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DOI:

[10.1080/21582041.2023.2192700](https://doi.org/10.1080/21582041.2023.2192700)

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Document Version

Publisher's PDF, also known as Version of record

Citation for published version (Harvard):

Bailey, D, De propriis, L, De ruyter, A, Hearne, D & Ortega-Argilés, R 2023, 'Brexit, trade and UK advanced manufacturing sectors: a Midlands' perspective', *Contemporary Social Science: Journal of the Academy of Social Sciences*, pp. 1-16. <https://doi.org/10.1080/21582041.2023.2192700>

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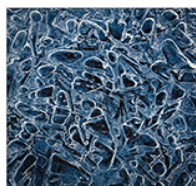
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Contemporary Social Science

Journal of the Academy of Social Sciences



ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/rsoc21>

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To cite this article: David Bailey, Lisa De Propriis, Alex De Ruyter, David Hearne & Raquel Ortega-Argilés (2023): Brexit, trade and UK advanced manufacturing sectors: a Midlands' perspective, Contemporary Social Science, DOI: [10.1080/21582041.2023.2192700](https://doi.org/10.1080/21582041.2023.2192700)

To link to this article: <https://doi.org/10.1080/21582041.2023.2192700>



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Brexit, trade and UK advanced manufacturing sectors: a Midlands' perspective

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ABSTRACT

The paper examines how Brexit has impacted on Original Equipment Manufacturers (OEMs) and suppliers in the UK Midlands, and to what extent such firms are reconfiguring their supply chains with the increase in trade barriers with Brexit. To do this, the paper aims to add to macro studies in the area by using a mixed-methods approach that combines descriptive quantitative analysis of secondary data with a complementary qualitative research analysis based on a novel interview dataset. The latter is generated from 14 semi-structured interviews conducted in late 2021 with senior managers and directors in advanced manufacturing firms across the East and West Midlands regions of the UK. A key finding of this paper is that the imposition of new non-tariff barriers through Brexit has proved particularly challenging to smaller firms in manufacturing supply chains. The findings of our research highlight the need for policy support for smaller firms engaging in EU-wide supply chains, particularly around skillsets and access to talent, cost reduction for exports and facilitating trade.

ARTICLE HISTORY

Received 10 January 2023
Accepted 10 March 2023

KEYWORDS

Brexit; Covid-19; manufacturing; supply chains; trade; industrial policy

1. Introduction

As a major manufacturing region with sectors closely entwined with European 'Just in Time' (JIT) supply chains, the Midlands was expected to be particularly exposed to the disruption caused by Brexit (Los et al., 2017) given the latter's potential to impact on intra-industry trade across the UK and the European Union (EU).¹ Such JIT supply chains had previously been tightly integrated into the EU economies thanks to the frictionless nature of the Single Market and Customs Union. Whilst there is considerable macro evidence on the impact of Brexit on trade between the UK and EU (Posen & Rengifo-Keller, 2022), the impacts on particular supply chains are just starting to be explored (Freeman et al., 2022). The latter has particular significance for manufacturing focused

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regions which have been highlighted as being particularly vulnerable to the impacts of post-Brexit trade barriers on manufacturing (Brown et al., 2019; Chen et al., 2018; Moradlou et al., 2021; Pournader et al., 2020; Roscoe et al., 2020). It is therefore timely to better understand the implications for advanced manufacturing at the regional level of such impacts. Accordingly, this paper aims to provide a more granular understanding of the implications for international supply chains of the UK's withdrawal from the EU. In particular, the following research questions are explored:

- a. To what extent have the disruptive processes driven by Brexit (and the pandemic) led to a decoupling of UK manufacturing supply chains from the EU (in the Midlands)?
- b. How have firm-level characteristics (especially size) affected firms' ability to adjust to Brexit?
- c. What policy issues arise from this, and what spatial scales could and should be considered for these?

The paper aims to add to the macro level data by examining to what extent final assemblers (Original Equipment Manufacturers or OEMs) and suppliers are reconfiguring their supply chains. This could be by shifting operations away from the UK, or avoiding the UK when expanding operations, or by changing the nature of their operations in the UK for example when trade barriers increase. Such effects can have short- and long-term consequences for UK manufacturing and the regional economy. So as to explore such impacts, the paper's empirical analysis draws on qualitative primary data generated from 14 semi-structured interviews conducted in late 2021 with representative senior managers and directors in advanced manufacturing firms across the East and West Midlands regions of the UK. We use a mixed-methods approach that combines a qualitative research analysis based on such a unique and novel interview dataset with a complementary descriptive quantitative analysis of drawing on secondary data.

Our findings suggest that the supply chain impact of Brexit is heterogeneous, with effects more severely felt by smaller supply chain firms in particular. This correlates with macro-level perspectives which suggest the impacts of trade barriers fall more heavily on smaller firms (see Section 2 below). Such firms have fewer intangible resources (Surroca et al., 2010) available which can be used to anticipate and avoid disruption (Braunscheidel & Suresh, 2009), with the effect that smaller manufacturing firms have faced greater export disruption and supply chain segmentation arising from new trade barriers between the UK and EU. We also find little evidence thus far of any significant reshoring trends to the UK (although interestingly firms do appear to be considering this). It is also evident that the impact of the UK-EU trade agreement thus far is asymmetric due to the relative sizes of the two actors and because the UK has waived most import checks until 2024.² That means that EU firms can export to the UK without checks while UK exporters to the EU are subject to EU customs requirements and hence extra costs.

Our research suggests that, overall, Midlands-based SMEs face extra costs (including transactions costs – see Bailey, de Ruyter, Hearne, et al. 2022; Bailey, de Ruyter, MacRae, et al. 2022), delays and disruption in getting supplies to EU customers. In some cases, EU customers have started looking instead to EU-based suppliers, and in other cases, Midlands-based firms have opened or expanded operations in the EU. In

retrospect, this is perhaps unsurprising. In 2019, the 'rest of world' (extra-EU) goods exports accounted for only 45% of SMEs' exports compared to 60% of larger firms' exports (Her Majesty's Revenue and Customs, 2020). The EU market was thus especially important for SMEs.

The paper proceeds as follows: Section 2 summarises the recent literature on Brexit and its impact on trade and manufacturing supply chains; Section 3 outlines the mixed-methods approach taken in this paper; Section 4 reports findings from interviews; Section 5 discusses these further and raises policy implications, while Section 6 concludes.

2. Brexit, trade and manufacturing: a brief summary

The EU is the UK's largest trading partner, accounting for some 46% of UK goods exports and 53% of UK goods imports (Bailey & Rajic, 2022). Key manufacturing sectors, like automotive and aerospace, are highly integrated into EU-wide supply chains. Intermediate goods often criss-cross the borders of various EU countries (and also the UK) multiple times, as they are shipped from factory to factory to undergo value adding processes, before being assembled into final products. The latter in turn could be sold in any EU country or indeed globally. Sectors such as chemicals often need such intermediate goods delivered 'just-in-time' to save on the costs of stockpiling.

Whilst the Trade and Cooperation Agreement (TCA) between the UK and the EU at the end of 2020 avoided tariffs and quotas (subject to complying with Rules of Origin rules), it nevertheless introduced lots of extra new costs (including transaction costs) for trade in goods between the UK and EU (Bailey & Rajic, 2022). These costs include customs delays, the costs of completing customs forms, Sanitary and Phytosanitary (SPS) checks on agri-food, complying with rules of origin rules, regulatory alignment and data protection issues. So despite the claim by the ex-Prime minister Boris Johnson that the TCA ensured 'no non-tariff barriers', this was clearly not the case. In fact non-tariff barriers came back, and in a big way. Customs checks in particular have introduced delays at the UK-EU border for UK manufacturing firms, adding to costs and disrupting tightly interwoven supply chains. Manufacturers have found ways to mitigate risks such as delays, such as by stockpiling and/or changing supply or distribution routes, but such actions have brought higher costs, in turn impacting negatively on the competitiveness of UK manufacturing (Bailey, de Ruyter, Hearne, et al. 2022; Bailey, de Ruyter, MacRae, et al. 2022).

The UK has repeatedly delayed the imposition of full customs checks on imports in order to keep imported goods flowing. These have been delayed until 2024. This has offered some relief for manufacturers in bringing in components, especially given the ongoing impacts of Covid-19. However, challenges remain around exporting (e.g. the costs of completing declarations) given that the EU has not waived customs checks. In this regard, there is an asymmetry that disadvantages British manufacturers; the latter have had to spend much time and money on complying with customs rules while EU competitors can still trade freely with the UK (Bailey, de Ruyter, Hearne, et al., 2022).

While firms are responding to Brexit in several ways, such as by switching to non-EU sourcing, recent macro-level work suggests that smaller firms really struggle with customs and Rules of Origin paperwork (Bailey & Rajic, 2022). In some cases, such firms have either ceased exporting or bear greater costs by for example stockpiling at hubs

in, say, the Netherlands. Supply chain disruptions have been exacerbated by Covid-19 (such as semi-conductor chip shortages in manufacturing, skills shortages in certain sectors), and the war in Ukraine (through higher energy costs and key materials and component shortages). British manufacturers are thus exposed to risks and additional costs that are unlikely to disappear going forward, in what can be seen as a 'slow-burn' disruptive process.

Larger firms, experienced in trading internationally, have been better placed to deal with this, albeit again at a significant transaction cost. For example, *Make UK* estimated an increase in the number of customs declarations that UK firms have to fill out from 55 m to 275 m, costing some £15 billion per year. The *Make UK* estimates were similar to those of the HMRC (2021), which also put the overall cost of customs declarations at around £15 billion. On top of this, the HMRC (2021) estimated that fulfilling 'rules of origin' requirements likely increases costs by a further £5.5-6 billion per year (see Bailey & Rajic, 2022 for details). This includes both paying for rules of origin certificates and, for more complex products, facing the much higher costs of evidencing that the requirements have been met (supply chain audits, legal advice, agents' fees, and so on).

The TCA offered some flexibility by allowing self-certification on Rules of Origin (along with an initial one-year grace period). Beyond this, however, the complexity and cost of the paperwork involved means that some firms cannot or do not wish to claim zero tariff. Work by the UK Trade Policy Observatory in 2021 showed a significant number of UK-based firms not claiming zero tariffs when exporting to the EU (implying 26-32% of UK exports to the EU that could have entered under zero tariffs did not actually do so) (Ayele, 2021). While this may improve over time, more help is needed for small firms to comply with the new rules.

By using data up to Quarter 1 of 2022, Freeman et al. (2022) indicate that the negative, large and statistically significant impact of the TCA on UK exports had persisted and even deepened into 2022. This, they suggest, highlights the continuing export challenges that UK firms have faced since the TCA was put in force and underscores the need to reconsider the UK's post-Brexit trade policy. Similarly, Du and Shepotylo (2022) estimated that by mid-2022 exports to the EU were 26% lower than they would have been without the additional barriers to trade introduced by Brexit. In addition, the UK appears to have experienced a significant contraction in its trading capacity in terms of the varieties of goods being exported to the EU post TCA (Freeman et al., 2022). An estimated loss of over 40% of product varieties over the period since Brexit, combined with an increased concentration of export values to fewer products raise serious long-term concerns about the UK's future exporting and productivity (Freeman et al., 2022).

In contrast, the negative impact of the TCA on imports appears overall to have been subsiding (Du & Shepotylo, 2022; Freeman et al., 2022). This is not a surprise given that the UK has waived customs check until 2024. Nevertheless, in sectors with high non-tariff barriers (including motor vehicles and their supply chains), there have still been significant falls in imports. Indeed, in early 2021 a third of businesses were reporting that they had issues importing from the EU to the UK due to Brexit, with the most-cited reasons being delays at the border, additional customs and administrative costs, and regulatory checks (Freeman et al., 2022).

Furthermore, the make-up of imports has changed. It appears that after the TCA, UK imports from the EU declined by about 25% more than UK imports from the rest of the

world, with this decline continuing throughout 2021. Indeed, imports from the EU, relative to imports from non-EU countries, have fallen for goods used in many UK supply chains. There is also evidence that some sectors (including automotive) started to reorganise their supply chains away from EU countries, even before the TCA, perhaps in anticipation of likely barriers to trade on the imported inputs regardless of the outcome of the Brexit negotiations (Freeman et al., 2022). Such sectors have also seen a rise in imported components from non-EU countries, suggesting that their supply chains have been through a process of adjustment and dis-integration from EU supply chains. It is noteworthy that if firms initially chose to source their inputs from the EU, then this is likely to have been the most efficient option, so this reallocation is likely to reflect a decline in efficiency.

Other concerns for British manufacturers include issues around regulatory divergence and changes to the safety product testing certification process (or marking regime) which has been delayed until January 2023. The marking of UK-made goods will transfer from the current CE³ marking regime (for products that meet EU health, safety and environmental protection standards) to a new UK conformity assessed (UKCA) marking regime. Concerns focus on whether there are enough conformity assessment laboratories in the UK to successfully implement CA marking, the additional costs for UK manufacturers in moving from CE to UKCA, and whether multinationals will anyway choose to supply to the UK if they have to create two versions of the same product just to comply with two different marking regimes.

Overall, there have been significant extra costs in terms of non-tariff barriers on trade in goods which have impacted especially on smaller firms. Going forward, there are some early signs that the UK government may be prepared to review its ambitions to become a rule-maker as seen in the discussions over the shift from CE to UKCA kite-marks, and even to pragmatically align with the EU, as in the case of aviation . However, the post-Brexit trading arrangements for goods seem to be in a persistent transitory state. This can be seen in deadlines unilaterally being pushed back by the UK government multiple times. While this recognises the genuine difficulties faced by business in transitioning to new regimes, it also adds to uncertainty for such firms, and potentially stores up compliance issues in the future (Marshall, 2021).

3. Methodology

In order to explore the research questions introduced earlier, a mixed-methods approach was adopted. The methodology combines quantitative analysis of secondary data with qualitative analysis drawing on a novel interview dataset. The secondary data were used to assess the impact of Brexit on trade from a value-chain perspective, particularly noting the position of advanced manufacturing in the Midlands within European supply chains. This enabled us to obtain a holistic but targeted view of the sector, which in turn was used to inform the interviews. A pragmatist philosophical framework underpinned the research (Morgan, 2014), so as to enable the triangulation of various ontological and epistemological perspectives.

An inductive research approach was adopted, allowing for theoretical insights derived from the data analysis process. Given the difficulties in establishing a known population, an overtly hypothetico-deductive approach was eschewed. Instead, broader insights were obtained via an interpolative process of theoretical sampling, which closely aligns with

interviewing as an approach to data gathering (Foley et al., 2021). Doing so ensured that a sufficient selection of respondents could be obtained to allow for a modicum of theoretical saturation (Foley et al., 2021) and hence a cautious generalisation of our findings. In this context, the research design adopted was a case study in the context of the West Midlands and East Midlands. These NUTS1 regions were selected because prior work (Chen et al., 2018; Thissen et al., 2020) suggests that these regions' manufacturing sectors are particularly vulnerable to Brexit.

Qualitative primary data were collected in the form of 14 semi-structured interviews undertaken in late 2021, of approximately 60 minutes duration. These were undertaken with senior managers drawn from a variety of functional areas, including operations, finance and human resources (HR). Given the difficulties noted with firm classification, we took a relatively expansive view of the definition of the sector. The key to defining advanced manufacturing in this work was the use of sophisticated tools and methods in manipulating inputs (e.g. robotics) and innovative technologies and methodologies for improving competitiveness.⁴ Likewise, the primary criterion for interview selection was that these people 'owned' the issues of Brexit and Covid-19 in their businesses, for example in the sense that they had a major responsibility in their roles in terms of planning for and dealing with the implications of Brexit for their businesses. A mix of respondents across different tiers of the supply chain was sought as part of the theoretical sampling methodology, from major assemblers (Original Equipment Manufacturers or OEMs) to small and medium-sized enterprises (SMEs) further down the supply chain. Key summary statistics pertaining to respondents (sector, supply tier, firm size, etc.) are detailed in Table 1. The interview questions focussed on preparations for Brexit, supply chain responses to Covid-19 and related HR, regulatory and compliance issues arising from both events. A series of general questions were also asked in order to understand the utility of potential policy choices such as physical and digital infrastructure expenditure, addressing skills gaps, grants for R&D and tax changes.

Interview participants were provided with preliminary information about the purpose of the research to ensure fully informed consent, and the interviews were conducted in

Table 1. Respondents' key information.

Pseudonym	Sector	Location	Size of enterprise (approx. # employees)
Participant 1	Automotive	Midlands*	2000
Participant 2	Metal fabricator	Black Country	500
Participant 3	Industrial Service Provider	Birmingham	5
Participant 4	Metal fabricator	Black Country	150
Participant 5	Metal fabricator	Black Country	100
Participant 6	Metal fabricator	Black Country	100
Participant 7	Machine tools	Black Country	100
Participant 8	Jewellery	Birmingham	50
Participant 9	Metal fabricator	Black Country	100
Participant 10	Med Tech	Birmingham	600
Participant 11	Industrial Automation	Birmingham	100
Participant 12	Metal fabricator	Worcestershire	1300
Participant 13	Information Management for Manufacturing	Midlands*	15,000 (globally)
Participant 14	Information Management for Manufacturing	Midlands*	15,000 (globally)

*Owing to the size of these companies and the relatively low number of large OEMs in a given local area, the geographic locale of these participants has been kept less distinct in order to avoid identification.

accordance with the ethical tenets of voluntary participation, anonymity, confidentiality and non-disclosure where requested. The interviews were recorded online via secure digital recording platforms (MS Teams). Data were kept on secure servers, and all personal identifiers were destroyed upon the conclusion of the research (Office for National Statistics, 2019). In the sections that follow, we detail the research findings by addressing the three research questions spelt out above.

4. Findings

Our findings are organised in terms of outlining the cumulative impact of Brexit and Covid-19 on our respondents. In so doing, we wish to compare and contrast the immediate short-term impact of these disruptions with the longer-term impact. Our results suggest that firm size has been a critical factor in coping with these disruptions. Given that the cost of Brexit appears to fall especially on SMEs, policy recommendations focus on supporting the latter specifically to deal with and adapt to extra trade frictions will be discussed in the next section.

4.1. *The short-term impact on supply chains: from 'Just in Time' to 'Just in Case'?*

The most striking (and consistent) finding within our research was the extent to which firms' Brexit experiences varied depending upon their size. Typical of larger firms was this response from an OEM:

We had prepared for all reasonable eventualities of Brexit and had software in place and ready so we could start the year on the right foot. (Participant 1)

They went on to note that, 'There have been some documentation problems but really not very much'. Indeed, such was the minimal impact that they went so far as to state,

We had many more problems with our supply being disrupted when immigrants in the Channel Tunnel caused all sorts of problems a few years ago. (Participant 1)

In contrast, smaller firms suffered substantially. One had suffered an 11-week delay on components with a 7-week lead time (Participant 4). Another found that £40,000 of materials shipped from the EU to the UK was six weeks late, noting that, 'for a small company, such as ourselves, 40,000 pounds, being late is not good news'. (Participant 5).

As such, evident from some of our respondents was that the disruption to supply chains triggered by exiting the Single Market and Customs Union had resulted in lost orders from EU customers that in turn had triggered plant shutdowns and hence workforce redundancies; for instance, this respondent who had been forced to close a site in Worcestershire:

Germany stopped ordering as they always do in August ... That is not unusual. But then there was nothing in September either. And October, so, and then they want you to do a price reduction ... So, we parted company, which was very sad, because we've been working for them for 25 years or so and closed the site down ... this major company was taking around about 20% of our turnover, actually at that site. So yes, that site was taken away by problems with Brexit (Participant 5).

In this way, a key impact of Brexit has been to force changes in the nature of supply chain and logistics linkages. Interestingly, this appears partly driven by 'intangible' aspects of the infrastructure. As one respondent noted, 'I think the real problem was visibility, and efficiency, and productivity of the electronic systems that were put in place'. (Participant 14). Some of these would take months (due to the challenges of sourcing alternative suppliers and distributors, with contracts varying in time length) as companies re-evaluate the efficacy of utilising particular transport routes and modes.

Similarly, manufacturers based in the Midlands are having to re-examine the costs and benefits of producing and sourcing locally instead of elsewhere in the EU as the new trading relationship unfolds. In this regard, Brexit had impacted the operation of 'Just-in-Time' supply chains, with manufacturers stockpiling in the lead up to exit from the Single Market to try and avoid anticipated shortages of parts and components (in line with macro evidence presented earlier). To the extent that delays are now part of the system, firms' responses necessitated that some degree of resource slack (e.g. inventories) be built into their operations, 'Just-in-Case'. The timing of the UK's exit from the Single Market and EU Customs Union also appears to be a factor in this development, as noted by a respondent:

I think as we progress, this particular discussion, there's going to be sort of getting into this thought process around trying to get the perfect storm. Yeah, so we've got Brexit ... we've got COVID-19. In the US, we've got Biden's investment in North America supply chains, because he wants to reassure supply chains back to North America to prevent future disruptions, etc. (Participant 14).

Brexit also forced other adjustments in terms of the need to adapt to a new Customs declaration regime and the need for various checks on products exported to the EU. These changes have been particularly problematic for the smaller manufacturers and that lacked the expert capacity of larger firms. Intriguingly, this reality was corroborated by some of the larger firms in our sample. One noted that,

Many small companies bringing parts or materials into the UK were underprepared [...] Now that it is a reality some of our specialist suppliers have found the paperwork a challenge. (Participant 2)

Particularly acute issues are apparent when third-party logistics firms are involved, corroborating the earlier macro level issues raised in Section 2:

[W]e put them on [logistics firm] carriers, and they've I think both consignments have come back, certainly one has, because they just got stuck in customs somewhere. (Participant 6)

In contrast, another interviewee noted that,

When we've done it from the team within [parent company] run very smoothly when we're booking, transportation and a wagon comes over from Europe [...] it just comes to us and our other colleagues in the UK. That's gone pretty smoothly. (Participant 12)

Nevertheless, the increasing importance of 'just-in-case' manufacturing was not lost on respondents, with one expressing the view that 'So I think there will be an uptick in warehouse requirements, in my, my honest opinion. But we're still going to wait and see how that sort of plays out'. (Participant 14)

4.2. Long-term consequences

Moving beyond the immediate impact of Brexit, a number of issues were identified by our respondents as potentially having an impact upon their production configurations – most notably those relating to the ‘twin transitions’ around digitalisation and net-zero. A challenge raised by respondents was the extent to which dealing with both Brexit (and Covid-19) detracted from their capacity to focus strategically on these longer-term challenges and opportunities (e.g. electrification in the automotive industry). As Participant 12 framed the issue:

Both of those [Brexit and COVID-19] if I’m being frank and honest with you are really unhelpful distractions for us as a company as we’ve got a topic called climate change on the horizon. The products that we generate 100% of revenue and profit from today and likely to be banned in this decade, so that should be what we’re concentrating our minds and efforts on. These short-term challenges are seriously a distraction from us really focusing on those challenges. (Participant 12)

Notwithstanding the regulatory imperatives, this is also increasingly important from a consumer perspective. ‘Ethical sourcing is at the top of mind with [sic] every consumer today, knowing where there’s going to come from’, as pointed out by Participant 14.

Of course, climate change and the drive towards greater sustainability raise a host of wider issues. In this sense, Brexit (and even Covid-19) are likely to be precursors to a far greater period of disruption. Disruptive weather is already a challenge in some sectors:

[There was] a big weather event and they declared force majeure, and they lost a load of production capacity and many supply chains again across the world are expecting plastic shortages in the coming months as a consequence of that. (Participant 12)

Likewise, respondents saw automation and digitalisation inherent to Industry 4.0 as a longer-term issue. Many noted the opportunities inherent in this shift.

I think it [automation] creates the higher-level skilled jobs, the programming jobs the way to use the automation to use the automation, it does get rid of the dull, dirty, dangerous tasks. (Participant 11)

Nevertheless, it was clear that there were profound implications for upskilling and lifelong learning since, ‘[t]hey [robots] take roles, they create jobs’. (Participant 11). Digitalisation throughout the supply-chain was also seen as a potential partial solution to ease some of the challenges raised by Brexit:

You know, one of the hottest trends at the moment in supply chain tech is around something called control towers. So the same way that the control towers at Heathrow guide and manage all the airplane movements, a control tower in the supply chain is used to manage all movements of trucks, multimodal logistics, if you will. So basically, the customer knows where their stuff is, where’s my order going to? When is my order actually going to arrive. (Participant 14)

Overall, our respondents painted a mixed picture in considering the longer-term implications of Brexit. Some felt that the current situation was simply that of constituting ‘tee-thing problems’, whilst others (e.g. Participant 11) argued that the imposition of new trade checks was only pressing if products had a tight transit schedule to reach final markets (as with that of fresh produce for example):

We are confident that it will settle down, and delays have been in terms of hours and an occasional lost shift, may be a day or so, but not weeks and months of sustained disruption to manufacturing ... Brexit has not been as much of a disaster as it could have been, but that is partly because of our own preparation and flexibility, and hard work by our logistics people. (Participant 2).

Nevertheless, SME participation in wider supply chains was repeatedly raised as a problematic longer-term issue.

Sometimes, it's difficult to get to on big projects [...] it's difficult to get to the first tiers that are going to be purchasing from SMEs. (Participant 9)

Some expressed a degree of – sceptical – hope that government would look to help address some of these value-chain issues, at least in industries where public-sector procurement was dominant.

So, HS2, you know, rail, nuclear, all these industries that allegedly, are going to flourish in the UK under our new sort of deal with sovereignty that we've got now, I have to say that has to be delivered, they have to start getting UK SMEs into the supply chain (Participant 4)

Some other long-term ramifications from Brexit were related to the use of EU labour and skills. Almost our entire sample had at least part of their workforce from the EU. While most (but not all) existing employees had chosen to remain in the UK, there will be significant changes and challenges moving forward. Indeed, one firm stated that 80% of its workforce was European. Respondents repeatedly noted that they had gaps in terms of skillsets – and these will only become more difficult to plug now that they have lost access to a broader pool of European talent, even with a relatively liberal post Brexit immigration policy (see Portes & Springfield, 2023, in this issue). Once again, a disparity was seen across larger firms and their smaller counterparts in terms of how to access resources to tackle such issues:

Most SMEs are still completely oblivious to how apprenticeships work, the benefits and how they could access them. (Participant 10)

Last but not least, there was concern expressed over the prospective impact of any regulatory divergence going forward. For example, the repeatedly delayed introduction of the new UK Conformity Assessed (UKCA) kite-mark for product labelling to meet agreed regulatory requirements (health, safety and environmental issues) to replace the current EU CE-mark was seen to be particularly problematic in this regard by a couple of our respondents:

So, we've got a big spike of activity going on now where every product and of course, because of our multiple locations ... We've got to get all the existing product portfolio UKCA marked. And then there's a few complications around Ireland, which is a pain in the butt ... (Participant 12).

5. Discussion and policy implications

What is clear from the findings above is that at the firm level, the additional costs arising from exiting the EU Single Market and Customs Union are leading to supply chain adjustment. By way of illustration, in 2022 the Tier 1 automotive supplier, GKN closed its historic

Birmingham driveline plant and shifted assembly to Poland, France and Italy to be closer to major end-users.⁵ Drivelines previously assembled at Birmingham used components from UK, Spain, Italy, France and Germany, with components and the final assembled driveline crossing the Channel several times. Post-Brexit this became a much more challenging and costly process to manage, given the highly intertwined nature of the supply chain. The plant closed in the summer of 2022 with the loss of over 800 jobs. An added downside was that drivetrain production for electric vehicles (EVs) would subsequently not take place in the UK, even though the development of the firm's new e-drive system had been heavily supported by the UK Government through Innovate UK. Overall, this results in regionally significant job losses and the UK losing its role in an important segment of the EV supply chain.⁶

Interestingly, our interviews suggest that firms were beginning to consider at least reshoring opportunities given supply chain disruption globally (although there can be substantial barriers to such trends as previous work has noted – see Bailey & De Propriis, 2014). But as one participant noted, from a global manufacturing perspective that might involve reshoring to Europe, not necessarily the UK:

[W]e've seen a massive increase in price at [sic] China [...] there's been massive increases in metal price and massive increases in logistics costs. I think shipping around the world is going to become less and less favourable, and local [European] manufacturing is going to benefit in the long run, I hope. (Participant 13)

The findings also highlight that a key issue for participants was how to source and develop the right skillsets in their workforce to deal with these emergent changes. As such, a key policy response is investing in appropriate skills. It should be noted that skill shortages can be observed across different stages of the value chain and not only in the case of high-skilled (engineering) posts. These clearly signal a need to rethink the national-regional-local education-skill system. This needs to extend to life-long learning to improve the skills of workers already working in the auto and related industries.. Brexit has had a major impact on firms in this regard and is likely to have an ongoing impact, given the longer-term challenges around skills notwithstanding the UK's liberal migration policy post Brexit (see Portes & Springfield, 2023, in this issue):

I mean generally the business has had to battle with skills gaps for the last 10 years really. (Participant 4)

it's a key area in engineering, generally is a lack of engineering skills. (Participant 9)

[W]e [are] just trying to catch up with the skill demand that we need [...] because we've got gaps in competencies and knowledge. (Participant 10)

There is also a broader question about the right spatial scale over which to target skills interventions. The UK has deep-seated inter-regional disparities compared to many of its international peers (McCann, 2019), with recent calls for greater decentralisation of powers and resources to tackle these (Labour Party, 2022). Even such calls, however, fall short of calling for a much greater devolution of skills policy and provision to the regional scale, with the necessary focus on (regional) labour demand. Likewise, an appropriate place-based industrial policy (see Bailey, Pitelis, et al., 2018) needs to complement such skills-focussed policies with targeted infrastructure enhancements. One element of a

regionally focussed education programme could involve vocational education targeting pre-existing regional strengths. As participant 13 put it:

[We need more] apprenticeships without question [...] The apprenticeship [*sic*] there used to be available to people in my day were phenomenal. Today you barely see apprenticeships. [We need more] college education rather than university education, I think [it] is much more favourable to industry and manufacturing. To me, it was a godsend. (Participant 13)

What emerges from interviews (and is in line with macro evidence summarised earlier) is that Brexit has damaged the ability of manufacturing SMEs to diversify by imposing additional trade barriers with close neighbours geographically. Policy needs to therefore focus on removing or mitigating such barriers as far as possible. With joining the Single Market and Customs Union off the agenda politically, policy could focus on assisting smaller firms in the supply chain on several fronts (as the British Chambers of Commerce has highlighted recently – BCC, 2022). For example, extra support in understanding and complying with new requirements around rules of origin and customs is necessary in the former case to avoid tariffs being imposed and in the latter case to help firms meet tight just-in-time delivery ‘slots’ without hold ups and penalties.

Any incentives need to recognise the disparity in resource slack between SMEs and larger firms. As one respondent said:

If you’re a new start-up company, you’ve got a totally different requirements than a medium sized company that’s been going for 50 years. There’s no point giving me tax breaks next year if I could have no cash flow this year. So, we do need to look at them. (Participant 11)

Place-based industrial policy further needs to respond to the challenges of Industry 4.0 in a more forward looking way. As pointed out by our participants, the future of manufacturing will be increasingly shaped by Industry 4.0 including human-machine interaction (in all its forms) and the growing use of ‘big data’.

Now, like I said, some of the robots for collaboration with people and they really are cobots (collaborative robots), we put a couple in, handling parts of people using them as very intelligent partners [...] So, I think automation will be [increasingly] used. (Participant 11)

[T]he new business currency is going to be tracking, you know, tracking data across, across companies across joint ventures, across device trees, across vehicles, regardless of where they are, and the lifecycle. (Participant 14)

Incentivising digitalisation in terms of supply-chain management will be another aspect of this, and might help companies navigate Brexit-induced supply chain bottlenecks, as pointed out:

So leveraging AI and machine learning to predict what’s likely to happen in the future, around the supply chain based on all this historical data that you’ve captured. (Participant 14)

A high prevalence of medium and high-tech sectors in the UK (which substantially overlap with advanced manufacturing) should be associated, in theory at least, with high levels of regional resilience to shocks (Brakman et al., 2015), but our interviews suggest that the nature of trade disruption flowing from Brexit induces vulnerabilities. These particularly impact smaller companies and suppliers, and policy needs to take account of this to support such businesses in diversifying. Furthermore, there is a need to pay closer attention to ultimate ownership and decision-making than has hitherto been the case. This was

illustrated in our sample, where the decisions of the global parent company ultimately led to the loss of pivotal contracts and wind-down of parts of manufacturing.⁷

It was really more about the relationship between [corporate parent] and [OEM A] from a corporate level [...] Business Development North America suddenly got involved because [OEM B] is a massive customer of ours globally [...] but, our [UK plant] main customer was [OEM A]. So [OEM A] understood very quickly [...] OEM B] would always get preference. So if we were running really tight on capacity here, if anybody was going to be stopped, then stop [OEM A] production line rather than [OEM B]. (Participant 13)

6. Conclusions

A key finding of this paper is that the imposition of new non-tariff barriers through Brexit has proved particularly challenging to smaller firms in manufacturing supply chains. The findings of our research highlight the need for policy support in a number of areas, particularly around skillsets and access to talent, cost reduction for exports and facilitating trade. There is a clear need to support smaller supply chain firms: there is a risk of further ‘hollowing out’ of the UK-located manufacturing. Opportunities for ‘reshoring’ are seen as existing by manufacturers but will be limited without a more supportive industrial policy to push this along (Bailey & De Propriis, 2014). This is reinforced by skills shortages which have impacted production. Boosting productivity through investment in plant and new equipment will be necessary, especially in the context of industry 4.0. Furthermore, our research has illustrated that the ways these developments play out at the micro-level will vary for individual firms and their industries and could entail a variety of scenarios and mitigating responses. What we can say, however, is that our findings suggest that trade barriers have increased post Brexit and that they have impacted most on small firms especially. This correlates with macro evidence highlighted in Section 2. Further research could usefully explore these issues, across sectors and regions, and in the form of longitudinal studies tracking individual firms and stages of the supply chain over time.

Notes

1. Just-in-time (JIT) production systems are widespread across UK advanced manufacturing, logistics and retail, and especially those sectors highly integrated with the rest of Europe. In JIT supply chains, firms hold little or no inventories. Supplies are delivered in very small quantities at high frequencies from suppliers which are located in nearby regions or countries. As well as reducing costs, a key advantage of JIT systems is in maximising quality. JIT systems allow for errors in production or machining to be identified quickly and for problems to be rectified as they arise. Many thousands of UK firms depend critically on JIT systems to ensure their products and services are competitive on international markets. But for JIT to work, the whole delivery system has to be seamless or frictionless. Such systems are especially important in those regions of the UK with strong manufacturing bases such as the Midlands (Bailey, McCann, et al., 2018).
2. <https://www.euractiv.com/section/economy-jobs/news/uk-confirms-plan-not-to-introduce-checks-on-eu-goods-until-2024/>
3. The *Conformité Européenne* (CE) Mark is the EU’s conformity marking for goods sold within the European Economic Area (EEA). It is a declaration by manufacturers that products comply with EU Directives.

4. <https://weforum.org/communities/advanced-manufacturing>
5. See: <https://www.theguardian.com/business/2021/feb/25/melrose-plans-close-gkn-factory-birmingham>
6. The recent collapse of Britishvolt has highlighted concerns that the UK is not doing enough to build a supply chain for battery electric vehicles.
7. These issues are long-standing and were highlighted in an earlier literature developed by Cowling and Sugden (1998) and others.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The authors would like to acknowledge the funding support provided by the ESRC's UK in a Changing Europe programme under grant number S/T000848/1 and the Midlands Engine and Research England (West Midlands – Regional Economic Development Institute).

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