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Brexit and investment

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Abstract

In 2016, the UK voted to leave the European Union and growth in UK manufacturing investment ground to a halt. This paper uses administrative trade data to investigate the causal relationship between these events. We exploit firm-level customs data from 2005 on-wards to quantify firms' exposure to EU and non-EU trade in inputs and outputs. Focusing on investment as a forward-looking, dynamic outcome (since the UK did not leave the EU until 2021), we relate firms' investment to their pre-referendum EU exposure. This analysis shows firms' exposure to EU trade had a negative impact on investments post-referendum, especially in 2021. Estimated impacts are stronger for import exposure than for export exposure and there is some evidence of depressed investment from exposure to non-EU imports, likely due to the large depreciation in sterling that followed the vote. Had the UK voted to remain in the EU, these estimates imply manufacturing investment would have been over 7% higher, about £2.4 billion annually between 2016 and 2021.

Data Disclaimer: this work was produced using statistical data from the UK Office for National Statistics ("ONS"). The use of ONS data does not imply the endorsement of the ONS in relation to its interpretation or analysis. Analysis using ONS research datasets may not exactly reproduce ONS aggregates and was carried out in the Secure Research Service, part of the Office for National Statistics.

Keywords: firm level, investment, international trade, European Union, manufacturing
JEL: D22; D25; F14; F55; L60

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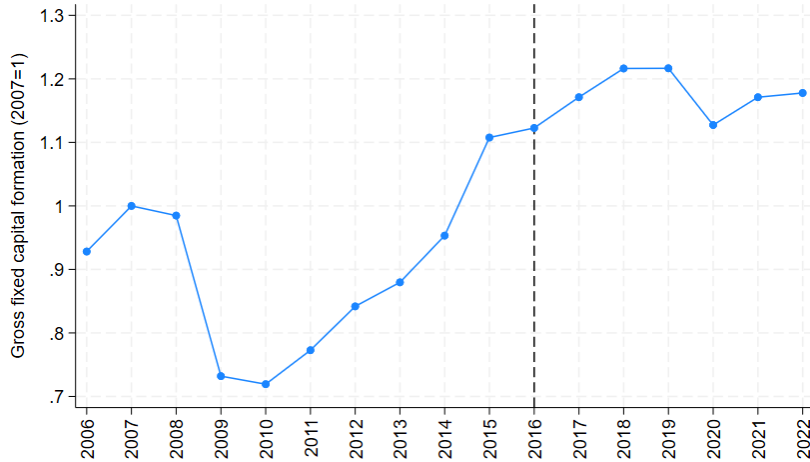
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1 Introduction

On June 23 2016, the United Kingdom (UK) voted to leave the European Union (EU), its largest trading partner. Investment in the UK manufacturing sector started to slow around the time of the vote after accelerating strongly for several years (see Figure 1). This is of great concern to policymakers as UK business investment as a share of GDP was already low by international standards and such deceleration contributed to slowing productivity growth (Brandily et al. 2023). Brexit - that is, the UK's departure from the political structures of the EU and introduction of its replacement legislation - did not formally occur until 2021, suggesting the impact of the vote was more likely to impact on forward looking decisions subject to substantial adjustment costs, rather than variable inputs which primarily respond to immediate market conditions. Investment decisions today determine future capital stock and are therefore sensitive to firms' expectations about and uncertainty over the future (Nick Bloom et al. 2007). It is therefore plausible the Brexit vote caused investment growth to slow but, to date, no empirical research has had access to firm-level administrative data on trade and investment to examine whether this is really the case.

Figure 1: UK Manufacturing Gross Fixed Capital Formation



Note: figure shows total chained-volume measure gross fixed capital formation indexed to 1 in 2007. The series is restricted to the manufacturing sector, defined as Standard Industrial Classification codes in divisions 10-33. Dashed line indicates 2016, the year of the Brexit referendum.

Source: authors' calculations using ONS 'Annual gross fixed capital formation by industry and asset' series.

In this paper we use administrative trade data to ask whether the Brexit result and the UK's subsequent departure from the EU caused investment to slow. While existing work has used similar trade data to look at changes in the UK's trading patterns following the referendum, we are the first to leverage a linked version that enables us to match firms' trade patterns with investment data, thereby obtaining a powerful resource to estimate the effects of the Brexit referendum on firm performance. We use this linked data to quantify firms' exposure to trade with EU and non-EU countries in the pre-referendum period, both as a source of inputs and a market for output, and then relate these exposure measures to firms' subsequent investment. Our baseline approach constructs firm-level trade exposure measures from 2005-2012 to analyse outcomes

in 2013-15 for “announcement effects” (a pre-referendum period) in 2016-2020 (immediately after the Brexit vote) and in 2021 (when Brexit actually happened).¹

The largely unanticipated Brexit referendum announcement in 2013 and subsequent result allow us to identify the causal effect of Brexit on investment by relating within-firm differences in investment over time to the across-firm variation in firms’ trade exposure. We find that manufacturing firms who were more reliant on imported inputs from the EU invested less after the referendum vote than other firms, with firms’ reliance on imported inputs from non-EU countries also having a significant negative effect on investment between 2016 and 2020. We also observe negative effects from firms who are more exposed to EU (and non-EU) export markets, but these are somewhat noisier. Overall, our estimates imply manufacturing investment would have been 7% higher had the UK electorate voted to remain in the EU, equivalent to around an extra £2.4 billion per year between 2016 and 2021.

Our findings contribute to several literatures. First, our context provides a novel contribution to work on the determinants of investment. A key finding of this literature is that uncertainty over future outcomes reduces investment, which has been shown both theoretically (Nick Bloom et al. 2007), and empirically (Gennaioli et al. 2015). Viewing Brexit as an uncertainty shock, particularly with respect to the UK’s future trade policy, our results reiterate this finding and closely parallel those of Caldara et al. (2020), who show increased US trade policy uncertainty in 2018 caused a reduction in US business investment.

We also contribute to a body of work that examines the economic consequences of Brexit. This research has estimated the Brexit result slowed UK GDP growth due to the price and labour market consequences of sterling depreciation (Breinlich et al. 2021; Costa et al. 2019), reduced job posting (Javorcik et al. 2023), and lower business investment (Nicholas Bloom et al. 2019; Hassan et al. 2020).² While both Nicholas Bloom et al. (2019) and Hassan et al. (2020) examine the impact of Brexit on business investment and find negative effects, our work extends their analysis in a number of ways. First, we can observe investment in 2021 after Brexit actually happened whereas prior papers use pre-Brexit outcomes. Second, while Nicholas Bloom et al. (2019) rely on firms’ self-reported reliance on EU trade, we leverage administrative data to obtain more accurate measures of firms’ trading patterns. This data also allows us to look at a representative sample of the UK’s manufacturing sector, unlike Hassan et al. (2020) who analyse publicly-listed firms. Importantly, and unlike both papers, we also account for the fact that the UK’s global trade policy became increasingly uncertain after the Brexit vote, suggesting that firms reliant on trade with non-EU countries may also have been subject to heightened uncertainty after Brexit. Indeed, we find that firms’ reliance on imported inputs from non-EU countries depressed investment between 2016 and 2020.

The remainder of this paper is as follows. Section 2 provides a brief timeline of key events in the Brexit process. Section 3 describes the data we use to estimate the impacts of Brexit on investment. Section 4.2 explains our estimation methodology, presents our main results and

1. We have to observe a firm for at least one year between 2005-2012 to be in our sample, so we cannot look at the effects on entry, which would likely make the negative impact even stronger.

2. A summary of the literature on the economic impacts of Brexit prior to the implementation of the Trade and Cooperation Agreement (TCA) is provided by Dhingra and Sampson (2022). We discuss the magnitudes of our implied aggregate effects below, finding them similar to those using a more macro approach such as Haskel and Martin (2023) and Springford (2022).

discusses a number of robustness exercises while Section 5 concludes.

2 Timeline

On January 23, 2013, British Prime Minister David Cameron made a speech that many regard as the start of the Brexit process. Cameron promised that should his Conservative Party win the forthcoming general election he would renegotiate the UK's relationship with the EU and then give the British people the choice to stay in the EU under these new terms or leave the EU altogether. While euroscepticism among certain politicians pre-dated (and likely precipitated), Cameron's announcement, the speech was the first political act to raise serious doubt over the UK's future relationship with the EU. Following the Conservative Party's electoral victory in May 2015, Cameron embarked on EU negotiations achieving new terms for the UK's EU membership that were widely portrayed as a compromise and were subsequently voted on by the UK public in the Brexit referendum on June 23, 2016. The UK voted to reject the new terms and leave the EU by a margin of 51.9% to 48.1%, which was a result that was unanticipated by many.

For the next four years, UK politics were dominated by debates over the terms of Brexit. The EU maintained that the freedoms of the single market were indivisible, meaning the UK could not enjoy frictionless trade without accepting free movement of people. Under the leadership of Prime Minister Theresa May, the UK government opted to prioritize immigration control and disengage from the jurisdiction of the European Court of Justice, despite attempting to preserve a close trade relationship. However, May's position weakened after losing her parliamentary majority in a June 2017 snap election, and her negotiated withdrawal agreement was rejected three times by Parliament in early 2019. This rejection led to a postponed Brexit date and May's subsequent resignation.

May was succeeded by Boris Johnson, a proponent of the Leave campaign, who renegotiated the withdrawal agreement. Johnson's election victory in December 2019 under the "Get Brexit Done" slogan enabled him to pass this new agreement. The UK officially left the EU on 31 January 2020, three and a half years after the referendum. The agreement included a financial settlement and protections for citizens but left post-Brexit trade terms undefined, initiating a transition period through the end of 2020 during which the UK remained in the single market and customs union to negotiate the future relationship. This period was not extended despite the COVID-19 pandemic striking Europe in early 2020.

The UK government aimed to secure as much access to EU markets as possible while retaining autonomy over its immigration, trade, and economic policies, necessitating an exit from the single market and customs union but allowing for the possibility of a free trade agreement. The EU offered a deal with zero tariffs, zero quotas, and zero dumping, conditional on adherence to level-playing-field measures to prevent unfair competitive advantages. The negotiations for the future relationship remained uncertain throughout 2020. Without a deal, UK-EU trade would have defaulted to World Trade Organization terms with most-favored nation tariffs. However, a deal was finalized on Christmas Eve 2020 and provisionally implemented on January 1, 2021.

3 Data

The intuition behind the empirical method outlined in section 4.1 is that the impact of Brexit on investment will be greater for firms that are more reliant on the EU. If it is possible to clearly demarcate the year after which Brexit started to affect firms, data from earlier years can be used to quantify firms' EU reliance and the impact of Brexit can be estimated by relating changes in the relative performance of firms in later years to their pre-period EU reliance. While there are many ways one could characterise EU reliance, we focus on reliance due to trade and implement this intuition by combining administrative goods trade data from the UK's tax authority with survey data on firms' inputs and outputs.³

Data on imports and exports of goods comes from the linked Trade in Goods/IDBR (TIG-IDBR) dataset, which is available from 2005 onwards and constructed from trade declarations submitted to the UK tax authority (Office for National Statistics and HM Revenue and Customs 2022). While the data has universal coverage of non-EU goods trade, trade with EU member countries before the UK formally left the EU in 2020 only had to be reported if the annual value of flows was above a certain threshold. These thresholds were specified in line with Intrastat, the EU-wide system of monitoring goods trade, and were set at £225k for both imports and exports in 2005. From 2010 separate thresholds for each trade flow were introduced and in 2012 (the last year of trade data used in our main analysis), they were £600k for imports and £250k for exports. This means the coverage of exports to the EU will be more comprehensive than the coverage of imports from the EU in later years. Whereas the administrative trade flow data is reported at the enterprise-level, most UK business data is reported at the 'reporting units' and so the TIG-IDBR data apportiones enterprise-level totals to constituent reporting units according to employment shares.

While the TIG-IDBR data provides a near-universal information on goods trade, the only source of data on UK services trade is the International Trade in Services (ITIS) survey. As a survey, the ITIS data is far less comprehensive than the TIG-IDBR data both across firms and over time. Incorporating services trade into our analysis would therefore introduce a substantial degree of measurement error since we would not observe information on services trade for all firms and for firms sampled by the ITIS there is a risk the year in which they were sampled is not representative of their average trade behaviour over a longer period. For these reasons, we do not consider services trade in our analysis and restrict our analysis sample to manufacturing firms as imports and exports of goods account for the vast majority of trade undertaken by the sector.

We match the TIG-IDBR data with the Annual Business Survey (ABS), which is the UK's primary source of administrative data on firm performance (Office for National Statistics 2024). The ABS collects data on inputs, output and investment for a representative sample of private sector firms in the UK's economy, excluding the financial and agricultural sectors. Firms with 250 or more employees are surveyed every year while firms below this threshold are selected using a stratified sampling design with strata defined according to employment size band, industry and

3. An alternative would be to characterise firms' EU dependence using the share of their workforce who are citizens of EU member states. We do not pursue this because of a lack of data on the nationality of firms' workforces.

geographical region. Firms that are selected under the stratified sampling method are surveyed for two consecutive years, after which they are unlikely to be re-selected for at least two years.

The key variable in our analysis is firms' exposure to EU trade in the 'pre-period' before David Cameron's referendum announcement in 2013. Whereas Brexit introduced trade policy uncertainty over both imports and exports, the consequences of this uncertainty are likely to differ between firms that are relatively reliant on the EU as a source of inputs and those that are relatively reliant on the EU as a market for output. This is because the consequences of trade policy changes depend on the ease with which firms can switch suppliers in the former case and the ease with which they can transition from supplying foreign to domestic markets in the latter, and there is little reason to think these margins of adjustment are symmetric. Furthermore, exchange rate movements will affect import- and export-reliant firms differently with a depreciation of sterling having a negative impact on importers via an increase in input costs and a positive impact on exporters as their products become more cost-competitive in foreign markets. We therefore construct two separate measures of EU trade exposure to allow the impact of Brexit to differ according to firms' EU import reliance and export reliance.

We define a firm's EU import exposure as the share of the firm's intermediate goods inputs that are sourced from the EU:

$$EU_i^M = \frac{1}{N_i^{PRE}} \sum_{t \in PRE} \frac{M_{it}^{EU}}{C_{it}}, \quad (1)$$

where PRE is the set of pre-period years (2005-2012 inclusive for our main analysis), M^{EU} are goods imports from EU countries, C are goods inputs, N^{PRE} is the number of pre-period years a firm is observed in the ABS and all other notation is as before.

Firms' exposure to exports to the EU is similarly defined as the pre-period average of EU goods exports as a share of turnover:

$$EU_i^X = \frac{1}{N_i^{PRE}} \sum_{t \in PRE} \frac{X_{it}^{EU}}{Y_{it}}, \quad (2)$$

where X^{EU} are goods exports to EU countries, Y is turnover and all other notation is as before. We henceforth refer to EU_i^M and EU_i^X as EU import reliance and EU export reliance respectively. Since Brexit also raised uncertainty over the UK's and define measures of non-EU import and export reliance, NEU_i^M and NEU_i^X , analogously using imports/exports to non-EU countries.

EU import and export reliance is only defined for firms observed at least once in the ABS in the 2005-2012 pre-period. Our analysis sample is therefore restricted to manufacturing firms that fit this criterion. Table 1 summarises the characteristics of this analysis sample, both overall and according to EU import reliance. The first column shows the mean EU import reliance among all firms in our analysis sample is 0.09, which indicates the average manufacturing firm in the 2005-2012 period imported 9% of their goods inputs from EU countries. Mean non-EU import reliance is similar at 0.08, while firms on average obtained 4% of their turnover from exports to EU countries and another 4% from exports non-EU countries.

Columns 3-8 of Table 1 stratify firms according to their EU import reliance. Columns 3 and

4 show characteristics of firms with zero import reliance, columns 5 and 6 show characteristics of firms with import reliance that is non-zero but in the lower half of the non-zero import reliance distribution and columns 7 and 8 show characteristics of firms with import reliance in the upper half of the non-zero import reliance distribution. The information in these columns reveal four main points. First, EU import reliance is highly skewed with almost 40% of the sample not importing any goods from the EU while the average above-median importer sourcing 24% of their inputs from the EU. Second, firms that are more reliant on EU imports are also relatively reliant on imports from non-EU countries, which is shown by the increase in mean NEU import reliance across columns from 0% among firms without any imports from the EU to 21% among firms in the top half of the non-zero EU import reliance distribution. Third, there is a positive correlation between import reliance and export reliance, which is shown by the increase in the mean EU and NEU export reliance measures across columns. Fourth, firms that are more reliant on EU imports are larger in terms of input, output and investment: the average firm without any EU imports employed 41 workers whereas the average firm with relatively high EU import reliance employed 344.

Table 2 shows the equivalent information as Table 1, stratifying firms according to EU export reliance. As with EU import reliance this shows EU export reliance is highly skewed, although to a lesser extent than import reliance with a mean of 11% among firms in the top-half of the non-zero distribution. EU export reliance is positively correlated with non-EU export reliance and with both EU and non-EU import reliance. EU export reliance is also positively related to firm size, although differences in firm size between firms that export nothing to the EU and firms that are relatively more and less reliant on EU exports are smaller than the equivalent differences according to EU import reliance.

Table 1: Sample Characteristics by EU Import Reliance

	All		$EU_i^M = 0$		$EU_i^M > 0$ Q1		$EU_i^M > 0$ Q2	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
EU Import Reliance	0.09	0.17	0.00	0.00	0.03	0.04	0.24	0.21
EU Export Reliance	0.04	0.07	0.00	0.02	0.04	0.06	0.08	0.09
NEU Import Reliance	0.08	0.17	0.00	0.00	0.03	0.04	0.21	0.24
NEU Export Reliance	0.04	0.07	0.01	0.03	0.04	0.07	0.07	0.09
Capex	1267	8280	212	7493	1326	4722	2429	10810
Turnover	48675	299624	4312	23786	64705	400920	86746	362851
Emp.	198	685	41	180	240	622	344	991
Materials	28817	227953	1966	17023	40068	323704	50604	260280
N	74429		28983		20114		25332	

Note: sample sizes pertain to the number of firms with materials observed. Samples for other characteristics are slightly higher.

Table 2: Sample Characteristics by EU Export Reliance

	All		$EU_i^X = 0$		$EU_i^X > 0$ Q1		$EU_i^X > 0$ Q2	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
EU Import Reliance	0.09	0.17	0.02	0.08	0.10	0.17	0.17	0.20
EU Export Reliance	0.04	0.07	0.00	0.00	0.01	0.01	0.11	0.09
NEU Import Reliance	0.08	0.17	0.02	0.09	0.09	0.18	0.15	0.21
NEU Export Reliance	0.04	0.07	0.00	0.00	0.01	0.01	0.10	0.09
Capex	1267	8280	245	7311	1806	7618	2056	9656
Turnover	48675	299624	6159	27174	79242	400892	74757	367611
Emp.	198	685	54	217	309	1040	279	658
Materials	28817	227953	3028	19329	48687	318834	43562	268292
N	74429		29626		20172		24631	

Note: same as note to Table 1.

4 Estimating the impact of Brexit on investment

4.1 Methodology

To identify the causal effect of the Brexit referendum on firm outcomes, we assume that David Cameron’s 2013 announcement was unanticipated. Assuming the UK’s departure from the EU was not regarded a serious consideration in earlier years, firms’ actions prior to 2013 are therefore unaffected by Brexit and can hence be used to quantify firms’ differential reliance on the EU and other countries as a source of inputs and a market for output. Using these exogenous measures of trade exposure, we can compare the performance of more- and less-exposed firms in subsequent years and attribute any differences to the impact of Brexit. Specifically, we test for the presence of Brexit effects using variants of the following specification:

$$\begin{aligned}
I_{it} = \exp(&D[2013 \leq t \leq 2015] * (\beta_{13-15}^{EU} EU_i + \beta_{13-15}^X X_i) \\
&D[2016 \leq t \leq 2020] * (\beta_{16-20}^{EU} EU_i + \beta_{16-20}^X X_i) + \\
&D[t = 2021] * (\beta_{21}^{EU} EU_i + \beta_{21}^X X_i) + \iota_i + \tau_t + \epsilon_{it}),
\end{aligned} \tag{3}$$

where I_{it} denotes investment of firm i in year t , ι is a firm fixed effect, τ is a full set of year-form type fixed effects and EU_i is a firm’s pre-period exposure to EU imports or exports as defined in Section 3.⁴ We interact firms’ EU exposure with three period dummies, denoted by the D functions, which allow the effect of EU exposure to differ between three periods: 2013 to 2015, 2016 to 2020 and 2021.⁵ X is a vector that contains firms’ average size over the same pre-2013 period and interacted with the same period dummies as EU_i (in order to allow the impact of firm size on investment to vary over time). As our sample period uses data between

4. We include year-form type fixed effects to account for changes in the notes to the ABS questionnaire that were implemented at different times in the ‘short’ and ‘long’ forms of the survey which we find to have a substantive impact on reporting zero investment. Further details are available from the authors on request.

5. We focus on results using these three periods for parsimony but also discuss results that allow for yearly variation in the impact of EU exposure. The impact of EU exposure on firm investment prior to 2013 is absorbed by the firm fixed effect since our measures of firm exposure to the EU are constant within firms over time.

2005 and 2021, any impact of the fixed firm characteristics EU and X over the 2005-2012 period is subsumed within the firm fixed effect ι_i .

As well as raising considerable uncertainty over the UK's future relationship with the EU, Brexit raised uncertainty over the UK's global trade policy. To account for Brexit effects that operated via this channel we also estimate an extension of equation 3, which controls for time-varying effects of firms' non-EU trade exposure as well as EU trade exposure

$$\begin{aligned} I_{it} = & \exp(D[2013 \leq t \leq 2015] * (\beta_{13-15}^{EU} EU_i + \beta_{13-15}^{NEU} NEU_i + \beta_{13-15}^X X_i) \\ & + D[2016 \leq t \leq 2020] * (\beta_{16-20}^{EU} EU_i + \beta_{16-20}^{NEU} NEU_i + \beta_{16-20}^X X_i) \\ & + D[t = 2021] * (\beta_{21}^{EU} EU_i + \beta_{21}^{NEU} NEU_i + \beta_{21}^{EU} X_i) + \iota_i + \tau_t + \epsilon_{it}), \end{aligned} \quad (4)$$

where NEU_i is firms' pre-period reliance on trade with non-EU countries and all other notation is as before.

Firms' investment is highly dispersed, but cannot be expressed in logarithms due to the well-known high frequencies of zeros (suggestive of fixed and sunk costs of adjustment). Dropping all the zero investment observations would be a highly non-random sample selection and we therefore estimate equations (3) and (4) using pseudo-poisson maximum likelihood Silva and Tenreyro (2006). The coefficients estimates can be approximately interpreted as the percentage change in the outcome variable for a one-unit change in the corresponding regressor. Due to the inclusion of fixed effects, the β^{EU} parameters in equations 3 and 4 indicate whether firms more exposed to the EU invested less compared to their 2005-2013 average in years after Brexit was announced than less-exposed firms.

The interpretation of the β^{EU} and β^{NEU} coefficients as the *causal* effect of Brexit requires two key assumptions. The first, as stated above, is that Brexit was unanticipated by firms before 2013. Under this assumption, firm behaviour prior to 2013 is unaffected by Brexit and one can therefore define a measure of firm-level Brexit exposure using data from the earlier period. If this was not the case, our measures of exposure would themselves be effected by Brexit and thus comparing the outcomes of more- and less-exposed firms would fail to identify the causal impact of Brexit. Given that Cameron's 2013 announcement was unexpected, that he was in a coalition and an election was scheduled for 2015, we find this reasonable. In addition, we do not find much systematic change in the 2013-2015 period.

Second, we assume that changes in the association between investment and EU and NEU reliance from 2013 onward are due to Brexit rather than to some correlated event. While we cannot test this formally, the relative magnitude of the β_{13-15}^{EU} coefficient to the β_{16-20}^{EU} and β_{21}^{EU} coefficients can help give confidence to this assumption as one would expect the impact of Brexit to become more pronounced after the referendum result.

4.2 Results

Table 3 contains the pseudo-poisson maximum likelihood estimates of the β^{EU} and β^{NEU} coefficients of equations (3) and (4). Columns (1) and (2) show the estimates obtained when exposure to the EU and rest of world (NEU) are defined using imports, while columns (3) and

(4) use export exposure. Column (1) shows firms with greater EU import exposure invested significantly less than other firms between 2016 and 2020 (17 log points), with the significant negative effect increasing after Brexit came into effect in 2021 (21 log points). In contrast, in the 2013-15 pre-referendum announcement period, the exposure coefficient is insignificant. These magnitudes are economically meaningful. Comparing a firm which sourced all its inputs from the EU to one which sourced inputs domestically, we would predict a 36% fall in investment in 2021 according to column (1).⁶

Column (2) of Table 3 includes non-EU import exposure. The effects of EU import reliance are largely unchanged, and as with EU import exposure, there is no pre-referendum effect for non-EU export exposed firms. However, there is a significant and negative coefficient for non-EU import reliance in the 2016-2020 period. There are two effects at play here. The primary reason is the fact sterling crashed by about 16% following the vote, which made all imports more expensive. Secondly, because global supply chains are complex, increases in costs in any part of the chain can reverberate on trade across multiple countries.⁷

Columns (3) and (4) of Table 3 show the impacts of EU export reliance are less precise and robust than those of import reliance. The pattern of coefficients in column (3) is similar to those in column (1), with the largest one in absolute magnitude in 2021 (-0.66), smallest in the pre-referendum period (-0.27) and middling in the 2016-20 period (-0.303). Only the 2016-2020 coefficient is significant, however. Column (4) has no significant effects post-referendum and a puzzling pre-referendum pattern (e.g. a significant *positive* effect of non-EU export dependence 2013-15).⁸

6. $[\exp(0.307) - 1] \times 100$.

7. Figure 2 in Appendix A shows the non-EU reliance effect was most negative in 2019 and 2020, suggesting it may be partly due to the heightened risk the UK would default to WTO trading terms in these years.

8. Table 6 in Appendix A repeats the analysis of columns (2) and (4) of Table 3, replacing the firm-specific reliance measures with average reliance within each firms' industry. These results indicate whether the impacts shown in Table 3 are primarily due to differences in investment across-industries rather than within-industries. This suggests industries with greater import and export reliance saw significantly lower investment relative to their pre-Brexit average in 2021 but not in 2013-2015 or 2016-2021. This highlights the Brexit effects we estimate would not be observed using publicly-available industry aggregates, which emphasises the value of the firm-level micro-data used in our work.

Table 3: Impact of Trade Exposure on Investment

	Import Reliance		Export Reliance	
	(1)	(2)	(3)	(4)
(EU Reliance)*(13-15)	-0.113 (0.111)	-0.114 (0.111)	-0.27 (0.262)	-0.580** (0.32)
(EU Reliance)*(16-20)	-0.169* (0.109)	-0.165* (0.108)	-0.432* (0.299)	-0.199 (0.344)
(EU Reliance)*(21)	-0.307* (0.189)	-0.303* (0.188)	-0.655 (0.537)	-0.446 (0.524)
(NEU Reliance)*(13-15)		0.014 (0.109)		0.664* (0.351)
(NEU Reliance)*(16-20)		-0.321*** (0.112)		-0.462 (0.348)
(NEU Reliance)*(21)		-0.165 (0.165)		-0.398 (0.581)
Year	Yes	Yes	Yes	Yes
Year-form type	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes
Mean Reliance	0.124	0.124	0.049	0.049
N obs.	59588	59588	51666	51666
N firms	16555	16555	14711	14711

Note: estimates by PPML using data between 2005 and 2021 inclusive. Standard errors clustered at the firm level. ‘EU Reliance’ in columns (1) and (2) is defined as the firm-specific share of goods intermediate inputs imported from the EU averaged over 2005-2012. ‘NEU Reliance’ is the same, but uses non-EU imports. The reliance measures in columns (3) and (4) are defined similarly using the ratio of exports (either to EU or non-EU countries) to turnover. */**/** denote significance at the 10/5/1 percent level respectively.

Table 5 in Appendix A shows the significant negative impacts of EU and NEU import reliance on investment are robust to taking 2016, rather than 2013, as the Brexit base year and defining reliance using data over 2005-2015, whereas the impacts of export reliance are not.⁹ Viewed alongside the results of Table 3, there appears robust evidence that investment among manufacturing firms with a reliance on imported inputs was significantly lower in the years after the Brexit announcement. By contrast, measuring EU exposure using export as a share of turnover does not indicate systematically different performance between more- and less-exposed firms. This conclusion is consistent with Nicholas Bloom et al. (2019), who find the share of firms’ costs imported from the EU is a stronger predictor of Brexit-related uncertainty than the share of firms’ turnover exported to the EU. It also parallels the results of Freeman et al. (2024), who show the introduction of the UK’s new Trade and Cooperation Agreement in 2021 led to a large and permanent decline in relative UK imports from the EU whereas the decline in relative UK exports to the EU is much smaller and only transitory.

As well as being consistent with other research, the difference in our estimated Brexit effects between import and export reliance measures is reasonable when one considers the effect of exchange rate movements. Sterling depreciated approximately 10% on a trade-weighted basis in the immediate aftermath of the Brexit referendum, which would have increased the price of

9. These results also show a significant negative effect in the 2013-2015 period and we therefore focus on the results using 2005-2012 as the pre-Brexit period, which are robust to such pre-vote effects.

imported inputs while improving the cost-competitiveness of UK exports. The importance of these effects would be in proportion to our measures of import and export reliance respectively and therefore, if higher costs or improved demand affect investment, our estimated ‘Brexit effects’ in Table 3 encompass the impact of exchange rate movements.¹⁰

To analyse the magnitude of the aggregate impact of Brexit on investment, we focus on the results of Column (2) of Table 3 as the more comprehensive specification of the import reliance which, as discussed, is the measure of trade reliance where we have robust evidence of negative post-Brexit effects. We use the coefficient estimates from this specification to estimate investment among sample firms, once using the EU and non-EU import coefficient estimates shown in Table 3 and once setting them to zero. The second estimate in effect ‘turns off’ the post-Brexit effects and thereby provides an estimate of what firm investment would have been in the absence of Brexit.

Table 4 summarises the results of this counterfactual exercise. The first panel shows the percentage difference in total investment calculated either over 2013-2021 (in column (1)) and 2016-2021 (in column (2)).¹¹ The first row shows the percentage change in investment when only the $\hat{\beta}_{1315}^{EU}$, $\hat{\beta}_{1620}^{EU}$ and $\hat{\beta}_{21}^{EU}$ coefficients are set to zero, which assumes Brexit only affected investment according to firms reliance on EU imports. In this scenario, total manufacturing sector investment over the 2013-2021 period would have been 2.9% higher had Brexit not occurred, whereas over over the 2016-2021 period it would have been 3.3% higher.

The results in column (1) are a conservative estimate of how much higher investment would have been in the absence of Brexit, as they do not account for the negative impact that Brexit also had on investment among firms that rely on imported inputs from non-EU countries. To account for these effects, column (2) additionally sets the $\hat{\beta}_{1315}^{NEU}$, $\hat{\beta}_{1620}^{NEU}$ and $\hat{\beta}_{21}^{NEU}$ coefficients to zero. This more comprehensive counterfactual scenario suggests total manufacturing sector investment would have been 5.2% higher over 2013-2021 without Brexit and 7.3% higher over 2016-2021. The second and third panels convert the percentage changes into monetary values using official data on manufacturing sector investment. Our preferred estimates are those which include all the trade effects in the post-referendum years. These suggest an annual impact of reducing investment by 7% or £2.43 billion annually between 2016 and 2021. These magnitudes are comparable to work using more aggregate data. Haskel and Martin (2023) estimate that UK business investment is 10% lower because of Brexit compared to its pre-Brexit trends. **Springfield**<empty citation> uses a synthetic cohort approach comparing the UK with doppleganger countries to uncover an 11% impact. These macro approaches can capture non-trade effects on investment, so it is plausible that they reflect elements our narrow approach misses (although causal identification is more challenging).

10. We are currently implementing an extension of specification 4 that will allow us to separate out the effect of post-Brexit exchange rate movements from other aspects of Brexit, such as trade policy uncertainty, by using bespoke firm-level exchange rate indices.

11. The estimates that underpin these counterfactual exercises suggest the impact of Brexit on investment in the 2013-2015 period is, while negative, insignificant. For this reason, we believe the 2016-2021 counterfactuals are more appropriate but additionally present the 2013-2021 counterfactuals for completeness.

Table 4: Estimated Counterfactual Investment

	(1)	(2)
	2013-2021	2016-2021
	% Change	
EU impacts	2.9%	3.3%
EU and NEU impacts	5.2%	7.3%
	Total £bn. Equivalent	
EU impacts	8.22	6.59
EU and NEU impacts	14.74	14.59
	Annual £bn. Equivalent	
EU impacts	0.91	1.10
EU and NEU impacts	1.64	2.43

Note: table contains estimates of counterfactual manufacturing sector investment implied by the Brexit effects of Column 2 in Table 3. Percentage differences in the ‘EU impacts’ row are calculated by setting $[\hat{\beta}_{1315}^{EU}, \hat{\beta}_{1620}^{EU}, \hat{\beta}_{21}^{EU}] = [0, 0, 0]$, while those in the ‘EU and NEU impacts’ row are calculated by setting $[\hat{\beta}_{1315}^{EU}, \hat{\beta}_{1620}^{EU}, \hat{\beta}_{21}^{EU}, \hat{\beta}_{1315}^{NEU}, \hat{\beta}_{1620}^{NEU}, \hat{\beta}_{21}^{NEU}] = [0, 0, 0, 0, 0, 0]$. t -values are obtained by applying the estimated percentage differences to total manufacturing sector investment over the period denoted in the column heading observed in the ONS ‘Annual gross fixed capital formation by industry and asset’ series.

5 Conclusion

The Brexit announcement, referendum result and the eventual departure of the UK from the EU each marked dramatic changes in the relationship between the UK and its largest trading partner. In this paper we show the aftermath of the Brexit vote caused a significant reduction in investment among firms reliant on the EU as a source of intermediate inputs, with particularly large negative impacts in 2021 when the UK formally ‘left’ the EU. We also find firms reliant on the imported inputs from non-EU countries reduced their investment between 2016-2020, reflecting how exchange rate depreciation caused the impact of the Brexit vote to spread beyond UK-EU trade relations. We also find negative effects for export exposed firms, but these are more imprecise.

Our findings suggest several directions for future work. First, the contrast between our results on import and export reliance suggest the Brexit shock affected importers more adversely than exporters. This is similar to the results of Freeman et al. (2024), who show the introduction of the TCA in 2021 had a larger and more persistent negative impact on imports than on exports. Understanding the mechanisms behind these differences, for example examining the ease with which firms can switch input suppliers and the responsiveness of EU customers to price changes, may shed light on this interesting asymmetry. In addition to raising uncertainty over the UK’s future trade policy, the Brexit result prompted a large depreciation in sterling. Because firms’ exposure to trade policy uncertainty is likely to be highly correlated with their exposure to sterling devaluation, it is difficult to separately identify the impact of one factor from the other. Given the different policy implications that stem from each channel, addressing this question would be a valuable contribution to the literature on Brexit impacts and trade policy shocks more broadly. We plan to shed light on this in future work by explicitly controlling for firm-specific exchange rate indices and thereby isolating the impact of Brexit on investment that occurred via sterling’s depreciation from impacts due to other aspects of Brexit.

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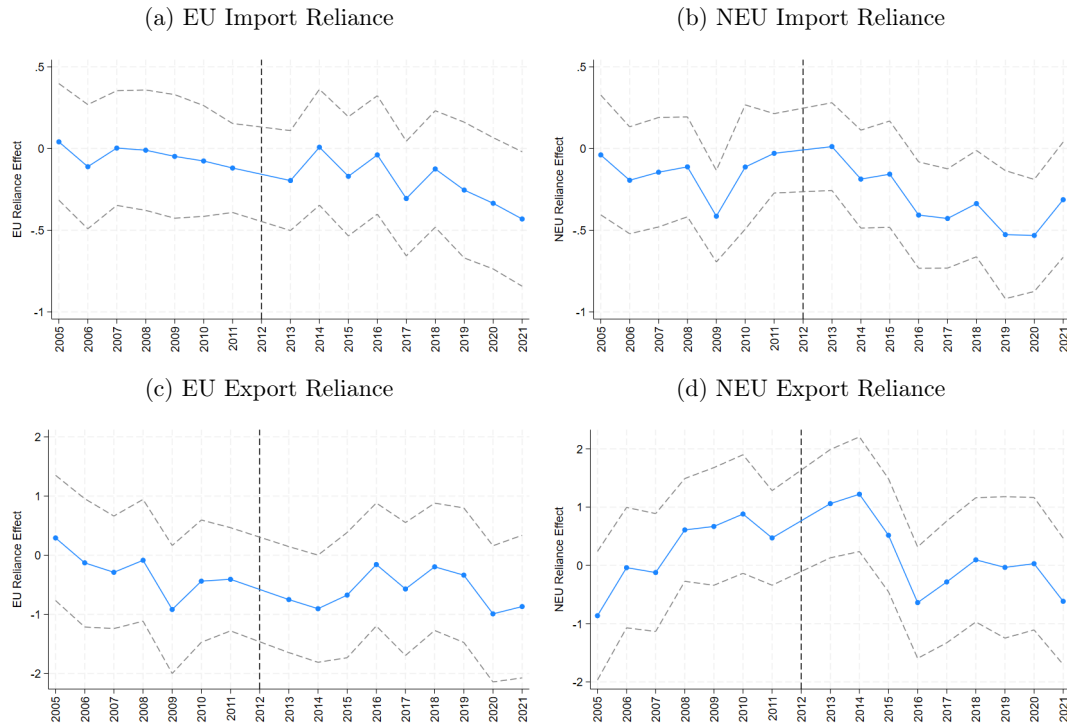
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A Supplementary results

Figure 2: Annual Impact of Trade Reliance on Investment



Note: figures plot estimates of β^{EU} and β^{NEU} coefficients from an extension of equation 4, where trade reliance is interacted with a set of year dummies rather than the three post-Brexit periods. Grey dashed lines indicate 95% confidence intervals and the vertical dashed black line denotes 2012, which is taken as the reference year immediately prior to David Cameron’s 2013 Brexit referendum announcement. Subfigure titles denote the measure of trade reliance used.

Table 5: Impact of Trade Reliance on Investment, 2005-2015 pre-period

	(1)	(2)	(3)	(4)
	Import Reliance		Export Reliance	
(EU Reliance)*(13-15)	-0.195** (0.114)	-0.199** (0.115)	-0.272 (0.27)	-0.347 (0.331)
(EU Reliance)*(16-20)	-0.356*** (0.109)	-0.355*** (0.109)	-0.670*** (0.312)	-0.334 (0.353)
(EU Reliance)*(21)	-0.501*** (0.175)	-0.479*** (0.173)	-0.914** (0.477)	-0.447 (0.536)
(NEU Reliance)*(13-15)		0.033 (0.091)		0.171 (0.366)
(NEU Reliance)*(16-20)		-0.162* (0.097)		-0.687* (0.351)
(NEU Reliance)*(21)		-0.337** (0.148)		-0.924* (0.488)
Year	Yes	Yes	Yes	Yes
Year-form type	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes
N obs.	66998	66998	57509	57509
N firms	19101	19101	16811	16811

Note: estimates by PPML using data between 2005 and 2021 inclusive. Standard errors clustered at the firm level. ‘EU Reliance’ in columns (1) and (2) is defined as the firm-specific share of goods intermediate inputs imported from the EU averaged over 2005-2015. ‘NEU Reliance’ is the same, but uses non-EU imports. The reliance measures in columns (3) and (4) are defined similarly using the ratio of exports (either to EU or non-EU countries) to turnover. */**/** denote significance at the 10/5/1 percent level respectively.

Table 6: Impact of Trade Reliance on Investment, industry-level reliance measures

	(1)	(2)
	Import Reliance	Export Reliance
(EU Reliance)*(13-15)	-0.429 (0.406)	-1.265* (0.795)
(EU Reliance)*(16-20)	-0.225 (0.447)	-0.236 (0.872)
(EU Reliance)*(21)	-1.831*** (0.747)	-2.743** (1.604)
(NEU Reliance)*(13-15)	0.427 (0.419)	0.421 (0.663)
(NEU Reliance)*(16-20)	-0.291 (0.458)	-0.544 (0.726)
(NEU Reliance)*(21)	-0.766 (0.683)	-0.249 (1.416)
Year	Yes	Yes
Year-form type	Yes	Yes
Firm FEs	Yes	Yes
N obs.	59588	51666
N firms	16555	14711

Note: estimates by PPML using data between 2005 and 2021 inclusive. Standard errors clustered at the firm level. ‘EU Reliance’ in columns (1) and (2) is defined as the industry-specific share of goods intermediate inputs imported from the EU averaged over 2005-2012. ‘NEU Reliance’ is the same, but uses non-EU imports. The reliance measures in columns (3) and (4) are defined similarly using the ratio of exports (either to EU or non-EU countries) to turnover. */**/** denote significance at the 10/5/1 percent level respectively.

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