The Effects of Polish Special Economic Zones on Employment and Investment: Spatial Panel Modelling Perspective.

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Agenda

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Context and motivation

- Special economic zones (SSE) have been used in Poland since 1995. Recently SSE lifespan has been prolonged until 2026.
- The area available for SSE development has been gradually increased.
- Literature on SSE functioning in Poland does not permit to draw conclusions with respect to the effects SSE have on the economy.
- Investment incentives used by SSE in Poland entail fiscal costs. Lack of comprehensive benefit estimation rules out rational decision making.

Research problem

The analysis of SSE effectiveness as policy tools requires an aswer to the following questions:

- Are there any differences in the scale of employment creation and investment attraction between SSEs? If so, what explains these differences?

- What is the impact of firms located in SSEs on economic outcomes outside SSEs territory

Our research seeks to answer the second question.

Literature review (1/2)

- **Main conclusions:**
  - Literature on SEZ effectiveness is inconclusive, with most of the analyses pointing to positive albeit weak impact of SSE functioning on economic development on regional level
  - Drawing conclusions from international research is unwarranted given the significant differences in goals and features of SEZ across countries
  - A large part of the literature on Polish SSEs focuses on descriptive analyses based on case studies

Literature review (2/2)

- **Literature limitations:**
  - Mainly case-by-case descriptive analyses
  - Effects of exogenous factors not separated from SSE designation
  - Scarce econometric analyses do not account for economic outcomes outside SSEs territory
  - Use of SSE dummy variables averaging out the impact of zone designation

Contribution: dataset

- Two main data sources:

- Unique dataset covering investment outlays and employment of individual companies located in special economic zones, spanning 2003-2012. Data aggregated on NUTS 4 (counties) level which gives 3790 observations.

- Main economic variables covering labor market, corporate sector and local governments finances on NUTS 4 (county) level.

Contribution: dataset

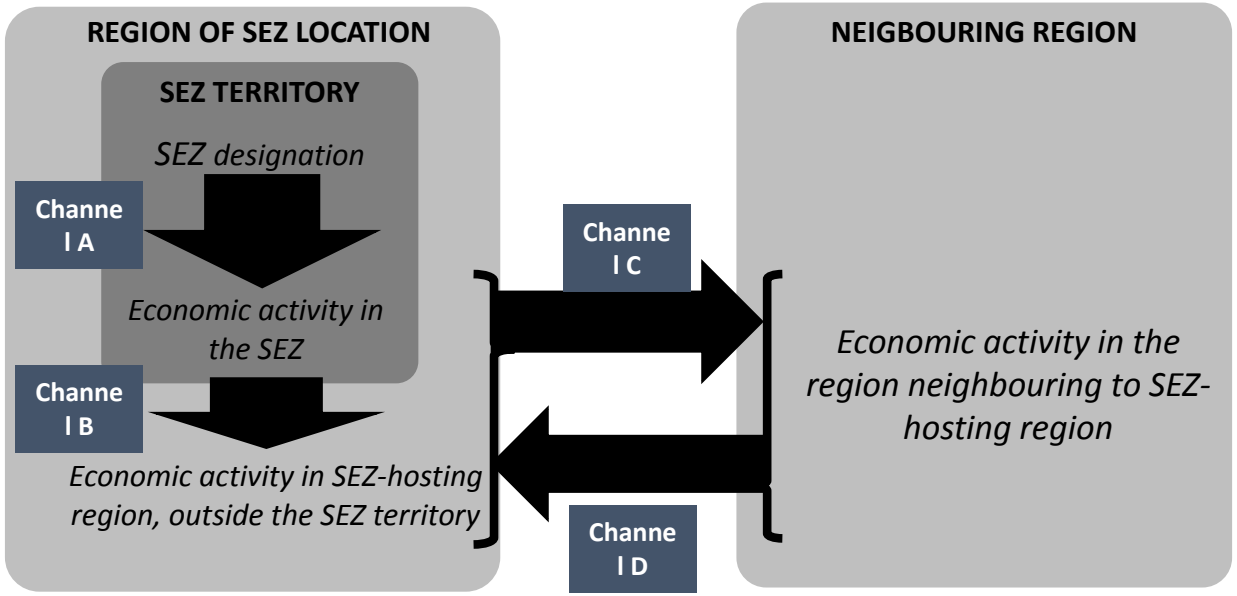
Table 4 . Variable definitions and data sources.

Variable	Name in models		Definition	Source
Variables concerning SSE functioning				
Employment in SSE	emp_sse	-	Total employment in SSE firms in a given county, including both retained jobs of firms functioning prior to SSE designation and newly created jobs after SSE designation	own calculation based on Ministry of Economy data
New employment in SSE	emp_sse_new	-	Newly created jobs in SSE-based companies after SSE designation	own calculation based on Ministry of Economy data
Employment excluding SSE	emp_non_sse	-	Employment in a county exluding employment in SSE firms, computed as a difference between employment in a given county (emp) and total employment of SSE firms (emp_sse)	own calculation based on Ministry of Economy and Central Statistical Office data
Capital in SSE	cap_sse	mln PLN	Capital outlays in SSE firms; computed as amortized capital stock in previous year plus real value of capital investment undertaken during the year	own calculation based on Ministry of Economy data
Capital outside SSE	cap_non_sse	mln PLN	Capital outlays of frims located outside SSE, computed as a difference between total capital outlays in a given county (cap) and capital oultays of SSE firms (cap_sse)	own calculation based on Ministry of Economy and Central Statistical Office data
Regional macroeconomic data				
Employment	emp	-	Average employment in a county, computed as number of unemployed persons divided by the unemployment rate minus the number of unemployed persons	own calculation based on Central Statistical Office data
Capital	cap	mln PLN	Value of gross fixed assets in the corporate sector (enterprises employing more than 9 persons)	Central Statistical Office
Industrial production	ind_prod	PLN	Industiral production per inhabitant, computed as value of industrial production sold by companies registered in a county divided by the number of the county inhabitants	Central Statistical Office
Rural population	rur_pop	per cent	Share of population living in rural area in total population of a county	Central Statistical Office
Working age population	work_age	per cent	Share of working age population 18-59/64 (women/men) in total population of a county	Central Statistical Office
Old working age population	old	per cent	Share of individuals aged 55-59/64s (women/men) in total working age population of a county	Central Statistical Office
Young working age population	young	per cent	Share of individuals aged 18-24 in total working age population of a county	Central Statistical Office
Number of firms	firms	-	Number of firms in National Office Business Register (REGON) per 10000 inhabitants	Central Statistical Office
Social expenditures	social_exp	th PLN	Social expenditures of local governments (counties and communities) per 1 person in working age	own calculation based on Central Statistical Office data
Investment expenditures	investment_exp	th PLN	Investment expenditures of local governments (counties and communities) per 1 person in working age	own calculation based on Central Statistical Office data

Contribution: analytical framework

Majority of the literature examines only channel A and B using dummy variable indicating zone existence in a particular region and time period.

Our study analyses channels B, C and D.



Contribution: new methodology (1/2)

- Employment and investments of firms located in SSE (i.e. channel A) as explanatory variables

- As opposed to studies based on special economic zone dummy variable, this approach allows to:
  - distinguish between channel A and B
  - capture unique characteristics of particular counties
  - account for marked differences in SSE development between induvidual counties

Table 1. Jastrzębie Zdrój and Żory: SSE divergence in economically similar cities

		no. of firms	utilized area (ha)	available area (ha)	employment	capital (PLN mln)	employment /ha	capital/ha
2012	Jastrzębie Zdrój	1	8,0	16,7*	154	15,4	19,3	1,9
	Żory	14	36,4	46,7*	1 313	462,6	36,1	12,7
2003	Jastrzębie Zdrój	1	4,1	20,6	179	3,7	44,0	0,9
	Żory	3	6,2	76,9	311	37,8	50,4	6,1

Source: KSSE maps, own calculation based on Ministry of Economy data, *latest available data

Contribution: new methodology (2/2)

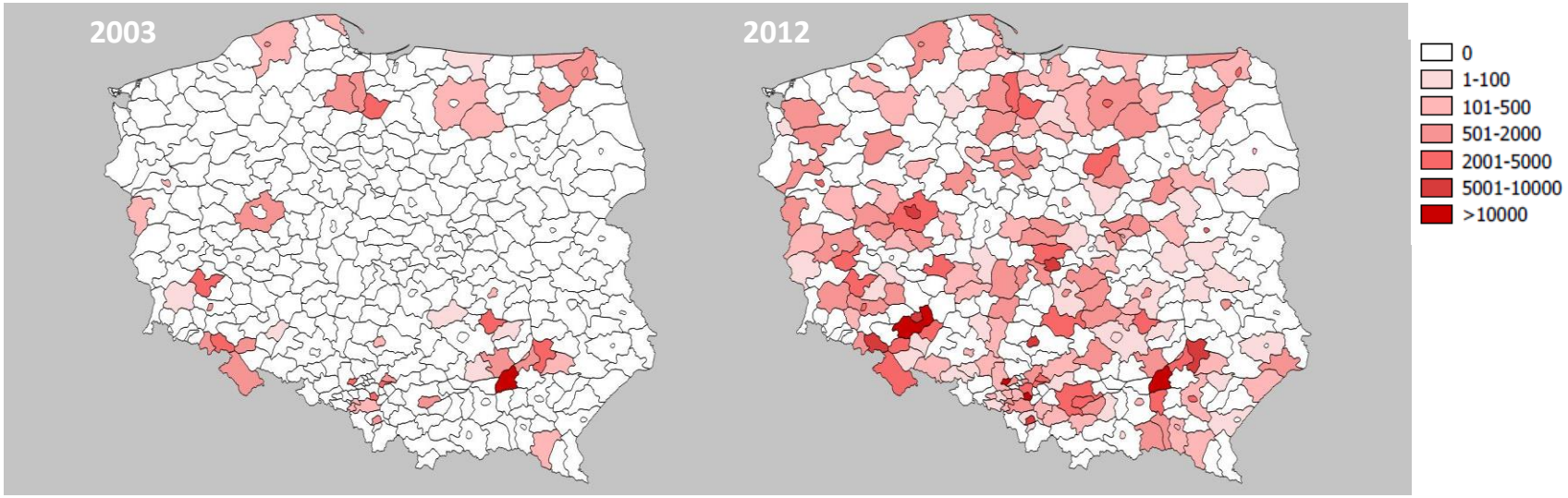
- Use of spatial data models and LeSage and Pace spatial effects decomposition
- Our approach allows to distinguish three types of induced effects of SSE:
  - effects outside SSE in hosting counties (channel B)
  - externalities to neighbouring counties (channel C)
  - feedback loop effects from neighbouring counties to SSE-hosting counties (channel D)

Special economic zones in Poland: some stylized facts (1/4)

- Fast increase in SSE designations between 2003-2012, accompanied by investment outlays and employment growth (Figure 1)

- SSEs are not concentrated in any particular region

Figure 1. SSE-based employment in counties: 2003 and 2012



Source: own calculation based on Ministry of Economy data

Special economic zones in Poland: some stylized facts (2/4)

- SSEs development was accompanied by inflow of FDI to Poland. In 2012, 81% of capital stock in SSEs came from foreign investors.
- Counties hosting SSEs are very heterogeneous in terms of number of persons employed in SSE- based companies. In 2012, the SSE-based employment ranged from 1 to nearly 13 000.
- 96% of capital invested in SSE in Poland is concentrated in manufacturing industries.
- In 2012 most of companies functioning in SSE represented medium and low-tech sectors. However, there were marked differences between individual zones (Table 2).

Table 2. SSE capital stock structure by OECD technology intensity classification, 2012

	high-tech	medium-high-tech	medium-low-tech	low-tech
	(1)	(2)	(3)	(4)
Kamieniogórska	0%	19%	19%	18%
Katowicka	1%	55%	31%	12%
Kostrzyńsko-Słubicka	1%	26%	21%	51%
Krakowska	0%	30%	17%	12%
Legnicka	0%	57%	33%	9%
Łódzka	4%	11%	49%	39%
Mielecka	12%	26%	23%	38%
Pomorska	0%	4%	33%	63%
Słupska	0%	7%	40%	51%
Starachowicka	0%	15%	39%	46%
Suwalska	0%	1%	44%	55%
Tarnowska	0%	11%	66%	22%
Wałbrzyska	0%	37%	28%	35%
Warmińsko-Mazurska	0%	15%	22%	60%
Average	1%	30%	34%	32%

Source: own calculation based on Ministry of Economy data, OECD
Note: values in rows do not sum up to 100% as some of the PKD activity groupings (Polish equivalent of NACE classification) could not be assigned to a particular OECD technology intensity classes

Special economic zones in Poland: some stylized facts (3/4)

Table 3. Average values of selected economic variables in counties with and without SSE designation

		2003				2012				delta 2012-2003			
		all counties	counties without SSE	counties with SSE	ttest (p)*	all counties	counties without SSE	counties with SSE	ttest (p)*	all counties	counties without SSE	counties with SSE	ttest (p)*
labour market		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
unemployment rate	%	23.4	23.6	23.3	0.740	16.5	17.3	15.8	0.021**	-7.0	-6.3	-7.5	0.003***
long-term unemployment	%	12.4	12.6	12.2	0.430	5.9	6.4	5.5	0.004***	-6.5	-6.2	-6.7	0.105
economic participation rate	%	40.3	39.9	40.6	0.143	38.9	38.1	39.7	0.012**	-1.3	-1.8	-1.0	0.012**
demographic dependency ratio	%	1.5	1.5	1.5	0.386	1.6	1.7	1.6	0.055*	0.1	0.1	0.1	0.031**
average wage	PLN	1952	1905	1994	0.002***	3187	3108	3256	0.001***	1234	1202	1262	0.012**
corporate sector													
industrial production/population	PLN/th persons	10116	7630	12295	0.000***	21155	14584	26914	0.000***	11039	6954	14619	0.000***
capital intensity	PLN th	26.2	21.0	30.8	0.000***	33.5	26.5	39.7	0.000***	7.3	5.6	8.9	0.006***
REGON registered companies/population	-	826	786	861	0.003***	889	843	929	0.002***	63	57	68	0.180
microcompanies/registered companies	%	95.1	95.1	95.1	0.888	95.3	95.3	95.4	0.779	0.2	0.2	0.2	0.545
large companies/registered companies	%	0.11	0.10	0.12	0.000***	0.08	0.07	0.09	0.000***	-0.02	-0.02	-0.02	0.986
self employed/working age pop.	%	10.6	10.3	10.8	0.046*	10.5	10.1	10.9	0.006***	-0.1	-0.2	0.1	0.033**
manufacturing employment/total emp.	%	28.6	25.1	31.7	0.000***	28.3	24.8	31.3	0.000***	-0.3	-0.3	-0.4	0.886
market services employment/ total emp.	%	19.4	17.1	21.4	0.000***	19.9	18.4	21.2	0.003***	0.5	1.4	-0.2	0.000***
non-market services employment/ total emp.	%	21.1	20.8	21.3	0.424	21.4	20.6	22.0	0.058*	0.3	-0.2	0.7	0.014**
local government finances													
revenues/ working age pop.	PLN th	1.9	1.9	1.9	0.727	4.0	4.0	4.0	0.762	2.1	2.1	2.1	0.827
invest. exp./ working age pop.	PLN th	0.3	0.3	0.3	0.576	0.7	0.7	0.7	0.473	0.4	0.4	0.4	0.603
social. exp./ working age pop.	PLN th	0.3	0.4	0.4	0.891	0.8	0.8	0.7	0.050**	0.4	0.4	0.4	0.014**
budget balance	%	-2.1	-2.2	-2.0	0.613	-0.4	-0.5	-0.1	0.330	1.8	1.7	1.9	0.694

Source: own calculation based on Ministry of Economy data, GUS. Note: county included in SSE group encompass all counties in which SSE-based companies were active in at least one year during 2003-2012 period; *ttest column present t-test p-values for means difference between SSE and non-SSE counties.

Special economic zones in Poland: some stylized facts (4/4)

- In 2003, when most of the special economic zones were in early stage of development, few significant differences existed between counties which hosted SSE at any point over 2003-2012 and counties without SSE.
- The existing differences pointed to better economic situation of SSE-hosting counties.
- In the considered period, the analyzed variables improved markedly in SSE-hosting counties. In non-SSE counties the improvement was in general significantly smaller. The local government finances were one of the few exceptions.

Estimation strategy (1/4)

- **Panel data models** which allow to examine **induced effects** of SSE functioning described by **channel B.**

  - $\text{emp}_{\text{it}} = \alpha_i^{emp} + \beta^{emp}\,\text{emp\_sse}_{\text{it}} + \mathbf{X_{it}}\boldsymbol{\gamma^{emp}} + \varepsilon_{it}$ (Model 1)
  - $\text{cap}_{\text{it}} = \alpha_i^{cap} + \beta^{cap}\text{cap\_sse}_{\text{it}} + \mathbf{Z_{it}}\boldsymbol{\gamma^{cap}} + v_{it}$ (Model 2)

  where $\mathbf{X_{it}}$ and $\boldsymbol{Z_{it}}$ are sets of control variables which determine, respectively, employment and investment but are not directly related to SSE functioning

- Estimates of β^{emp} and β^{cap} allow to examine effects of SSE described by **channel B** and should be interpreted as follows:
  - β^{emp} <1 (β^{cap} <1) - SSE generates crowding-out effects in the hosting county; if estimate of the parameter is not significantly different from zero than full crowding out takes place i.e. the net effect of SSE designation for the hosting region is null;
  - β^{emp} =1 (β^{cap} =1) – SSE creates employment (attracts investment) to the hosting counties, but it does not have any additional impact on employment (investment) of companies located in this county but outside SSE territory;
  - β^{emp} >1 (β^{cap} >1) - SSE generates crowding-in effects in the hosting county.

- Panel data models ignore possible impact of channels C and channel D, what may result in biased and inconsistent estimates due to omitted variable problem.

Estimation strategy (2/4)

- **Spatial Durbin Models** with assumption that the only explanatory variable with spatial lag is respectively $\text{emp\_sse}_{\text{it}}$ and $\text{cap\_sse}_{\text{it}}$

  - $\text{emp}_{\text{it}} = \alpha_i^{emp} + \rho^{emp}(\mathbf{Wemp})_{\text{it}} + \beta^{emp}\text{emp\_sse}_{\text{it}} + \mathbf{X}_{\text{it}}\,\boldsymbol{\gamma}^{emp} + \delta^{emp}(\mathbf{Wemp\_sse})_{\text{it}} + \varepsilon_{it}$ (Model 3)
  - $\text{cap}_{\text{it}} = \alpha_i^{cap} + \rho^{cap}(\mathbf{Wcap})_{\text{it}} + \beta^{cap}\text{cap\_sse}_{\text{it}} + \mathbf{Z}_{\text{it}}\,\boldsymbol{\gamma}^{cap} + \delta^{cap}(\mathbf{Wcap\_sse})_{\text{it}} + v_{it}$ (Model 4)

  If the assumption is not correct, than estimates of parameters δ^{emp} and δ^{cap} may be biased due to omitted spatial dependence

- **Spatial panel data models** with set o of spatially lagged variables broadened with vectors $\mathbf{X_{it}}$ and $\mathbf{Z_{it}}$ respectively

  - $\text{emp}_{\text{it}} = \alpha_i^{emp} + \rho^{emp}(\mathbf{Wemp})_{\text{it}} + \beta^{emp}\text{emp\_sse}_{\text{it}} + \mathbf{X_{it}}\boldsymbol{\gamma}^{emp} + \delta^{emp}(\mathbf{Wemp\_sse})_{\text{it}} + (\mathbf{WX})_{\mathbf{it}}\boldsymbol{\theta}^{\boldsymbol{emp}} + \varepsilon_{it}$ (Model 5)
  - $\text{cap}_{\text{it}} = \alpha_i^{cap} + \rho^{cap}(\mathbf{Wcap})_{\text{it}} + \beta^{cap}\text{cap\_sse}_{\text{it}} + \mathbf{Z_{it}}\boldsymbol{\gamma}^{\boldsymbol{cap}} + \delta^{cap}(\mathbf{Wcap\_sse})_{\text{it}} + (\mathbf{WZ})_{\text{it}}\boldsymbol{\theta}^{\boldsymbol{cap}} + v_{it}$ (Model 6)

Estimation strategy (3/4)

- **Interpretation of estimates from SDM**
  - As indicated by LESAGE and PACE (2009) point estimates of spatially lagged variables cannot be directly used to test the hypothesis of spatial spillovers existence**.**
  - In models 3-6 even positive and significant estimates of δ^{emp} and δ^{cap} can not be interpreted as indication that SSE exerts positive impact on employment or investment outside hosting county.
  - The impacts' interpretation requires the construction of matrices of partial derivative impacts of the form:

$$\frac{\partial \mathbf{emp}}{\partial \mathbf{emp\_sse}} = \boldsymbol{S}^{emp}(\mathbf{W}) = \left(\mathbf{I}_{\mathrm{NT}} - \rho^{emp}(\mathbf{I}_{\mathrm{T}} \otimes \mathbf{W})\right)^{-1}(\mathbf{I}_{\mathrm{NT}}\beta^{emp} + (\mathbf{I}_{\mathrm{T}} \otimes \mathbf{W})\delta^{emp}$$

$$\frac{\partial \mathbf{cap}}{\partial \mathbf{cap\_sse}} = \boldsymbol{S}^{cap}(\mathbf{W}) = \left(\mathbf{I}_{\mathrm{NT}} - \rho^{cap}(\mathbf{I}_{\mathrm{T}} \otimes \mathbf{W})\right)^{-1}(\mathbf{I}_{\mathrm{NT}}\beta^{cap} + (\mathbf{I}_{\mathrm{T}} \otimes \mathbf{W})\delta^{cap})$$

Estimation strategy (4/4)

- The matrices allow for calculation of three scalar summary measures for the impacts' interpretation:
  - **Direct impact.** Average of diagonal elements of matrices. Measures the change in county employment or capital outlays due to the change in employment or investment of firms located in SSE hosted by this county, i.e. impact exerted through **channel B** and **channel D.** The scale of effects exerted through **channel D** may be calculated as the difference between direct impact measure and β^{emp} or β^{cap} estimates. The values of direct impact estimates should be interpreted in the same way as the estimates of β^{emp} and β^{cap} in Models 1 and 2 (i.e. direct impact>1: crowding in; direct impact<1: crowding out; direct impact= 1: neither crowding in nor crowding out);
  - **Indirect impact.** Average of the off-diagonal elements of matrices. Measures the cumulated change in employment or capital formation outside SSE hosting county due to the change in employment or investment of firms located in SSE hosted by this country, i.e. impact exerted through **channel C**. Positive and statistically significant value of the indirect impact indicates that the effects of SSE activity are not restricted to hosting county, but spill over to neighbouring counties; on the contrary, negative and significant estimates indicate that SSEs crowd-out employment or investment from neighbouring counties;
  - **Total impact** which is the sum of direct and indirect impact.
- **Estimators:** Fixed Effects (FE) estimator and Driscoll and Kraay (1998) nonparametric covariance matrix estimator (DK) which corrects for standard errors bias due to common unobserved time-varying omitted variables with a heterogeneous impact across counties. This estimator also addresses standard errors bias due to a potential heteroscedasticity and autocorrelation of the error terms.

Main results (1/6)

Table 5. Employment: panel and spatial models estimation results.

Specification	Model 1 Non-spatial panel FE	Model 1 Non-spatial panel DK	Model 3 SDM panel with emp_sse spatially-lagged FE	Model 3 SDM panel with emp_sse spatially-lagged DK	Model 5 SDM panel with all variables spatially-lagged FE	Model 5 SDM panel with all variables spatially-lagged DK
	(1)	(2)	(3)	(4)	(5)	(6)
emp_sse	1.860*** (24.180)	1.860*** (12.100)	1.723*** (23.480)	1.723*** (13.863)	1.559*** (22.558)	1.559*** (18.343)
work_age	0.068*** (4.220)	0,068 (1.410)	0.040*** (2.585)	0,040 (0.923)	0.122*** (7.818)	0.122** (2.087)
old	9,763 (0.170)	9,763 (0.070)	-230*** (-3.851)	-230** (-2.000)	-1000*** (-7.718)	-1000*** (-7.083)
young	-154.885* (-1.940)	-154,885 (-0.590)	-160** (-2.084)	-160 (-0.868)	-1800*** (-17.682)	-1800*** (-5.512)
firms	1.461*** (37.560)	1.461*** (10.100)	1.434*** (39.142)	1.434*** (9.323)	1.546*** (44.227)	1.546*** (11.440)
capital_non_sse	1.035*** (13.750)	1.035*** (3.570)	0.983*** (13.912)	0.983*** (3.642)	0.913*** (13.803)	0.913*** (3.522)
ind_prod	-0,01 (-1.580)	-0,01 (-1.290)	-0.012* (-1.953)	-0.012* (-1.881)	-0.013** (-2.214)	-0.013*** (-2.601)
W emp_sse	NA	NA	0.919*** (4.691)	0.919*** (2.841)	0.788*** (3.639)	0.7883** (2.066)
W work_age	NA	NA	NA	NA	-0,037 (-0.984)	-0,037 (-0.945)
W old	NA	NA	NA	NA	1400*** (8.748)	1400*** (7.370)
W young	NA	NA	NA	NA	2500*** (17.707)	2500*** (6.235)
W firms	NA	NA	NA	NA	-0.845*** (-8.153)	-0.845*** (-4.238)
W capital_non_sse	NA	NA	NA	NA	-0,073 (-0.363)	-0,073 (-0.425)
W ind_prod	NA	NA	NA	NA	0.039** (2.005)	0.039** (2.216)
W emp	NA	NA	0.158*** (6.331)	0.158* (1.760)	0.295*** (9.296)	0.295*** (8.471)
N	3790	3790	3790	3790	3790	3790
R2	0,71	0,71	0,98	0,98	0,986	0,986
SDM vs SEM	NA	NA	90,23 (0.000)	8,18 (0.017)	640,03 (0.000)	10929,44 (0.000)
SDM vs Non-spatial FE	NA	NA	41,35 (0.000)	7,27 (0.007)	255,7 (0.000)	405,78 0,0000

Main results (2/6)

Table 6. Employment: Spatial Durbin Model direct and indirect effects (LeSage and Pace, 2009).

Specification	Dependent variable: emp											
	Model 3						Model 5					
	SDM panel with emp_sse spatially-lagged						SDM panel with all variables spatially-lagged					
	FE (3)			DK (4)			FE (5)			DK (6)		
	Direct	*Indirect*	*Total*	*Direct*	*Indirect*	*Total*	*Direct*	*Indirect*	*Total*	*Direct*	*Indirect*	*Total*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
emp_sse	1.738***	1.368***	3.106***	1.743***	1.528**	3.266***	1.594***	1.762***	3.356***	1.594***	1.779***	3.373***
	(28.132)	(6.603)	(14.458)	(16.258)	(2.084)	(4.406)	(27.265)	(6.229)	(11.434)	(22.913)	(2.659)	(5.082)
work_age	0.041**	0.007***	0.048*	0,043	0,014	0,057	0.123***	-0,003	0.120*	0.126**	0,013	0,139
	(2.442)	(2.584)	(2.490)	(0.941)	(0.798)	(0.927)	(7.053)	(-0.0579)	(1.975)	(2.025)	(0.155)	(0.984)
old	-230.00***	-41.930***	-270.0***	-230*	-57,955	-290	-980.00***	1500.0***	515.496***	-980.00***	1500.0***	494.995***
	(-3.554)	(-2.774)	(-3.473)	(-1.925)	(-1.051)	(-1.720)	(-7.039)	(8.179)	(4.503)	(-6.483)	(7.082)	(4.924)
young	-150.0**	-28.266*	-180.0*	-140	-10,296	-150	-1700.0***	2800.0***	1000.0***	-1700.0***	2800.0***	1000.0***
	(-2.070)	(-1.902)	(-2.063)	(-0.736)	(-0.234)	(-0.677)	(-18.223)	(15.936)	(7.084)	(-5.558)	(6.395)	(4.867)
firms	1.444***	0.264***	1.708***	1.442***	0.286*	1.728***	1.542***	-0.538***	1.004***	1.540***	-0.531***	1.009***
	(41.938)	(5.817)	(27.149)	(9.480)	(1.653)	(10.968)	(46.769)	(-3.722)	(6.664)	(11.763)	(-2.810)	(6.124)
capital_non_sse	0.975***	0.178***	1.152***	0.955***	0.172*	1.127***	0.908***	0,239	1.147***	0.873***	0,235	1.107**
	(13.993)	(5.721)	(13.718)	(3.282)	(1.758)	(3.903)	(13.598)	(0.939)	(4.164)	(3.248)	(1.083)	(3.079)
ind_prod	-0.011*	-0.002*	-0,013	-0.011*	-0,002	-0,012	-0.011*	0.05*	0,04	-0.011**	0.049*	0,038
	(-1.763)	(-1.659)	(-1.759)	(-1.683)	(-1.227)	(-1.786)	(-1.808)	(1.887)	(1.410)	(-2.167)	(1.924)	(1.385)

Main results (3/6)

- **Results interpretation:**
  - **Model 1** (non-spatial model): channel B contributes to an increase in employment in SSE hosting counties. Estimate of β^{emp} amounts to 1.860 and is significantly higher than 1 for both FE and DK estimators (t-test *p*-values<0.01). Thus, every 100 jobs in firms located in SSE create on average 86 additional jobs in hosting counties outside the SSE.

  - **Model 3** (only SSE-employment spatially lagged): Estimates of *direct impact* of SSE-based companies' employment amounts between 1.738 (for FE) and 1.743 (for DK) and are statistically higher than 1. The estimates of *indirect impact* of emp_sse_{it} variable are significant both statistically and economically. They amount to between 1.368 (for FE) and 1.528 (for DK) indicating that an increase in SSE- based employment in a given county substantially increases the employment in neighbouring counties through spatially induced effects (channel C).

  - **Model 5** (full set of explanatory variables spatially lagged): estimates of *direct* and *indirect impacts* are statistically significant, *direct impact* estimates are lower and *indirect impact* higher than in Model 3, but the differences are not significant. These similarities indicate that spatially-induced effects between employment in SSE-located companies and total employment in neighboring counties identified using Model 3, has not been driven by omitted spatial lags of remaining control variables.

Main results (4/6)

Table 7. Capital: Panel and spatial models estimation results.

	Model 2		Model 4		Model 6	
Specification	Non-spatial panel		SDM panel with emp_sse spatially-lagged		SDM panel with all variables spatially-lagged	
	FE	DK	FE	DK	FE	DK
	(7)	(8)	(9)	(10)	(11)	(12)
cap_sse	1.114***	1.114***	1.0941***	1.094***	1.088***	1.088***
	(12.400)	(9.260)	(12.568)	(9.430)	(12.495)	(9.524)
rur_pop	-29.278**	-29.278**	-29.030**	-29.030***	-39.876***	-39.876***
	(-2.080)	(-2.590)	(-2.155)	(-3.838)	(-2.909)	(-3.951)
emp_non_sse	0.053***	0.053***	0.052***	0.052***	0.054***	0.054***
	(13.860)	(4.080)	(14.364)	(4.303)	(14.387)	(4.152)
firms	0.308***	0.308***	0.310***	0.310***	0.310***	0.310***
	(33.570)	(5.140)	(35.076)	(5.825)	(33.710)	(5.305)
ind_prod	0.013***	0.013***	0.013***	0.013***	0.013***	0.013***
	(9.350)	(5.050)	(9.425)	(4.508)	(9.189)	(4.207)
W cap_sse	NA	NA	0,276	0,276	0,26	0.260***
			(1.360)	(1.229)	(1.021)	(3.712)
W rur_pop	NA	NA	NA	NA	137.605***	137.605***
					(3.979)	(7.890)
W emp_non_sse	NA	NA	NA	NA	-0.020**	-0.02*
					(-2.256)	(-1.959)
W firms	NA	NA	NA	NA	-0,021	-0,021
					(-0.886)	(-0.412)
W ind_prod	NA	NA	NA	NA	-0,001	-0,001
					(-0.201)	(-0.165)
W cap	NA	NA	-0,029	-0,029	0,034	0,034
			(-1.090)	(-0.559)	(0.907)	(1.050)
N	3790	3790	3790	3790	3790	3790
R2	0,666	0,666	0,898	0,898	0,864	0,864
SDM vs SEM	NA	NA	2,13	1,53	25,88	1014,87
			(0.344)	(0.465)	(0.000)	(0.000)
SDM vs Non-spatial FE	NA	NA	1,62	1,55	24,25	528,35
			(0.203)	(0.213)	(0.000)	(0.000)

Main results (5/6)

Table 8. Capital: Spatial Durbin Models direct and indirect effects (LeSage and Pace, 2009).

Specification	Dependent variable: cap											
	Model 4						Model 6					
	SDM panel with emp_sse spatially-lagged						SDM panel with all variables spatially-lagged					
	FE (9)			DK (10)			FE (11)			DK (12)		
	Direct	*Indirect*	*Total*	*Direct*	*Indirect*	*Total*	*Direct*	*Indirect*	*Total*	*Direct*	*Indirect*	*Total*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
cap_sse	1.092***	0,267	1.359***	1.091***	0,245	1.336***	1.088***	0,362	1.450***	1.087***	0.324***	1.411***
	(14.745)	(1.445)	(7.562)	(11.150)	(1.400)	(5.490)	(14.751)	(1.353)	(5.476)	(11.262)	(3.348)	(11.591)
rur_pop	-29.015**	0,917	-28.097**	-29.476***	1,208	-28.269***	-39.467***	137.507***	98.039***	-40.260***	142.737***	102.477***
	(-2.242)	(0.893)	(-2.241)	(-3.748)	(0.704)	(-4.106)	(-3.011)	(4.316)	(3.105)	(-3.706)	(7.688)	(8.378)
emp_non_sse	0.053***	-0,002	0.051***	0.053***	-0,002	0.052***	0.054***	-0.019**	0.035***	0.055***	-0.019**	0.035***
	(14.382)	(-1.132)	(12.759)	(4.925)	(-0.597)	(4.567)	(14.419)	(-2.204)	(3.935)	(4.763)	(-1.977)	(3.827)
firms	0.311***	-0,01	0.301***	0.313***	-0,012	0.301***	0.310***	-0,01	0.300***	0.313***	-0,015	0.297***
	(31.934)	(-1.144)	(26.977)	(6.124)	(-0.687)	(7.808)	(30.710)	(-0.460)	(14.422)	(5.576)	(-0.284)	(23.172)
ind_prod	0.013***	-0,0004	0.012***	0.013***	-0,0005	0.012***	0.013***	-0,0009	0.012***	0.013***	-0,0003	0.013***
	(9.025)	(-1.142)	(9.564)	(4.925)	(-0.640)	(5.115)	(8.815)	(-0.248)	(3.311)	(4.664)	(-0.089)	(3.586)

Main results (6/6)

- **Results interpretation:**
  - **Model 2** (non-spatial model): investments in SSE neither crowd-in nor crowd-out investments in hosting county outside the SSE. The estimates of β^{cap} equals 1.114 and are not significantly different from 1.
  - **Model 4** (only SSE-investment spatially lagged): there are no spatially induced effects (channel C effects do not exist): ρ^{cap}, δ^{cap} and *indirect impact* estimates are statistically insignificant. Estimates of *direct impact* of SSE-based firms' investment amount to between 1.092 (for FE) and 1.091 (for DK) and are not significantly different from 1, confirming the results from the Model 2.
  - **Model 6** (full set of explanatory variables spatially lagged): *direct impact* amounts to 1.088 and is not significantly different from 1, whereas *indirect impact* is not statistically significant. In case of DK estimator *indirect impact* amounts to 0.326 and is statistically significant. However, this result ought to be treated with caution as this is the only estimate in which variance-covariance matrix has not been positive definite and spatial effects standard errors have been computed using a modified matrix according to the method proposed by REBONATO and JACKEL (2000).

Robustness analysis (1/2)

- **The findings are robust to changes in estimation methods, sample composition, set of explanatory variables and spatial weight matrix, as indicated by following robustness checks:**
  - Exclusion of counties belonging to consecutive voivodeships from the sample, which allows to examine if the results are not driven by above-average impact of SSEs in particular area of the country.
  - Restriction of the sample to counties which hosted SSE in any of the analysed years and cross-check with exclusion of entire voivodeships from the sample, which allows to examine the problem of endogeneity related to self-selection of counties for SSE designation.
  - Change of explanatory variable in SDM with full set of spatially lagged explanatory variables from total SSE-based employment to the number of newly created jobs in SSE-based companies, which allows to control for the situation in which some of the already functioning companies have been included into SSE.

Robustness analysis (2/2)

- Broadening the set of explanatory variables to include local government social and investment expenditure per capita in SDM for employment and investment respectively to check whether the correlation between activity of SSE-based companies and employment or capital outlays outside SSE is not spurious and driven by more generous public expenditure of counties with SSE designation

- Use of alternative weight matrices to evaluate robustness of the estimated spatial effects to the assumed spatial dependence structure:

  - Inverse distance matrix based on geographic **distance between centroids** of every pair of counties with a cut-off distance of 60 km beyond which weights are assumed to be zero;

  - Two inverse distance matrices based on **time needed to get by car from one counties' capital to another**, according to Google Maps; **cut-off distance** beyond which weights are assumed to be zero is set at **60 and 90 minutes**.

Conclusions (1/3)

- **SSEs have substantial positive effect on employment. This effect is not restricted to the SSE hosting county, but spills over to neighbouring counties** in accordance with spatially induced effects. According to our findings every 100 jobs in a given SSE create, on average, about 72 jobs outside the SSE in hosting county and 137 jobs in neighbouring counties. By contrast, reverse inductions or feedback loop effects are negligible.

- **Effect of SSEs on investments is weaker, but still positive**. Investments in a given SSE do not crowd in investments outside the SSE, but do not crowd them out either.

Conclusions (2/3)

- There are at least **two possible complementary explanations of the results**:
  - SSE-based companies may induce employee commutations from nearby areas with no significant impact on investment. Moreover, foreign owned companies offer their workers relatively high earnings, thereby contributing to higher local demand and spurring employment outside SSEs, in particular in services, which are labour intensive, but do not require large investments.
  - Foreign owned companies are often strongly integrated with international value chains. As a result, they might not require supplies from local companies and local markets are not necessarily their target markets. If this explanation was correct, then the positive effect of SSEs on employment and investments could falter with domestic firms climbing closer to technological frontier.

Conclusions (3/3)

- Our findings are **more optimistic than the ones obtained in most other studies on SEZs**.
  - It may be due to the **new methodology used** in our study as against the analyses based on dummy variable approach. One advantage of our methodology is that it **allows to take into account spatially induced effects** that other studies on the topic ignore.
  - Additional factor explaining the difference may be the development gap between Poland that we do analyse, and advanced economies analysed in other studies.

- Areas for further research inlude the issue of faltering of benefits from SSEs in the long run, possible non linearity in effects of SSEs of different characteristics, design of fiscal cost sharing scheme.