Chaos Before Order: Productivity Patterns in U.S. Manufacturing

ASSA 2022 Annual Meeting
January 9, 2022

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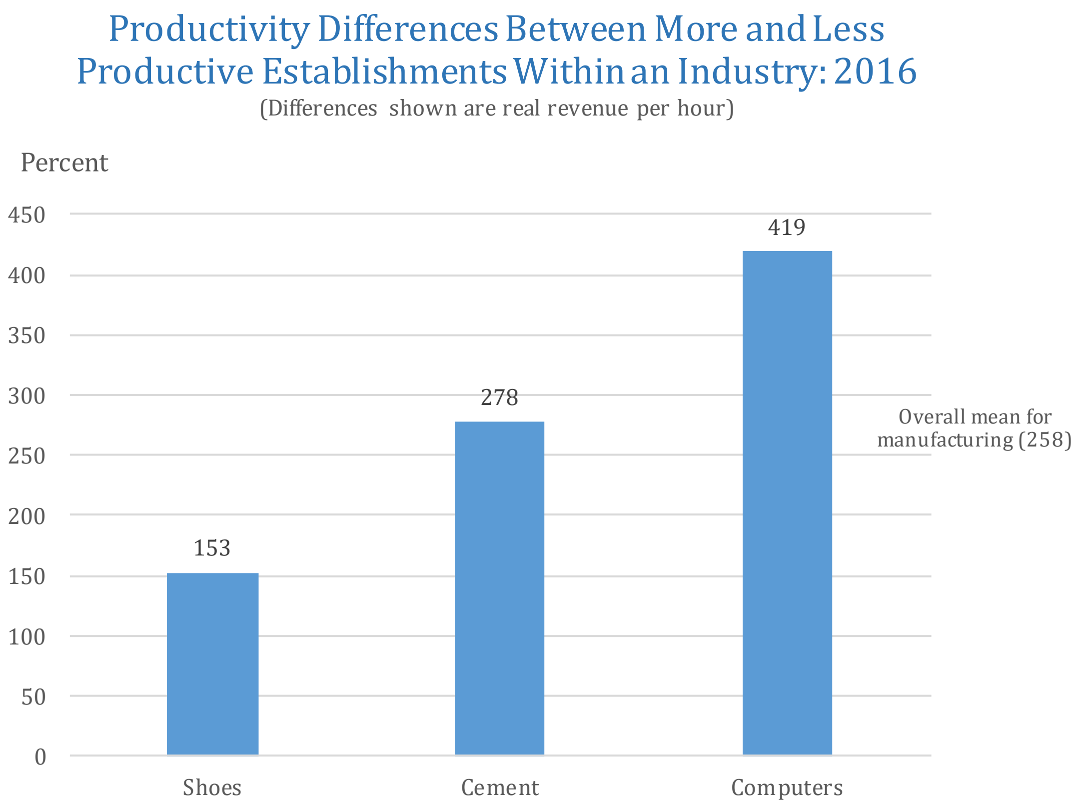
BLS

Dispersion Statistics on Productivity (DiSP)

- BLS-Census joint experimental data product
  - 86 4-digit NAICS manufacturing industries
  - Two productivity measures: Output per hour (LP) and total factor productivity (TFP)
  - Three dispersion statistics: Interquartile range (IQR), interdecile range (90-10), standard deviation
  - Activity-weighted and non-activity-weighted estimates
  - 1997–2016 (Released September 2020)

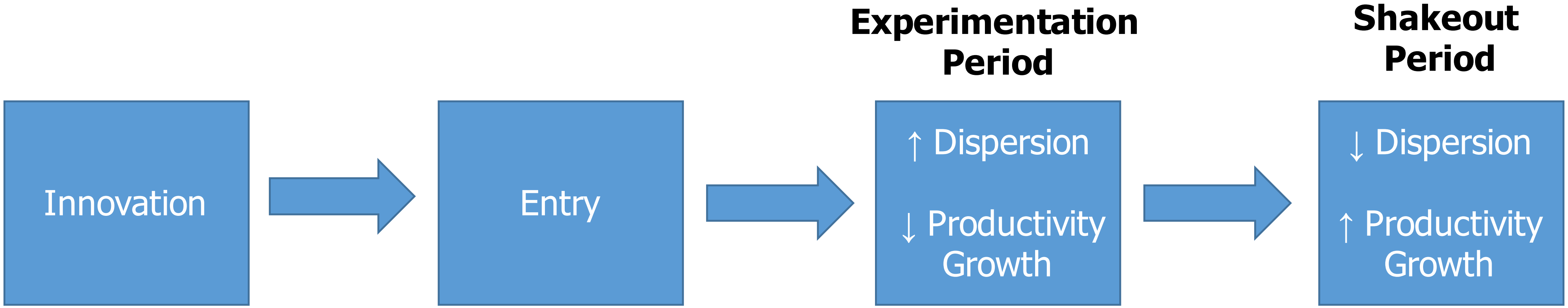
- Key Findings
  - Enormous within-industry dispersion in productivity
  - Large differences between industries as well
  - Size, state, and age don't explain the dispersion



What accounts for the enormous variation in productivity across establishments within detailed industries?

- Frictions and distortions that inhibit productivity-enhancing reallocation
  - Costs of adjusting factors of production (Decker et al. 2020)
  - Barriers to entry
  - Regulations that prevent the equalization of marginal products across plants
  - Establishment-specific markups (De Loecker et al. 2020)
- Differences in management skills (Bloom et al. 2019)
- Differences in technologies (Zolas et al. 2020)
- Innovation dynamics (Foster et al. 2021)
  - Building on Gort and Klepper (1982)

Innovation Hypothesis



Data

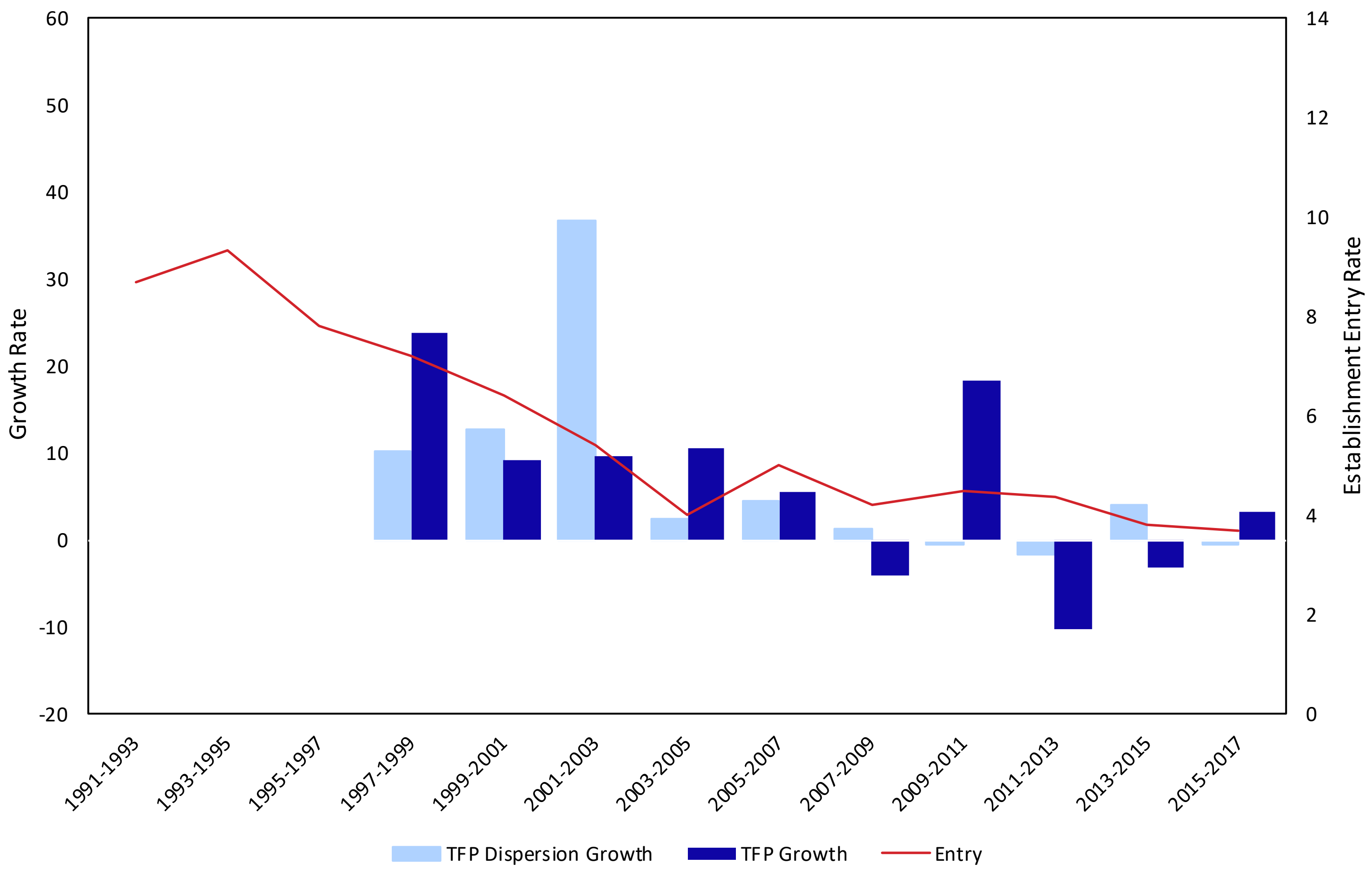
Sources:

- BLS Aggregate Industry Productivity Statistics
  - Labor productivity (LP)
  - Total factor productivity (TFP)
- Dispersion Statistics on Productivity (DiSP)
  - Activity-weighted dispersion measures (IQR, 75–50, 50–25)
- Business Dynamics Statistics (BDS)
  - Establishment and firm age distributions allow us to calculate entry rates

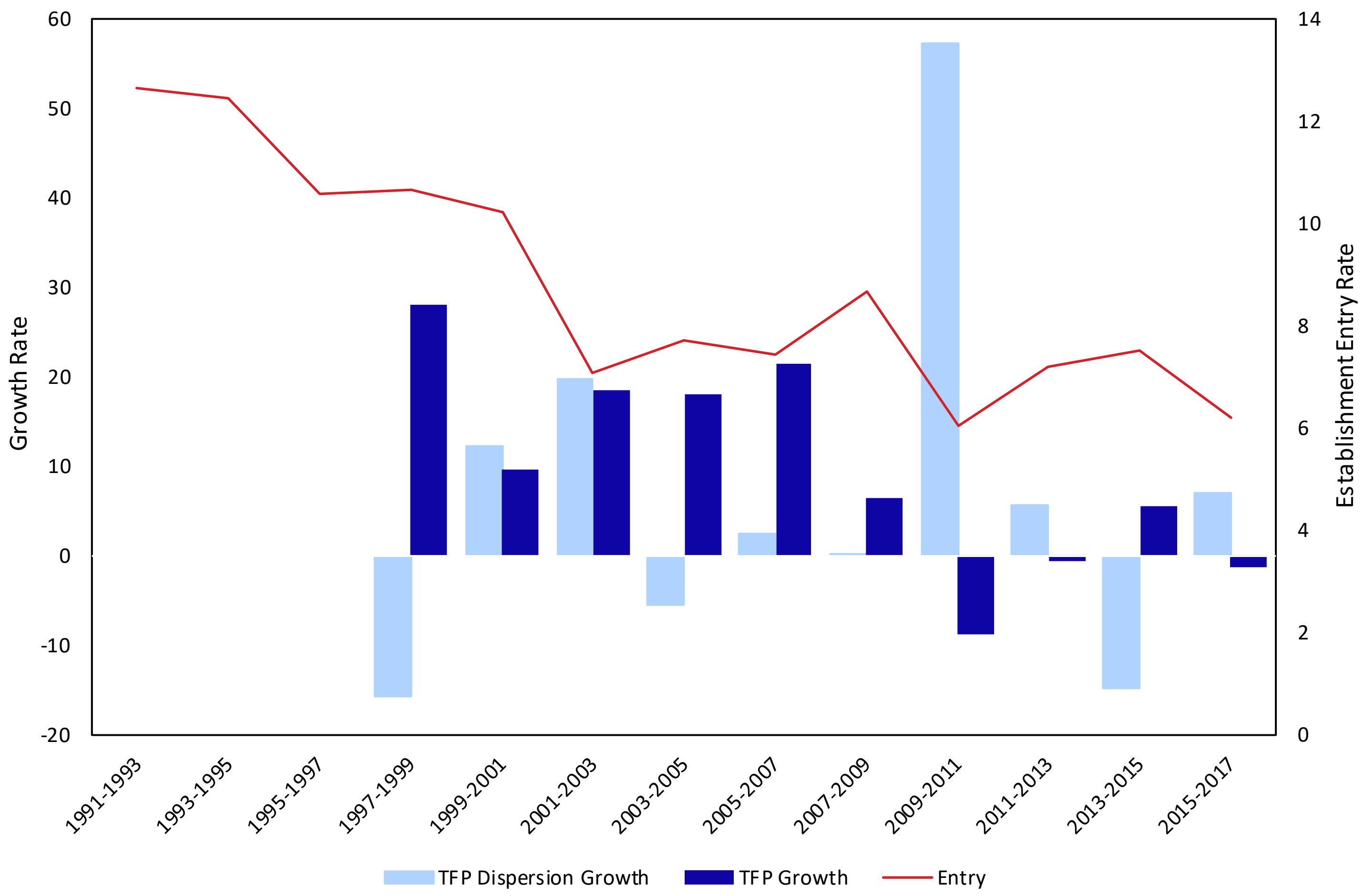
Sample:

- 86 4-digit NAICS manufacturing industries
- Construct the <u>average annual growth rate </u>for two-year periods for productivity dispersion and growth (to abstract from business cycle dynamics)
- Construct average entry rates for two-year periods

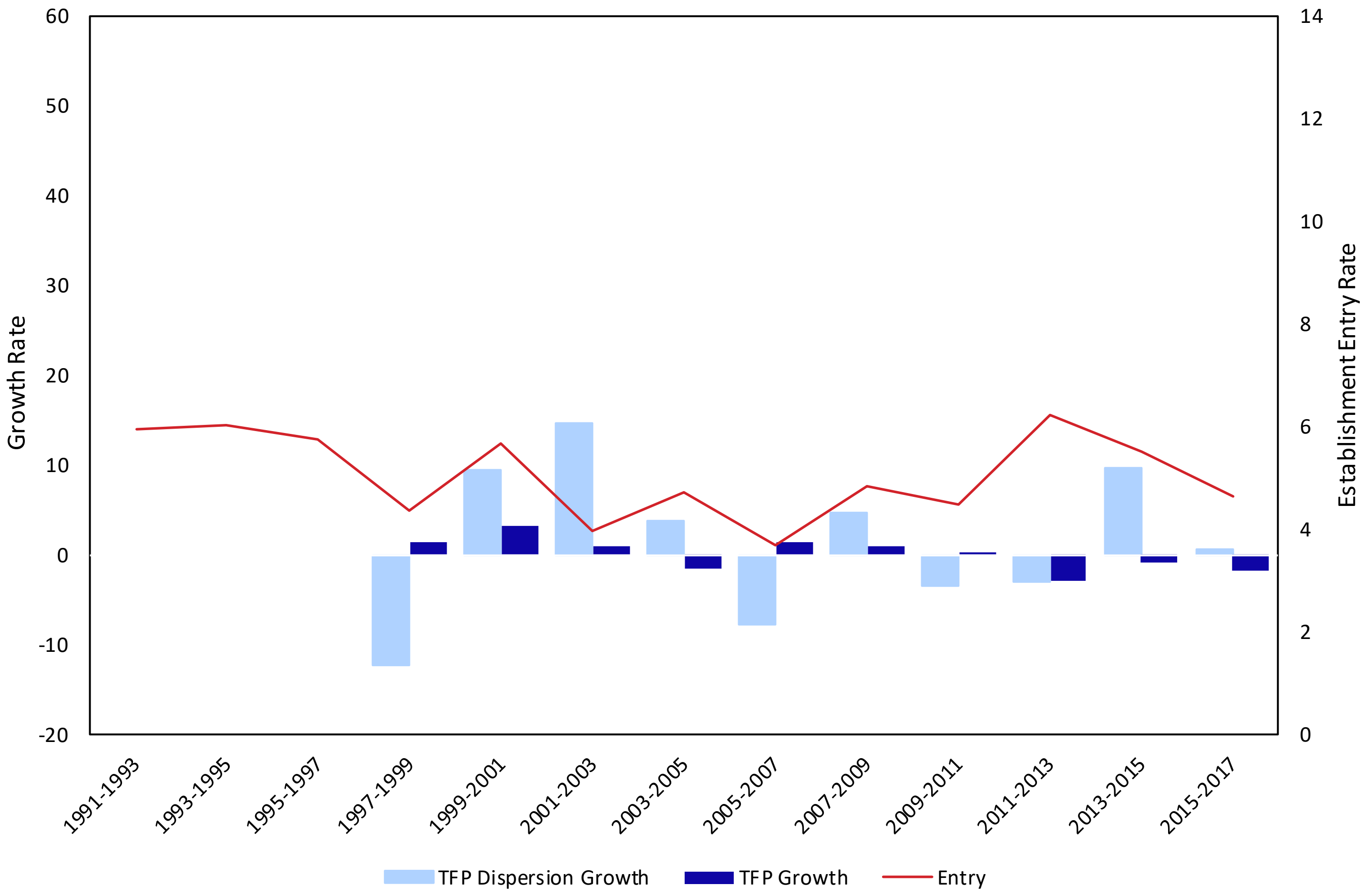
Semiconductor and Other Electronic Component Manufacturing



Computer and Peripheral Equipment Manufacturing



Grain and Oilseed Manufacturing



Model

$$Y_{i,t} = \alpha + \lambda_t + \lambda_i + \sum_{k=1}^{3} \left[\beta_k Entry_{i,t-k} + \delta_k Entry_{i,t-k}\, x\, Tech_i\right] + \varepsilon_{i,t}$$

$Y_{i,t}$ – within-industry/period productivity dispersion growth or industry/period productivity growth (TFP)

Entry – establishment or firm entry rates

Tech – indicator for high-tech industry (16 out of 86 4-digit NAICS industries based on share of STEM jobs)

λ_t – period effects

λ_i – industry effects

TFP Dispersion Growth, TFP Growth, and Establishment Entry Rates

	Dispersion	Productivity
Lag 1 Entry	0.01 (0.44)	0.01 (0.07)
Lag 2 Entry	-0.35 (0.42)	**-0.20**** (0.09)
Lag 3 Entry	0.33 (0.40)	-0.05 (0.09)
Lag 1 Entry x Tech	**2.90*** (1.49)	**-0.67**** (0.30)
Lag 2 Entry x Tech	**-4.24**** (1.63)	**0.78***** (0.46)
Lag 3 Entry x Tech	0.85 (1.94)	**0.83**** (0.57)
Joint Hypothesis Tests:		
Lag 1 Entry + Lag 1 Entry x Tech	**2.91**** (1.41)	**-0.66**** (0.31)
Lag 2 Entry + Lag 2 Entry x Tech	**-4.59***** (1.60)	0.58 (0.45)
Lag 3 Entry + Lag 3 Entry x Tech	1.18 (1.90)	0.79 (0.58)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

TFP Dispersion Growth and Establishment Entry Rates

	75–50 range	50-25 range
Lag 1 Entry	-0.39 (0.53)	0.05 (0.75)
Lag 2 Entry	0.11 (0.56)	-1.27 (0.79)
Lag 3 Entry	**-0.94*** (0.49)	**0.97*** (0.56)
Lag 1 Entry x Tech	3.34 (2.22)	3.04 (1.86)
Lag 2 Entry x Tech	**-7.20***** (2.72)	-1.54 (1.50)
Lag 3 Entry x Tech	**4.51***** (1.69)	-1.02 (1.66)
Joint Hypothesis Tests:		
Lag 1 Entry + Lag 1 Entry x Tech	2.95 (2.20)	**3.54**** (1.76)
Lag 2 Entry + Lag 2 Entry x Tech	**-7.09***** (2.69)	**-2.80**** (1.36)
Lag 3 Entry + Lag 3 Entry x Tech	**3.57**** (1.65)	-0.05 (1.61)

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

TFP Dispersion Growth, TFP Growth, and Firm Entry Rates

	Dispersion	Productivity
Lag 1 Entry	-0.23 (0.35)	-0.04 (0.07)
Lag 2 Entry	-0.01 (0.28)	**-0.11*** (0.06)
Lag 3 Entry	0.14 (0.32)	-0.07 (0.09)
Lag 1 Entry x Tech	2.00 (1.75)	-0.19 (0.32)
Lag 2 Entry x Tech	**-4.96**** (1.75)	**1.08**** (0.42)
Lag 3 Entry x Tech	2.08 (1.58)	**1.76***** (0.43)
Joint Hypothesis Tests:		
Lag 1 Entry + Lag 1 Entry x Tech	1.27 (1.80)	-0.13 (0.27)
Lag 2 Entry + Lag 2 Entry x Tech	**-4.95***** (1.82)	0.23 (0.36)
Lag 3 Entry + Lag 3 Entry x Tech	2.48 (1.54)	**0.90*** (0.48)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusions

- Innovation (proxied by entry rates) can initially lead to a rise in productivity dispersion and a decline in aggregate productivity.
- After a shakeout period, dispersion will eventually fall and aggregate productivity will rise.
- Dynamic relationship between entry, dispersion, and growth
  - High-tech industries
  - Stronger using establishment entry rates than firm entry rates
  - Stronger for TFP than LP
- Recent (pre-pandemic) lower entry rates suggest slower productivity growth to come.
  - Preliminary evidence of surge in entry during pandemic (Dinlersoz et al. 2021; Haltiwanger 2021)

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FRED
Business Applications: Manufacturing in the United States
Percent Change from Year Ago
70
60
50
40
30
20
10
0
-10
-20
-30
May 2019
Sep 2019
Jan 2020
May 2020
Sep 2020
Jan 2021
May 2021
Sep 2021
Shaded areas indicate U.S. recessions.
Source: U.S. Census Bureau
myf.red/g/Js6o

Data Availability

- Dispersion Statistics on Productivity (DiSP)

https://www.bls.gov/lpc/productivity-dispersion.htm

https://www.census.gov/disp

- Industry Productivity Statistics

https://www.bls.gov/lpc/tables_by_sector_and_industry.htm

- Business Dynamics Statistics (BDS)

https://www.census.gov/programs-surveys/bds.html

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References

- Bloom, Nick, Erik Bryjolffson, Lucia Foster, Ron Jarmin, Megha Patnaik, Itay Saporta-Eksten, and John van Reenen. 2019. "What Drives Differences in Management Practices?" *American Economic Review Papers and Proceedings* 109(5): 1648–83. https://www.aeaweb.org/articles?id=10.1257/aer.20170491.
- Decker, Ryan, John Haltiwanger, Ron S. Jarmin, and Javier Miranda. 2020. "Changing Business Dynamism and Productivity: Shocks vs. Responsiveness." *American Economic Review* 100 (12): 3952–90. https://doi.org/10.1257/aer.20190680.
- De Loecker, Jan, Jan Eeckhout, and Gabriel Unger. 2020. "The Rise of Market Power and the Macroeconomic Implications." *Quarterly Journal of Economics* 135 (2): 561–644. https://doi.org/10.1093/qje/qjz041.
- Dinlersoz, Emin, Timothy Dunne, John Haltiwanger, and Veronika Penciakova. 2021. "Business Formation: A Tale of Two Recessions." *American Economic Review Papers and Proceedings* 111: 253–57. https://doi.org/10.1257/pandp.20211055.
- Foster, Lucia, Cheryl Grim, John Haltiwanger, and Zoltan Wolf. 2021. "Innovation, Productivity Dispersion, and Productivity Growth." In Measuring and Accounting for Innovation in the 21st Century, edited by Carol Corrado, Jonathan Haskel, Javier Miranda, and Daniel Sichel, 103–36. Chicago: University of Chicago Press. https://www.nber.org/books-andchapters/measuring-and-accounting-innovation-twenty-first-century/innovation-productivitydispersion-and-productivity-growth.
- Gort, Michael and Steven Klepper. 1982. "Time Paths in the Diffusion of Product Innovations." *The Economic Journal* 92 (367): 630–53. https://doi.org/10.2307/2232554.
- Haltiwanger, John. 2021. "Entrepreneurship during the COVID-19 Pandemic: Evidence from the Business Formation Statistics." NBER Working Paper No. 28912. https://www.nber.org/papers/w28912.
- Zolas, Nikolas, Zachary Kroff, Erik Bryjolfsson, Kristina McElheran, David N. Beede, Cathy Buffington, Nathan Goldschlag, Lucia Foster, and Emin Dinlersoz. 2020. "Advanced Technologies Adoption and Use by U.S. Firms: Evidence from the Annual Business Survey." NBER Working Paper No. 28290. https://www.nber.org/system/files/working_papers/w28290/w28290.pdf.