Restructuring of Workforce Skills: adapting to automation technology in the wake of economic crisis

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Extended Abstract

Background

In an economy where the demand for a variety of manufactured goods is ever so increasing, the lumbering industrial robots that entered manufacturing plants around the turn of the millennium cannot keep pace. In recent years they have been complemented by sleeker, more flexible robots, in some cases bolstered by artificial intelligence, to respond to the need for more adjustable production processes and to work alongside their human coworkers. The impact on workers by the introduction of advanced automation technologies is summarized by earlier research in mainly two effects. A productivity effect where technology augments workers and increases their productivity, and a displacement effect where technology decreases labor demand. A telling example in which automation technologies increase labor productivity is the usage of artificial intelligence to optimize industrial robot movement; artificial intelligence can reduce programming time from 90 minutes (the average time it takes for a skilled human operator to optimize movement) to merely 2 seconds (ABB, 2023) – a significant productivity gain. This outcome can translate into the creation of news tasks for robot operators to focus on or a reduced need for robot operators. The overall impact of this outcome on

labor demand for robot operators hinges on the strengths of the displacement and productivity effects.

Earlier findings provide evidence that there has been technology induced polarization, where workers in the middle tiers on the wage income distribution have felt the brunt of the displacement effect, in particular blue-collar workers in manufacturing.

Objective and contribution

The purpose of the current paper is to augment the literature by investigating the timing and triggers of effects from the introduction of new automation technology. We do this by looking at individuals employed in manufacturing firms. These firms may or may not invest in automation technologies in a certain period. We then observe the outcomes for individual workers after an external shock. The external shock we will exploit is the great recession of 2007-2010. More succinctly put, we will examine the probability of job loss for workers in automating compared to non-automating manufacturing firms in the wake of the crisis in 2007. The hypothesis we aim to test is that the effects on employees of different skill levels from investing in automation technology may not be evident until there occurs a sizable pressure on the firm financially or otherwise. One important benefit following this design is that the economic shock comes much faster and is external to both firms and workers. This is in contradiction to investment programs of firms that may unfold in a much more gradual and piecemeal fashion. Thus, effects are more readily identified to a shorter time window.

The research design is crafted with the aim to minimize selection effects. This is accomplished by following workers that join the firm well before the actual investment in automation technology. Also, from the firm's perspective the investment is made well before the economic crisis known as the great recession. Thus, the timeline consists of three consecutive periods: 1) The period before the investment takes place; 2) The period when investments are done; 3) The crisis period leading to a shake-out of employees and possibly the discontinuation of some firms.

Data

We focus on workers in manufacturing and utilize an individual-level panel spanning from 2001 to 2021. We have access to a wide variety of information pertaining to these individuals. For instance, we know their wage, education, occupation, which firm (and plant) they work for, the industry of the firm, firm size, firm location, and crucially,

investments that the firm makes. Thus, we can work with a matched employer-employee panel for the period 2001-2021. The data is provided by Statistics Sweden.

Method

We use firms' machinery and equipment investments as a measure for automation technologies. This investment category covers a broad range of machines, including industrial robots and computers, and leasing of machinery. There is a tradeoff, however. A shortcoming of using machinery and equipment investments is that we cannot pinpoint the specific technologies adopted and thus cannot rule out the inclusion of technologies that do not adhere to automation. To confirm that our investments provide a suitable measure for automation technologies we regress firms' labor share (wages over value added) and labor productivity (value added over number of workers) on machinery and equipment investments, including a set of controls and fixed effects. This exercise yields an associated negative relationship between labor share and investments and an associated positive relationship between labor productivity and investments. These associated relationships confirm that machinery and equipment investments are an appropriate measure for automation technologies (Acemoglu et al., 2023a; Restrepo, 2023).

We then divide our sample of manufacturing firms into two groups: automating and non-automating. This is done by examining firms' cumulative investments in machinery and equipment prior to 2007. We use the mean of cumulative investments during a chosen pre-crisis time period as a cut-off, but we also consider other cut-offs including the median, the 75th percentile, and the 90th percentile for the sake of sensitivity checks.

The goal of the research design is to minimize selection effects. Particularly we seek to avoid selection of workers with certain skill sets to firms based on an anticipation of future investments and reaction to the economic crisis. This is attained through a deliberate approach of tracking workers who become part of the firm long before any substantial investment in automation technology takes place. By doing this, we capture a more complete and unbiased analysis of the workers.

Also, from the perspective of the firms under study, the investment in automation technology occurs significantly ahead of the upcoming economic shock - the great recession. This sequential division is crucial as it allows us to isolate the effects of the automation event, enabling a richer analysis of the impact of automation on the potential job loss of individual workers.

In essence, this research design allows for an improvement of the reliability and validity of findings by managing the timing of the choice of both the workers under study and the automation investment relative to the response to the economic downturn.

Unlike earlier studies, we do not treat sudden spikes in automation investments or greater cumulative automation investments over time as shocks on firms' workers. Rather, we are interested in how automating firms respond to shocks, such as economic crises compared to their non-automating equivalents and what the effect of this response is on the workforce. Acemoglu et al. (2023b) highlight the importance of considering labor market institutions when examining the impact of automation on workers. The Swedish labor market, like that of other European countries, is relatively rigid. Firms cannot adjust employment levels arbitrarily, regardless of whether there is a welding robot in the factory or not. In the wake of economic turbulence, however, adjustments to the workforce are likely to be made. The question is whether automating or non-automating firms are more prone to make such adjustments, and whether these adjustments decrease or increase labor demand.

Tentative results

We expect that the results of this research will enable us to shed light on the robustness of firms that automate relative to those that do not. To the extent that firms do lay off workers as a response to the crisis we will be able estimate the effects of automation on which type of workers that are in risk of lay-off based on their skill profile.

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