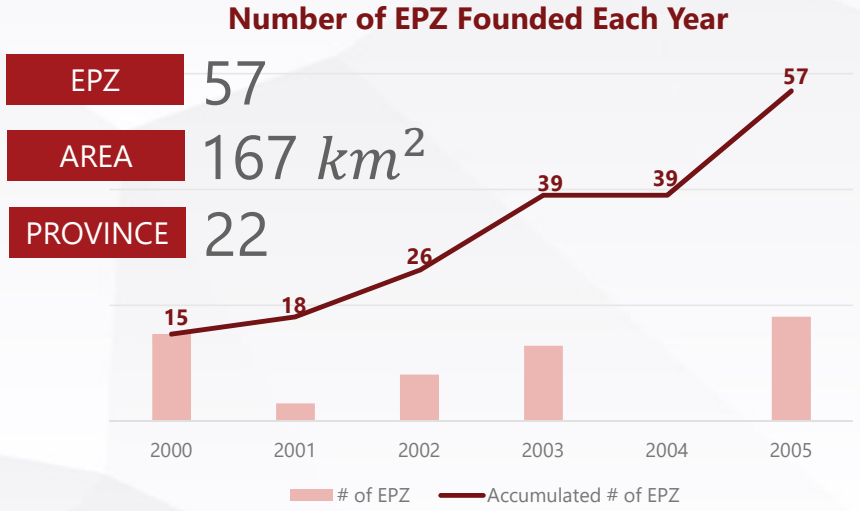
Spillover Effect of Export Processing Zone (EPZ)

Weixiao Wu*, Hong Chang

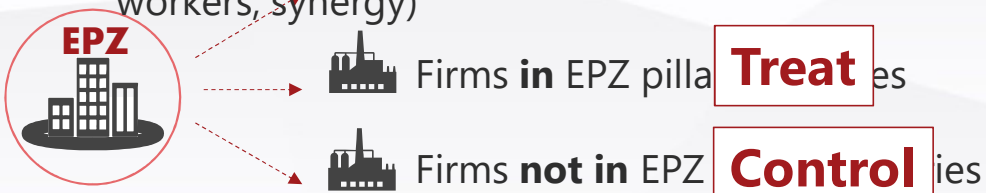
* Economic Department, Clark University, 950 Park Ave. Worcester, MA 01610

1. What is Export Processing Zone?

- Export processing zone (EPZ)
- Special Customs surveillance zone
- Encourage the exports of processing goods
- Support several industries as the pillar industries of the policy
- Use favorable tax and tariff policies to attract big multinational firms to locate inside EPZ
- As a side effect, create more opportunities and stimulate local economic activities in EPZ surrounding areas



Spillovers outside EPZ
(tech-transfer, share workers, synergy)



- The 57 EPZs are founded in 22 provinces during 2000-2005.
- This surge of EPZs provides an ideal quasi-natural experiments to quantify the EPZ spillovers.
- Difference-in-differences method

2. Research Intuition?

- ✓ DID method: Whether the pillar industry firms outside EPZ (treated group) can benefit more from EPZ policy (treatment) compared to other outside firms (comparison group)?
- ✓ Annual treatment analysis: Whether there is any time delay for the impacts of EPZ policies to become materialize?
- ✓ Triple difference method: Will this post-prior EPZ difference between treated and untreated groups be affected by their distance to EPZ and by whether the EPZ is high-tech supportive?
- ✓ Subgroups: Whether the EPZ's spillovers varies with local firms' ownership?

Literature Review

Studies on industrial park and special economic zone

- City-level Treatment Effect
  - Wang (2013) : 0.6% higher TFP in cities that have implementing a special economic zone policy.
- Micro-domain Studies
  - Schminke and Van (2013): detect positive effect of the China's preferential reginal policy programs on firms' export volume and product quality within the zone regions.

Geographic Effect in Spatial Economy

- Zheng, Sun, Wu, and Kahn (2015): used geocoded data to show that the presence of industrial park can promote productivity of firms close to the park.
- Lu, Wang, and Zhu (2018): based on a novel geocoded economic censuses data, they found that special economic zone can increase the capital investment and output in the treated areas.

Data Processing

- Annual Survey of Industrial Firms (ASIFs) 1998-2009
  - ✓ Firm Production
  - ✓ Total Factor Productivity (Olley-Pakes Method)
  - ✓ Zipcode
  - ✓ Ownership

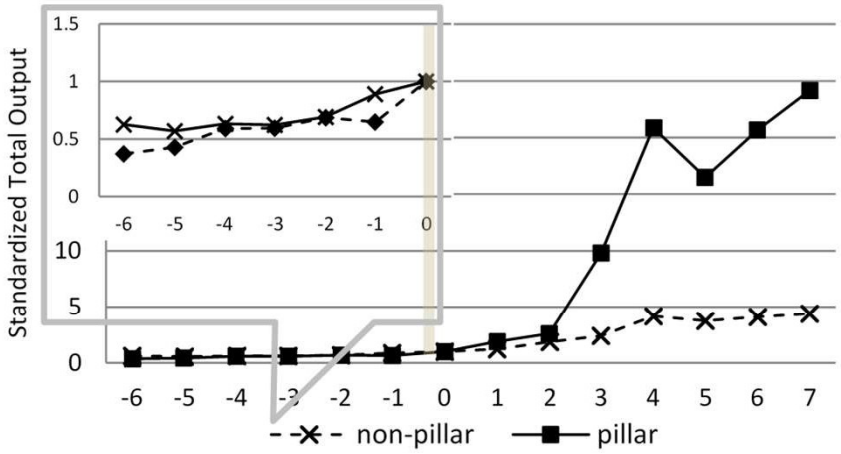
  Dependent variables

  Zipcode → Within-EPZ firms and outside-EPZ local firms
- China EPZ Index
  - ✓ Founding year → Post-treatment period
  - ✓ Zipcode
  - ✓ Pillar Industries → Treated group
  - ✓ High-tech EPZ
- Zipcode map
  - ✓ Distance (km) between firms and EPZs

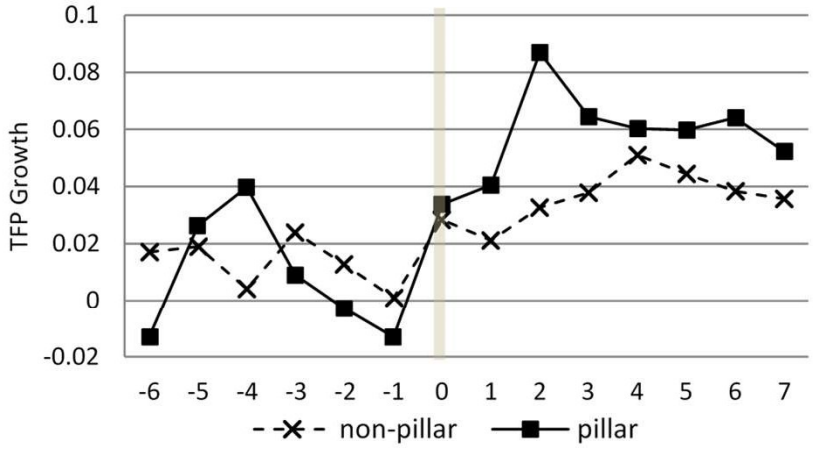
  Triple difference

Validation of DID Method: Pre-treatment Trends

- Compare Pre-treatment trends (Meyer 1995)



PANEL 3 — AVERAGE OF STANDARDIZED TOTAL OUTPUT
(PILLAR VS NON-PILLAR)



PANEL 4 — AVERAGE OF TFP GROWTH
(PILLAR VS NON-PILLAR)

Summary Statistics of Prior-post Differential

TABLE 1 — DESCRIPTIVE STATISTICS FOR CHANGES IN OUTPUTS, PRODUCTIVITY, DISTANCE, AND FIRM NUMBER OUTSIDE THE EPZS

Mean with standard deviations in parentheses:

	Pillar Industry Firms (Treated Cohort)			Non-pillar Industry Firms (Comparison Cohort)			Difference-in-differences (Pillar — Non-Pillar)
	Before	After	Changes	Before	After	Changes	
Output	32.70	46.97	**14.27**	32.09	41.44	**9.35**	**4.92**
	(42.15)	(51.05)	(1.06)	(38.98)	(47.50)	(0.12)	(0.01)
Foreign	40.97	55.16	**14.18**	39.42	51.07	**11.65**	**2.53**
	(49.82)	(56.31)	(2.21)	(44.20)	(53.15)	(0.28)	(0.03)
Domestic	27.07	42.86	**15.79**	27.83	37.60	**9.77**	**6.02**
	(35.71)	(47.64)	(1.15)	(34.39)	(44.30)	(0.14)	(0.01)
Productivity (OP)	1.19	1.34	**0.16**	1.19	1.31	**0.12**	**0.03**
	(0.27)	(0.26)	(0.01)	(0.31)	(0.28)	(0.00)	(0.00)
Foreign	1.21	1.32	**0.11**	1.23	1.31	**0.08**	**0.03**
	(0.22)	(0.28)	(0.01)	(0.31)	(0.29)	(0.00)	(0.00)
Domestic	1.19	1.36	**0.17**	1.21	1.32	**0.11**	**0.05**
	(0.27)	(0.24)	(0.01)	(0.28)	(0.27)	(0.00)	(0.00)
Distance	38.30	35.87	**-2.44**	34.50	37.97	**3.47**	**-5.91**
	(21.95)	(22.03)	(0.54)	(27.21)	(28.77)	(0.30)	(0.00)

Regression 1: Baseline Spillover Effect of EPZs

$$Y_{fict} = \alpha_0 + \alpha_1 \cdot postEPZ_{c,t} + \beta \cdot TREAT_{i,c} \cdot postEPZ_{c,t} + \delta_t + \omega_i + \varepsilon_{i,c,t} \quad (1a)$$

$$Y_{fict} = \alpha_0 + \alpha_1 \cdot postEPZ_{c,t} + \beta \cdot TREATsize_{i,c,t} \cdot postEPZ_{c,t} + \delta_t + \omega_i + \varepsilon_{i,c,t} \quad (1b)$$

(f: firm i: industry c: city t: year)

Y_{fic} : surrounding firm f's total output, TFP in year t.

$TREAT_{ic}$: = 1 if industry i is one of the pillar industries supported by EPZ in city c (treated group).

$TREATsize_{ict}$: = total (average) production of EPZ, for treated cohort; = 0 for control cohort.

$postEPZ_{ct}$: = 1 if year t is after the founding of EPZ in year c.

Standard DID estimator is the coefficient β of the interaction term $TREAT_{i,c} \cdot postEPZ_{c,t}$. We expect that this coefficient should be **positive** due to the larger treatment effect on pillar industry firms.

Regression 1: Baseline Spillover Effect of EPZs

TABLE 3 — OLS REGRESSIONS, DEPENDENT VARIABLE IS **OUTPUTS** OF LOCAL FIRMS OUTSIDE THE EPZS

	Pooled Sample			Foreign Firms			Domestic Firms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DID Treat Estimators:									
Pillar industry ×PostEPZ	**0.103*** ** (0.032)			0.189*** (0.056)			0.163** (0.072)		
Average EPZ size ×PostEPZ		**0.010*** ** (0.003)			0.016*** (0.005)			0.015** (0.006)	
Total EPZ size ×PostEPZ			**0.007*** ** (0.002)			0.012*** (0.004)			0.010* (0.005)

TABLE 4 — OLS REGRESSIONS, DEPENDENT VARIABLE IS **TFP** OF LOCAL FIRMS OUTSIDE THE EPZS

	Pooled Sample			Foreign Firms			Domestic Firms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DID Treat Estimators:									
Pillar industry	**0.016** ** (0.0070)			0.017*** (0.0050)			0.014* (0.009)		
Average EPZ size		**0.0013** ** (0.0006)			0.0014*** (0.0004)			0.0012* (0.0007)	
Total EPZ size			**0.0009* ** (0.0004)			0.001*** (0.0003)			0.0008 (0.0006)

Regression 2: Annual Treatment Effects

$$Y_{fict} = \alpha_0 + \alpha_1 \cdot postEPZ_{c,t} + \beta_t \cdot TREAT_{i,c} \cdot YEARpostEPZ_{c,t} + \delta_t + \omega_i + \varepsilon_{i,c,t} \qquad (2)$$

(f: firm i: industry c: city t: year)

Y_{fict}: surrounding firm f's total output, TFP in year t.

$TREAT_{ic}$: = 1 if industry i is one of the pillar industries supported by EPZ in city c (treated group).
this coefficient is estimated for each year from -4 years before to 8 years after the EPZ.

$postEPZ_{ct}$: = 1 if year t is after the founding of EPZ in year c.

$YEARpostEPZ_{ct}$: = 1 if year t is after the founding of EPZ in year c.

> We expect to find insignificant β before EPZ, and significant β after EPZ.
> There might be some delay to allow EPZ policy take into effect after establishment.

Regression 2: Annual Treatment Effects

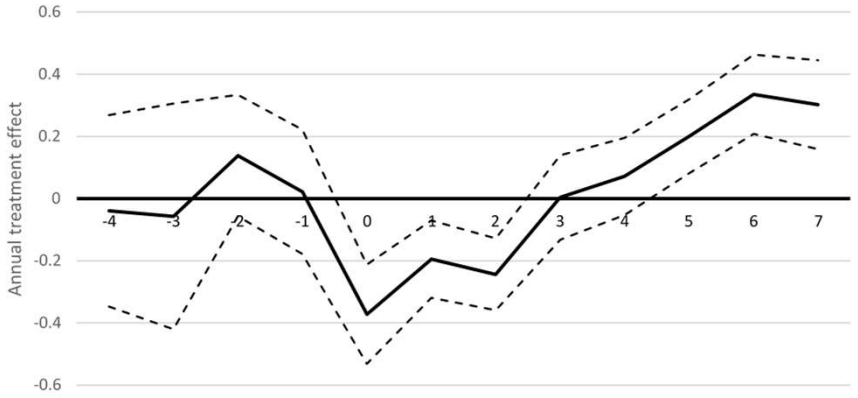


FIGURE 5. ANNUAL TREATMENT EFFECTS: TREATMENT ON OUTPUT= 1 FOR INDUSTRIES THAT SUPPORTED BY EPZS

Notes: Figure shows a 95 percent confidence interval of the annual treatment effects regression.

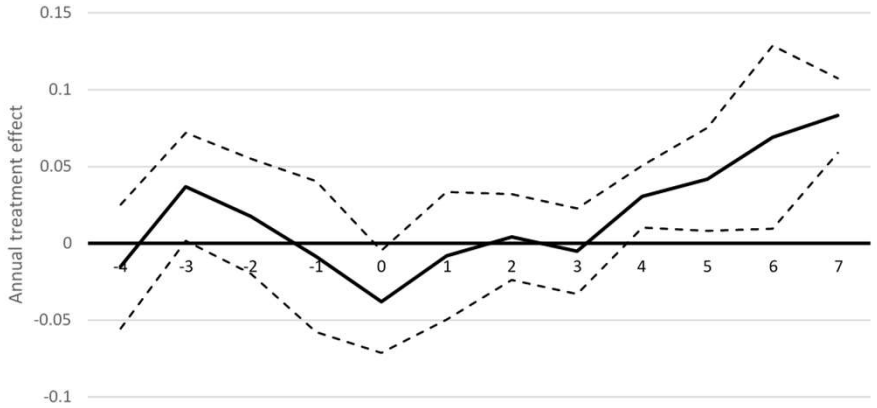


FIGURE 6. ANNUAL TREATMENT EFFECTS: TREATMENT ON TFP= 1 FOR INDUSTRIES THAT SUPPORTED BY EPZS

Notes: Figure shows a 95 percent confidence interval of the annual treatment effects regression.

Regression 3: Triple Difference

- Pillar Industry Type and EPZ Treatment Effect

$$Y_{fict} = \alpha_0 + \alpha_1 \cdot postEPZ_{c,t} + \alpha_2 \cdot TREAT_{i,c} \cdot postEPZ_{c,t} + \alpha_3 \cdot Tech_{i,c} \cdot postEPZ_{c,t}$$

$$+\beta \cdot Tech_{i,c} \cdot TREAT_c \cdot postEPZ_{c,t} + \delta_t + \omega_i + \varepsilon_{i,c,t} \quad (3)$$

(f: firm i: industry c: city t: year)

Y_{fict}: surrounding firm f's total output, TFP in year t.

$TREAT_{ic}$: include $TREATpillar_{ic}$ and $TREATsize_{ic}$ as defined before.

$Tech_{ic}$: = 1 if EPZ policies mainly support high-tech industries; = 0 for other EPZ policies.

$postEPZ_{ct}$: = 1 if year t is after the founding of EPZ in year c.

Standard DDD estimator is the coefficient β of the interaction term is $Tech_{i,c} \cdot TREAT_{i,c} \cdot postEPZ_{c,t}$. We expect that this coefficient should be **positive** due to the expectation that technology-supportive policy tend to have larger impact on the economy.

Regression 3: Triple Difference

TABLE 6 — TRIPLE DIFFERENCES REGRESSIONS OF TECHNOLOGY EFFECT, DEPENDENT VARIABLE IS **TFP** OF LOCAL FIRMS OUTSIDE THE EPZS

	Pooled Sample			Foreign Firms			Domestic Firms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DID:		**non-high-tech EPZs**							
Pillar industry ×PostEPZ	-0.006 (0.004)			0.007 (0.005)			**-0.013**** (0.006)		
Average EPZ size ×PostEPZ		-0.001 (0.000)			0.001 (0.000)			**-0.001**** (0.000)	
Total EPZ size ×PostEPZ			-0.0003 (0.000)			0.0004 (0.000)			**-0.0010**** (0.000)
DDD, Triple Differences:	**high-tech EPZs**								
Pillar industry ×PostEPZ×Tech	**0.037***** (0.005)			0.021** (0.009)			0.044*** (0.007)		
Average EPZ size ×PostEPZ×Tech		**0.0030***** (0.0005)			0.0015** (0.0008)			0.0036*** (0.0006)	
Total EPZ size ×PostEPZ×Tech			**0.0023***** (0.0004)			0.0011* (0.0006)			0.0028*** (0.0004)

Regression 3: Triple Difference

- Distance and EPZ Treatment Effect

$$Y_{fict} = \alpha_0 + \alpha_1 \cdot postEPZ_{c,t} + \beta_1 \cdot TREAT_{i,c} \cdot postEPZ_{c,t} + \beta_2 \cdot Dist_{f,c} \cdot postEPZ_{c,t}$$

$$+\gamma \cdot Dist_f \cdot TREAT_{i,c} \cdot postEPZ_{c,t} + \delta_t + \omega_i + \varepsilon_{i,c,t} \quad (4)$$

(f: firm i: industry c: city t: year)

Y_{fict}: surrounding firm f's total output, TFP in year t.

$TREAT_{ic}$: include $TREATpillar_{ic}$ and $TREATsize_{ic}$ as defined before.

$Dist_f$: the distance between firm and EPZ (in km).

$postEPZ_{ct}$: = 1 if year t is after the founding of EPZ in year c.

Standard DDD estimator is the coefficient γ of the interaction term. This coefficient should be **negative** due to our expectation that the spillover effect of EPZ will increase with the proximity to the firms.

Regression 3: Triple Difference

TABLE 8 — TRIPLE DIFFERENCES REGRESSIONS OF DISTANCE EFFECT, DEPENDENT VARIABLE IS TFP OF LOCAL FIRMS OUTSIDE THE EPZS

	Pooled Sample			Foreign Firms			Domestic Firms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Control Group									
Distance	**0.0001*****	0.0001***	0.0001***	0.0001*	0.0001*	0.0001*	0.0001***	0.0001***	0.0001***
×PostEPZ	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Treated Group									
1. DID									
Pillar industry	**0.035*****			0.033***			0.036***		
×PostEPZ	(0.006)			(0.012)			(0.007)		
Average EPZ size		0.003***			0.003***			0.003***	
×PostEPZ		(0.000)			(0.001)			(0.001)	
Total EPZ size			0.0022***			0.0020***			0.0022***
×PostEPZ			(0.0003)			(0.0007)			(0.0005)
2. DDD									
Pillar industry	**-0.0006*****			-0.0005*			-0.0005***		
×PostEPZ×Dist	(0.0002)			(0.0004)			(0.0002)		
Average EPZ size		-0.00005**			-0.00005*			-0.00005**	
×PostEPZ×Dist		(0.00002)			(0.00003)			(0.00002)	
Total EPZ size			-0.00004**			-0.00003*			-0.00004**
×PostEPZ×Dist			(0.00001)			(0.00002)			(0.00001)

3.5% ÷ 0.06%=58 km

Robustness Check

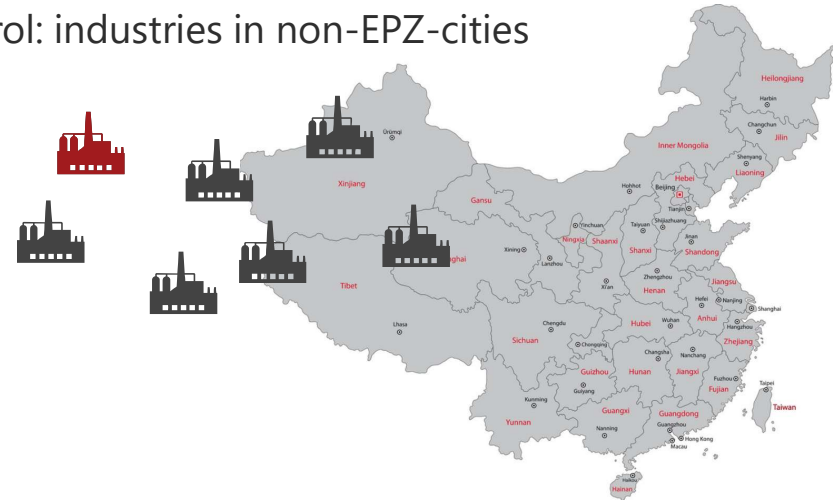
Validation of DID Method: 1) Selection Bias

- Selecting the treated group, i.e. pillar industries (Meyer 1995)
  - ✓ propensity score matching method or intention-to-treat estimate (Zheng, Sun, Wu, and Kahn, 2015)

Treated: pillar industry

Control: industries in non-EPZ-cities

Similar characteristics except for not being treated



Robustness Check

- Propensity Score Matching

TABLE 9 — COUNTERFACTUAL TEST: PROPENSITY SCORE MATCHING

PANEL A: Propensity score for 42 EPZ-cities

Treatment Effect	**Mean**	**Std. Dev.**	**Min**	**Max**
Output	0.12	0.02	0.09	0.16
TFP	0.014	0.002	0.009	0.018

PANEL B: Propensity score for all Cities in China

Treatment Effect	**Mean**	**Std. Dev.**	**Min**	**Max**
Output	0.13	0.01	0.11	0.15
TFP	0.015	0.001	0.013	0.018

Notes: This table reports results of treatment effect using propensity score matching method. Regressions are conducted at industry-level. Panel A identifies the control group for each treated industries from all other non-treated industries in the 42 EPZ-cities. Panel B extends the industry pool to the whole country - control group is matched from all non-treated industries in China.

Robustness Check

Validation of DID Method: 2) Omitted Variables

- Meyer 1995, Moser and Voena 2012

- DID estimator initially nets out the effect of socioeconomic development that apply to both the treated and control groups
- City Yearbooks: except for the investment on EPZ, there was no sudden outflow of government budget into the local treatment-related industries
- Big variation of the timing and location of EPZs: in 42 cities across 6 year

Conclusion

A **EPZ Policy Benefit Pillar Industry Firms More**

Compared to firms in non-pillar industries, those operating in pillar industries that supported by EPZ policy display a higher increase in their production and productivity.

B **High-Tech Supportive EPZ Policies are More Effective**

EPZs that support high-tech industries can better promote the economic performance in local treated groups, while other EPZs seem to have weak and insignificant or even negative spillovers.

C **Diverse Distance Effect on Treated and Control Groups, only Significant on TFP**

Pillar-industry firms can receive more enhancement in their TFP with proximity to EPZs, while this distance impact becomes the opposite for firms in non-pillar industries. This suggest a resource reallocation effect among these two groups and among different regions around EPZ.

D **Domestic-owned Firms Gain More from EPZ**

Local domestic-owned firms can take more advantages from the EPZ policy compared to foreign-invested firms.

Thanks