What happens to people when machines replace them in the workplace?

New technologies are replacing workers in a growing range of occupations, causing loss of earnings and employment. However, these losses are smaller than those suffered by workers who experience mass layoffs. ***Per-Anders Edin, Tiernan Evans, Georg Graetz, Sofia Hernnäs*** *and* ***Guy Michaels*** *write that, because the occupational decline they studied took years or even decades, its costs for individuals were likely mitigated through retirements, reduced entry into declining occupations and increased exits to other occupations.*

How costly is it for workers when demand for their occupation declines? As new technologies replace human labour in a growing number of tasks, employment in some occupations invariably falls. Until recently, technological change mostly automated routine production and clerical work. But machines' capabilities are expanding, as recent developments include self-driving vehicles and software that outperforms professionals in some tasks. Some recent work examines the labour market implications of such changes. But it is important to know not only the answer to the question 'will robots take my job?', but also 'what could happen to my career if robots take my job?'

Much is at stake. Occupational decline may hurt workers and their families, and may also have broader consequences for economic inequality, education, taxation and redistribution. If it exacerbates differences in outcomes between economic winners and losers, populist forces may gain further momentum.

In our research, we investigate the consequences for the career earnings and employment of individual Swedish workers of large declines in demand for their occupations, which are driven by technological change. We find that although average losses in earnings and employment for those initially working in occupations that later declined are relatively moderate (2-5 per cent of earnings and 1-2 per cent of employment), low earners lose significantly more (around 8-11 per cent of earnings).

In our analysis, we combine high-quality population-level administrative data spanning

several decades with a highly detailed occupational classification and a rich set of control variables. Using these, we regress workers' career earnings on an indicator for (large) occupational declines, controlling for potential confounders.

To learn more about the mean effect of occupational decline on workers in declining occupations, we consider how the underlying processes affect workers whose occupations do not decline. Workers in non-declining occupations are likely to gain, at least on average, through two channels: first directly, as demand increases for occupations that drive technological change; and second indirectly, as rising incomes increase demand more broadly. Overall, we expect technological change to benefit the average worker. And indeed, during the period we study, Swedish workers' incomes rose substantially – both on average and for all subgroups formed by age-by-gender-by-education cells.

In sum, our regression estimates likely provide an upper bound on the magnitude of the losses incurred by workers whose occupations decline. Across a range of specifications and robustness checks, we find that this bound is around 2-5 per cent of earnings from 1985-2013. This indicates that, at least on average, Swedish workers in declining occupations were able to avoid large income losses.

Focusing on cohorts that were in prime working age from the mid-1980s till the mid-2010s, we study how cumulative long-run outcomes (such as earnings and employment) differ for those who in 1985 worked in occupations that subsequently declined. We control for demographic characteristics and baseline income to address sorting of workers across occupations (indeed, conditional on these controls only negligible differences remain in terms of cognitive and non-cognitive skills, as well as parental education and income). In some specifications, we also control for occupation-level characteristics, including measures of occupation-varying life-cycle profiles and predictors of occupational employment growth, to address the concern that declining occupations would have delivered different outcomes in absence of occupational decline.

To measure occupational decline, we use the US Occupational Outlook Handbooks (OOH), which allow us to identify which occupations declined in the US since the mid-1980s; to check whether occupational declines had likely technology drivers; and to gauge expectations of employment growth at the time. Our baseline definition of

occupational decline requires that employment contracted by at least 25 per cent since the mid-1980s, though we also explore many alternative definitions, including declines using a range of thresholds as well as measure computed using only the Swedish data. We match the occupational information from the OOH to individual-level panel data on the entire Swedish population. Thus, we use the best aspects of both countries' data: the US data allow us to characterise occupational employment growth and control for anticipated changes in demand, while the Swedish data let us follow individuals who differ in their exposure to occupational declines but were otherwise very similar.

We confirm that both our OOH-based measure of occupational decline and the predicted changes in US employment correlate strongly with the employment changes in Sweden. Specifically, Swedish workers who started out in occupations that subsequently declined were exposed to employment growth that was 20-30 per cent lower than in non-declining occupations.

We find that relative to workers with similar characteristics in non-declining occupations, those in declining occupations lost about 5 per cent of mean cumulative pre-tax earnings and 2 per cent of mean cumulative employment. And compared to similar workers in similar occupations and industries, the cumulative earnings losses were only around 2 per cent, and the cumulative employment losses were around 1 per cent.

We also find that those in declining occupations were significantly less likely to still work in their 1985 occupation in 2013. Our evidence suggests that strong mobility across occupations mitigated the earnings losses for those who remained in declining occupations.

While mean relative earnings losses from occupational decline were around 2-5 per cent, those in the bottom tercile of their occupation's earnings distribution in 1985 suffered larger relative losses, amounting to 8-11 per cent. Those at the bottom (and possibly also the top) of their occupation's earnings distribution were also less likely to remain in their starting occupation than the median worker.

We further find that occupational decline increased the cumulative time spent in unemployment (accounting for roughly a third of lost employment) and retraining (accounting for just under ten per cent of lost employment). Moreover, occupational decline led to slightly earlier retirement among middle-aged (in 1985) workers. While

most of our analysis focuses on overall occupational decline, we also investigate variation stemming from technological replacement using three distinct methods, none of which is mechanically related to the other. We find that all three measures of technological replacement are associated with employment and earnings losses for individual workers that are broadly similar to those in our main estimates.

Conclusions

There is a vivid academic and public debate on whether we should fear the takeover of human jobs by machines. New technologies may replace not only factory and office workers but also drivers and some professional occupations. To shed light on the consequences of such changes, we study the career implications of occupational decline over almost 30 years. We show that although average losses in earnings and employment for those initially working in occupations that later declined are relatively moderate (2-5 per cent of earnings and 1-2 per cent of employment), low earners lose significantly more (around 8-11 per cent of earnings).

The losses that we find from occupational decline are smaller than those suffered by workers who experience mass layoffs. Because the occupational decline that we study took years or even decades, its costs for individual workers were likely to have been mitigated through retirements, reduced entry into declining occupations and increased job-to-job exits to other occupations. Compared with large, sudden shocks, such as plant closures, the decline may also have less pronounced effects on local economies.

While the losses we find are on average moderate, there are several reasons why future occupational decline may have adverse impacts. First, while we study unanticipated declines, the declines were nevertheless gradual. Costs may be larger for sudden shocks following, for example, rapid evolution of machine learning.

Second, the occupational decline that we study mainly affected low- and middle-skilled occupations, which require less human capital investment than those that may be affected in the future. As a result, switching occupations may be more costly.

Finally, and perhaps most importantly, our findings show that low-earning individuals are already suffering considerable (pre-tax) earnings losses, even in Sweden, where institutions are geared towards mitigating those losses and facilitating occupational

transitions. Helping these workers stay productive when they face occupational decline remains an important challenge for governments.

- *This blog post is based on Individual consequences of occupational decline.*
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