigate unemployment in regions burdened with inefficient industrial enterprises inherited from the centrally planned economy (Jensen & Winiarczyk, 2014). But over time, the primary reason behind the establishment of zones has lost its importance. The number of problem areas was reduced due to successful economic transformation and migration of labour (at least 1.5–2 million poles are migrant workers) after Poland's accession to the EU (Gomułka, 2014). Yet later, the government did not want to give up the instrument, since its overall assessment was positive (see e.g., the Najwyzsza Izba Kontroli [Supreme Audit Office], 2010, 2012). The scheme did attract considerable interest among foreign investors in Poland (KPMG, 2009, 2012). Therefore, in 2008 it was decided that instead of helping selected areas, the SEZ policy should enhance the competitiveness of the whole Polish economy and create new jobs more widely (Ministry of Economy, 2009, p. 4). So then in 2008, the design shifted from its original supply-led design, to what evolved into a more demand-led design, where individual investors choose their areas of preference within the mandate of the policy, and then contact with an ZMCs to get help with the further developing of the investment planning process (see also Ministry of Economy, 2016; and MEDT, 2020).

But by 2018 the policy has been mainstreamed, meaning that all areas of Poland were allocated to an ZMC. The consequences hereof are in principle that the policy has reverted to being supply-led, but in a different way than from the onset. Because now all land is allocated towards an ZMC. The meaning of 'special' has been taken out of the policy. One consequence being that the process of competition among ZMCs over land-development has ended. The ZMCs have thereby become a permanent and fixed new cross-cutting regional governance structure (see also MEDT, 2023).

The Polish Ministry for Development and Technology (MEDT, 2020 – see also the Official Journal of Law (2018) explains in a brief the recent amendment to the design as follows):

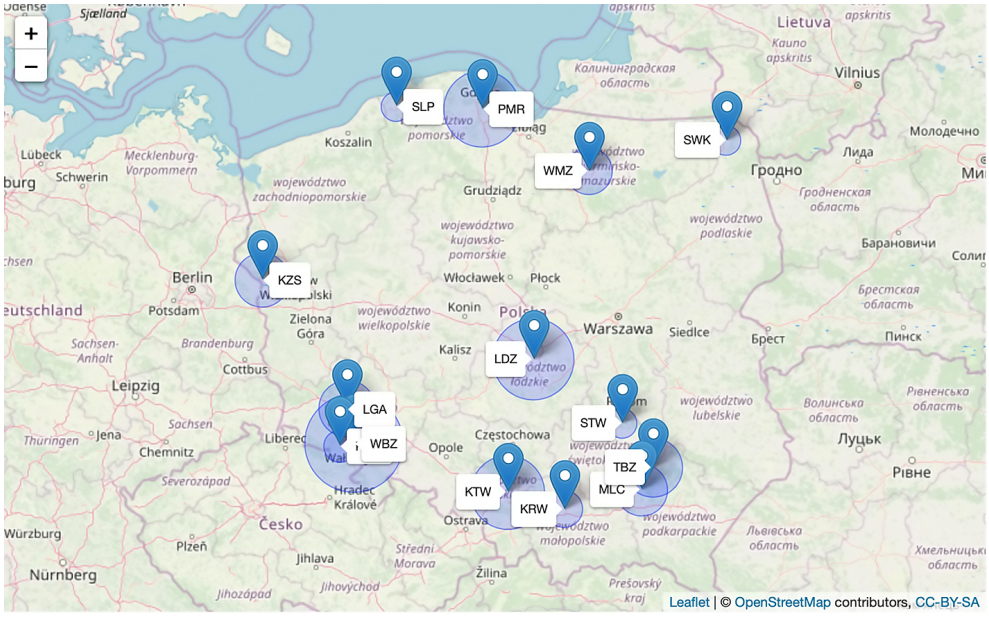
'The Polish Investment Zone was established based on the act of May 10th, 2018, on supporting new investments, thus becoming a single investment area. The Act entered into force on June 30th of 2018. For that reason, since September 5th of 2018, tax breaks have been available in the entire country. And not just solely – as it had been before – in Special Economic Zones. Starting from June 1st of 2019, new investments can only be situated in the PIZ. Special Economic Zones [ZMCs] play a key role in the P–I [PIZ] system - they manage its individual parts.'

Figure B1 shows the location of the 14 ZMC headquarters and their websites can be accessed by pressing on the pointers (only available in the html version of the paper). The size of the rings marks the cumulative investment outlays made under each ZMC at the end of 2016, which is the culmination of the policy in its demand-led form (see also the discussion

and conclusion), as by 2017, for the first time a considerable number of SEZ permits expired (i.e., 178 permits expired) (Ministry of Enterprise and Technology [MET], 2018).

Polish SEZs are under the full political control of the Polish State. Their location, size, and borders are ultimately decided by the government. The central government also appoints the ZMCs. These entities are limited liability or joint stock companies with state majority shareholdings. Every year the government presents a report to the Polish Parliament about the functioning of the zones. In their function the Polish SEZs exhibit two other features:

- Firstly, the ZMCs are distinguished in a legal rather than purely physical sense. Hence the plots are often dispersed, located in various administrative regions, sometimes several hundred kilometres away from each other. For example, an ZMC originating from the South-East of Poland may administer a sub-zone in the North-Eastern part of the country. In this regard the Polish scheme differs from the more traditional geographically delimited types of zones policies, established in China or in other developing countries (Zeng, 2015) and is in this regard similar to enterprise zones in some other developed countries (see i.e. Kolko & Neumark, 2010; Gobillon et al., 2010; Briant et al., 2015).
- The second distinctive feature of Polish SEZs concerns conditions of starting up a business. Zone governors do not enjoy any legislative autonomy which would enable them to offer special concessions and better compete for investors with other operators. In every SEZ in Poland, there is the same package of incentives with similar requirements.



Note: Ticker symbols: KMG – Kamienna-Gora, KTW – Katowice, KRW – Krakow, KZS – Kostrczyn-Slubice, LDZ – Lodz, LGA – Legnica, MLC – Mielec, PMR – Pomeranian, TBZ – Tarnobrzeg, SLP – Slupsk, STW – Starachowice, SWK – Suwalki, WBZ – Walbrzych, WMZ – Warminsko-Mazurska.

Figure B1. ZMC headquarters and websites

Therefore, the differences in maximum value of financial incentives between them are known in advance. They result solely from the EU regulations on State aid ceilings which are regionally diversified (Ambroziak, 2016).

Yet the differences in the administrative capacity of the zones could depend on a variety of more idiosyncratic factors as well. Such as the availability of larger-sized investment plots (which is an inheritance of the territorial concentration of industry in the Polish command economy), and ZMC managers ability and political clout to bargain for these with the local municipalities. In addition, the professionalism and varying attitude that investors can be met with both from the ZMC side and from local authorities in the specific geography where they wish to operate.

While investments in SEZs come with special incentives such as tax exemptions, fully developed investment plots and advanced technical infrastructure and the eventual exemption from property tax, there are also many requirements attached to these favourable investment conditions (see also Dorozyński et al., 2018, 2019)

Requirements include the extra bureaucracy of preparing the permit for operating in the SEZ, and minimum operational size requirements (in terms of employment generated, size of sunk investments and capital stakes held in the local entity). The design therefore involves an inbuilt favouring of larger firms that can afford the minimum size of investment capital required. On top of this investors also must pay an annual fee to the ZMC. Large investors must promise to operate for at least 5 years in the SEZ, while for smaller investors the minimum operation period is 3 years. Investors are liable to pay back the public support with interest, if failing to meet these requirements. A final more technical requirement for being eligible for public support (in this case a tax allowance) concerns the principle of additionality in public policy. The investment must represent genuine creation of a new activity, rather than the relocation of an existing activity (within the European Economic Area).