

# Unconditional Convergence in the Mexican Manufacturing Sector (1988-2018)

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\*The views presented here do not necessarily reflect the position of Banco de Mexico or their Board.

- ▶ Neoclassical growth model predicts **unconditional convergence**
  - ▶ Low-productivity regions would grow faster and catch up high-ones
    - ▶ *Unconditionally* of initial conditions
  - ▶ Contrary to other countries, lack of convergence *within Mexico* ●  
**USA:** Barro and Sala-i Martin (1992); **Mexico:** Esquivel (1999), Esquivel & Messmacher (2002), Chiquiar (2005)
- ▶ Is this experience general to all economic sectors?
  - ▶ Cross-country convergence in the **manufacturing** sector Rodrick (2013)
    - ▶ Produce tradable goods integrated into global production networks  
→ facilitates technology transfer and absorption
    - ▶ Operate under competitive threat from efficient suppliers from abroad  
→ requires to upgrade operations and remain efficient
  - ▶ **Within countries?**
    - ▶ Barriers to capital and labor reallocation are expected to be smaller

**Study** unconditional convergence in the Mexican manufacturing sector

- ▶ Build Industry-State manufacturing panel data for 1988-2018
  - ▶ Economic Censuses (1988-2018)
    - ▶ Digitized data for 1988-1993
    - ▶ Large period to study the evolution of the convergence process
  - ▶ GDP + Employment Surveys (2003-2018)
- ▶ Estimate convergence in the Mexican manufacturing sector
  - ▶ 3-digit: convergence at 1.18% per year
    - ▶ Low rate: close gap between 10th and 90th percentile in 81 years
    - ▶ Tendency towards *downward* convergence
  - ▶ 1-digit: lack of convergence
    - ▶ Fail to aggregate: low reallocation+underperformance of key sectors
- ▶ Convergence process broke down around early 2000s
  - ▶ Study impact of various economic forces
    - ▶ Informality
    - ▶ **China Shock** (Autor et al. (2013))

## 1. Stylized Facts

## 2. Empirical Strategy

- ▶ Estimation Framework
- ▶ Data

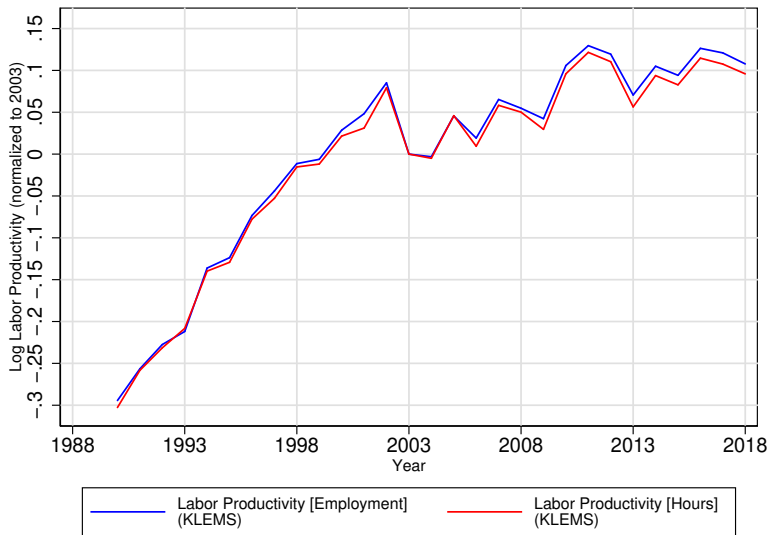
## 3. Results

- ▶ Main Results
- ▶ Convergence Decomposition
- ▶ Determinants of Convergence

## 4. Conclusion

## Stylized Facts

## Recent history of the Mexican Manufacturing Sector



# Empirical Strategy

- ▶ Following Rodrick (2013), estimate,

$$\hat{y}_{ijt,s} = -\beta \ln y_{ijt-s} + D_{it} + \epsilon_{ijt}$$

- ▶ Where,

- ▶  $\hat{y}_{ijt,s}$  : real labor-productivity growth  $(t, t - s)$  of industry  $i$  in state  $j$   
→ compound annual growth rate
- ▶  $y_{ijt-s}$ : (log) initial real labor-productivity  
→ real value-added (GDP), divided by total employment, or total hours
- ▶  $D_{it}$  : set of industry  $\times$  time fixed effects

- ▶ Alternatively, estimate for a specific cross-section,

$$\hat{y}_{ij} = -\beta \ln y_{ij} + D_i + \epsilon_{ij}$$

- ▶ **Unconditional convergence:** omit state-fixed effects
  - ▶ If included ( $D_j$ ) →  $\beta$  *conditional convergence*



## 1. Economic Census Tabulates (CE)

- ▶ Quinquennially: 1988-2018
  - ▶ Digitized for 1988-1993
  - ▶ Standardize industry codes (SCIAN/NAICS)
- ▶ Levels of aggregation: 3-digit industries + manufacture-wide
  - ▶ 12 SCIAN semi 3-digit (s3) manufacturing industries ●
- ▶ Value-added+Employment

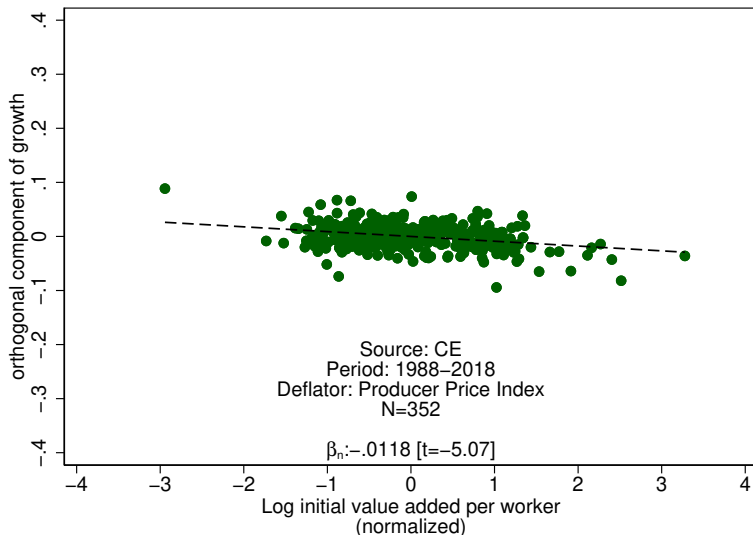
## 2. Industry-State GDP (PIBE) + Employment Surveys (ENOE)

- ▶ Quarterly microdata: 2003-2018
- ▶ Total employment and total hours worked by industry
- ▶ Yearly GDP (National Accounts)
- ▶ Exclude Petroleum Products Manufacturing (324-326)
  - ▶ Concentrates in few states+strong government presence
- ▶ Deflator: Mexican Production Price Index (INPP)

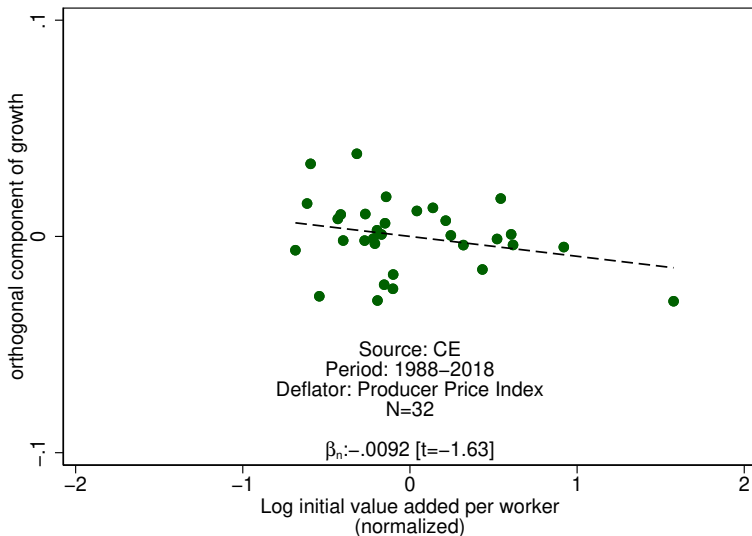
- ▶ CE and PIBE+ENOE differ in some significant aspects
  - ▶ GDP: market prices; Economic Censuses: producer prices
  - ▶ Allocation of regional production
  - ▶ Employment data from ENOE is not necessarily representative
- ▶ Strong correlation across sources 2008-2018
  - ▶ Levels: high correlation at both s3-digit and 1-digit industries
  - ▶ Growth rates: relatively low at both levels of aggregation
- ▶ Implications of measurement errors
  - ▶ Initial labor productivity  $\rightarrow \beta$  *overestimated*
  - ▶ Growth rates  $\rightarrow \beta$  with larger standard errors

## Results

## Results: Unconditional Convergence in s3-digit Manufacturing Sectors



## Results: Lack of Convergence in Manufacture-wide Labor Productivity



## Results: Change in the speed of convergence over time

**Table:** Convergence in Manufacturing Sector by Decade (1988-2018)

	SCIAN 1-digit		SCIAN s3-digit		SCIAN 3-digit	
	(1)	(2)	(3)	(4)	(5)	(6)
Log initial productivity	-.0126 (.0095)	-.0424*** (.015)	-.0248*** (.0021)	-.0347*** (.0061)	-.0343*** (.0047)	-.0359*** (.0082)
Log initial productivity, 1998		.0527*** (.0169)		.0211*** (.0064)		.0013 (.0119)
Log initial productivity, 2008		.0407* (.021)		.0077 (.0094)		.003 (.0087)
Observations	96	96	1054	1054	1598	1598
R-squared	.0853	.1991	.2022	.2131	.2074	.2076
State FE	No	No	No	No	No	No
Year FE	No	No	No	No	No	No
Industry FE	No	No	No	No	No	No
IndustryXYear FE	Yes	Yes	Yes	Yes	Yes	Yes

**Notes:** The sample includes all SCIAN s3-digit manufacturing industries, except 324-326. Clustered standard errors at the state level in parenthesis. Data sources: CE.

\* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

- ▶ Unconditional convergence at s3-digit manufacturing sectors
  - ▶ Rate of convergence (1988-2018): 1.18% per year
    - ▶ Productivity gap would close in 81 years ( $\ln(0.9)/\ln(0.1) - 1 / 0.0118$ )
  - ▶ Some industries exhibit downward convergence ●
- ▶ No convergence in manufacture-wide labor productivity
  - ▶ Different stages
    - ▶ 1988-1998: strong convergence (1-digit: 4.24% ; s3-digits: 3.47%)
    - ▶ 1998-2008: signs of divergence (1-digit: -1.03%; s3-digits: 1.36%)
    - ▶ 2008-2018: moderate recovery (1-digit: 0.17%; s3-digits: 2.70%)
- ▶ Other results
  - ▶ Robustness checks to alternative definitions; deflators; datasets
    - ▶ Account for measurement error → upper-bound?
  - ▶ Sigma-convergence consistent with beta-convergence ●
  - ▶ Evidence of *conditional* convergence ●
- ▶ Two open questions
  1. Why has convergence not added-up?
  2. Why convergence slowed-down after 1998?

# Convergence Decomposition

- Following Wong (2006), decompose labor-productivity growth as,

$$\frac{\Delta y_t}{y_{t-s}} = \underbrace{\sum_{i=1}^I \underbrace{\frac{y_{it-s}}{y_{t-s}} \left[ \frac{\Delta y_{it}}{y_{it-s}} \right]}_{\text{Growth Effect Sector } i \text{ (GE}_i\text{)}}}_{\text{Total Growth Effect (TGE)}} + \underbrace{\sum_{i=1}^I \left[ \frac{y_{it-s}}{y_{t-s}} \right] \Delta s_{it}}_{\text{Total Shift Effect (TSE)}} + \underbrace{\sum_{i=1}^I \left[ \frac{y_{it-s}}{y_{t-s}} \right] \left[ \frac{\Delta y_{it}}{y_{it-s}} \right] \Delta s_{it}}_{\text{Total Interaction Effect (TIE)}}$$

Total Reallocation Effect (TRE)

- Decompose  $\beta$ -convergence by estimating  $I+2$  regressions,

$$GE_{1jt} = \beta^{GE_1} \ln(y_{jt-s}) + \epsilon_{GE_{1jt}}$$

$$\vdots$$

$$GE_{Ijt} = \beta^{GE_I} \ln(y_{jt-s}) + \epsilon_{GE_{Ijt}}$$

$$TSE_{jt} = \beta^{TSE} \ln(y_{jt-s}) + \epsilon_{TSE_{jt}}$$

$$TIE_{jt} = \beta^{TIE} \ln(y_{jt-s}) + \epsilon_{TIE_{jt}}$$

- So,  $\beta^{1\text{-digit}} = \sum_{k=1}^K \beta^k \quad k \in GE_1, \dots, GE_I, TSE, TIE$ 
  - Some sectors may not show convergence, but could free labor



# Convergence Decomposition

Table: Beta-Convergence Decomposition

Dependent Variable	1988-2018		1988-1998		1998-2008		2008-2018			
	CE		CE		CE		CE		PIBE+ENOE	
	$\beta$	%	$\beta$	%	$\beta$	%	$\beta$	%	$\beta$	%
GLP	-.3953*	100	-.4723***	100	.07	100	-.0279	100	.0429	100
TRE	.0611	-15.46	-.0191	4.05	.0908*	129.7	.0005	-1.67	.0499	116.32
TSE	.087	-22.02	-.0526	11.15	.1307*	186.72	.0286	-102.66	.0338	78.89
TIE	-.0259	6.56	.0335	-7.1	-.0399	-57.02	-.0281	100.98	.0161	37.43
TGE	-.4564**	115.46	-.4532**	95.95	-.0208	-29.7	-.0283	101.67	-.007	-16.32
GE <sub>311</sub>	-.0207	5.25	-.0567	12	-.0442	-63.08	-.0048	17.32	-.0178	-41.39
GE <sub>312</sub>	-.2097	53.04	-.0879***	18.61	.0217	30.95	.0071	-25.48	.0166	38.81
GE <sub>313-314</sub>	-.0113	2.85	-.0108	2.29	-.0101*	-14.44	-.0167	59.98	.0058*	13.55
GE <sub>315-316</sub>	-.0112	2.83	-.0091*	1.92	-.0009	-1.25	-.008	28.58	-.0108	-25.18
GE <sub>321</sub>	.0041	-1.04	-.0009	.18	.0072***	10.26	.0018	-6.35	.0032	7.53
GE <sub>322-323</sub>	-.0129*	3.26	-.0043	.92	.0003	.48	-.0061	21.87	.0006	1.34
GE <sub>327</sub>	-.1109	28.06	-.0915	19.38	.0175	25.03	-.023	82.73	.0121	28.16
GE <sub>331-332</sub>	.051	-12.9	-.0062	1.32	.0245	35.06	-.013	46.54	.0075	17.56
GE <sub>333-336</sub>	-.1326	33.55	-.1852**	39.21	-.0458	-65.39	.044	-158.12	-.014	-32.56
GE <sub>337</sub>	-.0028	.7	-.0003	.06	-.0014	-2.04	-.0059	21.03	.0003	.64
GE <sub>339</sub>	.0006	-.14	-.0002	.05	.0103	14.72	-.0038	13.58	-.0106	-24.79

**Notes:** The sample includes all SCIAN s3-digit manufacturing industries, except 324-326. p-values from Robust standard errors.

Data sources: CE; PIBE; ENOE.

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01

- ▶ Overall, main force of convergence: growth within sectors
  - ▶ 1988-1998: some industries pulled-up convergence
    - ▶ Beverage & Tobacco (312), Nonmetallic Mineral (327), Machinery (333-336)
  - ▶ From 1998: no sector alone contributed significantly
    - ▶ Some industries pulled towards divergence (333-336 for 2008-2018)
  - ▶ Significant shocks seems to have hit manufacturing industries
    - ▶ Limited influence towards aggregate convergence
- ▶ Little contribution of the Reallocation Effect (TSE + TIE)
  - ▶ 1988-1998: 4.05%
  - ▶ From 1998: operate in the opposite direction

# Determinants of Convergence

- ▶ Long tradition to study determinants of convergence
  - ▶ Caveats
    - ▶ Inclusion of covariates may reflect conditional convergence
    - ▶ Endogeneity issues

- ▶ Estimate,

$$\hat{y}_{ij} = -\beta \ln y_{ij} + \gamma \text{Determinant}_{ij} + \lambda \text{Determinant}_{ij} \times \ln y_{ij} + D_i + \epsilon_{ij}$$

- ▶ The speed of convergence is given by:  $-\beta + \lambda \text{Determinant}_{ij}$ 
  - ▶ If  $\lambda < 0 \rightarrow$  convergence accelerates
  - ▶ If  $\lambda > 0 \rightarrow$  convergence slows down, or even revert
- ▶ Study two forces
  - ▶ Informality (share of informal employment)
    - ▶ Pervasive presence in the Mexican economy Busso et al. (2012)
    - ▶ Cross-country evidence exclusively from the formal sector Rodrik (2013)
  - ▶ **China Shock** (Autor et al. (2013))
    - ▶ Negative shock to labor markets **US**: Autor et al. (2013); **Mexico**: Chiquiar et al. (2017)
    - ▶ Entrance into the WTO (2001) coincides with convergence's decline

# Determinants of Convergence

**Table:** Determinants of Convergence (2008-2018)

	SCIAN 1-digit			SCIAN s3-digit		
	Informality		China Shock	Informality		China Shock
	(OLS)	(OLS)	(IV)	(OLS)	(OLS)	(IV)
	(1)	(2)	(3)	(4)	(5)	(6)
Log initial productivity	.0125 (.021)	-.1936 (.1446)	-.2371* (.1267)	-.0373*** (.0096)	-.1231** (.048)	-.0758* (.0444)
Log initial productivityXDeterminant	-.0494 (.0372)	.0184 (.0146)	.0227* (.0128)	.0118 (.0165)	.0052* (.0026)	.0027 (.0024)
Determinant	.5717 (.4715)	-.2191 (.1846)	-.2712* (.1617)	-.1864 (.1906)	-.0578* (.0319)	-.0263 (.0294)
Observations	32	32	32	351	351	350
R-squared	.1085	.1148	.1116	.2672	.2669	.2555
F-statistic			92.4282			606.106
State FE	No	No	No	No	No	No
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

**Notes:** The sample includes all SCIAN s3-digit manufacturing industries, except 324-326. Clustered standard errors at the state level in parenthesis. Data sources: CE; COMTRADE.

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01

- ▶ Informality

- ▶ No significant effect, either at the sub-industry or aggregate level

- ▶ China Shock

- ▶ Negative impact (OLS and IV) at aggregate level

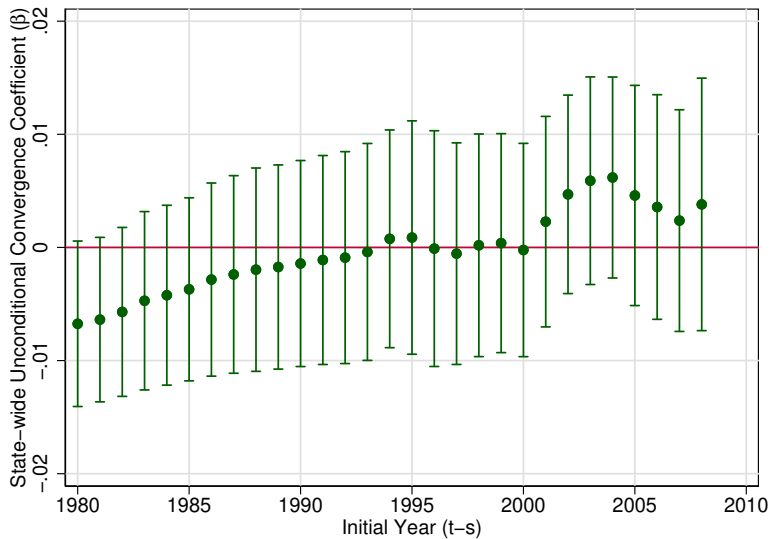
- ▶ 
$$\underbrace{-\beta + \lambda ChinaShock_i}_{-0.2371 + 0.0227 ChinaShock_i} \rightarrow \text{Convergence}=0 \text{ if } ChinaShock_i > 10.45$$

- ▶ Reverts convergence if values are above the 25th percentile ●
    - ▶ Disruption caused by China's penetration into the US market →
      - ▶ Underperformance of sub-industries → lack of aggregation?

## Conclusion

- ▶ Unlike the international experience, **unconditional convergence** in the **Mexican manufacturing** sector is only slightly existent
- ▶ Heterogeneous across industries, aggregation levels, and periods
  - ▶ Observed only at s3-digit industries during 1988-2018 (1.18%)
    - ▶ Strongest during 1988-1998 (4.24%)
  - ▶ Present at all levels of aggregation until 1998-2003
- ▶ Decomposition exercise shows lack of aggregation is due to
  - ▶ Low reallocation+underperformance of key industries
- ▶ Open question: why convergence stopped in the early 2000s?
  - ▶ Suggestive evidence: **China Shock**
- ▶ Convergence could be elusive even in this promising sector
  - ▶ Intrinsic property of manufacturing industries?

## Lack of State-wide Unconditional Convergence



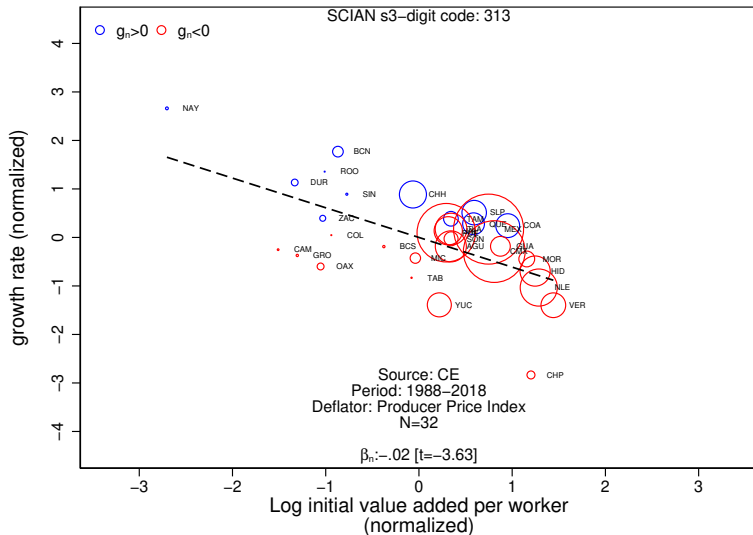


**Table:** Mapping between SCIAN 3-digit and s3-digit industries

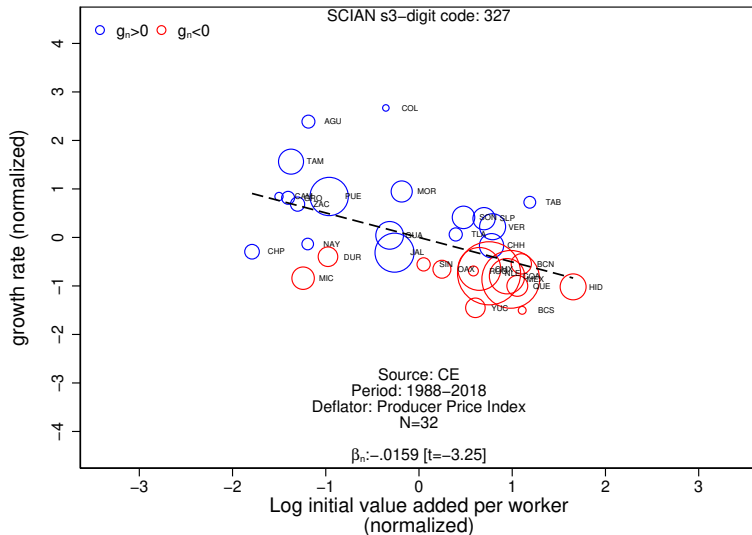
	SCIAN s3-digit	SCIAN 3-digit	Description
1	311	311	Food Manufacturing
2	312	312	Beverage and Tobacco Product Manufacturing
3	313-314	313	Textile Mills
		314	Textile Product Mills
3	315-316	315	Apparel Manufacturing
		316	Leather and Allied Product Manufacturing
5	321	321	Wood Product Manufacturing
6	322-323	322	Paper Manufacturing
		323	Printing and Related Support Activities
7	324-326	324	Petroleum and Coal Products Manufacturing
		325	Chemical Manufacturing
		326	Plastics and Rubber Products Manufacturing
8	327	327	Nonmetallic Mineral Product Manufacturing
9	331-332	331	Primary Metal Manufacturing
		332	Fabricated Metal Product Manufacturing
10	333-336	333	Machinery Manufacturing
		334	Computer and Electronic Product Manufacturing
		335	Electrical Equipment, Appliance, and Component Manufacturing
		336	Transportation Equipment Manufacturing
11	337	337	Furniture and Related Product Manufacturing
12	339	339	Miscellaneous Manufacturing

**Notes:** Industry grouping for comparability purposes.

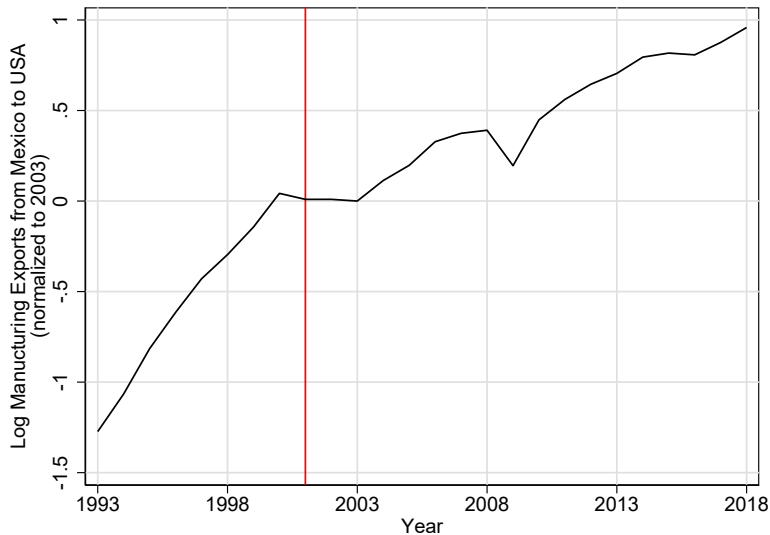
## Downward Convergence (Textile Mills; Textile Product Mills)



# Downward Convergence (Nonmetallic Mineral Product Manufacturing)



## Evolution of manufacturing exports to the USA ●



## Interaction between convergence and the China Shock

