

PIN - Productivity Projects Fund

Small Project Report

Global Supply Chains, Skills and Resilience After Covid-19

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About PIN

The Productivity Insights Network was established in January 2018 and is funded by the Economic and Social Research Council. As a multi-disciplinary network of social science researchers engaged with public, private, and third sector partners, our aim is to change the tone of the productivity debate in theory and practice. It is led by the University of Sheffield, with co-investigators at Cambridge Econometrics, Cardiff University, Durham University, University of Sunderland, SQW, University of Cambridge, University of Essex, University of Glasgow, University of Leeds and University of Stirling. The support of the funder is acknowledged. The views expressed in this report are those of the authors and do not necessarily represent those of the funders.

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Abstract

The purpose of this project is to identify the mechanisms that firms can use to improve the resilience of their supply chains and the implications that these may have on the demand for skilled workers. The importance of mechanisms to absorb shocks to supply chains has been highlighted by the impact of COVID-19 on global supply chains. However, very little is known on the impact that alternative mitigation strategies may have on the demand for skilled workers. In this project, we develop a small model of supply chains and study alternative configurations of the supply chain. The results show that sourcing suppliers from a number of geographies may insulate the focal firm from major disruptions to the supply chain. Importantly, if the suppliers are drawn from countries that are closer to the technology frontier, the supply chain may help transfer knowledge spillovers from the suppliers to the focal firm. As result, the focal firm's demand of skilled workers may increase.

Background

While there is optimism among policy-makers that the pandemic may be under control, there is a number of challenges that need to be addressed before the world economy can go back to the pre-COVID19 levels.

First, the pace of vaccination is not even in the world and in turn, this, may limit cross-border movements of goods and people. This means that the risks associated to the disruption of the supply chain are still there and the expectation is that these disruptions will not be as global as in early 2020, it is reasonable to expect firms to learn to strike a fine balance between local and global.

Of course, changes to the supply chains may imply that some industries or companies will face more disruptions while some other industries may benefit from these changes. Second, it is still unclear the impact of the pandemic on the labour market. Once the government support is withdrawn, unemployment may increase although there is still some discussion on which types of employment will be affected most. In this respect, the aftermath of the 2008 financial crisis showed that companies may tend to change the ratio between skilled and unskilled occupations after large scale shocks and as a result they may not be able to take advantage of new opportunities, e.g., those related to reorganisation of global supply chains, that emerge in the post-Covid-19 world.

Against this background, the research project has focused on the following research questions:

- (1) *Are supply chain configurations with many suppliers and buyers (many small players in a network structure) better in dealing with disruptions compared to those with a single supplier and buyer (serial structure)?*
- (2) *What is the additional benefit of geographical dispersion of suppliers and/or buyers in situations where major global disruptions hit multiple supply chain entities (e.g., backup suppliers or alternative customers) at the same time?*
- (3) *How does the skill mix in a firm change following the re-organization of the supply chain? Under what conditions can they increase the demand for skilled workers?*

Literature Review

The interest in supply chain disruptions and resilience has grown over the last year. Generally speaking, the literature has been interested in two aspects of the supply chain structure: a) its *configuration* (or the structure of the network underlying the supply chain) and b) the *location* of the suppliers. Traditionally, a small number of suppliers (concentrated in a region) may offer the focal firm the opportunity to develop longer term relationships which may reduce transaction costs and delays. In addition, geographical concentration may reduce costs of managing a large network of suppliers and increase the profits of the focal firm. However, geographical concentration of suppliers may be costly as it exposes the supply chain to region-specific shocks. Therefore, it makes sense for the focal firm to increase the geographical dispersion of suppliers across several geographies to create a resilient supply chain. Still, there are clearly implications on the transaction costs as now the focal firm has to manage suppliers based in a number of locations, but the benefit is in avoiding the large costs associated to a major disruption of the supply chain.

Previous research is inconclusive about the optimal level of geographical concentration; in addition, there is some discussion that geographical diversification may not be the best strategy for SMEs which may not be able to manage efficiently large number of suppliers either because they do not have the financial resources or because they do not have sufficient market power in the suppliers' market. Crucially, this literature overlooks the impact that changes to the supply chain have on the demand for skilled workers in the focal firm. This is an omission which is justifiable given the fact that most literature on supply chain management assumes the production function of the focal firm (and implicitly its skill mix) is given. The reality of the post-pandemic world makes it a risky assumption: for instance, in the UK changes to the furlough regime may induce an increase in unemployment. At the moment, it is unclear whether specific types of occupations will be affected mostly; still, the implications for the supply chain management are clear: it is not realistic to assume that the skill mix is constant for focal firms which may (for other reasons) start a process of internal re-adjustment of its skill base as well as changing suppliers. How do the two processes affect each other? Will it be possible to mitigate the supply chain risk while changing the skill ratio in favour of the skilled workers?

Model

We have developed a model where three alternative designs of the supply chain have been considered and have analysed the impact that each of these designs has on the focal firm's profits and on the demand for skilled labour. We assume that the focal firm can change the structure of the supply chain and that can choose from a number of suppliers of different size and from different geographies. One scenario assumes that the focal firm sources materials from two suppliers of the same size in the same region while the alternative scenario assumes that suppliers are located in different regions and are of the same size. Finally, the third scenario assumes that the two suppliers differ in term of size (while being located in different regions). We also assume that suppliers (even if they belong to the same industry) differ on the basis of their distance from the technology frontier that is, suppliers may use different technologies which may either be on the technology frontier or away from it.

Shocks are modelled in line with the current literature on supply chain management (see for instance Meena et al., 2011). Therefore, we consider three types of shocks in our model: (1) disruption at a supplier, (2) demand disruption (a buyer requesting to cancel an already placed order), and (3) disruption to the transportation network. We assume that the shocks follow a Poisson distribution and that they do not hit all the regions in the system. Clearly, in the case of suppliers co-located in the same region, the shocks hit all the suppliers at the same time, and we can safely assume that the duration of the shock is the same for both types of suppliers. Viceversa, in the case of a supply chain distributed across two locations, shocks do not hit the two locations at the same time. Importantly, the shocks do not affect the technology employed by the suppliers and we can assume that their position with respect to the frontier technology is unaltered as a result of the shocks.

Results

The results of the simulation show that sourcing materials from suppliers located in different geographies improves resilience of the supply chain and allow the focal firms to maximise the revenues and through that route its profits. This result is independent of the size of the suppliers although a shock to the large suppliers implies that the level of profits in the focal firm will be lower than in the alternative scenario when the shock hits the small supplier.

Another key difference is that the focal firm has to face increasing transaction costs when managing a supply chain across different locations. In our model, the transaction costs vary with the size of the orders from each supplier and therefore the final transaction costs faced by the focal firm vary with the type of supplier mostly affected by the shock. In spite of this, a dispersed supply chain configuration is the best scenario for the focal firm. Our initial simulations show that the profits of the focal firm fall by 30% on average in the case of a concentrated supply chain and this result highlights the fact that the economies of scale that can be a source of competitive advantage in the case of concentrated supply chains may be useful in the case of large-scale shocks.

The simulations show clearly that there is an important trade-off that the focal firm has to consider when deciding the structure of the supply chain that is, the balance between the extra-profits generated by the increasing flexibility of the supply chain and the extra costs associated to the management of several suppliers. This trade-off may be relevant to SMEs that may face financial constraints and therefore might forego the extra profits to be able to save on costs.

The results from the simulations have also shown how important reliability of the suppliers is to the working of the supply chain. Indeed, unreliable suppliers (that is, suppliers with an history of missed orders) are more exposed to shocks than other types of suppliers and therefore when a large-scale shock happens, they are more likely to collapse in a catastrophic way. Therefore, in a world where shocks are frequent, reliability of suppliers becomes an important indicator of the supply chain's robustness and should trigger reconfigurations of the supply chain.

The simulation model has also focused on the impact that alternative supply chain designs have on the focal firm's demand for skilled work. Changes to the structure of the supply chain affect the demand for labour through the changes in revenues and

costs and the simulations of the model confirm this result: the configurations of the supply chains affect the focal firm's costs and revenues and while trying to manage the overall costs, the focal firm may need to change the mix of skilled and unskilled workers they hire. This option can be particularly relevant to firms that are cash-constrained or face substantial financial constraints (such as SMEs).

We have studied in our simulation model whether there are particular configurations of the supply chain which may not have a negative impact on the demand for skilled workers in the focal firm. We have in particular focused on the distributed supply chain scenario which better insulates the focal firm from large-scale disruptions to the supply chain. In this case, the balance between costs and revenues drives the demand for skilled work but crucially, the position of the supplier with respect to the technology frontier has an important bearing on the focal firm's revenues which are now an increasing function of the supplier's distance from the frontier. The intuition is that suppliers that are more advanced technologically can induce the focal firm to improve the quality of its final product(s). Ultimately, increasing quality may boost revenues and support the demand of skilled workers in the focal firm.

Conclusions

The major contribution of the project is in the analysis of impact of alternative supply chain configurations on the demand for skilled workers. Changes to the structure of supply chain are considered to be an example of proactive measures that can absorb the impact of major shocks or disruptions. This tend to be considered strategic decisions which require upfront investment and time and therefore a lot of research effort has been devoted to the topic. Most studies have focused on these proactive measures but have not considered the impact on other dimensions of the focal firm's production process such as the skill mix of its workforce.

One major contribution of this research is the analysis of the impact of supply chain changes on the demand for skilled workers. However, in studying the relationship between supply chain and demand for skilled workers, we have also contributed to the literature on the "ripple effect" which is commonly used to identify high-risk suppliers and to inform alternative configurations of the supply chain. In this project we have expanded the concept of ripple effect and studied its impact on labour demand and the focal firm's skill mix.

We find that "proactive alone" measures improve profits for a given skill mix, but they may have an adverse impact on the skill mix of the focal firm unless this is using suppliers which are closer to the technology frontier. Our policy recommendation is to direct business towards suppliers which are closer to the technology frontier and later engineer a change in the supply chain structure after a careful evaluation making sure that profits would not suffer.