Department for International Trade

Analysis

Exchange Rates and Trade

Final Report

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Economic Insight

This is a report of research carried out by Economic Insight, on behalf of the Department for International Trade.

Economic Insight is a leading economics consultancy that combines rigorous analysis with exceptional consulting skills. Economic Insight works closely with government departments and public policy teams to help deliver better public policy design and communication.

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1. Introduction and executive summary

1.1 Background and objectives

Economic Insight has been commissioned by the Department for International Trade (DIT) to undertake research into the complex impact of exchange rates on international trade, with a specific focus on the UK.

DIT secures UK and global prosperity by promoting and financing international trade and investment, and championing free trade. The Department helps businesses to export, drives inward and outward investment, negotiates market access and trade deals, and represents the UK's interests at international institutions, monitoring and evaluating its interventions to achieve the greatest impact.

As such, it is vital that DIT has a deep understanding of the role of exchange rates in the UK's international trade volumes. Traditional economic theory anticipates a relatively simple relationship between exchange rates and trade volumes, where export volumes increase and import volumes decrease for a depreciation in the country's exchange rate (and vice versa for an appreciation). However, recent events in the UK suggest this relationship may be much more complex, with UK trade volumes responding less than anticipated in response to exchange rate fluctuations, notably after the depreciation in the pound following the EU referendum result. It is essential that DIT understands these potential complexities and the implications they may have on achieving its objectives. Therefore, the primary purpose of this research is to equip DIT analysts and policy colleagues with the knowledge required to understand the complex issues and relationships surrounding exchange rates.

This report details the process, findings and implications of research into the impact exchange rates have on international trade. This section provides a summary of each element of the research methodology, including the key results, before outlining the main conclusions and policy implications of this research considered as a whole. More detail is then provided in turn for each of these research elements in subsequent chapters of the report.

1.2 Methodology

In order to ensure the robustness of the findings, a mixed-method approach was adopted so that conclusions are based on a broad range of insights. This comprised four elements:

i. a review of academic, grey[1] and commercial literature;

ii. an online survey of UK businesses trading internationally;

iii. case study interviews with UK-based trade associations; and

iv. an econometric feasibility study, assessing the potential to conduct further empirical work.

The approach to each of these and the main findings from the research are discussed in turn. Before this, a brief outline of the conceptual framework used to structure the research and tie each research element together is provided.

1.2.1 Conceptual framework

To guide the research, a conceptual framework was designed at the outset. The purpose of this was to ensure each aspect of the research was itself clearly structured, as well as being consistent with the other areas of research. This enabled comparisons across the different parts of the research and allowed the findings from the earlier stages to inform the methods for the later aspects.

The conceptual framework considers the impact that exchange rates have on trade in two overarching categories. *Firstly*, the **macro-level** transmission mechanisms. These relate to the role of exchange rates in the economy as a whole, and the impact they have on trade at the aggregate-level. Within this level of the framework, the following concepts were considered: the Marshall-Lerner condition; the J-curve; the S-curve; and Keynesian absorption theory.

Secondly, the **micro-level** transmission mechanisms. As the macroeconomic effects are ultimately driven by what happens at the micro-level, it is important to also consider the market- and firm-level impact of exchange rates on trade. This part of the framework looks at how exchange rates factor into trading firms' pricing and volume decisions. The topics covered were invoice currency, globalisation, heterogeneity, volatility, and expectations.

1.2.2 Literature review

A review of 185 academic, grey and commercial articles was conducted. The literature was selected for review based on a search strategy, using Google and Google Scholar as well as the JSTOR and Elsevier databases. Search terms were selected, in consultation with DIT, to generate insight across the full range of priority topics.

[1] Grey literature refers to articles from non-academic research institutions, such as the IMF and Bank of England.

The main finding from this review is that micro-level theories should be prioritised over the macro-level in explaining the relationship between exchange rates and trade volumes. In general, the literature suggests a degree of disconnection between exchange rates and trade at the aggregate-level, and it appears this can largely be explained by micro-level factors. The disconnect at the macro-level may also be the result of difficulties inherent in estimating the relationships predicted in these theories, due to complicating factors, rather than these theories not holding. Nonetheless, the research suggests it would be appropriate to place more emphasis on micro-level theories, for which there is robust and consistent evidence in the literature. Macro-level theories should still be acknowledged, but this should be consigned mostly to explaining the relationship between exchange rates and trade in the long-run, where there is some evidence to suggest that the predictions of these theories can hold over a longer time horizon.

More generally, the reviewed literature suggests:

- **The invoice currency (i.e. the currency chosen for trade contracts) can have a significant role in the link between exchange rates and trade.** The basic theory explaining the impact of exchange rates on trade generally assumes that exporters price goods and services in their own currency. However, vehicle currencies are now used extensively in world trade (including in the UK), meaning that exports are often sold in a currency unrelated to either trading party. As a result, fluctuations in countries' own currencies have considerably less influence over the price of their exports, as these are priced in terms of separate currencies. Furthermore, many exporters price goods and services in the currency of the country receiving the export (local currency pricing) rather than their own currency. This can lead to fewer price movements in terms of the local currency following exchange rate fluctuations, reducing the impact on trade volumes (as compared to when exporters price in their own currency).
- **Global value chains seem to suppress the response of trade to exchange rates.** As a consequence of globalisation, final products or services are often comprised of inputs from multiple countries. This means that exporters sell products or services that have large imported components, and as a result the change in export prices resulting from an exchange rate fluctuation is offset by the fact that the input costs change in the opposite direction. One caveat to this point for the UK is it has a high value-added ratio relative to other countries, meaning – in relative terms – that UK exports have a lower proportion of imported components on average. This means the suppressing effect of global value chains is likely to be not as strong for the UK.
- **There appears to be a high degree of heterogeneity on the firm and industry-level.** The research indicates that the role of exchange rates varies depending on factors such as: the size and productivity of firms; the level of imported costs; product differentiation; industry-level inflation; goods versus services; and distribution costs. Crucially, this appears to contribute to why

many macro-level theories and studies of trade in aggregate often fail to adequately explain the impact of exchange rates on trade. For example, a country with a large manufacturing industry (a sector with low exchange rate pass-through[2] according to the literature) would likely have a weaker response to exchange rate movements *as a whole*.

- **There is no current consensus to the effect of exchange rate volatility and exchange rate expectations on trade.** While there is relatively strong and consistent evidence on the topics outlined above, exchange rate volatility and expectations – while expected to be important factors in understanding trade responses in theory – present mixed results. On volatility, there is a rich literature, but with inconclusive results overall. Although intuitively volatility is expected to act as an impediment to trade, its full effect is unclear – at most one could say that it has a weak negative impact on trade. In contrast, the level of research on expectations is less developed and has few solid conclusions. However, caution should be exercised as there is some suggestion in the literature that excluding expectations from exchange rate studies altogether may lead to an incomplete understanding.
- **As noted above, there are indications that the relationship between exchange rates and trade volumes in aggregate is restored in the long-run.** The literature suggests that in the longer term, the differences in responses to exchange rates driven by micro-level concepts – such as the choice of invoice currency – become narrower. That is, over an extended time horizon the impact of exchange rates on aggregate predicted by macro-level theories is more likely to be observed.

In addition to literature relating directly to the conceptual framework, evidence on recent events that have impacted UK exchange rates and their relationship with trade was reviewed. Specifically, literature pertaining to the following three events was reviewed: (i) the EU referendum; (ii) the global financial crisis; and (iii) COVID-19. Overall, and perhaps unsurprisingly, the literature suggests that these shocks have material implications for UK trade.

The lack of a trade response from the depreciation of the pound following the EU referendum appears to be explained through: (i) greater use of the dollar for trade invoicing; (ii) global value chains suppressing the impact of exchange rates on trade; (iii) anticipation of future tariffs reducing trade levels; and (iv) trade policy uncertainty. While the global financial crisis also induced a depreciation in the pound, the effect of this on trade appears to have been outweighed by factors independent of exchange rates. In addition, there is some evidence to suggest that compared to before the crisis, the relationship between exchange rates and trade has weakened. Finally, although the evidence around the impact of COVID-19 on trade is nascent, it seems clear that it has and will have a large negative effect on trade globally, and similar to the global financial crisis, exchange rate effects will be outweighed by other factors. Issues that would be of most importance in determining the effect of the

[2] Exchange rate pass-through refers to the responsiveness of prices to exchange rate movements.

pound depreciation from COVID-19 on trade volumes appear to be: (i) the choice of invoice currency; (ii) global value chains; (iii) the stock of external debt; and (iv) the industry composition of trade.

1.2.3 Fieldwork – survey and case study analysis

Following the literature review, fieldwork was conducted to assess the micro-level of the conceptual framework in greater detail. This comprised two parts: (a) a survey of UK businesses; and (b) a case study of UK-based trade associations.

A survey of businesses registered in the UK involved in international trade was run from the 14th July 2020 to the 29th July 2020 and was hosted online by the market research company Omnisis.[3] After removing 40 responses that did not meet the quality assurance process, there was a final sample of 124 firms. The survey asked respondents about the importance of exchange rates to business decisions in broad terms as well as asking how firms reacted to four episodes which saw fluctuations in the value of the pound: (i) depreciation after the EU referendum, (ii) depreciation from April to August 2019, (iii) appreciation from August 2019 to December 2019, and (iv) depreciation around the outbreak of COVID-19.

Care needs to be taken when interpreting the results of this survey as the sample is insufficient to be representative of the population of UK firms trading internationally and, consistent with all surveys, responder bias is possible. Taking this into consideration, the central findings from the survey are as follows:

- Consistent with the literature review (see above) and case studies (see below), **firms appear to face obstacles (nominal rigidities) which limit the response to exchange rate fluctuations**. In particular, the responses emphasised that invoice currency may be key to understanding the international trade response to exchange rate fluctuations:
    - The majority of respondents indicated that prices in the main invoice currency were *not actively changed* in response to exchange rate fluctuations, and even more businesses indicated that quantity was not actively changed.
    - **Exchange rate pass-through therefore seems to be driven overwhelmingly by the invoice currency and is mostly either zero or complete**. As a high share of respondents use the pound in the survey, relative to that observed in the population of UK firms trading

[3] https://www.omnisis.co.uk/

internationally, this may potentially overstate the export price response and understate the import price changes.[4]

- In contrast**, there is limited heterogeneity in the exchange rate response across firm characteristics** in the survey (e.g. position in supply chain, industry, type of good), which is slightly inconsistent with evidence from the literature review and case study. To the extent that cross-firm differences, such as industry or position in the supply chain, drive exchange rate pass-through, this seemed to be via the invoice currency.

- **Three factors appear to restrict the trade response of firms to exchange rate movements**: (i) exchange rate expectations, (ii) the length of contracts (i.e. the duration for which trade contracts were set), and (iii) the size of the exchange rate fluctuation. When asking respondents what factors restricted their trade response to exchange rate fluctuations, these factors were emphasised above all others.

In the case of exchange rate fluctuations around the time of the EU referendum and COVID-19 crisis, survey responses suggest non-exchange rate factors seem to be important in business decision making and likely outweigh exchange rate considerations, consistent with the literature review. For instance, a non-trivial number of firms indicated they changed prices in the opposite direction economic theory would predict, given the exchange rate depreciation following these events.

Following on from the business survey, case study interviews were conducted with five trade associations representing UK and international businesses involved in international trade. The aim was to discuss in greater detail the findings from the literature review and business survey. The key findings from these discussions are:

- Consistent with the literature review, **invoice currency rigidities due to contract terms (from invoicing in US dollars or euros) and global value chains suppress the relationship between exchange rates and trade**.

- A possible explanation for this is that firms often have long-term contracts for cross-border trade. This prevents prices and volumes adjusting to exchange rate movements in the short-term and mitigates the effect of exchange rate volatility on trade. To balance the effects of large movements in the exchange rate however, many firms employ hedging mechanisms via forward contracts.[5]

- Also consistent with the literature, **interviewees indicated there is sizeable heterogeneity across firms**. All trade associations stressed that there is no uniform response across members, and across trade associations different

[4] This is based on HMRC customs data: https://www.gov.uk/government/collections/currency-of-invoice. Note, while this relates only to non-EU trade, pound invoicing is still considerably lower than suggested in the survey.
[5] Forward contracts occur where trading partners commit to a set price or volume of trade for a fixed period into the future.

issues were emphasised, which seems to reflect the idiosyncrasies of each industry and firm. The size of the firm in question and their importance is likely to be key to determining the response to exchange rates. Most trade associations indicated that the larger a firm (i) the more able it would be to dictate or alter contract terms, including the invoice currency, and (ii) the better equipped it would be to hedge exchange rate risk, as unlike small firms larger companies should have available funds to engage in substantial hedging.

1.2.4 Econometric feasibility study

An econometric feasibility study was conducted with the purpose of informing DIT and other researchers on how econometrics could be used to further enhance their understanding of the relationship between exchange rates and trade, beyond that provided by the literature review and fieldwork. To develop this, the literature review and survey results were used as a starting point to identify separate modelling possibilities suggested by each. The scope of the study was to provide a range of options and recommendations for using econometrics for different purposes, as opposed to implementing any models.

Although the research suggests that emphasis should be placed on micro-level theories rather than macro-level concepts, as explained above, full consideration was given to macro-level theories in the econometrics feasibility study. This is because: (i) often models that tackle micro-level subjects consider trade at the macro-level, due to data availability issues at the micro-level; and (ii) it would allow DIT and others to test the robustness of findings from literature for macro-level models. These models and the research questions they seek to address are outlined in full in the main report but are omitted here for brevity.

1.3 Conclusions

The sum of evidence gathered in the research approach outlined above indicates three main conclusions. Each of these emphasises the importance of micro-level transmission of exchange rate fluctuations through to international trade and suggest less focus on macro-level theories.

1. **Micro-level theories and the obstacles firms face in adjusting to exchange rate movements appear to be key to understanding the impact of exchange rates on international trade volumes**. In contrast, macro-level theories seem to perform poorly in explaining the role of exchange rates on international trade, except in the long-run. Therefore, the balance of empirical evidence suggests there should be a greater focus on micro-level theories and evidence, rather than the macro-level, at least in looking at short to medium term dynamics. It is possible that the mixed evidence for relationships

at an aggregate-level may reflect both: (i) fundamental difficulties in empirically testing macro-level theories; and (ii) a general disconnection between exchange rates and trade in the short to medium term. However, the micro-level evidence appears to explain a substantial part of the absence of a macro-level link and produces consistent findings across different research elements. Therefore, the most robust platform on which to base policy decisions and practical assistance is one that places greater emphasis on micro-level factors and gives less weight to the macro-level.

2. **Among micro-level considerations, the invoice currency seems to be the most important factor in determining the response to exchange rate fluctuations**. Specifically, businesses tend to keep the price fixed in terms of the invoice currency (for reasons such as being tied to contracts, or perceptions that fluctuations are not significant enough to warrant a price change), meaning businesses either pass-through all or none of an exchange rate fluctuation, depending on the invoice currency. Both the literature review and business survey highlighted invoice currency as important in determining the reaction to exchange rate fluctuations. In the business survey, although based on a small sample, the reaction to exchange rate fluctuations seemed to be driven entirely by the invoice currency. Where other factors were reported to explain variation in business response, this seems to be because they lead to differences in the composition of invoice currency. Therefore, when analysing the impact of an exchange rate movement, it would be appropriate to consider dynamics at the industry-level, and factor in invoice currency choices, which themselves may differ based on sector, product heterogeneity, firm size, and other factors.

3. **Other micro-level factors are likely to be important also, but across the various strands of research there was less consistent evidence of their impact on trade**:

    i. The growth of *global value chains* and firms' positions within those was emphasised in the literature and was mentioned in the case study interviews. However, this was not a major factor in the survey responses.

    ii. *Heterogeneity* across firms and industries was emphasised in the literature review and case studies but did not receive prominence in the survey responses.

    iii. The length and restrictiveness of *contracts* was also noted, especially in the case studies, and to a lesser extent the survey and literature review.

    iv. Exchange rate *expectations* and *volatility* were acknowledged by respondents in the survey and case studies, but due to difficulties in measuring these, there is limited evidence from the literature. Additionally, during the case studies it was noted that while expectations play a role, many firms would lack the resources to

reliably anticipate exchange rate fluctuations so would look to *hedge* rather than rely on expected movements in exchange rates.

Future research on this topic should focus on the main areas below, to further understanding and test the wider validity of the research findings:

- This report highlights the importance of micro-level factors and the potential heterogeneity across firms and industries in terms of the trade response to exchange rate fluctuations. Understanding sector- and firm-level characteristics that drive differences in the response to exchange rates would be a sensible next step for research in this area. For instance, deeper understanding of the invoice currencies used and the degree of global value chain involvement across different industries would help in estimating the overall impact of exchange rate fluctuations.
- The research presented mixed evidence on the role of expectations, but firms indicated that these are a consideration, especially when determining hedging strategies. Micro-level analyses of the role of expectations, specifically how important expectations are relative to other factors and how different firms account for them, would be a valuable extension to the research.
- The fieldwork that formed a major part of the research into micro-level issues is a good starting point for understanding the key issues governing the relationship between exchange rates and trade in the UK. However, both the case study and, to a lesser extent, the survey provided less insight for the service industry. This is in part due to the greater proportion of trade associations that represent manufacturing as compared to services and the desire to get a broad range of views in the initial survey. Nonetheless, given the importance of the service sector to the UK, it would be appropriate to conduct fieldwork solely on the service industry in the next stages of research.
- Related to the above, conducting a similar survey to the one in this research but on an expanded sample would be beneficial. The survey and its results were helpful in identifying initial findings and demonstrating the feasibility of such research. However, the sample was small and statistical inference is limited for this reason. Therefore, it would be useful to expand this to a larger sample that would enable more definitive conclusions on the issues discussed in this report, as well as potential future research outlined above.

1.4 Structure of this report

The remainder of this report is organised as follows:

- **Section 2** outlines the conceptual framework used to inform the research design in more detail;
- **Section 3** details the review of academic, grey and commercial literature and the role of exchange rates in international trade, with a focus on the UK;
- **Section 4** gives details on the survey of UK businesses trading internationally and the implications of the responses for the relationship between exchange rates and international trade in the UK;
- **Section 5** documents the second part of the fieldwork, case study interviews with trade associations based in the UK and highlights the main findings;
- **Section 6** outlines the feasibility of further econometric study of the relationship between exchange rates and international trade volumes based on the literature review and fieldwork; and
- **Section 7** concludes and offers policy implications from the sum of research evidence.

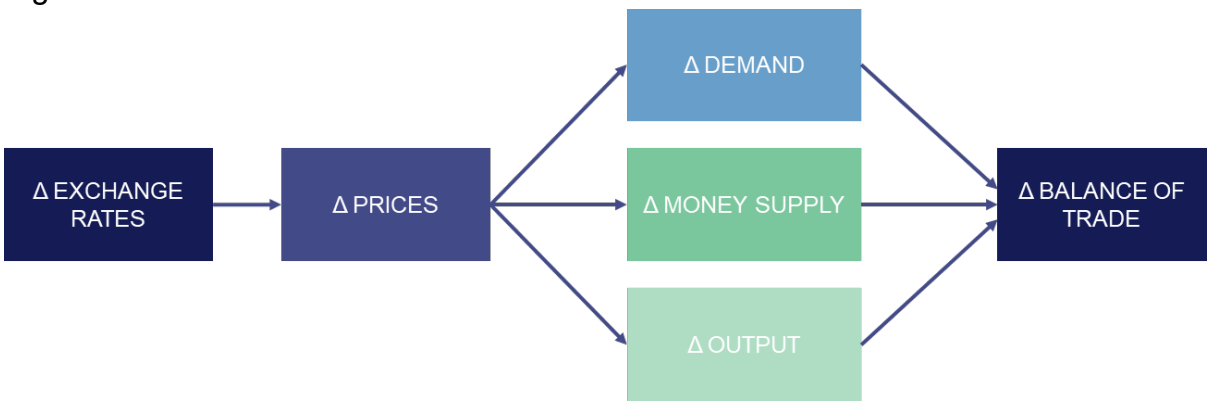
2. Conceptual framework

In order to structure and guide the research, a conceptual framework was developed, split into macro-level and micro-level transmission mechanisms through which exchange rates may be expected to impact international trade. In this section a brief summary is provided of the framework initially designed to structure the research.

2.1 Macro-level transmission

The macro-level aspect of the framework relates to the effects of exchange rates on trade from an aggregate perspective. Given that trade and exchange rates are traditionally studied under a macro lens, it is reasonable to begin by considering the mechanisms by which exchange rates affect trade from this perspective. At a macro-level, exchange rates lead to price changes which affect the trade balance through shifts in demand, money supply, and output. This framework is illustrated in Figure 1 below.

Figure 1: Macro-level framework



There are a number of traditional theories which have been advanced as explanations for the possible mechanisms, in particular:

- Standard theory of trade. The standard theory of trade states that an exchange rate depreciation would both (a) increase the cost of imports, and (b) reduce the cost of exports, resulting in an increase in export volumes and reduction in import volumes.
- Marshall-Lerner condition. This theory considers how the elasticity of demand for imports and exports affects trade volumes and, specifically, the trade balance. In particular, the Marshall-Lerner condition states that, as long as the sum of the absolute value of the elasticities of imports and exports is greater

than 1, the trade balance would improve when a currency depreciation occurs.

- J-curve. The J-curve builds on the Marshall-Lerner condition and considers whether the effect of exchange rate fluctuations varies over time. In the short-term, currency depreciation may worsen the balance of trade, due to inelastic short-run import and export demand. Indeed, depreciation would result in higher priced imports, but import volumes may remain the same in the short-term, perhaps because of binding existing contracts. The trade balance would then improve over time, as contracts are renegotiated or end, resulting in a J-shaped curve.
- Keynesian absorption theory. Under this approach, the trade balance is assumed to be a function of output and domestic consumption (known as 'absorption'), and so would improve if: (i) output rises; and / or (ii) domestic consumption declines relative to income.

2.2 Micro-level transmission

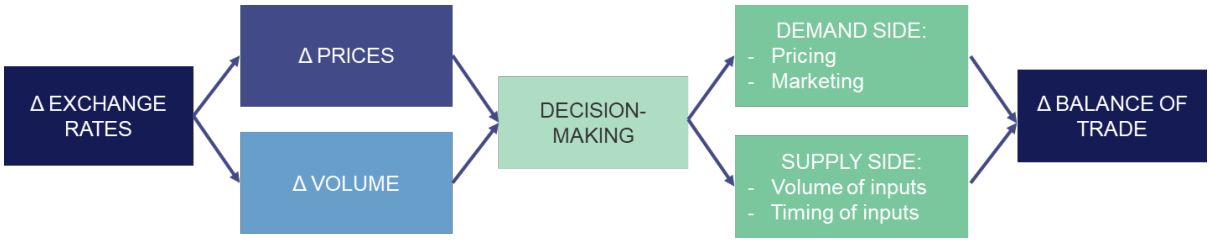
The macro-environment is ultimately driven by what happens at a micro-level. As such, a micro-level framework is necessary to better understand how exchange rate fluctuations affect business decision-making. In addition, given the known complexities around exchange rates, and the high degree of heterogeneity across the economy, one may expect macro-level analysis to give rise to possible aggregation bias and potentially obscure relationships between exchange rates and trade volume at the industry or firm-level. The aspects of the literature review that addressed the micro-level framework fed directly into the survey design and implementation, which – being directed at individual trading firms – aimed to gain further understanding of these micro-level transmissions. This framework is described below and is illustrated in Figure 2.

- The immediate effect from exchange rate fluctuations for exporters / importers would be a change in profit margins, due to a change in prices of the goods and services they export / import. In industries where contracts are absent, there would also be an immediate volume impact for: (i) direct exporters and importers; and (ii) firms at different points in the supply chain, who buy / sell to these trading businesses.
- Following this, businesses would be faced with a number of demand- and supply-side decisions, which would ultimately affect the macro-environment and trade volumes. These include:
    - *Pricing* – for example, when faced with a currency depreciation, exporting firms can decide whether to: (i) reduce foreign prices of its goods and services, which would increase quantities sold; or (ii) maintain foreign prices, which would increase its profit margins. Firms at earlier stages in

the supply chain would face a similar decision when selling to exporters, as they may need to consider the impact of a fluctuation on an exporter's revenues when setting their own prices. The extent to which these effects play a role also depends on exporters' choice of invoice currency. Importers would face an analogous situation, though with the opposite effect from a depreciation.

- *Volume of inputs* – for example, importing firms would decide whether to change the volume of *domestic* inputs purchased relative to *imported* inputs. Firms buying from importers would also make volume purchase choices in response to exchange rate fluctuations. This decision also affects exporting firms that are part of a global supply chain, for which a large part of their exported product consists of imports.
- *Timing of inputs* – businesses must decide whether to enter into short-term or long-term contracts with suppliers, as well as whether they should bulk-buy and stock certain inputs. These would occur at various points in the supply chain.
- Other business decisions, such as marketing and investment.

Figure 2: Micro-level framework



The macro- and micro-level frameworks above formed the basis of the research approach, which is discussed in detail in the remainder of this report. Reflections on the implications of the research for this framework are provided in the conclusion.

3. Literature review

This chapter discusses the findings from the literature review of 185 articles on various topics around exchange rates and international trade. Consistent with the conceptual framework, the findings from the literature review are split into: (i) macro-level transmissions of the impact of exchange rates on trade; (ii) micro-level transmissions; and (iii) evidence from specific recent exchange rate shocks in the UK. Each of these areas are discussed in turn.

3.1 Introduction

The first part of the research was desk-based research in the form of a literature review. The purpose of this was to set out the landscape of exchange rate research in general, both in terms of traditional theories and the most recent updates in this area of research. This enabled insight into: (i) what the theory says about the response of trade to exchange rate movements; (ii) which of these theories have the most evidence and relevance today; and (iii) how the behaviour of UK trade compares to what theory predicts. Crucially, the findings of the literature review were also used to inform the fieldwork stages of the research – a survey of UK trading firms and case studies with UK-based trade associations – so that they were designed to target the most important aspects of exchange rates.

To carry out the literature review, a robust methodology was developed, comprising a search strategy, used to source the relevant literature, and a set of evaluation criteria, used to determine which articles found in the search would be reviewed. This methodology was designed to best meet DIT's research requirements, as well as to capture a range of topics, theories, and time periods (whilst also placing emphasis on the most recent research). In addition to the papers sourced from this methodology, further articles were included in the review in order to reflect feedback from DIT following a presentation of initial findings.

The findings from the literature review are split into three broad categories, based on the conceptual framework: (i) *macro*-level transmission mechanisms; (ii) *micro*-level transmission mechanisms; and (iii) evidence from recent events. This final category is included as it is important to understand how exogenous shocks can affect exchange rates and trade in light of recent events, specifically: the global financial crisis, the 2016 EU referendum, and the COVID-19 pandemic.

Overall, the evidence from the literature suggests that micro-level mechanisms are much more effective in explaining the relationship between exchange rates and trade than macro-level theories. This appears to be due to the macro-level theories suffering from aggregation bias, meaning they do not fully capture the intricacies of exchange rates at the firm- or industry-level. However, when longer time frames are considered, there is at least some evidence of the traditional relationship between exchange rates and trade as implied by the macro-level theories. Therefore, greater

emphasis on the micro-level of the conceptual framework is applied to the subsequent fieldwork research, discussed in the next two chapters.

The following subsections outline in more detail the findings regarding: (i) *macro*-level transmission mechanisms; (ii) *micro*-level transmission mechanisms; and (iii) evidence from recent events.

3.2 Macro-level transmission

From the literature, the following key concepts as part of the macro-level of the framework were identified:[6]

- the Marshall-Lerner condition;
- the J-Curve;
- the S-Curve; and
- Keynesian absorption theory.

In what follows, each theory in turn is summarised on the theoretical background and concepts, before empirical evidence on these theories is outlined. As noted earlier, there is limited support for the macro-level transmission mechanisms in the literature. At the end of this sub-section a brief discussion is given on the possible explanations for this finding.

3.2.1 Marshall-Lerner condition

The Marshall-Lerner (M-L) condition states that if the sum of the price elasticities of export and imports is greater than 1, then a currency depreciation would lead to an improvement of the trade balance. In other words, if a country's trade volumes are sufficiently sensitive to changes in price, then following a depreciation, the value of the change in **prices** imported and exported would be outweighed by the change in their respective **quantities**. Since a depreciation should increase exports and decrease imports, the result is a trade balance improvement.

Possibly due to the complexities around estimating price elasticities of demand (particularly on an aggregate scale as in macro trade), there are relatively few studies that directly address the M-L condition. Indeed, as shown in a literature review by Bahmani, Harvey and Hegerty (2013), many of the research studies that claim to test the M-L condition do not actually estimate price elasticities, and instead

[6] Another key macro-level concept reviewed is purchasing power parity (PPP). However, the evidence for PPP is overall extremely weak, and suggests that it does not hold in the short-run, and only weakly in the long-run (Rogoff, 1996; Taylor and Taylor, 2004). In addition, in the context of this research it is not clear that PPP has any implications for how trade volumes adjust to exchange rate movements. Therefore, a full discussion of PPP in not included in this report.

analyse whether trade responds to exchange rates. Furthermore, the same literature review finds that some papers that do calculate elasticities do not link this to the M-L condition. Therefore, it is difficult to reach any firm conclusions as to whether the M-L condition itself holds.

One research paper – Rose (1991) – which does directly test for the M-L condition, concludes that amongst five OECD countries there is not sufficient evidence to support the M-L condition. Similar results are found by Bahmani et al. (2013) who use an autoregressive distributed lag (ARDL) approach for 29 countries, including the UK. This paper finds that exchange rates have a statistically significant[7] effect on trade volumes in less than half of the 29 countries, with only three countries being found to exhibit the M-L condition. In addition, upon reviewing 91 estimates of trade elasticities from previous research, Rose (1991) finds that in only 27 cases does the M-L condition hold at a statistically significant level.

A more recent report by Bussière, Gaulier and Steingrass (2017) relating to the M-L condition also finds that the UK was one of four countries (out of a study of 51) whose trade balance improved by less than 0.3% following a 10% currency depreciation. Notably, this study also found the UK to have price elasticities of greater than 1. This suggests that there is little that the M-L condition can explain as to the reaction of UK trade to exchange rate movements.

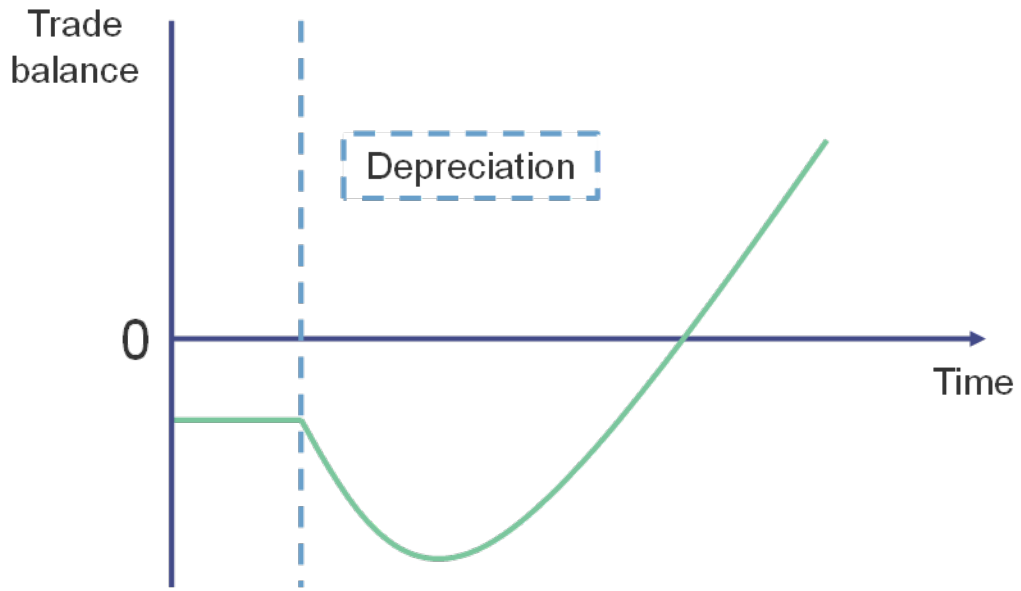
Overall, given the mixed evidence for the M-L condition – particularly when looking at the UK – it appears that this theory is likely to perform poorly in explaining the relationship between exchange rates and trade.

3.2.2 The J-curve

As noted above, many studies that claim to test the M-L condition do so only indirectly. In a number of instances, such papers focus instead on the J-curve. The concept of the J-curve was first introduced by Magee (1973) and can be summarised as the theory that a currency depreciation should initially lead to a worsening of the trade balance, before then improving. When the trade balance is charted over time, a depreciation therefore exhibits a ‘J’ shaped curve, as shown in Figure 3. As this concept relates to the elasticity of trade over time, in essence the J-curve is a dynamic variation of the M-L condition (Michail, 2018).

[7] Statistical significance refers to the 95% confidence level unless stated otherwise.

Figure 3: The J-curve



Given that the J-curve is linked to the M-L condition, it is unsurprising that the literature generally provides weak support for it empirically. As pointed out by Rose and Yellen (1989), although a number of early studies do show evidence for the existence of a J-curve, these are generally unreliable as, among other things, they focus on aggregate trade data (as opposed to bilateral) and do not account for unit-roots in the key variables.[8]

In that same study, Rose and Yellen test for the existence of a J-curve on bilateral trade between the US and seven countries including the UK. They find no evidence of a J-curve pattern in the US's trade balance following a depreciation and reach an even stronger conclusion that the exchange rate has no impact on the trade balance in either the short- or long-run. This is corroborated by subsequent studies (e.g. Demirden and Pastine, 1995) which find weak evidence for the J-curve, and an overall disconnection between exchange rates and trade volumes (e.g. Rose, 1991).

Consistent with Rose and Yellen (1989), there is more recent evidence which suggests that the J-curve does not arise in practice. For instance, Bahmani-Oskooee, Economidou and Goswami (2006) assess the UK's trade on both an aggregate and bilateral basis, finding a J-curve pattern only for trade with the US and Canada. Following the UK's decision to leave the EU, Michail (2018) finds that there should be no expected impact of the depreciation of the pound on the UK's trade balance, further implying the absence of a J-curve.

[8] Variables with unit roots have no tendency to return to a long-run trend following a shock, and therefore cause difficulties in forecasting. For example, real GDP is often tested with a unit root. This means that, given a recession (two quarters of negative growth), real GDP would not return to its original path pre-recession and would instead follow a "random walk" pattern. In order to use variables with unit roots in time series regressions (for example, examining the relationship between GDP and cross-border trade), techniques such as differencing values from one period to the next would need to be applied.

With the lack of support for the M-L condition, as well as a general disconnection between exchange rates and international trade at an aggregate-level, it is unsurprising that there is little empirical evidence of the J-curve. In fact, the most common finding across studies appears to be that there is no consistent pattern that arises from an exchange rate depreciation, let alone a J-curve. While there are instances of J-curve relationships appearing for trade between specific countries or industries, this theory is generally not considered to be a reliable indicator of the relationship between exchange rates and international trade.

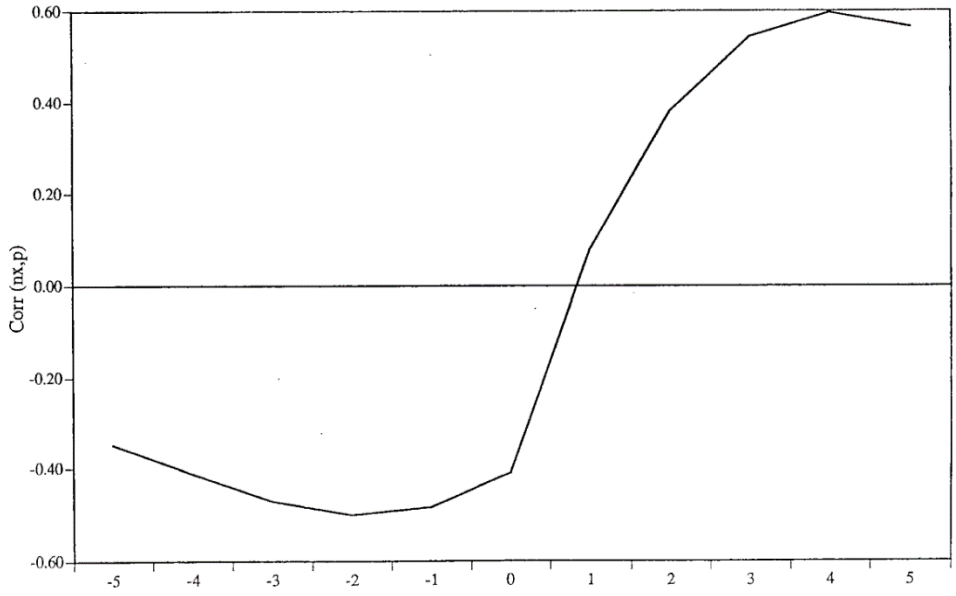
3.2.3 The S-curve

The S-curve was first proposed by Backus, Kydland and Kehoe (1992) and consists of two separate observations.

- The first is that the current exchange rate is negatively correlated with the historic trade balance, but positively correlated with the current and future trade balance. So, for example, if exports were historically high, this would suggest that the current exchange rate would be low. By contrast, a high future level of exports would imply a high current exchange rate. This relationship between the exchange rate and trade balance over time gives rise to an 'S' shaped curve, as illustrated in the figure overleaf.[9]
- Second, the paper also shows that the trade balance is countercyclical, meaning that it is high during economic downturns and lower during upturns. This is due to positive productivity shocks leading to increased output, lower costs, and therefore a rise in the terms of trade (i.e. the cost of imports rises relative to the cost of exports). At the same time, the domestic boom should lead to increased consumption, including of imports, which exceeds the increase in output, leading to a trade deficit.

[9] Backus, D., Kehoe, P. J., & Kydland, F. E. (1992). Dynamics of the Trade Balance and the Terms of Trade: The S-curve (No. w4242). National Bureau of Economic Research.

Figure 4: The S-curve



Source: Backus, D., Kehoe, P. J., & Kydland, F. E. (1992). Dynamics of the Trade Balance and the Terms of Trade: The S-curve (No. w4242). National Bureau of Economic Research.

Empirical evidence for the S-curve is mixed, and as shown by Bahmani-Oskooee and Ratha (2008), it is sensitive to aggregation bias (i.e. the S-curve does not exist for trade across the entire economy). When assessed at an industry-level, there appears to be an S-curve in some, but not all, industries. In the UK specifically, Bahmani-Oskooee and Ratha (2008) find that for trade between the UK and the US in 52 industries, 36 of them exhibit an S-curve. While there is limited dedicated research into the S-curve for the UK, studies focussed on the UK's trading partners (such as the US) find similar results – namely that the S-curve exists in a little over half of industries but not at the aggregate-level. For example, Bahmani-Oskooee and Ratha (2009) find this to be the case for trade between the US and Canada, and Bahmani-Oskooee and Xi (2015) for trade between the US and Brazil. In all the above studies, it is found that there are no clear patterns that determine which industries exhibit an S-curve. For example, there is evidence of an S-curve across both durable and non-durable products, and in large and small industries.

While the S-curve provides some insight into the movements of the trade balance, there is insufficient evidence to indicate that it is a dependable theory for explaining exchange rate impacts on UK trade.

3.2.4 Keynesian absorption theory

Keynesian absorption theory was first considered in the 1950s and contemplates the relationship of trade and exchange rates in terms of the relationship between real expenditure, real income, and price levels. Specifically, the effect of a devaluation on

a trade balance may depend on: (i) how the devaluation affects income; (ii) how a change in the level of income affects absorption; and (iii) how the devaluation affects absorption for any given level of income. Absorption here refers to "the taking of goods and services off the market" (Alexander, 1952), i.e. the sum of consumption and investment.

In a seminal paper on this subject, Alexander (1952) outlines several counteracting effects of a currency depreciation, including:

- The idle resources effect, which states that, with unemployed resources in the economy, a depreciation would increase income and, if the propensity for absorption is below 1, the balance of trade would also increase.
- The terms of trade effect, which implies that a depreciation would initially worsen the balance of trade due to reduced absorption levels. Specifically, if the impact of a change in exchange rate on the balance of trade is equal to $[t - (ct)]$, where *t* represents the trade balance and *c* represents the propensity to absorb, then if the propensity for absorption is below 1 and the trade balance is negative, a depreciation would worsen the trade balance. This therefore counteracts the idle resources effect.

Therefore, for a depreciation to improve the trade balance (i.e. the idle resources effect outweighs the terms of trade effect), it must cause: (i) an increase in output; and (ii) a decrease in absorption relative to income.

Due to Keynesian absorption theory being relatively abstract and conceptual, it is not a subject that is regularly empirically tested. However, it does carry some useful high-level messages for the research, namely:

- there can be counteracting effects from a currency depreciation; and
- it is possible that a depreciation would lead to an improvement in trade balance only if there are unemployed resources.

3.2.5 Possible explanations for the lack of support for macro-level concepts

As the empirical evidence is generally stacked against the macro-level transmission mechanisms between exchange rates and trade, it is worth briefly considering *why* this is the case. This section considers two factors that may account for the failure of macro-level concepts to explain the impact of exchange rates on trade: (i) the Lucas Critique; and (ii) the endogeneity of exchange rates.

What has come to be known as **the Lucas Critique** was first posited by Robert E. Lucas in the 1970s. In short, it argues that macroeconomic models used to assess the impact of economic policies are fundamentally biased, particularly if they are based on historical, aggregated data. This is because such models fail to take account of the fact that a change in policy would alter behaviour and expectations, thereby changing the underlying parameters of the model (Lucas, 1976).

Consequently, models that estimate the change in a macroeconomic variable without accounting for the concurrent change in expectations would be inaccurate. While the Lucas Critique has proved to apply in theory and in certain empirical settings, there are methods for addressing this issue, such as the use of autoregressive models which take account of time dynamics (Rudebusch, 2002). Nonetheless, given this generally accepted criticism of macroeconomic models built on aggregated data, this may go some way to explaining why there is little support for the macro-level transmission concepts set out above.

Intuitively, it is also possible that it is difficult to dissect the effect of exchange rate movements on trade at the macro-level because **exchange rates may be endogenous**. That is, while the exchange rate affects trade volumes, the current and expected balance of trade may also influence the exchange rate. This could result in macro-level studies failing to disentangle the respective effects, thus masking the true impact of exchange rates on trade. While there is not sufficient literature to show that exchange rates are or are not endogenous, there is some evidence to suggest there is a degree of endogeneity. For example, Gantman and Dabos (2016) find that both the trade balance and level of trade openness have a statistically significant effect on the exchange rate. An alternative view – the 'asset market' view – states that the trade balance conveys information about macroeconomic variables that also affect the exchange rate (Mussa, 1982; Doukas and Lifland, 1994). In this sense, exchange rates may be endogenous to trade in an indirect manner. Although the evidence is not wholly conclusive, it does appear that the exchange rate may be somewhat endogenous to trade at the macro-level. As a result, this could partially explain the weak support for macro-level studies of exchange rates and trade.

Regardless of whether these explain some or all of the weak support for macro-level theories, on balance it is unlikely that these macro-level theories would provide a sufficiently robust explanation of the empirical relationship between exchange rates and international trade to inform policy. This is not to say that the evidence is completely one-sided on this point. For example, Leigh et al. (2015) find that in aggregate trade does respond to exchange rates as classical theory would predict, with a 10% depreciation of a country's currency leading to an increase in exports worth 1.5% of GDP. However, on the whole, the literature on macro-level transmissions is neither conclusive nor consistent enough to be used to understand the relationship between exchange rates and trade, or to inform policy. In contrast, micro-level theories have substantial evidence to support them, appear to explain at least some of the disconnect between exchange rates and international trade at a macro-level, and are not subject to the Lucas Critique. Therefore, greater emphasis should be placed on the micro-level framework, which is discussed next.

3.3 Micro-level transmission

This section considers the literature relating to the micro-level transmission mechanism as set out in the conceptual framework, focussing on the empirical evidence for drivers at the business decision-making level. Given the inability of the macro-level concepts discussed above to effectively and consistently explain the relationship between exchange rates and trade – as well as the Lucas Critique that may be valid in any macroeconomic model – it seems to be more pertinent to consider trade at the micro-level.

The micro-level concepts discussed are:

- invoice currency;
- globalisation (including intra-firm trade);
- heterogeneity;
- exchange rate volatility; and
- expectations.

Overall, invoice currency, globalisation, and firm and industry heterogeneity play a significant role in determining the impact of exchange rates on trade. In addition, these factors provide some explanation for why a disconnect between exchange rates and trade appears at the macro-level.

3.3.1 Invoice currency

As discussed in the following subsections, recent empirical evidence has found that the choice of invoice currency (i.e. the currency chosen in a trade contract) is crucial to the pricing behaviour of firms under exchange rate fluctuations. Namely, the prevalence of three types of invoice pricing: (i) producer currency pricing; (ii) local currency pricing; and (iii) dominant currency pricing, govern how trade reacts to changes in exchange rates. This section first outlines these three invoice currency paradigms, before moving on to describe their implications for UK trade.

3.3.1.1 Predictions of PCP and LCP: aggregate evidence

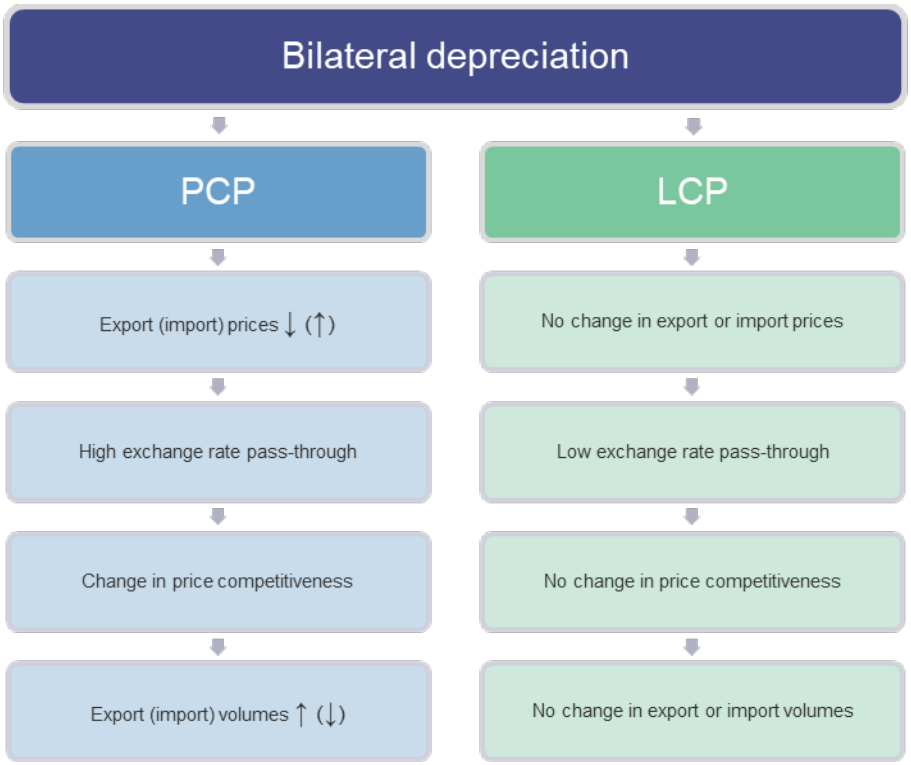
Under producer currency pricing (PCP), prices are set and are rigid in the currency of the *producing* country. The consequence of this is that bilateral exchange rate fluctuations alter the terms of trade (i.e. the relative prices of imports vs exports) and change the price competitiveness of traded goods. As an example, for UK exports invoiced in pounds, prices are rigid in terms of the pound (i.e. currency of the exporting country). Under a depreciation of the pound, prices fall in terms of the

destination currency. Bilateral exchange rate fluctuations, therefore, alter the competitiveness of exports when they are priced in terms of the producing country.

Under local currency pricing (LCP) on the other hand, prices are set and are rigid in the currency of the *local* (destination) country. Bilateral exchange rate fluctuations of the pound are absorbed into the exporting firms' mark-ups, thus leaving price competitiveness unchanged. For instance, under a bilateral depreciation of the pound, the price of exports, in terms of the destination currency, are rigid, leaving prices to rise in terms of the pound. As a result, this increase in revenue is absorbed into firms' mark-ups. In principle, when firms invoice in the currency of the local destination, exchange rates fluctuations lead to no change in consumer prices of traded goods, their demand, or their imported and exported volumes.

Thus, PCP and LCP in theory generate opposite effects, as the former case predicts a strong relationship with the foreign currency price of products and the exchange rate (i.e. high exchange rate pass-through[10] with the law of one price holding), whilst the latter predicts little or no relationship, with exchange rate fluctuations causing systematic deviations from the law of one price (i.e. identical goods can trade at different prices across different international markets). PCP is the assumption that underpins many macro-level theories and therefore predicts the same impact on trade. Figure 5 below summarises the predictions of PCP and LCP under a bilateral exchange rate depreciation. Note that these predictions are symmetric for an exchange rate appreciation.

Figure 5: Trade predictions under producer currency pricing (PCP) and local currency pricing (LCP)



[10] Exchange rate pass through refers to the responsiveness of prices to exchange rate movements.

Evidence at the aggregate-level suggests that the predictions from PCP are not observed. *Firstly*, empirical research finds deviations from the law of one price, meaning both trade price and volume responses to exchange rates are not as PCP would predict.[11] Exchange rate pass-through of import and export prices are much lower than unity.[12] This contradicts PCP, which, in the extreme case, predicts an exchange rate pass-through of 1. For example, several early studies from various developed countries provide estimates of exchange rate pass-through of below 50% (Knetter, 1989; Marson, 1990; Gagnon and Knetter, 1995).

One key explanation for why firms adopt LCP is pricing-to-market (PTM) (Krugman, 1986; Betts and Devereux, 2000). This is the idea that the prices of exported goods are set such that they reflect the conditions in the local destination. If changes in exchange rates do not alter these conditions, or alternatively, are a consequence of competitive conditions changing, this causes prices of exports to be 'sticky' in the currency of the destination country. For example, Herzberg, Kapetanios and Price (2003) find evidence of PTM for UK imports after the pound appreciated in 1996, whereby exporters from the "major six" countries to the UK increased their margins as opposed to decreasing prices for their goods (i.e. they did not pass-through the appreciation in the pound to UK customers).

Empirical support for LCP too, however, is mixed. Antoniades (2012) uses the elimination of exchange rate volatility from the introduction of the euro as a natural experiment to demonstrate that LCP does not hold completely. In particular, the study shows that as exchange rate volatility fell after the creation of the Eurozone, import price volatility simultaneously fell. This supports at least some PCP – *import* prices should not be related to exchange rate volatility if LCP holds, as the *export* market should dictate pricing under this theory. In addition, more recent evidence suggests that, across countries globally, PCP is more prevalent than LCP (IMF, 2019).

Most literature confers that *incomplete* exchange rate pass-through is the modern reality. Campa and Goldberg (2005) for instance estimate the exchange rate pass-through for UK imports in aggregate to be around 0.4 in both the short and long-run. While this figure is relatively low when compared to the OECD countries in the study (with a mean of 0.61 in the short-run and 0.77 in the long-run), this nevertheless indicates that exchange rate pass-through is *partial*. Other studies that use UK data find similar pass-through rates (Mumtaz, Oomen and Wang, 2006; Chandler, 2019). These findings would suggest that neither PCP nor LCP hold to either extreme, but most likely co-exist.

Price elasticities, which govern the responsiveness of traded volumes given a change in price, have also generally been found to be below 1. For example, one

[11] Generally, the law of one price should hold under PCP (Gopinath et al., 2020). However, as noted the evidence does not support this. As the law of one price underpins purchasing power parity, this is therefore consistent with the finding that there is very limited evidence in support of the latter, and for this reason purchasing power parity is not discussed in detail in this report.
[12] Note that this is different to the M-L condition, which relates to unity in price elasticities of quantities traded, rather than pass-through of prices.

recent UK study estimates an export price elasticity of around 0.6 to 0.9, and an import price elasticity of around 0.2 to 0.7 (Bussiere, Gaulier and Steingress, 2020). This study estimates this on a global scale, quoting quantity elasticities to be significantly below unity. In G7 countries, Hooper, Johnson and Marquez (1998) find the responsiveness of export price volumes in response to movements in the real exchange rate to be below 1.

Nevertheless, whilst price elasticities and exchange rate pass-through are lower than what would be traditionally predicted by PCP, as with much of the literature on exchange rates, the evidence is not completely conclusive. For example, some studies, such as Leigh et al. (2015), suggest that these variables on aggregate still move in the direction that PCP theory would suggest (i.e. a bilateral exchange rate depreciation is associated with lower export prices and an increase in export volumes).[13] However, as noted above, the evidence on macro-level theories, a number of which are predicated on PCP, is not consistent or robust enough to consider PCP on its own to adequately explain the relationship between exchange rates and trade.

Overall, aggregate evidence on PCP versus LCP generally indicates that neither is dominant. Trade, in terms of volumes and prices, still responds to exchange rates, but not to the extent that PCP suggests. LCP nominal rigidities, which are largely explained by the presence of pricing-to-market, play a large role in muting trade responses to bilateral exchange rate fluctuations. As a result, exchange rate pass-through and price elasticities are generally estimated to be below unity.

3.3.1.2 Predictions of DCP: aggregate evidence

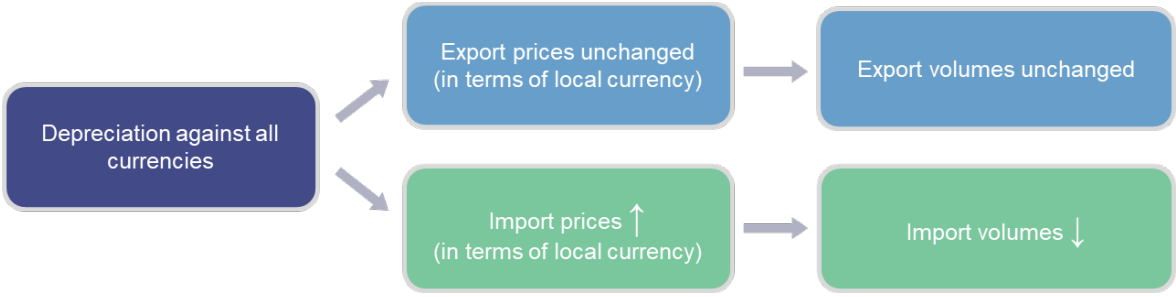
Recent empirical work has shown that global trade is invoiced in a small number of currencies, with the US dollar playing a major role (Gopinath et al., 2020). Under dominant currency pricing (DCP), trade flows between two countries A and B are affected by their exchange rates with the dominant currency – that is, both A and B's exchange rate against the dominant currency. Therefore, unlike PCP or LCP, pass-through is driven by the value of the dominant currency against both currencies, rather than the bilateral exchange rate between the trading countries. Therefore, exchange rate pass-through (of both exports and imports) is likely to be under- or over-estimated when measured solely against bilateral exchange rates. This effect has been shown to be greater for countries that use more dollar invoicing (Goldberg and Tille, 2006).

In the UK for instance, one recent study finds that more than half of all UK imports are invoiced in 'vehicle currencies' (i.e. currencies from countries that are not involved in the trade), with the majority of these vehicle currency transactions using the dollar (Chen, Chung and Novy, 2019). Worldwide, the US dollar is used for the majority of transactions that *do* involve the US and is used extensively for

[13] The converse applies to imports.

transactions that *do not* involve the US (Goldberg and Tille, 2008). In fact, for most countries, the share of all trade that is invoiced in US dollar exceeds the corresponding share of trade from the US (IMF, 2019).

Figure 6: Trade predictions under dominant currency pricing (DCP)



Similarly, this paradigm predicts that an appreciation of the dollar against all other currencies would lead to a reduction of trade worldwide. For example, Boz, Gopinath and Plagborg-Møller (2017) evidence this using a cross-country panel dataset of 55 countries, using the period 1989 to 2015. The authors estimate that a 1% appreciation in the US dollar against all currencies, holding constant the global business cycle, is associated with a 0.6% to 0.8% decrease in aggregate weighted trade volumes between non-US countries.

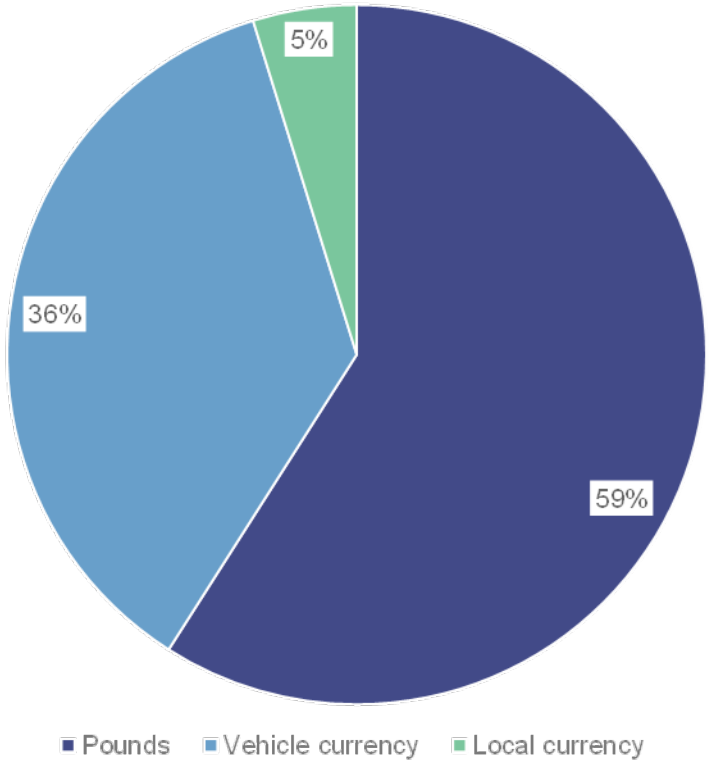
Recent data from the IMF confirms the prevalence of DCP in global trade (Boz et al., 2020). For example, the study finds that for countries that extensively use the dollar or euro as an invoice currency, pass-through is higher from fluctuations in the dollar or euro than in the bilateral exchange rate. In addition, the findings suggest that DCP has become more important over time, as the use of the dollar and euro as invoicing currencies has generally increased over time, despite the US and Eurozone contributing to a smaller proportion of global trade over the same time period. Specifically, the dollar and euro are each found to be used as the invoice currency for around 40% of global exports, meaning together they account for over 80% of exports. By contrast, 10% of exports worldwide are destined for the US, and 37% for the Eurozone. Proportionately, this implies that the US dollar is the most commonly used vehicle currency.

3.3.1.3 Short-run microeconomic evidence and implications

As the predictions of PCP, LCP and DCP for the response of trade to exchange rate fluctuations are substantially different, looking deeper at the *composition* of exports and imports in terms of invoice currency is important to determining the effects of exchange rates on trade. Namely, for the UK, the proportion of exports and imports invoiced in the producer currency, local currency, and a vehicle currency determines the aggregate trade response.

Figure 7 shows the estimated proportion of the UK's extra-EU[14] *exports* invoiced in (i) pounds, (ii) local currency, and (iii) a vehicle currency from a recent paper by Crowley, Corsetti and Han (2020). Invoicing in pounds is the most prevalent, followed by invoicing in the vehicle currency. In addition, the authors find that this proportion has been relatively stable over time.[15] Interestingly, the majority of firms in the study invoice in more than one currency, with 15% of all exports coming from firms who use more than one invoice currency for the same product and to the same destination in a given year.[16] In addition, these firms make up almost 50% of the UK's extra-EU export value.

Figure 7: Value of UK extra-EU *exports* by invoice currency



Notes: Total value of extra-EU exports for the period 2010-2017[17]; firms with over £100,000 exports per year; transaction level custom data obtained from HMRC.

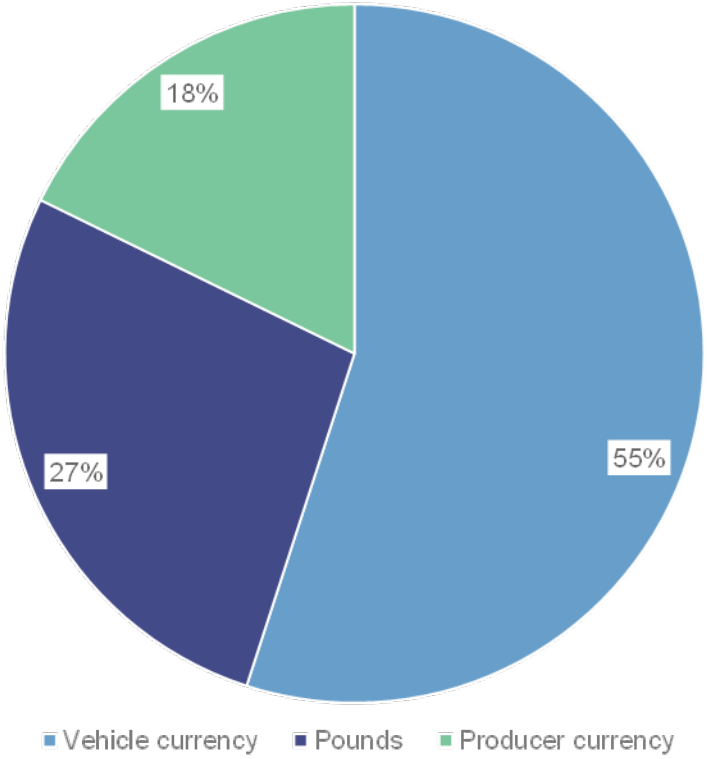
Evidence from this study also confirms the response of UK trade under each invoice currency. After the depreciation of the pound following the EU referendum, export prices fell (in terms of the local destination currency) in the short-run when they were invoiced in pounds with *complete* exchange rate pass-through. However, export

[14] Extra-EU refers to trade with non-EU countries. If trade with the EU was included, it is likely that the proportions here would change somewhat. While it is not clear exactly how they would change, one would expect that the proportion of vehicle currencies would fall.
[15] This does not necessarily contradict the finding shown in Figure 9 that the proportion of the UK's trade invoiced in the dollar and euro has increased, as this increase could be partially driven by an increase in extra-EU trade in general, while the split of invoice currencies within this trade may not have changed as much.
[16] This meant that for survey design, the possibility of multiple invoice currencies needed to be addressed. This was accounted for by specifying questions in terms of the *main invoice currency* for the *main traded good or service* to limit potential confusion arising from several invoice currencies.
[17] The length of sample is dictated by the availability of the dataset.

prices were stable for those invoiced in the local destination currency. For vehicle currency transactions, exchange rate pass-through was also low. These results are in line with the predictions of PCP, LCP, and DCP theories.

For UK *imports*, Chen, Chung and Novy (2019) use firm-level data for UK imports from non-EU countries over the years 2010 to 2017 and find that more than half of transactions (around 55%) use a vehicle currency. A full breakdown of invoice currencies (for non-EU country imports) is shown in Figure 8. LCP (i.e. imports in terms of the pound) comprises around 27% of all imports, whilst PCP makes up only 18% of all transactions.[18]

Figure 8: Value of UK extra-EU *imports* by invoice currency



Notes: Total value of Extra-EU imports for the period 2010-2017[19]; transaction level custom data obtained from HMRC.

This study finds that short-run exchange rate pass-through for imports invoiced in the producer currency is 62%, while pass-through for goods invoiced in the local currency is almost zero. In addition, pass-through is 24% for transactions invoiced in vehicle currencies, but controlling for the vehicle currency exchange rate pass-through increases to 59%. Again, this study verifies the predictions of the three invoicing currency paradigms. Namely, both PCP and DCP (after controlling for the vehicle currency) are associated with high exchange rate pass-through to imports, while LCP is associated with little to no pass-through.

[18] Again, it is likely that including trade with EU countries would change these proportions to some degree, possibly with a decrease in the share of vehicle currencies.
[19] The length of sample is dictated by the availability of the dataset.

Overall, UK microeconomic evidence on PCP, LCP, and DCP match the predictions.

- For UK exports invoiced in pounds and imports invoiced in the producer country (non-UK) currency, short-term exchange rate pass-through is high. Accordingly, short-term import and export volumes should also move. This is consistent with PCP.
- For UK exports invoiced in the local destination currency and imports invoiced in pounds, short-term exchange rate pass-through is low. There is no movement in either import or export volumes.
- For UK imports and exports invoiced in a vehicle currency, exchange rate pass-through is driven by the value of the vehicle currency. Namely, for a depreciation of the pound vis-a-vis all currencies (including vehicle currencies), import prices rise, with lower import volumes. For exports, however, a depreciation in the pound versus vehicle currencies would not necessarily entail greater volumes (only if the local currency saw an appreciation in its bilateral exchange rate with the vehicle currency, would the local price fall in the *short-term*).[20]

Table 1 below summarises these predictions, focusing on a depreciation of the pound against all other currencies.

Table 1: Short-term effects of a depreciation against all currencies

	PCP	LCP	DCP
Export prices	↓	Unchanged	Unchanged
Export volumes	↑	Unchanged	Unchanged
Import prices	↑	Unchanged	↑
Import volumes	↓	Unchanged	↓

Notes: Export and import prices are considered in terms of the currency of the local destination country (i.e. imports in pounds, and exports in other currencies).

[20] Beyond the short-term, exporters may choose to reduce prices in the vehicle currency to pass-through the benefit of the depreciation to its customers (i.e. smaller amounts of the vehicle currency are required to generate the same pound amount following the depreciation). In the short-term this is ignored, which explains why the price is unchanged in this scenario, as outlined in Table 1.

On the aggregate short-term response of UK trade, the following implications can be drawn:[21]

- The pound to dollar exchange rate is important for trade. The dollar appears to be the most common vehicle currency used, with vehicle currencies comprising over half of UK trade in imports (from outside the EU), and a third of UK trade in exports (to outside the EU). Looking solely at bilateral exchange rates understates the extent of exchange rate pass-through.
- Under an exchange rate depreciation, exchange rate pass-through should be greater for UK exports than UK imports, given that PCP is most common for exports (to outside the EU), with DCP being most common for imports (from outside the EU).
- Relatedly, LCP rigidities are more prevalent for UK imports than UK exports (in extra-EU trade), as a greater share of UK imports is invoiced in local currency terms than UK exports. However, as a proportion of total trade, LCP rigidities are low.

3.3.1.4 Long-run microeconomic evidence and implications

In the long-run, the differences between exchange rate pass-through for the various invoice currencies narrows. For instance, Crowley, Corsetti and Han (2020) find that after six quarters, the difference in the reaction of export prices after the depreciation of the pound following the EU referendum fell, with all prices gradually complementing the weaker pound. In addition, as forward contracts gradually expire in the long-run, this gives companies the opportunity to modify their invoice currency (Coille, Mayhew and Turnbull, 2009).

There also exists evidence that the importance of *vehicle* currency exchange rates reduces over time (IMF, 2019). That is, in the long-run, the response of trade volumes is driven by bilateral exchange rates rather than the dominant currency exchange rate. A depreciation against dominant currencies would, in the long-run, cause the prices of exported goods invoiced in dominant currencies to fall, with traditional expenditure switching effects resulting in an increase in export volumes (Hooper, Johnson and Marquez, 1998). Globally, a 10% depreciation against all trading partners results in an increase in the trade balance by 0.3% in the short-term but rises to 1.2% in the medium term. On the aggregate-level, trade therefore may adjust to lower prices in the long-run. This again implies that the disconnect observed between exchange rates and aggregate trade in the short-run (which can be explained by the micro-level concepts) is less prevalent in the long-run, at which

[21] These findings are most clearly the case with the UK's trade with extra-EU countries. However, it is likely that the split of invoice currencies used in the UK's trade with EU countries may be different and so these conclusions may not apply unambiguously to the UK's trade as a whole.

point the predictions of macro-level theories such as the M-L condition regain empirical support and relevance.

The price elasticity of demand becomes important for evaluating the long-run volume effects to price changes as caused by exchange rate movements (e.g. Coille, Mayhew and Turnbull, 2009). For goods that initially face nominal rigidities in the short-term and therefore experience low exchange rate pass-through from a depreciation of the pound, firms have a choice to either keep prices high (in terms of the pound), or to lower prices and increase export volumes. This decision depends on the price elasticity of demand. Namely, higher price elasticity of demand results in a greater reduction of prices, expanding volumes further.

There is also a role for the price elasticity of supply in the long-run. That is, if profit margins rise due to nominal rigidities from a depreciation in the short-run, how much this incentivises an expansion of exports would depend on the ability of firms to increase export supply. This depends on a number of factors, including market entry costs.

An important caveat to this is that in the long-run, incomplete pass-through of prices still exists. One study by Campa and Goldberg (2005) for instance finds that long-run pass-through to UK import prices is 0.47. Chen, Chung and Novy (2020) evidence that, while long-run exchange rate pass-through to UK imports after two years increases for producer currency transactions, pass-through remains low for transactions invoiced in the pound. Such evidence of persistent differences in pass-through, depending on the currency of invoicing, is also found in the US (Gopinath, Itskhoki and Rigobon, 2010). Contrary to the previous suggestions that in the long-run the classical macro-level relationship between exchange rates and trade is observed, these findings imply that over longer time periods exchange rate movements are still not reflected in trade prices. Therefore, in the long-run there appears to be evidence that the macro-level transmission mechanisms have practical implications but this evidence is *mixed* and should not be overstated.

As already discussed briefly, pricing-to-market (PTM) contributes to LCP nominal rigidities. As an example, Crowley, Corsetti and Han (2020) evidence pricing-to-market for UK exports invoiced in local currency prices. Namely, firms that invoice in the local destination currency adjust their mark-ups in line with bilateral exchange rates. Fitzgerald and Haller (2014) also find evidence of PTM for UK imports from Ireland, using plant-level data. This study finds that for exports invoiced in the local currency, mark-ups vary one-to-one with the bilateral exchange rate. However, where exports are invoiced in the producer currency, mark-ups do not co-vary with the exchange rate.

PTM, however, is less prevalent under DCP. This offers an explanation as to why prices under vehicle currencies do eventually adjust after an initial exchange rate shock. That is, when firms invoice in a dominant currency, it is posited that they price to the *global market* (Gopinath et al., 2020). As a result, firms price in relation to global demand rather than adjusting to market-specific demand elasticities. This would be consistent with the increasing role of *globalisation*, which is discussed

below, and suggests that exporters do not focus on individual countries to which they are selling, but rather all the countries they trade with as a collective.

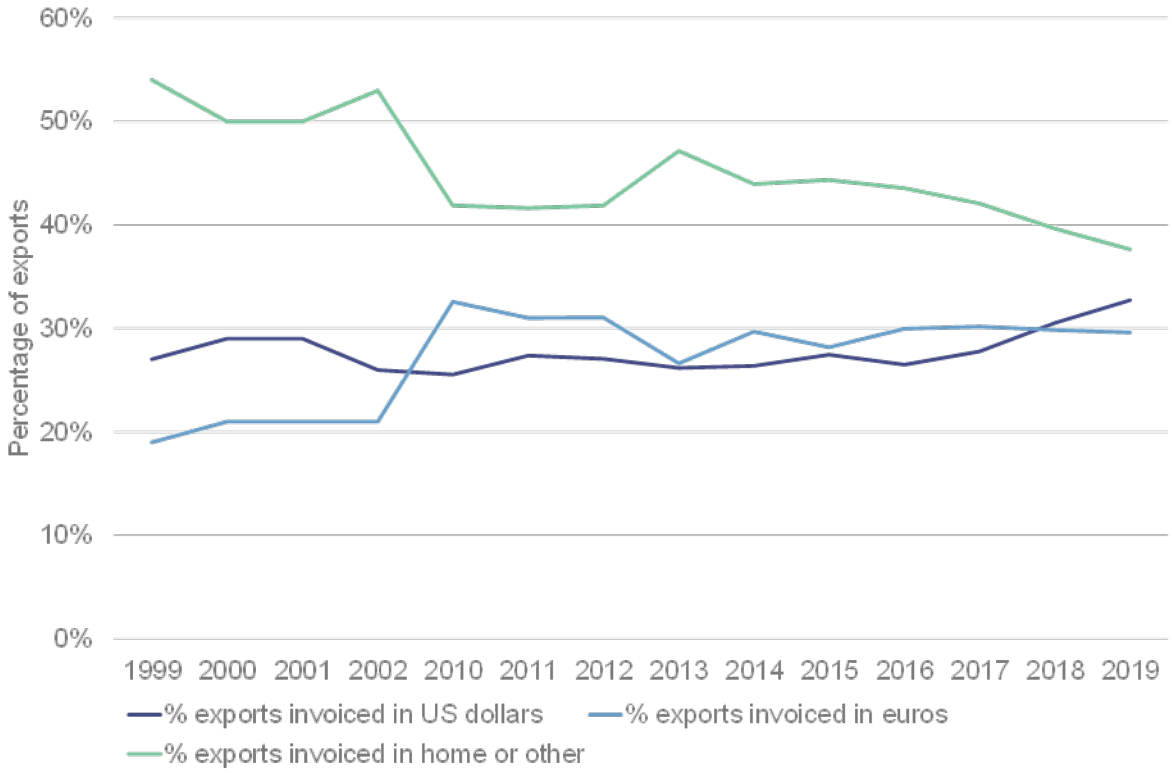
Overall, the difference between trade responses to exchange rates for different invoice currencies narrows over time, with prices gradually adjusting to reflect the new exchange rate. Under a depreciation, prices fall and volumes eventually expand, but not fully to the degree that PCP predicts. In addition, LCP rigidities persist over time for goods priced in local destination currencies. For the UK, given the prevalence of PCP and DCP (particularly for exports), this implies that in the long-run trade prices and volumes can potentially adjust to movements in the pound, as shown by Crowley, Corsetti and Han (2020). However, the pass-through may still not be complete.

Recent data from the IMF has made it possible to look more specifically at the invoice currencies used over time at a country level (Boz et al., 2020). For the UK, between 1999 and 2019 28% (40%) of exports (imports) were invoiced in dollars, and 27% (30%) of exports (imports) were invoiced in the euro. This means that only the minority of the UK's trade – particularly imports – is carried out using the pound.[22] However, compared to the rest of the world, the UK actually has relatively low use of the dollar and euro, with around 90% of global exports being invoiced in these two currencies.[23] This may be reflective of the fact that vehicle currencies are particularly common in developing countries (Fukuda and Ono, 2006).

Similar to the rest of the world, it appears that the UK's dependency on the euro and dollar as invoice currencies has increased over time. The figure below shows how the percentage of the UK's exports invoiced in the dollar and euro have increased by similar proportions over the last 20 years. A similar trend is also observed for imports, although the share of trade in the dollar and euro is higher across the period.

[22] The structure of the data does not allow the proportion of UK trade under PCP, LCP or DCP to be distinguished.
[23] "Global exports" here includes the US and the Eurozone countries.

Figure 9: UK invoice currency in exports over time



Source: Economic Insight analysis of Boz et al. (2020), "Patterns in Invoicing Currency in Global Trade," IMF Working Paper 20/126.
Notes: Data not available between 2003 and 2009.

3.3.2 Globalisation

Globalisation plays a large role in shaping the relationship between exchange rates and trade. This section explores how global value chains and other factors have collectively diminished the response of trade to changes in relative prices, through their impact on individual firm decision making. Despite the name suggesting otherwise, globalisation addresses the micro-level of the conceptual framework. This is because the mechanism through which globalisation affects the relationship between exchange rates and trade relates to factors such as input costs and volumes, which relate to the supply side of firms' decision making.

3.3.2.1 Global value chains

Over time, a reduction of travel costs and trade barriers has led to a rise in global value chains, creating more fragmented production processes. This has resulted in a sizeable amount of global trade in intermediate products. For instance, Gunnella, Fidora and Schmitz (2017) observe that approximately 60% of world trade is accounted for by intermediate goods. This finding is supported by another study by

Georgiadis and Grab (2019), who estimate that the proportion of intermediate goods in total international trade has risen over time and now accounts for approximately 56% and 73% of total trade in goods and services respectively. This results in a low "value-added" for exports (i.e. total exports minus imported costs). As of 2008, the UK had a ratio of value-added to gross exports of 0.78 (Johnson, 2014). However, according to the OECD Trade in Value Added (TiVA) data, the UK's value-added ratio rose to 0.93 by 2015.[24]

In general, greater integration in global value chains is associated with a lower sensitivity of trade volumes to exchange rate changes. The main mechanism for this is through imported intermediate goods – while an exchange rate depreciation should theoretically improve the competitiveness of exports, this is partially counteracted by a rise in imported costs. In addition, under an exchange rate appreciation, a decrease in the cost of imported inputs counteracts any decrease in competitiveness for exports. Similarly, the sensitivity of the *trade balance* to exchange rates also reduces with greater global value chain integration (IMF, 2019).

Literature broadly corroborates this result. For example, Adler, Meleshchuk, and Buitron (2019) examine trade in manufacturing goods across 37 economies and find that greater participation in global value chains results in lower exchange rate elasticities of gross trade volumes, both in the short and medium term.

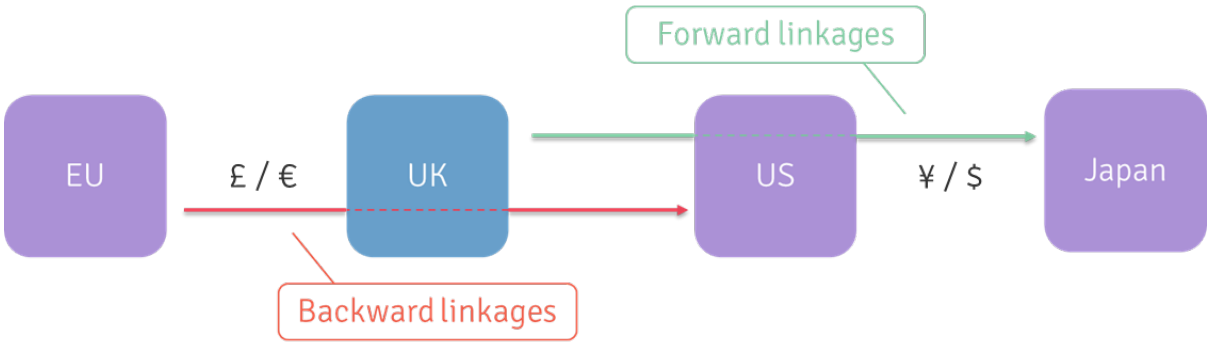
Ahmed, Appendino and Ruta (2015) conduct a global study with 46 countries between 1996 to 2012, and evidence that global value chains explain around 40% of the decline in the sensitivity of export volumes to exchange rates over time. The exchange rate elasticity of manufacturing exports, for instance, has fallen from an absolute value of 1.1 in 1996 to 0.6 in 2012. In addition, this study finds that export volumes increase less under a depreciation for countries with a higher imported content. Moreover, a higher share of a sector's exports that returns to the original exporter as imports, or alternatively to another country with the same currency, also reduces the exchange rate elasticity of exports (De Soyres et al., 2018). In fact, in certain cases, export volumes can theoretically *decline* when the exchange rate depreciates. For instance, suppose the UK exports intermediate goods to the US, who then produces a final product to be exported back to the UK. A depreciation of the pound decreases UK demand for the final imported product, which in turn, given certain conditions, can reduce the demand for intermediate exports that produce these final products.

De Soyres et al. (2018) also show that exchange rate pass-through to export prices falls with a larger share of imports bought in foreign currencies, which decreases the response of export volumes. This finding is supported by Amiti, Itkshoki and Konings (2014), who show that Belgian firms with higher import intensity have lower pass-through to their exports. Georgiadis and Gräb (2019) find that, in addition to a decline in pass-through to export prices, there has also been a global decline in pass-through to *import* prices since the mid-1990s, largely attributable to global value chains.

[24] http://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm

One further implication of global value chains is that they cause trade to be dependent on exchange rates, not only with immediate trading partners, but for indirect trading nations also. This takes place via forward and backward linkages, as illustrated in Figure 10. If the UK imports components from the EU (through backward linkages) to produce exports to the US, these exports are affected by the value of the EU's currencies (e.g. euro, Czech koruna) against the pound (as this directly impacts UK marginal costs). Similarly, if these exports to the US are then used as inputs to produce re-exports to Japan, then the initial exports to the US would be influenced by the bilateral exchange rate between the US and Japan (as they indirectly determine demand through derived demand). In other words, the price and volume that the UK imports from the EU is influenced by the bilateral exchange rates between the UK and EU, *as well as* between the US and Japan.

Figure 10: Example of backward and forward linkages in global value chains



The effect of global value chains on the relationship between exchange rates and trade volumes depends on how flexible supply is to adjust, given changes in prices. As an example, take the value chain with forward linkages between the UK and Japan. Under an appreciation of the pound against all currencies, the price of UK exports to the US would increase under PCP. The effect on these export volumes, however, would depend on the extent to which the US can substitute production costs in the event of having higher import costs from the appreciation of the pound.

- UK exports to the US would be affected less if the supply chain is *inflexible.* That is, the US would use the same inputs from the UK regardless of how input prices change. The appreciation of the pound only affects UK exports to the extent that it contributes to the price of the final good. As a result, bilateral exchange rates between the US and Japan would drive the demand for UK exports. In this particular case, if bilateral exchange rates between the US and Japan are held constant, then the US' demand for UK exports would be relatively unaffected.
- UK exports to the US would be affected more if the supply chain is *flexible*. This is where the US may switch to other foreign or domestic suppliers in the event of a cost increase, or alternatively switch to exporting a different product. In this scenario, Bems and Johnson (2017) show that the US is irrelevant to the supply chain.

Bayoumi, Barkema, and Cerdeiro (2019) provide evidence that supply chains are generally inflexible in both the short and long-run, with this inflexibility increasing over time due to greater reliance on global value chains. As a result of this, the importance of bilateral exchange rates for both UK imports and exports of intermediate goods reduces.

Overall, global value chains reduce the sensitivity of trade to bilateral exchange rates, and most significantly for trade in intermediate goods. There are, however, caveats worth mentioning. The first is that the progressive integration in global value chains has increased trade, independent of exchange rates. One of the mechanisms for this is through domestic resources being freed up from the use of imported inputs as a substitute to domestic inputs (e.g. IMF, 2019). Thus, these additional resources can be used to produce other exports. As a result, when looking at the effect of exchange rates on gross trade *over time*, although integration in global value chains has decreased the sensitivity of the trade balance through the value-added channel, this is mitigated through an accompanying increase in trade volumes (Adler, Meleshchuk and Buitron, 2019). In addition, some evidence suggests that the expansion of global value chains may have slowed over time, particularly after the financial crisis (Gunnella, Fidora and Schmitz, 2017).

Notwithstanding these caveats, literature indicates that global value chains are an important factor in suppressing the *reaction* of trade to exchange rates. The level of firms' imported costs plays a major role in their export decisions, and vice versa.

For the UK specifically, it is possible that the suppressing effect of global value chains on the impact of exchange rates may be less than for other countries. According to OECD data, the UK has a relatively low import content in its exports – 15.4% in 2016 (OECD, 2018). For comparison, Germany, France and Italy all had exports consisting of just over 20% imports. In addition, as mentioned above, the UK's value-added ratio appears to have increased to 0.93 in 2015, meaning the proportion of imports within exports has fallen.[25] As such, this may limit the extent to which global value chain participation mitigates the impact of exchange rate movements on exports, as the value-added from the UK's exports is still relatively high.

3.3.2.2 Other effects of globalisation

There is another channel whereby globalisation decreases exchange rate pass-through via invoice currency choices. Namely, globalisation increases the amount of trade being invoiced in the dollar (DCP). This is primarily for two reasons. *Firstly*, greater market integration and increasing complementarity in pricing means that firms increasingly 'herd' currency choices to keep prices in line with competitors. *Secondly*, with increasing imported costs, firms generally choose to invoice in the same currency as these costs (Chung, 2016). Therefore, globalisation is associated

[25] http://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm

with greater invoicing in DCP (i.e. common currency), which subsequently creates short-term nominal rigidities that are associated with a decrease in the sensitivity of exports to exchange rates.

Financial integration provides another mechanism through which exchange rates affect trade. This is through firms' increased holdings of cross-border foreign assets and liabilities. In the case of a net debtor with foreign liabilities outweighing assets (a negative net international investment position, or NIIP), a depreciation works against the benefits to trade, as the value of foreign liabilities rise in terms of the domestic currency (Frankel, 2005). Therefore, in this case, the benefits to trade from a depreciation are counterbalanced from this 'balance sheet effect'. Under foreign currency borrowing, a depreciation increases these borrowing costs, leading to a decrease in the number of exporting firms. On the firm-level, a greater proportion of foreign liabilities relative to domestic assets strengthens this balance sheet effect. In addition, there is evidence to suggest that this effect happens instantaneously, while the traditional expenditure switching effects on trade take place more in the long-term (Culiuc, 2020).

It is important to note, however, that this financial channel is markedly more important for firms in emerging markets than developed economies, due to their limited ability to raise funds in their domestic currency (Kearns and Patel, 2016). Trade openness and low external short-term debt also reduces this balance sheet effect (Krugman, 1999). As most industrialised countries (including the UK) have their assets denominated in foreign currency, with liabilities being denominated in domestic currency (a positive NIIP), an appreciation would worsen the trade position of developed countries (Di Mauro, Rüffer and Bunda, 2008). One caveat for the UK is that its large international banking sector has a relatively large foreign liability value. Thus, this limits the benefits from a depreciation of the pound (McCrae, 2020).

Another key feature that has arisen from globalisation is *intra-firm* trading, referred to as transfer pricing. As firms expand globally, transfer pricing can become more important – it has been estimated that up to 40% of all US trade is intra-firm (Clausing, 2003; Neiman, 2010). Generally, evidence suggests that multinational firms use transfer pricing to hedge against macroeconomic variability, including exchange rate fluctuations (Song, 2015; Chung et al. 2010; Pantzalis et al. 2001). However, the motivations for transfer pricing are not always clear. Chan et al. (2004) find that firms are not consistent in carrying out transfer pricing in a way that maximises profit, while Clausing (2003) finds a strong relationship between transfer pricing and tax minimisation. Overall, larger firms with more overseas premises are at a comparative advantage over smaller companies as they can mitigate against (or benefit from) exchange rate movements via operational and investment adjustments (Chung et al. 2010). This is particularly true of companies with a higher *breadth* across many countries, as opposed to greater *depth* within a smaller number of countries (Pantzalis et al, 2001).

It appears that transfer pricing plays a role in affecting the relationship between exchange rates and trade. Neiman (2010) finds that intra-firm trade exhibits a higher level of exchange rate pass-through, and has fewer price rigidities. Specifically, it is

found that price spells last for 20-30% longer in *inter*-firm trade than *intra*-firm. One could put this down to the significance of trade contracts, which result in firms being unable to adjust their prices or volumes quickly in response to an exchange rate fluctuation. By contrast, intra-firm trade is not restricted in this way.

3.3.3 Heterogeneity

Literature points towards considerable heterogeneity at the firm- and industry-level in the response of trade to exchange rates. Some studies have shown that estimating exchange rate pass-through and trade elasticities in the presence of heterogeneity would create aggregation bias. Specifically, macroeconomic trade elasticities are systematically overestimated when compared to microeconomic trade elasticity estimates (Imbs and Mejean, 2015). In addition, using aggregate exchange rate pass-through measures may also overstate the extent of pass-through (e.g. Mumtaz Oomen and Wang, 2006; Dekle, Jeong and Ryoo, 2009). Therefore, looking at microeconomic data is crucial to quantifying the aggregate response of trade to exchange rates (e.g. Thoenig, Mayer and Bas, 2015). In doing so, several factors, including the size and productivity of firms and the degree of product differentiation, provide explanations to the observed variation in trade elasticities and pass-through at the firm and industry-level. These factors will be explored further in this section.

3.3.3.1 Size and productivity of firms

Firstly, larger and more productive firms are less reactive to exchange rates, both in terms of prices and volumes. As a result, omitting firm-level productivity in estimating the aggregate export elasticity of exports yields a considerable amount of bias (Dekle, Jeong and Ryoo, 2009).

Using firm-level data from Belgium, Amiti, Itkshoki and Konings (2014) show that larger exporting firms tend to absorb exchange rate movements in their mark-ups rather than changing local currency prices. One of the reasons for this is due to larger firms generally having a higher proportion of imported costs, which is associated with lower exchange rate pass-through. Specifically, firms at the 95th percentile of market share and import intensity measures have pass-through of around 50%, whilst smaller non-importing firms have almost complete pass-through.

Furthermore, Amiti, Itshoki and Konings, (2018) find that larger, more import-intensive firms tend to denominate their transactions in dollars. As previously discussed, this results in low exchange rate pass-through to exports in the short-term. Meanwhile, smaller, less import-intensive firms tend to price their exports in terms of the home currency (PCP). The authors show that these firms have almost 100% pass-through to destination currency prices.

Berman, Martin and Mayer (2012) support these findings through a French firm-level study. This paper finds that high performance firms tend to absorb exchange rate movements in their mark-up, which decreases the sensitivity of export volumes. For the average exporter, a 10% exchange rate depreciation increases their export volumes by 4%. However, as total factor productivity (TFP) increases by 1 standard deviation, this figure drops to 2.8%. This finding contributes to explaining the partial exchange pass-through as generally observed on the aggregate-level.[26] As a result, more productive firms (with low exchange rate sensitivity) occupy a high proportion of countries' trade balances. Fernandes and Winters (2018) find similar results for Portuguese exporters to the UK, while Berthou, Demian and Dyne (2018) confirm these findings on a cross-country scale in Europe.

One study that uses Canadian transaction-level data finds slightly different results (Devereux, Dong and Tomlin, 2017). On the importing side, large importers have lower pass-through and invoice more often in the local currency. However, on the exporting side, the study finds that very large firms tend to invoice more in the producer currency – with higher resultant pass-through rates. Therefore, while the size of firms does contribute to explaining exchange rate pass-through, this study indicates that the direction of trade (i.e. imports or exports) may matter.

3.3.3.2 Product differentiation and product competition

Literature generally finds that less competitive goods with higher degrees of product differentiation are less reactive to exchange rates than homogenous goods (Menon, 1996). This is due to lower substitution effects taking place for goods that are more differentiated, in the event of a price change. The optimal response for exporting firms of differentiated goods following an exchange rate depreciation is, therefore, to keep local prices higher and to absorb the changes in relative prices in their mark-up. In addition, it has been theorised that goods with lower competition exhibit greater pricing-to-market (Krugman, 1986). This offers a further explanation for the relative price rigidity of differentiated goods.

Fernandes and Winters (2018) for example find that pricing-to-market for UK imports from Portugal is more prevalent for consumer goods than intermediate goods, and therefore exhibit lower pass-through. Hahn (2007) also finds that trade in consumer goods has a relatively lower response to exchange rate changes than other economic sectors in the euro area. This is attributed to the comparatively more differentiated nature of consumer goods. Likewise, exchange rate pass-through for energy and intermediate goods is higher than that for capital goods. Furthermore, trade volumes for intermediate goods production adjust *quicker* than those for capital goods after changes in relative prices. The intuition for this result is that more

[26] That is, as there exist fixed costs to exporting, only the most productive firms are able to enter foreign markets.

homogenous goods are generally more easily substituted, and therefore require faster price and quantity adjustments.

One caveat to this is that generic goods with more competition are likely to be priced in vehicle currencies (Gopinath, Itskohi and Rigobon, 2010), and therefore may experience short-term rigidities in pricing. Some studies also find that PCP is more common for differentiated goods. In the UK for example, the pound is used more for exporting differentiated goods than homogenous goods (Goldberg and Tille, 2008). Similarly, through a Swedish questionnaire survey, Friberg and Wilander (2008) find that Swedish firms that export more differentiated products are more likely to invoice in kronor (i.e. PCP). This evidence potentially points towards differentiated goods being more responsive to changes in exchange rates in the short-term.

3.3.3.3 Other sources of heterogeneity

Firstly, Berman, Martin and Mayer (2012) find that more pricing-to-market occurs for consumer goods than intermediate goods, and that *higher distribution costs* are also associated with greater pricing-to-market. This is because these distribution costs are priced in local currency terms, and with a greater proportion of exports priced in LCP, this reduces the remaining value of goods that can gain competitiveness from a depreciation.

Secondly, trade in *services* has been found to be more responsive to exchange rates than trade in *goods*. Eichengreen and Gupta (2013) use a dataset comprising 66 countries, with a mix of high income and low income countries, and find that exchange rate pass-through for services, and especially modern services,[27] is higher than traditional services,[28] which in turn exhibits greater pass-through than trade in goods. There are two posited reasons for this. *Firstly*, services generally have lower fixed costs of entry, resulting in trade being more reactive to exchange rates on the extensive margin than trade in goods. *Secondly*, and consistent with the predictions of global value chains, services have lower imported costs than goods (Ahmed, Appendino and Ruta, 2015).

Finally, *inflation rates* also have an impact on pass-through. Namely, low inflation environments allow firms to update their prices less frequently (Takhtamanova, 2010), and are therefore associated with lower pass-through to consumer prices (Forbes, Hjortsoe and Nenova, 2017). In addition, average industry-level inflation rates have been found to explain variation in pass-through across industries (Mumtaz, Oomen and Wang, 2006).

[27] For example communications, computer and information services.
[28] For example trade, tourism, financial services and insurance.

3.3.3.4 Implications of heterogeneity

Overall, different sectors in the economy will have different reactions to trade, due to heterogeneity in industry-level characteristics such as product differentiation and the level of imported costs, and heterogeneity in firm-level characteristics such as productivity. For instance, manufactured goods have a considerably lower ratio of value-added to gross exports than services (Johnson, 2014). Similarly, trade in goods with fewer imported costs, such as energy, are more reactive to changes in exchange rates. However, manufacturing is *more* reactive to trade than consumer goods due to their greater homogeneity. Industry-level inflation rates and the size and productivity of firms are also important considerations for pass-through and trade volume responses.

These results imply that the industry *composition* of trade matters for how, in aggregate, trade responds to exchange rate movements. Mumtaz, Oomen and Wang (2004) conduct a study to examine exchange rate pass-through onto UK import prices at the industry-level. The authors find that, as manufacturing goods have low pass-through, and simultaneously contribute to a large proportion of the UK's imported trade balance, this explains the partial exchange rate pass-through to UK imports on the aggregate-level.

In addition, in the presence of heterogeneity, *shifts* in the composition of industry trade affects estimates of pass-through and trade elasticities *over time*. Campa and Goldberg (2005) find that the industry composition of trade that makes up a country's imports is markedly more important for pass-through rates than macroeconomic variables such as the stability of monetary policy (Devereux and Engel, 2001), or country size (Dornbusch, 1987). Namely, a move away from energy imports to manufactured imports provides the main basis of decreasing pass-through for OECD countries between 1975 and 1999.[29]

3.3.4 Exchange rate volatility

This section summarises literature on the effects of exchange rate volatility on trade, which focuses on the impact of volatility on firms' decision making. Although, on the face of it, volatility may seem like a macro-level issue, it is considered as part of the micro-level framework. This is because research seems to reveal that the impact of volatility occurs at the firm-level and is interlinked with other aspects of the micro-level framework such as heterogeneity. Specifically, theory predicts that volatility should enter into firms' decision-making process across pricing, the volume of inputs, and the timing of inputs.

[29] Other studies also corroborate the importance of shifts in trade composition over time (to sectors that are less sensitive to exchange rates) to explaining changes in exchange rate pass-through (Di Mauro, Rüffer and Bunda, 2008).

On the whole, evidence suggests that the relationship between these variables is unclear. First summarised are the theories that specify the mechanisms for how volatility impacts trade. Next, the empirical evidence is examined, which is generally inconclusive.

3.3.4.1 Theory

Theoretically, exchange rate volatility is expected to decrease trade. The main intuition for this is that volatility creates uncertainty about firms' future profits. If firms are assumed to be risk averse, this uncertainty directly reduces firms' willingness to trade. This is because trading contracts are generally agreed before the delivery of goods. Therefore, unanticipated fluctuations in exchange rates would affect the realised revenues from these goods (Dellas and Zilberfarb, 1993).

Early models of exchange rate volatility impose strict assumptions to demonstrate this result. For example, Clark (1973) creates a model of exporters with a homogenous commodity under perfect competition. The author shows that, under this simple framework, trade under exchange rate volatility is a decreasing function of risk aversion. Hooper and Kohlhagen (1978) extend the idea of risk aversion under a bilateral trade model, whereby both import demand and export supply are considered. They show that both exporters' and importers' preferences for risk are relevant, with higher aversion leading to lower levels of trade volumes. Generally, the availability of hedging contracts should reduce the effects of volatility (Ethier, 1973), but may depend on the sign of the trade balance (Viaene and De Vries, 1992).

By contrast, some theories show that volatility may actually increase trade. For example, De Grauwe (1988) develops a theory whereby volatility reduces the probability of obtaining an extreme outcome when trading, and so risk-averse agents would increase their utility by trading when volatility is greater.[30] Similarly, Broll and Eckwert (1999) show that if firms view their exports as an *option*, then larger fluctuations increase the value of that option, inducing firms to trade. More generally, two opposing forces exist when determining the overall impacts of volatility. First, the substitution effect, where firms reduce trade due to risk aversion,[31] and second, an income effect, whereby volatility increases the potential gains to trade.[32]

[30] A sustained extreme outcome is less likely as the presence of volatility means that exchange rates would not remain at sustained high or low levels.
[31] By extension, one could argue that the strength of the domestic market affects the strength of the substitution effect, as exporters with a larger domestic market would have more alternative options to exporting.
[32] De Grauwe (1988) highlights another method to understand this counterintuitive result. An increase in risk has a substitution and income effect. The substitution effect is intuitive and leads risk-averse exporters to reduce exports when risk increases. However, the increase in risk also has an income effect, making exporters poorer by reducing the value of exports, which can be offset by allocating more resources to exports. For those that are extremely risk-averse this may lead them to increase exports, as the income effect dominates.

Another strand of literature shows that the *magnitude* of exchange rate fluctuations matters for trade. If exchange rate shocks are large enough, this induces firms to overcome the (sunk) fixed costs associated with entry and exit into foreign markets and therefore change their entry/exit status. Without reaching this exchange rate, firms do not change their export position. A temporary rise in the exchange rate of sufficient magnitude would induce permanent entry by foreign firms (Baldwin and Krugman, 1986).[33]

Overall, while there exist many factors for evaluating the impact of volatility, with some models suggesting that its effect is ambiguous, in general, theory suggests that trade is negatively affected by exchange rate volatility (Côté, 1994).

3.3.4.2 Empirical evidence

Empirical literature on the relationship between exchange rate volatility and trade is well developed, however provides mixed conclusions. Results are sensitive to the model specification, the measure of volatility used, the countries studied, the sample period, as well as whether the effects are measured on the aggregate or sector level.

To estimate volatility itself, usually a form of variance is used. The simplest case uses the standard deviation of exchange rates in a period of time or alternatively, a moving average of standard deviations (e.g. Bahmani-Oskooee and Kovyryalova, 2008). Perhaps most popular today however are more complex measures, for example, Generalised Autoregressive Conditional Heteroskedasticity (GARCH) models, which specify, loosely speaking, that present volatility depends on past volatility (e.g. Doyle, 2001).

Studies that use data from the UK generally indicate a mixed effect of volatility on trade. The earliest post Bretton Woods study uses various sample periods from 1974 to 1982 and various model specifications does not find a significant link between exchange rates and trade (Gotur, 1985). This is echoed by Chowdhury (1993), who uses data on trade values from G7 countries. Here, across the several measures of volatility used, only a weak effect is found for the UK.

Similarly, other UK-based studies that use pre-euro data have mixed findings. Doyle (2001), modelling volatility as a GARCH process, examines Irish imports to the UK from 1979 to 1992 and does not find a negative effect of bilateral exchange rate volatility on trade. Several explanations are offered for this. *Firstly*, a high level of multinational ownership offers opportunities to diversify exchange rate risk. *Secondly*, there are considerable entry and exit costs of exporting, which decreases the effect of exchange rate volatility on trade on the *extensive* margin. Hwang and Lee (2005) using monthly data from 1990 to 2000, and similarly estimating volatility using a GARCH process, find that higher exchange rate volatility in fact increases

[33] In addition, it has been shown that sunk costs are a higher barrier to exporting for smaller firms than larger firms (Bugamelli and Infante, 2003), suggesting heterogeneity in the response to exchange rate fluctuations.

imports, while its effect on exports is insignificant. Aristotelous (2001) uses a generalised gravity model for UK exports to the US between 1889 and 1999, additionally controlling for changes in exchange rate regimes, and shows that volatility does not significantly impede export volumes.

On the other hand, some studies for this period observe a negative effect of exchange rate volatility. Cheong, Mehari and Williams (2005) use vector autoregressive (VAR) models on UK manufacturing data from 1976 to 2000 and find that volatility increases prices and decreases trade volumes, thus reducing overall trade. De Vita and Abbott (2004) use an ARDL bounds testing procedure on monthly data for UK exports to the EU from 1993 to 2001 and show that while exports are generally insensitive to short-term volatility, trade is sensitive to a *long-term* measure of volatility. In addition, Bahmani-Oskooee and Kovyryalova (2008) estimate the effects of exchange rate volatility on commodities, between the UK and the US, using the bilateral exchange rate, and find that volatility does impede trade.

Several studies have been conducted on UK data from later periods. Choudhry and Hassan (2015) use monthly data for UK imports from three developing countries, Brazil, China and South Africa, from 1991 to 2011, and evidence that volatility negatively impacts trade flows. Another study by Serenis and Tsounis (2015) uses sector-level data from 1973 to 2010. While the effects of volatility on sectoral exports display signs of heterogeneity, the relationship between volatility and trade is negative.

Studies that use data from other countries corroborates findings that evidence regarding the effects of exchange rate volatility is inconclusive.[34] There are, however, some notable results worth mentioning. *Firstly*, studies that use bilateral trade find a greater effect of volatility than studies that use aggregate trade (Auboin and Ruta, 2013). *Secondly*, imports are generally less sensitive to changes in exchange rates than exports (Huchet-Bourdon and Korinek, 2011). In addition, there is evidence to suggest that short-term volatility is only a barrier to trade for developing countries (Nicita, 2013). In developed economies, on the other hand, limited effects are found (Caglayan and Di, 2010; Caglayan and Di, 2010).

Côté (1994) cites the reasons for a lack of a clear relationship in the literature as: (i) an increase in risk does not necessarily entail a reduction in risky activity, even for businesses that are risk-averse; (ii) an increasing amount of hedging techniques to avoid risk altogether; and (iii) in many situations exchange rate volatility may create profitable opportunities.

Altogether, empirical evidence on the effects of exchange rate volatility is mixed. Furthermore, theory on volatility does not consistently indicate that it would reduce international trade volumes. As a result, its effects on trade are inconclusive. On balance, volatility may only be a *weak* impediment to trade for the UK, if any.

[34] For example, see literature surveys from McKenzie (1999) and Ozturk (2006).

3.3.5 The role of expectations

Finally, the role of exchange rate expectations in firms' decision making is considered. Expectations are likely to fit into both the demand side and supply side of firms' decision making, particularly in terms of marketing and timing of inputs which, in theory, should rest on businesses' expectations. Overall however, the role of expectations appears to be ambiguous. While firms should theoretically make decisions based on expectations, it is unclear whether these factors are involved in decision making, and to what degree.

In theory, as future exchange rates are an important determinant of future profits, firms' current decisions are affected by expected future rates. Froot and Klemperer (1988) specify a model whereby firms' future demand for their profits depends on their market share. A *temporary* depreciation induces foreign exporters to reduce their local currency prices less than what would be traditionally predicted, as these firms find investment in market share to be less attractive. As a result, these temporary exchange rate changes are absorbed into firms' mark-ups.[35] Contrastingly, a *permanent* depreciation incentivises firms to invest in market share. The authors provide evidence that an expectation of a future depreciation of the dollar, during its appreciation in the early 1980s, is related to pricing-to-market for exports to the US. This provides an explanation to why trade was relatively unreactive for this period.

Empirically however, these theoretical predictions are difficult to verify. One strand of literature has focussed on the systematic overshooting of exchange rate expectations in the short-run, leading to anticipation of a mean-reversing correction of this exchange rate in the future (Chakrabarti and Scholnick, 2002). For example, Frankel and Froot (1985) examine data from three independent surveys of investor expectations and find that current increases in the spot rate generates investor anticipation of a future decrease in the spot rate. Similarly, there is evidence that exchange rate expectations are *time inconsistent* (Froot and Ito, 1989).[36] Overall, if a current exchange depreciation is associated with an expected future appreciation, then this implies current trade responses would be muted.

Few studies examine whether firms directly factor in expectations in their decision making. One study finds that for Chinese exports to the US, controlling for forward exchange rates increases exchange rate pass-through estimates (Li and Zhao, 2015). Notwithstanding the limitations of using forward rates as a proxy for expectations, this study suggests that expectations are considered in decisions about pass-through.

Exchange rate expectations should also theoretically play a role in the choice of invoice currency, which in turn impacts pass-through and export and import volume responses (Fukuda and Ono, 2006). However, Friberg and Wilander (2008), through

[35] In the extreme case, firms may choose to *increase* their foreign currency prices if the exchange rate appreciates substantially over time as to erode future profits.
[36] Namely, expectations at different forecasts into the future do not match up.

survey data, find that expected exchange rate changes matter little for the choice of invoice currency.

Overall, theory suggests that exchange rate expectations matter for trade. However, the empirical evidence on this topic is much less developed, and as a result, substantive conclusions are difficult to draw. While literature finds that expectations do overreact in the short-term and therefore lead to a mean-reversion of long-term expectations, to what extent firms factor expectations into their decision making is an unresolved empirical question. If firms take expectations into account, evidence would suggest that it dampens the relationship between exchange rates and current trade (as firms have been found to expect future reversals of current movements).

3.4 Evidence from recent events

This section departs from the micro- and macro-level framework to consider direct evidence in the literature on recent events in which the UK's exchange rate has seen substantial fluctuations. First examined is the depreciation of the pound in the context of the EU referendum, before evidence from the global financial crisis and COVID-19.

3.4.1 EU referendum

The absence of an export response after the EU referendum despite the sizeable depreciation of the pound is difficult to explain with traditional macroeconomic theory. Adding to this, as a large proportion of UK exports is invoiced in pounds (PCP), this should theoretically have induced a fall in local prices and an expansion in export volumes (Corsetti, Crowley and Han, 2019).

On the importing side, exchange rate pass-through to consumers was relatively high (Nasir, Simpson, 2018). In fact, Breinlich et al. (2019) find that complete exchange rate pass-through cannot be rejected. These estimates are considerably higher than what would be expected, given recent literature on incomplete pass-through.

These empirical facts can be explained by four key factors, according to the literature, which will further be explored in this section.

1. Greater use of the **dollar** for trade invoicing creates short-term nominal rigidities.
2. **Global value chains** suppress the relationship between exchange rates and trade.
3. Anticipation of future **tariffs** reduces the future gains from trade.
4. Trade policy **uncertainty** generally has a negative effect on trade.

Firstly, the majority of UK imports, as well as a significant proportion of UK exports, are invoiced in vehicle currencies, with the dollar being the most used currency (Crowley, Corsetti and Han, 2020; Chen, Chung and Novy, 2019). As described in section 3.3.1, a depreciation of the pound against all currencies (including the dollar), is associated with *unbalanced* export and import volume responses. That is, export prices for those invoiced in the dollar exhibit short-term nominal rigidities; imports prices, on the other hand, do respond.

Secondly, global value chains play a role in suppressing any benefits to a depreciation. This is supported by recent evidence from the FTSE stock market, which found that firms with greater imported costs fared worse immediately after the depreciation (Davies and Studnicka, 2018). As discussed in detail in section 3.3.2, imported costs work against any benefits that a depreciation has in improving the price competitiveness of exports.

Thirdly, there appear to be mechanisms other than the suppressed impact of exchange rates that contributed to the lack of export response to the EU referendum. For example, the *anticipation of future tariffs* provides one such mechanism, with various literature indicating that tariffs themselves have a substantial impact on trade. For example, Fitzgerald and Haller (2014) estimate that entry into markets and export revenue is four and six times more responsive to tariffs than exchange rates, respectively.

In addition, *uncertainty about future trade policy* has been posited to have a large impact on trade. One study by Crowley, Exton and Han (2018) directly examines the role of uncertainty to trade during the EU referendum. Using a difference-in-difference methodology, and crucially controlling for the depreciation of the pound, the authors estimate that 5,344 exporters in 2016 did not enter the EU market as a result of the EU referendum, and 5,437 firms exited the EU market. Thus, without the EU referendum result, entry and exit would have been 5.1% higher and 6.1% lower, respectively, had UK firms not faced increased trade policy uncertainty following the EU referendum.

The benefits of trade policy certainty are evidenced by other studies that exploit variation from uncertainty-reducing trade agreements from around the world. The US granting of permanent normal trade relations (PNTR) for China in 2000 for instance, reduced uncertainty of Chinese import tariffs without changing its actual rates. Pierce and Schott (2016) finds a link between this reduction of uncertainty and a reduction of US manufacturing employment, one of the channels being through an increase in Chinese imports to the US as a result of this trade policy.

Another example is through China's accession to the WTO. Between 1990 and 2010, China's exports to the US rose tenfold without any major change to US trade barriers. Handley and Limao (2017) estimate that the reduction of uncertainty associated with China's membership of the WTO is responsible for over one third of China's export growth to the US over the period of 2000 to 2005.

Lastly, Handley and Limao (2015) develop a model which explains export entry and exit in terms of trade policy uncertainty. This model posits that preferential trade

agreements encourage export investments if they introduce tariff reductions that are credible. Thus, trade policy certainty encourages greater trade, even when tariffs are currently low. Applying this model to data, the authors find that the reduction of uncertainty as a result of Portugal's accession to the European Community in 1986 had a sizeable positive impact on exports. Specifically, two thirds of the increase in trade is attributable to the reduction in trade policy uncertainty, whilst the remainder is due to reduced tariffs. This suggests that uncertainty reduction is more important than trade barriers themselves in stimulating trade.

Overall, the EU referendum has been linked to numerous changes in macroeconomic variables, many of which are likely to mask how exchange rates impact trade. For example, anticipation of the consequences of the referendum has been estimated to reduce domestic investment by 11% over the three years following the EU referendum (Bloom et al., 2019). The referendum may also be associated with a decrease in labour productivity (Costa, Dhingra and Machin, 2019) as well as other income and welfare losses (Dhingra et al., 2017). This is likely to impact trade, independent of exchange rates. Nevertheless, the reviewed evidence suggests that once uncertainty is resolved through trade agreements, trade volumes may eventually improve (Michail, 2018).

3.4.2 Global financial crisis

The literature indicates that the trade collapse during the global financial crisis (GFC) largely operated from huge negative demand shocks, causing trade elasticities to overshoot globally, independent of exchange rates. As a result of strong production links between countries, in part due to inflexible global value chains, shocks to firms and industries are transmitted through these production links, causing macroeconomic shocks across borders (Gunnella, Fidora and Schmitz, 2017).

The GFC also initiated a *supply* side shock to trade through the decline in the availability of credit. Specifically, trade credit, which firms borrow to fund their exports (which generally requires more funding than domestic production), contracted considerably during the crisis, thereby reducing export supply (Chor and Manova, 2012). Sectors that required more external financing were particularly affected. This suggests that the health of financial institutions that provide external finance is crucial for trade to expand under an exchange rate depreciation.[37]

Novy and Taylor (2014) posit that another mechanism for the large decrease in trade is due to uncertainty. That is, as trade in foreign intermediate goods carry larger fixed costs than domestic goods, firms optimally choose to reduce their holdings of these foreign goods in response to a shock in uncertainty.

In addition, exports after the GFC remained relatively unresponsive, partly as an artefact of slow global economic growth. However, it has been suggested that the

[37] Arguably, the impact of this for the UK may not have been as strong as for other economies, as trade finance generally becomes less important for developed countries.

relationship between macroeconomic variables and exports showed no clear signs of structural change (Lewis and De Schryder, 2015).

Nonetheless, there exists literature that suggests that the UK's export competitiveness and net trade did improve as a result of the depreciation of the pound. Specifically, by 2011, Kamath and Paul (2011) show that relative export prices fell by 15% compared to the period before the large exchange rate depreciation. Imports, however, failed to contribute to the improvement in the trade balance, although the study highlights reduced demand for service imports as an exception.

Kang and Dagli (2018) conduct a global study, using data from 72 countries over 2001-2015 to study the relationship between the real exchange rate and trade over the GFC period. Prior to the crisis, there was some relation between exchange rates and export volumes, but this is much weaker in the period after the crisis. More specifically, a 1% depreciation of an exporter's real exchange rate led to a 1.05% increase in export volumes over 2007-2010, but after 2012, this relationship disappeared.[38] Several reasons are posited to explain this weakening. These include: (i) increased participation in global value chains; (ii) changes in the import composition, namely changes in the composition of primary goods to processed goods; and (iii) changes in the stock of external debt of exporters and importers.

Overall however, the general trade response from the financial crisis appears to be an artefact of factors independent of exchange rates. Namely, a slump in global demand, coupled with tight credit restrictions, is widely believed to be the main cause of the global trade collapse.

3.4.3 COVID-19

To some extent, there are parallels that can be drawn between the exchange rate impact of COVID-19 and the GFC – at least at a high-level. COVID-19 is associated with demand shocks similar in nature to the financial crisis, which propagates to trade through reliance on global value chains. In addition to this, the COVID-19 crisis is associated with vast supply shocks across most sectors of the economy. The recovery of supply would, like the GFC, be partly dependent on the availability of trade credit. However, unlike the GFC, how well these supply shocks recover is not entirely in the hands of access to credit and would depend on how fast COVID-19 itself dispels.[39]

More specifically, while it is still unclear exactly what the effects of COVID-19 will be – with events still unfolding and research being continually developed – there are some studies that have looked at the impact on trade and the role of exchange rates.

[38] Evidence here of a relationship between exchange rates and trade at the aggregate-level further reinforces the conclusion that, although the macro-level transmission mechanisms individually do not appear to sufficiently explain the relationship, in the long-run the micro-level mechanisms may converge such that the relationship is restored.
[39] See CEPR blog post: https://voxeu.org/article/greater-trade-collapse-2020

For instance, there is evidence of substantial economic uncertainty, which would serve as a large impediment to trade. Altig et al. (2020) assess the impact of the pandemic on a range of uncertainty indices and find that on a number of different measures uncertainty rose to an all-time high, with little indication of falling. As discussed in sections 3.4.1 and 3.4.2, uncertainty can severely restrict trade, and so it is likely that COVID-19-induced uncertainty may have an effect on trade for the foreseeable future. Furthermore, early estimates from Maliszewska, Mattoo and Mensbrugghe (2020) indicated that, as a result of the general decline in GDP, exports would fall by 2.5% globally. However, the World Trade Organisation (WTO) predicted that over the course of 2020 world trade would fall between 13% and 32% (Bekkers et al., 2020). Outturn data from the first half of 2020 confirms this forecast, with global trade in Q2 falling by 18.5% compared to the previous year (WTO, 2020). The large demand and supply shocks resulting from the COVID-19 outbreak, coupled with their coinciding uncertainty largely overshadow the effects of exchange rate movements to trade. Indeed, COVID-19 may have persistent effects on trade, independent of exchange rates.

Ultimately, the *causal relationship* between exchange rates and trade would be influenced by the factors as described in section 3.3. *Firstly*, the proportion of trade denominated by each invoice currency would determine short-term rigidities to trade. For instance, one key issue is whether 'dollarisation' would continue to dominate trade after the crisis. A recent paper from the IMF indicates that the prevalent use of the dollar may accentuate the negative impact of COVID-19 on trade, as many countries (particularly developing countries who use the dollar extensively) would be unable to realise the trade benefits of having a weaker domestic currency (Adler, Gopinath and Osorio Buitron, 2020). In addition, due to the use of the dollar as a vehicle currency, if other currencies depreciate more than the dollar (i.e. the dollar becomes relatively stronger) then world trade as a whole would fall as exports invoiced in dollars are more expensive.

Secondly, if COVID-19 instigates structural changes to global value chains, this would influence how trade reacts to exchange rates. For instance, a rise in the number of companies sourcing their imported intermediate goods domestically, rather than from abroad, would reduce reliance on foreign supply chains. Consequently, it is possible that less developed countries may be left out of global value chains, which could significantly damage their trade presence (Gonzalez Behar and Terai, 2020).

Thirdly, COVID-19 may also impact trade through financial channels. One of the immediate effects of a depreciation of the pound is to change the UK's net international investment position. Similar to the GFC, this improves with a depreciation in the pound. Nevertheless, the extent of this 'balance sheet' effect would depend on how COVID-19 affects the UK's stock of external debt. Greater accumulation of foreign liabilities would mute any effect of exchange rate changes. It is possible that any balance sheet effect may be asymmetric between exports and imports. This is because exporters are more likely to maintain prices and finances in the same currency, meaning that revenues and liabilities move together. By contrast, importers – who have less control over what currency they trade in – use a range of

different currencies and so are more susceptible to a balance sheet effect (Adler, Gopinath and Osorio Buitron, 2020).

Lastly, the industry *composition* of trade matters, as heterogeneity of exchange rate pass-through and trade volume elasticities will continue to exist. For example, shifts in UK exports and imports towards industries that exhibit less exchange rate pass-through would decrease the UK's aggregate trade sensitivity to exchange rates. On a larger scale, the impact of COVID-19 would depend on the structure of the economy as a whole – but it is unclear exactly *how*. For example, Gonzalez Behar and Terai (2020) argue that developing countries would be more negatively affected in terms of trade, as they rely on global value chains, which may now be shrinking, as well as the tourism industry, which is amongst the most damaged by COVID-19. On the other hand, Baldwin and Forslid (2020) suggest that the trade shock brought on by the pandemic presents an opportunity for newly/less developed countries, as remote working is facilitating more cross-border labour markets, meaning these countries can use their comparative advantage in cheaper skilled labour.

Initially, it was suggested that the COVID-19 crisis would bear a resemblance to the GFC – particularly in terms of its demand shock – in its effect on trade. However, the impacts of the pandemic have unfolded rapidly and unpredictably, meaning that now it is not possible to draw direct comparisons between these two events (Bekkers et al., 2020). In fact, in the context of international trade, there is reason to believe that the effect of COVID-19 would not be as severe as other events such as the GFC and the EU referendum (De Lyon and Dhingra, 2020; WTO, 2020). Whilst the extent and duration of the effects of COVID-19 are unclear, the review suggests that several key factors will be crucial to governing the resulting relationship between exchange rates and international trade.

3.5 Literature review conclusions

185 articles were reviewed and split across: (i) macro-level transmission mechanisms; (ii) micro-level transmission mechanisms; and (iii) evidence from recent events. The main findings from the review are as follows.

- The macro-level transmission mechanisms generally consider more traditional theories of trade such as the Marshall-Lerner condition, the J-Curve, the S-Curve, and Keynesian absorption theory. While these have theoretical backing, empirically they do not appear to consistently explain the relationship between exchange rates and trade. Possible reasons for this include: (i) studies of trade at an aggregated level are unable to accurately capture the underlying mechanisms; (ii) the Lucas Critique implies that macroeconomic models cannot successfully estimate the impact of policy if they do not account for changing consumer behaviour and expectations; and (iii) at the macro-level, exchange rates may be somewhat endogenous, so that the trade balance itself has an effect on them. There is some evidence that these theories may offer some insight into the long-run relationship between

exchange rates and international trade. On balance though, the literature suggests placing less emphasis on macro-level theories and more on micro-level theories.

- The shortcomings of the macro-level theories may be reconciled by looking at the micro-level transmission mechanisms. Three main features appear to play a large role in the link between exchange rates and trade. *Firstly*, the use of different invoice currencies – particularly vehicle currencies and local currencies of the importing country – means that the bilateral exchange rate has significantly less importance in determining trade than the theory would suggest. *Secondly*, globalisation has given rise to extensive global value chains which reduce the impact of exchange rate movements on trade, primarily because many exporting firms rely on imports for their production. In addition, firms' increasing globalisation has also affected the role of exchange rates due to factors such as financial integration and transfer pricing. *Thirdly*, there is significant heterogeneity in the economy that determines the effect that exchange rates have on trade. This exists across several dimensions, including:
    - size and productivity of firms;
    - product differentiation and competition;
    - distribution costs;
    - inflation; and
    - goods versus services.

  Taken together, these findings suggest that trade and exchange rates have overall become somewhat disconnected at an aggregate-level. This is particularly true in the short- to medium-term, but the relationship appears to be slightly re-established in the long-run.

- At the same time, there are some elements of the micro-level transmission mechanisms that counterintuitively do not play a significant role in exchange rates and trade. There is only mixed evidence that volatility is an impediment to trade. Similarly, the literature around exchange rate expectations is limited and inconclusive.

- Finally, recent exogenous events have material implications for UK trade. *Firstly*, it was observed that the depreciation of the pound following the EU referendum did not result in an increase in exports. However, given the other main findings that exchange rates and trade volumes have become more disconnected at an aggregate-level, and that traditional macro theories of trade are often not substantiated by empirical evidence, this is perhaps unsurprising. *Secondly*, the most recent research on COVID-19 suggests that the effects of the outbreak on trade have been large, with world trade falling 18.5% in the first half of 2020. While the extent of the effects of the pandemic

are still unknown, evidence suggests that the impact on trade is likely to be asymmetric across industries and economies.

These findings were used to shape the remaining parts of the research so that they effectively targeted the key issues identified regarding exchange rates and trade. At the same time, where the literature review was unable to comprehensively address any of DIT's research questions, the survey and case studies attempt to reconcile this, as is discussed next.

4. Survey

This chapter discusses the findings from an online business survey of 124 registered UK firms involved in international trade (i.e. exporters, importers or both). The survey asked respondents about the importance of exchange rates to business decisions and how firms react to exchange rate fluctuations. The survey was designed to test the findings from the literature review regarding micro-level transmission and uncover additional insight on the micro-level trade response to exchange rate fluctuations.

4.1 Introduction

As part of the fieldwork for the project, a survey of registered UK business involved in international trade was run. The purpose of this survey was twofold:

- Answering DIT's priority questions; and
- Verifying or otherwise the findings from the literature review.

The survey was in the field from the 14th July 2020 to the 29th July 2020 and was hosted online by the market research company Omnisis.[40] Responses were targeted towards 100 businesses registered in the UK involved in international trading, aiming for a broad split of respondents across each of (i) trading function (i.e. importer, exporter or both), (ii) size (by number of employees), and (iii) industry. After removing 40 responses that did not satisfy quality assurance processes described below, the remaining 100 responses were substantially different from the intended sample proportions. Therefore, the survey was kept in the field until sufficient responses, meeting the quality threshold, were obtained to arrive at approximately the targeted sample breakdown, resulting in a final sample of 124 registered UK businesses.[41]

The survey asked respondents about the importance of exchange rates to business decisions in broad terms as well as asking how firms reacted to four episodes which saw fluctuations in the value of the pound: (i) depreciation after the EU referendum, (ii) depreciation from April to August 2019, (iii) appreciation from August to December 2019, and (iv) depreciation around COVID-19.

The central findings from the survey are as follows:

[40] https://www.omnisis.co.uk/

[41] The conclusions outlined in this report are robust to including the 40 responses that were removed (i.e. running the analysis on the sample of 164, including responses deemed to be of low quality).

- Consistent with the literature review and case studies, firms appear to face obstacles (nominal rigidities) which seem to limit the response to exchange rate fluctuations:
    - the majority of respondents indicated that prices in the main invoice currency were *not actively changed* in response to exchange rate fluctuations, and even more businesses indicated that quantity was not actively changed.
    - Exchange rate pass-through therefore seems to be driven overwhelmingly by the invoice currency and is mostly either zero (0%) or complete (100%). As a high share of survey respondents use the pound relative to that observed in the population of UK firms trading internationally[42], this may potentially overstate the export price response and understate the import price changes. This follows the predictions of PCP theory highlighted in the literature review.
- In contrast, there is limited heterogeneity in the exchange rate response across firm characteristics in the survey (e.g. position in supply chain, industry, type of good), which is slightly inconsistent with evidence from the literature review and case study analysis. To the extent that cross-firm differences, such as industry or position in the supply chain, drove exchange rate pass-through in the survey, this seemed to be via the invoice currency.
- Three factors appear to restrict the trade response of firms to exchange rate movements: (i) exchange rate expectations, (ii) the length of contracts (i.e. the duration for which trade contracts were set), and (iii) the size of the exchange rate fluctuation. When asking respondents what factors restricted their trade response to exchange rate fluctuations, these factors were emphasised above all others.
- In the case of exchange rate fluctuations around the time of the EU referendum and COVID-19 crisis, respondents suggested non-exchange rate factors are important in business decision making and likely outweigh exchange rate considerations. For instance, a non-trivial number of firms changed prices in the opposite direction suggested by theory, given the exchange rate depreciation following these events.

These findings will be discussed in more detail in the remainder of the section, along with the survey methodology.

[42] For instance, see HMRC customs data: https://www.gov.uk/government/collections/currency-of-invoice. Note, while this relates only to non-EU trade, pound invoicing is still considerably lower than suggested in the survey (which covers all trade).

At the outset, it is important to note that the responses obtained from a survey sample would not perfectly reflect the wider population that the sample represents.[43] As such, statistical significance testing of the survey responses is applied throughout to guide the commentary – this is where, within a pre-specified level of probability (e.g. 95%), results also apply to the wider population. Where 'significance' is referenced, this is only intended as a guide to the findings that stood out within the dataset (i.e. where responses are statistically significant) – in all other cases, the results are not statistically significant. In addition, where applicable, charts throughout this section will also highlight where differences across sub-groups are sufficiently large to note.

4.2 Survey methodology

The survey design involved both the construction of a sampling methodology and the development of a set of survey questions. This sub-section briefly discusses each of these in turn, before documenting the implementation of this survey design with the market research company Omnisis.

4.2.1 Sampling methodology

A sampling framework was developed to ensure that the appropriate breakdown of respondents was targeted, given the research interests. In particular, the target sample breakdown was chosen as follows:

i. **Trading firms**. An equal split across exporters (one third), importers (one third) and exporters & importers (one third). This represented an over-sampling of those that both export and import, relative to the population and under-sampling of those that import or export only based on Office for National Statistics (ONS) data (see Figure 12).

ii. **Size (by number of employees)**. An equal split across micro and small (one third), medium (one third) and large firms (one third).[44] This represented an over-sampling of medium and large firms and an under-sampling of micro and small firms (that represent around 73% of all internationally trading firms according to ONS data, although they are likely to represent a much smaller proportion of traded volumes/revenues).

[43] Survey data in general would be less reflective of the population if respondents are not randomly drawn. In this survey, there was a deliberate over-sampling of certain firm characteristics to achieve a desired sample size across these characteristics.
[44] Based on an EU definition employed from 1 January 2005, these are categorised as follows: micro firms – less than 10 employees; small firms – 10 to 49 employees; medium firms – 50 to 249 employees; large firms – over 250 employees.

iii. **Industry**. An equal split across manufacturing (one third), services (one third) and distribution (one third). This represented an over-sampling of manufacturers relative to the population and under-sampling of services, based on ONS data.

The aim of this breakdown was for the sample of businesses to be reasonably representative of the population of internationally trading firms, as documented in the ONS Annual Business Survey (ABS) of exporters and importers in Great Britain.[45] Owing to the limited sample size targeted in the research, it was acknowledged that the sampling methodology would not be able to provide a sample that was *truly* representative of the population. For this reason, it was decided to base the sampling framework on only three characteristics and aim for an equal split across these three characteristics.[46] This was to ensure that sufficient firms of each type would be in the sample in order to draw inference, despite this leading to slight over-sampling of certain characteristics (and under-sampling of others).

4.2.2 Questionnaire

Following the sampling framework, a questionnaire was developed to answer the priority research questions on this sample. This consisted of questions around two main topics:

i. the importance of exchange rates to business decisions in abstract terms; and

ii. how firms reacted to four specific episodes which saw fluctuations in the value of the pound, namely (i) the depreciation after the EU referendum, (ii) the depreciation from April to August 2019, (iii) the appreciation from August 2019 to December 2019, and (iv) the depreciation around COVID-19.

Prior to these questions, respondents were asked several screening questions. In addition to screening questions used to implement the sampling methodology above, the highly specialised nature of the research necessitated that particular individuals at each firm were targeted, namely decision-makers involved in international trade. Therefore, the questionnaire contained several screening questions at the beginning to guarantee that respondents had experience of international trading at their current business. Additionally, respondents were only asked questions in relation to the four

[45] See https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/annualbusinessurveyimportersandexporters

[46] These characteristics were not available in the business data panel that Omnisis uses to recruit businesses. Therefore, this sample breakdown was targeted using screening questions and monitored in real-time by Omnisis to achieve the required proportions.

specific instances of historic exchange rate fluctuations (ii. above) if they indicated they were at their current business and involved in international trade at that time.

4.2.3 Implementation and quality assurance

The survey design underwent multiple revisions before being fully launched, to ensure respondents understood the questions and quality responses were achieved. In addition, the survey was subjected to a quality assurance process after its initial design. This quality assurance process consisted of:

i. A pilot survey of ten respondents run between 23rd July 2020 and 24th July 2020 to test respondents' understanding of the questions. As part of this exercise, the drop-out rate and the average time for survey completion was monitored to gauge potential response fatigue.

ii. Real-time filtering of responses once the survey was fully launched. This led to the exclusion of those where either there were obvious contradictions, or potential contradictions where the respondent provided inadequate explanation, each suggesting a poor-quality response.

On (i), the average time it took to complete the survey was seven minutes and only one respondent dropped out. As such, it was concluded that the survey was reasonably concise and thus response fatigue was limited. In terms of modifications to the questions, some clarifications to questions were made where it was deemed that confusion could have arisen. This, for example, included specifying 'main traded' good/service for questions about price/quantity, to avoid confusion in case the respondent traded in multiple goods/services.

The reason for adding 'main traded' was that during the pilot respondents chose options that, while not mutually exclusive, seemed unlikely to be valid responses. For instance, one respondent indicated that the price both increased and decreased following an exchange rate fluctuation, despite the invoice currency being specified. However, there still existed concern about receiving responses of this kind. In particular, it was decided that a method was required for filtering out instances where this likely reflected a poor-quality response, but avoided unduly restricting the possible responses, and corresponding insights.

Therefore, a real-time filtering process of responses was adopted, as identified in (ii) above. Importantly, the survey logic was not restricted to prevent such responses as these were not necessarily contradictory (e.g. the respondent may have been considering multiple customers or countries when discussing price changes). Instead, a log of potential contradictions that could arise in responses was generated, and where these were not mutually exclusive, the survey prompted the respondent to explain seemingly contradictory responses in an open-text box. Responses were checked daily and reviewed in more detail for those that had at

least one potential contradiction, as this was an indication that the response was potentially of poor quality. This process ensured the quality of responses for the analysis.

The survey was conducted online, and respondents were recruited from the Dynata panel that Omnisis accesses to recruit business respondents.[47] As noted above, Omnisis monitored the sample characteristics in the background in order to achieve the breakdown in the sampling framework. Following the quality assurance process outlined above, the first 100 quality responses were substantially different from the targeted sample proportions. Therefore, the survey was kept in the field until sufficient responses, meeting the quality threshold, were obtained to arrive at approximately the targeted sample breakdown, resulting in a final sample of 124 registered UK businesses. The remainder of this section outlines the results from this final sample.[48]

4.3 Survey results

This sub-section discusses the results of the survey of 124 registered UK businesses involved in international trade. *Firstly*, the sample breakdown and how this relates to the targeted breakdown and population of internationally trading firms in the UK is discussed. The central findings from the survey follow, which covers the impact of exchange rate fluctuations on international trade decisions made by firms and the factors that determine them.

4.3.1 Characteristics of surveyed firms

The final sample contained 124 businesses registered in the UK. Figure 11 below presents the main characteristics of the surveyed firms 'at a glance'.

Across the three sample characteristics targeted, the final sample achieved a higher response rate from businesses that both export and import (44% of responses), in comparison with businesses that either export (29% of responses) or import (27% of responses) only. The UK aggregate breakdown as recorded in the ABS survey is illustrated in Figure 12.[49] This shows that, as a result of oversampling businesses that both export and import relative to the target sample, the survey sample broadly matched the population distribution according to the ABS. In terms of industry breakdown, the targeted equal split across manufacturing, services and other

[47] Dynata is a member of ESOMAR (the European Society for Opinion and Marketing Research).
[48] The conclusions outlined in this report have been checked to be robust to including the 40 responses that were removed. However, due to concerns about their reliability as outlined in the quality assurance process, these responses are excluded from the results outlined in this section.
[49] Annual Business Survey, tab '2018 Goods and Services'. Link to source: https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/annualbusinessurveyimportersandexporters

industries was achieved. Lastly, in terms of firm size, a higher proportion of micro and small firms (42% of responses) in comparison with medium (30% of responses) and large (27% of responses) firms was achieved in the final sample. The UK aggregate breakdown of trading firms by size is illustrated in Figure 13.[50]

As shown in Figure 11 below, the EU is the most common trading partner for the sample of businesses, followed by the US and China. This is broadly consistent with UK macro-level figures, as displayed in Figure 14. For instance, in 2016, the EU alone accounted for 49% of goods exported from the UK, while 15% of the UK's exports went to the US.[51]

The majority of respondents have domestic supply chains (56% of respondents) and a smaller proportion (44% of respondents) have international supply chains with the stages of supply chain located across different countries. Relatedly, the majority of respondents (67%) sourced their internationally traded product domestically, and the rest of the respondents (33%) sourced their inputs from abroad. These two questions are used in subsequent analysis as an indicator for whether businesses are involved in GVCs (Global Value Chains).

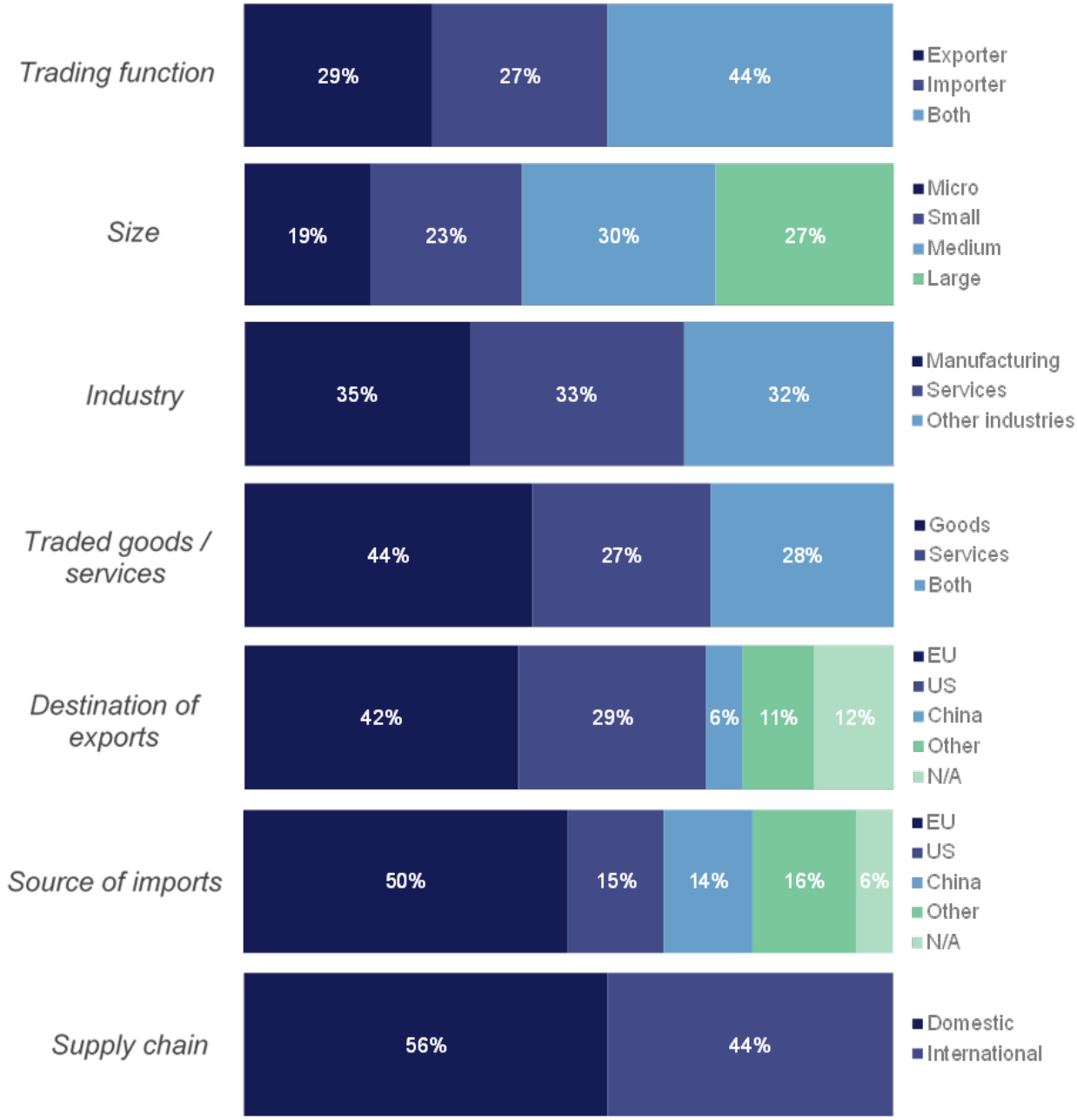
Another characteristic of survey respondents, not shown below, is that they are on average relatively experienced in cross-border trade as compared to the UK population. Specifically, survey respondents have on average 20 years of trading experience. The latest data from the ABS shows that the majority of businesses (between 69% and 74% of total) are less than 20 years old.[52]

[50] Annual Business Survey, tab '2018 Goods and Services'. Link to source: https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/annualbusinessurveyimportersandexporters

[51] See: https://www.ons.gov.uk/businessindustryandtrade/internationaltrade/articles/whodoestheuktradewith/2017-02-21

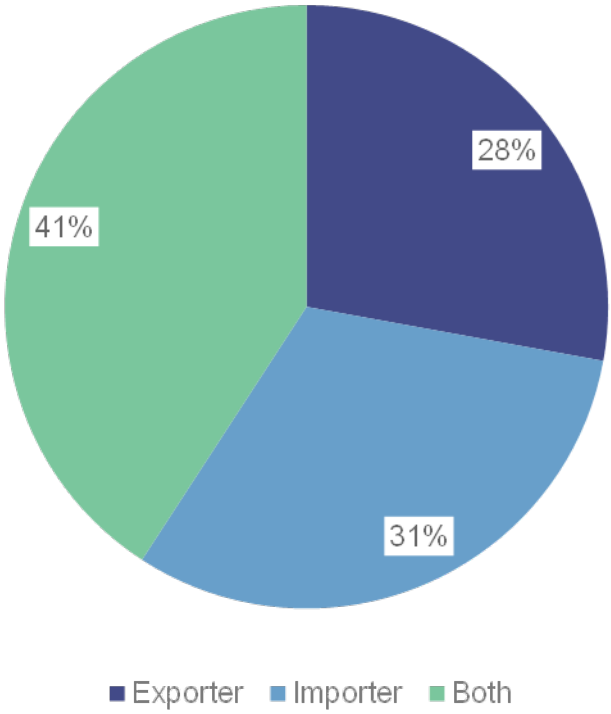
[52] Annual Business Survey, tab '2018 Goods and Services'. Link to source: https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/annualbusinessurveyimportersandexporters

Figure 11: Survey sample characteristics



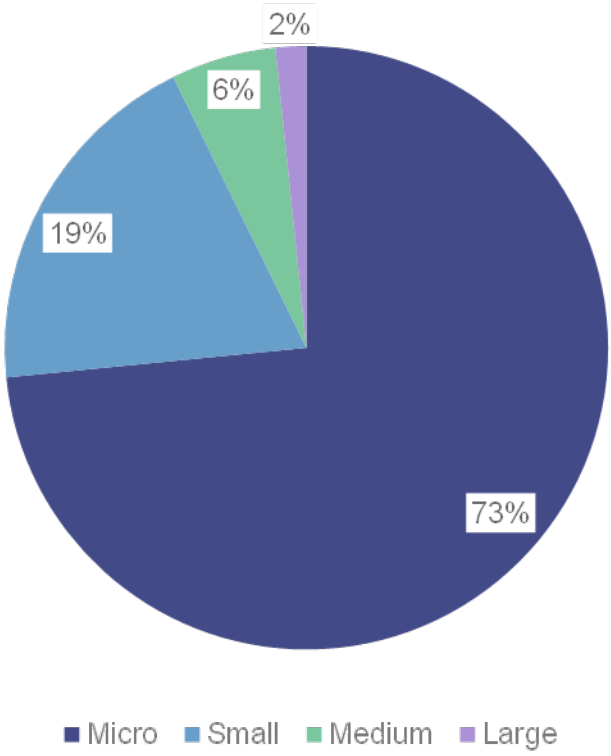
Source: Economic Insight analysis of survey responses.
Base sizes: Destination of exports - 90; Source of imports - 88; All other characteristics - 124
Notes: For both destination of exports and source of imports respondents were asked to give open text responses. Where "Europe" was the response this is included under "EU". It is possible that these respondents had in mind European countries outside of the EU. There are seven instances for exports and six instances for imports. If shown separately, for exports the share would be 8% for Europe and 34% for the EU, and for imports the share would be 7% for Europe and 43% for the EU.

Figure 12: UK trading firms by trading function



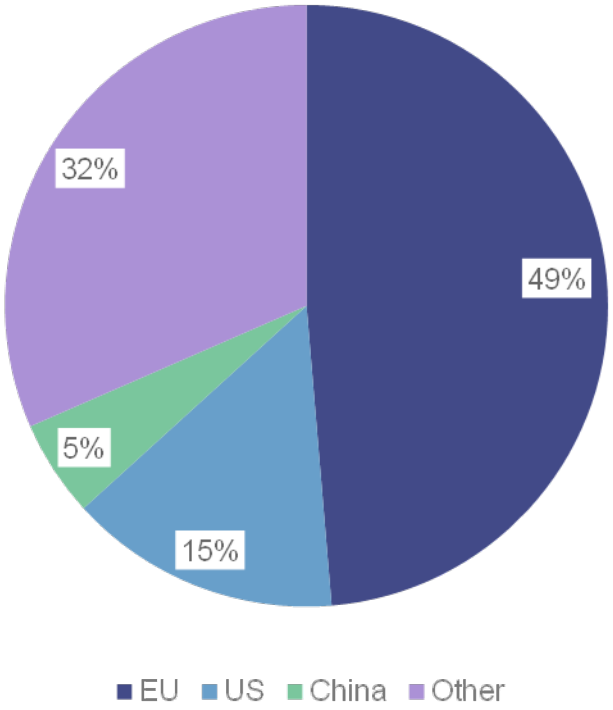
Source: Annual Business Survey (ABS) of exporters and importers in Great Britain.

Figure 13: UK trading firms by size



Source: Annual Business Survey (ABS) of exporters and importers in Great Britain.

Figure 14: UK trading partners by total value traded



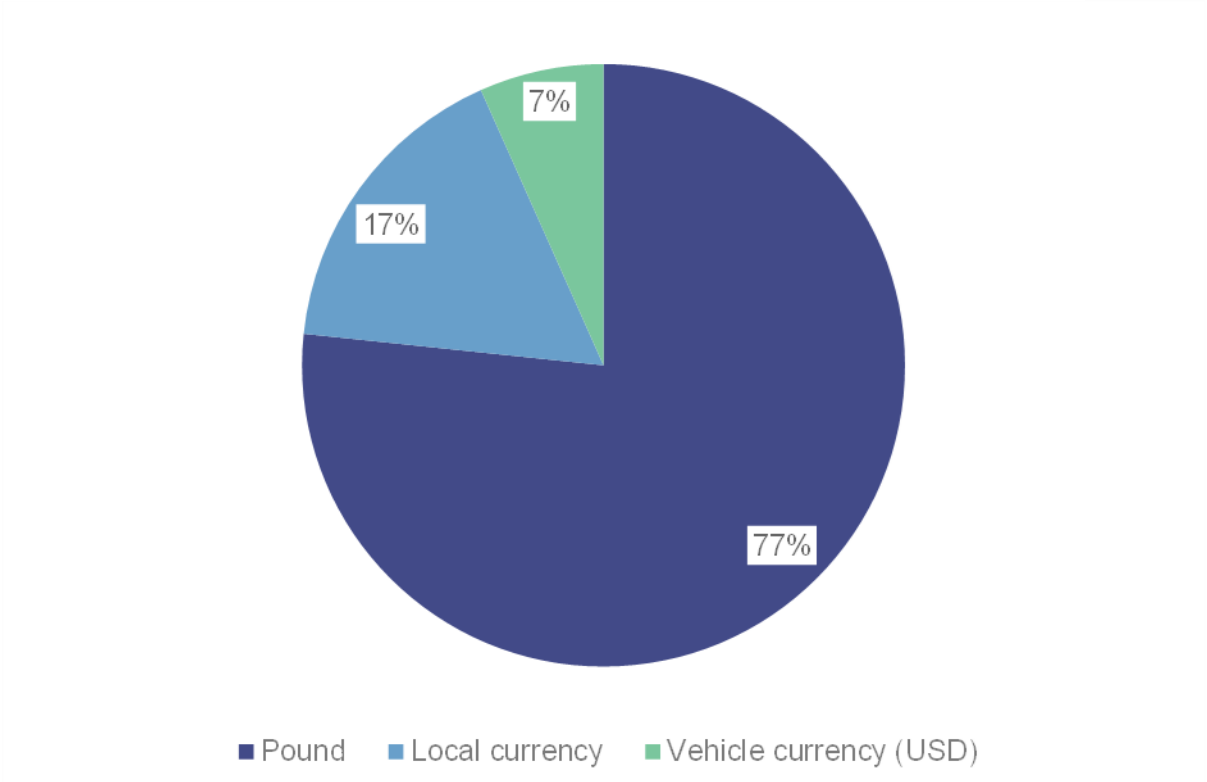
Source: ONS statistics (2016)

Before examining the responses of businesses to exchange rate fluctuations, a brief discussion is provided on the breakdown of invoice currencies used in the sample. This is on the basis that invoice currency is expected to be an important driver of exchange rate pass-through to trade prices, as indicated in the literature review.

Invoice currency

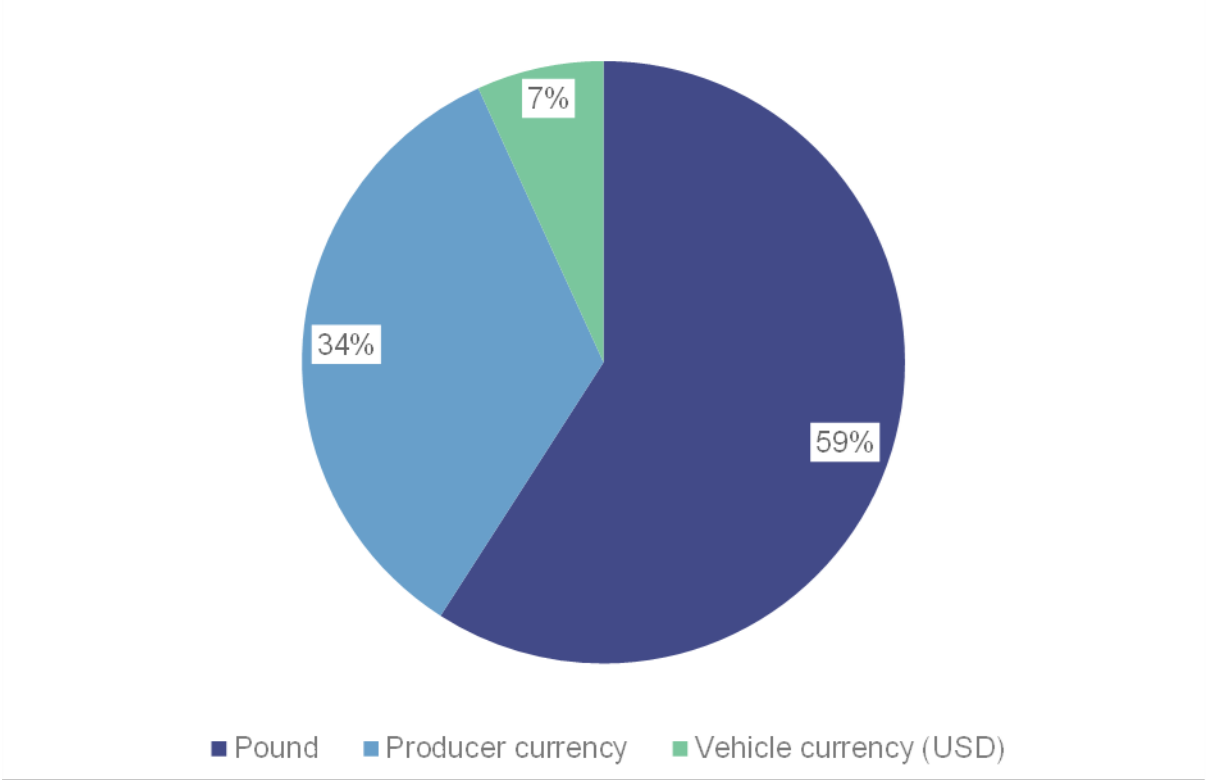
Figure 15 and Figure 16 below show the invoice currency breakdown in the survey sample for exporters and importers respectively. These show that 77% of those exporting and 59% of those importing in the final sample chose the pound as their main invoice currency. As mentioned above, these proportions are higher than suggested in data for the population of UK trading firms. One possible explanation is that large and often multinational firms comprise a relatively greater proportion of the UK's trade balance in *value*. This can skew the population distribution of invoicing towards non-pound currencies if these firms invoice more in local and vehicle currencies. In addition, it is important to note that not only are aggregate UK statistics quoted in value terms, but most of these statistics exclude EU trade – if a relatively higher proportion of firms invoice in pounds when trading with the EU compared with non-EU countries, this could contribute to the difference in invoicing seen between surveyed firms and in aggregate data.

Figure 15: Main exporting invoice currency



Source: Economic Insight analysis of survey responses.
Base size: 90

Figure 16: Main importing invoice currency



Source: Economic Insight analysis of survey responses.
Base size: 88

Next, the factors that influence businesses' response to exchange rate movements are outlined. This is broken down into three sections. *Firstly*, in sub-section 4.3.2, firms' responses in the abstract (i.e. how they would react to hypothetical exchange rate fluctuations). *Secondly*, in sub-section 4.3.3 (price response), how firms responded in practice to specific historical exchange rate fluctuations in terms of pricing. *Lastly*, in sub-section 4.3.4 (quantity response), how firms responded in practice to specific historical exchange rate fluctuations in terms of quantity. Both hypothetical and actual responses to exchange rates were considered in the design, as the former provides general insights into how firms view exchange rate fluctuations in business decisions, while the latter considers whether there is a difference when firms recall actual exchange rate events.

4.3.2 Response to hypothetical exchange rate fluctuations

Respondents were asked whether exchange rate fluctuations actively drive changes in prices (in terms of the main invoice currency) and quantities.[53] The majority (61%) of respondents indicated that a hypothetical fluctuation in exchange rate *does not* lead to an active change in invoice price or quantity of goods/services traded. This is consistent with empirical literature discussed in the previous chapter. In particular, as a sizeable proportion of firms do not invoice in the producer currency (which equates to pounds for exports and producer currency for imports), this lack of a change in invoice price suggests firms adjust less to exchange rate fluctuations than would be predicted by traditional theory.[54]

The survey also asked respondents to indicate the reasons why they do or do not respond to exchange rate fluctuations. In the case of those that did not respond to exchange rate movements, firms were asked about potential obstacles that prevent them from responding to exchange rate fluctuations, either in terms of invoice price or quantity, or whether a decision was made not to respond to exchange rate fluctuations as the movements would be beneficial (i.e. it is expected to lead to increased margins). Specifically, respondents were asked to indicate which of the following factors influence their ability to respond to exchange rate movements:

- Business position in the supply chain
- Contracts entered with businesses / customers

[53] The existence of multiple currencies in international trade necessitated the specification of the main invoice currency for these questions, to avoid respondent confusion. This is because an exporter that invoices in pounds may not actively change the price following a depreciation, but this would mean the price in terms of the receiver country would change. This allowed the respondents to be clear to which currency the question refers to (i.e. the one identified by the respondent in the profiling questions).

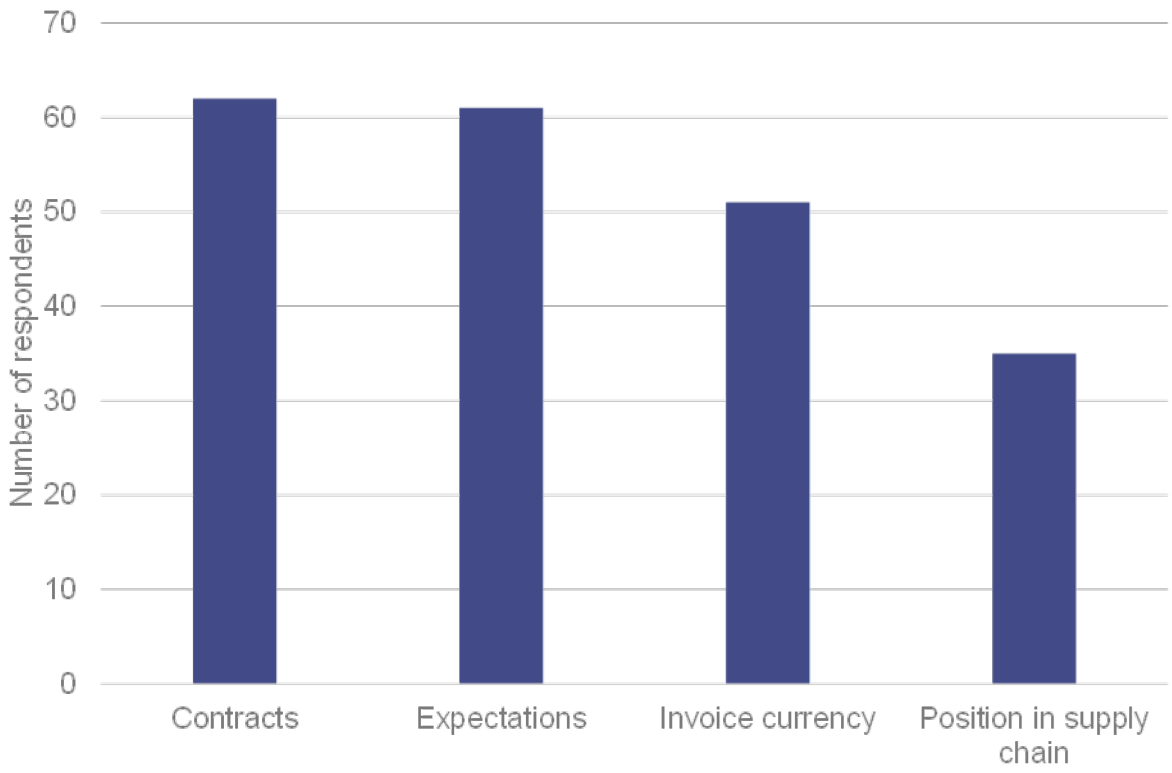
[54] If all respondents invoiced in the producer currency then the lack of a change in invoice price would imply 100% exchange rate pass-through to *local prices*, which would indicate firms are responding according to traditional theory.

- Invoice currency
- Role of expectations: whether the movement in exchange rate is perceived as temporary / permanent

Figure 17 outlines the number of respondents that chose each factor above. The results indicate that all these factors play a role - the proportion of firms that chose each option is significantly greater than zero at the 95% confidence level. Long-term contracts are the most frequently selected out of the four, with 62 firms (50% of all respondents) indicating that these contracts tie them in to pre-determined prices and quantities. Expectations, namely whether the exchange rate movement is perceived as temporary or permanent, follows closely. 51 and 35 respondents indicated that the invoice currency and position in the supply chain respectively influences their ability to respond to exchange rate fluctuations.

The findings highlight that expectations are an important factor that businesses in the sample consider in decision-making, at least when considering a hypothetical exchange rate fluctuation. This is slightly at odds with the role of expectations according to the literature review. This suggests that, as noted in the discussion of the literature review, expectations should not be dismissed when considering the role of exchange rates on trade volumes. However, due to the small sample, the differences between each of the four factors should not be overstated. At most, these responses indicate that all factors are likely to be important for UK businesses.

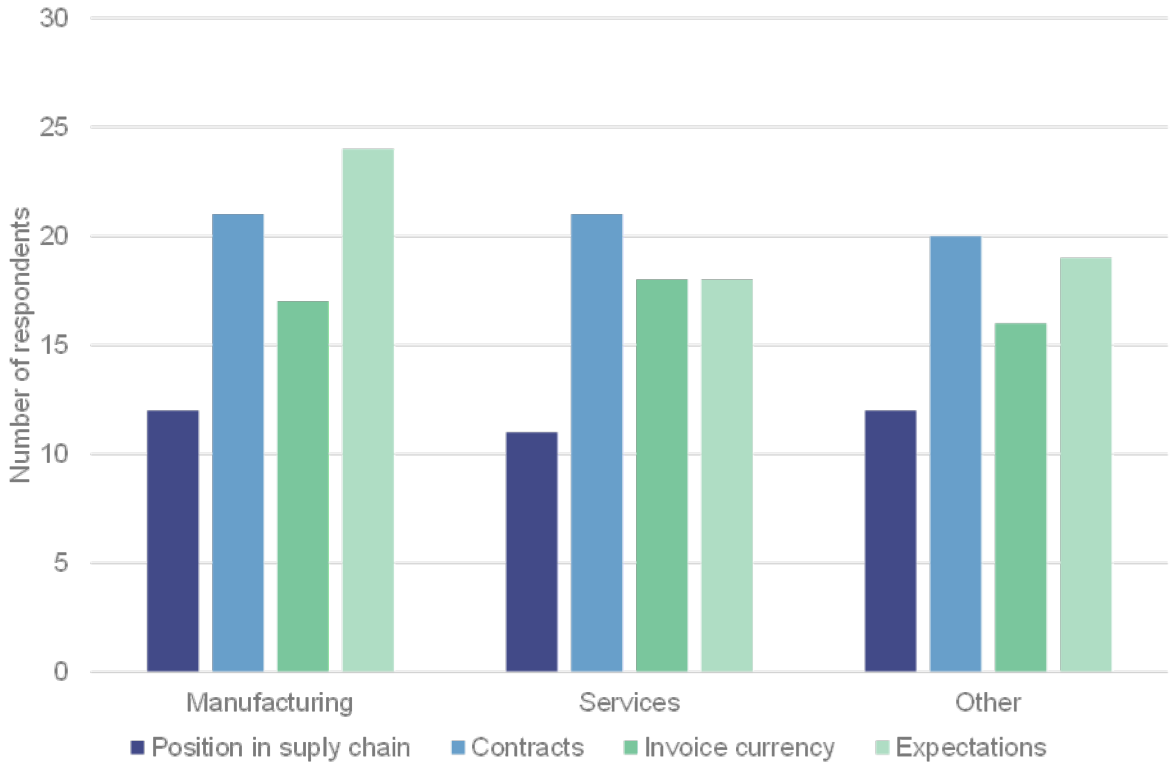
Figure 17: Factors influencing response to exchange rate movements



Source: Economic Insight analysis of survey responses.

The following chart breaks down the responses by the industry of the respondent. In the sample, expectations seem to be most relevant factor for manufacturers, whereas long-term contracts are most relevant for firms in the service and other industries (including wholesale and retail). As above, this result should not be overstated, but it does suggest greater focus on expectations, especially when examining the manufacturing industry.

Figure 18: Factors influencing response to exchange rate movements, by industry



Source: Economic Insight analysis of survey responses.

The following two sub-sections discuss how businesses responded *in practice* to specific historic exchange rate fluctuations. Focus is given to price responses first, followed by quantity responses. Both are considered with respect to specific fluctuations in the value of the pound, to further test how firms react to exchange rates and whether these responses vary by firm characteristics.

4.3.3 Response to specific exchange rate fluctuations – price response

Respondents were asked how they reacted to four specific periods in which the value of the pound fluctuated, namely (i) the depreciation after the EU referendum, (ii) the depreciation from April 2019 to August 2019, (iii) the appreciation from August 2019 to December 2019, and (iv) the depreciation around COVID-19. Similarly to the hypothetical exchange rate fluctuations above, respondents were asked whether they actively changed prices (in terms of the main invoice currency) in response to each of these events. For firms that did change the price in terms of the main invoice

currency, a further question was asked as to what extent they changed the price, compared with the magnitude of the exchange rate fluctuation.

Taken together, the responses to these questions and the invoice currency for each respondent enabled the generation of the implied exchange rate pass-through.[55] Exchange rate pass-through is generally measured as the percentage change in local price relative to the percentage change in exchange rate. It is expressed as a percentage (relative to the exchange rate percentage change) and can take any value. Therefore, for ease of analysis, exchange rate pass-through is split into the five following categories:

- **Zero pass-through**: the local price of the traded product does not change when exchange rates move (0%).
- **Partial pass-though**: only part of the change in exchange rate is passed through to the local price of the traded product (between 0% and 100%).
- **Complete pass-through**: the change in the exchange rate is passed in full to the local price of the traded product (100%).
- **Larger than full pass-through**: the local price of the traded product moves by more than the change in exchange rate (>100%).
- **Reverse pass-through**: the local price of the traded product changes in the opposite direction of what theory would predict (<0%).

In what follows, exchange rate pass-through is considered separately for firms that export and import, before responses are broken down further by firm characteristics such as industry and size. The total sample of exporting firms consists of 36 firms that export only, and 54 firms that both import and export (total of 90). Similarly, the total sample considered for imports consists of the same 54 firms that trade in both directions, and 34 firms that only import (total of 88).[56]

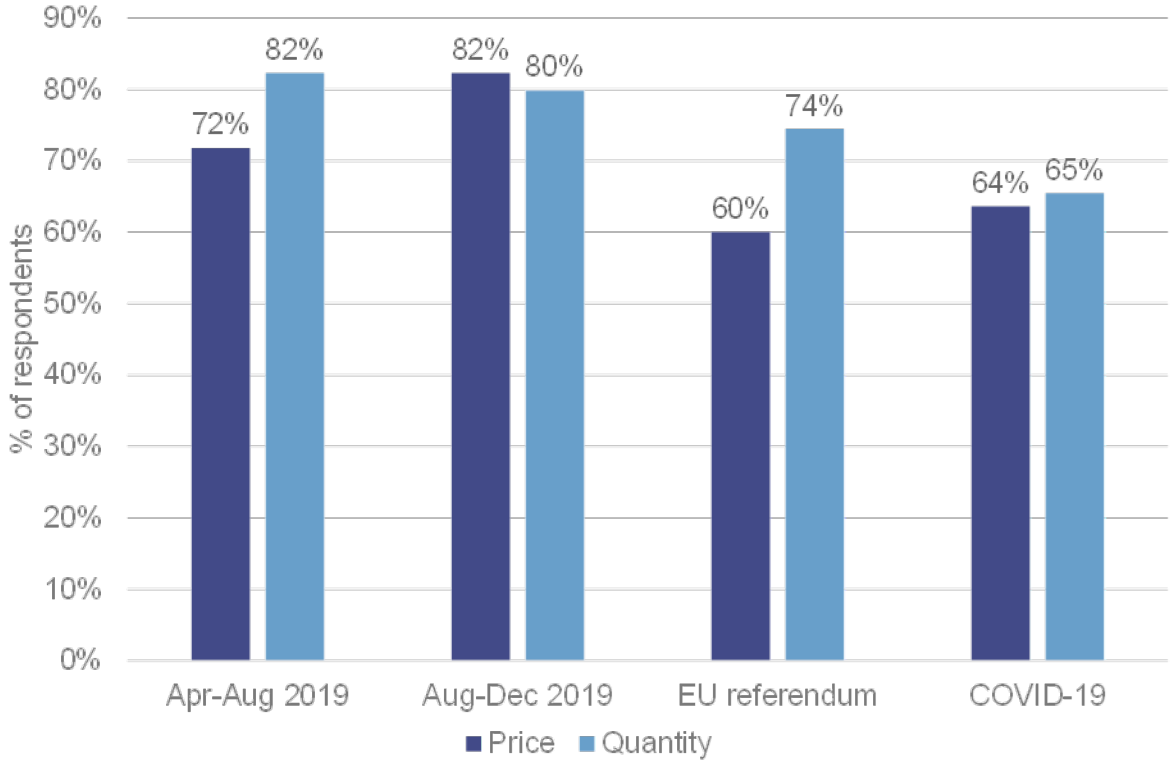
Before pass-through is considered directly it is worth noting that, consistent with the responses for hypothetical exchange rate fluctuations, the vast majority of respondents indicated that prices in the main invoice currency and quantities did not change. This is shown in Figure 19 below. Therefore, whether respondents reflect on hypothetical or actual exchange rate fluctuations, price in terms of the main invoice currency and quantity generally do not change. In the case of price, this means that much of the trade response to exchange rate fluctuations is likely to be driven by the

[55] The exchange rate pass-through depends on the invoice currency, such that even respondents indicating no change in price in terms of the main invoice currency may have 100% pass-through if the invoice currency is the producer country currency. The invoice currency indicated by each respondent is taken and combined with their response to determine the exchange rate pass-through for the purposes of the analysis.

[56] There are 54 firms that overlap in the sample of exporting and importing firms. It is assumed in the analysis that for these firms, all responses with respect to pricing changes apply to both their exports and imports. Nevertheless, the results illustrated are not sensitive to this assumption – it has been checked that omitting these 54 firms produces the same conclusions.

composition of invoice currencies and whether producer currency pricing or local currency pricing is more prevalent. This is discussed in more detail in the remainder of this sub-section.

Figure 19: Proportion of firms holding prices and quantity fixed at each period



Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 124/124/90/110; Quantity - 124/124/90/110.

Exports

Figure 20 illustrates the level of exchange rate pass-through for firms that export at each exchange rate movement period, according to the sample responses. As shown in the figure, complete and zero pass-through is the most common, with the former being significantly greater than partial, larger than full, and reverse pass-through at the 95% confidence level. This is consistent across the four time periods.

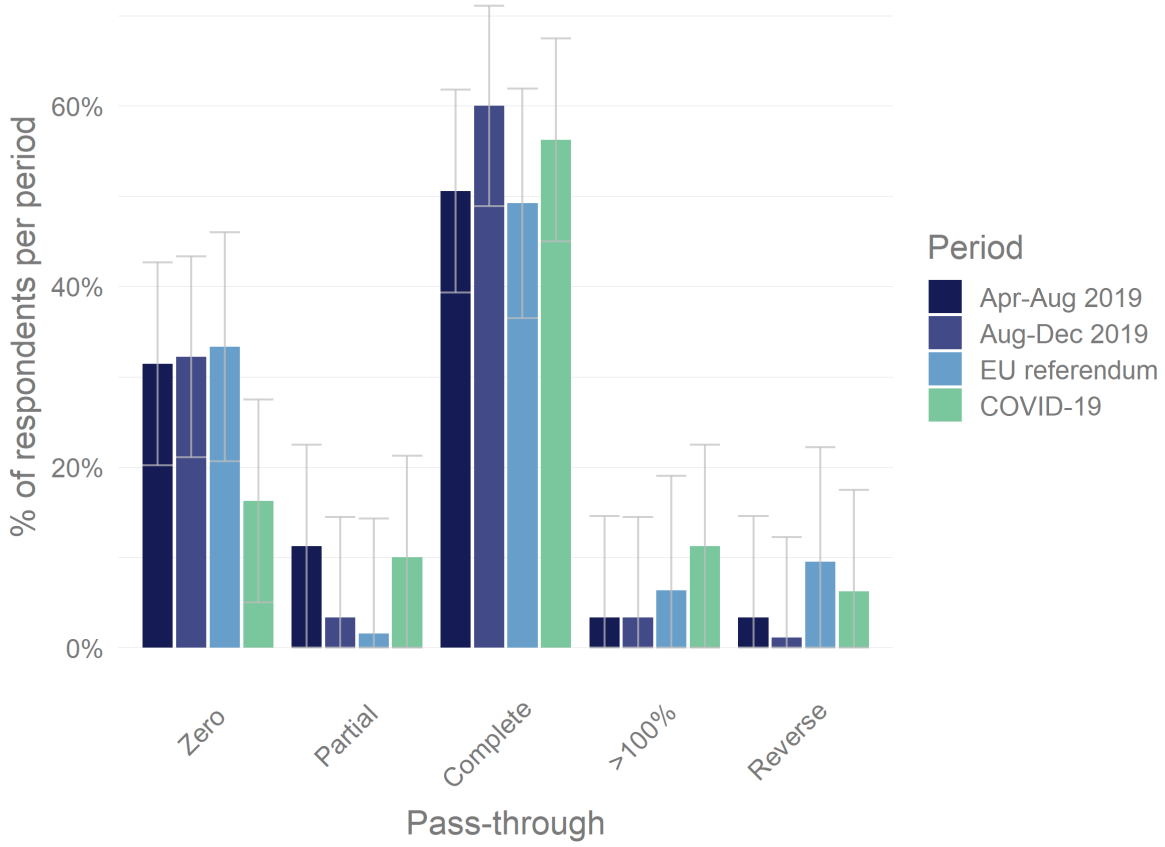
The finding that pass-through is mostly complete or zero is also consistent with the fact that most respondents did not change the price in terms of the main invoice currency. As explained in the literature review:

- Under producer currency pricing (PCP) where prices do not change, an exchange rate fluctuation changes the price competitiveness of traded goods/services in the local currency. This implies 100% pass-through of exchange rate changes.
- Under local currency pricing (LCP) where prices do not change, an exchange rate fluctuation is absorbed into the exporting firms' mark-up, leaving price

competitiveness unchanged in the local currency. This implies 0% pass-through of exchange rate changes.

In relation to the EU referendum and the COVID-19 outbreak, a number of respondents indicated that export prices either changed by more than the change in the exchange rate (>100% pass-through) or in the opposite direction that theory would predict ("Reverse" pass-through). While this occurs for the depreciation and subsequent appreciation in 2019, it is to a lesser extent. Both these types of pass-through indicate that non-exchange rate factors simultaneously affect prices in addition to the exchange rate movement itself. It is therefore intuitive to expect that the EU referendum and COVID-19 outbreak, which were likely both associated with changing economic conditions, affect prices indirectly through other channels such as the change in economic and trade policy uncertainty (as described in section 3.4). Note, however, that this result is not statistically significant at the 95% confidence level.

Figure 20: Exchange rate pass-through for exports

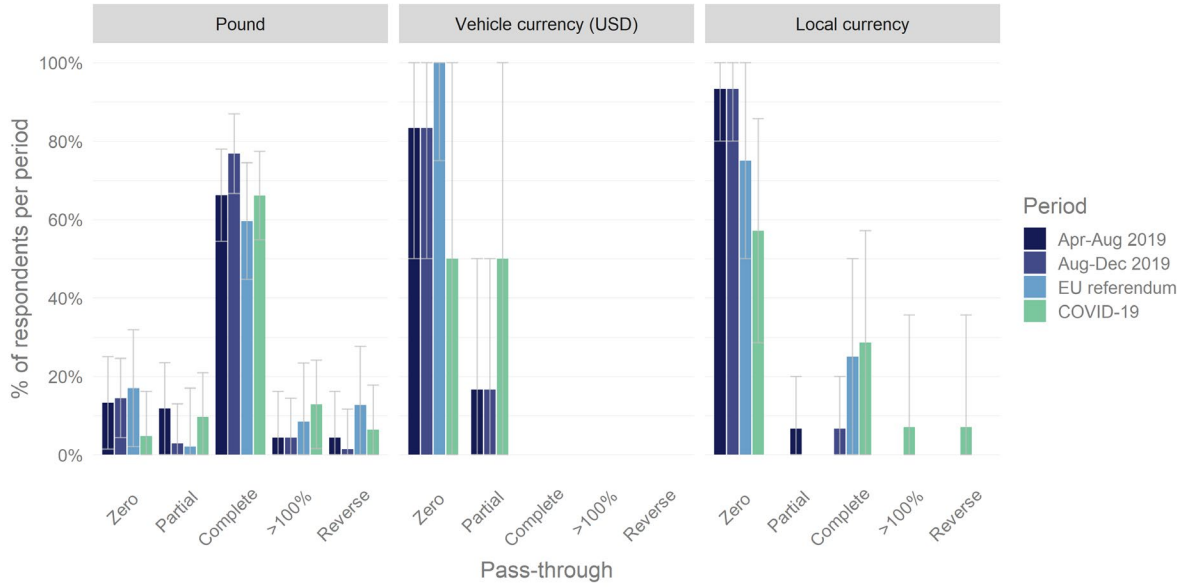


Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): 90/90/65/80. Grey bars show 95% confidence intervals.

To confirm that the invoice currency is the probable driver of observed pass-through rates, due to prices remaining rigid in terms of the main invoice currency, exchange rate pass-through is broken down by invoice currency in Figure 21. For pound invoicing, complete pass-through is significantly greater than other forms of pass-

through for all periods, at the 95% confidence level. For local currency invoicing, zero pass-through is most common, and is significantly greater than other forms of pass-through for all periods except COVID-19. These findings are consistent with a mix of PCP and LCP, as posited in the literature. In addition, while a smaller sample of exporters invoice in vehicle currencies and therefore statistical significance cannot be achieved here, results suggest that zero pass-through is also most common for US dollar (vehicle) invoicing.

Figure 21: Exchange rate pass-through for exports by invoice currency



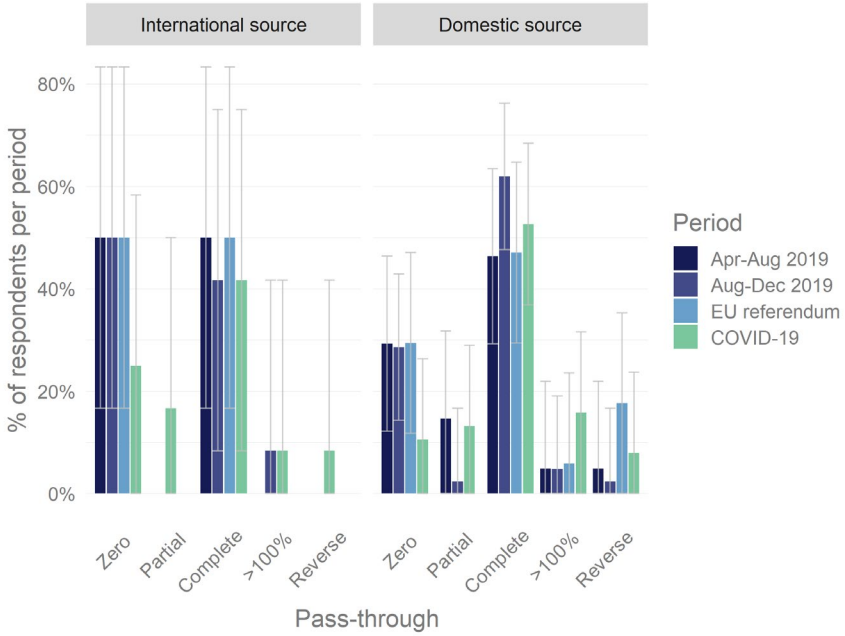
Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Pound - 69/69/49/62; Vehicle currency - 6/6/4/4; Local currency - 15/15/12/14. Grey bars show 95% confidence intervals.

Next, the relationship between exchange rate pass-through and other characteristics is considered, including: industry; size (by number of employees); type of product; involvement in GVCs and source of traded products. This is also driven by findings from the literature. Specifically, as detailed in section 3.3.2, GVCs reduce the sensitivity of trade to exchange rates; larger firms are more likely to absorb exchange rate movements in their mark-ups; services are more responsive to exchange rate changes than goods; and goods subject to more competition are also more likely to have a larger local price response to exchange rate movements.

In general, results indicate minor differences in exchange rate pass-through across these characteristics. As a consequence, given the sample size, there does not exist enough evidence to prove that any characteristic significantly drives variation in pass-through. For example, Figure 22 below shows the level of exchange rate pass-through for exports, by the source of the traded product (i.e. whether inputs are sourced domestically or abroad). On balance, pass-through for internationally sourced exports is lower (as indicated by the greater proportion of zero pass-through rates for these goods and services). This, whilst consistent with the literature, is not statistically significant. Similarly, Figure 23 shows the breakdown of exchange rate pass-through by industry. As shown below, exchange rate pass-through is greater

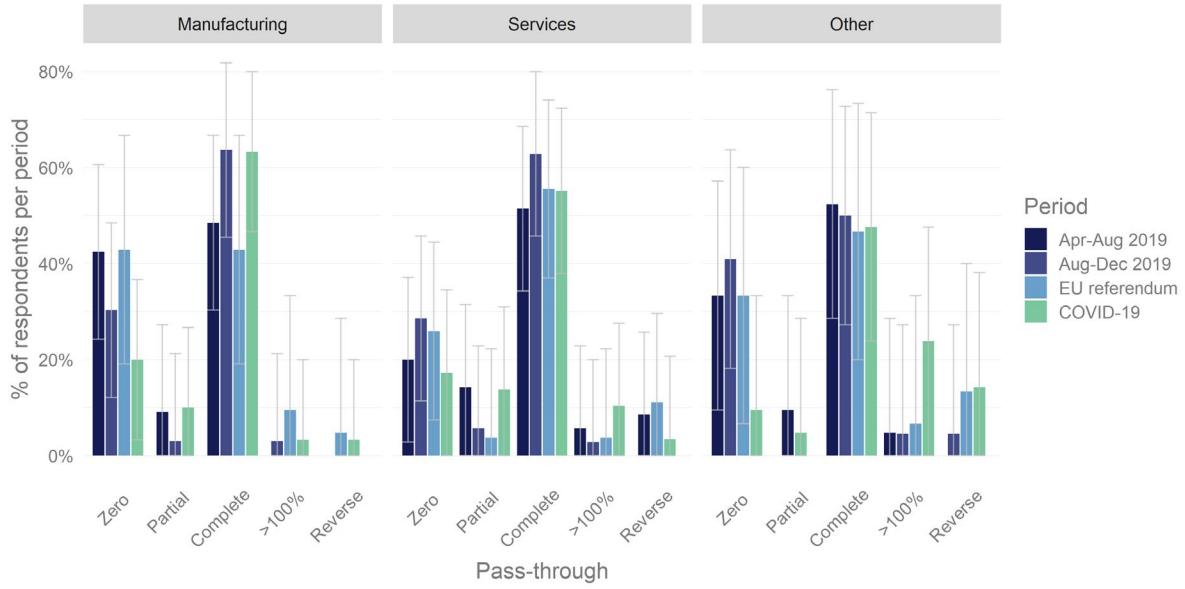
for service exports than manufacturing exports, consistent with the literature. However, overlapping confidence intervals indicate that there is insufficient evidence to reliably extrapolate the result to the population. Other business characteristics similarly do not indicate a clear relationship with exchange rate pass-through (not shown).

Figure 22: Exchange rate pass-through for exports by input source



Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): International source - 12/12/6/12; Domestic source - 42/42/35/38. Grey bars show 95% confidence intervals.

Figure 23: Exchange rate pass-through for exports by industry

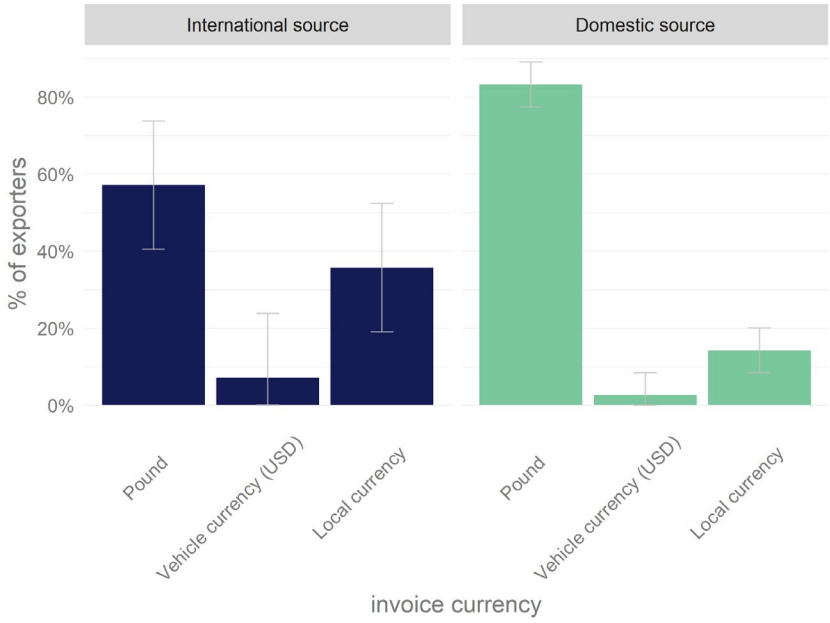


Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Manufacturing - 33/33/21/30; Services - 35/35/28/29; Other – 22/22/16/21. Grey bars show 95% confidence intervals.

As the invoice currency appears to explain a large portion of variation in exchange rate pass-through, it is likely that any differences in invoice currencies across business characteristics would influence pass-through via this indirect route.

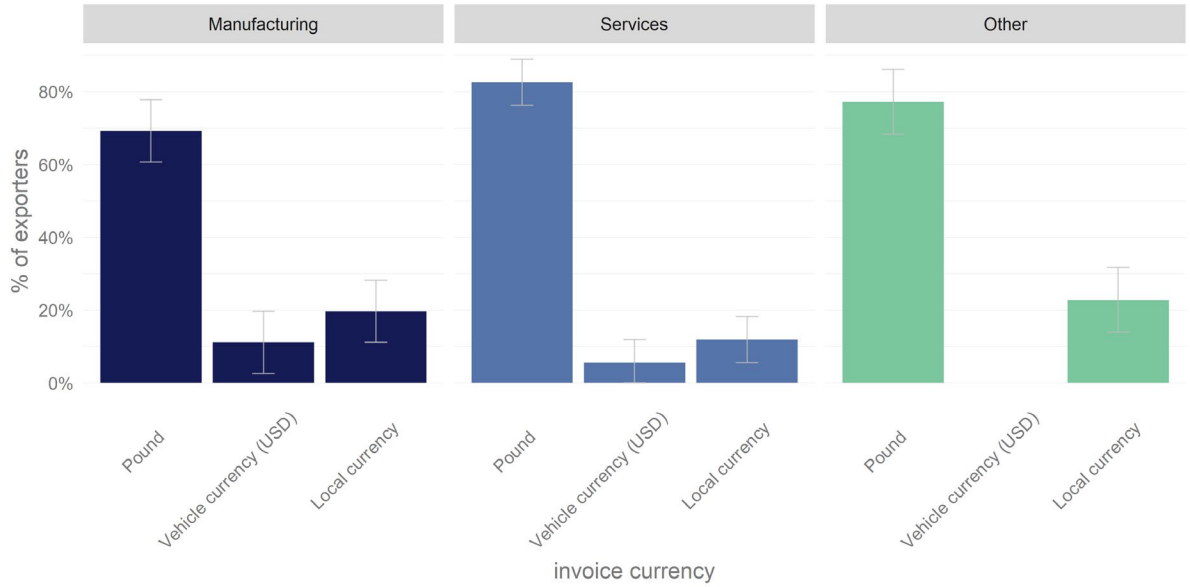
As shown in Figure 24 below, greater pound currency invoicing is used for exports whose inputs are domestically sourced, compared to exports whose inputs are internationally sourced. This is statistically significant at the 95% confidence level. As pound invoicing is associated with greater pass-through for exports, this provides an explanation as to why slightly more complete pass-through relative to zero pass-through is observed for domestically sourced exports. In addition, as shown in Figure 25, a lower proportion of firms in manufacturing invoice in pounds relative to services. This again offers an explanation as to why slightly higher pass-through is observed for services exports relative to manufacturing. Across other business characteristics however, there is limited evidence for any differences in the choice of invoice currency.

Figure 24: Invoice currency for exports by source of inputs



Source: Economic Insight analysis of survey responses.
Base size: International source - 12; Domestic source - 42

Figure 25: Invoice currency of exports by industry

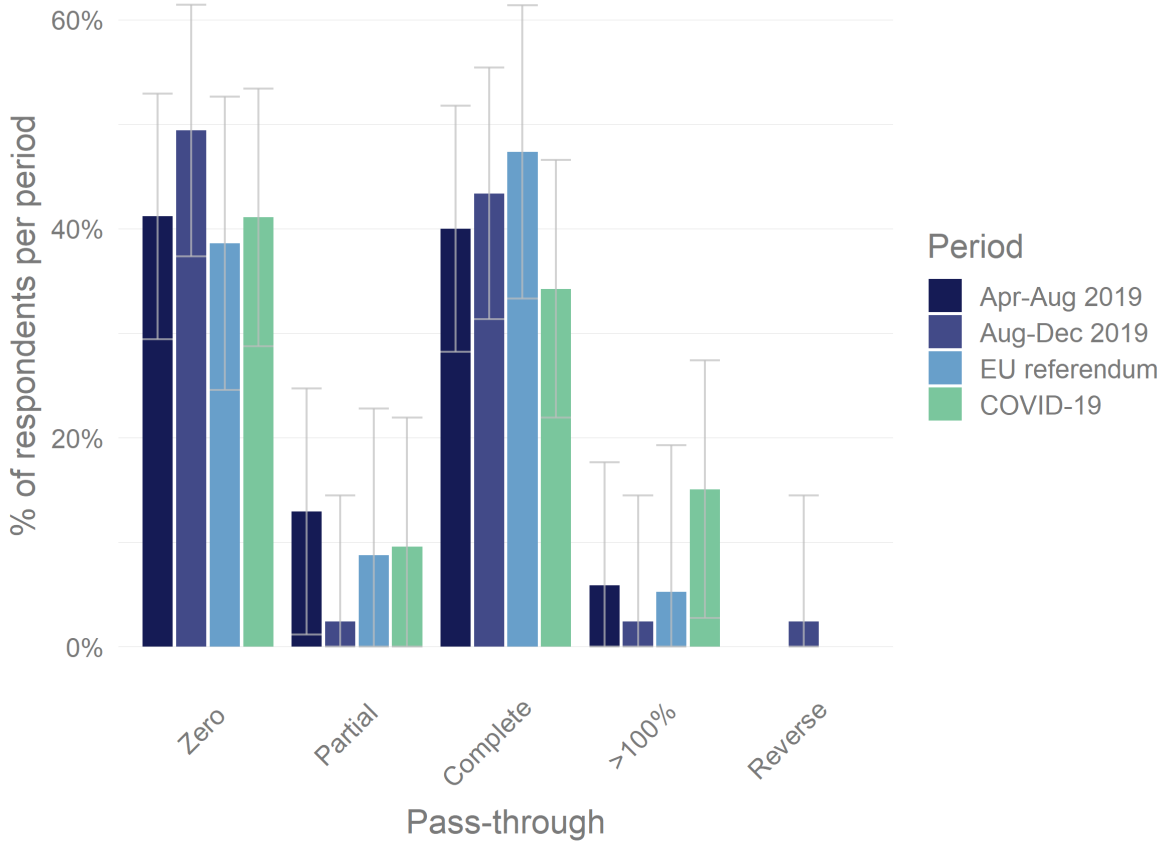


Source: Economic Insight analysis of survey responses.
Base size: Manufacturing - 33; Services - 35; Other - 22

Imports

The exchange rate pass-through for imports (which includes firms that only import, and both export and import) is analysed in the same vein as for exports above. As shown in Figure 26 below, complete and zero pass-through are most common in the sample. However, compared to exports, there exist more firms with zero pass-through, implying that import prices are generally less responsive to exchange rates than export prices in the sample. In addition, the proportion of firms with zero and complete pass-through are significantly greater than the proportion of firms with partial, >100%, or reverse pass-through at the 95% confidence level.

Figure 26: Level of pass-through for imports

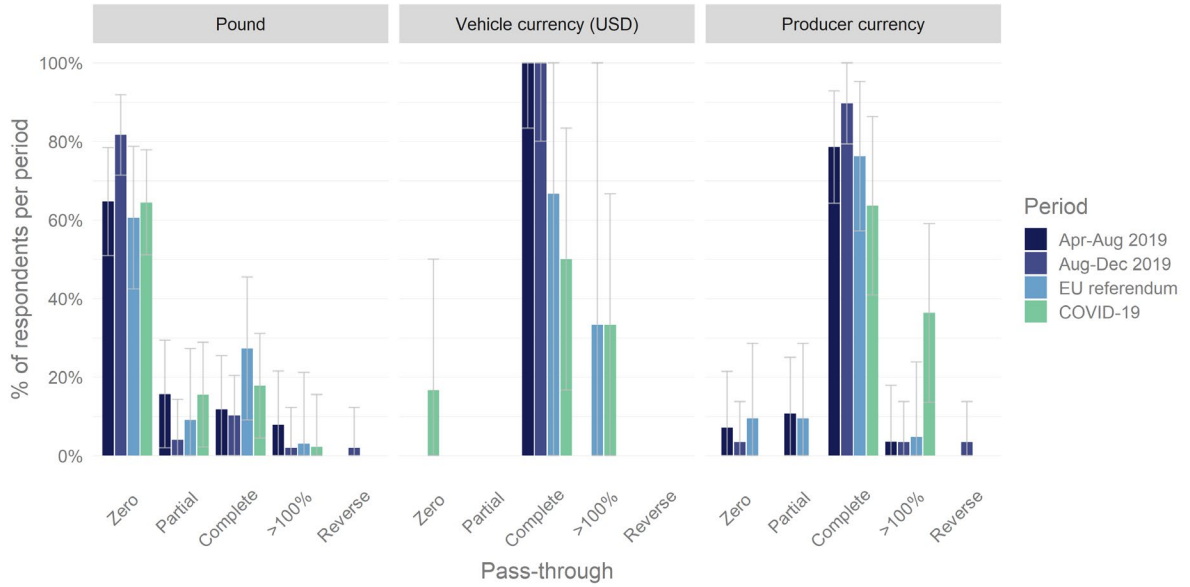


Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): 88/88/66/80. Grey bars show 95% confidence intervals.

Again, breaking down import price exchange rate pass-through by invoice currency appears to offer an explanation for this trend. As shown in Figure 27 below, zero pass-through is most common for pound invoicing (local currency pricing), while complete pass-through is most common for vehicle and producer currency invoicing. These levels of pass-through are significantly greater than others in each case at the 95% confidence level, except for: (i) those engaged in producer currency pricing during COVID-19, where a sizeable number of firms chose >100% pass-through; and (ii) those engaged in vehicle currency invoicing across all four periods where, the small sample of firms in this category limits statistical inference.

As the majority of the sample invoice in pounds for both exports and imports, this drives more zero exchange rate pass-through for imports, than in the case of exports. These results, again, appear to verify the literature on PCP and LCP.

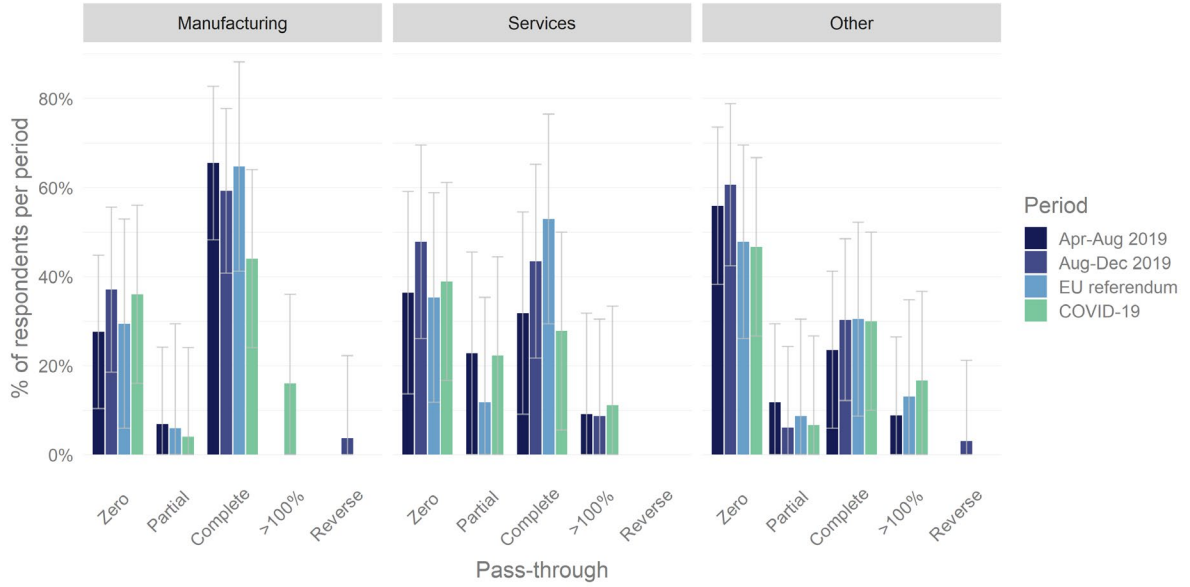
Figure 27: Level of pass-through for imports, by invoice currency



Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Pound - 52/52/40/48; Vehicle currency - 6/6/3/6; Producer currency - 30/30/23/26. Grey bars show 95% confidence intervals.

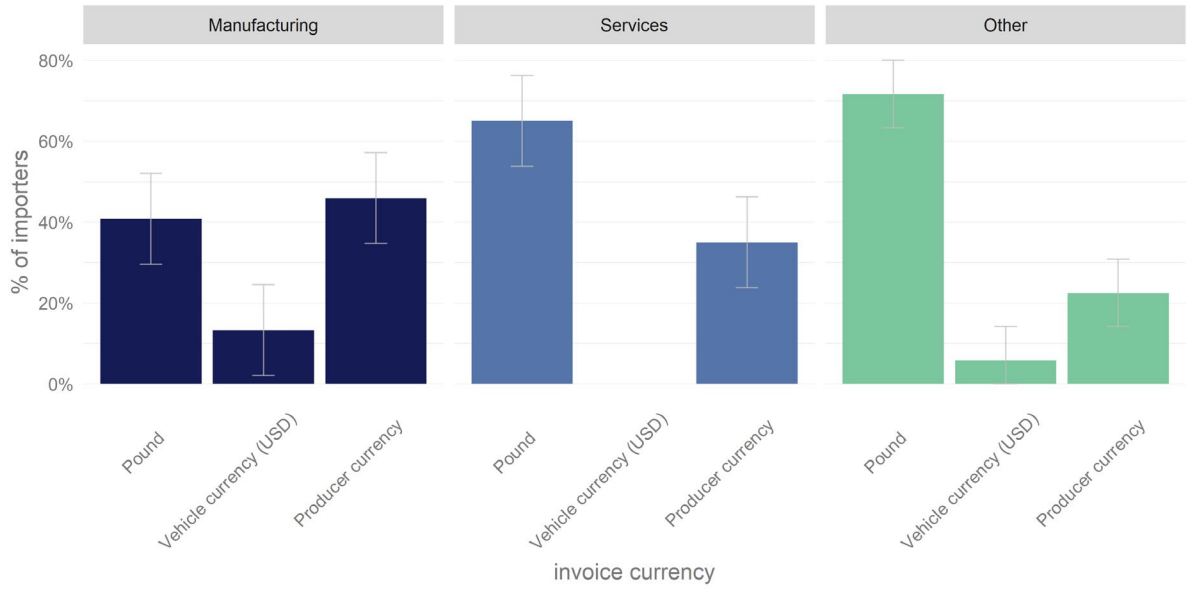
Similarly to exports, import exchange rate pass-through is mostly driven by the invoice currency. Differences of exchange rate pass-through between various business characteristics are not statistically significant, and where noticeable but not significant differences exist, this appears to be explained by the invoice currency. As an example, Figure 28 displays exchange rate pass-through for each period for each industry. More complete pass-through and less zero pass-through is observed for firms in the manufacturing industry, relative to services and other industries. However, as Figure 29 below shows, this may be partially explained by differences in the choice of currency between industries – there is a significantly lower proportion of manufacturing firms invoicing imports in the pound relative to services and other industries, and a greater proportion of firms invoicing in the producer currency (which is statistically significant compared to other industries).

Figure 28: Exchange rate pass-through for imports by industry



Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Manufacturing - 29/29/19/26; Services - 24/24/21/21; Other - 35/35/26/33. Grey bars show 95% confidence intervals.

Figure 29: Invoice currency for imports by industry



Source: Economic Insight analysis of survey responses.
Base size: Manufacturing - 29; Services - 24; Other - 35. Grey bars show 95% confidence intervals.

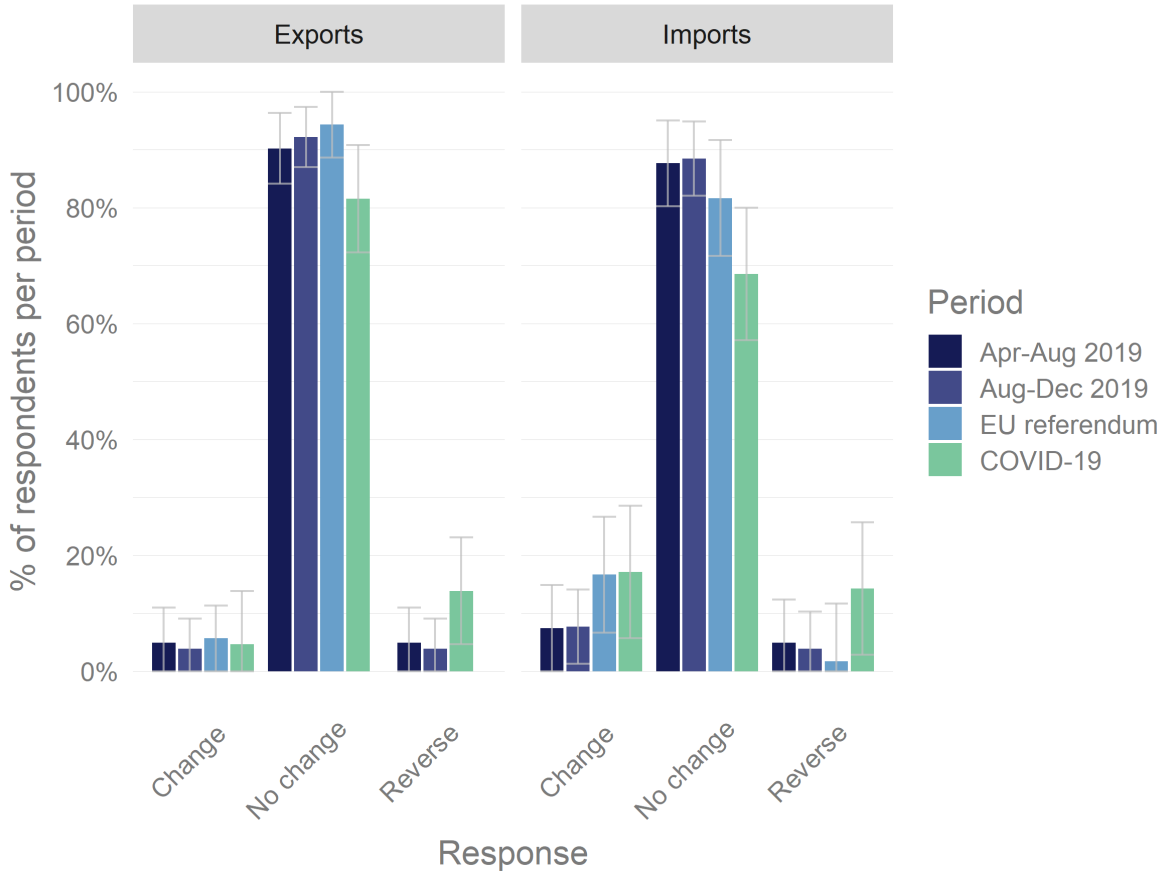
4.3.4 Response to specific exchange rate fluctuations - quantity response

This sub-section looks at whether businesses indicated that quantities changed in response to the specific periods of exchange rate fluctuations, in the same fashion as for prices above. In comparison with price responses, fewer businesses indicated that the quantity of the main good/service that they trade internationally changed in response to an exchange rate movement.

Figure 30 below shows respondents' quantity responses to exchange rate movements separately for exports and imports. Where respondents indicated that quantities did change, this is separated into: (i) "Change" for instances where a change in quantities is in the direction theory would expect (e.g. for a depreciation, export quantity should increase); (ii) "Reverse" for instances where the change is in the opposite direction expected (e.g. a decrease in quantities exported for a depreciation). It shows that the large majority of respondents indicated that quantities exported / imported did not change following an exchange rate movement. This result is statistically significant at the 95% confidence level.

Some firms did change traded quantities in the opposite direction than expected. This was most notable following the COVID-19 period, where the proportion of firms that indicated that quantities exported decreased and imports increased is statistically significant on the 95% confidence level. This suggests that non-exchange rate factors are relevant in explaining trade decisions during this period in time.

Figure 30: Quantity response to exchange rate movements



Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Exports - 90/90/65/80; Imports - 88/88/66/80. Grey bars show 95% confidence intervals.

Examining quantity responses according to other business characteristics including the industry, size, type of product, and involvement in global value chains produces similar results across these characteristics. Namely, there is no discernible variation

across business characteristics, in part due to the small number of businesses changing quantities in the sample.

4.3.5 Reasons for lack of exchange rate response (price and quantity rigidities)

This sub-section examines the reasons for price rigidities (i.e. prices being rigid in terms of firms' main invoice currencies) and quantity rigidities, as outlined above. In the survey, where firms chose 'no' to changing prices or quantities at a given exchange rate movement period, they were presented with several options as to why this was the case. Specifically, firms were asked whether rigidities existed due to the following factors:

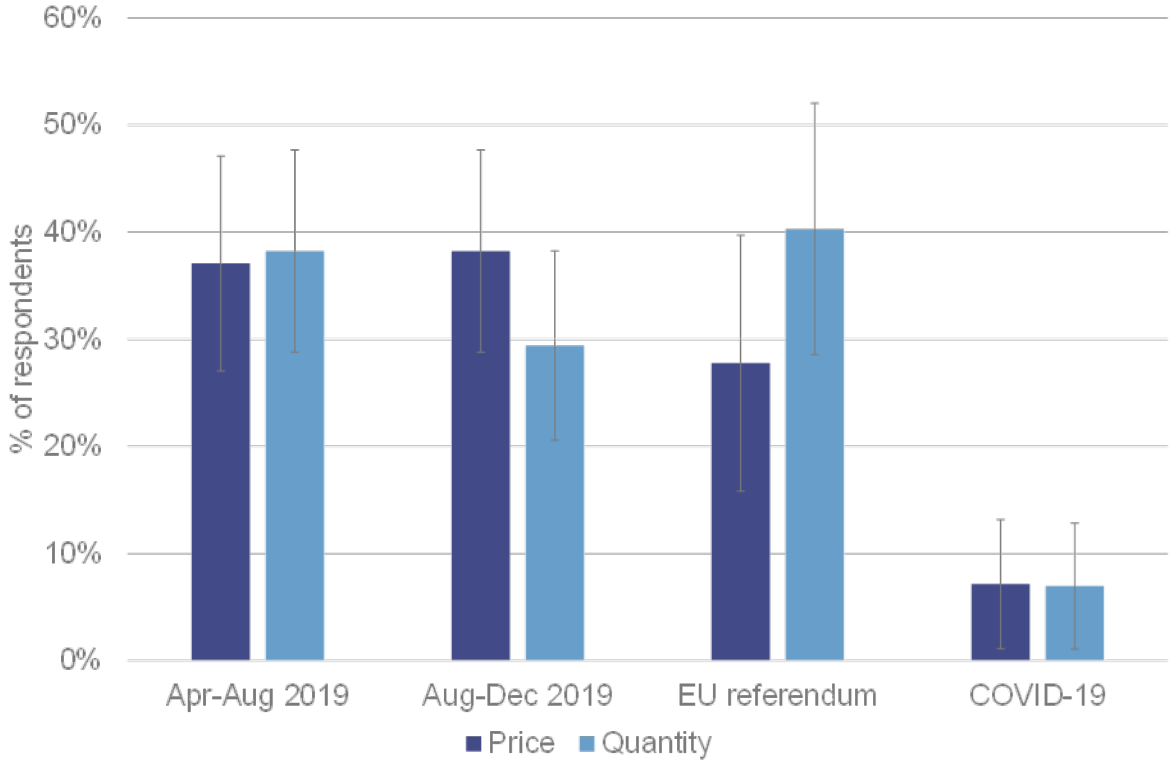
- Exchange rate expectations
- Long-term contracts
- Non-tariff barriers
- Hedging
- Size of exchange rate movement, compared to market conditions
- Business investment cost to change prices/quantities

The relevance of each of the factors above for prices and quantities is assessed in turn. Based on the sum of this evidence, the factors that appear to most restrict the exchange rate response of firms are (i) exchange rate expectations, (ii) long-term contracts, and (iii) the size of the exchange rate fluctuation.

Exchange rate expectations

First examined is the proportion of firms that chose to hold prices and quantities constant in each period due to the change in the exchange rate being perceived to be temporary, rather than permanent. During 'normal' times around the depreciation and appreciation of the pound in 2019, between 28% and 40% of respondents indicated that such expectations played a role in holding prices and quantities fixed. Around COVID-19 on the other hand, expectations appear to play less of a role in price and quantity rigidities, with only 7% of firms choosing this as an option. This is significantly less than other periods. Nevertheless, these results indicate that expectations appear to be an important consideration for many firms.

Figure 31: Reasons for rigidities, expectations

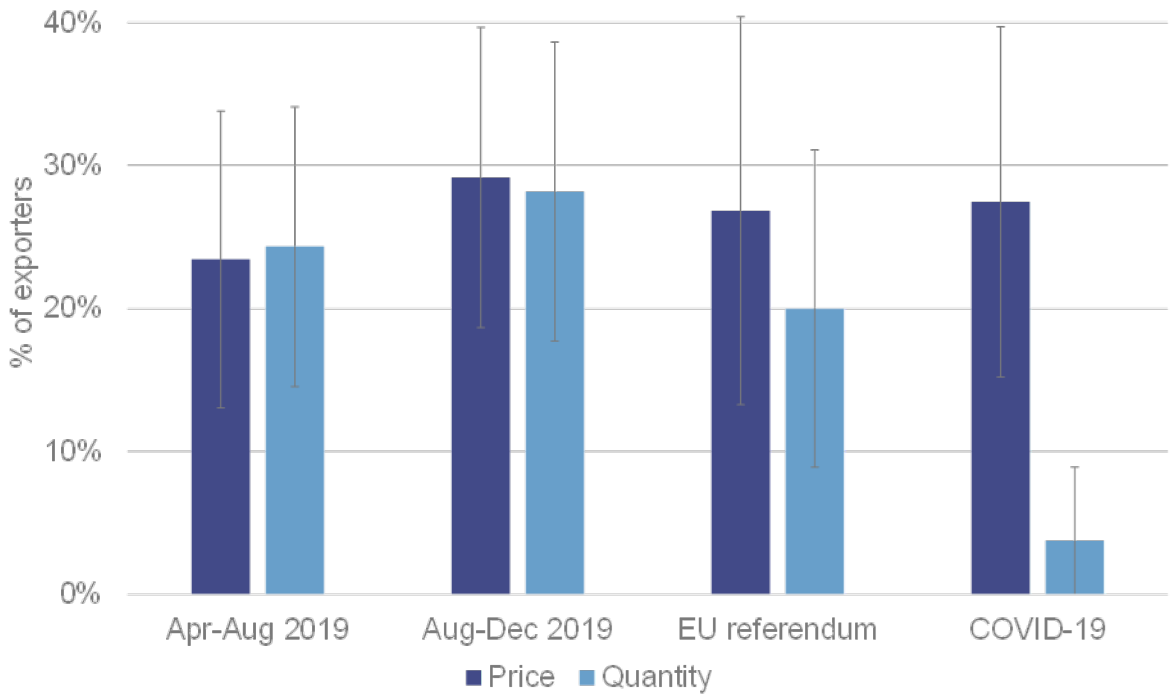


Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 89/102/54/70; Quantity - 102/102/67/72. Grey bars show 95% confidence intervals.

Long-term contracts

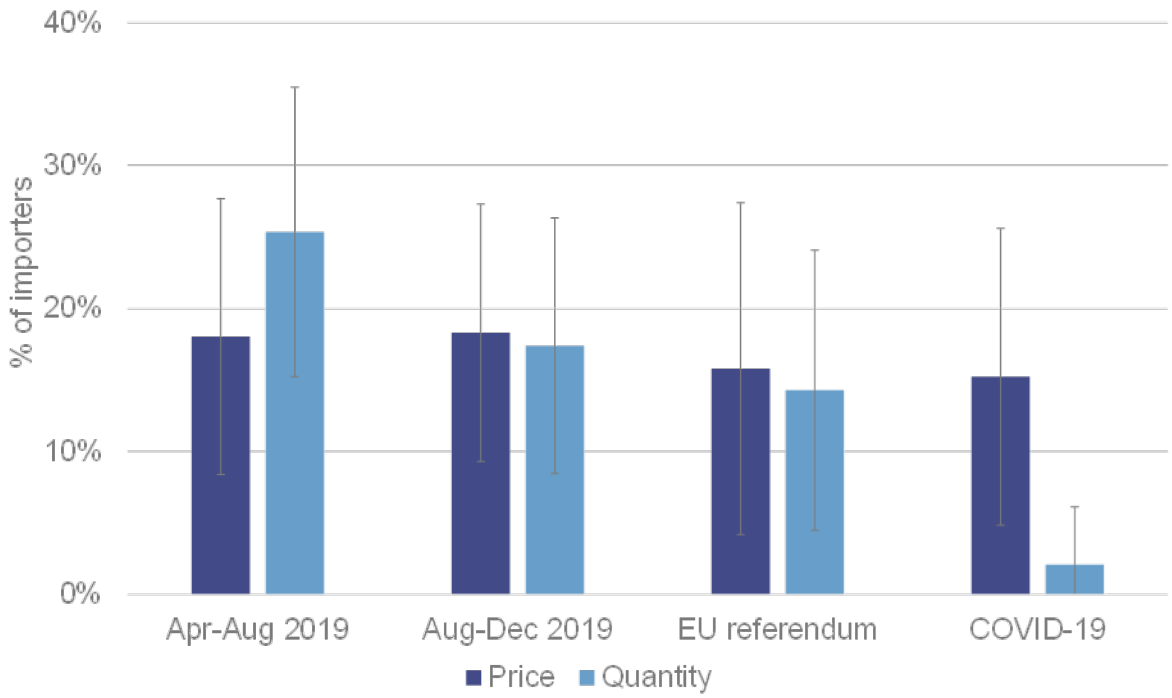
Figure 32 and Figure 33 show the proportion of exporters and importers respectively, that chose long-term contracts as a reason for holding prices/quantities fixed in each period. This is likely to be because the contracts specify the invoice currency, price and in some cases quantity, which would need to be renegotiated. In the sample, long-term contracts have been more frequently indicated by exporters as a reason for rigidities than for importers. In addition, following COVID-19, long-term contracts were not a significant factor in limiting the quantity response to the exchange rate depreciation – the proportion of firms that chose this is not significantly different from zero at the 95% confidence level for COVID-19.

Figure 32: Reasons for rigidities, long-term contracts for exports



Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 64/72/41/51; Quantity - 74/71/50/53. Grey bars show 95% confidence intervals.

Figure 33: Reasons for rigidities, long-term contracts for imports

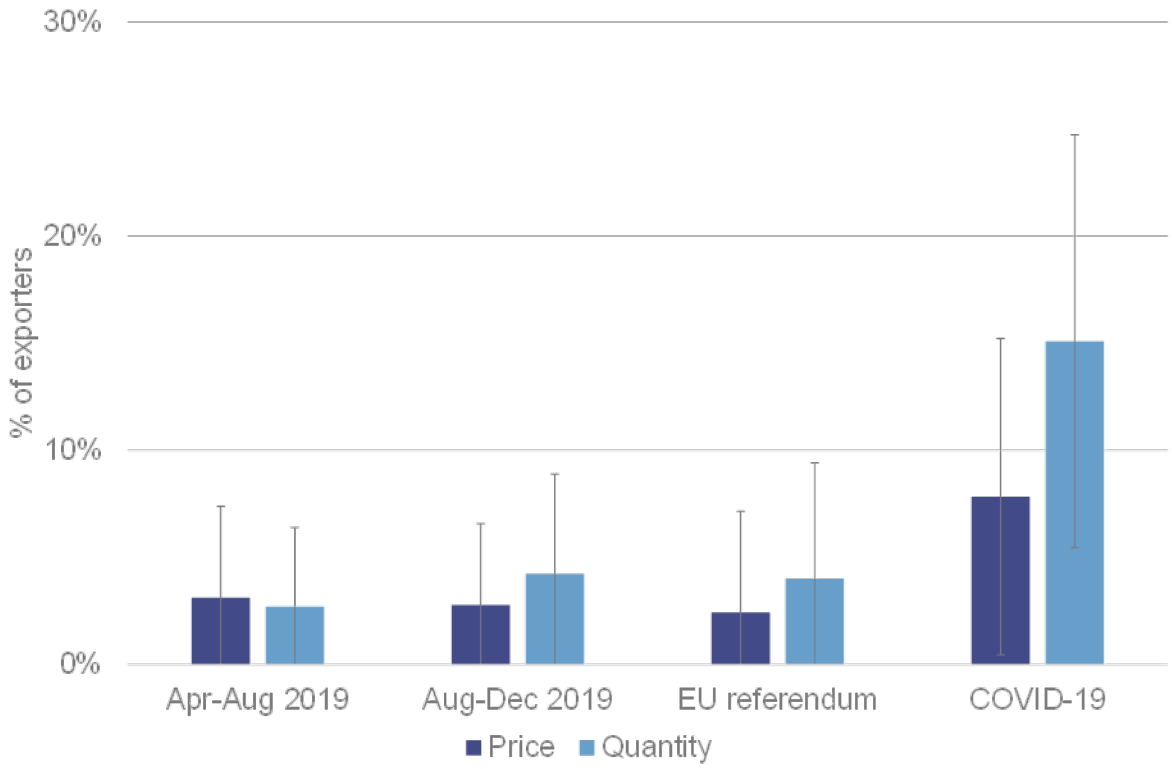


Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 61/71/38/46; Quantity - 71/69/49/48. Grey bars show 95% confidence intervals.

Non-tariff barriers

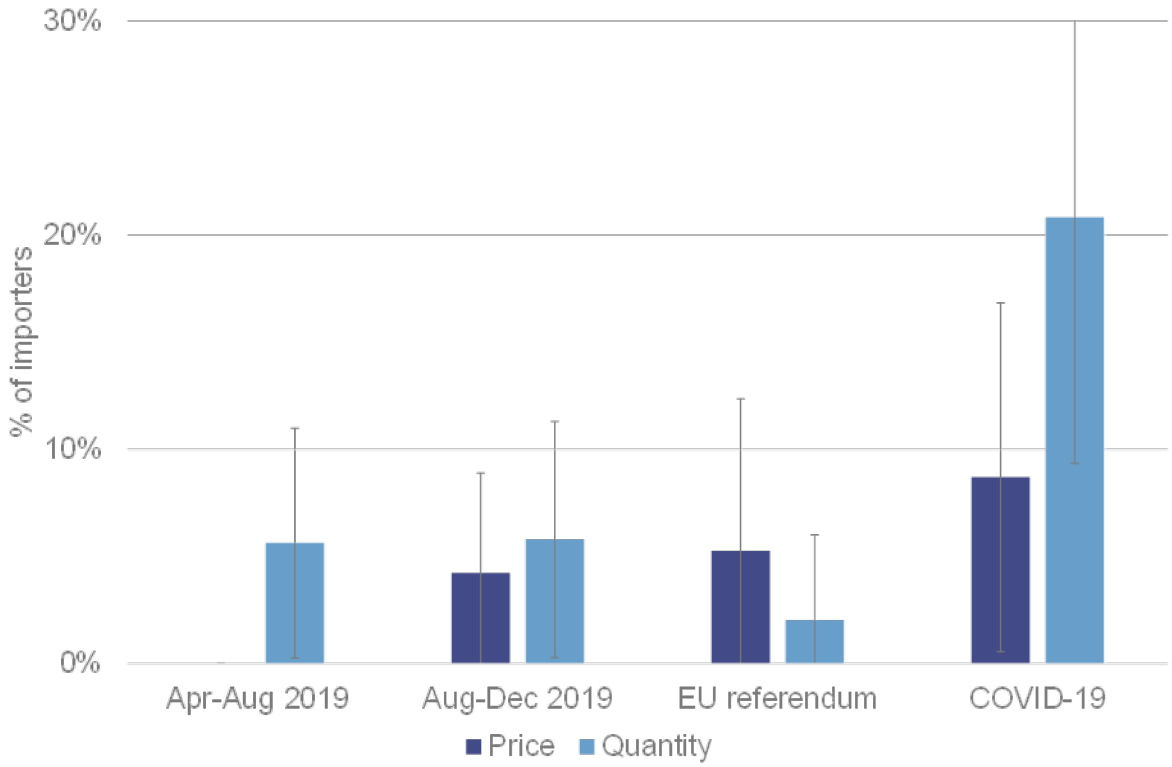
In general, non-tariff barriers appear to be less important than expectations and long-term contracts as a factor in limiting responses to exchange rate movements. However, as expected, non-tariff barriers are more prevalent following COVID-19 than for other periods, as shown in Figure 34 and Figure 35 below. This result is statistically significant for trade quantities, for both exports and imports.

Figure 34: Reasons for rigidities, non-tariff barriers for exports



Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 64/72/41/51; Quantity - 74/71/50/53. Grey bars show 95% confidence intervals.

Figure 35: Reasons for rigidities, non-tariff barriers for imports

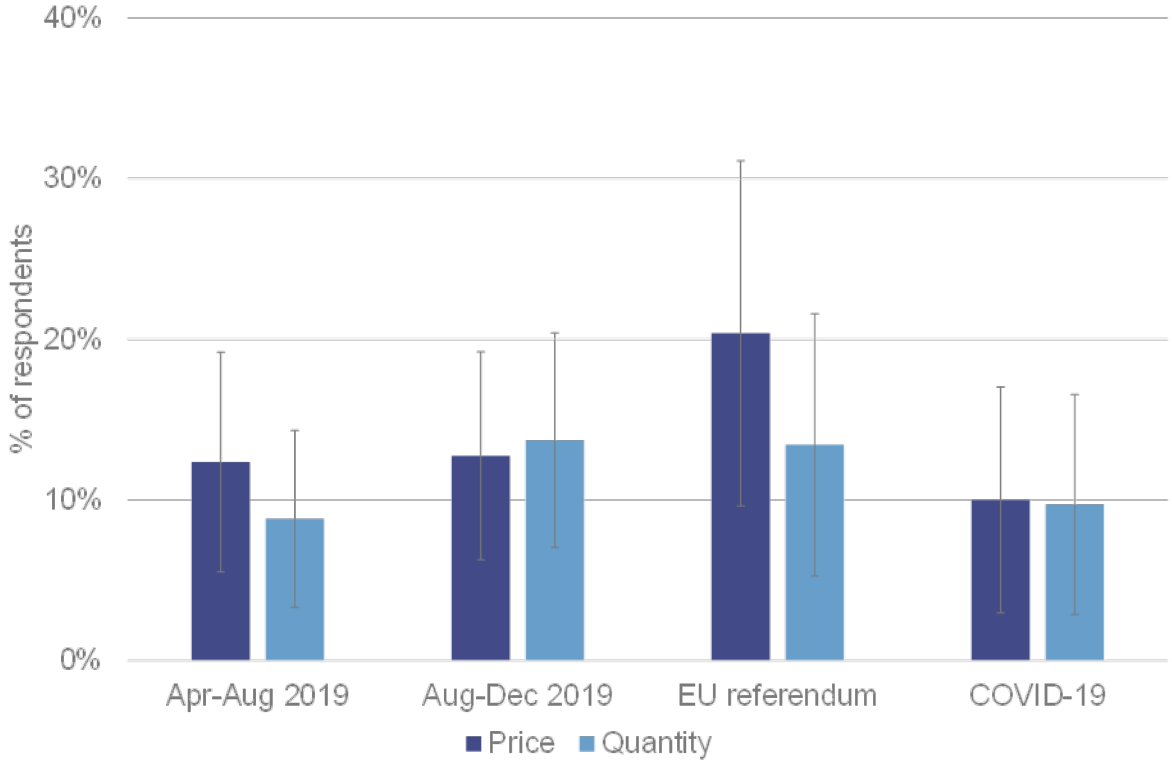


Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 61/71/38/46; Quantity - 71/69/49/48. Grey bars show 95% confidence intervals.

Hedging

A minority of firms reported not responding to exchange rate movements due to hedging mechanisms in place. This is outlined in Figure 36 below and does not appear to vary substantially across periods.

Figure 36: Reasons for rigidities, hedging

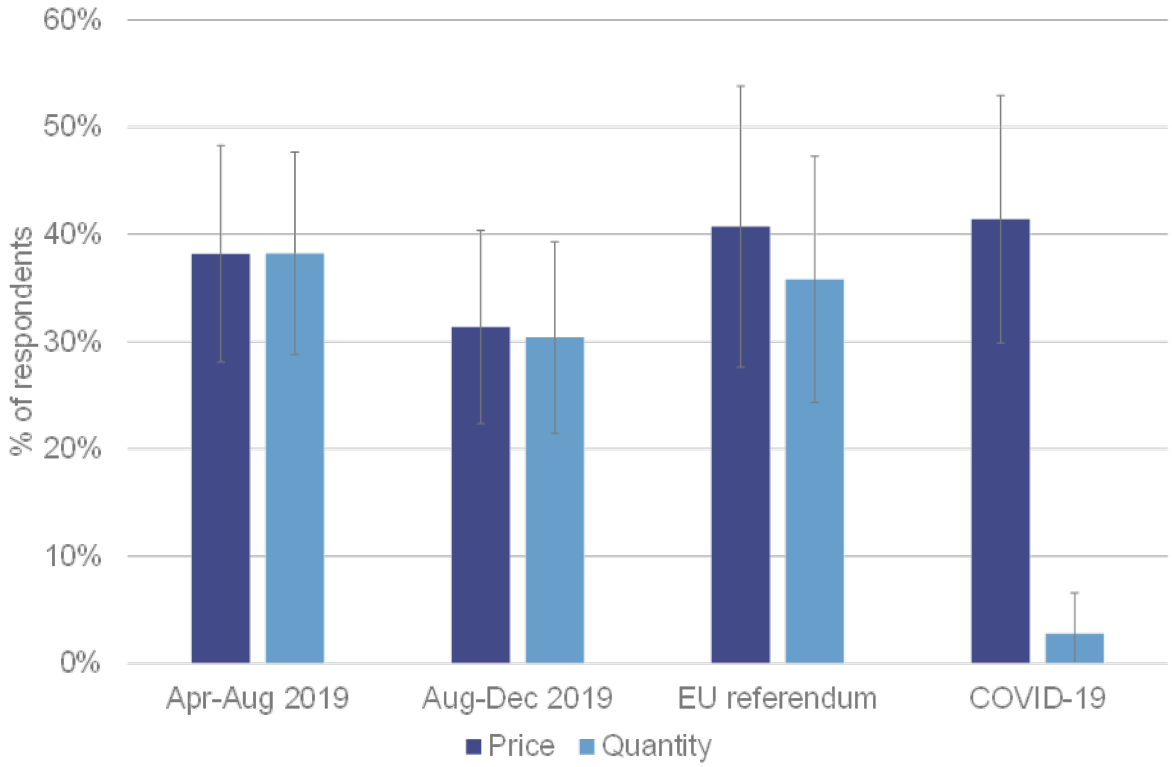


Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 89/102/54/70; Quantity - 102/102/67/72. Grey bars show 95% confidence intervals.

Size of exchange rate fluctuation

The size of the exchange rate movement, relative to other market conditions, is likely to capture the importance of exchange rates in business decision making compared to other demand and supply factors. Figure 37 below shows that around 30 to 40% of respondents who indicated that price/quantity did not change as a result of exchange rate fluctuations, indicated that it was due to the change being 'small' in comparison with other market conditions at the time. This, however, is chosen less in the case of quantity rigidities during the COVID-19 period. This appears to be because most respondents selected that non-tariff barriers and business investment costs (see below) were the most important factors for quantity following COVID-19.

Figure 37: Reasons for rigidities, size of exchange rate change

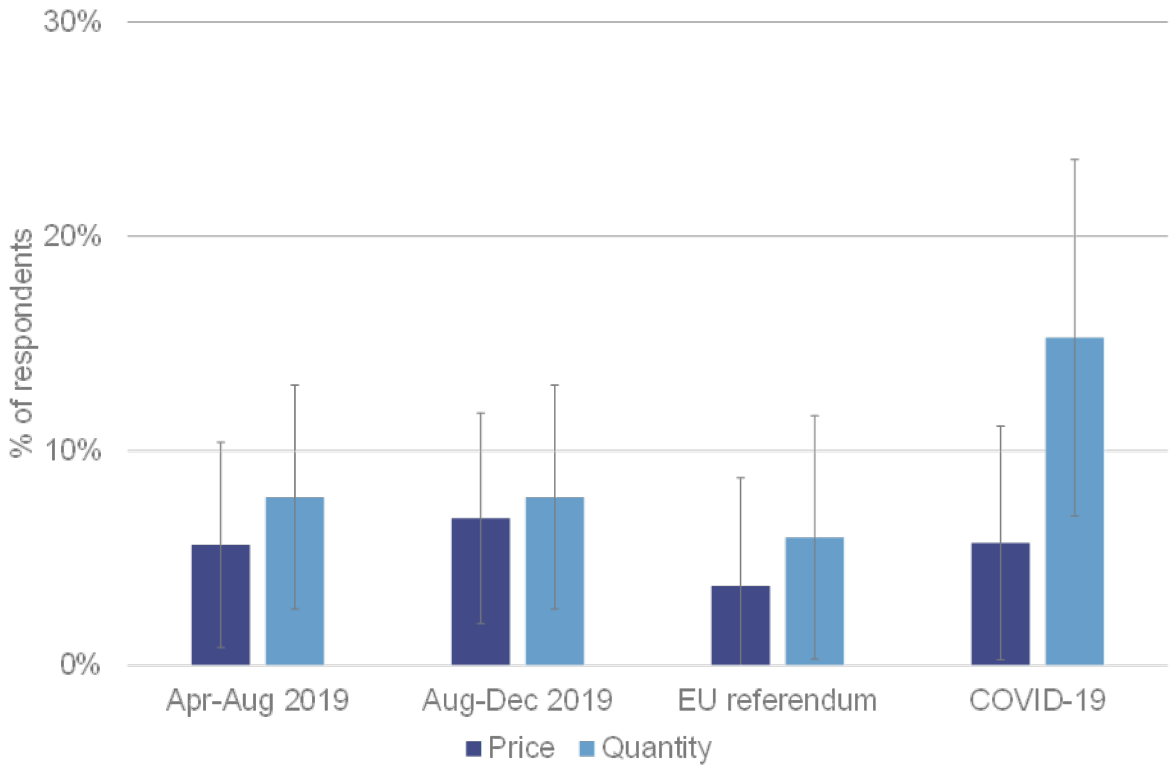


Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 89/102/54/70; Quantity - 102/102/67/72. Grey bars show 95% confidence intervals.

Business investment costs

Figure 38 shows the proportion of firms that chose business investment costs as a reason for not changing prices and quantities at each period. Generally, few firms (around 3 to 8%) chose these costs as a reason for not responding to exchange rate movements. This, however, does appear to be more important following COVID-19 for traded quantities.

Figure 38: Reasons for rigidities, business investment costs



Source: Economic Insight analysis of survey responses.
Base size (by order of period shown): Price - 89/102/54/70; Quantity - 102/102/67/72. Grey bars show 95% confidence intervals.

4.4 Survey conclusions

The central findings from the survey responses are as follows:

- Consistent with the literature review and case study interviews, firms appear to face obstacles (nominal rigidities) which limit the response to exchange rate fluctuations. In particular, the responses emphasised that invoice currency is likely to be key to understanding the international trade response to exchange rate fluctuations:
    - The majority of respondents indicated that prices in the main invoice currency were *not actively changed* in response to exchange rate fluctuations, and even more businesses indicated that quantity was not actively changed.
    - Exchange rate pass-through therefore seems to be driven overwhelmingly by the invoice currency and is mostly either zero or complete. As a high share of respondents in the survey use the pound, relative to that observed in the population of UK firms trading internationally, this may

potentially overstate the export price response and understate the import price changes.[57]

- In contrast, there is limited heterogeneity in the exchange rate response across firm characteristics in the survey (e.g. position in supply chain, industry, type of good), which is slightly inconsistent with evidence from the literature review and case study. To the extent that cross-firm differences, such as industry or position in the supply chain, drive exchange rate pass-through, this seems to be via the invoice currency.

- Three factors appear to restrict the trade response of firms to exchange rate movements: (i) exchange rate expectations, (ii) the length of contracts (i.e. the duration for which trade contracts were set), and (iii) the size of the exchange rate fluctuation. When asking respondents what factors restricted their trade response to exchange rate fluctuations, these factors were emphasised above all others.

- In the case of exchange rate fluctuations around the time of the EU referendum and COVID-19 crisis, survey responses suggest non-exchange rate factors seem to be important in business decision making and likely outweigh exchange rate considerations, consistent with much of the literature on these periods. For instance, a non-trivial number of firms indicated they changed prices in the opposite direction economic theory would predict given the exchange rate depreciation following these events.

[57] This is based on HMRC customs data: https://www.gov.uk/government/collections/currency-of-invoice. Note, while this relates only to non-EU trade, pound invoicing is still considerably lower than suggested in the survey.

5. Case studies

This chapter of the report summarises the findings from five case study interviews with trade associations. Each case study was conducted as a qualitative interview and focuses on trade association members' cross-border trade responses to exchange rate fluctuations. The case studies were designed to validate and further explore the results from the survey and literature review.

5.1 Introduction

The case studies further consider the real-world evidence by interviewing several trade associations representing firms that engage in cross-border trade. In particular, the case studies were designed to: (i) verify the key findings from the literature review and survey, as outlined in chapters 3 and 4; (ii) investigate the underdeveloped topics in the academic literature, and; (iii) discuss the additional areas that businesses cited in the survey that influenced their response to exchange rate fluctuations.

In total, five case studies were conducted between 28th September and 19th October 2020, each lasting between 45-60 minutes.[58] The organisations were selected on the criteria that they support businesses who engage in cross-border trade. In addition, collectively, the associations represent firms that trade in both goods and services, and across a variety of industries (with focus on the main goods and services that are imported to and exported from the UK). This ensured that, should exchange rates be of importance to members, (i) their collective insights should, to a greater extent, reflect the views of a sizeable proportion of firms involved in UK trade, and (ii) heterogeneity across firms and industries could be captured.

The trade associations interviewed are summarised below[59]:

- *Trade association 1*. Body that represents companies from the pharmaceutical industry. This industry consists of firms ranging from SME's to large international corporations. Members predominantly trade in goods and consist of both exporters and importers.
- *Trade association 2*. Supports exporting firms across multiple industries in the UK, including their service providers such as banks and credit insurers. Members range from SMEs to large firms. Despite being export focussed, a

[58] Each case study call was conducted by at least two members from Economic Insight, consisting of a pre-designated lead and note-taker. All interviews were conducted via telephone and were not recorded, due to GDPR and concerns that recording would substantially reduce response rates.
[59] Trade associations are not named due to GDPR.

large number of businesses have imported components. Around a third to a half of members export in services, and the rest in goods.

- *Trade association 3*. Represents businesses in all areas of the manufacturing industry. Members both import and export, and trade in both goods and services. This reflects the growing importance of services embodied within manufactured goods.
- *Trade association 4*. Also supports firms in the manufacturing industry, with a focus on trade in capital goods and their respective services. Represents the interests of manufacturers (who export and import), as well as the interests of importers specifically.
- *Trade association 5*. Represents firms in the automotive industry, which consists of original equipment manufacturers through to end vehicle suppliers. Members are a mix of importers and exporters, and international firms that both import and export. Members focus on trade in goods, though some services relating to engineering also exist.

5.2 Summary of responses

Overall, trade associations indicated that the responses to exchange rate movements are mixed and depend on a variety of factors. Generally, the consensus is that firms *should* respond, but there exist a range of variables that limit their ability to do so. As a result, and consistent with the literature, the scale of firms' exchange rate responses is less than what would be predicted by traditional economic theory.

This section summarises the case study findings thematically in accordance with key themes identified in the literature review and the survey. Specifically, interviewee insights are outlined according to: (i) the importance of invoice currency; (ii) contracts and hedging; (iii) the role of global value chains in dampening trade response to exchange rates; (iv) whether exchange rate expectations are considered by firms; (v) heterogeneity across firm characteristics, and finally; (iv) the relevance of exchange rates following the EU referendum and during COVID-19.

5.2.1 Invoice currency

One key finding from the literature review and the survey concerns the choice of invoice currency. Particularly, this is a significant determinant of exchange rate pass-through, as prices are generally rigid in terms of the invoice currency of trade (see section 3.3.1). This trend is also echoed in the case studies.

To illustrate, one trade association stated that for exporters selling in the pound, firms would increase their market share when the pound is weak (i.e. reduce prices in the local currency and expand trade volumes). In contrast, exporters invoicing in

local currencies would absorb exchange rate movements fully in their margins (i.e. hold prices constant). This is consistent with literature on PCP and LCP.

According to two trade associations (the rest of which had no specific knowledge on the exact invoice currencies of trade), the pound is used more commonly for imports than exports. For exports, few firms invoice in pounds as the US dollar and euro are more popular. The reason for this is twofold. *Firstly*, one association mentioned 'a need for exporters to be local'. That is, firms gain a competitive edge from using the currency of the customer. *Secondly*, while the pound is a popular currency amongst banks and foreign exchange traders, it remains behind the US dollar and euro as an 'international currency'. One association speculated that, due to its stability, the US dollar is likely to be used more for global trade, even if it does not involve the US. The use of vehicle and local currencies (which includes pounds for imports) amplifies invoice currency rigidities as observed in the literature (i.e. aggregate pass-through is lower than what theory would predict due to LCP and DCP).

It is important to note, however, that two trade associations corroborated that the pound is the *preferred* currency for both UK importers and UK exporters. There are two reasons for this. *Firstly*, firms based in the UK usually run operations in terms of the pound. Transaction costs are therefore minimised if the pound is used for invoicing. *Secondly*, if prices are rigid in terms of the pound (from pound invoicing), exchange rate movements do not impact the profitability of pound-based firms. The use of the pound therefore acts as a natural hedge for business profitability against exchange rate movements. However, due to the reasons outlined above, pound invoicing is increasingly less common.

Lastly, associations were asked whether digitisation plays a role in the choice of invoice currency. All associations commented either that digitisation has not, or not yet, initiated a significant impact. For example, one association stated that while there are advances in the digitisation of operations, rapid digitisation of sales does not yet exist. Another said that while digitisation is assisting currency transactions to become more seamless (e.g. with currency transfer systems that avoid third party brokers and reduces transaction costs), there has not yet been a concrete impact on invoice currencies. In addition, digital currencies, such as Bitcoin and USD Digital may be used increasingly more for trade in the future, but only if they are connected with the rest of the supply chain (for instance, in distribution) – which currently still uses traditional currency. Finally, one association emphasised the importance of 'on the ground' relationships with customers for invoicing procedures. This alleviates the effect digitisation plays, if any.

Overall, consistent with the literature, non-pound currencies are increasingly used for exports, while for imports, pound invoicing is still common. This leads to invoice currency rigidities which dampen the effect of exchange rates on trade.

5.2.2 Contracts and hedging

One key theme running through the case study interviews was that contracts, which are often long-term, limit the ability for members to respond to exchange rate fluctuations in the short-term. Combined with the role of invoice currency, fixing prices and volumes via contracts implies that exchange rate pass-through is either complete or zero for the duration of the contract, depending on which currency is used. If contract periods are long, prices are updated less frequently. One reason for long-term contracts are 'the long-term relationships suppliers have with their customers'.

All five trade associations mentioned the existence of contracts between suppliers and customers as a mitigating factor in the relationship between exchange rates and trade. For instance, in manufacturing, one association commented that the 'the duration of contracts would be far longer than any expectation of a currency fluctuation'. In its view, contracts dissociate trade from short-term exchange rate volatility. In fact, 'short-term fluctuations would balance themselves out' within a contract period, and therefore would not influence the setting of new contracts. In addition, one association stated that it is also unlikely that either the invoice currency or prices would change mid-contract due to relationships suppliers have with their customers. Specifically, there are 'administration issues' and also issues with 'business relationships' if invoice currencies and prices constantly change.

There is, however, consensus that many firms pursue hedging to mitigate the impact of 'significant unfavourable swings' in the exchange rate. This is particularly the case when goods are large in their order value. For instance, one association provided an example of an exported good whose length of contract was over a month, with a value of several million pounds. The decision to hedge (via forward contracts) is an important decision to mitigate the risk of large losses. More generally, three trade associations stated that firms 'should' hedge, although there would be variation across firms on whether they actually did so, as will be described in section 5.2.5.

It is also worth noting that contracts can include exchange rates. This was briefly mentioned by two out of five trade associations, although further details were not provided.

According to one association, for goods whose prices are agreed at the point of sale (and not locked into long-term contracts), prices are more flexible. For these goods, partial exchange rate pass-through may be possible. Notwithstanding this, the decision of how much prices adjust in response to an exchange rate movement, in relation to how much is absorbed into firms' profits, is a case-by-case decision. Partial pass-through was not mentioned by the other four trade associations.

Long-term contracts, consistent with the survey, are an important feature of trade that mitigates the impact of short-term volatility. Due to their length and relationships with customers, contracts can dampen the relationship between exchange rates and trade altogether. As a result of contracts being used widely across firms, hedging is common, and at times a necessary business decision.

5.2.3 Global value chains

Global value chains, whilst not explicitly questioned in the case studies, were raised as an issue in four out of the five case studies. In general, involvement in global supply chains was acknowledged as suppressing the effect of exchange rates on trade. This corroborates the literature.

Exchange rates affect import and export competitiveness in opposite directions. Thus, businesses that source their inputs from abroad to produce exports, or alternatively simply engage in exporting and importing activities, would be restricted in their ability to respond to exchange rate movements. At the extreme, one trade association, whose typical members comprised of firms that were 'mid-supply chain' and therefore traded in both directions, revealed that 'members have continuously made clear that a depreciation of the currency is not in their advantage'. Two other organisations also agreed that supply chains through this mechanism serve as a dampening factor for the relationship between exchange rates and trade.

It is important to note, however, that this is not negatively viewed by trade associations. Indeed, one association cited the ability for supply chains to act as a hedge against exchange rate movements, mitigating the risk associated with exchange rate fluctuations. Moreover, due to the significant role of invoice currency, this association stated that firms would prefer to keep the currency of invoicing the same for their imports and exports. In the case of a firm with equal importing and exporting value, exchange rate risk would be eliminated altogether.

The inflexibility of supply chains was also raised several times in the case studies. In the pharmaceutical industry for instance, small changes to supply chains can take a long period of time to implement (i.e. often over a year), and thus the investment required to respond to an exchange rate shift is generally not worth the high costs needed to do so. In manufacturing, the rigidity of supply chains means that the effect of exchange rates on business decisions depends on how they affect other stages of the supply chain. This is consistent with literature – firms' positions in the supply chain influence their ability to respond to exchange rates – supply chain rigidity causes trade to be dependent on downstream demand, as outlined in section 3.3.2, which in turn potentially depend on other exchange rates. Three out of five associations emphasised the crucial relationship between suppliers and their customers inherent in setting up long-term contracts. This amplifies supply chain inflexibility.

It is worth noting that supply chains are not completely inflexible, however. One association in the manufacturing industry stated that some firms can sometimes shift their focus from overseas markets to domestic markets when exchange rates are very unfavourable, if they have a large enough domestic presence. This will be further discussed in section 5.2.5.

Nevertheless, the case studies show that involvement in global value chains reduces the aggregate trade response to bilateral exchange rates, consistent with literature. At the firm-level, exporting firms in some cases may even prefer a stronger pound.

5.2.4 Expectations

As the role of exchange rate expectations on trade was unclear from the literature review, but highlighted as a key consideration for firms in the survey, case study interviewees were asked whether, and how, firms took these expectations into account. Particularly, associations were asked whether expectations being perceived as temporary or permanent affects their members' import and export decisions. In general, associations stated that their members would take a view on exchange rate expectations with regards to their hedging strategies and would be likely to take a view with regards to setting prices and volumes. In particular, it was noted that firms often lack expertise to correctly anticipate exchange rate fluctuations and therefore hedge to eliminate the need to consider expectations.

Firstly, as described earlier, the length of contracts can eradicate the need or ability to consider short-term expectations of the exchange rate altogether, as suggested by an association in the manufacturing industry. Medium- to long-term expectations would, however, probably factor into firms' decision making. The trade association representing the pharmaceutical industry stated that, due to the large price rigidities in the industry created by price and competition regulation, short-term exchange rate fluctuations are unlikely to elicit a response in prices or volumes.

Another association stated that firms would 'use short-term fluctuations to their advantage if they are time limited, but if it was long-term, they would probably want to gear their business towards minimising the impact of the exchange rate to the cost base or export price'.

One association stated that short-term expectations are an important component in deciding hedging arrangements. Exchange rates fluctuate in value, and thus, at what time to purchase forward contracts when hedging against exchange rate movements becomes a crucial choice, particularly if the trade is large in value. Delaying hedging for even 'a couple of days' can risk significant losses if the exchange rate moves unfavourably.

Lastly, trade associations were asked whether responses differ for an expectation of an exchange rate appreciation versus a depreciation. In general, insights were limited on this matter, although one association raised a point on the psychological aspect of expected appreciations versus depreciations. Namely, for exporters, expected depreciations would encourage 'positivity' (e.g. cause a large push in marketing) while expected appreciations would cause firms to plan to minimise their losses (e.g. looking to minimise their overheads). However, this association also noted that expectations can be a 'distraction' for businesses, especially for smaller firms with less resources to deliberate them.

5.2.5 Heterogeneity

Heterogeneity across firms and industries with regards to their trade response to exchange rate fluctuations is a key finding in the literature review. In particular, the size of firms and product competition, among others, has been shown to influence the sensitivity of trade to exchange rate movements.

The sub-sections below outline the various sources of heterogeneity discussed by trade associations: (i) goods versus services; (ii) size and trading experience; (iii) competitiveness of the good/service in the global market; (iv) the size of firms' domestic market; (v) regulation; and (vi) firms' relationships with their banks.

It is worth noting here that four associations asserted that, while general variables governing heterogeneity may exist, firm-level heterogeneity is difficult to quantify. Namely, how trade reacts to exchange rates would depend on the individual business models of firms, therefore making it difficult to predict how any single firm would behave.

Goods versus services

One association confirmed that services have lower input costs than goods. Thus, exchange rates have a greater impact on trade in services. For exports for instance, given a depreciation of the pound, its effect on the aggregate trade in goods would be dampened by higher imported input costs, while this GVC effect is less prominent for trade in services. This corroborates the literature review.

Size of firms and experience in trading

Three out of five associations commented on heterogeneity with respect to the size and/or the experience of trading firms. Smaller and inexperienced firms are less likely to have hedging arrangements in place, due to a lack of awareness or lack of experience respectively. For instance, one association stated that several SME members that both import and export faced financial difficulties following the depreciation after the EU referendum. This was due to import costs tied into contracts rising without sufficient hedging arrangements in place to mitigate this. In addition, another association stated that those with a historical focus on trade with the EU (rather than the rest of the world) are less educated on hedging matters.

Larger firms, in contrast, are more likely to have foreign exchange teams focusing on exchange rate movements. These firms are sometimes spread over larger territories, and in some cases, can hedge themselves against exchange rate movements from trading in many countries. In some cases, firms can shift focus from one geographical market to another if exchange rates move unfavourably.

In addition, some multinational firms engage in transfer pricing, which, according to one trade association, would reduce the sensitivity of trade to exchange rates. An

example was given for an importer who purchases goods from a parent company abroad. Here, exchange rates would only lead to business changes insofar as unfavourable movements lead to UK operations becoming unprofitable, which in the extreme would lead to a shift in trade to other markets.

Lastly, there exists heterogeneity in the size of firms with respect to the choice of invoice currency. Namely, one association commented on a 'battle of contracts' whereby firms who have the upper hand in negotiations control who bears the exchange rate risk, inherent in the choice of invoice currency. Larger companies would generally have the power to push smaller companies to take on more risk. For instance, one association stated that 'a large German company exporting a machine to the UK may have the power to set prices in euros in order to make their customer bear the full exchange rate risk'. Another association gave the example that an international corporate manufacturer based in the US would almost certainly be invoicing in the US dollar, due to a combination of the stability of the dollar, as well as the manufacturer's dominance.

Overall, exchange rate fluctuations would be less costly for large firms, due to hedging arrangements and their upper hand in contract terms.

Competitiveness of trade in the global market

Related to the above, one association commented that suppliers of competitive goods would generally have less power in contract negotiations. This affects the invoice currency of trade. To illustrate, this association stated that exporters of relatively homogenous goods under greater competitive international pressure would not be able to invoice these goods in the pound due to customers having local currency invoice demands. In contrast, firms exporting a 'unique good', under lower competitive pressure, would be able to invoice more in the pound, due to their greater market power to set contract terms.

Size of firms' domestic market

One association mentioned that firms with more domestic customers may be more flexible to respond to exchange rate fluctuations by shifting focus to them, given an unfavourable exchange rate swing. Firms with reliance on international trade, on the other hand, would not be able to mitigate against significant currency fluctuations. This relates directly to the *rigidity* of global supply chains. That is, firms with greater flexibility to move supply given a change in exchange rates (i.e. less rigid supply chains) would be more reactive to exchange rate fluctuations.

Regulation

Regulatory controls can inhibit the ability of firms to respond to exchange rates. For instance, in the branded pharmaceutical industry, there exist price controls for medicines. As a result, in the UK, the power of large customers (often the government) to set prices far dominates the ability of suppliers to change prices in response to exchange rate fluctuations. Specifically, once price controls are set these can only be changed during the period for which the controls are in place if these threaten companies' viability. Therefore, exchange rates would only impact prices insofar as exchange rate fluctuations make sales of the branded medicine unprofitable. In contrast, without price regulation (e.g. markets for generic medicines), firms are more likely to respond to exchange rates.

Relationship with banks

Lastly, one association commented that firms' relationships with banks impact whether firms can mitigate the impact of currency fluctuations in the short- to medium-term. Namely, they may be able to mitigate the cost implication of an unfavourable exchange rate shift (e.g. through a freeze in repayment fees).

5.2.6 EU referendum

The case studies concluded by asking trade associations how their members responded to the pound depreciation following the EU referendum, and whether the relationship between exchange rates and trade would change in the future as a result. Overall, exchange rates were not the primary consideration following the EU referendum, with trade policy uncertainty causing large counterbalancing effects to the depreciation.

All five associations stated the magnitude of uncertainty with regards to the UK's trading relationship between the EU as a major factor in reducing any positive impact of the depreciation on trade. Uncertainty and potential tariffs play a larger role than exchange rates do in influencing firms' decision making. One association stated that changes in safety and quality regulations would be a markedly more important consideration for firms than exchange rate movements.

The roles of global value chains and invoice currencies were once again mentioned in this discussion. One association emphasised that global value chains mitigated any positive impact of the depreciation. This is particularly prominent for firms that source a large number of imported components from the EU. On invoice currency, one association stated that for firms selling in pounds, the depreciation would have allowed exporters to become more competitive. However, as only a minority of exporters invoice in sterling, the depreciation would not have affected local export prices.

Lastly, one association mentioned that the referendum caused a growth in the number of firms looking to trade outside the EU. This means that UK aggregate trade would be increasingly reliant on non-euro exchange rates.

Overall, however, it is unclear as to whether the EU referendum result would fundamentally change the relationship between exchange rates and trade. It is clear, however, that exchange rates are not the fundamental consideration for businesses in relation to the UK's exit from the EU, as trade policy uncertainty represents a much larger concern for businesses.

5.3 Case study conclusions

The main findings from the case studies are summarised as follows.

- Consistent with the literature review, invoice currency rigidities are key in suppressing the relationship between exchange rates and trade. While firms may prefer to invoice in pounds, competitive pressure and the widespread use of US dollars and euros prevents them from doing so.
- A possible explanation for this finding is that long-term contracts are common, and prevent prices and volumes adjusting from exchange rate movements. These contracts also dampen the effect of exchange rate volatility on trade.
- Global value chains reduce the responsiveness of trade to movements in the exchange rate. This mitigating effect is greatest for industries that are mid-supply chain, with a high proportion of inputs sourced from abroad.
- There is sizeable heterogeneity across firms. The main source of heterogeneity comes from the size of the firm: larger firms (i) have the upper hand in contract negotiations, including the decision of the invoice currency, and (ii) have more resources to deal with exchange rate fluctuations. In addition, trade in goods is less responsive to exchange rates than trade in services due to their higher imported content.
- Furthermore, most trade associations stressed that there is no uniform response across members and across trade associations, different issues were emphasised, which seems to reflect the idiosyncrasies of each industry and firm. Responses differ for each firm depending on their individual strategies in dealing with exchange rates.
- Many firms employ hedging mechanisms to mitigate the risk of large changes in the exchange rate. Exchange rate expectations are likely considered by firms in these hedging decisions.

6. Econometric feasibility study

This chapter sets out how DIT could further enhance its understanding of the relationship between exchange rates and trade by using econometrics. The scope of this study is to provide a range of options and recommendations for using econometrics for different purposes, as opposed to implementing any models. The approach was to build upon the findings of the literature review and survey, in order to identify econometric techniques that can provide analyses at both the macro- and micro-level transmission mechanisms as set out in chapter 3. The model options derived from the literature review are discussed first, before the micro-level models are identified based on the survey.[60]

6.1 Introduction

The econometric feasibility study aims to inform DIT on how econometrics could be used to further enhance its understanding of the relationship between exchange rates and trade. The literature review and survey results were used as the starting point for the econometric feasibility study, and separate modelling possibilities from each were identified, which are outlined here.

From the literature review, models were identified that predominantly fall into the macro-level framework, even if the subject of the paper was within the micro-level framework.[61] This is because, even where the subject of interest is micro, in most cases the models in the literature review consider trade at a macro-level. Trade and exchange rates are themselves macro-level variables, and so it is logical that most papers analyse them at the macro-level. In addition, the firm-level data that is required for micro-level analyses of the sort found in the literature review would be challenging for DIT to obtain, other than via a survey, due to the level of detail needed. For example, to understand the impact of exchange rates on individual firms, one would need access to information such as volumes of sales across different products; invoice currencies used for each sale; and whether a firm is part of a global value chain (GVC). Granular data such as this is not available publicly, however macro-level data is more accessible.

This data availability issue could be somewhat overcome through econometric analysis of the survey, which deals with the impact of exchange rates on individual firms. Given the relatively small sample in the survey (n=124), the scope of this part

[60] The study has been developed with support from Professor Anthony Glass of the University of Sheffield.

[61] Although the literature review concluded that macro-level concepts generally do not successfully explain the relationship between exchange rates and trade, they have been given full consideration in the econometrics feasibility study. This is because: (i) as noted, often models that tackle micro-level subjects consider trade at the macro-level; and (ii) it would allow DIT to test the robustness of findings from literature for macro-level models.

of the feasibility study is limited to suggestions for how econometrics could be used on surveys with larger samples. That is, the survey would be unlikely to provide robust results given the sample size but could offer a framework for future econometric analysis using any pre-existing or upcoming survey data, which collect similar data for larger sample sizes.

6.2 Macro-level models from literature review

6.2.1 Method for assessing feasibility

The first stage in the feasibility study was to go through selected papers from the literature review that utilise econometrics and collect views on what types of models are generally used and for what purpose. By going through a range of articles, the most prevalent econometric approaches were identified based on: (i) the context in which econometrics is applied; (ii) what types of regressions are used in each context; (iii) the relevant dependent variables; and (iv) independent variables. Using this, recommendations are made as to the possible model specifications that could be used by DIT.

6.2.2 Potential research questions

Econometric techniques are used for a range of purposes in the relevant literature, with the most common areas of research being:

- analysing the effect of exchange rate changes on trade in general;
- measuring exchange rate pass-through;
- testing for the J-curve; and
- assessing the impact of volatility.

Overall, this suggests that there would be scope to use econometrics to answer general questions around whether exchange rates have an impact on trade volumes and prices. In contrast, given the conclusion from the literature review that, on balance, exchange rate volatility does not appear to have a significant effect on trade, econometric analyses which specifically focus on volatility may not be reliable. Therefore, macro-level analyses should be limited to the other three research questions, namely: (i) what is the general effect of exchange rate changes on trade; (ii) what is the level of exchange rate pass-through; and (iii) is there evidence of a J-curve or other timing effects patterns?

6.2.3 What is the general effect of exchange rate changes on trade?

6.2.3.1 Model specification

For more straightforward analyses such as those covered by this research question, there may be benefits in adopting a **gravity model** approach. The gravity model is a classic model of trade, and rests on the principles that the closer countries are together, and the larger their combined GDPs, the more they would trade. In recent studies, the gravity model is often enhanced to account for not only the distance between countries, but also whether they share a border or language. In addition, the relationship between countries can be accounted for. Many applications of the gravity model in academic / research articles include fixed effects in the model. Fixed effects allow for correlations between observations that may affect the dependent variable but cannot be accounted for by an explanatory variable. Given the prevalence of fixed effects models in the literature, and the fact that the complexities of international trade mean there are likely to be unobserved correlations across firms, products, etc., incorporating **fixed effects** can be beneficial when using gravity models (e.g. Nicita, 2013; Kang and Dagli, 2018).

The gravity model also has the benefit of being simple to implement and interpret the results; such models are also likely to be relatively straightforward to augment with additional explanatory variables.

6.2.3.2 Dependent variable options

For general analyses of the relationship between exchange rates and trade, the most intuitive dependent variable is **export or import volumes**, measured by quantity or value. This is also in line with the dependent variable used in existing studies adopting a gravity model.

6.2.3.3 Independent variable options

Given that the purpose of econometrics in this context is to assess the impact of exchange rates on trade, it is self-evident that an **exchange rate** explanatory variable should be included.

Using a gravity model for this type of analysis, the independent variables should include – in addition to the exchange rate – at a minimum:

- the combined GDP of the two countries; and
- the distance between the two countries.

The gravity model can also be supplemented with additional geographical features that might affect trade, such as: (i) whether the countries have a **shared border**; and (ii) whether they **share a language**. These are relevant factors which are worth considering for econometric modelling.

In addition to these, other explanatory variables of interest that arose include:

- a measure of GVCs;
- exchange rate volatility;
- inflation;
- trade structure; and
- exchange rate expectations.

Based on the findings from the literature review and assessment of studies that specifically use econometrics, the following judgements can be made on the relevance of each of these variables to the research question:

- **GVCs** have played a role in driving trade, independent of exchange rates. Therefore, there is value in including a measure of GVCs as an explanatory variable. One possible method of measuring GVCs is to use the share of domestic-value-added of exports, as by Kang and Dagli (2018). The impact of GVCs is generally considered in terms of a country's exports because it is the change in export competitiveness following an exchange rate movement that is offset due to a counteracting change in import prices. Therefore, it intuitively makes sense to use GVCs as an explanatory variable in models where the dependent variable is related to exports. This is also consistent with the suggested measure of GVC participation above.
- Despite the wide array of studies on **exchange rate volatility**, the overall conclusions are mixed. Therefore, there is limited scope to yield reliable answers on the impact of volatility, and it does not seem that volatility would be an explanatory variable that would yield robust relationships.
- **Inflation** would not be expected to affect trade volumes significantly, and so is unlikely to be a relevant explanatory variable for this modelling aim. This is consistent with existing econometric analyses that take import or export volumes as the dependent variable.
- As found in the literature review, the impact of exchange rates on trade exhibits significant heterogeneity. Consequently, the **structure of trade** may have an effect on the level of trade independent of exchange rates. Therefore, there is scope to account for the structure of imports in a model (i.e. the composition of trade by product type). Logically, this would only be applicable to analyses of trade in aggregate, which cover multiple industries. One such method of accounting for trade structure is exemplified by Kang and Dagli (2018), who calculate the ratio of commodity goods to manufactured goods imported by one country from another. Alternatively, given the specific nature

of the UK economy and its heavy reliance on services, a measure that captures this may be more accurate, such as the proportion of trade made up of services.

- As the empirical role of **exchange rate expectations** is a topic that is not fully understood, there could be value in including a measure of expectations in a model. A simple way to represent expectations would be to use future exchange rates, so long as one could be confident that expectations are accurate and reflected future exchange rate movements. Li and Zhao (2015) suggest that this is a sensible assumption. A benefit of using econometrics to account for the impact of expectations is that multiple forward-looking time frames could be incorporated at once, allowing for distinguishing between short- and long-term expectations.

Based on the literature review findings, there are two other key factors that could be included in the model.

Firstly, the **invoice currency** plays a significant role in determining the impact of exchange rates on trade. Therefore, to implement models that accurately capture the role of exchange rates, it may be important to account for invoice currency. An initial way to do this would be to use dummy variables to represent the method of invoicing – producer, local, or dominant currency pricing. However, data availability may be a challenge for this variable, as detailed firm-level information would be required.

Secondly, the effect of **trade policy** can often dominate that of exchange rates in determining trade flows, and so this could also be introduced as a variable in a model. Including trade policy would also allow for comparisons between the relative effects of exchange rates compared to policy. One possible method to measure trade policy could be to use a normative scale of different 'levels' of trade policy which could be converted into a numerical scale. For example, higher numbers could represent greater levels of tariffs and restrictions. However, given that an approach that uses qualitative judgments may be inaccurate and unsuitable for econometric models, alternative methods of measuring trade policy are available, such as in Nicita (2013), which uses the tariff trade restrictiveness index. This measures the level of trade restriction between countries based on: the level of exports; import demand elasticity; and applied tariffs. A third alternative to measuring trade policy would be to include a free trade agreement dummy variable, in the event the analysis covered several countries (the dummy variable would not be appropriate for a one-country analysis as it is defined at the country-level and therefore does not vary within a country).

In addition to these two variables, from the literature review, **heterogeneity** across different aspects of the economy appears to be an important factor in the relationship between exchange rates and trade. While the suggestion of using a variable to account for the structure of trade would somewhat account for this at an aggregated level, heterogeneity can also be dealt with by assessing trade at non-aggregate levels, such as by industry. Based on the range of evidence in the literature, this may

help avoid aggregation bias and yield more accurate results (Bahmani-Oskooee and Fariditavana, 2016).

In a gravity model, heterogeneity can also be accounted for with the use of **fixed effects** terms. As noted above, fixed effects can allow for unobservable characteristics between data points which may impact the dependent variable (in this case, trade). As such, fixed effects can be used to control for heterogeneity in trade, which may otherwise be unaccounted for and lead to an omitted variable bias. As such, one could include fixed effects at either the firm or product level, which would allow for heterogeneity between traders or products. The type of fixed effects used would primarily depend on the level of data available and the specification of the dependent variable. For example, within-firm, product-level data would provide scope to distinguish heterogeneity between products, thus allowing for product-level fixed effects. Alternatively, if the data in use was more aggregated and product-level differentiation was not possible, then fixed effects across exporters or importers would facilitate firm-level heterogeneity. Imposing fixed effects would not only produce potentially more robust coefficient estimates, but would also allow for comparison against a model without fixed effects, to compute the impact that heterogeneity has on the relationship between exchange rates and trade.

6.2.4 What is the level of exchange rate pass-through?

6.2.4.1 Model specification

In order to assess the level of pass-through, it is possible to use a simple **OLS model with fixed effects** (Li and Zhao, 2015) – with the rationale for using fixed effects being the same as outlined in section 6.2.3.1. Such a model would be simple to implement and interpret, plus it would allow for flexibility in the explanatory variables included.

6.2.4.2 Dependent variable options

If the objective of the analysis is to measure exchange rate pass-through, the dependent variable would be the **change in prices**. Since pass-through relates to the degree of change in prices for a given change in exchange rates, the approach in the literature is to generally use the change variables rather than levels to conduct the analysis. It is possible to implement the analysis in levels, but this is less common and is therefore not discussed here.

As discussed in the invoice currency section of the literature review, short-run import prices are generally more sensitive to exchange rates than export prices. This is because, due to price rigidities, movements in the exchange rate of the pound would only cause the price of UK exports to change (from the purchaser's perspective) if

they were invoiced in pounds. By contrast, for UK importers, movements in the pound would cause the price of imports to change if they were invoiced in any currency other than the pound – and literature finds that only a minority of UK imports are purchased in pounds. Therefore, for models relating to price changes and pass-through, focussing on **import prices** rather than exports would be more effective. This is also the approach taken by existing studies on pass-through (e.g. Li and Zhao, 2015; Mumtaz, Oomen and Wang, 2006). While import prices may be the priority as a dependent variable, there may also be benefits in testing models that assess pass-through in UK export prices, as this may reveal and test any asymmetries between the two.

6.2.4.3 Independent variable options

Based on the literature (e.g. Goldberg and Knetter, 1996), as well as general considerations about what may reasonably be expected to impact import prices, the following factors should be included as the core independent variables in this model:

- **The change in exchange rates**. This acts as the independent variable of interest. The coefficient on the change in exchange rate reflects the degree of pass-through.
- **The inflation rate** of the exporting country is a factor that independently drives changes in import prices. Alternatively, if the dependent variable being used was the change in export prices, then the relevant exchange rate would be that of the exporting country.
- **The change in nominal GDP** of the importing country. This is based on the model used by Mumtaz, Oomen and Wang (2006). It would be expected here that prices would increase with GDP. Again, the change in GDP of the exporting country should be used here if the dependent variable is pass-through in export prices.

While these variables may serve as the basis for the model, there are other factors which are known to affect trade, and which may also affect prices and the level of pass-through. Specifically:

- **The change in trade policy**. One would logically expect that an increase in tariffs would be passed through to import prices. In order to capture the effect of this fully, the change in the tariff would need to be accounted for, as this could either increase or decrease.
- The level of participation in **GVCs**. As noted in the literature review, GVCs have somewhat weakened the relationship between exchange rates and trade, including trade prices. Therefore, in order to accurately estimate the coefficient for the change in the exchange rate variable, it may be relevant to control for the effect of GVCs. This could be done using the share of

domestic-value-added of exports measure noted above (Kang and Dagli, 2018).

- **Invoice currency**. As with GVCs, the use of different invoice currencies seems to have diluted the relationship between trade and exchange rates. In the literature review it was highlighted that the degree of pass-through can depend on the invoice currency used (for the reasons noted in section 3.3.1). Therefore, it would also be worth testing the impact on the pass-through coefficient when invoice currency is controlled for.
- As in the previous model, the **structure of trade** may also be useful to include here – particularly in a multi-industry analysis – as this can help to capture the effect of heterogeneity. For example, it might be the case that in more manufacturing-based economies there is a higher degree of pass-through, and so this would need to be controlled for to accurately estimate the pass-through coefficient.
- **Exchange rate expectations**. As noted above, expectations are not a particularly well-understood area of research, and so there may be value in testing its impact in this model. Specifically, prices may change independently of exchange rates if future expectations are sufficiently strong.

The rationale for using the changes in GDP and trade policy, rather than the levels, is that failure to account for movements in these factors may result in a model misattributing changes in prices to exchange rate pass-through, when in fact it was caused by a change in another variable. However, as a point of comparison and robustness check, there would be value in also testing this model with the GDP and trade policy *levels* (keeping exchange rates as the change).

Lastly, as noted by Goldberg and Knetter (1996), it is possible that pass-through is impacted by geographical features of the trading countries (i.e. the features included in the gravity model). For instance, it may be that pass-through increases with the distance between countries due to transportation costs. As such, there would also be value in testing the effect on pass-through of the distance between countries or whether they share a border.

In addition to this model, there are two possible tests that could be carried out using this framework. *Firstly*, the change in exchange rate variable could be decomposed to assess two further points of interest:

i. whether exchange rate appreciations and depreciations have a symmetric effect on trade; and

ii. whether the size of the exchange rate change matters for the effect on trade.

In order to analyse (i), it would be possible to split the change in exchange rate variable to discern between an appreciation or depreciation. That is, the appreciation term would be equal to the value of the exchange rate change if it is an appreciation, and equal to zero otherwise, and vice-versa for a depreciation.

A similar approach may be used to analyse (ii), but where three distinct exchange rate variables are specified for small, medium, and large exchange rate changes. As there are no clear definitions of what constitutes small, medium, or large fluctuations, the decision about where to define the cut-offs would be somewhat arbitrary. However, this problem may be mitigated by testing the sensitivity of model results to different choices about the magnitude of the fluctuations.

Secondly, the results of the survey indicated that the level of pass-through at the firm level generally exists at the extremes (i.e. either full or zero). Whether full or zero pass-through is observed appears to be driven by the invoice currency. While the proposed model here does control for invoice currency, the pattern observed in the survey would likely be obscured because the model considers trade in aggregate and would include all types of invoice currency. However, the model could be adjusted to test for the survey finding by running separate models for each type of invoice currency. For example, if the change in import prices is the dependent variable, then separate models could be run for: (i) only trade invoiced in *local* currency; and (ii) only trade invoiced in *producer or vehicle* currencies. In the former, a coefficient on the exchange rate variable would be expected to be near zero (i.e. low pass-through), whereas in the latter a coefficient close to one, (i.e. near-full pass-through) would be consistent with the survey findings. If the change in *export* prices was instead the dependent variable, then lower pass-through would be associated with local and vehicle invoice currencies, and higher pass-through with invoicing in the producer currency. Alternatively, rather than running separate models, one could include dummy variables that indicate whether the invoice currency is local, producer or vehicle (omitting one to avoid multi-collinearity) and assess whether the coefficients are statistically significantly different from zero.

6.2.5 Is there evidence of a J-curve or other timing effects patterns?

6.2.5.1 Model specification

In several studies that analyse timing effects or test for a J-curve, the autoregressive distributed lag (ARDL) model is the preferred method (e.g. Bahmani-Oskooee, Economidou and Goswami, 2006; Bahmani-Oskooee and Kovyryalova, 2008). ARDL is an econometric technique which, in short, allows for dynamic effects in time series analysis by including lags of the explanatory variables. In most cases, the ARDL model is implemented with error-correction. The benefit of this is that it allows for cointegration, meaning that short-run and long-run effects can be distinguished. The ARDL model with error-correction is known as the **ARDL bounds-testing** approach, as first presented by Pesaran et al. (2001). This approach may be preferable to alternatives such as Vector Error Correction models as it simultaneously allows for both the stationarity and non-stationarity of different variables; as pointed out by Bahmani-Oskooee and Fariditavana (2016), it is possible that the exchange rate is stationary while the trade balance is non-stationary.

Given the capabilities of the ARDL model, and its use in the literature, this specification would likely be most effective for research around the J-curve and timing effects.

6.2.5.2 Dependent variable options

For tests of the presence of a J-curve or the effect of exchange rates on trade over time more generally, the dependent variable would most likely be the bilateral UK / industry trade balance. This is because the J-curve theory predicts that a currency depreciation would initially lead to a worsening of the trade balance, followed by an improvement. Therefore, for analysis of this sort, the **trade balance** should be the dependent variable. Alternatively, similar analyses could be carried out using only **export or import volumes**, as this would still provide a method of assessing the effect of exchange rates on trade over time, but without specifically focussing on the J-curve.

6.2.5.3 Independent variable options

As noted above, two independent variables found in most ARDL models for trade are the **bilateral exchange rate**, and a **measure of income** in the country of interest (usually GDP). Therefore, these two factors are undoubtedly necessary for an analysis of the J-curve or timing effects.

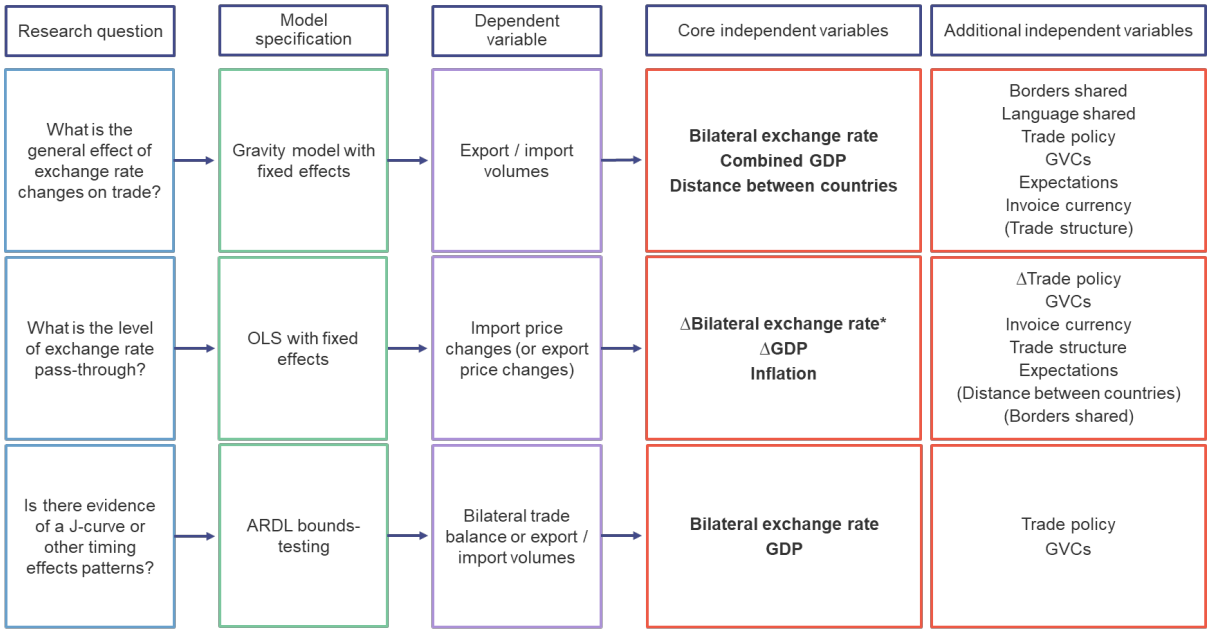
From the literature review, it is evident that there exist other factors that impact trade volumes aside from exchange rates. Therefore, to obtain reliable results, it may be necessary to include additional explanatory variables. In this model, the relevant explanatory variables would be similar as those for general models of trade, outlined in section 6.2.3.3. However, because the ARDL model is more complex than a simple OLS model, there may be benefits in being parsimonious with the variables used, to aid interpretation of the results. As such, control variables should be prioritised, and adding controls for **GVCs** and **trade policy** could be important in explaining the trade balance / volumes over time.

The diagram overleaf summarises the options set out for econometric modelling based on the literature. While a wide range of options for explanatory variables has been provided, and the variables chosen would depend on the research question at hand, certain variables should be included as a minimum in specific models – these are in the second to last column.

It is worth noting that a number of the other variables suggested for testing (such as trade policy and GVCs) may exhibit a degree of endogeneity. That is, while these factors would have an effect on the level of trade, they may also be influenced by the level of trade themselves. To mitigate against this, attention should be given to the

results to ensure they are in line with expectations in terms of coefficients' signs, magnitudes, and statistical significance.

Figure 39: Roadmap of modelling options from literature review



6.3 Micro-level models from survey

6.3.1 Method for assessing feasibility

As outlined above, a survey of 124 UK-based internationally trading companies was run as part of this project. The purpose of this survey was to understand more about the micro-level factors that influence firms' decisions about trade, and the extent to which exchange rates play a role in these decisions. Due to the relatively small sample size, the survey aimed to cover a relatively broad mix of firms in terms of size and industry, rather than to target a sample that is representative of the population (which would not be possible due to the small scale). The survey gathered information on:

- firms' characteristics (e.g. size, industry);
- the impact of COVID-19 on business operations;
- the impact of exchange rate fluctuations during COVID-19;
- the importance of exchange rates to firms in general;
- the impact of the EU referendum and the associated exchange rate fluctuations; and
- other factors that might determine firms' responses to exchange rate movements.

This data can therefore act as a basis for scoping econometric analyses, however, due to the small sample size, it is not expected that robust results from this particular survey could be obtained. Rather, it may be possible to apply the recommendations here to analyses of (i) other existing surveys or (ii) similar surveys run in the future with larger samples. Therefore, recommendations here are not based on the results of the survey analysis, as while it provides useful insights, decisions on which factors to include or exclude in an econometric analysis should be taken based on larger samples and, at a minimum, factors should not be excluded on the basis of this relatively limited sample.

To identify what type of analysis could be carried out from survey data, data points were first identified from the survey design that could act as potential **dependent variables**, given: (i) the specific areas that DIT is interested in understanding from the research; and (ii) the design of the survey questions (i.e., some question / answer formats would be more suited to econometric analysis than others). Following this, other questions from the survey that could act as **independent variables** (i.e. explanatory factors) were identified. These were based on: (i) factors that one would generally expect, in theory, to affect firms' decision-making; (ii) the findings from the literature review as to which factors appear to be most important in firms' decision-making; and (iii) again, the design of the survey questions. Finally, based on the conclusions from the stages above, recommendations are made as to the best way to specify the models.

6.3.2 Potential research questions

Based on what factors are known to be important to firms' decision-making in relation to trade and exchange rates, as well as what information is available in the survey, the following research questions could be analysed using econometrics:

- What factors determine whether exchange rates play a role in determining firms' pricing and marketing decisions?
- What factors determine the level of pass-through from exchange rate changes to prices?
- What factors explain the invoice currency used by firms?

For each of these research questions, the options for: (i) dependent variables; (ii) independent variables; and (iii) model specifications are outlined.

6.3.3 What factors determine whether exchange rates play a role in determining firms' pricing and marketing decisions?

6.3.3.1 Dependent variable options

For this research question, the most straightforward dependent variable is to use a question with a binary yes/no response to whether firms do or do not consider exchange rates when making business decisions. There are four such questions in the survey: **B1, C9, C20, and D3**; each of which frames the circumstance of an exchange rate change differently.[62] A list of each of the relevant questions in full is provided at the end of section 6.3.

6.3.3.2 Model specification

The dependent variable options for models that explain whether exchange rates play a role in determining firms' pricing decisions are B1, C9, C20, and D3. In each case, the response is a binary 'yes' or 'no' answer. For such cases where the dependent variable can only take one of two values, **logit regressions** can be used.

6.3.3.3 Independent variable options

Based on both (i) factors that might generally be expected to affect firm behaviour, and (ii) the findings from the literature review, the following are the possible explanatory variables (a list of the relevant questions in full is provided at the end of 6.3):

- **Industry**. The degree to which exchange rates affect firms' decision-making may vary by industry. There are a number of reasons for this, for instance, certain industries may be more exposed to international competition and so are more affected by exchange rates. Alternatively, the industry structure – whether firms are price-takers or price-setters – would also have an impact. Question A4 provides data for this. To incorporate this into a model, dummy variables could be included for individual industries.
- **Size**. Similar to the above, a firm's size can be expected to impact its price-setting power. Furthermore, in the literature review, heterogeneity exists between exchange rates and trade across different sizes of firms, and so this could be a relevant explanatory factor. Questions A8 and A9 distinguish firms by size according to employees and turnover, respectively. Because the size

[62] Question C6 may also be considered to fall into this category, however it is not included as it only asks whether firms consider exchange rate movements to be important in business decisions in general. It therefore is less precise and exposes more scope for subjectivity than the other questions.

of firm increases with the response number in this question, this variable could be included with no transformation in a regression.

- **Goods vs services**. Again, from the literature review, there appear to be differences in the sensitivity to exchange rates between goods and services. Question A11 identifies whether a firm trades in goods or services. This would best be controlled for by using a dummy variable, equal to one if a firm trades in services, and zero otherwise (or vice-versa).
- **Invoice currency**. Invoice currency appears to be an important micro-level determinant in the relationship between exchange rates and trade. Therefore, this could be used to show whether certain types of invoice currency mean firms are more sensitive to exchange rates. Questions A20-A23 identify the primary invoice currency used by firms. The effect of invoice currency on the responsiveness to exchange rates could be captured by using a dummy variable.
- **Global value chain participation**. There is some evidence that GVCs dilute the responsiveness of prices to exchange rates; by using an econometric model on survey data this could be tested. In the survey, questions A27, A30, and A31 all deal with firms' participation in GVCs. Question A27 could act as a dummy variable to proxy whether a firm's main traded product is part of a GVC or not, thereby indicating whether participation in GVCs affects firms' responses to exchange rates. Questions A30 and A31 indicate the proportion of costs / revenue subject to exchange rate fluctuations, and so by extension would proxy firms' degrees of involvement in GVCs. Because the proportion of costs / revenue subject to exchange rate fluctuations increases with the response number in this question, this would require no transformation to be used in a regression.
- **Importance of traded goods**. Within the population of internationally trading firms, some would rely more heavily on trade than others. One would expect that those firms for which trade makes up a larger proportion of their business to react differently to exchange rates compared to those who do not trade intensively. Questions A28 and A29 ask what proportion of company sales / expenditure are made up by trade. Because the proportion of trade increases with the response number in this question, this variable could be included with no transformation in a regression.
- **Whether exporters also sell domestically**. If a firm also sells a product domestically, then it is possible that it has less ability to alter its overseas prices in response to exchange rates. Questions A32 and E3 distinguish whether firms also sell their product domestically. In both cases, since the response to the question is binary, it could be included in the regression as a dummy variable.
- **Other restricting factors**. The survey asks – in question E1 – what factors influence their ability to respond to exchange rate movements. By using dummy variables for the responses in this question, one could analyse

whether each factor has a positive or negative (or no) effect on the responsiveness to exchange rates.

6.3.4 What factors determine the level of pass-through from exchange rate changes to prices?

6.3.4.1 Dependent variable options

Questions **B3, C11, C22 and D5** ask respondents to indicate the extent of the price change as compared to the exchange rate movement, which provides some indication of the level of pass-through (those indicating that they did not change prices would have a zero or complete pass-through rate depending on the invoice currency). A list of each of the relevant questions in full is provided at the end of section 6.3. A regression using these responses (i.e. nominal outcome variable as the dependent variable) could test what factors increase the likelihood and scale of pass-through.

It would be possible to specify this variable such that each response corresponds to a certain degree of pass-through, with higher levels of pass-through being assigned a higher value. For example, focussing on question B3, for an exporter who invoices in pounds:

- **Full** pass-through occurs if they did not change their price (i.e. they answer 'No' to question B1), as this means the change in exchange rates would be reflected in the currency of the importing country.
- **Partial** pass-through occurs if they increased their price by a smaller scale than the depreciation, as this would slightly offset the decrease in price in terms of the currency of the importing country.
- **More than full** pass-through occurs if they decreased their price, as the depreciation already means the price is relatively cheaper in the currency of the importing country.
- **No** pass-through occurs if they increased their price by a similar scale to the depreciation, as this would fully offset the decrease in price in terms of the currency of the importing country.
- **Reverse** pass-through occurs if they increased their price by a larger scale than the depreciation, as this would more than fully offset the decrease in price in terms of the currency of the importing country.

It would be crucial to consider whether the respondent is an importer or exporter, and which invoice currency they use, as both these factors would affect which responses correspond to what degree of pass-through. To further account for this asymmetry, as well as any other characteristic differences between importers and

exporters (which could impact model results), it may be appropriate to run models for both types of traders separately.

6.3.4.2 Model specification

In a model that explains the degree of pass-through the dependent variable is non-binary and can take on a defined number of values ranging from 'no pass-through' to 'more than full pass-through'. For categorical variables that can take on more than two possible values, one can use a **multinomial logistic regression**.

6.3.4.3 Independent variable options

The question of what explains the level of pass-through is closely related to the first suggested dependent variable – whether firms account for exchange rates in pricing decisions. Both deal with firms' responses to exchange rate changes, albeit from slightly different perspectives.[63] Therefore, the same factors as outlined in section 6.3.3.3 above would be expected to be relevant in this case as well.

6.3.5 What factors explain the invoice currency used by firms?

6.3.5.1 Dependent variable options

Literature suggests that the invoice currency is an important factor in determining whether exchange rates affect trade prices / volumes. There are two survey questions (one for importers, one for exporters) that ask what invoice currency respondents use for the main product: **A20 and A22** (each of these questions in full is provided at the end of section 6.3). This distinguishes whether respondents primarily use: (i) pounds; (ii) US dollars; or (iii) the local currency of the countries they trade with.

6.3.5.2 Model specification

The suggested dependent variables for analysing firms' choices of invoice currency (A20 and A22) have three possible responses (if one ignores the 'other' text

[63] The link between whether a respondent does or does not factor exchange rates into its pricing decisions and the degree of exchange rate pass-through is not direct. For example, if an importer states that exchange rates do affect its pricing decisions, this might indicate that there is exchange rate pass-through. By contrast, if an exporter gave the same response, this might indicate that there is no pass-through.

response). Therefore, as above, for econometric analyses of this sort it would be appropriate to use a **multinomial logistic regression**.

6.3.5.3 Independent variable options

Based on both (i) factors that might generally be expected to affect firm behaviour, and (ii) findings from the literature review, the following provide possible explanatory variables (a list of each of the relevant questions in full is provided at the end of section 6.3):

- **Industry**. Certain industries may have established currencies used for trading. Question A4 distinguishes which industry each firm operates in. To incorporate this into a model, dummy variables could be included for individual industries.
- **Size**. A firm's size may impact its ability to choose an invoice currency. Questions A8 and A9 distinguish firms by size according to employees and turnover, respectively. Because the size of firm increases with the response number in this question, this variable would require no transformation for use in a regression.
- **Goods vs services**. From the literature review, there appear to be differences in the sensitivity to exchange rates between goods and services; the same may be true for the choice of invoice currency. Question A11 identifies whether a firm trades in goods or services. This would best be controlled for by using a dummy variable, equal to one if a firm trades in services, and zero otherwise (or vice-versa).
- **Global value chain participation**. It might be expected that firms involved in GVCs are more likely to use vehicle currencies. In the survey, questions A27, A30, and A31 all deal with firms' participation in GVCs. Question A27 could act as a dummy variable to proxy whether a firm's main traded product is part of a GVC or not, thereby indicating whether participation in GVCs affects firms' choice of invoice currency. Questions A30 and A31 indicate the proportion of costs / revenue subject to exchange rate fluctuations, and so by extension would proxy firms' degrees of involvement in GVCs. Because the proportion of costs / revenue subject to exchange rate fluctuations increases with the response number in this question, this variable would require no transformation to be used in a regression.
- **Whether exporters also sell domestically**. If a firm also sells a product domestically, then it is perhaps more likely that it also sells it overseas in the same (domestic) currency, either for administrative or contractual purposes. Questions A32 and E3 distinguish whether firms also sell their product domestically. In both cases, since the response to the question is binary, it could be included in the regression as a dummy variable.

- **Destination**. The country that a firm is selling to or buying from would be expected to affect the invoice currency used. Questions A24 and A25 in the survey deal with the destination of trade. A complication with this question is that the responses are taken as text, rather than from a defined list of multiple answers. Therefore, its direct applicability to econometric analysis may be limited. One possible method of incorporating the trade destination into a regression may be to create dummy indicators to represent different regions of trade. For example, a dummy variable could be created to represent firms that state they primarily trade with Eurozone countries, the US, or any other international region.

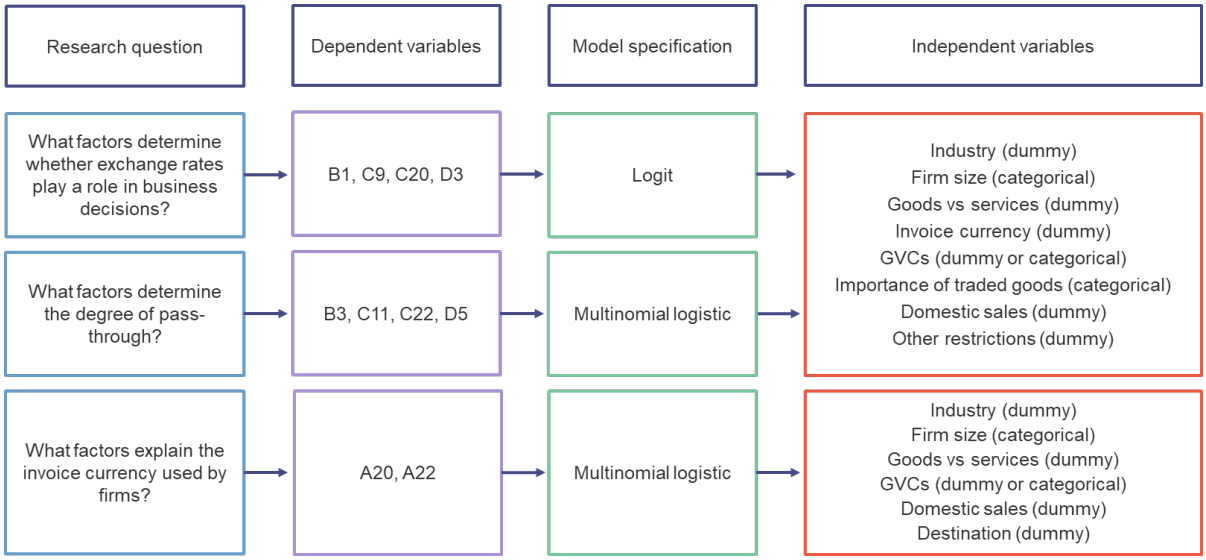
The diagram overleaf summarises the options for econometric modelling based on the survey. For reference, the questions suggested as dependent and independent variables in this section are outlined in full below:

- Factors that determine whether exchange rates play a role in business decisions (dependent variables):
    - **B1**: “In March 2020, following the outbreak of COVID-19, the pound depreciated against other currencies. In response to this, did you or your international trade partners actively change pricing decisions (as per you main invoice currency) for the main good/service your business internationally trades?”
    - **C9**: “In 2019, the pound depreciated from April 2019 to August 2019. In response to this, did you or your international trade partners actively change pricing decisions (as per your main invoice currency) for the main good/service your business internationally trades?”
    - **C20**: “In 2019, the pound appreciated from August 2019 to December 2019. In response to this, did you or your international trade partners actively change pricing decisions (as per your main invoice currency) for the main good/service your business internationally trades?”
    - **D3**: “In June 2016, the pound depreciated against other currencies. In response to this, did you or your international trade partners actively change pricing decisions (as per your main invoice currency) for the main good/service your business internationally trades?”
- Factors that determine the level of pass-through from exchange rate changes to prices (dependent variables):
    - **B3**: “If yes [to B1], how did pricing for your main traded good/service (as per your main invoice currency), actively change?”
    - **C11**: “If yes [to C9], how did pricing for your main traded good/service (as per your main invoice currency) actively change?”
    - **C22**: “If yes [to C20], how did pricing actively change?”
    - **D5**: “If yes [to D3], how?”

- Factors that explain the invoice currency used by firms:
    - **A20**: “What is the invoicing currency of the majority of your exported goods/services?”
    - **A22**: “What is the invoicing currency of the majority of your imported goods/services?”
- Independent variables:
    - **A4**: “Prior to January 1st, 2020, which sectors did your organisation mainly operate in?”
    - **A8**: “Prior to January 1st, 2020, what is the size of your business, by number of employees?”
    - **A9**: “Prior to January 1st, 2020, what is the size of your business, by annual turnover?”
    - **A11**: “Prior to January 1st, 2020, did your business internationally trade in: (i) Goods, (ii) Services, or (iii) Both?”
    - **A20**: “What is the invoicing currency of the majority of your exported goods/services?”
    - **A21**: “What is the invoicing currency of the main good/service that your business exports?”
    - **A22**: “What is the invoicing currency of the majority of your imported goods/services?”
    - **A23**: “What is the invoicing currency of the main good/service that your business imports?”
    - **A24**: “Prior to January 1st 2020, which country was the main destination for the majority of your exports?”
    - **A25**: “Prior to January 1st 2020, from which country did the majority of your imports originate?”
    - **A27**: “Considering your main internationally traded good/service and the situation prior to January 1st 2020, which of the following best describes the supply chain: (i) Mostly domestic, or (ii) International network with stages of supply chain located across different countries?”
    - **A28**: “Prior to January 1st 2020, on average, what proportion of your business sales, in terms of value, were exported?”
    - **A29**: “Prior to January 1st 2020, on average, what proportion of your business expenditure was on imports?”
    - **A30**: “Prior to January 1st 2020, on average, what proportion of your costs of production were subject to exchange rate fluctuations?”

- **A31**: “Prior to January 1st 2020, on average, what proportion of your revenue was subject to exchange rate fluctuations?”
- **A32**: “Prior to January 1st 2020, did you also sell your main internationally traded product/service domestically?”
- **E1**: “What factors influence your ability to respond to exchange rate movements?”
- **E3**: “Are prices of the goods/services you sell: (i) Determined *separately* for domestic and international sales, or (ii) Determined *together* for domestic and international sales?”

Figure 40: Roadmap of modelling options from survey



7. Conclusions

This report details the methods and findings on research regarding the relationship between exchange rates and trade. The approach combined different research methods, namely: (i) a literature review of 185 articles; (ii) a survey of 124 UK businesses; and (iii) in-depth case studies with five UK trade bodies. Assessing the sum of evidence gathered from each of these elements, three main conclusions emerge. Each of these emphasises the importance of micro-level transmission of exchange rate fluctuations through to international trade and suggest less focus on macro-level theories.

1. **Micro-level theories and the obstacles firms face in adjusting to exchange rate movements appear to be key to understanding the impact of exchange rates on international trade volumes**. In contrast, macro-level theories appear to perform poorly in explaining the role of exchange rates on international trade, except in the long-run. Therefore, the balance of empirical evidence suggests there should be a greater focus on micro-level theories and evidence, rather than the macro-level, at least in looking at short- to medium-term dynamics. It is possible that the mixed evidence for relationships at an aggregate-level may reflect: (i) fundamental difficulties in empirically testing macro-level theories; and (ii) a general disconnection between exchange rates and trade in the short- to medium-term. However, the micro-level evidence appears to explain a substantial part of the absence of a macro-level link and produces consistent findings across the different research elements. Therefore, the most robust platform on which to base policy decisions and practical assistance seems to be one that places greater emphasis on micro-level factors and gives less weight to the macro-level.
2. **Among these micro-level considerations, the invoice currency (i.e. the currency chosen for trade contracts) seems to be the most important factor in determining the response to exchange rate fluctuations**. Specifically, businesses tend to keep the price fixed in terms of the invoice currency (for reasons such as being tied to contracts, or perceptions that fluctuations are not significant enough to warrant a price change), meaning businesses either pass-through all or none of an exchange rate fluctuation, depending on the invoice currency. Both the literature review and business survey highlighted invoice currency as important in determining the reaction to exchange rate fluctuations. In the survey, although based on a small sample, the reaction to exchange rate fluctuations seemed to be driven entirely by the invoice currency. Where other factors were reported to explain variation in business response, this seems to be because they lead to differences in the composition of invoice currency. Therefore, when analysing the impact of an exchange rate movement, it would be appropriate to review responses at the industry-level, and factor in invoice currency choices, which themselves may differ based on sector, product heterogeneity, firm size, and other factors.

3. **Other micro-level factors are likely to be important also, but across the various strands of research there was less consistent evidence of their impact on trade**:

    i. The growth of *global value chains* and firms' positions within those was emphasised in the literature and was highlighted in the case study interviews. However, this was not a major factor in the survey responses.

    ii. *Heterogeneity* across firms and industries was emphasised in the literature review and case studies but received less prominence in the survey responses.

    iii. The length and restrictiveness of *contracts* was also noted, especially in the case studies, and to a lesser extent the survey and literature review.

    iv. Exchange rate *expectations* and *volatility* were acknowledged by respondents in the survey and case studies, but due to difficulties in measuring these there is limited evidence from the literature. Additionally, during the case studies it was noted that while expectations play a role, many firms would lack the resources to reliably anticipate exchange rate fluctuations so would look to *hedge* rather than rely on expected movements in exchange rates.

Future research on this topic should focus on the following main areas, to further understanding and test the wider validity of the research findings:

- This report highlights the importance of micro-level factors and the potential heterogeneity across firms and industries in terms of the trade response to exchange rate fluctuations. Understanding sector- and firm-level characteristics that drive differences in the response to exchange rates would be a sensible next step for research in this area. For instance, deeper understanding of the invoice currencies used and the degree of global value chain involvement across different industries would help in estimating the overall impact of exchange rate fluctuations.

- The research presented mixed evidence on the role of expectations, but firms indicated that these are a consideration, especially when determining hedging strategies. Micro-level analyses of the role of expectations, specifically how important expectations are relative to other factors, and how different firms account for them, would be a valuable extension to the research.

- The fieldwork that formed a major part of the research into micro-level issues is a good starting point to understanding the key issues governing the relationship between exchange rates and trade in the UK. However, both the case study and, to a lesser extent, the survey provided less insight for the service industry. This is in part due to the greater proportion of trade associations that represent manufacturing as compared to services and the desire to get a broad range of views in the initial survey. Nonetheless, given

the importance of the service sector to the UK, it would be appropriate to conduct fieldwork solely on the service industry in the next stages of research.

- Related to the above, conducting a similar survey to the one in this research but on an expanded sample would be beneficial. The survey and its results were helpful in identifying initial findings and demonstrating the feasibility of such research. However, the sample was small and statistical inference is limited for this reason. Therefore, it would be useful to expand this to a larger sample that would enable more definitive conclusions on the issues discussed in this report, as well as potential future research outlined above.

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Department for International Trade

Analysis

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