The Geography of Trade and Technology Shocks in the United States

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The U.S. and many European countries have experienced growing income inequality and increasing employment polarization (i.e., concentration of employment in the highest and lowest paid occupations) over the past several decades (David H. Autor, Lawrence F. Katz and Melissa S. Kearney 2008; Christian Dustmann, Johannes Ludsteck and Uta Schoenberg 2009). The two most prominent potential causes for these "effects" are rapid technological change (e.g., the computer revolution) and expanding international trade (e.g., the rise of China). There is a growing sense that trade and technology are a unified force affecting labor markets. Commencing with the work of Alan S. Blinder (2009), economists have posited that job tasks that are suitable for automation are also suitable for offshoring.[1] For the low-skill work that presently cannot be automated, substantial pieces of production chains have already moved to the developing world.

The objective of this paper is to explore the geographic overlap of trade and technology shocks. If the overlap is extensive, there would be a strong case for viewing trade and technology as linked phenomena. However, if the evidence reveals only limited overlap, trade and technology may be playing substantively different roles in shaping labor-market developments in the U.S. and other rich countries. Focusing on Commuting Zones (CZs) that approximate U.S. local labor markets, we examine whether the CZs that are most exposed to rising trade penetration are also those most impacted by computerization. On the technology front, we follow Autor and David Dorn (forthcoming) who use data on industry and occupation mix by CZ and data on job tasks by occupation to measure the degree to which CZs are specialized in routine job activities well-suited to computerization. On the trade front, we follow Autor, Dorn and Gordon H. Hanson (forthcoming) in identifying trade shocks using cross-industry and cross-CZ variation in import competition stemming from China's rapidly rising productivity and falling barriers to foreign trade and investment.[2]

I. Measurement and Results

Our analysis requires a time-consistent definition of regional economies. Our concept for local labor markets is Commuting Zones (CZs) developed by Charles M. Tolbert and Molly Sizer (1996), who use county-level data from the 1990 Census data to create clusters of counties that are characterized by strong commuting ties within a cluster, and weak commuting ties across clusters. Our analysis includes the 722 CZs that cover the entire mainland United States.

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[1] The reasoning here is that tasks that follow explicit codifiable procedures (what Autor, Frank Levy and Richard J. Murnane 2003 call "routine" tasks) are both well suited to automation because they can be computerized and well suited to offshoring because they can be performed at a distance without substantial loss of quality.

[2] A number of papers consider the roles of both computerization and offshoring simultaneously (e.g., Autor and Dorn forthcoming; Maartan Goos, Alan Manning and Ana Salomons 2012; Sergio Firpo, Nicole M. Fortin and Thomas Lemieux 2012; Lindsay Oldenski 2012; Guy Michaels, Ashwini Natraj and John Van Reenen forthcoming).

Following an extensive literature, we conceive of automation as taking the form of a decline in the cost of computerizing routine tasks, such as bookkeeping, clerical work, and repetitive production and monitoring activities, thereby potentially displacing the workers performing these tasks. To measure the degree to which CZs were historically specialized in routine, codifiable job activities that were intrinsically amenable to computerization, we proceed in two steps. Using data from the Dictionary of Occupational Titles (1977), we create a summary measure of the routine task-intensity RTI of each occupation, calculated as:

$$(1)\ RTI_k = \ln\left(T^R_{k,1980}\right) - \ln\left(T^M_{k,1980}\right) - \ln\left(T^A_{k,1980}\right),$$

where T^R_k, T^M_k and T^M_k are, respectively, the routine, manual and abstract task inputs in each occupation k in 1980.[3] This measure is rising in the importance of routine tasks in each occupation and declining in the importance of manual and abstract tasks. To measure cross-market variation in employment in routine-intensive occupations, we classify as routine occupations those that fall in the top-third of the employment-weighted distribution of the RTI measure in 1980. Using this classification, we then assign to each commuting zone a routine employment share measure (RSH_{jt}) equal to the fraction of CZ employment at the start of a decade that falls in routine task-intensive occupations.:

$$RSH_{jt} = \left(\sum_{k=1}^{K} L_{jkt} \cdot 1\left[RTI_k > RTI^{P66}\right]\right) \times \left(\sum_{k=1}^{K} L_{jkt}\right)^{-1} \quad (2)$$

Here, L_{jkt} is the employment in occupation k in commuting zone j at time t, and $1\left[\cdot\right]$ is the indicator function, which takes the value of one if the occupation is routine-intensive by our definition.

The rapid growth in U.S. imports from low-income countries since the early 1990s is driven largely by China, whose transition to a market-oriented economy has yielded rapid rates of productivity growth arising from massive rural-to-urban migration, industries gaining access to long banned foreign technologies and inputs, and multinational enterprises being permitted to operate in the country (Barry Naughton, 2007). Compounding the effects of these internal reforms is China's accession to the WTO in 2001, which further expanded the country's access to foreign markets.

Following the empirical specification derived by Autor, Dorn, and Hanson (forthcoming), our main measure of local-labor-market exposure to import competition is the change in Chinese import exposure per worker in a region, where imports are apportioned to the CZ according to its share of national industry employment:

$$(3) \qquad \Delta IPW_{uit} = \sum_j \frac{L_{ijt}}{L_{ujt}} \frac{\Delta M_{ucjt}}{L_{it}}.$$

In this expression, L_{it} is the start of period employment (year t) in CZ i and ΔM_{ucjt} is the observed change in U.S. imports from China in industry j between the start and end of the period. The difference in ΔIPW_{uit} across local labor markets stems entirely from variation in local industry employment structure at the start of period t. This variation arises from differential concentration of employment in manufacturing versus non-manufacturing activities and specialization in import-intensive industries within local manufacturing. Differences in manufacturing employment shares are not the primary source of variation, however; in a bivariate regression, the start-of-period manufacturing employment share explains less than 25% of the variation in ΔIPW_{uit}.

Are the CZs that are most exposed to rising trade penetration also those most impacted by computerization? To explore this question, Figures 1a to 1c illustrate the geography of trade and technology exposure at the Commuting Zone level. Each panel of the figure presents a map of the 48 con-

[3] Tasks are measured on a zero to ten scale. For the five percent of microdata observations with the lowest manual task score, we use the manual score of the 5th percentile. A corresponding adjustment is made for abstract scores.

tiguous U.S. states with all 722 CZ boundaries outlined in gray. In Figure 1a, the interior of each CZ is shaded to indicate its quartile rank within the distribution of CZs in the fraction of workers that were employed in routine task-intensive occupations in 1990.[4] Darker colors correspond to higher quartiles of RSH, with the lightest color denoting CZs in the lowest quartile and the darkest color denoting CZs in the fourth quartile.

Evident from this figure is that the CZs with the highest employment shares in routine task-intensive occupations constitute a mixture of manufacturing-intensive locations (e.g., manufacturing locations around the Great Lakes and in the Southeast) and human-capital intensive population centers such as New York, Boston, San Francisco, and Dallas. This pattern reflects the dual sources of routine task-intensive occupations: blue-collar production occupations associated with capital intensive manufacturing; and white-collar office, clerical and administrative support occupations associated with banking, insurance, finance and other information-intensive sectors.

Figure 1b presents analogous information for exposure to import competition from China. In this panel, the lightest shading indicates CZs in the lowest quartile of trade exposure increase between 1990 and 2007 (measured as the change in real dollars of imports per worker) and the darkest color indicates CZs that are in the highest quartile of trade exposure increase. As expected, many manufacturing-intensive regions appear among the most trade-exposed CZs, including substantial parts of the Northeast and South Central U.S., where labor-intensive goods manufacturing, such as furniture, rubber products, toys, apparel, footwear and leather goods, is concentrated.

A comparison of the first two panels of Figure 1 indicates both clear overlaps and pronounced differences among the sets of CZs with high trade exposure and those with high technology exposure. Most notable, however, is that the geography of trade exposure is highly concentrated. A substantial fraction of the top quartile of trade-exposed CZs are located in a small number of states, including Tennessee, Missouri, Indiana, Alabama, North Carolina, Pennsylvania, New York, Rhode Island, New Hampshire and Maine. By contrast, routine task-intensive CZs are more dispersed throughout the U.S.

Figure 1a. Routine Employment Share by Commuting Zone in 1990

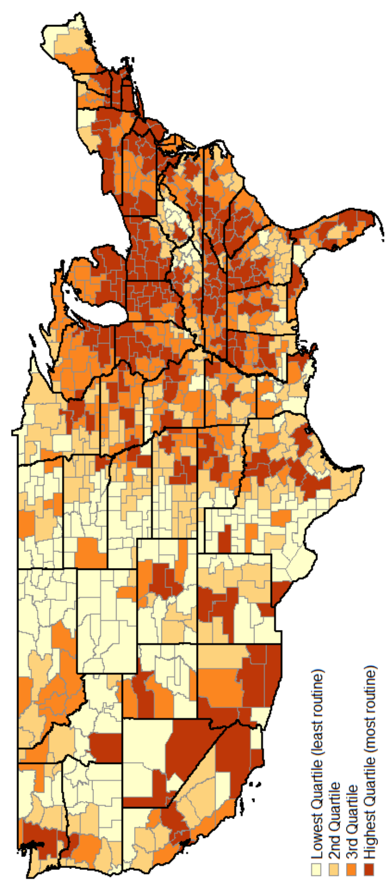


Figure 1c facilitates a direct comparison of exposure to technology and trade by dividing CZs into three groups: those in the highest quartile of both trade and technology exposure; those in the lowest quartile of both trade and technology exposure; and the remainder. If trade and technology exposure were perfectly positively correlated across locations, one-fourth of CZs would be found in each of the first two groups. If instead they were uncorrelated, roughly six percent

[4]Rankings are unweighted, and hence each quartile contains roughly one-fourth of the 722 total CZs.

(one-sixteenth) of CZs would be in the high-high and low-low groups, with remaining seven-ninths in the remaining category. In reality, nine percent of CZs are in the top quartile of both trade and technology exposure and 14 percent are in the bottom quartile of both trade and technology exposure. A simple population-weighted correlation between the trade and technology exposure variables finds that there is almost no relationship between the two: the correlation is −0.02 for the 1990 to 2000 period and 0.01 for the 2000 to 2007 period.

Figure 1b. Trade Exposure by Commuting Zone, 1990-2007

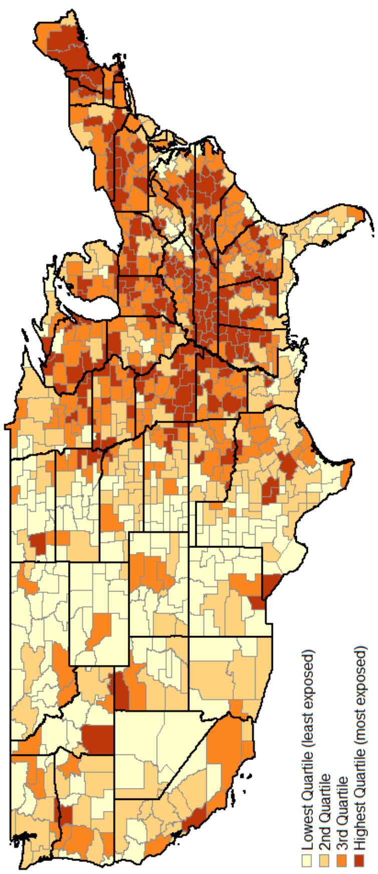
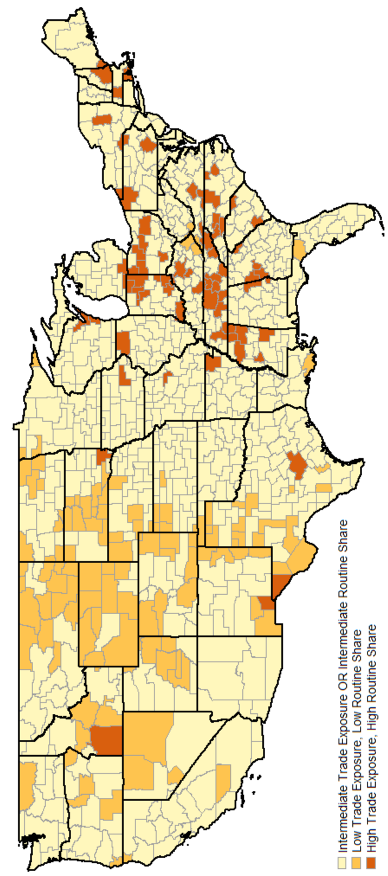


Figure 1c. The Joint Geographic Distribution of Trade and Technology Exposure



Thus, a summary answer to our question regarding the geography of trade and technology exposure is that the sets of heavily trade-exposed CZs and of heavily technology-exposed CZs are largely disjoint. This feature of the data facilitates the identification of the independent contributions of trade and technology to local-labor-market outcomes. We do not interpret the absence of overlap in the geography of trade and technology shocks to mean that these two forces are unconnected. Multinational enterprises choosing how pervasively to automate production would naturally consider offshoring to low-wage countries as an alternative or even as a complementary strategy. Rather, our point is that at the regional level, the perceived consequences of trade and technology are likely to be distinct. The U.S. local labor markets that have born the brunt of import competition from China appear to be quite different from those most subject to the computerization of the work place. These differences in exposure likely matter for regional adjustment to trade and technology shocks and may contribute to regional variation in changes in the structure of employment and wages.

II. Conclusions

There is a wide agreement among economists that technological change and expanding international trade have led to changing skill demands and growing inequality or polarization of labor market outcomes in the U.S. and in other rich countries. This paper highlights important differences in the exposure of local labor markets to the impacts of technology and trade. Regional exposure to technological change, as measured by specialization in routine task-intensive production and clerical occupations, is largely uncorrelated with regional exposure to trade competition from China. While the impacts of technology are present throughout the United States, the impacts of trade tend to be more geographically concentrated, owing in part to the strong spatial agglomeration of labor-intensive manufacturing. Our findings suggest that it should be possible to separately identify the impacts of recent changes in trade and technology on U.S. regional economies.

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