Long abstract for EPC 2020

Robot Production and Human Reproduction.
Assessing the role of changing labour markets on fertility in Europe.

Anna Matysiak [1]
anna.matysiak@oeaw.ac.at
Daniela Bellani [2]
daniela.bellani@unifi.it
Daniele Vignoli [2]
daniele.vignoli@unifi.it

[1] Vienna Institute of Demography (VID)
[2] University of Florence, Italy

Short abstract

The concern that robots will take over our jobs has intensified in the advanced economies where robot adoption in production has tripled since the mid-1990s. The effects of robot adoption on overall employment are not yet clear, but robots certainly increase disparities in labour market opportunities between the highly- and the low-to-medium skilled. They may also have consequences for fertility as they affect partners' earning opportunities and division of unpaid labour. We address this issue by linking regional level data from Eurostat (NUTS-2) on fertility and employment structures by industry with data on robot adoption by industry from International Federation of Robotics. We employ multi-level models for longitudinal data with the within-region, across-region within-country and between country decomposition to estimate robot effects net of the between-region and between –country variation. We also examine whether (and which) employment policies and gender norms alleviate the impact of automation on childbearing.

Research objective: In this study, we investigate the impact of robot adoption in production on fertility across the EU member states. We also examine whether (and which) employment policies and gender role ideologies alleviate the impact of automation on childbearing.

1. Background

The fear that machines will take our jobs has been a concern for at least two centuries (World Bank 2019). Already in the early 19th century massive protests among workers against the transition from hand to mechanised production have been recorded as the anxiety about a loss of earning opportunities has spread across the western world. In the end, however, the first industrial revolution resulted in faster economic growth, improvement of living standards and expansion of job opportunities. In the 21st century we are facing a new wave of anxiety that robots will take our jobs. Arguments are also raised why this time "it might be different" and the massive robot adoption will in the end lead to a decline in the number of jobs and massive structural unemployment (OECD 2019).

The word robot was introduced in 1921, about once century ago, to indicate those machines that can navigate through and interact with the physical world of factories, warehouses, battlefields and offices. The adoption of robots in the workplace has, however, intensified only in the last two to three decades: the stock of robots per 1000 workers has tripled since the mid-1990s in the EU-28. It is estimated that around 10% of jobs in OECD countries will be fully replaced by robots and that for further 25% of jobs around 50-70% of tasks will be automated in the next two decades (Arntz et al 2016). Other studies, conducted for Germany and the US, although with a different methodology, came up with even higher estimates (Frey and Osborne, 2017, Brzeski and Burk, 2015). While it is certain that some jobs are destroyed by robots, especially jobs involving routine tasks, automation also creates new jobs, e.g. in the IT sector, engineering and low paid services (e.g. cleaning, delivery services, repair). Its overall effects on employment are thus unclear. Studies for the US usually show negative impact of robot adoption on employment (Acemoglu and Restrepo 2019). Empirical findings for the EU-28 are more diverse. While Chiacco et al (2018) found the job destruction effect to overcome the job creation effect, the Autor and Salomons (2018) find no employment-displacing effects of robot adoption.

What is certain, however, is that robot adoption leads to an increase in income inequalities; a process which has been observed in most advanced economies over the last three decades (OECD 2017). It was demonstrated that automation leads to a decline in the so called labour share, i.e. the proportion of generated income which is paid to workers, and an increase in the capital share, i.e. the proportion of generated income paid to capital owners (OECD 2018, Autor and Salomons 2018). Furthermore, the newly created jobs in the IT sector and engineering are usually available for the highly skilled workers. The medium educated, who tend to get replaced by robots, have to compete for jobs with the low educated workers in the small service economy (OECD 2018, 2019). Such jobs like cleaning or delivery services are less routine and thus easily automatable, but they are often of lower social status, less paid and stable and often offered on a part-time basis, which forces workers to accept several fragmented work contracts in order to make ends meet (World Bank 2018).

These changes may have consequences for fertility as they clearly affect earning opportunities, increase uncertainty about the future income and lead to an increase of social deprivation of the lower skilled in comparison to the highly skilled. Automation may also influence work-family balance. The direction of these effects is unclear, however. Individuals who face better earning opportunities in the IT sector and engineering shall face better financial conditions for having children. On the other hand, such jobs may be more demanding, requiring high involvement and availability in case of a system failure, and may thus intensify tensions between paid work and family. The less skilled, on the other hand, face poorer earning opportunities and thus have fewer financial resources, which clearly poses constraints to family formation. At the same time, however, the displaced individuals, usually men, can take over the childcare responsibilities from their female partners if the latter have more stable and better paid employment opportunities. The effect of the declining job status may also play a role. While one may expect it will lower fertility of those who experience it, as they will not be able to offer good material conditions to their children, research from the US has shown that socially deprived individuals tend to have children earlier in order to improve their social status and earn a feeling of achievement if not in the public then in the private life (Edin and Kefalas 2011).

Finally, the consequences of automation on fertility can be moderated by public policies and social norms. In countries, where fathers' involvement in childcare is more accepted, men may be more inclined to accept this new role if they cannot find a new job. In such countries automation may thus have weaker impact on childbearing. Weaker impacts can be also found in countries which provide generous support for the unemployed, either financial or in form of active labour market policies (training, work counselling, etc). Employment protection legislation and union density may matter as well, although their role is unclear. On the one hand, they prevent incumbent workers from being displaced, on the other hand, however, strong employment protection legislation may jeopardise employment opportunities of young workers as it is the case in Italy or Spain (Adsera 2005, Bentolila et al 2012).

To the best of our knowledge, empirical research on the effects of automation on fertility hardly exists. The only study we were able to locate refers to the US and finds negative impact of robot adoption on union formation and marital fertility, but positive impact on non-marital fertility (Anelli et al 2019), which is very consistent with previous research on diverging destinies for this country (McLanahan 2004). In this paper, we will extend this study to Europe and will investigate how the diverse European institutional and cultural frameworks moderate the effects of labour market changes, caused by growing robot adoption, on fertility. We will also examine the effects of workers' exposure to robot adoption by gender.

2. Data

In order to address our research objectives, we make use of the Eurostat regional data at the NUTS-2 level on employment structures by industry and gender and fertility rates. NUTS-2 are defined by Eurostat as the basic regions for monitoring social cohesion and application of regional policies. The population of NUTS-2 regions ranges from less than one million up to three million inhabitants. Although country-level data are available as well, the regional approach allows us to capture the local labour market conditions, which better depict the conditions in which fertility decisions are made.

We also make use of the data of the Industrial Federation of Robotics (IFR) on robot adoption by industry. The IFR data cover more than 50 countries for a period of more than 20 years, from 1993 to 2015, for about 90% of the total industrial robots market based on yearly surveys of robot suppliers. Specifically, the IFR definition refers to manipulating industrial robots as defined by ISO 8373 – an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications. In particular, IFR (2016) lists five different types of industrial robots defined as having harms, Cartesian, SCARA, Articulated, Parallel and Cylindrical.

We select 24 European countries that report data on the total stock of industrial robots. The data of IFR are organized according to industry level, at two- or three-digits. In particular, IFR collects data on the use of robots in eight industries (according to 1 digit NACE classification), manufacturing; agriculture, forestry and fishing; mining; utilities; construction; education, research and development; and other non-manufacturing industries (e.g., services and entertainment). In manufacturing, we have consistent data on the use of robots for a more detailed set of 13 industries (at two or three-digit level): food and beverages; textiles; wood and furniture; paper; plastic and chemicals; glass and ceramics; basic metals; metal products; metal machinery; electronics; automotive; other vehicles; and other manufacturing industries (e.g. recycling).

Following the methodology proposed by Acemoglu and Restrepo (2017), we next link the Eurostat data on employment structures to IFR data on robot adoption by industry (at 2-digit level). In this way we construct measures of workers' exposure to robot adoption at work at regional-industry-year level by gender since 2000s. This measure constitutes our main explanatory variable while fertility rates (the Total Fertility Rate as well as the age-specific fertility rates) are used as our dependent variables.

Finally, we also use data from the OECD Statistics Database in order to derive time series of indicators of employment policies, such as Employment Protection Legislation (EPL), union density or expenditures on unemployment benefits and active labour market policies; all at the country level. We also construct country-level indicators of gender role ideology by combining data from European Value Study (1998, 2008, 2018) and International Social Survey Programme (1994, 2002, 2012).

3. Method

The structure of our data is hierarchical given that year-observation units are nested within regions and regions are nested within countries. Our analytical approach follows the approach by Matysiak et al (2018) who investigated the impact of the Great Recession on European fertility using regional data at NUTS-2 level. We thus estimated three-level models for longitudinal data after decomposing the variation in our explanatory covariates into within-region, between-region/within country and between country-effects. Such decomposition allows us for modelling the effects of change in workers' exposure to automation on total and age-specific fertility, net of the between-region within-country and between-country variation in workers' exposure to robot adoption. Furthermore, we are able to set the functional form of the pattern of change in the dependent variable and the parameters describing the change (intercepts and slopes) to vary across the studied units (regions and countries), which allows us to predict fertility rates at the regional and country level conditional on workers' exposure to robot adoption. This feature allows us also to assess the effects of the actual change in fertility rates due to an increase in robot adoption by comparing the predicted fertility rates from two scenarios: (1) no increase in robot adoption since 2000 and (2) actually observed changes in robot adoption. Finally, by interacting our main explanatory variable with policy indicators and indicators of social norms we can draw conclusions how the country context moderates the influence of workers' exposure to robot adoption on fertility.

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