Online Appendix for New Perspectives on the Decline of U.S. Manufacturing Employment (Fort, Pierce and Schott 2018)

This online appendix contains additional figures referenced in the main text as well as more detailed information about the regression results referenced in the main text.

A Regression Detail

A.1 Premia Regressions

We examine the correlation between use of technology and both firm employment and labor productivity via a series of cross-sectional OLS regressions in each census year of the form

$$ln(Attribute_f^t\} = \alpha + \beta 1\{Activity_f^t\} + \eta_j^t + \epsilon_f^{t:}. \tag{A.1}$$

The left-hand side variable is either the log employment or the log labor productivity (shipments divided by employment) for firm f in census year t. The first right-hand side variable represents participation in one of the following technology or trade activities in census year$t$: purchase of computers, use of electronic networks to control or coordinate shipments, direct importing of industrial robots (HS 84.7950.0000) or direct importing of any good from any country. η_j^t represents industry fixed effects. We estimate separate regressions for each activity and each census year from 1977 to 2012. Data for computer purchases is not available in 1997. Data for importing, importing robots, and use of electronic networks are not available before 1992, 1997 and 2002, respectively. Point estimates and ninety-five percent confidence intervals for each activity and year are displayed in Appendix Figure A.5. As indicated in the figure, firms engaged in each of the examined activities are larger and more productive than those not engaging in the activities. These size and productivity premia generally shrink over time, though the decreases are considerably larger for the technology activities versus direct importing.

A.2 Plant Death Regressions

We examine the correlates of plant death *within* multi-establishment firms by estimating the following OLS regression,

$$1\{Death_{pf}^{t:t+5}\} = \alpha + \beta 1\{Activity_{pf}^t\} + \gamma ln(Emp_p^t) + \delta_f + \rho^t + \epsilon_{pf}^{t:t+5}. \tag{A.2}$$

The left-hand side variable is an indicator for whether the plant exits between census years t and $t+5$. After the constant, the second variable on the right-hand side

represents indicators for whether the plant engages in a particular activity, such as purchasing computers or using an electronic network to control or coordinate shipments in census year t. The third variable on the right hand side is the natural log of plant employment, the fourth covariate represents firm fixed effects, and the fifth covariate represents year fixed effects. We estimate this equation separately across census years before and after 2000, i.e., 1977 to 1997 and 2002 to 2012. Data for computer purchases are available in all census years except 1997, when this information was not collected. Data for use of electronic networks are available starting in 2002. We also estimate a variant of equation A.2 in which we replace $Activity_{pf}^{t}$ with either the change in import penetration or the change in import penetration from China in the plant's industry between years t and $t+5$.

Coefficient estimates are reported in the first two columns of Table A.1. Because the regressors are endogneous and no instrumental variables are employed, these coefficient estimates should be treated as correlations, with no claim of causality.

Dependent variable is an indicator equal to one if a plant or firm exits in the next 5 years

	Plant Death		Firm Death	
	Pre 2000	2000s	Pre 2000	2000s
Computer Purchases$_{pf}^{t}$	-0.057***	0.00	0.060***	-0.019***
	(0.003)	(0.003)	(0.00)	(0.00)
Electronic Networks$_{pf}^{t}$		-0.039***		-0.027***
		(0.003)		(0.00)
Robots$_{f}^{t}$				0.097***
				(0.03)
Importer$_{f}^{t}$			0.043***	0.002
			(0.00)	(0.00)
China Importer$_{f}^{t}$			0.070***	0.031***
			(0.01)	(0.00)
ΔImport Penetration$_{pi}^{t:t+5}$	0.251***	0.06	0.003	0.034
	(0.059)	(0.046)	(0.06)	(0.05)
ΔChinese Import Penetration$_{pi}^{t:t+5}$	0.721***	0.09	-0.036	0.204***
	(0.121)	(0.084)	(0.13)	(0.06)
Initial log of firm employment	Yes	Yes	Yes	Yes
Fixed Effects	Firm and Year		Industry and Year	

Notes: First two columns panel reports the results of OLS panel regressions of an indicator for *plant* death between years t and t+5 on indicators for noted *plant* activities in year t. The sample period for the first column is census years from 1977 to 1997 while the sample period for the second column is census years from 2002 to 2012. Regressions in the first two columns include both firm and year fixed effects. Third and fourth columns reports the results of analogous OLS panel regressions of indicators of *firm* death between years t and t+5 on indicators of *firm* activity. Firm-level regressions include industry and year fixed effects. Each cell in the table reports the results of a separate regression. Activities examined are the purchase of computers, use of electronic networks to control or coordinate shipments, direct importing of industrial robots (HS 84.7950.0000) and direct importing of any good from any country. Final two rows of table examine the association between plant or firm death and year t to t+5 changes in import penetration of plants' or firms' major industry. Importing data are not available until 1992 and are available only at the firm level. Computer purchase data are not available in 1997. All regressions control for initial plant or firm size. Standard errors for regressions with industry import penetration are clustered at the industry level. *, **, *** signify statistical significance at the 10, 5, and 1 percent level respectively.

Table A.1: Plant and Firm Death Regressions

For comparison, we also report a series of analogous firm death regressions in the second two columns of Table A.1,

$$1\{Death_f^{t:t+5}\} = \alpha + \beta 1\{Activity_f^t\} + \eta_j^t + \rho^t + \epsilon_f^{t:t+5}, \tag{A.3}$$

where η_j^t captures industry fixed effects. In these regressions, we are also able to investigate the association between firm death and being a direct importer of industrial robots (HS 84.7950.0000) in year t as well as being a direct importer or being a direct importer from China of any good in year t. As noted in the main text, we are unable to examine these relationships at the plant level given that trading is observed only at the firm level.

A.3 Continuing-Firm Regressions

To assess the potential role of trade and technology in US manufacturers' employment changes within continuing firms, we examine how firm outcomes relate to various activities using firm-level OLS panel regressions of the form

$$\Delta log(Outcome_f^{t:t+5}) = \beta Activity_f^t + \eta_j^t + \rho_t + \epsilon_f^{t:t+5}. \tag{A.4}$$

$\Delta log(Outcome_f^{t:t+5})$ represents the log difference in firm-level manufacturing employment, total employment, real value added in manufacturing, or real value added in manufacturing per manufacturing worker between census years t and $t+5$. $Activity_f^t$, as above, represents one of several actions, including purchasing computers, using electronic networks to control or coordinate shipments, being a direct importer of industrial robots (HS 84.7950.0000), being a direct importer of any good from any country, or being a direct importer from China. When considering the latter two activities, we also include contemporaneous t to $t+5$ changes in the analogous industry-level import penetration, that is, change in overall import penetration or the change in import penetration from China. These additions allow for the possibility, discussed in Section 3 of the main text, that import competition and direct foreign sourcing may have different associations with firm outcomes. We note that these regressions are purely descriptive and should not be interpreted as providing causal evidence. As an additional caveat, we note that regressions are unweighted.

Results are presented in Table A.2, where the top and bottom panels display results for census years before and after 2000. The top panel reports the results of three regressions for each outcome variable, where the three regressions are separated into rows. The first regression examines the relationship between computer purchases and the outcome variables while the second and third examine relationships with respect to being an importer or being an importer from China. Computer purchase data are not available in 1997, and importing data are not available until 1992. As a result, the number of observations for the first regression is larger than for the second and third regressions. The bottom panel of Table A.2 considers years after 2000 and reports the results of five regressions for each outcome variable. All regressions in this panel have the same number of observations. We note that observations are rounded to the nearest thousand per Census Bureau disclosure guidelines.

Before 2000, computer purchasers exhibit declines in employment and real value added relative to non-purchasers, with the declines in the former being somewhat larger in absolute value. As a result, during this period, computer purchases are associated with increases in labor productivity. Results for being an importer or an importer from China are similar. A second notable trend in this panel is that for all three activities, the coefficients in regressions considering total firm employment (column 2) are smaller than those for manufacturing employment (column 1), indicating that employment adjustment to the noted activities occurs disproportionately among manufacturing establishments.

After 2000, we find a different pattern of results for firms that purchase computers and are direct importers. These activities are now associated with rising employment and rising real value added. Moreover, we find the same pattern of results for firms that use electronic networks to control or coordinate shipments. In contrast, firms that import industrial robots see relatively less manufacturing employment growth than firms that do not import these robots, though there is no significant relationship with their total employment and a positive and significant relationship with real value added and labor productivity. These results are consistent with the premise that technology may replace workers even as it boosts output. Finally, importing from China is associated with a statistically significant decrease in manufacturing employment after 2000, but no statistically significant relationship with total employment or real value added.

Results for changes in either overall or Chinese import penetration at the industry level indicate negative correlations with employment after 2000. Table A.2 contains two other suggestive results. First, being an importer in post-2000 years is correlated with relatively higher growth in employment and real value added, whereas increased import penetration in the firm's initial and primary (based on employment) manufacturing industry is associated with statistically significant relative reductions in growth in both outcomes. Higher growth in Chinese import penetration is associated with relatively lower growth in manufacturing and total employment, while the relationship with real value added growth is negative but statistically insignificant at conventional levels (p-value=0.12). Furthermore, the divergence in firm-level employment versus output correlations for robot importing and importing from China highlight the possibility that technology and trade may be factors in decreased manufacturing employment and increased output of US manufacturing firms.

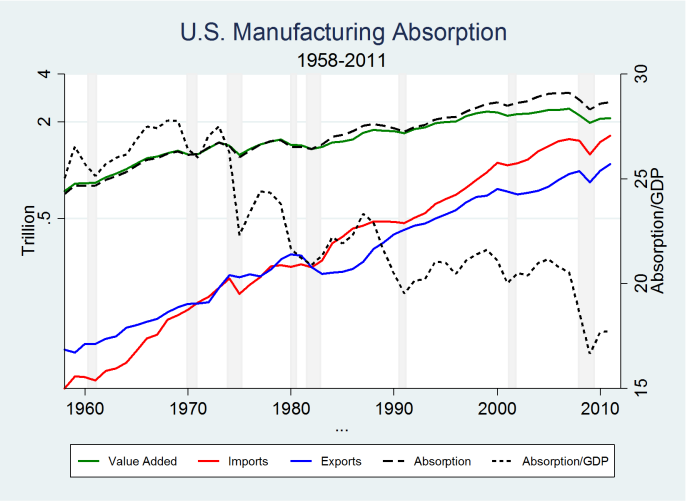
Dependent variable is 5-year differences in firm variable listed in colum:

	PANEL A: Pre-2000 Years			
	Δlog Employment		Δlog	Δlog VA
	Manuf	Total	Value Added	per Worker
Computer Purchases$_f^t$	-0.061***	-0.036***	-0.038***	0.023***
	(0.01)	0.00	(0.01)	(0.01)
Observations	323,000	323,000	323,000	323,000
Years: 1977, 1982, 1987, 1992				
Importer$_f^t$	-0.039***	-0.024**	0.01	0.046***
	(0.01)	(0.01)	(0.02)	(0.01)
ΔImport Penetration$_i^{t:t+5}$	-0.21	-0.12	0.26	0.474**
	(0.21)	(0.19)	(0.36)	(0.21)
ΔChina Importer$_f^{t:t+5}$	-0.169***	-0.130***	-0.097***	0.071***
	(0.02)	(0.02)	(0.03)	(0.02)
ΔChinese import Penetration$_i^{t:t+5}$	-0.15	-0.01	-0.24	-0.09
	(0.26)	(0.24)	(0.41)	(0.27)
Observations	91,000	91,000	91,000	91,000
Years: 1992-1997				
	PANEL B: 2000 Years			
	Δlog Employment		Δlog	Δlog VA
	Manuf	Total	Value Added	per Worker
Computer Purchases$_f^t$	0.026***	0.021***	0.013***	-0.013***
	0.00	0.00	0.00	0.00
Electronic Networks$_f^t$	0.009**	0.018***	0.030***	0.022***
	0.00	0.00	(0.01)	0.00
Robots$_f^t$	-0.069*	-0.01	0.105**	0.174***
	(0.04)	(0.03)	(0.05)	(0.05)
Importer$_f^t$	0.026**	0.025**	0.064***	0.038***
	(0.01)	(0.01)	(0.01)	(0.01)
ΔImport Penetration$_i^{t:t+5}$	-0.346**	-0.211*	-0.420**	-0.07
	(0.14)	(0.11)	(0.20)	(0.12)
China Importer$_f^t$	-0.023**	-0.02	0.02	0.039***
	(0.01)	(0.01)	(0.01)	(0.01)
ΔChinese Import Penetration$_i^{t:t+5}$	-0.743***	-0.522***	-0.34	0.402***
	(0.17)	(0.13)	(0.21)	(0.10)
Observations	178,000	178,000	178,000	178,000
Years: 2002, 2007, 2007				

Notes: Table reports the results of a series of firm-level OLS panel regressions of year t to year t+5 log changes in firm attributes on indicators of firm-level activities and, in some cases, changes in firms' initial industry import penetration. The left-had side variables examined are log changes in manufacturing employment, total employment, manufacturing real value added and manufacturing real value per manufacturing worker. Year t firm-level activities examined are purchasing computers, using electronic networks, being a direct importer of industrial robots (HS 84.7950.0000), being a direct importer of any good from any country, or being a direct importer from China. Panel A reports estimations across census years from 1977 to 1997, while panel B reports results for census years from 2002 to 2012. Computer purchase data are not available in 1997, and importing data are not available until 1992; as a result, the number of observations for the first regression in Panel A is larger than for the second and third regressions in Panel A. Observations are rounded to the nearest thousand per U.S. Census Bureau disclosure guidelines. There are three regressions for each dependent variable reported in Panel A, and five regressions reported for each dependent variable in Panel B. All regressions include year fixed effects. Standard errors for regressions with industry import penetration are clustered at the industry level. *, **, *** signify statistical significance at the 10, 5, and 1 percent level respectively.

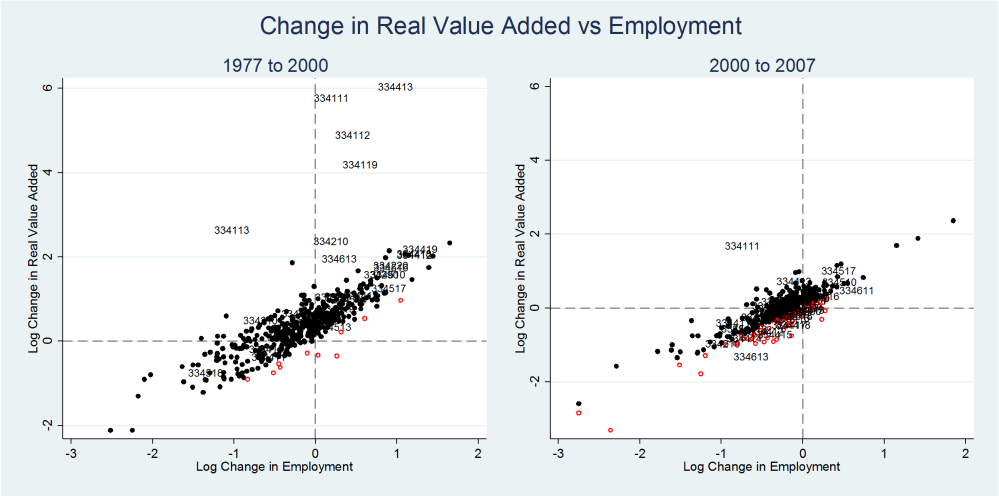
Table A.2: Continuing-Firm Regressions

B Additional Figures



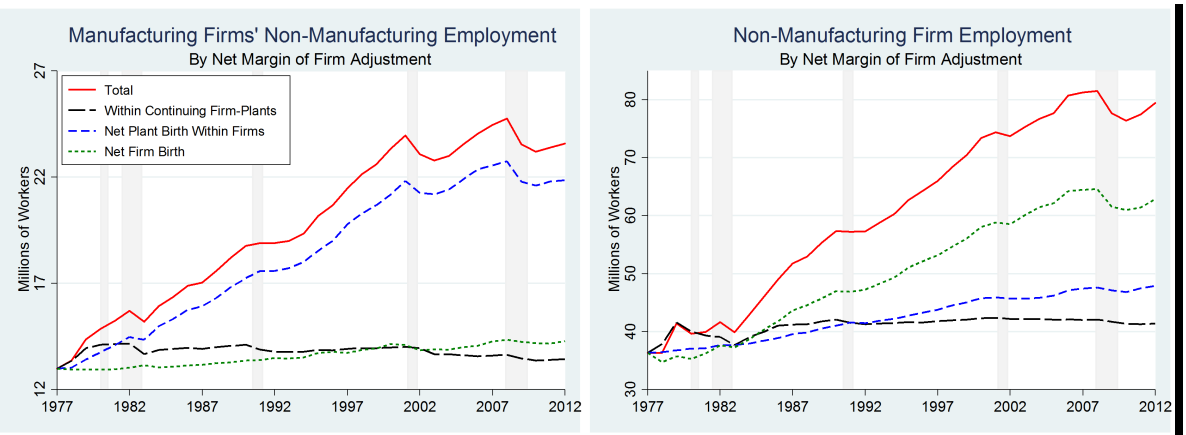
Source: Annual manufacturing real value added (VA) is from NBER-CES Manufacturing Industry Database (Becker et al. 2013). Annual manufacturing imports (M) and exports (X) are from Feenstra (1996) and Schott (2008). Manufacturing absorption is defined as the sum of value added and imports less exports (VA+M-X), all in real terms. Real GDP is from the US Bureau of Economic Analysis. Units for value added, imports, exports and absorption are on left axis. Units for absorption as a percent of GDP are on right axis. Gray bars indicate duration of recessions as determined by the NBER Business Cycle Dating Committee.

Figure A.1: US Manufacturing Absorption



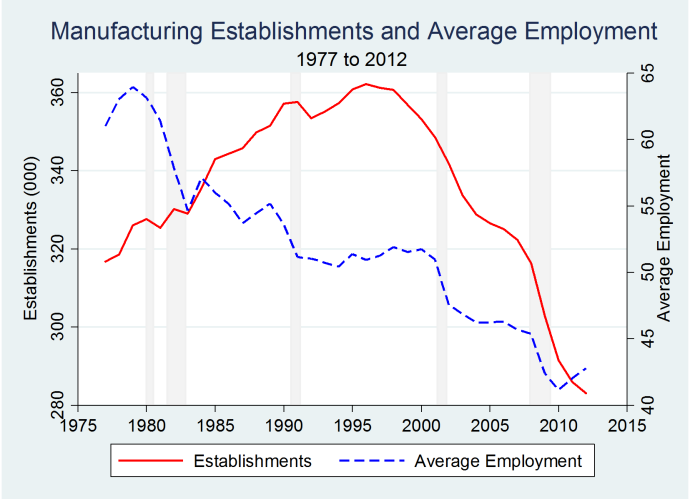
Source: Publicly available NBER-CES Manufacturing Industry Database (Becker et al. 2013) and authors' calculations. Value added is deflated using shipment price deflators contained in the database. Industry codes for Computer and Electronic Product (334) are highlighted. Industries below the 45 degree line, that is, with falling labor productivity, are indicated by open red circles.

Figure A.2: Employment versus Value Added Growth Across Six-Digit NAICS Sectors



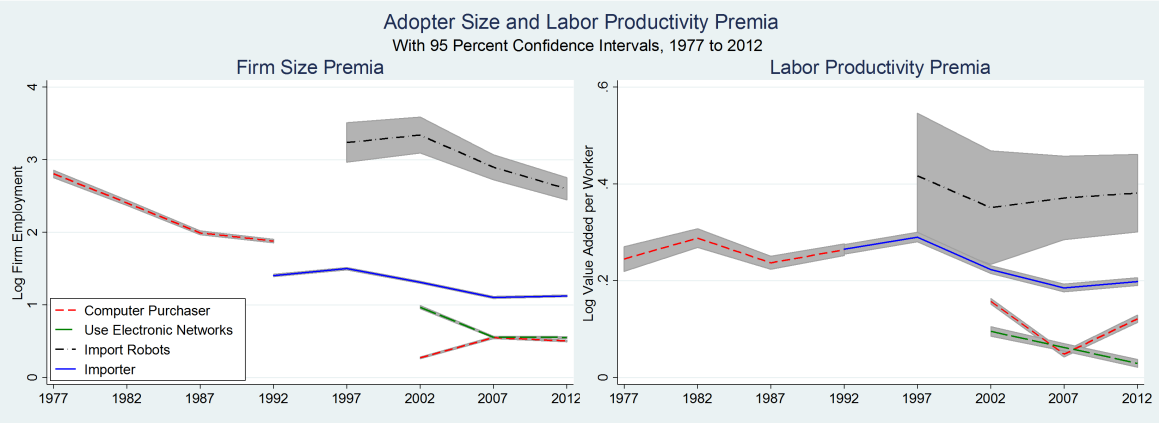
Source: Longitudinal Business Database and authors' calculations. Left panel decomposes U.S. manufacturing firms' non-manufacturing employment by noted net margins of firm adjustment. Right panel performs similar decomposition for non-manufacturing firms, which, by definition, do not have any manufacturing establishments. In both panels, change in employment along the noted net margins of firm adjustment are relative to the firms and plants present in 1977, the "base" year. Gray bars indicate duration of recessions as determined by the NBER Business Cycle Dating Committee.

Figure A.3: US Non-Manufacturing Employment by Net Margins of Adjustment



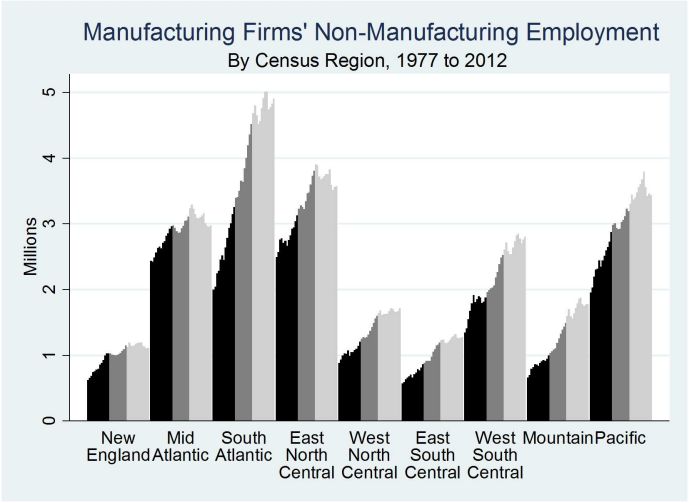
Source: Business Dynamics Database and authors calculations.

Figure A.4: US Manufacturing Establishment Count



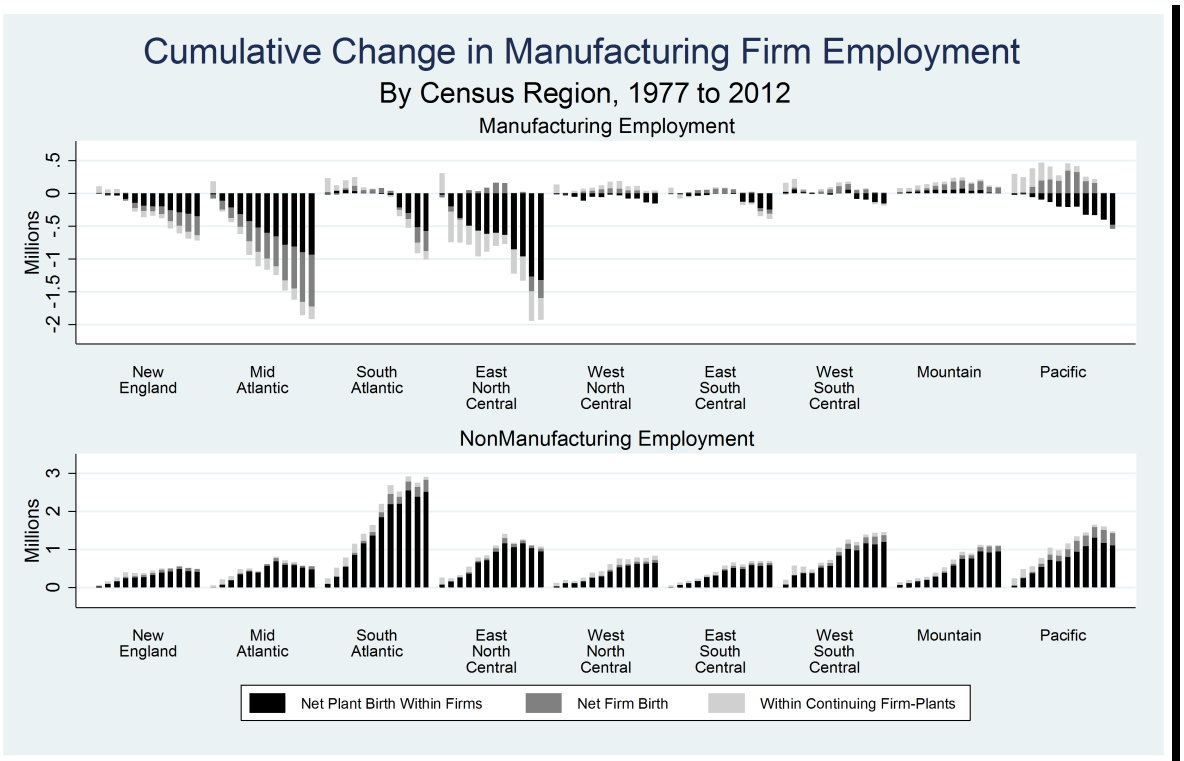
Source: Census of Manufactures and Longitudinal Trade Transactions Database and authors' calculations. Figure reports the results of cross-sectional regressions of noted firm characteristics on a dummy variable for noted firm activity. A separate regression is run for each Census year and activity. Point estimates and confidence intervals for a given activity are connected across years. The break in line for computer purchases in 1997 represents unavailable data in that year. Data for importing, importing robots, and use of electronic networks is not available before 1992, 1997 and 2002, respectively. In the right panel, the connection of the confidence intervals for computer purchases and importing in 1992 is coincidental.

Figure A.5: Technology Adopters' Size and Productivity Premia



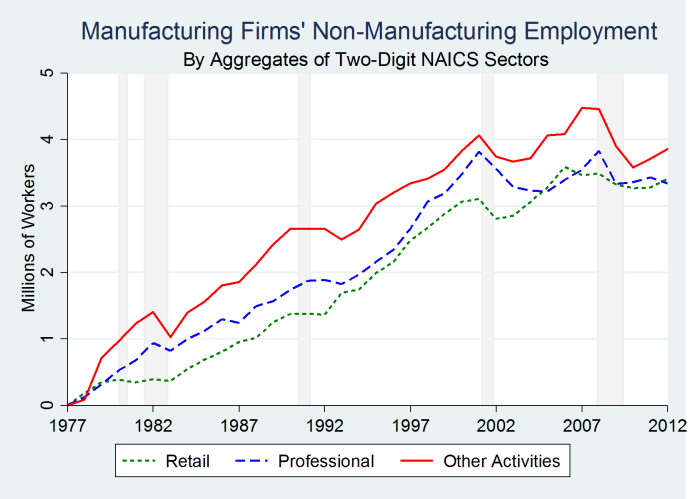
Source: Longitudinal Business Database and authors' calculations. Figure reports manufacturing firms' non-manufacturing employment across years and census regions. Years from 1977 to 1989, 1990 to 1999 and 2000 to 2012 are shaded black, dark grey and light grey, respectively. Census regions are defined as follows. New England: CT, ME, MA, NH, RI, VT. Middle Atlantic: NJ, NY, PA. East North Central: IN, IL, MI, OH, WI. West North Central: IA, KS, MN, MO, NE, ND, SD. South Atlantic: DE, DC, FL, GA, MD, NC, SC VA, WV. East South Central: AL, KY, MS, TN. West South Central: AR, LA, OK, TX. Mountain: AZ, CO, ID, MT, UT, NV, WY. Pacific: AK, CA, HI, OR, WA.

Figure A.6: US Manufacturing Firm Non-Manufacturing Employment, by Census Region



Source: Longitudinal Business Database and authors' calculations. Panels report cumulative change in manufacturing firms' manufacturing and non-manufacturing employment from 1977 to 2012 by net firm margin of adjustment and region. Bars report cumulative changes at three-year intervals, starting with 1979. Census regions are defined as follows. New England: CT, ME, MA, NH, RI, VT. Middle Atlantic: NJ, NY, PA. East North Central: IN, IL, MI, OH, WI. West North Central: IA, KS, MN, MO, NE, ND, SD. South Atlantic: DE, DC, FL, GA, MD, NC, SC VA, WV. East South Central: AL, KY, MS, TN. West South Central: AR, LA, OK, TX. Mountain: AZ, CO, ID, MT, UT, NV, WY. Pacific: AK, CA, HI, OR, WA.

Figure A.7: US Manufacturing Firm Employment by Net Margin of Adjustment and Region



Source: Longitudinal Business Database and authors' calculations. Retail is NAICS sectors 44 to 45. Figure displays cumulative changes in manufacturing firms' non-manufacturing employment since 1977. Professional Services are: information technology (NAICS 51); finance, insurance, real estate and leasing (NAICS 52-4); engineering and other technical services (NAICS 55); headquarters services (NAICS 56); and administrative support and waste management (NAICS 56). Other Activities are all other NAICS sectors. Gray bars indicate duration of recessions as determined by the NBER Business Cycle Dating Committee.

Figure A.8: US Manufacturing Firm Non-Manufacturing Employment, by Super NAICS Sectors

DELETE THIS PAGE FROM PDF: the following data cites appear exclusively in figure and table notes: Becker et al. (2013), Feenstra (1996) and Schott (2008).