Industry 4.0 – job-producer or employment-destroyer?

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What to expect

This comment discusses the consequences of a potential fourth industrial-digital revolution ("Industry 4.0") from a labour market perspective. In particular, we look at the development through the lens of a comprehensive macroeconomic modelling approach for Germany. Additionally, the significance for public policies is addressed.

1 Industry 4.0 and the labour market

The latest wave of technological progress, known as "Industry 4.0", has been the subject of intensive debate. After the previous industrial revolutions, this current process involves interconnecting the virtual-digital and physical world, as well as machine learning in production. This includes machines, products, information and communication systems, and humans. The objective is that the value chain can be controlled entirely by digital means or that it can control itself in a self-organized way, also beyond company borders. The result shall be a more efficient, flexible and individual production.

This goes hand in hand with discussions about the future of labour under these circumstances (compare amongst others Frey/Osborne 2013, Autor 2015). And the positions could not be more different: On the one side, fears of massive job losses if current jobs became redundant due to interconnected robots. On the other side, shiny images of huge employment and innovation gains and of stress relief for employees.

Technological progress is as old as mankind and work has not ceased to exist yet. Of course, every generation tends to see its own future as a qualitative leap rendering all hitherto existing laws and reaction patterns obsolete. On the one hand, however, this idea regularly turns out to be wrong. Why should technological progress massively reduce work just now when it has not done so over thousands of years? Yet on the other hand, this is not as easy as it seems: The change from conventional factory work in Germany starting in the 1970s, for example, has been accompanied by a strong increase in structural unemployment in particular of low-skilled workers.

2 A comprehensive macro study for Germany

This contrast illustrates one thing in particular: In order to obtain an extensive assessment of the economic effects of Industry 4.0 one must consider a multitude of effects; jobs disappearing and new jobs being created, changing requirements, more efficient processes and new products, macroeconomic interrelationships, adjustment of (labour) supply and demand, price and quantity reactions. The Institute for Employment Research (IAB), the Federal Institute for Vocational Education and Training (BIBB) and the Institute of Economic Structures Research (GWS) have now presented such a study for Germany (Wolter et al. 2015).

This study is based on the idea of using a complex macroeconomic model for a scenario analysis of Industry 4.0. It uses the Q-INFORGE model from the QuBe project, which connects comprehensive macroeconomic modelling with a labour market mapped in detail. The latter organises labour supply and demand according to industries, professions and qualifications. The functional core of this model is a matching module allowing for occupational flexibilities and generating feedback effects via wage and price reactions.

We use a baseline scenario considering technological progress to the usual extent as reference. Until 2030, the baseline projections (third wave of Qube) show an increase in labour demand only in the field of tertiary qualifications. According to the development derived from the model, the labour supply increasing significantly in line with the propensity for academic studies will not be utilised completely. Shortages occur in the medium qualification section since the supply decreases more strongly than the labour demand in particular due to demographic reasons. The field of low qualified persons shrinks slightly as a whole, however, the situation of underemployment does not relax. Shortages in the healthcare and nursing industry but also in typical production professions become more severe due to the demographic change.

Now, in this model a set of parameters should be identified and quantified, which can map the phenomenon of Industry 4.0 economically. We use a comprehensive literature analysis, interviews with company representatives and economic analyses as foundation, another representative company survey will follow. We proceeded in five scenario stages. Initially, the implementation of Industry 4.0 will require considerable investments in equipment. To this end, we consider refitting modifications as well as additional investments, which include material improvements using digital systems. Expenditures for faster internet access are included in the section of construction investments. Regarding labour and material costs, we expect a significant increase in expenses for further training and consulting. Finally, we have simulated a doubling of the digitalisation level of the production chains while considering respective expenditures for IT services.

All assumptions have been located on the expense side up to now. The idea is to determine the necessary increases in efficiency in production inputs using dynamic investment calculation to obtain a good entrepreneurial return for the implementation of Industry 4.0. Hence, the laws of economic reason hold true also facing technological revolutions. We find improvements in the cost of material rates and labour productivity of 1.2 per cent respectively within ten years as compared to the baseline scenario.

Furthermore, we consider that the technological changes will, in addition to the mechanisms endogenous in the model, affect the demand for certain professions. We concretely expect that the number of professions with a high level of routine tasks will decrease in the course of digitalisation and that of others will increase. To this end, we use the results of Dengler/Matthes (2015) based on the expert database BERUFENET of the Federal Employment Agency. The structural changes towards better paid professions lead to extra labour expenses of 0.9 per cent. In the scenario, these additionally increase work productivity in the sense of economic reason and the orientation of wages on productivity.

Lastly, we also need to consider the demand for goods. Regarding external demand, we assume a strong position of the German industry in the fields of mechanical engineering and sensor technology (as opposed to big data). In the scenario of a profound implementation of Industry 4.0, this leads to an advantage as compared to

average foreign countries, which is reflected in additional exports in parallel with foreign investment increases. We expect a moderate plus for domestic final demand, which can be substantiated with additional consumer demand due to individualisation and interconnection.

3 Outcomes of the modelling approach

The scenario shows an increasing creation of value, which, with increasing productivity and higher requirements on employees, results especially in growing wages. The employment level does not show significant changes; as a whole, Industry 4.0 is thus neither a job-producer nor an employment-destroyer. Behind that, however, there are considerable changes: In the cells consisting of 54 occupational fields and 63 economic sectors 490,000 jobs will be lost while in other areas 430,000 jobs will be newly created within ten years beyond the baseline scenario.

In particular professions in the manufacturing area decline, for instance machine- and facility-controlling and maintaining professions. There are increases in a number of occupational fields and in particular in service professions, most significantly in IT and scientific professions. In terms of qualification levels the academic field gains, the majority of losses occur in the field of vocational training. Also the demand for low-qualified work decreases.

As a whole, it can be observed that the effects of Industry 4.0 can even lead to some kind of compensation of the imbalances emerging in the baseline scenario. Shortages in the field of vocational training of the industry are softened. In contrast, additional demand is generated for the strongly increasing supply in the academic field. For an effects analysis of the labour market development we must thus also consider the country-specific development of the labour supply in addition to the changes in labour demand dominating the debate.

4 Policy consequences

However, this seemingly elegant result should not be taken as an all-clear signal. According to the results, the difficult labour market situation of low-qualified persons will even deteriorate by trend. While also positive impulses, for instance by using assistance systems, can be imagined in this area, the necessity of labour supply-side measures will increase. The macroeconomic effects of the phenomenon of Industry 4.0 entail major challenges on a political and company level. After all, major shifts and changes of workplaces are foreseeable.

Education and further education play an important role. It seems obvious to encourage strengthening digital content. But it will be equally important to impart competences such as conceptional thinking, and abstraction and communication skills in order to make effective use of the new possibilities. Due to changing and increasing

requirements, further training after initial training will become decisive to continuously further develop competences.

For each country it will prove crucial to analyse the strengths and weaknesses of its education and qualification system with regard to digitalisation. For example, Germany should combine the important and productive role of formal qualifications with flexible and coordinated acquisition of competences. Likewise, while a growing focus on university education is of obvious importance, specific German strengths lie in the area of vocational education with parallel practical and theoretical training. Thus, a proactive policy should strengthen this system in a way that develops human capital enabling employees to form the process of putting digitalisation into practice in the German industry. Along with industry 4.0, production work, knowledge work and R&D will grow together, hierarchical management recedes. Logically, there is room for new tasks and jobs into which the sector of occupations based on vocational training can grow. Indeed, a business model of implementing digitalisation based on the creation of high-quality jobs will only emerge if qualified personnel for responsible tasks are available – also to newly founded companies, which are often drivers of economic and technological progress.

Labour market policies, too, need to adjust to new developments. In particular, we must expect increased dynamics and larger requirements for reallocation while the risk for dismissals is currently at a record low in Germany. If the structural and professional change increases, consulting in the fields of further and new qualification will become essential. Other areas such as occupational health and safety, working time regulation and management, codetermination, social security and data protection will be faced with new challenges. While the scenario described here focuses on the industrial (and agricultural) sector, there are already significant effects for the service sector as well. Nevertheless, a comprehensive analysis of the effect of digitalisation on the overall economy ("Economy 4.0") is still pending. The project partners will present such a study in 2016.

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