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Benign Effects of Automation

New Evidence from Patent Texts

By Katja Mann, Copenhagen Business School; and Lukas Püttmann, Puettmann Automatisierungstechnik

What is the effect of automation technology on employment? This question has received significant attention in public discourse and among researchers, but answers differ widely and depend on the definition of automation. In economics, automation is often understood as a type of labor-saving technology that reduces the demand for human workers at specific tasks. But automation technology could also create new products or lead to productivity improvements with no immediate replacement of human labor. Examples are printers, adaptive cruise control, and programs for automatic email management, which do not necessarily automate existing human tasks but may still affect employment. Our research finds that automation increases total employment, but the effect varies by industry.

We developed an approach to measure automation comprehensively from patent texts and began with a wide technological definition of automation without presupposing the effects, if any, that automation has on employment. Our definition encompasses diverse areas, including software, robotics, or any other physical or immaterial innovations involving a device that carries out a process independently of human intervention. Patents are a natural candidate for measuring technological progress and frequently serve as proxies of innovation. Although the number of patents and patent metadata are often used as measures, the text of patents has not been the focus of prior work. We classified automation patents based on a standard technology-based encyclopedia definition of automation: a device that carries out a process independently.

We extracted the texts of all 5 million US patents granted between 1976 and 2014 and trained a machine learning algorithm on a sample of 560 manually classified patents to distinguish between automation and nonautomation innovations. Our research reveals a large increase of automation patents over time. As a share of total patents, automation patents have increased from 23 percent in 1976

Editor, **JEFFREY MIRON**, Harvard University and Cato Institute.

to 59 percent in 2014. We matched patents to the industries where they are most likely to be used based on the patents' technology classes. Thus we produced a measure of newly available automation technology at the detailed industry level. We validated this measure by comparing it with previously used measures of automation—investment in computer capital and robot shipments—and found that the number of automation patents is positively correlated across industries with these measures.

Our research estimates the labor market effects of automation at the level of US commuting zones (CZs) using a data set of new automation technology patents that covers 722 CZs over 39 years. A complication is that local labor market conditions may influence the number of automation patents filed, making it difficult to isolate how automation patents influence local labor markets. Our research design addresses this concern by analyzing industries that are located in many different CZs throughout the country because national industries are unlikely to adopt automation in response to labor market trends in a specific CZ. Additionally, our research uses information on the patent filer to identify innovations that are unconnected to US labor market developments. Patenting activities by universities, public research institutes, foreigners, and governments are less likely to result from a business interest in the United States, making it less likely that these patents were filed in response to local labor market conditions.

Our research assesses the effect of automation patents on local employment-to-population ratios over a five-year horizon. First, it finds a significantly positive effect of automation on total employment, but our results show that the positive effect arises entirely in the service sector, whereas manufacturing workers do not benefit from automation. Second, our results reveal that automation has negative consequences for workers in CZs with a higher share of repetitive job tasks in manufacturing. Third, our results suggest that the effect of automation has become less positive over time. Our research also studies wages and provides evidence that automation has positive effects on wages in CZs with a low repetitive-task share but negative effects in others.

There are strengths and weaknesses to our approach to measuring automation technology. Text classification is an inherently imprecise activity, and we introduced further imprecision through probabilistic matching of patents to industries and CZs. Also, we made assumptions on the usefulness of patents and the way they are implemented. On the upside, we imposed fewer assumptions on the nature of advances in automation technology compared with past research that uses repetitive-task shares or computer and robot investment. Also, our measure allows us to closely track the technology frontier, translating newly granted patents into a detailed data set at the industry or CZ level. Therefore, we consider our measure a complement to previous measures of automation.

NOTE

This research brief is based on Katja Mann and Lukas Püttmann, "Benign Effects of Automation: New Evidence from Patent Texts," *Review of Economics and Statistics* 105, no. 3 (May 2023): 562–79.