Technology, trade, work councils and income distribution: new insights from MICROPROD*

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Summary

Ensuring prosperity and fairness is a dual challenge with major policy implications. Using various micro datasets, Work Package 5 of the MICROPROD project (https://www.microprod.eu/) made significant contributions to our understanding of the distributive implications of trade and technological change.

New research found that technological change could have been a driver of increased income inequalities in France, Italy and Spain, but trade globalisation was not. The main transmission channel of both trade and technology shocks was total factor productivity, which was increased by both shocks, and total factor productivity increased average wages. Yet after the China shock, wages did not increase as much as the total factor productive increase would have implied, indicating that the marginal impact of the China shock on wages was negative.

Low-novelty content innovation dominates innovation activities and played a major role in driving the college premium up in Hungary and Norway. This finding underlines that skill-biased technological change is not necessarily linked to generating new knowledge or high novelty products at the firm level.

Greater exposure to robot adoption is associated with increased support for nationalist and radical-right parties in 14 western European countries. Robot exposure can lead to poorer perceived economic conditions and well-being, lower satisfaction with the government and democracy, and a reduction in perceived political self-efficacy. Since a new wave of automation is on its way, electorates might further shift to radical parties in the absence of appropriate policies to address the adverse social consequences of automation.

German work councils, which are different from trade unions, increased productivity, wages and profits, even when controlling for the self-selection of high-quality personnel. These encouraging findings suggest that certain labour market institutions could result in a win-win

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situation for both workers and capital owners, thereby mitigating some adverse impacts of technological change on the labour market.

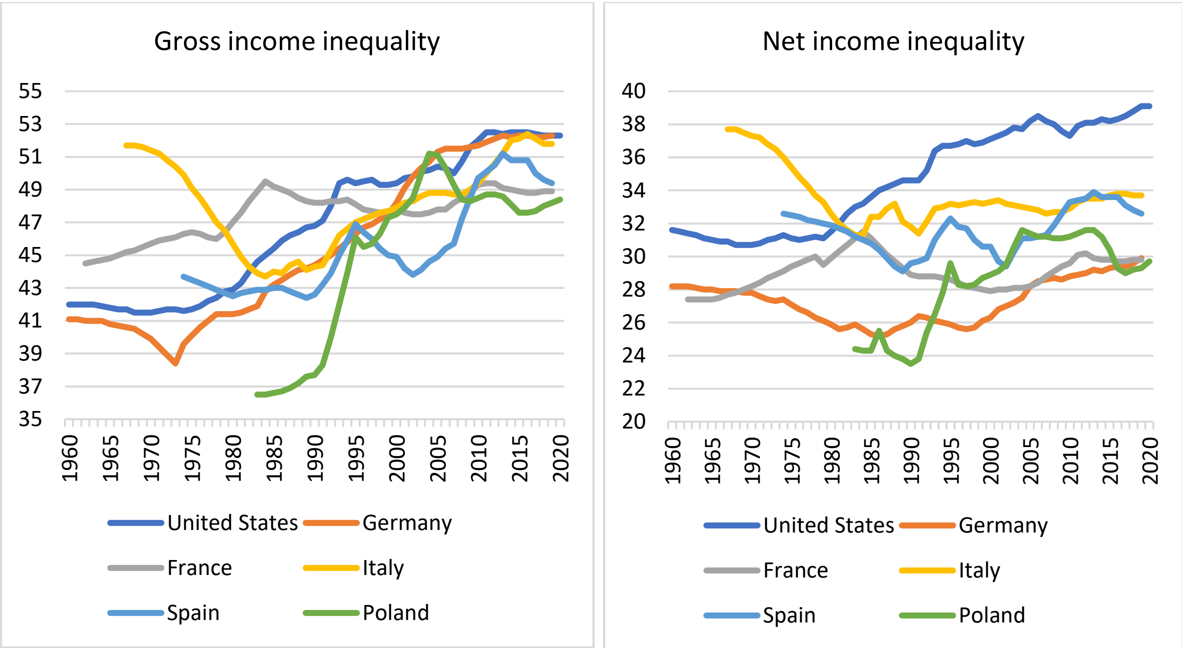
1. Introduction

There is growing recognition of the importance of fairness in the distribution of income and wealth, and the roles public policies could play to foster greater fairness. The literature has widely documented several adverse implications of income and wealth inequality. Children growing up in disadvantaged families tend to underperform compared to their classmates from richer families (Leventhal and Brooks-Gunn, 2000), while educational underachievement leads to low employability (Bynner, 2000). People with low educational levels tend to be less healthy and live shorter lives (Braveman and Gottlieb, 2014). By analysing European data, Darvas and Midões (2021) found that wealthy family background is related to better educational outcomes and higher educational attainment. They also found that the average advance in wealth due to inheritance is greater than the advance associated with obtaining a university degree (compared to primary school education only). Inequality can also result in increased support for extreme political parties, which sometimes offer seemingly easy solutions to social problems. A backlash against globalisation in certain segments of society could also grow when globalisation is seen as a driver of inequality.

The disadvantages suffered by those without rich family backgrounds, and the political implications of inequality, underscore the importance of a better understanding of the drivers of inequality in income and wealth.

Income inequality has risen in many developed countries. In 2020, gross income inequality, that is, the dispersion of income before taxes and redistribution, reached similar values in the United States, Germany and Italy, while values for Spain, France and Poland were smaller (Figure 1, Panel A). Because of larger European welfare states, there is a big difference in net (after taxes and subsidies) income inequality on the different sides of the Atlantic (Figure 1, Panel B).

Figure 1: Gini coefficient of income inequality: United States and selected EU countries



Source: Version 9.2 of the Standardized World Income Inequality Database of Solt (2020). Note: the Gini coefficient is measured on a 0-100 scale. Gross income inequality: the dispersion of income before taxes and redistribution. Net income inequality: the dispersion of income after taxes and redistribution.

Several factors could explain growing income inequality within developed countries (see, for example, Fröster and Tóth, 2015, for an excellent survey). Technological change and globalisation often feature prominently among possible causes. Technological change, by fostering capital-augmenting technical change, capital accumulation and a decline in the relative price of investment goods, could result in increased incomes of capital owners and lower employment due to automation. Technological change might also increase the wages of high-skilled workers relative to low-skilled workers if high-skilled workers are needed to operate new technologies. Globalisation can involve labour-abundant countries in the global economy, foster offshoring of production from developed to emerging and developing countries, facilitate cheap imports to developed countries and intensify competition. All these factors diminish job opportunities in developed countries, especially for low-value-added activities.

The MICROPROD project generated significant contributions to the literature on the understanding of the role of technological change and trade in driving the income distribution. Based on micro-data, these studies shed light on the differential impacts of technology and trade across firms, which have different levels of productivity. Such micro-data studies can exploit the dispersion of data across firms, in contrast to macro-data analyses, which are based on averages across firms. Faggio *et al* (2010) found that the bulk of increased wage inequality arises from variation between firms and sectors, which suggests that firm heterogeneity is crucial in analysing the developments in wage dispersion.

This policy paper summarises the key conclusions from Working Group 5 of MICROPROD, which focused on the distributional consequences of globalisation and technological progress.

2. Globalisation and trade

Globalisation is frequently seen as a key driver of inequality in developed countries. Altomonte and Coali (2020), and follow-up works by the same authors, studied this question by using labour market and inequality outcomes based on a unique firm-level dataset from France, Italy and Spain in the period from 2000 to 2017. Some of their results challenge earlier findings from the literature.

Globalisation can be measured in many ways. A major element of the globalisation process was China's integration into the global economy in the past decades. China experienced rapid economic growth averaging 10 percent per year from 1980-2011, subsequently slowing to the still high level of 7 percent per year on average from 2012-2019. Measured at purchasing power standards, China's output exceeded German output in 1994, Japanese output in 2000, and US output in 2016 to become the largest economy in the world[1]. China's accession to the World Trade Organisation in 2001 helped boost the integration of the country into global trade flows and value chains. The substantial productivity growth over the past decades resulted in lower production costs, while a push for research and technological development has gradually increased the value-added component of Chinese exports. Bernard *et al* (2006) found that greater exposure to imports from low-wage countries decreased plant survival and growth in the US manufacturing sector, while the surviving firms reduced their number of employees. These findings were subsequently confirmed for Europe (Auer *et al*, 2013).

[1] Data source: April 2022 IMF World Economic Outlook database; series: 'Gross domestic product, current prices', unit: 'Purchasing power parity; international dollars'.

Thus, it was a sensible choice by Altomonte and Coali (2020) to measure exposure to globalisation as the increase in imports from China, which they call – in line with the literature – *"China shock"*. Specifically, they used a cross-sectional indicator over a period preceding the global financial and economic crisis, 2000-2007. For each NUTS-2 (Nomenclature of Territorial Units for Statistics[2]) region, the change in real imports from China to a particular industry of a country is normalised by the total number of workers in the same industry of the country. The region-specific indicator is derived as the weighted average of the industry-specific normalised Chinese import changes, with weights corresponding to the relative share of workers in that specific industry within the region. Both the weights and the normalisation factor are taken in the 2000-2007 period to avoid possible endogeneity effects, as the analysis aims to study the impacts of the China shock in the post-global financial crisis period of 2011-2017.

The key labour market and inequality indicators studied are average labour compensation (total labour compensation divided by the number of employees – that hereafter we call 'average wages' for simplicity) and the household relative deprivation rate, which measures the discontent people feel when they compare their socio-economic status to that of other families. Both indicators are averaged at the NUTS-2 level. In addition to the deprivation rate, the authors included also the average Gini coefficient at the NUTS-2 level. The inequality variables are available from 2011-2014 while labour market outcomes cover the whole period 2011-2017

The unique MICROPROD dataset was used for the analysis, which includes firm-level data for the manufacturing industries of France, Italy and Spain between 2000 and 2017. The first challenge was setting up of the dataset, which was based on several vintages of the ORBIS/Amadeus database. A representative sample of the manufacturing industry was created with data from more than 500,000 unique firms. This dataset was merged with other data sources at a more macro level, including robotics data from the International Federation of Robotics (IFR) database, trade data from the BACI database and regional-level economic

[2] The NUTS classification is a hierarchical system for dividing up the economic territory of the European Union. See https://ec.europa.eu/eurostat/web/nuts/background. It has three levels: NUTS-1: major socio-economic regions; NUTS-2: basic regions; NUTS-3: small regions.

indicators from Eurostat and OECD databases. An extensive dataset validation process justified the dataset.

Several cross-section regressions were estimated in which alternative outcome indicators in 2011-2017 (2011-2014 for inequality) were regressed on the China shock and other determinants in 2000-2007 to avoid endogeneity problems. To further reduce the scope for possible impacts of endogeneity, in addition to ordinary least squares (OLS) estimation, instrumental variable (IV) estimations were also done. The years of the global financial crisis in 2008-2009 were excluded from the sample period because of the specificities of those years.

An important feature of the research was that it not only studied the direct impact of the China shock on inequality indicators and labour market outcomes, but also the indirect effects via average wages and total factor productivity (TFP), by estimating auxiliary regressions. Thereby, the research was able to offer a more comprehensive picture of the China shock impact.

Several interesting results emerged from the research:

- The China shock had a positive effect on total factor productivity in the medium term. This result is in line with earlier research (eg Auer *et al*, 2013).
- Average wages increased after the China shock, which is consistent with the shock's positive impact on total factor productivity.
- However, when controlling for total factor productivity, at the margin, the China shock has had a depressing effect on wages. This finding highlights the importance of studying the channels through which a shock (the China shock in this case) can influence an outcome variable (average wages in this case).
- The interaction between TFP and exposure to Chinese imports shows that among the most impacted regions, higher levels of TFP have a positive effect on wages.
- The direct impact of the China shock on the average relative deprivation is negative in preliminary regressions, that is, a higher level of the China shock is associated with a higher level of satisfaction (lower deprivation); these results hold both for the level and the growth of deprivation, and using both OLS and IV estimation.

- However, when controlling for average wages, at the margin, the China shock has a positive impact on both the deprivation rate growth and the Gini coefficient growth in the IV specification, indicating a detrimental effect on inequality.

Therefore, this research found that an increase in the trade exposure to China in France, Italy and Spain increased wages and decreased relative deprivation. But the China shock increased productivity which increases wages. Once the regressions control for average productivity and wages, the sign of the China shock parameter changes, indicating that wages have not increased as much as they should have based on productivity, while deprivation has not declined as much as it should have based on wage developments. Therefore, while the overall impact of the China shock was positive for wages and negative for deprivation, at the margin, the China shock had a depressing effect on wages and an increasing effect on inequality. Among the main channels of these developments, the increase in total factor productivity after the China shock has played a crucial role in driving up wages, since in highly exposed regions only higher levels of productivity help to smooth out the effect of the shock. The effect on inequality suggests that the trade shock effect is mediated by the existing conditions in the labour market[3].

3. Technology

Beyond globalisation, technological development, including automation and digitalisation, was another salient feature influencing productivity, wages and inequality. The parallel developments of China's integration into the world economy and technological advancements make it more difficult to disentangle the differential effects of technology and trade. Thus, Altomonte and Coali (2020) included a 'robotic shock' in their analysis, to be able to separate the impacts of technology and trade shocks. However, Autor *et al* (2015) showed

[3] In a related paper, Deng *et al* (2020) found that an increase in imports increases income risk, while an increase in exports decreases income risk. Thus, the full impact of trade globalisation on income risk depends on the developments of both imports and exports and the sensitivity of income risk to both. A higher income risk might have implications for income inequality, depending on which segment of the labour force faces higher income risk and consequently a reduction in income.

that these two transformations are quite different and can be treated separately. Altomonte and Billari (2022) followed this principle.

The two shocks are interrelated. Bloom *et al* (2016) found that in 12 European countries, higher imports from China accelerated technological change both through the adoption of new technologies and own innovations. The competitive pressure generated by the China shock boosted innovative activity within the surviving firms as measured by information technology (IT) intensity, patents and total factor productivity. The least technology-intensive companies suffered from higher exit rates, leading to increases in unemployment. The latter effect was partly counteracted by a reallocation of workers towards high-tech companies.

Some jobs are replaced by robots. The literature shows that while the first wave of automation affected manual and cognitive tasks requiring routine skills (Autor *et al*, 2001), the ongoing second wave of automation will see artificial intelligence (AI) and intelligent robots becoming more and more capable of carrying out non-routinised tasks, including high skill level jobs (Brynjolfsson and Mitchell, 2017).

For the US, Acemoglu and Restrepo (2020) found that higher levels of robot adoption depressed both wages and employment, particularly in the manufacturing sector and for workers with less than a college degree. The wage reduction was driven entirely by the lower half of the income distribution, ultimately leading to a larger wage gap and rising wage inequality.

However, Autor (2015) argued that automation not only substitutes for labour, but also complements labour and thus increases output. He stressed that the former effect tends to be overstated in public debates to the disadvantage of the latter.

For Europe, Gregory *et al* (2021) concluded that technologies can create more jobs than they destroy. They found that routine-replacing technologies destroyed 9 million jobs in Europe from 1999-2010 but created about 14-19 million jobs over the same period, resulting from lower product prices, which improve regions' terms of trade, raising their tradable output and employment. In addition, local incomes grew and there were positive demand spillovers to the non-tradable sector. Furthermore, Gregory *et al* (2021) showed that employment would have grown substantially more had firm mark-ups not increased, in line with the argument and evidence put forward by Autor *et al* (2020).

Altomonte and Coali (2020) defined the robotic shock similarly to the China shock described in the previous section: the change in the stock of robots in a particular industry of a country is normalised by the total number of workers in the same industry of the country, which is then weighted across industries. Data on country-industry level robot adoption comes from the International Federation of Robotics. The sample period for calculating the robotic shock, 2000-2007, is also identical to the sample period used for calculating the China shock.

The main conclusions of the research were:

- The robotic shock supports higher total factor productivity in the medium-term.
- Average wages increase after the robotic shock, which is consistent with the shock's positive impact on total factor productivity.
- When controlling for total factor productivity, the robotic shock appears to have a positive effect on average wages, which is different from the same impact for the China shock.
- The robotic shock also increases wage skewness when controlling for total factor productivity.
- A higher level of robot adoption increases relative deprivation and Gini coefficient growth, indicating a worsening of regional inequality.

Therefore, following the robotic shock, the authors found higher wages along with higher skewness, but also higher growth in relative deprivation rates. This evidence may suggest two fundamental features of the two shocks.

First, the China shock puts downward pressure on wages since local manufacturing in France, Italy and Spain competes with firms in China that benefit from comparative advantage in terms of labour costs and productivity. But since the China shock increases productivity, which pushes wages up, the overall impact of the China shock on wages is positive. By contrast, the increase in robot adoption is an innovative process that increases average wages, even after controlling for TFP.

Second, the mechanism through which the two shocks impact inequality is different. When controlling for wages and TFP, the China shock increases inequality, but since the China shock increases wages and TFP, the overall impact of the China shock is an inequality reduction. The robotic shock increases inequality even after controlling for wages and TFP. This result might stem from an increase in the skill premium. The literature shows that low-skilled workers are more substitutable by robots, while high-skilled workers are more complementary. Even if this process results in higher average wages, it also leads to an increase in inequality growth as there are relatively more people that feel dissatisfied when they compare their economic situations with those of their wealthier peers.

These results suggest that the mechanism underlying the effect of on inequality growth of import competition and increases in robot adoption are quite different and should be treated carefully when considering policy responses.

4. Different types of technological change

The literature on technological change often focuses on innovation to measure the generation of novel knowledge, including research and development (R&D) activities or generating patents. However, most innovation activity has a relatively low-novelty content, as highlighted by Linder and Muraközy (2020). Only between 25-35 percent of process innovator firms introduced a process that was 'new to the market', and 5-25 percent of product innovator enterprises introduced products which were 'new to the world' in Europe. Among low-novelty innovations, technological and organisational innovation can be distinguished.

Recent economic research studying the impact of technology on the labour market emphasised the role played by skill-biased technical change: the idea that technical changes shift production to technology that favours skilled over unskilled workers (see Violante, 2008, for a survey of the literature). By increasing the productivity of skilled workers, and thereby the demand for such workers, skill-biased technical change may explain rising wage inequality.

The skill premium and/or returns from schooling refer to the gain that a worker gets by investing in higher education. It is calculated as the ratio of wages of the high-skilled workers to the wages of low-skilled workers. Autor (2014) noted the dramatic rise in the skill premium in the United States and argues that this contributes substantially to the rise in income inequality. Autor (2014) attributed the sharp increase in the skill premium in the US to the decline in non-college employment in production, administrative and clerical work; the sharp rise in low-skilled labour supply and competition from the developing world; the decline in the bargaining power of labour unions; and reductions in top marginal tax rates.

Linder and Muraközy (2020) examined how different types of technological change affect wage inequality. They investigated the relationship between firm-level skill demand and different innovation activities. Skill demand is proxied by the share and wage premium of college-educated workers. Innovation activities involve the introduction of production processes, products and management methods, which are new for the firm but not necessarily for the market.

The dataset is a unique firm-level innovation survey linked to employee-employer data from Hungary and Norway. The dataset includes five repeated waves of a large-scale innovation survey, each of which covers around 5000 firms. The survey has a panel dimension as well. This allows worker-level wages to be studied and compositional changes resulting from increased skill demand due to innovation to be controlled for.

Hungary and Norway are two different countries in terms of innovation activities and labour markets (Linder and Muraközy, 2020). On average, Hungarian firms are more technology adopters, while Norwegian firms are more technology developers. Labour markets are less regulated in Hungary than in Norway. Thus, findings for these two countries with different characteristics have the potential to offer interesting insights into the effects of the different types of technological developments on the skill-premium, and ultimately on income inequality.

Linder and Muraközy (2020) first derived a theoretical model in which firms have two inputs in the production function: high skilled labour and low skilled labour. The model suggests that if wages are set in a non-competitive environment, then a negative relationship emerges between relative skill demand and relative wages at the firm level as long as there is no skill-biased technological change. They, therefore, examined both the quantity of labour and the wage response. By following the identification strategy of Caroli and Van Reenen (2001), the main results from the study were:

- Innovation is skill-biased both in Hungary and Norway: by controlling for the compositional change in the quality of the workforce after innovation, starting to innovate is associated with a 5-8 percentage point increase in the wage premium of skilled relative to unskilled workers in Hungary, and a 4-6 percentage point increase in Norway.
- Both low- and high-novelty innovations are associated with an increase in the college premium with similar magnitudes. Low-novelty innovation, given its prevalence, plays a greater role than high-novelty innovation in explaining the skill premium.
- By distinguishing between technological and organisational innovation, they found that the skill premium is mainly driven by technological innovation, while organisational innovation has only a minor, non-significant impact on skill premium.

Overall, the findings suggest that skill-biased technological change is not necessarily linked to generating new knowledge or high novelty products at the firm level. This main result is in line with theories of skill-biased technological change, which often emphasise technology diffusion and relatively low-novelty follow-up innovations as key sources of economy-wide technological change.

5. Robots and political outcomes

Income inequality might influence voting outcomes. By controlling for various voting-district specific characteristics, including age, education, race and the share of immigrants, Darvas (2016) found that high inequality and poverty boosted the 'leave' vote in the United Kingdom's June 2016 Brexit referendum, while Darvas and Efstathiou (2016) showed that in the 2016 US presidential elections, Donald Trump performed more strongly in states with higher income inequality. Both votes could be considered protest votes: perceived unfairness can lead to such results in referendums and elections.

Nationalist and radical-right parties and candidates have become increasingly successful in western European democracies over the past decades. Several papers in the literature analysed the cultural drivers of such political developments, while others focused on structural changes in the economy as possible drivers (Franzese, 2019). Anelli *et al* (2019) studied whether the increasing success of nationalist and radical-right parties is related to industrial robot adoption across regions of 14 western European countries between 1993 and 2016. Since higher robot exposure could result in increased income inequality, increased inequality and votes for extreme political parties might result from the same cause.

Data on the adoption of industrial robots at the country-industry level (from the International Federation of Robotics) was combined with regional employment data (either from Eurostat or from national sources). Historical labour market data is from the European Labour Force Survey and individual-level data is from the European Social Survey.

A key challenge was how to measure individual exposure to automation in a way that is not contaminated by the consequences of automation itself. The novel approach of Anelli *et al* (2019) calculated the vulnerability score for each individual as a weighted average of the automatability scores for each occupation, where weights are the probabilities of employment of each individual in each occupation. That is, in the first step they estimated predicted probabilities for each individual to be employed in each occupation, based on individual characteristics and on the historical composition of employment at the occupation level in the region of residence. In the second step, the individual vulnerability to automation was calculated as the product of probabilities and the automatability scores of occupations. To obtain the individual exposure to automation at the time of a given election, the vulnerability score was interacted with the pace of robot adoption in the specific country and election year. Thereby, for a given national pace of robot adoption, the measure of individual exposure assigned higher scores to individuals that would have been more likely – in the pre-sample historical labour market – to work in occupations for which automatability is higher.

The main findings of the research were:

- Higher exposure to robot adoption increases support for nationalist and radical-right parties.
- Higher robot exposure at the individual level leads to poorer perceived economic conditions and well-being, lower satisfaction with the government and democracy, and a reduction in perceived political self-efficacy.

- Structural changes in the economy, and in particular, the decline of manufacturing employment, play a significant role in the success of nationalist and radical-right parties in western Europe.

Overall, technological development, as reflected by industrial robot adoption, increased support for nationalist and radical-right parties over the last three decades and might have contributed to increased income inequalities. Since a new wave of automation is on its way, the findings suggest that electorates might further shift to the right in the absence of appropriate policies to address the adverse social consequences of automation.

6. Works councils

Labour market institutions might influence inequality between firms in terms of wages, productivity and profits. German work councils are a specific case of such labour market institutions. Work councils are establishment-level labour market institutions that grant workers in eligible plants extensive information, consultation, codetermination rights and certain veto rights, such as over individual dismissals. Work councils are different from trade unions and are not allowed to interfere with union wage bargaining or call strikes. In 2015, 42 percent of workers in west Germany worked in the 9 percent of plants that have work councils, while trade union membership amounted to 59 percent of workers in 31 percent of plants (Ellguth and Kohaut, 2016).

Work councils have the potential to raise firm productivity by generating a collective voice, reducing information asymmetries between workers and management, and fostering trust and longer-term relationships between them.

Earlier empirical research demonstrated that firms with such councils have less employee fluctuation, pay higher wages and enjoy a productivity premium (Addison *et al*, 2001; Mueller and Stegmaier 2017; Hirsch and Mueller, 2020). At the same time, high-quality personnel tend to seek high-productivity and high-wage firms (Andrews *et al*, 2012), where the prevalence of work councils is higher. Thus, a crucial question is whether work councils increase the performance of firms, or whether firms with such councils attract high-quality workers who increase the productivity of the firm.

Using data micro-level data from Germany, Mueller and Neuschäffer (2020) studied whether high-quality workers sort into work council establishments and whether the positive economic effects established in prior research remain once such sorting is taken into account. They also tested whether there is a complementarity between worker participation and worker quality in the form of excess productivity premia.

The linked-employer-employee data for Germany contains information on revenue, employment, capital stock, intermediate inputs, information on works councils and other firm characteristics, which allows observed and unobserved worker quality to be measured. Thus, the study analysed two important aspects of intangible capital: worker participation in decision making and unobservable worker quality.

The main conclusions from the research were the following:

- High-quality workers sort into works council establishments (assortative matching). However, this sorting only modestly mutes the positive link between work councils and labour productivity, wages and profits. Thus worker sorting does not invalidate the general result of positive council effects as documented in the literature.
- High-wage workers have a strong positive productivity contribution, but this is not influenced by work councils. Thus, worker quality and worker participation in work councils are not complements in performance management.
- There is a positive link between council existence and establishment profitability even after controlling for worker quality. This implies that councils can contribute to a fair sharing of productivity gains between labour and capital, thereby contributing to a stable labour share in income at the plant level.

Overall, the findings suggest that work councils have positive effects on productivity, wage and profit at the firm level. This also implies a difference between those firms that have work councils and those that do not. Since firms without work councils do not benefit from the positive effects of such councils, wage inequality could develop between the two types of firm. Another reason for wage inequality between the two types of firm is that firms with wage councils attract high-quality workers.

7. Conclusions

Ensuring prosperity and fairness is a dual challenge with major policy implications. A good understanding of the distributive implications of trade and technological change is crucial for the design of policy instruments to address possible adverse impacts. Working Package 5 of the MICROPROD project made significant contributions to this research theme by utilising various micro datasets, which allow distributional impacts across firms and workers to be studied.

There are several channels through which trade expansion and technological advances could drive income inequality higher in developed countries. However, new findings suggest that both increased imports from China and more robot adoption increased average wages in France, Italy and Spain. The main transmission channel was total factor productivity, which was increased by both shocks, and total factor productivity growth boosts average wages. However, when controlling for TFP, the marginal impact of the China shock on wages is negative, while the marginal impact of robot adoption on wages remains positive, underlining that the two shocks have different impacts. Relative deprivation growth is reduced by the China shock, but increases after a robot shock. The marginal impacts of both shocks change when the impact via average wages is filtered out, yet from a policy perspective, the overall impact is crucial. Thus, new findings demonstrate that technological change could have been a major driver of increased income inequalities in developed countries, but trade globalisation has not. Nevertheless, the different marginal impacts suggest that the China shock induced wage falls (ie wages did not increase as much as productivity increase would have implied), while the impact of the robot adoption shock is consistent with an increase in the skill premium.

Other novel research highlighted the important role of low-novelty content innovation, which accounts for at least two-thirds of all innovation activities. Estimates for Hungary and Norway, two countries at different stages of technological development and with different labour markets, reveal surprisingly similar quantitative impacts of innovation on the relative wages of high-skilled workers over low-skilled workers. Both low- and high-novelty innovations are associated with an increase in the college premium with similar magnitudes, but because of its greater prevalence, low-novelty innovation plays a greater role than high-novelty innovation in explaining the skill premium. Thus, skill-biased technological change is not necessarily linked to generating new knowledge or high-novelty products at the firm level.

Increased income inequality, or the causes of income inequality, like increased robot adoption, could have political consequences. New research found a causal relationship from greater exposure to robot adoption to increases in support for nationalist and radical-right parties. A possible reason for this finding is that greater robot exposure at the individual level leads to poorer perceived economic conditions and well-being, lower satisfaction with the government and democracy, and a reduction in perceived political self-efficacy. Since a new wave of automation is on its way, the findings suggest that electorates might further shift to radical parties in the absence of appropriate policies to address the adverse social consequences of automation.

Finally, labour market institutions might mitigate the adverse impacts of technological change on labour incomes and income inequality. For the specific case of German work councils (which are different from trade unions), new research found very positive results: such work councils increase productivity, wages and profits, results that remain significant even when controlling for the efforts of high-quality personnel to seek jobs in high-productivity and high-wage firms, where the prevalence of work councils is higher. Work councils can also contribute to a fair sharing of productivity gains between labour and capital. All these factors benefit workers, yet such benefits do not arise in firms where there are no work councils, so ultimately, work councils could increase inequality between workers at different firms. While further research should explore whether the German model of work councils could be adopted in the labour market structure of other countries, the encouraging findings on the German model suggest that certain labour market institutions could result in a win-win situation for both workers and capital owners, thereby mitigating the potentially adverse impacts of technological change on certain segments of the labour market.

References

Acemoglu, D. (2002) 'Technical change, inequality, and the labor market', *Journal of Economic Literature* 40(1): 7-72, https://doi.org/10.1257/0022051026976

Acemoglu, D. and P. Restrepo (2020) 'Robots and Jobs: Evidence from US Labor Markets', *Journal of Political Economy* 128(6): 2188-2244, https://doi.org/10.1086/705716

Addison, J.T., C. Schnabel and J. Wagner (2001) 'Works councils in Germany: their effects on establishment performance', *Oxford Economic Papers* 53(4): 659-694, https://www.jstor.org/stable/3488608

Altomonte, C. and F. Billari (2022) 'Distributional Consequences of Globalisation and Technical Progress', MICROPROD Deliverable D6.4, https://www.microprod.eu/scientific-results/publications/

Altomonte, C. and A. Coali (2020) 'Employment, Productivity and Import Shock: Evidence from the European Manufacturing Industry', MICROPROD Deliverable D5.2, https://www.microprod.eu/scientific-results/publications/

Andrews, M.J., L. Gill, T. Schank and R. Upward (2012) 'High wage workers match with high wage: Clear evidence of the effects of limited mobility bias', *Economics Letters*, 117(3): 824-827, https://doi.org/10.1016/j.econlet.2012.07.033

Anelli, M., I. Colantone and P. Stanig (2019) 'We Were The Robots: Automation and Voting Behavior in Western Europe', IZA DP No. 12485, https://www.iza.org/publications/dp/12485/we-were-the-robots-automation-and-voting-behavior-in-western-europe (MICROPROD Deliverable D5.5)

Auer, R.A., K. Degenand and A.M. Fischer (2013). 'Low-wage import competition, inflationary pressure, and industry dynamics in Europe', *European Economic Review*, 59: 141-166, https://doi.org/10.1016/j.euroecorev.2012.11.007

Autor, D.H. (2015) 'Why Are There Still So Many Jobs? The History and Future of Workplace Automation', *Journal of Economic Perspectives*, 29(3): 3-30, https://doi.org/10.1257/jep.29.3.3

Autor, D.H., D. Dorn, L.F. Katz, C. Patterson and J. Van Reenen (2020) 'The Fall of the Labor Share and the Rise of Superstar Firms', *Quarterly Journal of Economics*, 135 (2): 645-709, https://doi.org/10.1093/qje/qjaa004

Bernard, A.B, J.J. Bradford and P.K. Schott (2006) 'Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of US manufacturing plants', *Journal of International Economics*, 68(1), 219-237, https://doi.org/10.1016/j.jinteco.2005.06.002

Bloom, N., M. Draca and J. Van Reenen (2016) 'Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity', The Review of Economic Studies, 83(1): 87-117, https://doi.org/10.1093/restud/rdv039

Braveman, P. and L. Gottlieb (2014) 'The social determinants of health: it's time to consider the causes of the causes', *Public Health Reports* 129(2): 19-31, https://doi.org/10.1177/00333549141291S206

Brynjolfsson, E. and T. Mitchell (2017) 'What can machine learning do? Workforce implications', *Science* 358(6370): 1530-1534, https://doi.org/10.1126/science.aap8062

Bynner, J. (2000) *Risks and Outcomes of Social exclusion: insights from longitudinal data*, Institute of Education University of London, London, https://www.oecd.org/education/innovation-education/1855785.pdf

Caroli, E. and J. Van Reenen (2001) 'Skill-biased organizational change? Evidence from a panel of British and French establishments', *The Quarterly Journal of Economics* 116(4): 1449-1492, https://doi.org/10.1162/003355301753265624

Darvas, Z. (2016) 'Brexit vote boosts case for inclusive growth', *Bruegel Blog*, 13 July, https://www.bruegel.org/2016/07/brexit-vote-boosts-case-for-inclusive-growth/

Darvas, Z. and C. Midões (2021) *Wealth distribution and social mobility*, study prepared for Eurofound, Publications Office of the European Union, Luxembourg, https://www.bruegel.org/2021/04/wealth-distribution-and-social-mobility/

Darvas, Z. and K. Efstathiou (2016) 'Income inequality boosted Trump vote', *Bruegel Blog*, 9 November, https://www.bruegel.org/2016/11/income-inequality-boosted-trump-vote/

Deng, L., P. Krishna, M. Zeynep Senses and J. Stegmaier (2020) ‘Imports, Exports and Income Risk’, MICROPROD Deliverable D5.3, https://www.microprod.eu/scientific-results/publications/

Ellguth, P. and S. Kohaut (2016) ‘Tarifbindung und betriebliche Interessenvertretung: Ergebnisse aus dem IAB-Betriebspanel 2015’, *WSI-Mitteilungen*, 69(4): 283-291, https://www.nomos-elibrary.de/10.5771/0342-300X-2016-4/wsi-mitteilungen-jahrgang-69-2016-heft-4

Faggio, G., K. Salvanes and J. Van Reenen (2010) ‘The evolution of inequality in productivity and wages: panel data evidence’, *Industrial and Corporate Change*, 19(6): 1919-1951, https://doi.org/10.1093/icc/dtq058

Franzese, R.J. (2019) ‘The Comparative and International Political Economy of Anti-Globalization Populism’, *Oxford Research Encyclopaedia of Politics*, https://doi.org/10.1093/acrefore/9780190228637.013.638

Fröster, M.F. and I. György Tóth (2015) ‘Cross-Country Evidence of the Multiple Causes of Inequality Changes in the OECD Area’, in A.B. Atkinson and F. Bourguignon (eds) *Handbook of Income Distribution*, Volume 2B: 1729-1843, http://dx.doi.org/10.1016/B978-0-444-59429-7.00020-0

Gregory, T., A. Salomons and U. Zierahn (2021) ’Racing With or Against the Machine? Evidence on the Role of Trade in Europe’, *Journal of the European Economic Association*, https://doi.org/10.1093/jeea/jvab040

Hirsch, B. and S. Mueller (2020) ’Firm Wage Premia, Industrial Relations, and Rent Sharing in Germany’, *Industrial and Labor Relations Review* 73(5): 1119-1146, https://doi.org/10.1177/0019793920917105

Leventhal, T. and J. Brooks-Gunn (2000) ‘The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes’, *Psychological Bulletin* 126(2): 309-337, https://doi.org/10.1037/0033-2909.126.2.309

Linder, A. and B. Muraközy (2020) 'Technological Change and Skill Demand in Non-Competitive Labor Markets', MICROPROD Deliverable D5.4, https://www.microprod.eu/scientific-results/publications/

Mueller, S. and J. Stegmaier (2017) 'The dynamic effects of works councils on labour productivity: First evidence from panel data', *British Journal of Industrial Relations*, 55(2): 372-395, https://doi.org/10.1111/bjir.12200

Mueller, S. and G. Neuschäffer (2020) 'Worker participation in decision-making, worker sorting, and firm performance', *IWH Discussion Papers*, No. 11/2020, Leibniz-Institut für Wirtschaftsforschung Halle (IWH), https://nbn-resolving.de/urn:nbn:de:101:1-2020071511000371234439 (MICROPROD Deliverable D5.1)

Solt, F. (2020) 'Measuring Income Inequality Across Countries and Over Time: The Standardized World Income Inequality Database', *Social Science Quarterly* 101(3): 1183-1199, SWIID Version 9.2, December 2021, https://doi.org/10.1111/ssqu.12795

Violante, G.L. (2008) 'Skill-biased technical change', in S.N. Durlauf and L.E. Blume (eds) *The New Palgrave Dictionary of Economics*, Second Edition, Palgrave Macmillan, https://doi.org/10.1057/978-1-349-95121-5_2388-1