

Trade, value chains and labor markets in advanced economies*

By Marc Bacchetta (WTO) and Victor Stolzenburg (WTO)

ABSTRACT

Trade is a major source of employment. Nevertheless, trade has recently been caught in the crossfire in discussions around the decline of manufacturing employment and the polarization of labor markets in advanced economies. In this chapter we examine what the academic literature has to say on the relationship between trade and labor markets, with a specific focus on studies with a value chain perspective. We find that trade has only modest effects on aggregate employment and is unlikely to have been a major contributor to the decline of manufacturing. However, the effects

vary considerably across regions and individuals with different skill levels. This implies that policy has a central role to play in making sure that the gains from trade are shared evenly. Our findings highlight that a value chain perspective is important for assessing the impact of trade on labor markets. The emergence of value chains has strengthened linkages between sectors, magnified trade's impact on skill demand and requires novel trade statistics. Ignoring this leads to a biased view of trade and overestimates its role in the decline of manufacturing employment.

- Factoring in GVCs when studying the impact of trade on labor markets reveals that trade has not been a significant contributor to declines in manufacturing jobs in advanced economies, and that job gains in services have offset job losses in manufacturing.
- However, the effects of trade can vary considerably across regions and individuals with different skill levels, compounding regional disparities and labor market polarization driven by other factors such as automation.
- Adjustment policies should not differentiate between the various reasons for worker displacement, such as automation or trade, and should be less dependent on affected workers fulfilling certain conditions.

* We would like to thank Klaus Michael Keller for excellent research assistance and inputs to this chapter. We further would like to thank Michael Ferrantino, Bill Shaw and participants at the second conference for the GVC Development Report 2019 for helpful comments and suggestions.

1. Introduction

Trade is a major source of employment in advanced economies. Estimates suggest that exports supported 12 million jobs in 2014 in the United States alone.¹ The importance of exports for employment becomes even more apparent when expressed in terms of shares. Figure 2.1 shows that exports may account for almost 50% of jobs in Ireland and around 30% of jobs in Germany. Similarly, imports can contribute to employment. By reducing the costs of production, they can lead to higher demand which can translate into more jobs.² In addition, jobs supported by imports or exports pay a significant premium when compared to jobs supported by domestic demand. Martins and Opromolla (2011) find that average wages are up to 30% higher in exporting and importing plants compared to non-trading plants.

Despite this positive role, trade has recently been caught in the crossfire in the discussion around the decline of manufacturing employment in advanced economies. In fact, foreign competition has been blamed for job and income losses for many decades. In particular the rise of new economic powerhouses has traditionally caused popular backlashes against liberal trade regimes in incumbent countries leading to policies that increase barriers to imports. Examples reach from the British Merchandise Marks Act of 1887 targeted at German imports to Japan's 1981 voluntary export restraints. Today, import competition from emerging markets and formerly planned Eastern European economies has been mentioned among the main factors behind the labor market adjustments that have taken place over the last decades. A series of recent empirical studies find that trade liberalization episodes have had a detrimental impact on labor market outcomes.

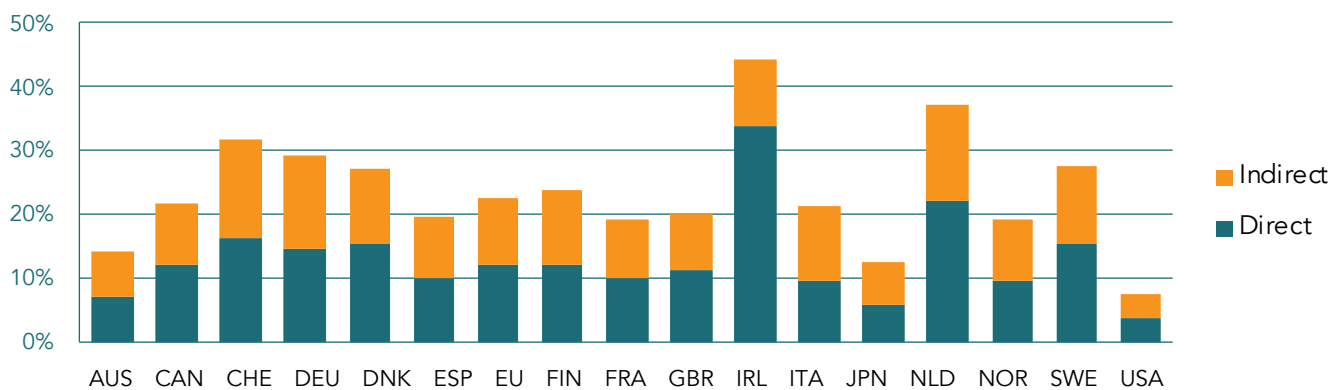
A prominent role in this regard has been given to China's WTO accession in 2001 (Autor *et al.*, 2013; Pierce and Schott, 2016), the conclusion of NAFTA in 1994 (Hakobyan and McLaren, 2016), and the EU enlargement in 2004 (Braakmann and Vogel, 2011).

Since the results of these studies are contrary to the common view among economists that trade has only minor employment impacts,³ several literature surveys have recently re-examined the role of international trade for labor market outcomes to reach a conclusive and comprehensive assessment of trade's impact on employment and wages.⁴ This chapter summarizes the findings of these surveys but, crucially, also sheds light on a topic that has not received sufficient attention in recent articles: the impact of the expansion of value chains on the relationship between trade and labor markets.

As discussed in the first chapter of this report and its 2017 predecessor, the rise of domestic and international production fragmentation has proceeded rapidly in recent decades. Firms have unbundled their factories and outsourced production stages across the globe. This has major implications for the interactions between trade and labor markets, and it is important to examine them separately from the wider trade and labor market discussion to fully understand their effects. Three main consequences of value chains can be highlighted.

Firstly, the impact of import competition on labor markets is not limited to import-competing industries anymore. Instead, downstream customers and upstream suppliers are affected much more than in a non-fragmented economy. Therefore, trade shocks propagate more widely through the economy than in the past. For instance, when an industry contracts due to foreign competition this will hurt its upstream supplier industries and the suppliers' suppliers since they will face lower demand.

FIGURE 2.1 Domestic employment supported by exports



Notes: Authors' calculations based on 2014 data from the World Input Output Database (WIOD). For the methodology please refer to Cali *et al.* (2016). Direct refers to employment supported in exporting establishments using the share of exports in total output of these establishments. Indirect refers to employment supported in establishments that supply exporters and depend on foreign demand via these supply linkages. In many countries more than half of the jobs supported by exports are due to indirect value chain linkages.

Downstream customers, on the other hand, could benefit from cheaper inputs that foreign competition implies. As a result, it is necessary to take into account input-output linkages between industries as well as the position of industries in the value chain when analyzing the effect of trade on labor markets. This becomes strikingly clear when looking at Figure 2.1. It shows that in several advanced economies more than half of the jobs supported by exports are not within exporting establishments but within supplier establishments.

Secondly, the expansion of value chains entails not only sectors that compete across countries but also tasks and stages. This means that competition happens at a much finer level with severe consequences for skill demand within countries. The production of many goods takes place in various stages that require different levels of skills. Value chains allow unbundling these stages spatially so that countries well-endowed in skilled (unskilled) labor can specialize in skilled (unskilled)-intensive stages. This shifts aggregate skill demand much more than traditional trade, which required all stages with their different intensities to be performed domestically, and might lead to an increased polarization of the labor market.

Thirdly, value chains imply that traditional gross trade statistics are insufficient to properly assess the impact of trade on labor markets because they mis-measure the scale and scope of import competition. For example, when firms offshore assembly stages but keep upstream stages domestic, gross import statistics heavily overstate import competition because they suggest that the complete value chain was offshored. Even if all stages are offshored, gross import statistics tend to falsely assign competition to downstream industries because they suggest that the full value of an imported good has been created by the downstream exporting industry when in fact much of the value is supplied by foreign upstream industries. This causes competition to be overstated downstream but understated upstream.

Due to these three changes, a comprehensive overview of the impact of trade on labor markets requires a value chain perspective. Moreover, a value chain perspective is not only relevant to correctly assess whether trade boosts employment and wages or not, but it also changes subsequent policy recommendations. For example, when trade shocks spread more widely within economies and when competition moves to ever finer degrees, it becomes increasingly difficult to target individuals hurt by trade.

This chapter discusses the three changes and their implications for the relationship between trade and labor markets and for adjustment policies along four major debates surrounding labor markets in advanced economies. The four debates concern the role of trade in:

- the decline of manufacturing employment,
- nation-wide employment trends,
- the rise in regional inequality, and
- the increase in labor market polarization.

In each case, the discussion starts with a summary of the results of studies that do not take value chains into account and then highlights the additional insights that value chain studies can add.

The chapter shows that trade is likely to raise aggregate employment and real wages and that taking a value chain perspective is important. In particular, cost savings due to cheap imports and export opportunities create employment in many sectors of the economy that do not trade directly but benefit from trade through input-output linkages. Even when the focus is on the manufacturing sector, the evidence paints a more benign picture of trade which contrasts with popular perception. Once the rise of value chains is properly accounted for, it suggests that trade has contributed at best a relatively small share to the decline of manufacturing employment in advanced economies.

Trade has, however, contributed to regional and individual disparities. Since industries tend to cluster regionally, studies show that the impact of trade is very heterogeneous across geographic areas. While trade benefits labor markets in regions with exporting industries and industries that rely on imported inputs, it might hurt regions that compete directly with foreign producers. Therefore, it leads to a spatial divergence in economic activity. Similarly, trade is shown to increase the demand for skills and, thus, has uneven effects across individuals, a trend that has been aggravated by the rise of value chains. This is where policy intervention has the potential to play an important role. The right interventions can spread the gains from trade more evenly and guarantee that regions and individuals are not hurt by globalization.

The chapter proceeds as follows. Section 2 discusses the role of trade in the decline of manufacturing employment. Section 3 assesses how trade affects aggregate nationwide labor market outcomes. Section 4 examines the impact of trade on regional inequality. Section 5 analyses the impact on skill demand and the polarization of the labor market. Section 6 proposes potential policy responses. Section 7 concludes.

2. Trade, GVCs, and the decline of manufacturing employment

One of the most contested issues in the trade and labor market debate is whether and by how much imports have contributed to the decline of manufacturing employment in advanced economies vis-à-vis alternative factors such as technology-driven productivity improvements or changes in preferences towards services. Across all high-income economies the share of manufacturing employment in total employment has been steadily declining for decades which has attracted considerable attention, potentially due to the fact the manufacturing jobs pay a premium even after controlling for a variety of worker characteristics (Langdon and Lehrman, 2012). In the public debate, trade has been and continues to be listed as a prime culprit behind job losses in the manufacturing sector.

Economic studies from the 1990s and early 2000s show in this regard that after a trade shock, employment in import-competing industries suffers relative to employment in export-oriented sectors (e.g. Revenga, 1992). More recent studies focusing on the effects of rising Chinese import competition on US labor markets

find similar results and have sparked a heated debate around the role of trade in explaining the loss of manufacturing jobs. US manufacturing employment was stable around 18 million workers between 1965 and 2000 before falling by 18 percent between 2001 and 2007. Estimates of the share of this loss of jobs due to trade based on “back-of-the-envelope” calculations in popular media outlets, blogs and policy briefs range between 1 and 20 per cent (De Long, 2017; Krugman, 2016b; Hicks and Devaraj, 2015) with one author going as far as to claim that the growing manufacturing trade deficit of the United States can explain almost all of the manufacturing jobs lost in the period between 2000 and 2007 (Scott, 2015).

More rigorous economic analyses support the claim that trade has played a limited role, explaining at the very most one quarter of the recent decline. Seminal work in this area by Autor *et al.* (2013), who examine the increase in Chinese import competition by comparing more and less exposed local labor markets in the United States, finds that it can explain around 25 per cent of the manufacturing decline. Studies based on this work show that similar but less pronounced trends can be observed in several European countries (Donoso *et al.*, 2015; Balsvik *et al.*, 2015; Malgouyres, 2017). There is also evidence of large productivity gains in advanced economies from trading with China, however with substantial job losses in exposed industries (Ahn and Duval, 2017). Another study shows that detrimental effects on employment in manufacturing in the United States arose because of the elimination of tariff uncertainty rather than tariff reduction after China’s WTO entry (Pierce and Schott, 2016).

One explanation could be that advanced economies react to increased import-competition in manufactured goods by specializing in the tradable services sector, such as business services, R&D, design or financial services, in which they typically have a comparative advantage (Spence and Hlatshwayo, 2012). The trade-induced shift from a manufacturing- to services-based economy is however not found to happen smoothly at the micro-level. Indeed, considering the movements of workers between sectors in Germany, there is little evidence that the increasing employment in service industries comes from incumbent manufacturing workers who directly switch jobs without undergoing an unemployment spell. Instead, the rise of services is found to be driven by young labor market entrants who exhibit different sectoral entry behaviours than previous generations, and by returnees out of non-employment who take up jobs in different industries than their previous one (Dauth *et al.*, 2018).

However, many factors other than trade have been boosting the non-tradeable sector in advanced economies over time. For instance, changing demand patterns caused by demographic change and increased incomes favour services over manufacturing. Moreover, Bernard and Fort (2017) suggest that part of the manufacturing decline is due to a statistical misconception, because some firms are counted as wholesalers despite their involvement in the production of goods, with Apple Inc. serving as a prime example. By re-classifying these firms as manufacturers, up to two million jobs in the US can be shown to have switched from services to manufacturing in 2007. Even more

remarkable is that half of the decline of manufacturing employment in Denmark between 1994 and 2007 is due to firms switching their sectoral affiliation from manufacturing to services which implies that no actual job loss has taken place in these instances (Bernard *et al.*, 2017).

Importantly, trade implies not just import competition but also export opportunities and cheaper inputs. According to recent work, the global export expansion of US manufacturing products, which was supported by cheap Chinese inputs into US production, almost completely offset job losses due to import competition from China (Feenstra *et al.*, 2017). In Germany, new export opportunities in Central Eastern Europe have even slowed down the decline of manufacturing employment despite rising import competition (Dauth *et al.*, 2018). In addition, Chinese imports and offshoring have reduced prices in the US considerably (Amiti *et al.*, 2017; Handley and Limao, 2018). This is likely to lead to significant cost savings for firms and higher consumer spending. Evidence shows that these cost reductions enabled import-competing US manufacturing firms to shift resources to industries in which they enjoy a comparative advantage relative to China. This has led, in turn, to an increase in overall manufacturing employment and wages among these firms (Magyari, 2017). Cost savings have also enabled offshoring firms to expand onshore employment, leading to overall employment gains in offshoring industries (Kovak *et al.*, 2017). According to recent evidence, higher consumer spending in addition with other indirect effects, such as the between-region elasticity of labor supply, can even fully cancel out manufacturing employment losses due to Chinese import competition (Adao *et al.*, 2019).

Another important issue brings us finally to the importance of a value chain perspective in the analysis. Value chains have spread considerably over the last decades both domestically and internationally. The average share of in-house production in total output decreased by 8% from 1995 to 2011, indicating an on-going fragmentation process.⁵ This spatial unbundling of production has profound implications for the impact of trade on labor market outcomes. Ignoring these implications can lead to severe mismeasurement of the impact of trade shocks on employment and wages.

The foremost reason why it is important to take value chains into account when assessing the impact of trade on labor market outcomes is that the spread of value chains within and across countries has strengthened inter- and intra-industry linkages considerably over the last decades. These linkages imply that trade shocks propagate through the economy much more than in a vertically integrated world. Evidence from Belgium shows for instance that while only 7.3% of Belgian firms export, 42.4% supply exporters directly or indirectly and are thus dependent on foreign demand (Dhyne and Rubinova, 2016). Even more strikingly, 97% of all Belgian firms are dependent on foreign inputs even though only 15% import directly (Tintelnot *et al.*, 2017). As a result, looking only at exporting and import-competing firms or industries when examining the trade and labor market relationship means missing a major part of the picture.

In this context, researchers have revisited the seminal work by Autor *et al.* (2013) that examines the effect of Chinese import competition on labor market outcomes in US commuting zones. In contrast to the original study, the new work considers as exposed not only industries that produce the products that the US imports from China but also these industries' upstream supplier and downstream customer industries (Wang *et al.*, 2018). It thus takes a value chain perspective. The hypothesis is that supplier industries are hurt by import competition when their customers contract because the demand for their products decreases. Customer industries, on the other hand, might benefit from import competition affecting their suppliers since they can reduce their costs by switching from domestic to cheaper foreign suppliers, which can raise demand for their products and subsequently employment. This would be in line with recent findings showing that firms that source more inputs from abroad expand production and increase domestic sourcing as well (Antràs *et al.*, 2017).

Extending the definition of import exposure in this value chain consistent manner attenuates the findings by Autor *et al.* (2013) for manufacturing employment. Wang *et al.* (2018) find that commuting zones more exposed to Chinese imports fare only slightly worse in terms of manufacturing employment and real wage growth than less exposed regions. This is mainly due to employment creation in downstream industries that expand, potentially due to cheaper inputs. Directly exposed industries

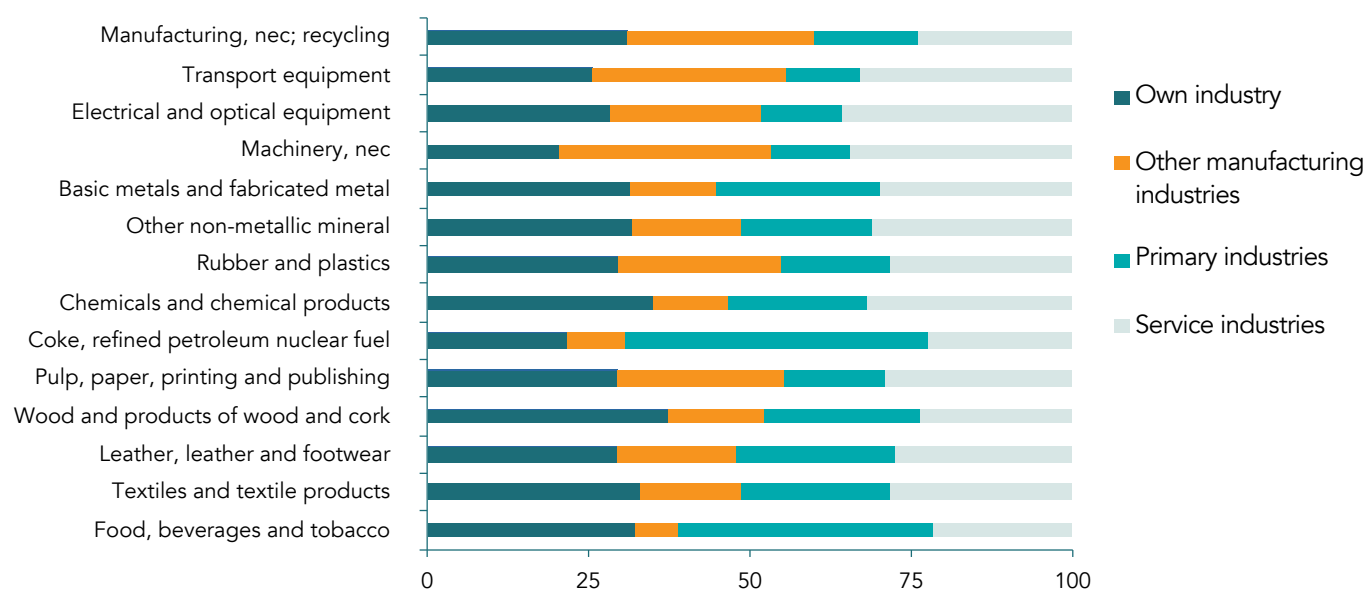
and upstream industries face relative employment and wage losses. These combined losses are however balanced out by the downstream gains, leading to a small negative impact of imports on manufacturing.

Other studies have performed similar exercises with different methodologies that take input-output linkages into account but have failed to observe positive effects on downstream industries of the same magnitude (Acemoglu *et al.*, 2016; Caliendo *et al.*, 2018). They nevertheless suggest that the contribution of Chinese import competition to the decline of US manufacturing from 2000 to 2007 is about one third smaller than the corresponding value by Autor *et al.* (2013) who do not have a value chain perspective. The difference regarding the magnitude of downstream effects is likely due to an improper measure of downstream and upstream exposure in the latter studies.^{6,7}

The difference in results across these studies raises a second important point. In the age of GVCs, gross trade statistics can be misleading because they ignore complex cross-border production linkages which are better accounted for by trade in value added statistics as highlighted by chapter 1 of this report. In particular, recent research highlights that by relying on gross trade data many studies on Chinese import competition ignore the high amount of US value added in Chinese exports to the US, the high services and primary sector content in manufacturing exports, as well as double counting due to back-and-forth trade.⁸ Figure 2.2 illustrates this point by showing that the

FIGURE 2.2 Value added sources of Chinese manufacturing exports

(% share of exports)



Notes: Author's calculations based on ADB-WIOD data for 2015. The chart highlights that the majority of value added in an industry's manufacturing exports is sourced from other industries, in many cases outside of manufacturing.

majority of value added in manufacturing exports is not added in the exporting industry but in upstream industries, including services. These three factors limit import competition exposure of manufacturing industries considerably. When using the more appropriate value-added trade statistics, the effect of Chinese import competition is reduced by about one third (Jakubik and Stolzenburg, 2018).

In sum, once exports, input-output linkages, and value-added trade statistics are accounted for, trade seems to have contributed to the recent decline in manufacturing employment in advanced economies only to a very small degree, if at all. In fact, trade even slowed the decline down in some countries, such as Germany. Separate from this, and potentially more important, is the question of how trade has affected the overall number of jobs across all sectors. After all, manufacturing is only responsible for a minor share of overall employment in most advanced economies. This question is discussed in the next section.

3. Trade, GVCs, and nation-wide labor market outcomes

As said above, other sectors than manufacturing make up for most of employment in advanced economies, in particular the services sector. Since more and more services become tradable or linked to foreign competition and demand through input-output linkages, aggregate labor market effects of trade have become increasingly distinct from its effect on manufacturing. This further highlights the importance of a value chain perspective for assessments of the trade and labor market relationship.

Theories of international trade typically suggest that trade should not have a major effect on the aggregate level of employment. They tend to predict that trade has second order effects by shifting resources across firms and sectors, which can affect aggregate employment if labor market frictions are sector or firm-specific (Helpman and Itskhoki, 2010; Davis and Harrigan, 2011; Carrère et al., 2015). They stress however that the dominant determinant of unemployment is country-, sector- and firm-specific labor market institutions.

Descriptive statistics are broadly in line with what economic theory predicts. In contrast to a relatively widespread perception in developed countries, trends in aggregate labor market outcomes, such as labor force participation, employment-to-population ratios, the unemployment rate or real wages have not shown dramatic changes since the early 1990s, other than those related to the Great Recession (World Trade Organization (WTO), 2017). There is no increasing trend in unemployment or decreasing trend in labor force participation that is common to developed countries and could potentially be related to globalization or more specifically to the expansion of North-South trade. What can be observed however, are differences in the levels of employment indicators across countries, which suggests that country-specific factors play an important role in explaining labor market outcomes.

Of course, theory can be based on false assumptions and descriptive statistics can be misleading. Therefore, it is important to examine the empirical literature to see if it confirms the predictions. Different methodologies have been applied to assess the relationship between trade and aggregate employment, and all are broadly in line with theory and simple correlations. For instance, cross-country econometric studies that estimate the effect of changes in trade policy or trade openness on changes in employment find that trade shocks reduce unemployment modestly. A 1 per cent decrease in tariffs is estimated to lower unemployment by about 0.35 per cent, while a 10 percentage point increase in trade openness is found to reduce aggregate unemployment by about three-quarters of a percentage point (Dutt et al., 2009; Felbermayr et al., 2011). Using novel value-added trade statistics, one study finds that the 2004 EU Enlargement led to employment gains of up to 0.11% in EU15 countries (Kaplan et al., 2018).

Similarly, an input-output analysis of trade-induced labor demand changes finds that trade added close to one million jobs to the US economy from 1995 to 2011, mostly due to an increase in services exports (Feenstra and Sasahara, 2017). An important feature of the study for the purposes of this chapter is that it highlights how important input-output linkages are for the outcome. For instance, it shows that exports generated 4.1 million additional jobs in services sectors, of which about 1.4 million were not due to services exports but rather to services embedded in manufacturing exports through cross-sector value chain linkages.

Other studies have estimated the effect of trade on aggregate employment by simulating the effects of trade flow or policy changes in structural models of trade. Applications of this approach lead to remarkably similar conclusions. For example, an analysis of the rise of Chinese import competition suggests that the US has experienced aggregate employment gains due to the expansion of services industries that benefit from cheap imported inputs (Adao et al., 2019; Caliendo et al., 2018). A related study on NAFTA emphasizes the relevance of taking input-output linkages into account in this approach by showing that in their absence some effects are underestimated by 50% (Caliendo and Parro, 2015).

One study with a similar approach finds that a return to most-favored-nation (MFN) tariffs between Britain and the EU-27 would lead to significant job losses in both Britain and the EU27. The same model predicts that a potential EU-US trade agreement, which would eliminate all import tariffs and reduce non-tariff barriers, would create about 0.35 million jobs in the US and over 1 million jobs in the EU. It then highlights that between 60% and 72% of the employment effects of these policy shocks would be due to indirect effects caused by value chain linkages rather than due to direct effects (Vandenbussche et al., 2017; Vandenbussche et al., 2018).⁹ An advantage of these two studies is that they rely on value added trade data and, therefore, avoid the pitfalls of gross trade data pointed out by Jakubik and Stolzenburg (2018).

National effects could also be inferred from intra-country studies. A study exploiting differences in exposure of US commuting zones to Chinese import competition finds that labor markets in more exposed regions perform better than less exposed labor markets as negative effects of trade on manufacturing employment are more than offset by trade-induced gains in services employment (Wang *et al.*, 2018). If less exposed labor markets incur only minimal employment and wage changes due to trade, then the effects of trade on labor market outcomes at the national level should be positive. Consequently, this approach further confirms the finding that trade leads to moderate but positive changes in labor market outcomes. Interestingly, the study also highlights, similar to Feenstra and Sasahara (2017) and Caliendo *et al.* (2018), that local job gains in services industries that benefit from cheap Chinese manufacturing inputs are of paramount importance for this finding.

Given the relative unanimity in the findings of studies that apply a large variety of methods, it is safe to conclude that trade has a small but positive effect on aggregate labor market outcomes in advanced economies. Due to the changing industrial structure of advanced economies, these gains mainly accrue in the services sector where many high-income countries have a comparative advantage. Once again, assessing the question from a value chain perspective has a major impact on the results and is central to the conclusion.

4. Trade, GVCs, and regional divergence

The finding that trade leads to small positive labor market outcomes at the aggregate level could conceal substantial heterogeneity in effects at the regional level. Since trade shifts resources across sectors and firms and since the distribution of sectors and firms across regions is not uniform, trade shocks should affect regions differently depending on their industrial structure. Indeed, the same research that was discussed for the debate on the decline in manufacturing shows that the effects of trade on labor markets vary considerably by region.

Initial work found that in the absence of accounting for input-output linkages, rising imports lead to higher unemployment, lower labor force participation, and reduced wages in US local labor markets that are more exposed to Chinese imports relative to less exposed labor markets. This applies to directly exposed manufacturing workers, and in terms of wage losses also to workers in non-tradable services industries whose output suffers from lower regional demand (Autor *et al.*, 2013). Moreover, workers in exposed local labor markets appear to be reallocated to non-exposed industries and therefore experience greater job churning and reduced lifetime income as a consequence of increased imports from China (Autor *et al.*, 2016; Asquith *et al.*, 2017). These results are also corroborated by studies that look at other advanced economies, including France, Germany, Norway and Spain (Autor *et al.*, 2016; Malgouyres, 2017; Dauth *et al.*, 2014).

However, as was the case with manufacturing employment, once the effects of export expansion, cheaper inputs, and value chain linkages are added to the equation, the picture changes. Regions home to offshoring firms have benefitted from local employment gains due to employment expansion in offshoring firms and positive spill-over effects (Kovak *et al.*, 2017). Moreover, the effect of import competition shocks can be attenuated at the regional level if job losses in some sectors or firms are compensated by job creation in other sectors or firms in the same commuting zone. Trade opening often means both opening of the domestic market and improved access to export markets at the same time, and firms that gain access to foreign markets raise their exports and generate new jobs. One study concludes that since many import-competing regions in the US also export or benefit from cheaper inputs, the effects basically balance out and exposed and unexposed local labor markets follow a similar trend (Feenstra *et al.*, 2017). Industrial diversification is therefore a key aspect for a fast and smooth regional adjustment to trade. Evidence from Germany shows that when regions are too concentrated, trade can widen regional disparities despite its positive aggregate effect (Yi *et al.*, 2017).

As with exports, analyses of input-output linkages can uncover positive effects of import competition by illustrating how industries might benefit from cheaper inputs. The advantage of analysis at the regional level compared to the within-manufacturing level is that one can capture a wider set of industries that benefit from cheaper inputs. After all, many services industries rely on manufacturing inputs as well. One study finds in this regard that Chinese imports raised US employment in the construction industry alone by 50,000 workers (Caliendo *et al.*, 2018). More generally, the inclusion of the services sector in the analysis made possible by comparing regions is important because manufacturing represents only a small share of employment. According to data from the Federal Reserve Bank of St. Louis, manufacturing accounted for only 20% of employment in Germany and 10% in the US in 2012. In contrast, industries that use manufacturing imports as inputs cover almost the entirety of employment. This observation is highlighted in Figure 2.3 which shows by how much industries are exposed to manufacturing import competition, differentiated into three different forms of exposure. The figure shows that while direct import competition is limited mainly to manufacturing, downstream exposure is prevalent in all sectors. This can explain why downstream employment creation can more than offset employment losses in upstream and directly exposed industries within the same local labor market, as shown by Wang *et al.* (2018).¹⁰

Finally, using value added data can show a very different picture of the geography of trade shocks than that indicated by analysis based on gross trade flows as Figure 2.4 shows. Locations specialized in downstream industries, in particular electrical machinery and electronic equipment, are much less exposed to import competition than what gross imports would suggest. On the other hand, the opposite holds for certain locations specialized in upstream manufacturing, including steel. Two extreme cases in this regard are San Jose, California, home to Silicon

FIGURE 2.3 The different forms of import exposure

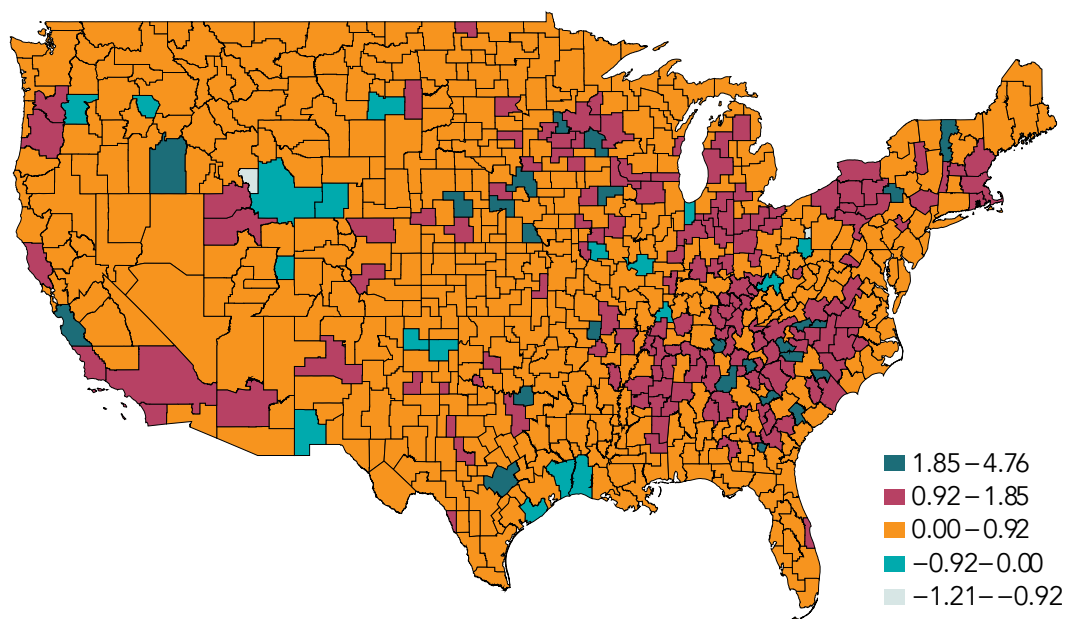


Notes: Taken from Wang *et al.* (2018). Horizontal units indicate annualized percentage changes in exposure to imports from China from 2000 to 2007. The graph shows that downstream import exposure, i.e. exposure stemming from the use of imported inputs, is much larger in scale and scope than upstream and direct exposure.

Valley and many of the US' main electronic equipment manufacturers, and North-West Indiana, home to the largest steel mill in the US and large aluminium producers. In these commuting zones, import competition in value added terms is more than a standard deviation different from gross import exposure (Jakubik and Stolzenburg, 2018). US regions specialized in consumer electronic production are clearly less exposed to import competition when it is measured in value added terms than what gross trade statistics would suggest, since high-tech imports contain both a high amount of US upstream content and inputs from other industries. On the other hand, gross trade statistics miss that upstream steel producers suffer when goods are imported that

use foreign steel as an input because it implies lower demand for domestic steel.

To sum up, the effects of trade can differ markedly by region. Areas that benefit from export expansion or cheaper inputs experience wage and employment growth while areas that compete with imports or have no access to foreign markets might fall behind. This creates considerable inequalities between regions, especially when regions are not sufficiently diversified. Although the general equilibrium effects of trade for aggregate employment are found to be positive, this highlights the need for policy intervention to facilitate adjustment in areas most affected by import competition.

FIGURE 2.4 Difference in import exposure between gross trade and value added trade

Notes: Taken from Jakubik and Stolzenburg (2018). The colour scale differentiates between below and above one standard deviation of gross trade based exposure differences. The units are in USD 1000 per worker. The graph shows that a value added import based exposure measure differs in some regions sharply from a gross trade one.

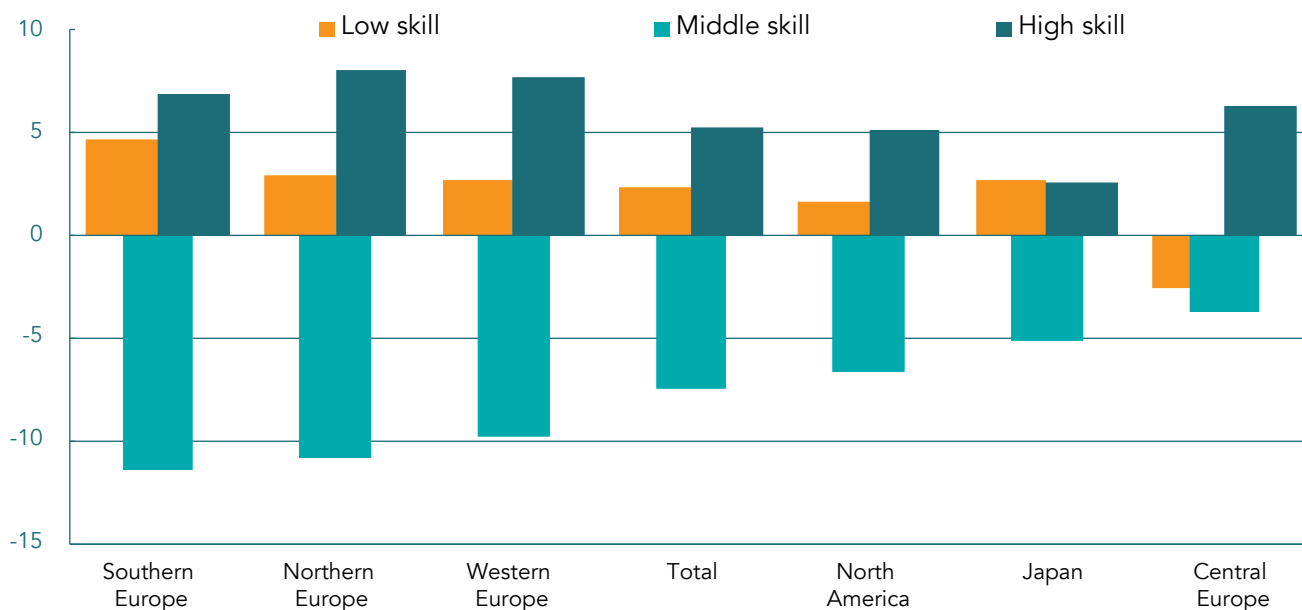
5. Trade, GVCs, and labor market polarization

This section finally turns to the question whether trade has contributed to a polarization of labor markets in advanced economies. Polarization refers to a rise in low- and high-skilled employment at the expense of medium-skilled jobs and has been observed across a wide range of advanced economies, as can be seen in Figure 2.5. Trade may play a role here because it can significantly affect the composition of employment by task and by occupation, in addition to trade's impact on the structure of employment by sector or by region. The new jobs that trade creates in more productive sectors and firms are not necessarily the same as those that disappear in import-competing industries or firms. Rather, together with technology, trade tends to increase the demand for high-skilled workers compared to mid- and low-skilled workers, and to decrease the demand for mid-skilled workers performing routine tasks compared to both high- and low-skilled categories. In order to account for this, it is necessary to examine the effect of trade on the demand for specific tasks, distinguishing in particular between routine and non-routine tasks.

Both traditional and more recent trade theories predict that trade should raise the demand for high-skilled relative to low-skilled workers. The traditional factor-endowment theory of comparative advantage predicts that trade will increase the relative demand for skills in an advanced economy that is relatively skill-abundant. More recent theories point out several additional

channels through which trade can lead to an increasing demand for skills, not only in developed countries. For instance, an increase in the relative demand for high-skilled workers can come from a trade-induced change in the firm composition. When trade liberalization opens new trading opportunities, the most productive firms try to seize them and expand their production. At the same time, international trade stiffens competition in the domestic market, leading the least efficient firms to reduce their sales or close down. High-productivity expanding firms tend to be more skill-intensive than low-productivity downsizing firms, and therefore this change in firm composition may translate into an increase in the relative demand for high-skilled workers irrespective of the industry specialization (Helpman *et al.*, 2010). In addition, trade may increase the rewards for skill-biased technical change, which further raises skill demand (Bustos, 2011).

The rise of value chains is likely to have exacerbated this phenomenon since it allows for the offshoring of not just complete production processes but production stages (Baldwin, 2016). Theory suggests that as offshoring costs fall, firms in developed economies can relocate more production stages to developing economies which will allow the former to technologically upgrade and specialize in a narrower set of stages that are relatively skill-intensive corresponding to their comparative advantage (Feenstra and Hanson, 1995; Grossman and Rossi-Hansberg, 2008; Lee and Yi, 2018). Moreover, foreign demand for high quality goods causes exporters to demand technological upgrading also from

FIGURE 2.5 Percentage point changes in employment shares by skill level between 1995 and 2015

Notes: Taken from OECD (2017). In many advanced economies the share of low- and high-skilled jobs expanded at the expense of middle-skilled jobs.

their suppliers which in turn have access to cheaper but more skill demanding inputs from abroad. This causes the upskilling effect to propagate through the supply chain. As a result, skill intensity has been shown to increase in close to one third of firms that neither import nor export (Fieler *et al.*, 2018).

Empirical research supports the view that international trade increases the relative employment of skilled workers in developed countries. Detailed information on the skill structure within French manufacturing firms shows that firms employ relatively more skilled workers in marketing and development when they sell their products outside of France (Maurin *et al.*, 2002). Other studies show that import competition leads to skill upgrading through its impact on product and process innovation. Using firm-level data for twelve European countries over the period 1996 to 2007, Bloom *et al.* (2016) estimate that increased trade with China accounted for about 15 per cent of the technology upgrading in Europe between 2000 and 2007. They also show that technology upgrading has had a significant impact on the relative employment of skilled workers. Supporting this evidence, an analysis of Belgian firms in the same period, 1996 to 2007, shows that import competition from China led to skill upgrading in low-tech industries (Mion and Zhu, 2013). The findings suggest that the response to imports from China accounted for 27 per cent of the increase in the share of non-production workers, and for almost half of the increase in the share of highly-educated workers in the low-tech industries.

Firm-level evidence from France shows that offshoring is associated with a lower relative demand for production workers, especially for the less-skilled ones. Between 1986 and 1992, French manufacturing firms that increased their imports of final

goods, and which were therefore likely to engage in offshoring of the assembly stage, changed their labor force composition towards non-production activities such as marketing or distribution (Biscourp and Kramarz, 2007). Evidence from the same study also shows that all types of offshoring, whether foreign sourcing of final goods or intermediate inputs, are associated with an increase in the share of skilled workers such as engineers or technicians among the remaining production workers. Interestingly, the employment changes in this study were due to offshoring to other OECD countries, suggesting that skills upgrading within firms from high-income countries is not necessarily linked to offshoring to low-wage countries. Rather, it appears to be associated with increases in sourcing from foreign markets in general. Evidence from the United States further shows that imports of intermediate inputs from China mildly increased the relative employment of non-production workers compared to production workers (Wright, 2014). This upskilling effect has been magnified as domestic value chains have developed in China allowing for an even finer degree of specialization (Dollar *et al.*, 2018).

Newly available data on occupational characteristics allows researchers to better characterize recent changes in the nature of work and the tasks required in each occupation beyond the high- vs low-skilled dichotomy. The types of tasks performed by a worker also determine whether a job is suitable to be offshored and whether it is susceptible to import competition from low-wage countries. Occupations that require repetitive, easily codifiable tasks are easy to relocate or automate. Non-routine and manual occupations that require abstract thinking, face-to-face communication, or physical presence are much less tradeable

and automatable. Since routine tasks tend to be medium-skilled, manual tasks low-skilled and abstract tasks high-skilled, labor market polarization can arise with trade liberalization and technological progress.

Firm- and worker-level evidence shows that offshoring and import competition have a small positive impact on the demand for non-routine occupations and thus on job polarization. Offshoring by German multinational enterprises for example is associated with an increase in non-routine and interactive tasks performed in the onshore plants, and a higher share of high-skilled workers, accounting for about 10 to 15 per cent of these changes (Becker *et al.*, 2013). Another recent study shows that in Denmark import competition from low-wage countries has led to a decline in routine, mid-skilled manufacturing occupations, and has therefore contributed to an overall shift in employment towards both high- and low-skilled occupations (Keller and Utar, 2016). Evidence from the United States and Western Europe suggests that increased import competition measured at the occupation-level (rather than at the industry-level), and offshoring to low-income countries have brought about a relative decline in real wages, especially for low- and mid-skilled occupations intensive in routine tasks (Ebenstein *et al.*, 2014). Import competition and offshoring are also found to reduce employment probabilities and wages for workers in exposed firms relative to those in exporting firms, thus leading to wage polarization between skill groups and firms (Hakkala and Huttunen, 2016; Utar, 2016; Hummels *et al.*, 2014). Finally, services offshoring also increases the relative demand for high-skilled workers in non-routine occupations but the effect is economically small (Crinò, 2010; Crinò, 2012).

However, studies that take a wider range of potential drivers of polarization into account find that technology is significantly more important in driving polarization than import competition or offshoring in value chains (Goos *et al.*, 2014; Autor *et al.*, 2015; Zhu, 2017). Two recent studies stand out for accounting explicitly for the rise of GVCs. The first builds a task-based model of production in global value chains and decomposes observed changes in occupational labor demand into an automation and an offshoring component. It finds that while both factors have contributed to polarization in advanced economies, the effect of automation is dominant (Reijnders and de Vries, 2018). The second study goes a step further and decomposes changes in US labor demand into that due to participation in GVCs, competition from imports of Chinese final goods, and automation. The results suggest that import competition from China increased the share of low-skilled employment, while participation in GVCs increased the share of high-skilled employment. Trade as a combination of the two has thus contributed to polarization. The results for trade are however dwarfed by the estimates for the role of technology (Beverelli *et al.*, 2018).

Independent of the exact driver, an increase in the demand for high- relative to low- or medium-skilled workers can translate into an increase in the share of skilled workers, an increase in the skill premium or a combination of both. In the short term, the supply of workers with a given skillset tends to be fixed and an increased demand for skills translates into increases in the skill

premium, i.e. the ratio of wages commanded by high-skilled and low-skilled workers. This higher skill premium acts as a signal for workers to increase their skill levels and acquire the appropriate type of skills. When skill supply responds to market changes, employment of high-skilled workers increases and the skill premium tends to decrease. Increases in the skill premium can therefore be an important mechanism in upskilling the labor force and consequently in advancing economic development. Due to labor market rigidities, the response of skill supply to an increased skill premium can take several years, leading to a sustained wage polarization. The ease of adjustment chiefly depends on workers' characteristics. While high-skilled workers can adjust to changes in skill demand more promptly than low-skilled workers, upskilling or re-skilling of low-skilled workers takes more time.

Evidence from the U.S. labor market suggests that low-wage workers churn primarily among manufacturing sectors, where they are repeatedly exposed to subsequent trade shocks, while high-wage workers are better able to move across employers with minimal earnings losses and are more likely to move out of manufacturing conditional on separation (Autor *et al.*, 2014; Krishna and Senses, 2014). Even when they move outside manufacturing, many workers faced with import competition have been shown to incur income losses as they land in low-skilled services jobs (Ebenstein *et al.*, 2014). Danish evidence shows that workers in occupations that require cognitive skills either stay in mid-wage jobs or move upwards, and therefore are unaffected or benefit from import competition (Keller and Utar, 2016). It also shows that vocational training with a manufacturing focus makes mid-wage workers less vulnerable to wage declines if they stay in their job but it does not shield them from being obliged to move into low-wage jobs. Post-secondary education and vocational training with an information technology focus, on the other hand, prevents workers from having to move to low-wage jobs and strongly increases their chances of moving to high-wage jobs if they face import competition from a low-wage country.

To conclude, trade has contributed to an increase in the demand for skills and labor market polarization in advanced economies. While it is by far not the most important factor behind these trends, its role is relevant. To make sure that the gains from trade are shared more widely across individuals with different skills, policy interventions are thus necessary. This is the focus of the next section.

6. Facilitating labor market adjustment to trade with GVCs

Economic openness, increased trade and investment, further integration in GVCs, and the diffusion of technology create greater wealth and opportunities, but they also induce job displacement and political discontent. By slowing the adjustment process, labor and capital market frictions generate an efficiency loss at the aggregate level which corresponds to the income and welfare that is foregone as the economy performs below its potential. Evidence suggests that following trade opening, unemployment

tends to increase before it decreases. A time-frame of 7 to 10 years appears to be necessary for economies to return to their new steady state (Arias *et al.*, 2013; Artuç *et al.*, 2010). Three factors have been found to determine how easily countries adjust to trade, namely trade balances, the pattern of trade opening and the degree of regional diversification (Krugman, 2016a; Hakobyan and McLaren, 2016; Yi *et al.*, 2017).

Adjustment processes also raise issues of equity, affecting the political support for an open economy. Even if on average the effects of trade are positive, workers with the wrong skills in negatively affected regions and/or sectors can suffer important and persistent losses. Evidence on the effects of NAFTA on the US labor market suggests, for instance, that despite average nominal wages and overall employment remaining largely unaffected, certain workers who lived in more exposed areas or worked in more exposed sectors incurred earnings losses relative to less exposed peers (Hakobyan and McLaren, 2016). The combined role of location and industry exposure implied that a blue-collar footwear worker without a high school degree in a town specializing in footwear production was hit across several dimensions. The study reports that in the most vulnerable regions and industries, high-school dropouts experienced a decrease in wage growth over the decade of respectively 4 and 17 percentage points compared to similar workers that were less exposed. Evidence for Germany further shows that the expansion of export-oriented sectors did not benefit workers displaced by import competition. Instead, gains in these industries accrued primarily to workers from the same sector, new labor market entrants, or previously unemployed workers (Dauth *et al.*, 2016). This is confirmed by Danish data (Keller and Utar, 2016), which suggests that many displaced mid-wage manufacturing workers moved into low-wage services jobs.

As a result of these efficiency, equity, and political economy issues, there is a strong rationale for governments to take a closer look at the concerns associated with adjustment processes and to take the necessary action to address them. This section discusses how governments can facilitate adjustment to trade liberalization with a specific focus on the challenges that arise due to value chains.

Policies that governments can implement to lower the cost of adjustment to a changing trade environment fall into three main categories: general adjustment policies, which typically consist of some combination of active labor-market policies (such as job search assistance and training) and passive labor-market policies (including income support and social insurance programs); specific adjustment programmes; and other policies (including education, infrastructure, credit market, trade, mobility and place-based policies) that do not directly intervene in labor markets. Available evidence on the effectiveness of these policies suggests that there is no one-size-fits-all recipe to reduce trade-related adjustment costs (World Trade Organization (WTO), 2017).

General adjustment policies – which aim at addressing adjustment problems independently of their cause – appear to be more adequate than specific trade adjustment policies for facilitating workers' adjustment to trade in the presence of global value chains. Increasing input-output linkages between domestic and

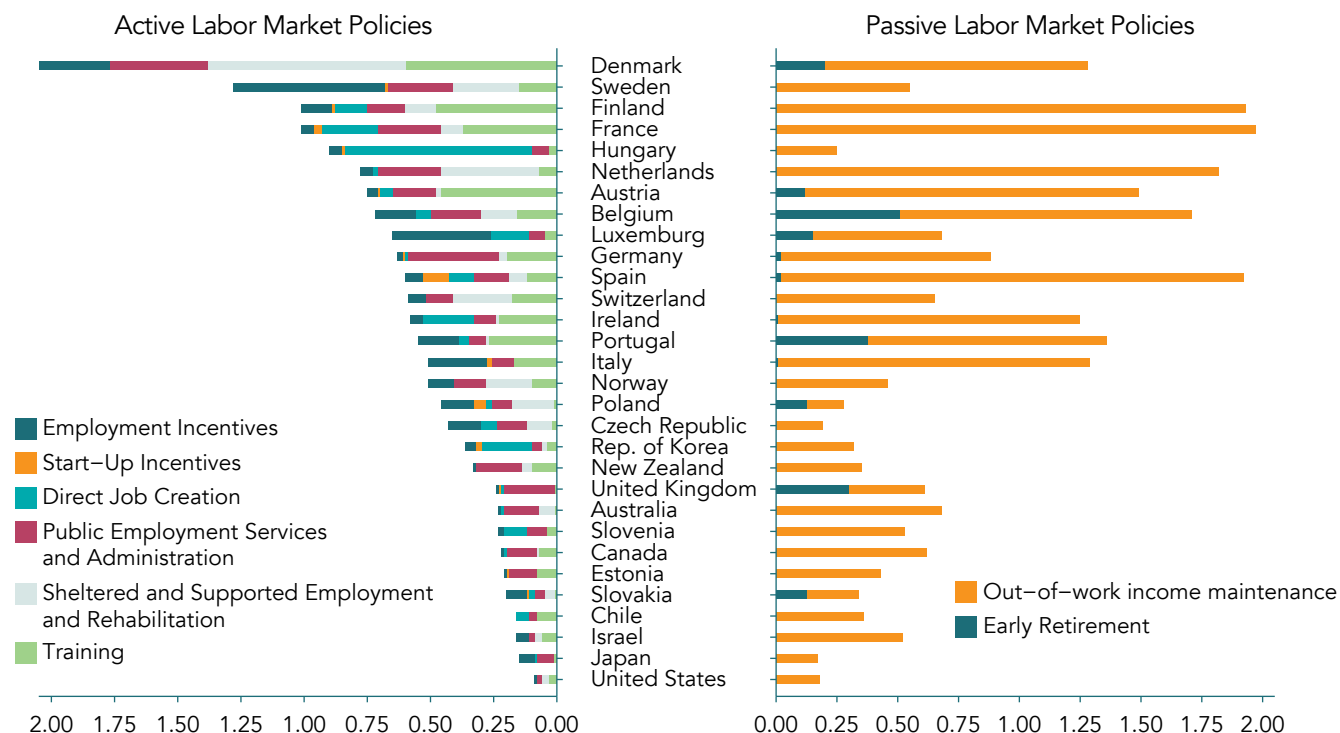
foreign firms have caused trade shocks to spread more widely in an economy, leading to indirect employment effects up and down the value chains. Therefore, it is increasingly difficult for adversely affected workers in up- or downstream firms to qualify for specific adjustment assistance. This means that not all of the adversely affected workers may be granted adjustment support, lowering the policy's effectiveness in facilitating adjustment. Although specific adjustment policies (e.g., the US Trade Adjustment Assistance program or the European Global Adjustment Fund) do cover workers from adversely-affected, first-tier upstream or downstream producers, they fail to account for linkages between firms further up or down the value chain as well as linkages across borders. General adjustment policies have the advantage that they can also support workers in those firms that are indirectly affected but do not qualify for specific adjustment assistance due to size thresholds or the difficulty to establish a clear chain of causality. More generally, non-specific adjustment policies also support workers adversely affected by technological change and other shocks which induce adjustment processes that are difficult to disentangle from, similar to and easy to confuse with those induced by trade. Figure 2.6 highlights that the scale and scope of these policies differs widely across advanced economies.

Training assistance and education programmes have an increasingly important role to play in facilitating adjustment to trade in global value chains. An important implication of value chain trade for labor markets is that it has transformed international competition, which now impacts economies at a much finer resolution (Baldwin, 2016). Traditionally, countries specialized in industries in which they were most competitive. With the rise of global value chains, however, comparative advantage has shifted towards the level of production stages and specific tasks within value chains. This has important implications for workers that lose their jobs in the adjustment process. While before the age of value chains it was easier to transition from sunset to sunrise sectors offering their initial human capital, these workers may now face difficulties marketing their initial skill set which might have become obsolete. As their old task might have disappeared altogether, workers either upgrade their skill sets to perform new different tasks with equal or better pay or transition without training into low-wage jobs (Keller and Utar, 2016). Therefore, training assistance programmes have become increasingly important in adjustment policies compared to employment subsidies or job search assistance, as they help displaced workers to better respond to the changing demand for skills. Effective training assistance and education policies promote skills that are relevant for multiple industries, increasing workers' flexibility and resilience in an unpredictable job market (Baldwin, 2016).

Taking a value chain perspective and more broadly accounting for input-output linkages and exports when assessing the effects of trade on labor markets at the regional level does not alter the conclusion that these effects are likely to differ considerably between regions. What it does is to help identify these effects with more accuracy, thereby helping with the design of appropriate adjustment policies. Most adjustment policies have a role to play in addressing regional adjustment difficulties but mobility

FIGURE 2.6 Public Spending on Labor Market Policies in OECD countries

(% of GDP)



Notes: Data from the OECD Labour Market Programmes database for 2015. UK data for 2011. The graph shows wide variation in scale and scope of labor market policies across OECD countries.

and place-based policies are the instruments of choice to address regional disparities in adjustment costs. When a region is negatively affected by import competition, some of the workers who lose their jobs and cannot find a new one may be willing to move to a region where they can be re-employed. However, because of mobility frictions they may not be able to do so. Mobility policies consist in various measures aimed at lowering or eliminating such frictions. Place-based policies can usefully complement mobility policies by helping those who are negatively affected but are not willing to move. They can dampen negative effects of trade openness on local labor markets. Finally, new technologies can be utilized to bring regions that have fallen behind closer to hubs of innovation by reducing face-to-face constraints that are inherent to services delivery and many manufacturing processes. Technology also can enable training and education programs to reach a much wider and diverse audience at little cost. This can help to counteract the forces that promote regional disparities. Importantly, successful coordination of the various policies requires cooperation between the different levels of government (Alden, 2017).

Trade in global value chains significantly affects the way governments can promote their economies' competitiveness. Traditionally, competitiveness policies aimed at fostering industries with the biggest spill-overs or at correcting market failures. They promoted investment in knowledge capital with government sponsored research, private-sector R&D subsidies and tax breaks,

in human capital with policies linked to education, training and retraining, and in infrastructure and social capital. However, as production factors, in particular financial and knowledge capital, have become much more mobile, competitiveness policies need to be targeted at those factors that are naturally more "sticky" such as certain types of human, social and physical capital as well as infrastructure in order to retain the investment's benefits. Moretti (2012) finds that highly skilled labor presents an attractive combination of low mobility with high spill-overs whereas financial capital gained for instance through tax breaks will likely flow to the place with highest return. As production structures are increasingly fragmented and productive factors increasingly more mobile, sectors have become the wrong operational unit with which to frame competitiveness and industrial policies. The focus now may rather be on cities as centres of excellence in a particular stage of production or developing to become a first-class centre (Baldwin and Evenett, 2012). In this perspective, cities should be seen as production hubs that provide a fast-adjusting range of diverse world-class services, including in particular inputs into manufactured exports, and a corresponding range of good jobs with a reasonably high level of resilience to international competition (Baldwin, 2016). With their localized social capital, cities can serve as the breeding ground of innovation and can be seen as the competitive frontier of developed economies in the 21st century. With more diversified labor markets they also allow for a greater

resilience of workers to adjust to changing economic conditions and can thereby improve the adjustment process (Yi *et al.*, 2017).

Last but not least, with global value chains trade policy has become an even more problematic trade adjustment instrument than before, as its consequences for employment have become increasingly difficult to assess. While trade restrictions, for example in the form of safeguards, can help domestic firms to adjust by temporarily limiting import competition and increasing their share in the domestic market, they also penalize export-oriented industries and industries that benefit from cheaper inputs. Tariffs on imports of intermediates, for instance, can increase the sourcing cost of domestic exports and thereby worsen their competitiveness. Moreover, increased import tariffs can also have a negative effect on domestic exporters if these are upstream suppliers of foreign firms adversely affected by the raised tariffs (Barbe and Riker, 2017). Vandenbussche *et al.* (2017) also point at the importance of such cross-border linkages for domestic employment. They estimate that a return to MFN tariffs between the UK and the EU would cause job losses since many British firms are important suppliers and buyers of continental European firms. Along the same lines, recent research suggests that spill-over effects due to supply chain linkages between manufacturing and non-manufacturing industries have become more important over time and should be taken into account when shaping trade policy (Kühn and Viegelaahn, 2018).

7. Conclusions

This chapter reviews research on the relationship between trade and labor markets in order to assess how trade has affected manufacturing and aggregate employment, as well as regional and skill-based inequality in advanced economies. It adds to the existing literature by taking a value chain perspective which properly accounts for the rise of global value chains in the last three decades. Based on the review, it discusses how policy can facilitate adjustment to international trade when production is increasingly fragmented across and within borders.

It highlights that value chain perspectives in labor market studies of international trade are crucial due to three factors. Firstly, value chains imply that trade shocks are felt much more broadly in economies since firms and industries are connected through input-output linkages. Secondly, value chains have magnified trade's impact on skill demand by allowing for specialization not only across but also within sectors according to comparative advantage. Thirdly, value chains make it necessary to complement traditional gross trade statistics with novel value added trade statistics in order to correctly measure the volume and geographical incidence of trade shocks.

Taking these factors into account shows that trade leads to employment and wage gains at the national level, although in the case of employment these are small. At the sectoral level, it stresses that trade is unlikely to be a major driver of employment losses in manufacturing due to offsetting factors. While import competition can hurt employment in exposed industries and their

suppliers, cheaper imports lower costs in downstream firms which allows them to expand. In addition, export expansion has benefited several manufacturing industries such that the combined effect of trade on manufacturing employment is likely to be minor.

However, moving from the nation-wide and sectoral level to regional and individual outcomes reveals substantial heterogeneity in how these aggregate effects map out. For instance, when local labor markets within countries are not sufficiently diversified, trade can widen regional disparities. Regions specialized in import-competing and upstream industries can fall behind, while areas with industries that export or benefit from cost savings pull away. Similarly, trade can lead to labor market polarization by favouring high-skilled employment over medium-skilled employment. While other factors like technological progress have contributed more significantly to these phenomena, policy can ensure a more even distribution of the gains from trade by addressing these inequalities.

The chapter finds that value chains make targeted or specific interventions increasingly difficult. As input-output linkages cause trade shocks to spread more widely within economies, import competition is less and less limited in terms of industries, regions, or skill levels. As a consequence, it becomes important for policies that ease adjustment to trade to be more general and less dependent on affected workers fulfilling certain conditions. This is especially the case as value chains magnify trade-induced changes in skill requirements and thereby raise the demand for worker flexibility and the need for training support.

In sum, this review shows that trade benefits on average not only consumers but also workers. This finding goes against common views in public discussions and highlights the need for better communication on the benefits of trade. It also shows that there is an important part to play for policy as these benefits tend to cluster regionally and among individuals with the right characteristics.

As always, a number of caveats apply. Beyond those that pertain to the generalization of country-specific results, two caveats are worth emphasizing here. First, this paper does not discuss the effects of trade in the presence of value chains on other outcomes such as, for example, labor force participation, employment volatility, the geographical mobility of workers, the labor share of income, or indirect effects on political, sociological, or health outcomes, etc. This is mostly because of a lack of evidence, but also because there seems to be considerable heterogeneity even among developed countries with regard to the evolution of these variables. Note, however, that it is not unreasonable to assume that evidence concerning these other effects would be in line with the evidence on sectoral and regional employment. Second, some indirect effects of trade, notably on technology and productivity, are not taken into account. This means that a clean separation of the effects of trade from those of technology, a notoriously difficult objective to achieve given the strong interactions between trade and technology and the isomorphic nature of their effects, remains somewhat elusive. This should certainly not be seen as an argument against trade adjustment policies but rather as another reason why general adjustment policies should be preferred to specific trade adjustment programs.

Notes

1. These numbers are based on an accounting exercise. They are not meant to suggest that an equivalent number of jobs would disappear in autarky. Note that the estimates are likely upward biased as exporting firms tend to have a higher import content than non-exporting firms and higher productivity and current input-output tables are not able to differentiate between the two.
2. Sales and distribution of imports in particular to households are also important contributors to jobs but not covered in this section. See Chapter 8 for details.
3. See for instance, Krugman's (1994, p. 25) famous quote: "It should be possible to emphasize to students that the level of employment is a macroeconomic issue [...] with microeconomic policies like tariffs having little net effect."
4. See, e.g., Helpman (2016), Muendler (2017), and WTO (2017).
5. Authors' calculation based on OECD-WTO TIVA data.
6. Positive downstream effects of Chinese imports have also been shown for Japanese firm sales (Fabinger *et al.*, 2017).
7. Wang *et al.* (2018) argue that to properly capture the impact on downstream producers it is for instance central to differentiate between intermediate and final goods imports, since only the former has the potential to reduce input prices. Failing to do so will lead to measurement error biasing estimates towards zero. Similarly, cross-border input trade might differ from intra-country input trade. The assumption that US industries source nationally in the same way as from abroad ignores that countries specialize within value chains and thus provide different types of inputs. This equally causes measurement error.
8. In the age of value chains gross trade data suffers from double counting when intermediates cross the same border twice. If for example, China produces phone cases and ships them to the US where high-tech components are inserted before the phone travels back to China for final assembly, then the phone case would be counted twice by gross trade data.
9. Carrere *et al.* (2015) find a small increase in the US unemployment rate due to a potential EU-US trade agreement but they don't account for input-output linkages. Moreover, they show that replacing NAFTA with 20% import tariffs would increase unemployment by 6% in the US and 21% in Mexico, an effect that might become even larger with input-output linkages that magnify sectoral effects.
10. As was the case for manufacturing employment, Acemoglu *et al.* (2016) and Caliendo *et al.* (2018) find a more muted balancing effect of input-output linkages on regional disparity due to the issues outlined in the section on manufacturing employment.

References

- Acemoglu, D., Autor, D. H., Dorn, D., Hanson, G. H. and Price, B. (2016), 'Import Competition and the Great US Employment Sag of the 2000s', *Journal of Labor Economics* 34(S1): S141-S198.
- Adao, R., Arkolakis, C., and Esposito, F. (2019), 'Spatial Linkages, Global Shocks, and Local Labor Markets: Theory and Evidence', NBER Working Paper No. 25544.
- Ahn, J. and Duval, R. (2017), 'Trading with China: Productivity Gains, Job Losses', IMF Working Paper No. 122, International Monetary Fund, Washington D.C.
- Alden, E. (2017), *Failure to Adjust: How Americans Got Left Behind in the Global Economy*, Rowman & Littlefield.
- Amiti, M., Dai, M., Feenstra, R. C. and Romalis, J. C. (2017), 'How Did China's WTO Entry Benefit U.S. Consumers?', NBER Working Paper No. 23487.
- Antràs, P., Fort, T. C. and Tintelnot, F. (2017), 'The margins of global sourcing: Theory and evidence from US firms', *American Economic Review* 107(9): 2514-2564.
- Arias, J., Artuc, E., Lederman, D. and Rojas, D. (2013), 'Trade, informal employment and labor adjustment costs', World Bank Policy Research Working Paper No. 6614.
- Artuç, E., Chaudhuri, S. and McLaren, J. (2010), 'Trade shocks and labor adjustment: A structural empirical approach', *The American Economic Review* 100(3): 1008-1045.
- Asquith, B. J., Goswami, S., Neumark, D. and Rodriguez-Lopez, A. (2017), 'U.S. Job Flows and the China Shock', NBER Working Paper No. 24080.
- Autor, D. H., Dorn, D. and Hanson, G. H. (2013), 'The China Syndrome: Local Labor Market Effects of Import Competition in the United States', *American Economic Review* 103(6): 2121-2168.
- Autor, D. H., Dorn, D. and Hanson, G. H. (2014), 'Trade adjustment: Worker level evidence', *The Quarterly Journal of Economics* 129(4): 1553-1623.
- Autor, D. H., Dorn, D. and Hanson, G. H. (2015), 'Untangling Trade and Technology: Evidence from Local Labour Markets', *Economic Journal* 125(584): 621-646.
- Autor, D. H., Dorn, D. and Hanson, G. H. (2016), 'The China shock: Learning from labor market adjustment to large changes in trade', *Annual Review of Economics* 8: 205-240.
- Baldwin, R. and Evenett, S. (2012), 'Value creation and trade in 21st century manufacturing: What policies for UK manufacturing?', in Greenaway, D. (ed), *The UK in a Global World*, [4] London: Center for Economic Policy Research: 71-128.
- Baldwin, R. (2016), *The Great Convergence: Information Technology and the New Globalization*, Cambridge (MA): Belknap Press.
- Balsvik, R., Jensen, S. and Salvanes, K. G. (2015), 'Made in China, sold in Norway: Local labor market effects of an import shock', *Journal of Public Economics* 127: 137-144.
- Barbe, A. and Riker, D. (2017), 'The Effects of Tariffs on Employment in Global Value Chains', USITC Economics Working Paper 2017-07-A.
- Becker, S., Ekholm, K. and Muendler, M. A. (2013), 'Offshoring and the onshore composition of tasks and skills', *Journal of International Economics* 90(1): 91-106.
- Bernard, A. B. and Fort, T. C. (2017), 'Factoryless Goods Producers in the USA', in Fontagné, L. and Harrison, A. (eds), *The factory-free economy: Outsourcing, Servitization, and the Future of Industry*, [5] Oxford: Oxford University Press: 136-168.

- Bernard, A. B., Smeets, V. and Warzynski, F. (2017), 'Rethinking De-Industrialization', *Economic Policy* 32(89), 5-38.
- Beverelli, C., Rubinova, S., Stolzenburg, V. and Woessner, N. (2018), 'Did Global Value Chains contribute to rising labour market polarization?', WTO, unpublished manuscript.
- Biscourp, P. and Kramarz, F. (2007), 'Employment, Skill Structure, and International Trade: Firm-Level Evidence for France', *Journal of International Economics* 72(1): 22-51.
- Bloom, N., Draka, M. and Van Reenen, J. (2016), 'Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity.', *The Review of Economic Studies* 83(1): 87-117.
- Braakmann, N. and Vogel, A. (2011), 'How does economic integration influence employment and wages in border regions? The case of the EU enlargement 2004 and Germany's eastern border', *Review of World Economics* 147(2): 303-323.
- Bustos, P. (2011), 'Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms', *American Economic Review* 101(1): 304-340.
- Cali, M., Francois, J., Hollweg, C. H., Manchin, M., Oberdabernig, D. A., Rojas-Romagos, H., Rubinova, S., and Tomberger, P. (2016), 'The Labor Content of Exports Database', World Bank Policy Research Working Paper 7615.
- Caliendo, L., Dvorkin, M. and Parro, F. (2018), 'Trade and Labor Market Dynamics: General Equilibrium Analysis of the China Trade Shock', Yale University, unpublished manuscript.
- Caliendo, L. and Parro, F. (2015), 'Estimates of the Trade and Welfare Effects of NAFTA', *The Review of Economic Studies* 82(1): 1-44.
- Crinò, R. (2010), 'Service Offshoring and White-Collar Employment', *Review of Economic Studies* 77(2): 595-632.
- Crinò, R. (2012), 'Service Offshoring and the Skill Composition of Labor Demand', *Oxford Bulletin of Economics and Statistics* 74(1): 20-57.
- Dauth, W., Findeisen, S. and Suedekum, J. (2014), 'The rise of the East and the Far East: German labor markets and trade integration', *Journal of the European Economic Association* 12(6): 1643-1675.
- Dauth, W., Findeisen, S. and Suedekum, J. (2018), 'Trade and Manufacturing Jobs in Germany', *American Economic Review* 107(5): 337-342.
- Dauth, W. and Suedekum, J. (2016), 'Globalization and local profiles of economic growth and industrial change', *Journal of Economic Geography* 16(5): 1007-1034.
- De Long, J. B. (2017), 'NAFTA and other trade deals have not gutted American manufacturing — period', <https://www.vox.com/the-big-idea/2017/1/24/14363148/trade-deals-nafta-wto-china-job-loss-trump>.
- Dhyne, E. and Rubinova, S. (2016), 'The supplier network of exporters: Connecting the dots', National Bank of Belgium Working Paper Research No. 296.
- Dollar, D., Kidder, M. and Khan, B. M. (2018), 'The effect of production fragmentation on skills reallocation: Is it felt equally across levels of development?', UIBE, unpublished manuscript.
- Donoso, V., Martin, V. and Minondo, A. (2015), 'Do differences in the exposure to Chinese imports lead to differences in local labour market outcomes? An analysis for Spanish provinces', *Regional Studies* 49(10): 1746-1764.
- Dutt, P., Mitra, D. and Ranjan, P. (2009), 'International trade and unemployment: Theory and cross-national evidence', *Journal of International Economics* 78(1): 32-44.
- Ebenstein, A., Harrison, A., McMillan, M. and Phillips, S. (2014), 'Estimating the impact of trade and offshoring on American workers using the current population surveys', *Review of Economics and Statistics* 96(4): 581-595.
- Fabinger, M., Shibuya, Y. and Taniguchi, M. (2017), 'International Influences on Japanese Supply Chains', RIETI Discussion Paper Series 17-E-022.
- Feenstra, R. C. and Hanson, G. H. (1995), 'Foreign Investment, Outsourcing and Relative Wages', NBER Working Paper No. 5121.
- Feenstra, R. C., Ma, H. and Xu, Y. (2017), 'US Exports and Employment', NBER Working Paper No. 24056.
- Feenstra, R. C. and Sasahara, A. (2017), 'The 'China Shock', Exports and U.S. Employment: A Global Input-Output Analysis', NBER Working Paper No. 24022.
- Felbermayr, G., Prat, J. and Schmerer, H.-J. (2011), 'Trade and unemployment: What do the data say?', *European Economic Review* 55(6): 741-758.
- Fielser, A. C., Eslava, M. and Xu, D. Y. (2018), 'Trade, Quality Upgrading, and Input Linkages: Theory and Evidence from Colombia', *American Economic Review* 108(1): 109-146.
- Goos, M., Manning, A. and Salomons, A. (2014), 'Explaining job polarization: routine-biased technological change and offshoring', *American Economic Review* 104(8): 2509-2526.
- Grossman, G. M. and Rossi-Hansberg, E. (2008), 'Trading tasks: A simple theory of offshoring', *The American Economic Review* 98(5): 1978-1997.
- Hakkala, K. N. and Huttunen, K. (2016), 'Worker-level consequences of import shocks', VATT Institute for Economic Research Working Paper No. 74.
- Hakobyan, S. and McLaren, J. (2016), 'Looking for local labor market effects of NAFTA', *Review of Economics and Statistics* 98(4): 728-741.
- Handley, K. and Limao, N. (2018), 'Policy Uncertainty, Trade and Welfare: Theory and Evidence for China and the U.S.', *American Economic Review* 107(9): 2731-2783.
- Helpman, E. (2016), 'Globalization and Wage Inequality', NBER Working Paper No. 22944.
- Helpman, E., Itskhoki, O. and Redding, S. (2010), 'Inequality and unemployment in a global economy', *Econometrica* 78(4): 1239-1283.
- Hicks, M. and Devaraj, S. (2015), 'The Myth and the Reality of Manufacturing in America', Ball State University, unpublished manuscript.
- Hummels, D. L., Jørgensen, R., Munch, J. R. and Xiang, C. (2014), 'The Wage Effects of Offshoring: Evidence from Danish Matched Worker-Firm Data', *American Economic Review* 104(6): 1597-1629.
- Jakubik, A. and Stolzenburg, V. (2018), 'The "China Shock" Revisited: Insights From Value Added Trade Flows', WTO Working Paper ERSD-2018-10.
- Kaplan, L. C., Kohl, T. and Martinez-Zarzoso, I. (2018), 'Supply-chain trade and labor market outcomes: The case of the 2004 European Union enlargement', *Review of International Economics* 26(2): 481-506. 9-25-2018.
- Keller, W. and Utar, H. (2016), 'International trade and job polarization: evidence at the worker level', CESIFO Working Paper No. 5978.
- Kovak, B. K., Oldenski, L. and Sly, N. (2017), 'The Labor Market Effects of Offshoring by U.S. Multinational Firms: Evidence from Changes in Global Tax Policies', NBER Working Paper Series No. 23947.
- Krishna, P. and Senses, M. Z. (2014), 'International Trade and Labor Income Risk in the U.S.', *Review of Economic Studies* 81(1): 186-218.

- Krugman, P. (1994), 'What Do Undergrads Need to Know About Trade?', *American Economic Review* 83(2): 23-26.
- Krugman, P. (2016a), 'Analytics of Trade Deficits and Manufacturing Employment (Very Wonkish)', <https://krugman.blogs.nytimes.com/2016/12/26/analytics-of-trade-deficits-and-manufacturing-employment-very-wonkish/>.
- Krugman, P. (2016b), 'Trade and Manufacturing Employment: No Real Disagreement', City University of New York, unpublished manuscript.
- Kühn, S. and Viegelahm, C. (2018), 'Foreign trade barriers and jobs in global supply chains', *International Labour Review*.
- Langdon, D. and Lehman, R. (2012), 'The Benefits of Manufacturing Jobs', U.S. Department of Commerce ESA Issue Brief #01-12.
- Lee, E. and Yi, K. M. (2018), 'Global Value chains and Inequality with Endogenous Labor Supply', *Journal of International Economics* (forthcoming).
- Magyari, I. (2017), 'Firm Reorganization, Chinese Imports, and U.S. Manufacturing Employment', Columbia University, unpublished manuscript.
- Malgouyres, C. (2017), 'The Impact of Chinese Import Competition on the Local Structure of Employment and Wages: Evidence from France', *Journal of Regional Science* 57(3): 411-441.
- Maurin, E., Thoenig, M. and Thesmar, D. (2002), 'Globalization and the demand for skill: an export based channel', CEPR Discussion Paper No. 3406.
- Mion, G. and Zhu, L. (2013), 'Import competition from and offshoring to China: A curse or blessing for firms?', *Journal of International Economics* 89(1): 202-215.
- Moretti, E. (2012), *The New Geography of Jobs*, Houghton Mifflin Harcourt.
- Muendler, M. A. (2017), 'Trade, Technology, and Prosperity: An Account of Evidence from a Labor-market Perspective', WTO Working Paper ERSD-2017-15.
- OECD (2017), 'OECD Employment Outlook 2017', OECD Publishing, Paris.
- Pierce, J. R. and Schott, P. K. (2016), 'The surprisingly swift decline of US manufacturing employment', *The American Economic Review* 106(7): 1632-1662.
- Reijnders, L. S. M. and de Vries, G. J. (2018), 'Technology, offshoring and the rise of non-routine jobs', *Journal of Development Economics* 135: 412-432.
- Revenga, A. (1992), 'Exporting Jobs? The Impact of Import Competition on Employment and Wages in U.S. Manufacturing', *Quarterly Journal of Economics* 107(1): 255-284.
- Scott, R. E. (2015), 'Manufacturing Job Loss', Economic Policy Institute Issue Brief 402.
- Spence, M. and Hlatshwayo, S. (2012), 'The Evolving Structure of the American Economy and the Employment Challenge', *Comparative Economic Studies* 54(4): 703-738.
- Tintelnot, F., Kikkawa, A. K., Magne, M. and Dhyne, E. (2017), 'Trade and Domestic Production Networks', Society for Economic Dynamics, 2017 Meeting Papers 381.
- Utar, H. (2016), 'Workers beneath the Floodgates: Impact of Low-Wage Import Competition and Workers' Adjustment', CESifo Working Paper Series No. 6224.
- Vandenbussche, H., Connell, W. and Simons, W. (2017), 'Global Value Chains, Trade Shocks and Jobs: An Application to Brexit', KU Leuven Discussion Paper Series DPS17.13.
- Vandenbussche, H., Connell, W. and Simons, W. (2018), 'The cost of non-TTIP: A Global Value Chain Approach', CEPR Discussion Papers No. 12705.
- Wang, Z., Wei, S.-J., Yu, X. and Zhu, K. (2018), 'Re-examining the Effects of Trading with China on Local Labor Markets: A Supply Chain Perspective', NBER Working Paper No. 24886.
- World Trade Organization (WTO) (2017) *World Trade Report 2017: Trade, Technology and Jobs*, Geneva: WTO.
- Wright, G. (2014), 'Revisiting the employment impact of offshoring', *European Economic Review* 66: 63-83.
- Yi, M., Müller, S. and Stegmaier, J. (2017), 'Industry Mix, Local Labor Markets, and the Incidence of Trade Shocks', US Census Bureau, unpublished manuscript.
- Zhu, W. (2017) *Heterogeneous Technological Changes and Their Impacts on Income Inequality and Productivity Growth*. Queen's University, Kingston, Ontario.