LUND UNIVERSITY
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# Does trade integration in Global Value Chains go hand in hand with anti-globalization sentiments?

## A regional analysis of the Brexit referendum

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**Abstract**

Globalization has intensified interdependencies between countries, generating both winners and losers from trade in Global Value Chains. While economic theory predicts a net welfare gain from international trade on the aggregate level of an economy, geographical differences on the regional level and the need for territorial redistribution policies have been neglected, causing political backlashes. This study scrutinizes disparities within the UK and presents evidence for a positive relationship between a region's 'Leave' vote share in the Brexit referendum of June 2016 and the foreign value added share in the region's final output, an indicator for the extent of offshoring activities and thus, regional economic insecurity. Hence, the study suggests that economic geography in terms of a region's exposure to offshoring has contributed to the voting pattern. The finding adds to the existing literature, explaining why anti-globalization sentiments have been expressed to different extents at ballot boxes across UK regions.

*Key words: Globalization; Offshoring; Brexit; Global Value Chains; Input-Output Analysis*

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# 1 Introduction

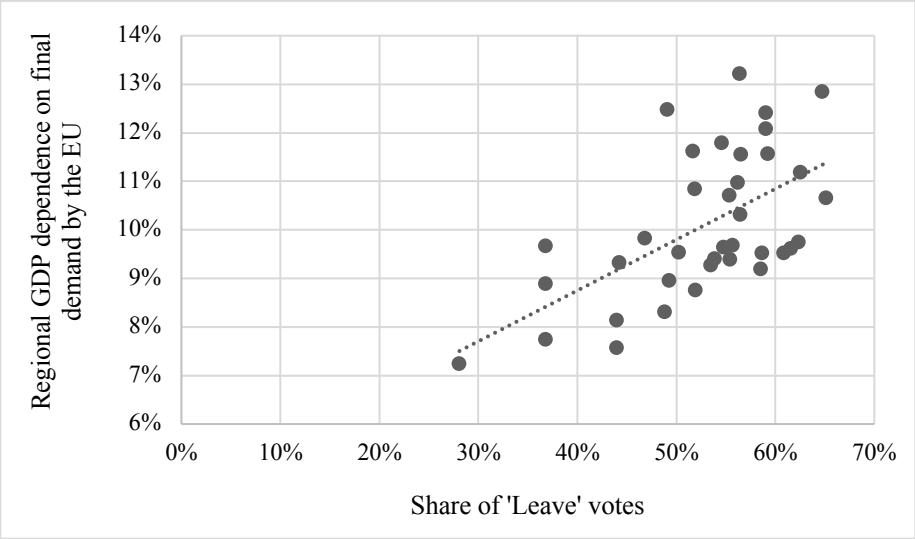
In June 2016, voters in the United Kingdom (UK) were asked whether their country should remain in the European Union (EU) or not. The Brexit referendum has revealed that a majority of 51.9% of all voters favors a return to nationally-oriented policies, expressing an increasing discontent of living in an integrated country with open borders. Undoubtedly, there are multidimensional reasons for the observed voting decisions of individuals besides a general globalization fear. These may include, among others, technological changes and erosion of labor market protections, national identity issues and sentiments against immigration and political elites (Arnosson and Zoega 2016; Coyle 2016; Goodwin and Heath 2016). However, as noted by Rodrik (2017), these reasons are not entirely independent from globalization as they have partly fostered it and have been reinforced by it.

Looking closer at the regional level of voting results reveals considerable geographical differences within the UK. While London and its hinterland, Scotland and Northern Ireland voted largely in favor of remaining in the EU, the decision to leave was made in provincial English regions such as Lincolnshire. This phenomenon has been described as 'geography of discontent', expressing that local economic conditions in the region interact with individual voters' characteristics such as the economic and employment status (Los et al. 2017). Since it is beyond the scope of this thesis to consider various variables in modelling the observed voting patterns, this analysis limits its focus to investigating the relationship between regional vote shares for 'Leave' and regional trade integration in Global Value Chains. This adds a new perspective, based on a new methodological approach, to the debate why the Brexit was decided in 2016.

A previous study based on input-output analysis by Los et al. (2017) finds that regions voting relatively more in favor of leaving the EU are regions whose Gross Domestic Product (GDP) is relatively more dependent on final demand by the EU market. Hence, the result suggests that voters voted against their economic interest as shown in Figure 1 where one dot refers to one NUTS2 region in the UK.[1] In nearly all regions where more than 50% of voters voted 'Leave', more than 9% of the economic output is directly dependent on consumption and investment demand by the EU. As leaving the trade union likely implies less trade with the EU or trade at higher cost with the EU, these regions' capital and labor income is at higher risk of being affected than in regions where the majority voted 'Remain'.

[1] The geocode standard NUTS stands for "Nomenclature of Territorial Units for Statistics" (French: "Nomenclature des unités territoriales statistiques").

**Figure 1: 'Mismatch' between regional GDP dependence on final demand by the EU and 'Leave' vote shares**




Notes: $R^2$=0.35. The computations are explained in detail in appendix B.
Source: Author's calculations using Thissen et al. (2017) based on Los et al. (2017).

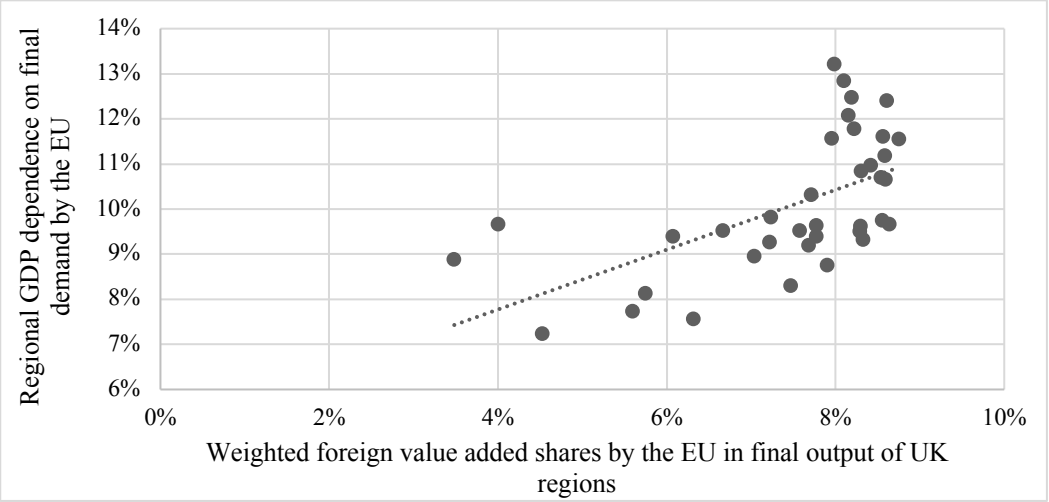
This study builds on Los et al. (2017) but extends the analysis from regional GDP dependencies on foreign final demand to foreign value added shares in UK regions' economies' outputs. This measure is used as a proxy for offshoring activities. Hence, it gives an indication to what extent a region may have suffered from job losses and economic insecurity due to the relocation of production stages or service activities to foreign countries.[2] For example, British Airways, headquartered in Harmondsworth in Outer London opened offices and call centers in India with the objective to increase productivity by making use of lower labor costs in India relative to the UK (Gagliardi et al. 2015). Such an offshoring activity increases the foreign value added share in Outer London's economic output. In contrast, if the company was to onshore activities back to the own region or another region in the UK from abroad, generating capital and labor income in the own country, the foreign value added share in Outer London's total output would decrease.

Figure 2 plots the regional GDP dependence on final demand by the EU as computed by Los et al. (2017) against the share of foreign value added by EU regions in the total final output of a specific UK region. The latter can be seen as indicator for the extent of offshoring activities to other EU regions outside the UK despite some data limitations and methodological shortcomings that are outlined in detail in section 5. As the two measures show a clearly positive correlation, Figure 2 suggests that the view that voters voted against their economic interest in the Brexit

[2] To avoid misunderstandings, the difference between offshoring and outsourcing should be emphasized here. This study focuses on offshoring because it refers to the movement of value added activities abroad whereas outsourcing could happen within the UK if production processes are shifted from one firm to another in the same or another British region (Schwörer 2013).

referendum needs to be put in perspective by adding additional insights to the economic differences between British regions. Assuming a region's economy has suffered from offshoring activities to locations with lower production costs in the EU and has experienced job losses that have made voters in the UK worse off, their reaction of voting against an integrated and open country becomes predictable despite their region's economy's relatively higher dependency on final demand by the EU. Therefore, we investigate the relationship between foreign value added shares by the EU as well as non-EU regions in UK production processes and regional 'Leave' vote shares in more detail in this study, complementing the analysis by Los et al. (2017). The hypothesis for the analysis is that the higher the share of foreign value added in a UK region's final output, the higher is the region's share of 'Leave' votes in the Brexit referendum following the reasoning that offshoring creates economic insecurity among voters, leading to political backlashes and anti-globalization votes.

**Figure 2: Correlation of regional GDP dependence on final demand by the EU and foreign value added shares by the EU in UK regions' total final output**




Notes: $R^2$=0.35. The methodology section describes the computation of foreign value added shares in detail.
Source: Author's calculations using Thissen et al. (2017).

The next section emphasizes the research contribution of this study, section 3 gives an overview of the literature and thus, provides the analytical background of the study. First, we review other scholars' findings on the relationship between international trade linkages, labor markets and anti-globalization voting. Second, the existing literature on the 'geography of discontent' in the UK is summarized including an overview of the Brexit referendum's outcomes on the NUTS2 level. Section 4 provides the specification of the methodology and section 5 discusses the data including the methodological limitations, followed by the presentation of the results. Section 7 concludes with policy implications.

## 2 Contribution and relevance of the concepts

As outlined in the introduction, this study adds a valuable perspective to understanding the reasons for pro-Brexit votes and to understanding the regional differences in the 'Leave' vote shares by going beyond labelling voters as voting against their economic interest.

In contrast to previous literature analyzing the negative effects of globalization on voting behavior on the regional level (e.g. Colantone and Stanig 2016), we expand the research frontier by making use of input-output analyses based on the most detailed economic and trade data available on the European NUTS2 level (Thissen et al. 2017). This method is highly relevant in today's world because globalization has significantly intensified the interdependencies between countries. For example, the production of a car requires sourcing several raw materials, components and business services along its value chain before the final product can be delivered to the customer. While these production steps used to be co-located within one country to a relatively large extent, the trade linkages within and between different countries have become highly complex. Today, trade increasingly involves trade in tasks whereas a few decades ago, gross exports contained nearly no foreign value added (Johnson 2014) with value added being defined as gross output value (at basic prices) minus the cost of intermediate goods and services (at purchasers' prices) (Timmer et al. 2013). Input-output analysis allows taking multiple cross-border movements of the same goods and services as well as all local supply chains "comprising many firms which themselves do not actually export" into account (Los et al. 2017:788). The methodology section explains the implications of fragmented production processes in more detail.

Los et al. (2017) take these implications into account in their measure of the regional GDP dependence on final demand by the EU. It should be emphasized that this measure does not capture the share of gross export values dependent on demand by the EU as in conventional trade statistics but rather the share of a UK region's capital and labor income generated by contributing to Global Value Chains that meet final demand in the EU. For example, if a British company supplies a German car manufacturer with a component and the German firm sells the final product to a customer in Germany or elsewhere in the EU outside the UK, the UK region's dependency on final demand by the EU increases. However, the British company's component itself may involve several production steps of which only a fraction is performed in the UK, i.e. only a fraction of the total value of the component is added within the UK. The higher the share of the component's value that is added outside the UK, the less increases the UK region's GDP dependence on final demand by the EU but the more increases the UK region's foreign value

added share. This foreign value added share is the key concept in this analysis. It is used as an indicator for offshoring as it measures the share of a UK region's final output that is contributed by foreign countries. Let us assume that the British company's components that are sold to the German car manufacturer are car seats. If the British company decides to source the textiles for these seats from China instead of from the local British market, the foreign value added share in the UK region's output where this British company is located increases.

Input-output analysis captures all these interdependencies and allows a more coherent analysis than the gross trade measures used in previous analyses of import competition in the UK or other Western countries (e.g. Dippel et al. 2015). In today's fragmented production processes, the same good may cross a border, e.g. between the EU and the UK, numerous times before the good is finalized. A traditional trade flow indicator would measure the gross value of the good each time it is exported and imported. The method used here avoids this double counting of value because it does not measure the gross value of the good, but rather the net value that is added within a region or country. Thus, it gives a more unbiased picture of the actual value added, i.e. capital and labor income generated in a region.

As the offshoring decision of the car seats' textiles to China in our example may cause job displacements in the UK region that had supplied the textiles before the offshoring to China had taken place, voters may feel economically more insecure, leading to political backlashes as expressed at ballot boxes in the Brexit referendum. Therefore, our analysis, based on input-output analysis adds a new perspective to the discussion why the Brexit was decided and whether globalization creates a counterforce to itself by taking the regional economic heterogeneity in terms of trade integration in Global Value Chains into account. Hence, this analysis complements Los et al. (2017), who also use input-output analysis but focus on the share of value added in UK regions that is dependent on final demand by the EU whereas we concentrate on UK region's dependency on foreign value added shares in UK production processes.

Furthermore, this study assesses not only the regional trade integration with the EU but additionally, takes foreign value added shares by non-EU regions into account. This follows the argument that voters may feel generally betrayed by trade integration's negative implications on local UK labor markets, no matter whether their jobs are mostly re-located to other EU countries or to more distant locations such as China. Hence, it can be shown whether the Brexit vote may have incorporated a vote against genuinely global trade integration rather than only European trade integration.

# 3 Literature Review

## 3.1 The effects of trade on economic insecurity and anti-globalization votes

Authors like Kevin O'Rourke argue that it has been obvious but ignored for too long that globalization, relying on "too much market and too little state", leaves people behind with potentially severe political consequences (O'Rourke 2016:43). In fact, economic history shows how globalization incentivizes a counterforce to itself (Rodrik 2017). In the late 19th century, landowners in European countries faced new competition from the New World as land supply on the other side of the Atlantic was elastic and cheap. Protests resulted in higher agricultural tariffs in nearly all European countries (O'Rourke and Williamson 1999; Rodrik 2017). Hence, already back then, globalization under the Gold Standard created its own opposition movement. Today, as European workers are exposed to elastic supplies of cheap labor, e.g. in Asia, populist parties spreading anti-globalization sentiments are on the rise again, as expressed in recent elections around the world. Policy demands from the negatively affected share of the population usually come in the form of compensation demands. If these are not met by policy makers and voters experience prolonged unemployment and find themselves under financial stress while they are exposed to import competition from abroad, compensation demands turn into protectionism demands (Colantone and Stanig 2017; Guiso et al. 2017). This is in line with retrospective voting theory according to which voting decisions are made based on past economic experiences (Lewis-Beck and Stegmaier 2007).

Rodríguez-Pose (2018) describes the pattern in recent elections as a "revenge of the places that don't matter" because the successful globalization dynamism is not equally distributed across geographical areas. Some regions, mostly provincial ones, are left behind in terms of future economic prospects, i.e. they suffer relatively more from poverty and economic decay than densely agglomerated regions in which global trade integration has benefitted job creation. Hence, the foundations of the populist rise are territorial rather than social, leading Rodríguez-Pose (2018) to call for better territorial development policies. He argues that the populist rise could have been predicted if one had considered that agglomerations do not only create negative externalities in the form of congestions and high land rents in cities but at the same time, "social and economic, real or perceived distress in many non-agglomerated areas" (Rodríguez-Pose 2018:200). Territorial inequality has been largely ignored in contrast to interpersonal inequality. Therefore, our methodology based on regional data from input-output tables suits this finding well and additionally fits economic voting behavior theory according to which voters punish the incumbent for bad economic times, reflecting not only on their personal economic situation but

according to sociotropic voting theory, reflecting rather on their regional or national economic situation (Lewis-Beck and Stegmaier 2007).

Moreover, the analysis in this paper rests on economic trade theory. Haberler (2013:146) argues that „in the long run, the working-class as a whole has nothing to fear from international trade" because labor will always be demanded, workers can be retrained and relocated, and workers are simultaneously consumers who benefit from lower prices for final goods that are imported from abroad, offsetting their lower wages as workers. However, this confidence of a Pareto improvement from trade has not been universally shared in economic theory. The distributional costs of trade have been recognized, too. The Stolper-Samuelson theorem predicts in a model with two goods, two factors of production and inter-sectoral factor mobility that owners of the production factor used intensively in the production of the imported good are made worse off with trade, i.e. they experience declines in their real earnings as the final price of the imported good drops with declining tariffs (Rodrik 2017). This happens even with a net welfare gain on the aggregate level of the economy. Thus, the working class is not as shielded from declining real earnings as suggested by Haberler (2013) if the imported good is relatively labor-intensive. While the model assumptions are far from complex reality, Rodrik (2017) points out that this result of the theorem generally applies. If the imported good continues to be produced in the importing country, there will be at least one production factor that loses from trade, making redistribution necessary to balance gains and pains from the liberalization of trade.

Additionally, the ratio of redistributive effects to net gains from trade increases the smaller the trade barriers get. While the relative efficiency gains become progressively smaller the lower the trade barriers get, the redistributive effects develop relatively linear to tariff changes, i.e. they are invariant at the margin. Therefore, the "losses incurred by adversely affected groups per dollar of efficiency gain are higher the lower the barrier that is removed" (Rodrik 2017:7). Consequently, Guriev et al. (2017) argue that "strengthening social safety nets is the necessary corollary to open trading systems". In line with this argument, Rodrik (1997) who asked whether globalization has gone too far already more than 20 years ago, finds that open states need bigger governments than closed states because workers are at higher risk and need more social protection (Rodrik 1998). This line of thought suggests an exchange of generous redistribution mechanisms and insurances against economic shocks on the one hand and political support for trade integration and open borders on the other hand. However, as globalization progresses, compensation becomes harder to maintain because capital becomes more mobile and gets increasingly attracted by tax heavens (Rodrik 1997). Additionally, after a politician has been

successfully elected into office by promising this exchange, the willingness to deliver the promised redistribution may decrease, leaving the globalization losers without the anticipated compensation. Consequently, voters lose trust and switch to parties promising more protectionist alternatives (Colantone and Stanig 2017).

Leipziger (2016) points out that globalization's benefits, increasing real income in emerging economies and lower prices for consumers in industrialized countries, has incurred worsening inequality within industrialized economies, partly undermining the "socio-political fabric" of these countries. This can be related to Milanovic's (2012) "Elephant curve" that shows how the middle class in advanced economies has been insufficiently recognized as globalization's loser who has suffered relatively more from job losses than other income classes. For example, Gagliardi et al. (2015) investigate the effect of offshoring of production activities on job creation and destruction in local labor markets in the UK, using outward foreign direct investment (FDI) flows as measures of offshoring. They find that, on the one hand, offshoring implies significant job losses in routine occupations, mostly held by the middle class, in regions that are initially heavily specialized in routine activities. On the other hand, the number of jobs in higher value added activities in the UK increases, specifically in response to offshoring to developing and emerging economies. Thus, the finding is in line with textbook economics, suggesting that countries specialize according to their Comparative Advantage. However, it remains questionable to what extent and in which timeframe the compensation mechanism works, i.e. if and when workers who lose their re-located job are sufficiently skilled to switch to a higher value added job. As Gagliardi et al. (2015) show, this does not only affect manufacturing workers but additionally and increasingly service workers as technology improvements make offshoring more feasible. For example, Barclays Bank became a media target in the UK in 2006 when it negotiated with unions over offshoring deals for back-office jobs (Gagliardi et al. 2015). Nevertheless, most literature has focused on the negative impact of trade on manufacturing employment in local labor markets in the importing country as the foreign value added shares remain higher in manufacturing industries than in services (Autor et al. 2013; Acemoglu et al. 2016; Pierce and Schott 2016).

While Autor et al. (2016) show that the degree of exposure of local labor markets to import competition from China has positively influenced the Republican vote shares in the U.S. presidential election in 2016, Dippel et al. (2015) and Malgouyres (2017) are among the few who have directly studied the link between trade and voting via labor market adjustments in European countries, namely Germany and France respectively. They confirm that there is major

channel from international trade via labor markets to voting support for fringe and far-right parties. While Malgouyres (2017) focuses on import competition, Dippel et al. (2015) take into account that trade has twofold effects on local labor markets. On the one hand, manufacturing activities in advanced countries have become substituted for by relatively cheaper activities in emerging economies such as China, affecting the relatively high wage manufacturing employment in European countries such as Germany negatively. On the other hand, globalization has amplified the opportunities for exporting goods and services, requiring relatively more factor inputs and thus, stimulating local labor markets. Depending on a region's specialization in either import competing industries or export-oriented industries, jobs are either lost or gained and votes for far-right parties either increase or decrease (Dippel et al. 2015). Thus, the distributional costs from trade and gains from trade are not equally distributed across different regions of a trading country. Even if the job increases may offset the job losses on the aggregate level, in reality some regions will be left behind with lacking opportunities for economic development because the mobility of factor inputs is not a frictionless as often assumed in economic theory. The cost of moving individuals from regions with lacking development opportunities to dynamic regions has been underestimated in urban economics. Emotional attachments to places besides lacking skills that would be required to find a job in the dynamic region are considerable labor mobility cost drivers (Rodríguez-Pose 2018).

Similar to the analysis by Dippel et al. (2015) for Germany, Colantone and Stanig (2016) have found a positive relationship between the Chinese manufacturing import shock between 1990 and 2007 and voting support for the 'Leave' option in the Brexit referendum on the NUTS3 level, attributing this causal effect to missing compensation mechanisms for regions losing from globalization. This effect from trade to voting behavior cannot only be seen on the level of individual workers employed in affected industries but homogenously across the regions suffering from economic decay, regardless of the voters' own employment situation. Interestingly, negative sentiments against immigration, the most self-reported reason to vote for 'Leave', are also determined by the extent of import competition, more than by the extent of immigration to a region, suggesting that immigration is being used as a scapegoat for lacking regional economic prospects due to job displacements (Colantone and Stanig 2016).

However, neither Colantone and Stanig (2016) nor Dippel et al. (2015) take the implications of Global Value Chains into account, i.e. their region-specific indicators measure gross imports and exports without taking into account where the net value added takes place. Thus, they allow for biases due to double counting of value added activities whereas the methodology in this study

takes the implications of fragmented production processes into account. Furthermore, we do not only focus on import competition from China but take a broader look by differentiating between European value added shares and global non-European value added shares in UK region's Global Value Chains.

Overall, it can be summarized that within many countries, globalization has caused job polarization and higher regional inequality. This implication of increased economic insecurity in local labor markets due to import competition and a lack of public safety nets has been noted by voters, causing political backlashes to globalization (O'Rourke 2016). Economic insecurity does not only influence voting turnout and voting decisions directly but also indirectly via a cultural channel as it contributes to losing faith in political parties and to developing adverse attitudes towards open borders and immigration (Guiso et al. 2017). Therefore, Guriev et al. (2017) call for more inclusive globalization strategies to restore trust in governments, businesses and the economic system in general. However, previous studies lack an understanding of the implications of fragmented production processes in analyses of the effects of increased import competition. This study aims at filling in this gap in the literature.

### 3.2 Geography of (economic) discontent in the UK

The most important non-economic common characteristics of 'Leave' voters have been found to be their age and education. The typical 'Leave' voter is older, less educated and more attached to traditional British values than the typical 'Remain' voter (Goodwin and Heat 2016). Furthermore, the referendum's outcome can be linked to a mismatch between the internationalization of British firms and the 'localistic' attitude of the firms' employees, a phenomenon called 'split Europeanization' by Cresenzi et al. (2017). They argue that this mismatch has triggered significant Euroscepticism by the employees as their employers' corporate, economic and international interests do no match their personal attitudes and cultural preferences. Furthermore, Kaufmann's (2016) commentary titled "It's NOT the economy, stupid: Brexit as a story of personal values" downplays economic factors as drivers of the referendum's outcome and instead, refers to identity, demography and cultural issues as being more important than income and occupation aspects. We acknowledge that non-economic issues should not be discarded in analyses of the Brexit vote, but our analysis' results highlight that economic factors should not be either.

The previous section has shown that globalization's distributional costs may have been recognized in theory, e.g. by the Stolper-Samuelson theorem, but the negative effects on local

labor markets have not been adequately addressed by policy makers, causing political backlashes of discontent voters. As a consequence of the regionally heterogenous economic reality, there are significant geographical differences on the NUTS2 level with regard to the shares of 'Leave' votes in the referendum. The aspect of economic geography as an explanatory variable of this regional heterogeneity has been recognized by Bell and Machin (2016) who show that regions with lower median wage levels as well as lower wage growth since 1997 were more likely to favor the Brexit over remaining in the EU. In line with this finding, McCann (2016) shows that the economic interregional inequality in the UK, one of the worst of OECD countries, correlates with the Brexit referendum's regional voting results. He argues that the UK economy has been internally decoupled into "two or possibly three quite separate economies" (McCann 2016:xxvi). First, there is London and its hinterland including the South West that could be counted as one of Europe's most successful economies, outperforming most of the economic OECD and EU averages. Regions in Scotland are on a prosperous path as well whereas the economic benefits and gains did not spread to the English regions of the North and Midlands where productivity is below or at best similar to many regions in Eastern Europe, e.g. in the Czech Republic and Poland (McCann 2016). Hence, London's prospering economy has not been able to "act as a motor driving the economy as a whole forward" (Los et al. 2017:5). This interregional inequality contributes to the fact that the position of the UK as an aggregate economy in a comparison with other OECD and EU countries has not changed since approximately 40 years (McCann 2016).

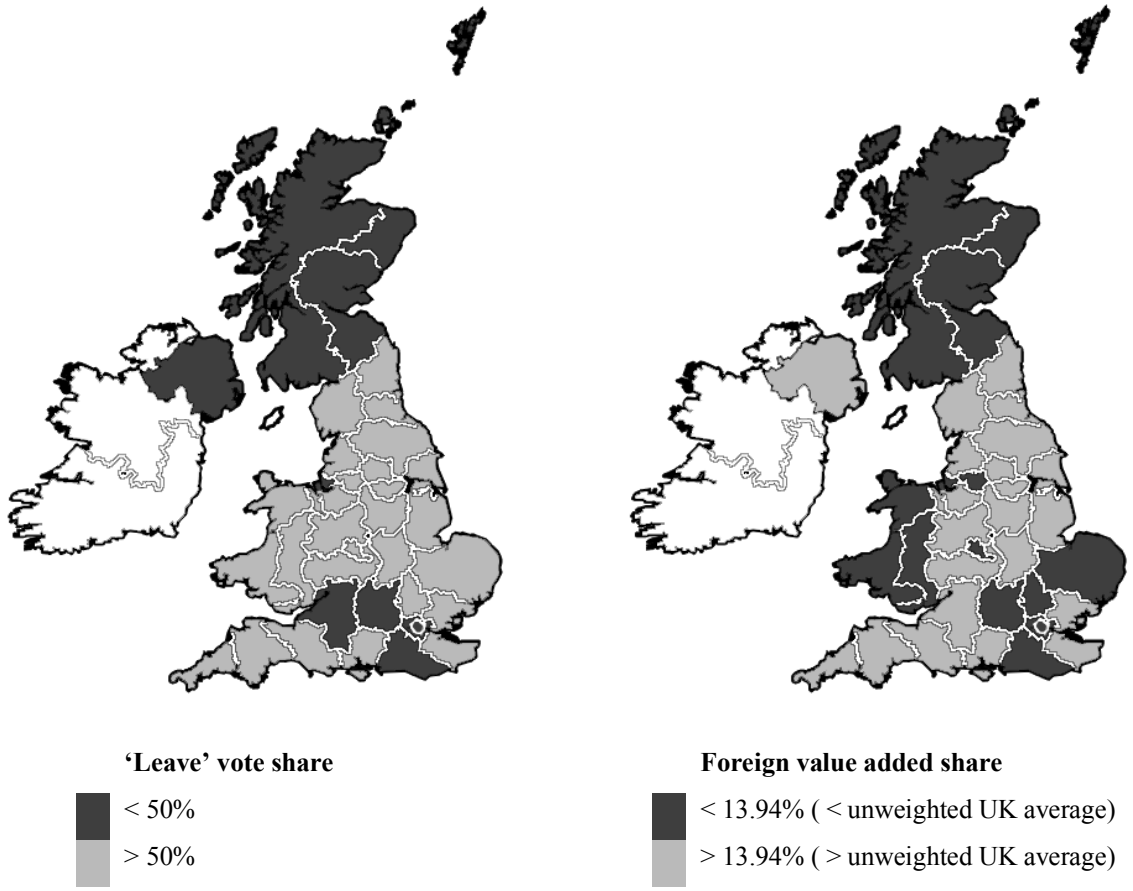
The 'Leave' vote share was highest in English regions where manufacturing prospered during the industrial revolution in the 19th century (Arnosson and Zoega 2016). For example, the "birthplace of the Industrial Revolution", the NUTS2 region of Shropshire and Staffordshire, voted 'Leave' with nearly 63% (Arnosson and Zoeage 2016:4). Lincolnshire, where more than 65% of voters voted 'Leave', is known for its booming engineering industry in the 19th and in the first half of the 20th century. Similarly, South Yorkshire, where the 'Leave' vote reached a majority of nearly 62%, had been an important center for coal, iron ore and steel industries as well as for the textile industry (Arnosson and Zoeage 2016). It is these regions in England that have significantly fallen behind the economic rise of London and its hinterland in recent years, partly due to offshoring of production steps to countries with lower production costs (Schwörer 2013).

In contrast, regions where the majority voted 'Remain', have seen economic upturns in recent decades with London being the prime example as its service sector has expanded continuously and only 28% of voters in Inner London voted 'Leave', the lowest share in the UK. Liverpool in

Merseyside and Bristol show a similar trend as service sectors, especially financial and IT services, have successfully replaced declining manufacturing sectors (Arnosson and Zoega 2016). Moreover, Berkshire, Buckinghamshire and Oxfordshire benefit from the close by thick London labor market and offer a home to the headquarters of many multinationals and thus, provide well-paid jobs to the high-skilled (Arnosson and Zoega 2016).

Table A-2 in the appendix provides detailed values of the 'Leave' vote shares by NUTS2 region while Figure 3 indicates which regions voted to leave in a light grey color in the map on the left-hand side.

**Figure 3: Illustrative comparison of regions voting 'Leave' and foreign value added shares relative to the UK average**




Source: Voting data are taken from Arnosson and Zoega (2016). Foreign value added shares are author's calculations using data from 2010 in Thissen et al. (2017).

To visualize the correlation between a more than 50% 'Leave' vote share and the extent of offshoring activities, the second map on the right-hand side indicates regions where the foreign value added share is higher than the unweighted UK average in light grey, i.e. these regions suffer relatively more from offshoring activities than the UK average. Regions where the foreign value added share is lower than the UK average are indicated in dark grey. It becomes evident

that regions voting to leave the EU are mostly regions where offshoring has played a relatively more important role, as proxied by the above-average foreign value added share of their final output across all industries.

The pro-Leave narrative that the 'metropolitan elites' of London were the only ones gaining from being a member of the EU, may be viewed from two different angles. On the one hand, London's GDP dependence on the EU market is significantly lower than in other British regions due to London's more global orientation (Los et al. 2017). Nevertheless, the narrative seems to hit a sore spot as London has not suffered from globalization and increased offshoring activities as much as other British regions where job losses from de-industrialization trends have deprived voters of their economic hopes and triggered anti-globalization sentiments. Coyle (2016) agrees with this association between globalization losers in the North of England and 'Leave' voters and she points out that globalization is "far from making the world flat", as it was suggested by Friedman (2005) because the geography of economic activity has become "more rather than less salient" (Coyle 2016:23).

Having established the analytical background, the next section explains the implications of increased production fragmentation and thus, reveals why the use of input-output analysis is highly relevant.

# 4 Methodology

## 4.1 Fragmentation of production processes

This section draws heavily on Wannicke (2017). Global Value Chains are defined as "the collection of all activities needed to produce" a good or service (Timmer et al. 2013:7). The difference to global supply chains is that not only physical production stages are included but also all "pre- and post-production phases including research and development, software, design, branding, finance, logistics, after-sales services and system integration activities" (Timmer et al. 2013:7). Advances in information and communications technologies (ICT) and lower transport costs have enabled the "second unbundling" or disconnection between the locations where value is added into the production process (Baldwin 2006:76). Nowadays, complex production processes may require the same good to cross the border between the EU and the UK several times before the good is finalized. This generates capital and labor income both in the UK and other EU regions, no matter where the good is finalized. Most production fragmentation analyses have been conducted as case studies on specific consumer products, e.g. the iPod (Dedrick et al.

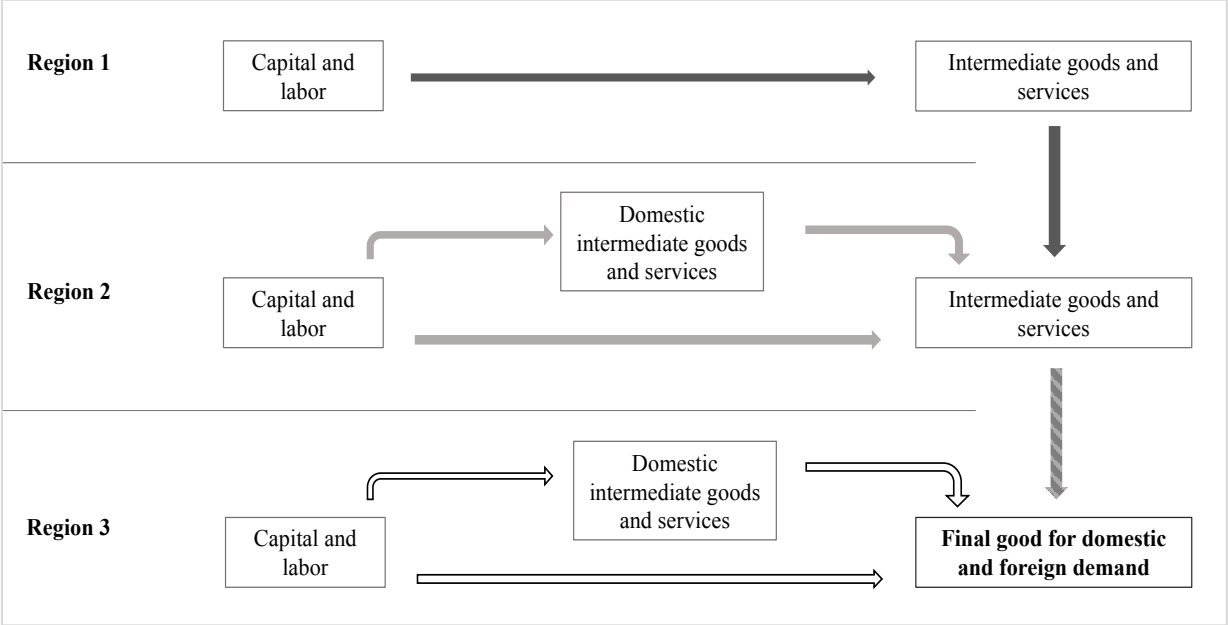
2010) or broader studies covering the fragmentation on the industry level, e.g. the automotive industry (Sturgeon et al. 2008) or the textiles industry (Gereffi 1999).

However, it should be emphasized that additional trade costs may remain in the form of non-tariff barriers or less quantifiable cultural or institutional barriers. Furthermore, the aspects of "viscidity" or "spatial inertia" of an economic activity limit the extent of production fragmentation or offshoring (Baldwin and Evenett 2012:110). Production processes may be kept together due to economies of scale and scope or agglomeration forces such as local supply and demand linkages. Moreover, a path dependency of keeping the production process together at one location may be created if high fixed costs for investments in equipment and skills in a geographical cluster act as sunk costs. Additionally, strict timely delivery restrictions or high transportation costs such as for complex components in the automotive industry may contribute to relatively low foreign value added shares in certain production steps. Only when a threshold is crossed which makes agglomeration rents less valuable than the advantage from relative wage or technological differences in other countries, the incentive to stay in the home country will decrease and offshoring will take place (Baldwin and Evenett 2012). Thus, economies of scale, both internal and external to a firm, are still highly relevant and can be seen as a counteracting force to Baldwin's (2006:76) "second unbundling".[3]

Figure 4 illustrates a stylized version of a regional value chain. We can assume that a manufacturing firm in region 3 needs to meet its final domestic and foreign demand for the good it produces. Region 3 is the location where the last stage of production takes place so that we call it the region-of-completion. The firm sources intermediate inputs from its home region and from region 2, generating domestic and foreign value added (capital and labor income). To produce the goods in region 2, inputs are not only sourced from region 2 itself but also from region 1. Thus, intermediate inputs delivered by region 2 to region 3 generate capital and labor income in region 1 and 2. Hence, the arrow, indicating the delivery of intermediate goods and services from region 2 to the final good in region 3 is colored in light and dark grey, referring to capital and labor income generated in both region 1 and region 2. The industry in region 2, delivering directly to the final production in the region-of-completion, is a first-tier supplier in the production of the final product. Consequently, we call the industry in region 1, delivering to the first-tier supplier, a second-tier supplier. Hence, we describe the value added generation in region 1 as being relatively more "upstream" in the value chain.

[3] Internal economies of scale refer to the benefits from co-location within one company whereas external economies of scale refer for example to thick labor markets and shared infrastructure with other companies/industries in the region.

**Figure 4: Stylized illustration of a regional value chain**




Source: Author's illustration adapted from Los et al. (2015).

Typically, the basic price value of a manufacturing good comes not only from other manufacturing industries. For instance, the production of a car in the UK does not only involve trade in car parts but also trade of natural resources further upstream in the Global Value Chain as well as supporting business services. All of these activities generate value added, either within the region-of-completion in the UK or elsewhere. One should be aware that the region-of-completion is not necessarily the region adding the largest share in the final output value.

This is highly relevant for customs authorities as argued by Morris (2018). Being in a customs union such as the EU offers the advantage of tariff-free exports and imports between the member states. Customs authorities require information about the different value added steps of a product that is crossing a border. Thus, they ensure that the origin requirements are matched, i.e. they confirm the "economic nationality" of the exported good. This way, they avoid an abuse of the preferential or zero tariff system. Such an abuse would take place if the majority of the value of the product is added under low production costs outside the EU, e.g. in Asia. Here, the so-called Rotterdam effect plays an important role. For example, in the computation of foreign value added shares by the EU in UK manufacturing production processes, an input good might be shipped from China to the UK via the port of Rotterdam. In some traditional trade statistics, this creates a bias as the trade linkage between the Netherlands and the UK is artificially inflated, even though the original source of the good is outside the EU with China adding the value to the good and not the region of Rotterdam. Moreover, a good imported to the UK for the production of a British car might embody value that has been added by the UK itself further upstream in the

production process. Conventional trade statistics would count this share of the final value of the product twice.

Input-output analysis, based on Leontief (1936) and applied in this study, takes these limitations of traditional trade flow indicators into account by considering that trade increasingly involves trade in tasks. The following two sections explain the computation of foreign value added shares in detail.

### 4.2 From input-output tables to the "Leontief inverse"

Drawing on Wannicke (2017), Table 1 gives a stylized overview of a World Input-Output Table with regional detail which zooms in on the European NUTS2 level, allowing calculations that make the heterogeneity at the subnational level visible. Assuming there are M regions and N industries in our dataset, consequently there are MN products. Table A-1 in the appendix gives a list of all included industries. The matrix **Z** (MNxMN) gives all intermediate deliveries.[4] For instance, the first value in the upper right corner of **Z** indicates the deliveries of industry 1 in region A1 to industry 2 in the "Rest of the World" or put differently, industry 2 in the "Rest of the World" transfers a payment to industry 1 in region A1.[5]

The vector **x** indicates gross output levels of all region-industry pairs. As input-output tables are obtained from double entry bookkeeping, the sum of all inputs into a production process equals the total sales of a region's industry. Hence, the vector **x** can be found twice in Table 1, once as a row vector and once as a column vector.

We define **A** as a matrix of intermediate input coefficients with the same dimension as **Z**. **A** is obtained by multiplying **Z** by the inverse of the diagonalized vector **x**.

*(1)* $\mathbf{A} = \mathbf{Z}\,(\hat{\mathbf{x}})^{-1}$

For example, an element in **A**, $a_{ij}^{kl}$, describes how the output from industry *i* in region *k* is used as an intermediate input by industry *j* in region *l* as a share of output in industry *j* in region *l*.

While the stylized Table 1 only depicts one final demand category per region, it consists of four categories in our dataset. These include the consumption expenditure of households and governments, investments and inventory adjustments. We sum over these categories within one

[4] Capital bold symbols denote a matrix and lowercase bold symbols a vector. Hats indicate a diagonal matrix with the corresponding vector on the main diagonal.

[5] To avoid misunderstandings, it should be pointed out that this study uses the international standard of calling different *sectors* of the economy, such as agriculture, textiles, transport equipment and financial services, different *industries*. In total there are 14 different industries in the dataset. They are described in Table A-1 in the appendix.

region and define matrix **F** (MNxM), giving the deliveries of final products to all regions M from all region-industry pairs. By multiplying the **F** matrix (MNxM) with a (M)-summation vector **e**, we compute the total final demand for each region-industry's final products **f**, a column vector (Wannicke 2017).

**Table 1: Stylized World Input-Output Table with regional detail**

| | | | | Purchasing industries | | | | | | | | | | Purchases by final demand categories | | | | | Gross output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Country A | | | | Country B | | | | RoW | | Country A | | Country B | | RoW | |
| | | | | R A1 | | R A2 | | R B1 | | R B2 | | | | R A1 | RA 2 | RB 1 | RB 2 | | |
| | | | | I 1 | I 2 | I 1 | I 2 | I 1 | I 2 | I 1 | I 2 | I 1 | I 2 | FD | FD | FD | FD | FD | |
| Delivering industries | Country A | R A1 | I 1 | **Z**: intermediate deliveries from row industries to column industries | | | | | | | | | | **F:** deliveries of final products/services from row industries to column categories (e.g. households) | | | | | **x** |
| | | | I 2 | | | | | | | | | | | | | | | | |
| | | R A2 | I 1 | | | | | | | | | | | | | | | | |
| | | | I 2 | | | | | | | | | | | | | | | | |
| | Country B | R B1 | I 1 | | | | | | | | | | | | | | | | |
| | | | I 2 | | | | | | | | | | | | | | | | |
| | | R B2 | I 1 | | | | | | | | | | | | | | | | |
| | | | I 2 | | | | | | | | | | | | | | | | |
| | RoW | | I 1 | | | | | | | | | | | | | | | | |
| | | | I 2 | | | | | | | | | | | | | | | | |
| Value added | | Labor income | | **w** | | | | | | | | | | | | | | | |
| | | Other income | | | | | | | | | | | | | | | | | |
| Gross output | | | | **x** | | | | | | | | | | | | | | | |

Notes: "FD" stands for Final Demand. "R A1" stands for Region A1. "I 1" stands for "Industry 1". "RoW" stands for "Rest of the World". The inclusion of the latter, ensures that the table covers the entire world economy.
Source: Adapted from Los et al. (2017).

The first required identity in input-output analysis is that global consumption equals all value added generated (market clearing). Put differently, it is assumed that a good is either consumed by final demand or used in another production process as an intermediate input (domestically or abroad). This refers to Leontief (1949) who stated that $\mathbf{x} = \mathbf{Ax} + \mathbf{f}$. Rewriting gives

*(2)* $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{f}$

where **I** is an identity matrix with zeros everywhere except ones on the diagonal. $(\mathbf{I}-\mathbf{A})^{-1}$ is the so called "Leontief inverse" **L**, where for example the element $l_{34}$ in row 3 and column 4 shows the total value added required by the region-industry in row 3 for the production of one unit of final output of the region-industry in column 4 (Leontief 1936).

The Leontief inverse gives the total production value in all stages of production generated for one (additional) unit of final demand. To show this, we can assume a final demand vector where only one element is positive while the other elements are zeros. For example, we can consider that only the value showing the final demand for the transport equipment industry from Lincolnshire ($\mathbf{f}^{L}$) is positive (equal to the output of this industry). Calculating $\mathbf{A}*\mathbf{f}^{L}$ gives the value added by the transport equipment industry in Lincolnshire and the value added by first-tier suppliers in the same or another region. However, this does not yet take into account where the different car inputs have been manufactured or from where their raw materials are sourced further upstream in the value chain. To consider all intermediate inputs used we do not calculate ($\mathbf{A}* \mathbf{f}^{L}$) or (($\mathbf{A} + \mathbf{A}^2 + \mathbf{A}^3$) * $\mathbf{f}^{L}$) but rather let the series converge to

*(3)* $\sum_{n=0}^{\infty} \mathbf{A}^n \mathbf{f}^{L} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{f}^{L}$

Thus, the calculation would cover an infinite number of higher order suppliers and production requirements can be calculated for any final demand vector (Wannicke 2017).

### 4.3 Computation of foreign value added shares

*"Only the dust gives it away, and the silence. There are no people here anymore, though the ghosts of past occupants are everywhere. In the boardroom, eight padded club chairs dressed in soft teal leather still sit around the board table as if waiting for the weekly meeting"* (Winstanley Norris 2012). As Britain, the heart of the industrial revolution and former workhouse of the world, has de-industrialized by offshoring manufacturing to locations with lower production costs, many British factories have ceased production and have been left empty, for example the leatherworks factory W. Pearce & Co in Northhampton which is described in the quote above. To capture such offshoring in the data, we rely on input-output analysis and compute foreign value added shares in the final output of British regions.

First, it will be explained why foreign value added shares are deemed an appropriate measure for offshoring activities. As mentioned, the trade measures used by Colantone and Stanig (2016) as well as Dippel et al. (2015) who also analyze the relationship between import competition and voting results, can be improved by taking value added contributions along Global Value Chains into account rather than using the gross value of a good or service crossing the border to the UK.

In the literature based on input-output analysis, offshoring has been measured in two different ways. Hummels et al. (2001) suggest using the foreign content of exports, a measure they call vertical specialization. Feenstra and Hanson (1996) propose using the foreign content of

domestic production, referring to the extent of imported intermediate inputs. The foreign content of exports is a narrower measure because it adds the condition that the resulting output of the Global Value Chain is exported whereas it is not important for the measure of the foreign content of production whether the final demand is abroad or in the home country. Moreover, the foreign content of exports relates more to the changing nature of world trade while the measure by Feenstra and Hanson (1996) better reflects the "elasticity of substitution of domestic value-added with respect to imported intermediate inputs" (Hijzen 2005:49). Hence, it refers to the implications for domestic employment and economic insecurity and thus, it is better suited as a possible explanation for the protectionist backlash expressed in the Brexit referendum. Therefore, we stick to the broader measure in this analysis and refer to it as foreign value added shares.

The computation used here is based on Los et al. (2015) who extend the fragmentation measure of Feenstra and Hanson (1996). Los et al. (2015) take into account that the foreign value added content of domestic intermediates is not necessarily zero and that the domestic value added content of imported intermediates is not either. Hence, the geographical origin of all value added steps further upstream are considered so that a double counting is avoided. Thus, the method allows exhaustively decomposing the value of a final product into value added shares by all regions in the dataset and we can show the share of value added by other EU regions in the production processes of a specific UK region-industry pair. Moreover, we calculate not only the share added by the EU but also by all non-EU regions to additionally test for the relationship between genuine globalization and 'Leave' vote shares besides the relationship between 'Europeanization' and 'Leave' vote shares. Furthermore, we present the results considering the value added shares by all non-UK regions. These can be computed by adding up the foreign value added shares by non-UK EU regions and non-EU regions.

We compute the foreign value added shares in the final output value of all 14 industries per region, i.e. in the total economic output (GDP) per region. Additionally, we restrict the analysis to foreign value added shares in the final output of five manufacturing industries for several reasons.[6] First, considering only manufacturing trade integration reveals larger differences between the regions in the UK than it is the case in computations considering foreign value added shares in the total final output of the entire regional economy. Hence, focusing on manufacturing Global Value Chains increases the variance in the data, possibly making it more likely that voters

[6] The five manufacturing industries are "Food, beverages and tobacco", "Textiles and leather etc.", "Coke, refined petroleum, nuclear fuel and chemicals etc.", "Electrical and optical equipment and Transport equipment", and "Other manufacturing".

in different regions express anti-globalization sentiments to different extents because the extent of offshoring, as proxied by the foreign value added shares, shows greater regional heterogeneity. Additionally, manufacturing value chains are more integrated in Global Value Chains than agriculture and service industries and hence, they are more by affected by offshoring. In fact, according to calculations from the database by Thissen et al. (2017), on average 26% of value added in a UK manufacturing value chain is added outside the UK whereas only 10% of value added in a UK service industry is added outside the country. Moreover, UK regions have, on average, lost 6.3% of domestic value added contributions in their manufacturing production processes to other regions between 2000 and 2010 in contrast to a loss of 1.7% of domestic value added contributions in service value chains. Thus, manufacturing value chain jobs have been relatively more affected by offshoring than other value chains. In line with this, Becker et al. (2017) show that regions with larger shares of lower-skilled or manual employment, a greater historical role in manufacturing, and higher levels of unemployment were more likely to vote 'Leave'. However, the implications of offshoring in service industries should not be discarded. Around 80% of total employment in the UK is in service industries so that offshoring could negatively affect a relatively large group of voters even though the foreign value added shares in service industries are lower than in manufacturing (World Bank 2018).

First, we compute the Leontief inverse as explained previously and we sum over "labor" and "other income" to create the vector **w** which is indicated in Table 1. The vector **b** is of dimension (1xMN) and shows the value added per unit of gross output **x**, i.e. the direct value added coefficients. The vector **b** is generated by multiplying the sum of all value added in one region-industry (**w)** by the inverse of the diagonalized vector **x**. Pre-multiplying **b** with the Leontief inverse **L** gives the value added multiplier **v** (1xMN). It shows the value added levels required to produce a final demand column vector **f** (Wannicke 2017).

*(4)* $\mathbf{v} = \hat{\mathbf{b}} (\mathbf{I} - \mathbf{A})^{-1} \mathbf{f}$

Considering the example of the transport equipment industry in Lincolnshire once more, we take a special final demand vector $\mathbf{f}^{L}$. In this vector, only the transport equipment industry in Lincolnshire has a positive value while all final demand for other final products is set to zero. With this, we derive the value added contributions at all stages of the production process of this single industry with Lincolnshire being the region-of-completion. Thus, we take all value added steps of this value chain into account, whether the value is added in Lincolnshire itself, in other UK regions, in other EU regions or elsewhere in the world, and whether the value is added downstream or upstream in the value chain.

This calculation is not only done for Lincolnshire's transport equipment industry but for all region-industry pairs so that a Global Value Chain cost-share table as sketched in Table 2 can be created. By summing column-wise, the total output value of a final product is derived, i.e. it equals the sum of all direct and indirect value added contributions along the respective value chain. We define **fino** as the respective row vector for all final output values where *i* is an industry in the region-of-completion *j*. The value added contribution by all industries in region *r* during this production process is denoted as $va_{ij}^{r}$ (Wannicke 2017).

*(5)* $fino_{ij} = \sum_{r=1}^{M} va_{ij}^{r}$

**Table 2: Stylized Global Value Chain cost-share table**

| | | | Final products by region-industry-of-completion | | | | | | | | | | Value added |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Region 1 | | | Region 2 | | | … | Region M | | | |
| | | | Industry 1 | … | Industry N | Industry 1 | … | Industry N | … | Industry 1 | … | Industry N | |
| Value added by regions and industries | Region 1 | Industry 1 | | | | | | | | | | | |
| | | … | | | | | | | | | | | |
| | | Industry N | | | | | | | | | | | |
| | Region 2 | Industry 1 | | | | | | | | | | | |
| | | … | | | | | | | | | | | |
| | | Industry N | | | | | | | | | | | |
| | … | … | | | | | | | | | | | |
| | Region M | Industry 1 | | | | | | | | | | | |
| | | … | | | | | | | | | | | |
| | | Industry N | | | | | | | | | | | |
| Total final output value (**fino**) | | | | | | | | | | | | | World GDP |

Source: Adapted from Timmer (2015).

In our dataset, there are 14 industries (14 rows) per region where value is added to the final output of Global Value Chains that have one of the 37 UK regions as their region-of-completion. If we are only interested in the foreign value added shares in the total final output value of UK manufacturing industries, we only look at 5 columns per UK region. However, the inputs into manufacturing value chains may come from all available 14 industries (14 rows per foreign region). To analyze the value added shares by other EU regions (except UK regions), the values from these regions' rows are extracted and summed column-wise so that a row vector **euva** is created. The share of the EU's contribution (**euvas**) to the production process of industry *i* in region *j* can then be calculated as

*(6)* $euvas_{ij} = euva_{ij} \,/\, fino_{ij}$

The closer this share is to one the more value is added in the EU. However, it could never be one because the last stage of production needs to take place in the region-of-completion in the UK. Finally, the average share of the EU's value added in the final output of a specific UK region is derived using the final output values of the respective industries as weights, either all 14 industries or only the 5 manufacturing industries. For the computation of non-EU regions' value added share in the total final output value of a UK region, only the respective rows referring to these non-EU regions are considered.

## 5 Data and limitations of the methodology

Production processes have become increasingly globally fragmented. Therefore, it is essential to track value added in a Global Value Chain. That is why we rely on the World Input-Output Database with regional detail for European regions by Thissen et al. (2017). Thus, we can compute the regional shares of economic activity that is dependent on trade with the rest of the EU or non-EU regions while accommodating issues such as the "Rotterdam Effect" (Los et al. 2017).

This data is available for the years 2000 to 2010. For the computations in this study we use the most recent data available, i.e. from the year 2010 so that a time gap of six years to the Brexit referendum in 2016 remains. However, it is likely that the negative effects of offshoring activities as measured by foreign value added shares, take some time until they are visible in voting results because parties have to organize their campaigns around anti-globalization issues, supporting and enhancing voters' sentiments against trade integration and open borders. Thus, it is reasonable to allow for a time gap in investigating the relationship between trade integration and voting results.

Furthermore, it important to consider that the global crisis caused a severe dip in global trade activities, specifically in 2009. Hence, it is likely that our data from 2010 is still affected by this trade shock and slightly underestimates the extent of offshoring activities. Timmer et al. (2016) and Los et al. (2015) show that the dip in the extent of production fragmentation during the crisis was a short-term effect and foreign value added shares re-gained pre-crisis levels rather quickly so that they were back at pre-crisis levels in 2011. Unfortunately, input-output data with regional details for the EU are not available for 2011 or later years. However, we calculated foreign value added shares using pre-crisis data from 2008 and find highly similar results to the ones presented in this study. These are available from the author upon request.

The annual tables cover 14 industries for each of the 266 regions and cover both domestic and international trade flows. Besides 251 European regions, 14 non-EU countries are included.[7] Together, they account for approx. 85% of world GDP (Timmer et al. 2013). In addition, the "Rest of the World" is modeled as a separate region to cover the remaining part of the world economy. The tables allow a differentiation of annual value added in "labor income" and "other income" (remuneration of capital). Details of the construction procedures of the database can be found in Thissen et al. (2017).

All values in the input-output tables are expressed in current euros. This would be an issue of concern if we compared values over time. However, we only use data from 2010 to compute *shares* of regional GDP dependent on final demand by the EU and *shares* of foreign value added in UK regions' industries' final output so that trade flows given in current values should not bias the results.

However, the growing disconnection between the location of production and the ownership of production is an important issue to consider. For example, showing that a certain share of the final output of manufacturing industries in Lincolnshire is added by other EU regions refers to a geography-based measure, i.e. it does not provide any information on the ownership of plants etc. Thus, we assign, for instance, a company's value added generated by providing a service to the transport equipment industry in Lincolnshire to the respective region where this company is located, e.g. in the NUTS2 region of Southern and Eastern Ireland. However, it might be the case that an American firm has set up this company in Ireland (e.g. through joint ventures or FDI) and might employ some American workers. Hence, our foreign value added share by the EU in the output of the transport equipment industry in Lincolnshire will be overestimated. However, we follow Baldwin and Kimura (1998:12) who state that geography-based measures should not be discarded as they remain appropriate measures "for most public policy and research issues."

Furthermore, the role of intangible assets in trade linkages is not considered as for example knowledge on R&D and design cannot be easily measured as physical products crossing a border between regions. This is not only a limitation in measures based on input-output analysis but also concerns conventional trade indicators.

[7] Most EU regions are given on the NUTS2 level while a few are given on the country level due to data limitations or a small country size. These are Bulgaria, Estonia, Latvia, Lithuania, Luxembourg, Malta, Romania and Slovenia. Croatia has been a member of the EU since 2013 but it is not part of the dataset (only in "Rest of the World"). The non-EU countries whose trade values are explicitly included in the dataset are Japan, Brazil, Australia, Mexico, Russia, India, Indonesia, Cyprus, Canada, China, South Korea, Turkey, USA, and Taiwan.

Additionally, it should be emphasized that foreign value added shares only refer to the extent of imported intermediates and not to imported final goods and services. However, the latter might also increase economic insecurity in UK regions by substituting for local production steps. Thus, it may further underestimate the actual offshoring activity. Our computation of foreign value added shares in the final output of a certain industry only reflects the use of foreign intermediates in Global Value Chains where the region-of-completion is in the UK. Thus, it ignores that the final stage of production, e.g. the final assembly of a product, could be offshored itself (Hijzen 2005). If that was the case, our data would not recognize this step as contributing to foreign value added in a production process where the UK is the region-of completion because the region-of completion would be somewhere else.

However, there are also limitations of the methodology that contribute to an overestimation of offshoring and the creation of economic insecurity among voters, working as a counterforce to the underestimation described above. First, production stages in a British Global Value Chain may have always been carried out by foreign countries, e.g. because a certain raw material cannot be sourced locally in the UK due to geographical limitations. This increases the foreign value added share in the computation but cannot be directly related to increased economic insecurity due to offshoring because the foreign sourcing of the raw material may have taken place for a long time. Thus, it is not reasonable to use this increased foreign value added share as an explanation for triggering anti-globalization sentiments due to job losses. Secondly, we can assume that a new company opens in the UK and starts sourcing inputs from the EU or non-EU regions right away. This contributes to a higher foreign value added share in the region where the company is located. However, as the company is new and has never employed local British employees in the production step that is provided by a region outside the UK, it may not cause as much economic insecurity. No British worker has to be fired, re-located or re-trained due to offshoring because offshoring takes place from the moment the company enters the market. However, voters may still be upset about missing out on potential new jobs that would have been created if they company had abstained from offshoring.

Another issue concerns the industry-level nature of the data in Thissen et al. (2017). It uses an average over all firms within one industry in a certain region and it treats their production homogenously. Thus, the analysis leaves ample room for more disaggregated analyses, e.g. using micro data on the firm level because foreign value added shares are likely to differ between firms in the same industry. Similarly, the voting results from the Brexit referendum that we use on the NUTS2 level could be broken down further, e.g. to the NUTS3 level to reveal further

geographical disparities of ‘Leave’ vote shares. Our voting data on the NUTS2 level is taken from Arnorsson and Zoega (2016).

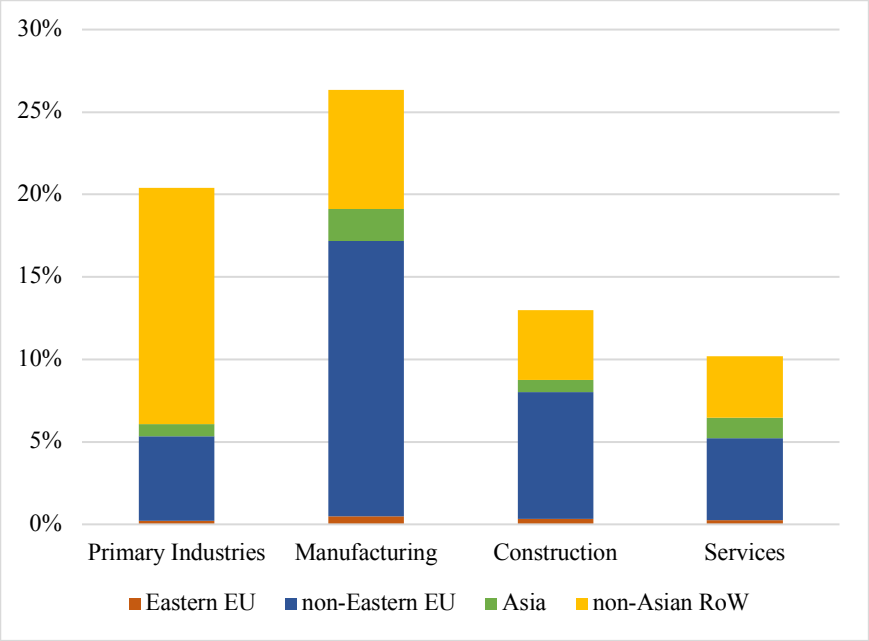
## 6 Results

As shown in the introduction, Los et al. (2017) argue that regions voting ‘Leave’ are to higher extent dependent on final demand by the EU than regions that want to remain in the trade union, suggesting that there is a ‘mismatch’ and that voters voted against economic interests. In fact, they show that London’s share of GDP that is directly dependent on final demand by the EU is the lowest of all UK regions, highlighting that London’s economy will be the least hit by the economic consequences of the Brexit. This can be explained by the fact that London’s economy is more specialized in services with a high global orientation beyond the EU market and by the fact that London’s economy is relatively large and therefore, relatively self-reliant, producing a large share of its output for local use (Chen et al. 2017; Los et al. 2017). In contrast, other UK regions, specifically Northern English regions where the majority voted ‘Leave’ are more specialized in manufacturing, extraction activities and agriculture and thus, more EU-oriented industries. These findings fly in the face of pro-Leave campaigners who argued in favor of more genuine globalization at the expense of Europeanization by promoting negotiations of new trade deals with non-EU countries such as the BRICs (Brazil, Russia, India and China) rather than new EU-directed deals (Los et al. 2017).

However, it remains questionable why and how voters would have based their voting decision in the referendum on the share of their region’s GDP that is dependent on the EU. Would voters in different UK regions feel differently about being a member of the EU because their region’s GDP dependence on the trade union differs by a few percentage points? The perception that voters voted against their economic interest may be true in the sense that Northern English regions are less resilient to economic trade shocks, but it is questionable whether the finding can be held against individual voters by labelling them as economically illiterate. This analysis points to another key driver of the voters’ decision, namely to the extent of offshoring in the region voters live and work in. Job losses due to the relocation of production steps and services to foreign countries are directly perceptible by voters. Therefore, we complement the analysis by Los et al. (2017) by matching regional ‘Leave’ vote shares to regional foreign value added shares that proxy the extent of offshoring.

Figure 5 gives an overview of the UK's foreign value added shares in the weighted final output of different UK industry branches, disaggregated in shares added by Eastern EU regions, non-Eastern EU regions, Asia and the non-Asian rest of the world.

**Figure 5: Overview of the UK's foreign value added shares**




Notes: Primary industries include the first two industries indicated in Table A-1 in the appendix, manufacturing includes industries 3 to 7, construction is industry 8 and services are industries 9 to 14. The average foreign value added shares per individual industry are weighted by their final output values. Additionally, the foreign value added shares in the final output of UK regions are weighted by the UK regions' share in total UK GDP. Eastern EU regions comprise regions that joined the EU in 2004 (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia), whereas non-Eastern EU regions cover the rest of the EU including Cyprus and Malta except for Croatia. Asian regions include Japan, Taiwan, Korea, China, India and Indonesia whereas non-Asian regions include the "Rest of the World" (RoW). Data are for the year 2010.
Source: Author's calculations using Thissen et al. (2017).

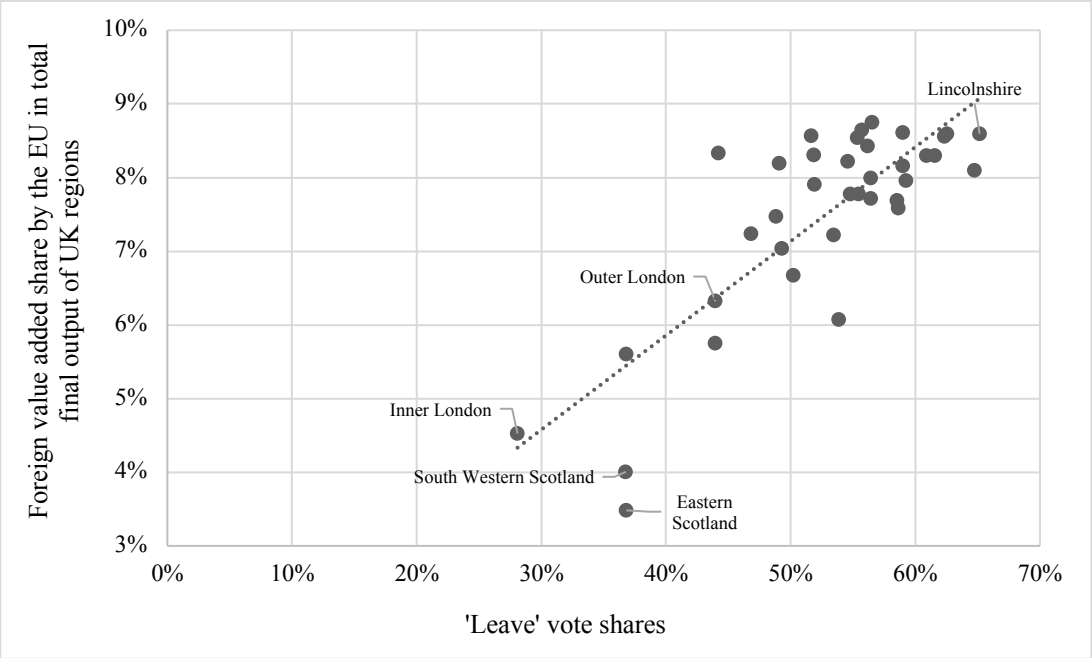
It highlights that the foreign contributions to the final output of manufacturing industries in the UK are relatively larger than the foreign value added shares in primary industries, construction and services. This holds across all UK regions and is in line with previous literature presenting evidence that manufacturing industries are relatively more integrated in Global Value Chains than other industries (Los et al. 2015). Furthermore, Figure 5 shows that the largest part of foreign value added in British manufacturing value chains comes from within the EU, referring back to the aspects of "viscidity" and "spatial inertia" of economic activities that keep production processes together, acting as counterforces to increasingly global production fragmentation trends (Baldwin and Evenett 2012). Further disaggregation beyond Figure 5 shows that the manufacturing industry that sources the highest foreign value added share from the EU are manufacturers of electrical and optical equipment and transport equipment. Eastern EU regions

that joined the trade union in 2004 only make up a very small fraction of the foreign value added, not only in manufacturing but across all UK industries. The contributions by Asian countries are relatively small, too. For example, only 2 percentage points of the total foreign value added share in manufacturing of 26.4% is added in the Far East. Further disaggregation shows that the Asian contributions are specifically high in the textiles and leather industry. Looking at service industries that make up 77.5% of total UK GDP, the foreign value added shares are relatively equally spread between EU regions and non-EU regions including Asia, suggesting a relatively more global trade integration compared to manufacturing industries.

Thus, we conclude from Figure 5 that foreign value added shares are specifically large in manufacturing, especially due to contributions by the EU, whereas the extent of offshoring in services is lower but relatively more globally-oriented.

Next, we turn to the analysis of the relationship between foreign value added shares by the EU and the regional 'Leave' vote shares. This is shown in Figure 6. It considers foreign value added shares in total final output of a region's economy, i.e. foreign value added shares across all 14 industries. Figure 6 presents a significantly positive relationship with the share of 'Leave' votes in each region.

**Figure 6: Foreign value added shares by EU regions in UK regions' total final output and 'Leave' vote shares**




Notes: $R^2$=0.66. The average foreign value added shares in each region are weighted by the region's industries' final output values.
Source: Author's calculations using Thissen et al. (2017).

Thus, it seems to confirm our initial hypothesis as well as previous literature, e.g. by Colantone and Stanig (2017) according to which the extent of offshoring leads to economic insecurity among voters and as public compensation mechanisms are lacking, voters fall for anti-globalization sentiments and favor protectionist policies over remaining in a trade union with open border policies.

Figure 6 indicates that the main pro-EU regions London and Scotland have relatively low foreign value added shares, e.g. 3.5% in Eastern Scotland. In contrast, the Northern English regions where the 'Leave' camp won considerable votes have been subject to offshoring activities to a relatively larger extent. For instance, the weighted foreign value added share in Lincolnshire amounts to 8.6% of the region's final output. Table A-3 in the appendix shows the detailed results for all regions.

Table 3 presents the regression results of further analyses that do not only consider foreign value added shares by the EU in UK industries' output but additionally, foreign value added shares by non-EU regions as well as all non-UK regions, i.e. the total foreign value added shares from all regions outside the UK. The relationship between 'Leave' vote shares and foreign value added shares across all industries is relatively strong as shown by the p-values and the coefficients of determination ($R^2$) in the first three columns and by Figures A-1 and A-2 in appendix A.

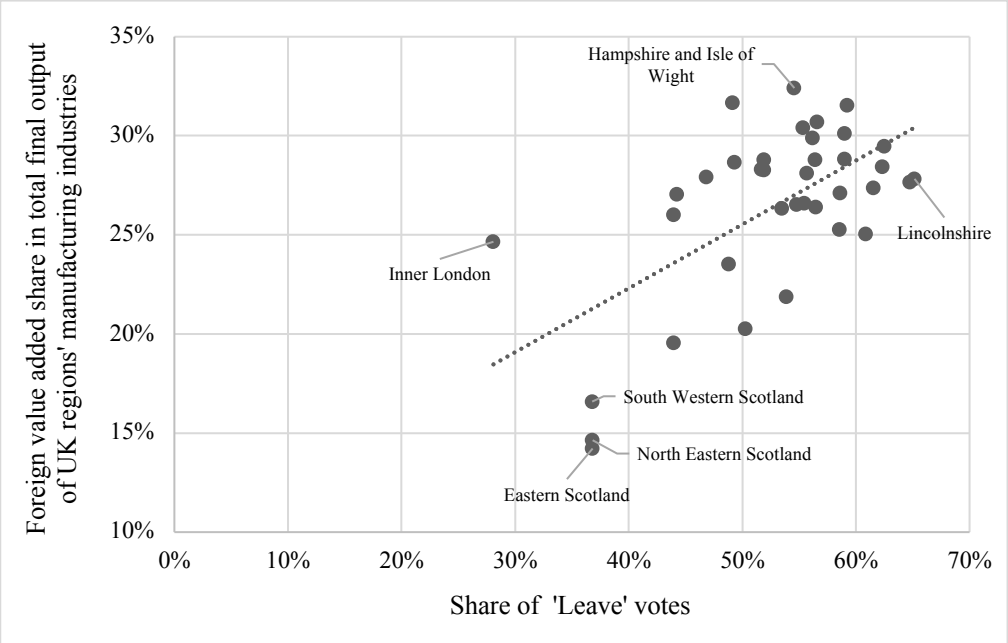
**Table 3: Regression results**

| | Value added shares by EU regions in | Value added shares by non-EU in | Value added shares by non-UK regions in | Value added shares by EU regions in | Value added shares by non-EU in | Value added shares by non-UK regions in |
|---|---|---|---|---|---|---|
| | total regional final output | | | final manufacturing output | | |
| **p-value** | 1.1e-09 | 2.1e-07 | 5.1e-09 | 0.029 | 0.002 | 4.9e-05 |
| **$R^2$** | 0.66 | 0.54 | 0.63 | 0.13 | 0.24 | 0.38 |

Source: Author's calculations using Thissen et al. (2017).

Moreover, we analyze the relationship between the share of 'Leave' votes in a region and the foreign value added shares in UK manufacturing industries for the reasons outlined in the methodology section. As shown in Table 3, the coefficients of determination are lower than in the analyses covering the weighted foreign value added shares across all industries but it remains a significantly positive relationship, especially when considering the foreign contributions to manufacturing Global Value Chains by all non-UK regions. This is shown in Figure 7 whereas Figure A-3 and A-4 in the appendix cover the foreign value added shares by EU regions and non-EU regions respectively.

**Figure 7: Foreign value added shares by non-UK regions in UK regions' manufacturing industries and 'Leave' vote shares**



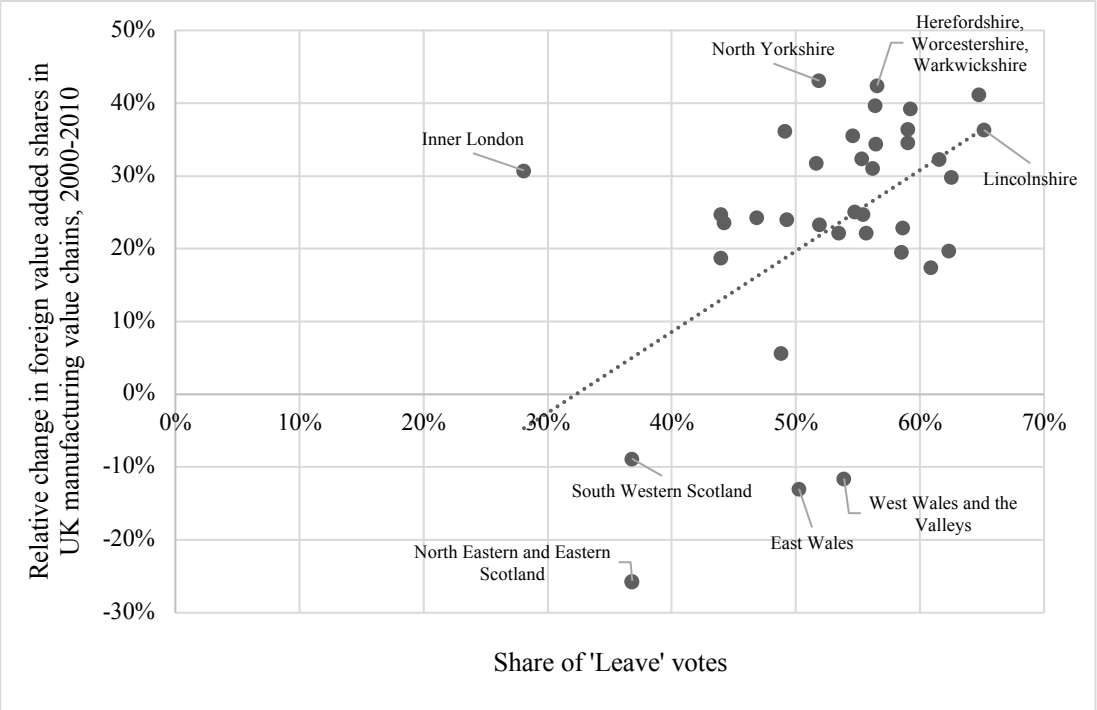

Notes: $R^2$=0.38. The average foreign value added shares in each region are weighted by the region's manufacturing industries' final output values.
Source: Author's calculations using Thissen et al. (2017).

The higher the trade integration in Global Value Chains, the higher seems to be the desire to leave the EU. However, the foreign value added share in the key pro-EU region Inner London is relatively high at 25% because the region's share of manufacturing in its economy is very low, making the sourcing of inputs from abroad necessary. Leaving Inner London out, would increase the coefficient of determination to 0.45. Scottish region's manufacturing dependency on foreign value added shares from abroad are the lowest in the UK whereas offshoring of activities in manufacturing value chains seems to be of relatively great importance in the pro-Leave regions. In fact, all regions that voted to leave the EU show foreign value added shares of more than 20% of the total final output of their manufacturing industries. The result allows hypothesizing that a decreasing number of jobs in manufacturing industries in affected regions could not be counteracted by a steady increase in service sector jobs as suggested by Gagliardi et al. (2015) and Haberler (2013), at least not in the sense that job losers are able to directly offset their loss by finding a new satisfying service job. These dynamics that seem to confirm the Stolper-Samuelson theorem could be analyzed further in subsequent micro studies.

Lastly, the relative change of foreign value added shares in manufacturing value chains between 2000 and 2010 is considered and matched to the regional share of 'Leave' votes in Figure 8. In this time period the global trade integration has increased significantly, amplified for example by China's accession to the World Trade Organization in 2001 and the Eastern EU enlargement

in 2004. These two events together with technological advances in ICT have incentivized and facilitated offshoring. However, as shown in Figure 5, the non-Eastern part of the EU has remained the main contributor to UK manufacturing industries.

**Figure 8: Relative change of foreign value added shares in UK regions' manufacturing industries from 2000 to 2010 and 'Leave' vote shares**




Notes: $R^2$=0.27.
Source: Author's calculations using Thissen et al. (2017).

As expected, the relative change of foreign value added shares over the 10 year period shows a significantly positive relationship with the regional 'Leave' vote shares. The more offshoring has taken place as proxied by the foreign value added contributions to the total final output of British manufacturing industries, the more jobs may have been lost in the first decade of the 21st century. This may have contributed to higher economic insecurity in the region and as redistribution mechanisms have been lacking, the louder has been the call for protectionist policies, as proxied by the share of 'Leave' votes. As indicated in Figure 8, in a few NUTS2 regions, Scotland and Wales, the foreign value added shares decreased within this 10-year time period, a potential indicator that these regions are on track in attracting economic activity through onshoring activities.

In contrast, Lincolnshire's foreign value added share in manufacturing has increased by 36%, in Herefordshire, Worcestershire and Warwickshire it has increased by 42% and in North Yorkshire's final manufacturing output by 43%. Hence, following our reasoning outlined above,

the majority vote for 'Leave' in these regions should not have come as surprise. Again, Inner London stands out in this graph as its foreign value added shares have increased by 31% as well. However, this region's manufacturing contribution to overall regional GDP is the lowest among all UK regions with 1.8%. Therefore, offshoring in the manufacturing sector may not increase economic insecurity among the London voters who are mostly employed in service industries. Therefore, it may not have incentivized voting in favor of the Brexit as much as in other English regions where a higher share of voters has been directly employed in manufacturing industries.

Overall, these results highlight the importance of putting the 'mismatch' between the regional 'Leave' vote share and the regional GDP dependence on final demand by the EU, as found by Los et al. (2017) into perspective. Our analysis reveals that foreign value added shares, used as a proxy for offshoring, are equally important to consider. Thus, we contribute to explaining the "paradoxical result" found by Los et al. (2017) (Garretsen et al. 2018:167) while acknowledging that the offshoring indicator can be further improved, e.g. by taking employment statistics into account that could reveal in more detail which jobs have been lost due to offshoring. Furthermore, our results show that offshoring does not only matter in manufacturing industries but offshoring in services, where the majority of the UK population is employed, should be taken into account, too. Regional foreign value added shares across all industries and regional 'Leave' vote shares show the most significant relationship among the analyses conducted in this study.

## 7 Conclusion

The result of the Brexit referendum has taken many by surprise, leading several commentators to look into the question why voters decided the way they did. In contrast to previous literature explaining the outcome of the referendum, we make use of input-output analysis in order to account for the fact that gross import values do not accurately reflect the dependency on foreign value added in a world of fragmented production processes. We match regional voting data from the referendum on the NUTS2 level to regional foreign value added shares by other EU regions as well as by non-EU regions. We use these foreign value added shares as proxies for the extent of offshoring to these regions outside the UK while we are critically aware of the limitations of this measure. For example, the methodology cannot differentiate between newly offshored activities that cause job losses in the UK and newly built companies that source inputs from abroad right away, affecting the local labor market not by job losses but merely by missing out on potential job gains. However, we still consider foreign value added shares as a highly relevant

measure because they capture the implications of fragmented production processes better than traditional trade indicators.

We find that there is a significantly positive relationship between the share of 'Leave' votes in a region and the relative change of foreign value added shares in manufacturing industries between 2000 and 2010. Furthermore, the vote for the Brexit does not seem to be a vote specifically against trade integration with the EU but a broader vote against globalization as we present evidence that the 'Leave' vote shares are not only correlated with foreign value added shares by the EU but also with foreign value added shares by non-EU regions. Furthermore, foreign value added shares are highest in manufacturing industries but offshoring increasingly affects service industries, too, e.g. due advances in communication technologies. In fact, the relationship between pro-Brexit votes and our offshoring indicator is most significant if one considers the foreign value added shares across all industries, with a coefficient of determination of 0.66.

Thus, our results suggest that deep trade integration in Global Value Chains has left many northern English regions in economic decay, causing a political backlash to offshoring activities and open border policies. Hence, trade integration in Global Value Chains seems to go hand in hand with anti-globalization sentiments in the UK. It could be the subject of future research to analyze whether the results presented here which point towards confirming the argument that globalization incentivizes a counterforce to itself, apply similarly in other Western countries.

In fact, the pro-Leave campaign slogan "Let's take back control" seems to have hit a sore spot in the UK and thus, has been very resonant for voters who have been deprived of their economic prospects. Consequently, neither voters nor regions should be left labelled as voting "against their (own) interest" but rather, one should listen and try to understand their voting decisions as best as possible in order to react with concrete policy actions beyond lip services (Garretsen et al. 2018:167).

Nevertheless, we strongly believe that stopping globalization forces and returning to protectionist policies is the wrong way as it would not only harm growth in emerging economies but also in the UK and other Western countries (Chen et al. 2017). Instead, policy makers should focus on balancing the gains and pains from trade integration across regions, provide more flexible labor markets that facilitate the re-allocation of workers from increasingly offshored and hence, stagnating industries to industries benefitting from the "second unbundling" (Baldwin 2006:76). Economic analyses on the subnational level are valuable resources in this undertaking as they offer insights where public safety nets for job losers and re-training programs are most severely required (Wannicke 2017). Thus, the policy implications derived from our study are in

line with Rodrik (1998) who argues that open states require bigger governments. Redistributive policies need to re-focus from London and the South East to relatively more affected English regions. Using the 'geography of discontent', revealed by the Brexit referendum, as a first broad indicator where compensation mechanisms are lacking the most, seems to be reasonable.

Future analyses in this field could include detailed employment statistics to get a clearer picture of regional job losses associated with offshoring of value added stages in both manufacturing and service industries, potentially on a more disaggregated level than NUTS2 to provide better policy implications for territorial development plans. Hence, we would welcome input-output tables on the NUTS3 level with data beyond the year 2010. Matching input-output data to detailed local employment statistics would improve the imperfect offshoring proxy used in this study.

Overall, our analysis contributes to a clearer understanding of the Brexit vote's roots by going beyond labelling voters as economically illiterate. However, we emphasize that the call for protectionism should give way to a call for a more inclusive model of globalization in which as many regions and individuals as possible are given the chance to reap benefits from open borders. We are hopeful that the most important result of the Brexit will be that policy makers switch from hearing the voters' voices to listening to the voters' voices and react by making the opportunities of globalization more accessible to a larger share of the population in the UK and other Western countries.

## 8 References


Acemoglu, D., Dorn, D., Hanson, G. H., & Price, B. (2016). Import Competition and the Great US Employment Sag of the 2000s, *Journal of Labor Economics*, vol. 34, no. 1, pp. 141-198, Available online: http://dx.doi.org/10.1086/682384 (accessed May 14, 2018).

Arnorsson, A. & Zoega, G. (2016). On the Causes of Brexit, CESifo Working Paper Series, no. 6056, Available online: https://ssrn.com/abstract=2851396 (accessed May 12, 2018).

Autor, D. H., Dorn, D., & Hanson, G. H. (2013). The China Syndrome: Local labor market effects of import competition in the United States, *American Economic Review*, vol. 103, no. 6, pp. 2121-2168, Available online: http://www.aeaweb.org/articles?id=10.1257/aer.103.6.2121 (accessed May 12, 2018).

Autor, D. H., Dorn, D., Hanson, G. H. & Majlesi, K. (2016). Importing Political Polarization? The Electoral Consequences of Rising Trade Exposure, NBER Working Paper, no. 22637, Available Online: http://www.nber.org/papers/w22637.pdf (accessed May 9, 2018).

Baldwin, R. E. (2006). Globalisation: the Great Unbundling(s), in *Globalisation Challenges for Europe*, Office of the Prime Minister of Finland, Helsinki.

Baldwin, R. E. & Evenett, S. J. (2012). Value Creation and Trade in 21st Century Manufacturing: What Policies for UK Manufacturing? in D. Greenaway (ed.): *The UK in a Global World. How can the UK focus on steps in global value chains that really add value?*, London: Centre for Economic Policy Research, pp. 71-128.

Baldwin, R. E. & Kimura, F. (1998). Measuring U.S. International Goods and Services Transactions, in R. E. Baldwin, R. E. Lipsey, & J. D. Richards (eds.): *Geography and Ownership as Bases for Economic Accounting*, Chicago: University of Chicago Press, pp. 9-48.

Becker, S., Fetzer, T., & Novy, D. (2017). Who voted for Brexit? A comprehensive district-level analysis, *Economic Policy*, vol. 32, no. 92, pp. 601-650, Available online: https://doi.org/10.1093/epolic/eix012 (accessed May 4, 2018).

Bell, B. & Machin, S. (2016). Brexit and wage inequality, in R. E. Baldwin (ed.): *Brexit Beckons: Thinking ahead by leading economists*, A VoxEU.org Book, London: CEPR Press, pp. 111-114.

Chen, W., Los, B., McCann, P., Ortega-Argilés, R., Thissen, M., & van Oort, F. (2017). The Continental Divide? Exposure to Brexit in Regions and Countries on Both Sides of the Channel, *Papers in Regional Science*, vol. 97, no. 1, pp. 25-54, Available online: https://doi.org/10.1111/pirs.12334 (accessed May 4, 2018).

Colantone, I. & Stanig, P. (2016). Global Competition and Brexit, BAFFI CAREFIN Centre Research Paper, no. 2016-2044, Available online: http://dx.doi.org/10.2139/ssrn.2870313 (accessed May 4, 2018).

Colantone, I. & Stanig, P. (2017). The Trade Origins of Economic Nationalism: Import Competition and Voting Behavior in Western Europe, BAFFI CAREFIN Centre Research Paper 2017-49, Available online: http://dx.doi.org/10.2139/ssrn.2904105 (accessed May 4, 2018).

Coyle, D. (2016). Brexit and globalization, in R. E. Baldwin (ed.): *Brexit Beckons: Thinking ahead by leading economists*, A VoxEU.org Book, London: CEPR Press, pp. 23-28.

Crescenzi, R., Di Cataldo, M. & Faggian, A. (2017). Internationalized at Work and Localistic at Home: The 'split' Europeanization behind Brexit, *Papers in Regional Science*, vol. 97, no. 1, pp.117-132, Available online: https://doi.org/10.1111/pirs.12350 (accessed May 9, 2018).

Dedrick, J., Kraemer, K. L., & Linden, G. (2010). Who profits from innovation in global value chains? A study of the iPod and notebook PCs, *Industrial and Corporate Change,* vol. 19, no. 1, pp. 81-116, Available online: http://dx.doi.org/dtp032 (accessed May 1, 2018).

Dippel, C., Gold, R. & Heblich, S. (2015). Globalization and Its (Dis-) Content: Trade Shocks and Voting Behavior, NBER Working Paper, no. 21812, Available online: https://ssrn.com/abstract=2706313 (accessed May 4, 2018).

Feenstra, R. C. & Hanson, G. H. (1996). Globalization, Outsourcing, and Wage Inequality, *American Economic Review*, vol. 86, no. 2, pp. 240-245, Available online: http://www.jstor.org/stable/2118130 (accessed May 4, 2018).

Gagliardi, L., Iammarino, S. & Rodríguez-Pose, A. (2015). Offshoring and the Geography of Jobs in Great Britain, SERC Discussion Paper, no.185, Available online: http://eprints.lse.ac.uk/id/eprint/65018 (accessed May 4, 2018).

Garretsen, H., Stoker, J. I., Soudis, D., Martin, R. L. & Rentfrow, P. J. (2018). Brexit and the Relevance of Regional Personality Traits: More Psychological Openness Could Have Swung the Regional Vote, *Cambridge Journal of Regions, Economy and Society*, vol. 11, no. 10, pp.165-175, Available online: https://academic.oup.com/cjres/advance-article/doi/10.1093/cjres/rsx031/4838371 (accessed May 9, 2018).

Gereffi, G. (1999). International trade and industrial upgrading in the apparel commodity chain, *Journal of International Economics*, vol. 48, no. 1, pp. 37-70, Available online: https://doi.org/10.1016/S0022-1996(98)00075-0 (accessed May 1, 2018).

Goodwin, M. J. & Heath, O. (2016). The 2016 Referendum, Brexit and the Left Behind: An Aggregate-Level Analysis of the Result, *Political Quarterly*, vol. 87, no. 3, pp.323-332, Available online: http://onlinelibrary. wiley.com/doi/10.1111/1467-923X.12285/pdf (accessed May 9, 2018).

Guiso, L., Herrera, H., Morelli, M., & Sonno, T. (2017). The spread of populism in Western countries, Centre for Economic Policy Research, Available online: https://voxeu.org/article/spread-populism-western-countries (accessed April 18, 2017).

Guriev, S., Leipziger, D., & Ostry, J. D. (2017). Making globalisation more inclusive: A way forward, Centre for Economic Policy Research, Available online: https://voxeu.org/article/making-globalisation-more-inclusive (accessed April 6, 2018).

Haberler, G. (2013). Der Internationale Handel: Theorie der Weltwirtschaftlichen Zusammenhänge sowie Darstellung und Analyse der Aussenhandelspolitik, Berlin: Springer Verlag, Available Online: https://books.google.se/books?id=J1mNBwAAQBAJ (accessed May 4, 2018).

Hijzen, A. (2005). A bird's eye view of international outsourcing: Data, measurement and labour demand effects, *Économie internationale*, vol. 4, no.104, pp. 45-63, Available online: https://www.cairn.info/revue-economie-internationale-2005-4-page-45.htm (accessed May 1, 2018).

Hummels, D., Ishii, J., & Yi, K. (2001). The Nature and Growth of Vertical Specialisation in World Trade, *Journal of International Economics*, vol. 54, no. 1, pp. 75- 96, Available online: https://doi.org/10.1016/S0022-1996(00)00093-3 (accessed May 1, 2018).

Johnson, R. C. (2014). Five Facts about Value-Added Exports and Implications for Macroeconomics and Trade Research, *Journal of Economic Perspectives,* vol. 28, no. 2, pp. 119-142, Available online: http://www.aeaweb.org/articles?id=10.1257/jep.28.2.119 (accessed May 1, 2018).

Kaufmann, E. (2016). It's NOT the economy, stupid: Brexit as a story of personal values, British Politics and Policy Blog, London School of Economics, Available online: http://blogs.lse.ac.uk/politicsandpolicy/personal-values-brexit-vote/ (accessed May 9, 2018).

Leipziger, D. (2016). Make globalisation more inclusive or suffer the consequences, Centre for Economic Policy Research, Available online: https://voxeu.org/article/make-globalisation-more-inclusive-or-suffer-consequences (accessed April 6, 2018).

Leontief, W. (1936). Quantitative input-output relations in the economic system of the United States, *Review of Economics and Statistics,* vol. 18, no. 3, pp. 105-25, Available online: http://www.jstor.org/stable/1927837 (accessed May 2, 2018).

Leontief, W. (1949). Structural matrices of national economies, *Econometrica,* vol. 17 (Suppl.), pp. 273-282, Available online: http://www.jstor.org/stable/1907314 (accessed May 2, 2018).

Lewis-Beck, M. S. & Stegmaier, M. (2007). Economic Models of Voting in R. J. Dalton & H.-D. Klingemann (eds.): *The Oxford Handbook of Political Behavior*, Oxford: Oxford University Press, pp.1-25.

Los, B., McCann, P., Springford, J., & Thissen, M. (2017). The Mismatch between Local Voting and the Local Economic Consequences of Brexit, *Regional Studies*, vol. 51, no. 5, pp. 786-799, Available online: https://doi.org/10.1080/00343404.2017.1287350 (accessed April 4, 2018).

Los, B., Timmer, M. P. & de Vries, G. J. (2015). How Global Are Global Value Chains? A New Approach to Measure International Fragmentation, *Journal of Regional Science*, vol. 55, no. 1, pp. 66-92, Available online: https://doi.org/10.1111/jors.12121 (accessed April 15, 2018).

Malgouyres, C. (2017). Trade Shocks and Far-Right Voting: Evidence from French Presidential Elections, Robert Schuman Centre for Advanced Studies, Research Paper, no. 2017/21, Available online: https://ssrn.com/abstract=2942173 (accessed May 2, 2018).

McCann, P. (2016). The UK regional-national economic problem: Geography, globalisation and governance, London: Routledge.

Milanovic, B. (2012). Global income inequality by the numbers: In history and now - an overview, *World Bank Policy Research Working Paper*, no. 6259, Available online: http://documents.worldbank.org/curated/en/959251468176687085/pdf/wps6259.pdf (accessed April 5, 2018).

Morris, C. (2018). Made in Britain: What does it mean for trade after Brexit? BBC News, March 26, Available online: http://www.bbc.com/news/uk-politics-43516496 (accessed April 5, 2018).

O'Rourke, K. H. (2016). This backlash has been a long time coming, in R. E. Baldwin (ed.): *Brexit Beckons: Thinking ahead by leading economists*, A VoxEU.org Book, London: CEPR Press, pp. 43-49.

O'Rourke, K. H. & Williamson, J. (1999). Globalization and History: The Evolution of a Nineteenth-Century Atlantic Economy, Cambridge, MA: MIT Press.

Pierce, J. R. & Schott, P. K. (2016). The Surprisingly Swift Decline of US Manufacturing Employment, *American Economic Review*, vol. 106, no. 7, pp. 1632-1662, Available online: http://www.aeaweb.org/articles?id=10.1257/aer.20131578 (accessed April 20, 2018).

Rodríguez-Pose, A. (2018). The revenge of the places that don't matter (and what to do about it), *Cambridge Journal of Regions, Economy and Society,* vol. 11, no. 1, pp. 189-209, Available online: https://doi.org/10.1093/cjres/rsx024 (accessed April 18, 2018).

Rodrik, D. (1997). Has Globalization Gone Too Far?, Washington, D.C.: Peterson Institute for International Economics.

Rodrik, D. (1998). Why do More Open Economies Have Bigger Governments?, *Journal of Political Economy*, vol. 106, no. 5, pp. 997-1032, Available online: http://www.jstor.org/stable/10.1086/250038 (accessed April 28, 2018).

Rodrik, D. (2017). Populism and the Economics of Globalization, NBER Working Paper, no. 23559, Available online: https://www.cssrn.com/abstract=2992819 (accessed May 1, 2018).

Schwörer, T. (2013). Offshoring, domestic outsourcing and productivity: evidence for a number of European countries, *Review of World Economics*, vol. 149, no. 1, pp. 131-149, Available online: http://www.jstor.org/stable/42636095 (accessed May 2, 2018).

Sturgeon, T., Van Biesebroeck, J., & Gereffi, G. (2008). Value chains, networks and clusters: reframing the global automotive industry, *Journal of Economic Geography*, vol. 8, no.3, pp. 297-321, Available online: https://doi.org/10.1093/jeg/lbn007 (accessed May 1, 2018).

Thissen, M., Lankhuizen, M., Los, B., van Oort, F. & Diodato, D. (2017). EUREGIO: A Global Input-Output Database with Regional Detail for Europe, GGDC Research Memorandum 172, University of Groningen.

Timmer, M. P. (2015). Slicing Up Global Value Chain: Major trends in the cost structure of global production, Presentation at the ECB conference "Enhancing competitiveness and fostering sustainable growth: methodological issues and empirical results" in Frankfurt, June 2015, Available online: https://www.ecb.europa.eu/home/pdf/research/compnet/20150625/1g_Timmer.pdf?ec3121493203812c520758fbd12b183e (accessed April 1, 2018).

Timmer, M. P., Los, B., Stehrer, R., & de Vries, G. J. (2013). Fragmentation, Incomes and Jobs. An analysis of European competitiveness, *Economic Policy*, vol. 28, no. 76, pp. 613-661, Available online: https://doi.org/10.1111/1468-0327.12018 (accessed May 1, 2018).

Timmer, M. P., Los, B., Stehrer, R., & de Vries, G. J. (2016). An anatomy of the global trade slowdown based on the WIOD 2016 release, GGDC Research Memorandum 192, University of Groningen, Available online: http://www.ggdc.net/publications/memorandum/gd162.pdf (accessed May 1, 2018).

Wannicke. V. (2017). Why has Europe's productive core become fragmented during the 2000s? The effects of China's rise and the Eastern EU enlargement on the "Blue Banana", Master's Thesis, University of Groningen.

Winstanley Norris, L. (2012). Factory of broken dreams: The demise of Britain's textile industry is leaving behind impressive buildings, The Independent, Available online: https://www.independent.co.uk/news/uk/this-britain/factory-of-broken-dreams-the-demise-of-britains-textile-industry-is-leaving-behind-impressive-8206081.html#gallery (accessed May 8, 2018).

World Bank (2018). World Development Indicators, Available online: https://data.worldbank.org/country/united-kingdom (accessed May 6, 2018).

# 9 Appendix A

## Table A-1: List of industries in global input-output tables with regional detail

| Industry name | |
|---|---|
| 1 | Agriculture |
| 2 | Mining, quarrying and energy supply |
| 3 | Food, beverages and tobacco |
| 4 | Textiles and leather etc. |
| 5 | Coke, refined petroleum, nuclear fuel and chemicals etc. |
| 6 | Electrical and optical equipment and transport equipment |
| 7 | Other manufacturing |
| 8 | Construction |
| 9 | Distribution |
| 10 | Hotels and restaurants |
| 11 | Transport storage and communication |
| 12 | Financial intermediation |
| 13 | Real estate, renting and business activities |
| 14 | Non-market services |

Source: Thissen et al. (2017).

## Table A-2: 'Leave' vote shares by NUTS2 region

| NUTS2 Code | Region Name | Leave vote share in % |
|---|---|---|
| UKC1 | Tees Valley and Durham | 60.9 |
| UKC2 | Northumberland, Tyne and Wear | 55.7 |
| UKD1 | Cumbria | 56.4 |
| UKD2 | Cheshire | 51.7 |
| UKD3 | Greater Manchester | 53.5 |
| UKD4 | Lancashire | 59.0 |
| UKD5 | Merseyside | 48.8 |
| UKE1 | East Riding and North Lincolnshire | 64.8 |
| UKE2 | North Yorkshire | 51.9 |
| UKE3 | South Yorkshire | 61.6 |
| UKE4 | West Yorkshire | 54.8 |
| UKF1 | Derbyshire and Nottinghamshire | 58.5 |
| UKF2 | Leicestershire, Rutland and Northamptonshire | 59.0 |
| UKF3 | Lincolnshire | 65.2 |
| UKG1 | Herefordshire, Worcestershire and Warwickshire | 56.6 |
| UKG2 | Shropshire and Staffordshire | 62.5 |
| UKG3 | West Midlands | 58.6 |
| UKH1 | East Anglia | 55.5 |
| UKH2 | Bedfordshire and Hertfordshire | 51.9 |
| UKH3 | Essex | 62.3 |
| UKI1 | Inner London | 28.1 |
| UKI2 | Outer London | 44.0 |
| UKJ1 | Berkshire, Buckinghamshire and Oxfordshire | 46.8 |
| UKJ2 | Surrey, East and West Sussex | 49.3 |
| UKJ3 | Hampshire and Isle of Wight | 54.6 |
| UKJ4 | Kent | 59.3 |
| UKK1 | Gloucestershire Wiltshire and North Somerset | 49.1 |
| UKK2 | Dorset and Somerset | 56.2 |
| UKK3 | Cornwall and Isles of Scilly | 56.5 |
| UKK4 | Devon | 55.3 |
| UKL1 | West Wales and The Valleys | 53.9 |
| UKL2 | East Wales | 50.3 |
| UKM2 | North Eastern Scotland | 36.8 |
| UKM3 | Eastern Scotland | 36.8 |
| UKM5 | South Western Scotland | 36.8 |
| UKM6 | Highlands and Islands | 44.0 |
| UKN0 | Northern Ireland | 44.2 |
| | *United Kingdom* | *51.9* |

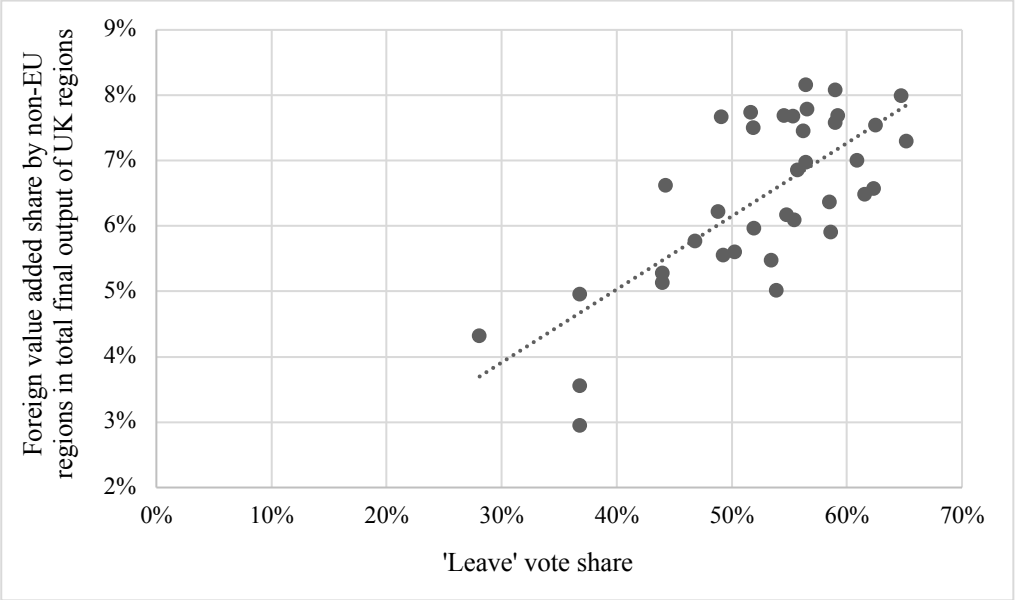
Notes: The region codes used in this study are the ones published by Eurostat in 2010.
Data Source: Arnosson and Zoega (2016).

## Table A-3: Foreign value added shares in UK regions' industries' final output

| NUTS2 Code | Region Name | Value added shares by EU regions in | Value added shares by non-EU regions in | Value added shares by non-UK regions in | Value added shares by EU regions in | Value added shares by non-EU regions in | Value added shares by non-UK regions in |
|---|---|---|---|---|---|---|---|
| | | total regional final output in % | | | final manufacturing output in % | | |
| UKC1 | Tees Valley and Durham | 8 | 7 | 15 | 17 | 8 | 25 |
| UKC2 | Northumberland, Tyne and Wear | 9 | 7 | 16 | 20 | 8 | 28 |
| UKD1 | Cumbria | 8 | 8 | 16 | 13 | 16 | 29 |
| UKD2 | Cheshire | 9 | 8 | 16 | 16 | 12 | 28 |
| UKD3 | Greater Manchester | 7 | 5 | 13 | 19 | 7 | 26 |
| UKD4 | Lancashire | 8 | 8 | 16 | 15 | 14 | 29 |
| UKD5 | Merseyside | 7 | 6 | 14 | 16 | 8 | 24 |
| UKE1 | East Riding and North Lincolnshire | 8 | 8 | 16 | 13 | 14 | 28 |
| UKE2 | North Yorkshire | 8 | 8 | 16 | 16 | 12 | 28 |
| UKE3 | South Yorkshire | 8 | 6 | 15 | 20 | 8 | 27 |
| UKE4 | West Yorkshire | 8 | 6 | 14 | 19 | 8 | 27 |
| UKF1 | Derbyshire and Nottinghamshire | 8 | 6 | 14 | 18 | 7 | 25 |
| UKF2 | Leicestershire, Rutland and Northamptonshire | 9 | 8 | 17 | 16 | 14 | 30 |
| UKF3 | Lincolnshire | 9 | 7 | 16 | 16 | 12 | 28 |
| UKG1 | Herefordshire, Worcestershire, Warwickshire | 9 | 8 | 17 | 17 | 13 | 31 |
| UKG2 | Shropshire and Staffordshire | 9 | 8 | 16 | 16 | 13 | 29 |
| UKG3 | West Midlands | 8 | 6 | 13 | 20 | 7 | 27 |
| UKH1 | East Anglia | 8 | 6 | 14 | 19 | 7 | 27 |
| UKH2 | Bedfordshire, Hertfordshire | 8 | 6 | 14 | 21 | 8 | 29 |
| UKH3 | Essex | 9 | 7 | 15 | 19 | 9 | 28 |
| UKI1 | Inner London | 5 | 4 | 9 | 17 | 8 | 25 |
| UKI2 | Outer London | 6 | 5 | 12 | 18 | 8 | 26 |
| UKJ1 | Berkshire, Buckinghamshire and Oxfordshire | 7 | 6 | 13 | 20 | 8 | 28 |
| UKJ2 | Surrey, East and West Sussex | 7 | 6 | 13 | 21 | 7 | 29 |
| UKJ3 | Hampshire and Isle of Wight | 8 | 8 | 16 | 18 | 15 | 32 |
| UKJ4 | Kent | 8 | 8 | 16 | 16 | 16 | 32 |
| UKK1 | Gloucestershire Wiltshire and North Somerset | 8 | 8 | 16 | 17 | 14 | 32 |
| UKK2 | Dorset and Somerset | 8 | 7 | 16 | 17 | 13 | 30 |
| UKK3 | Cornwall and Isles of Scilly | 8 | 7 | 15 | 15 | 12 | 26 |
| UKK4 | Devon | 9 | 8 | 16 | 17 | 13 | 30 |
| UKL1 | West Wales and The Valleys | 6 | 5 | 11 | 13 | 9 | 22 |
| UKL2 | East Wales | 7 | 6 | 12 | 12 | 9 | 20 |
| UKM2 | North Eastern Scotland | 6 | 5 | 11 | 9 | 6 | 15 |
| UKM3 | Eastern Scotland | 3 | 3 | 6 | 9 | 5 | 14 |
| UKM5 | South Western Scotland | 4 | 4 | 8 | 10 | 7 | 17 |
| UKM6 | Highlands and Islands | 6 | 5 | 11 | 10 | 9 | 20 |
| UKN0 | Northern Ireland | 8 | 7 | 15 | 20 | 8 | 27 |
| | *United Kingdom* | *7* | *6* | *13* | *17* | *10* | *27* |

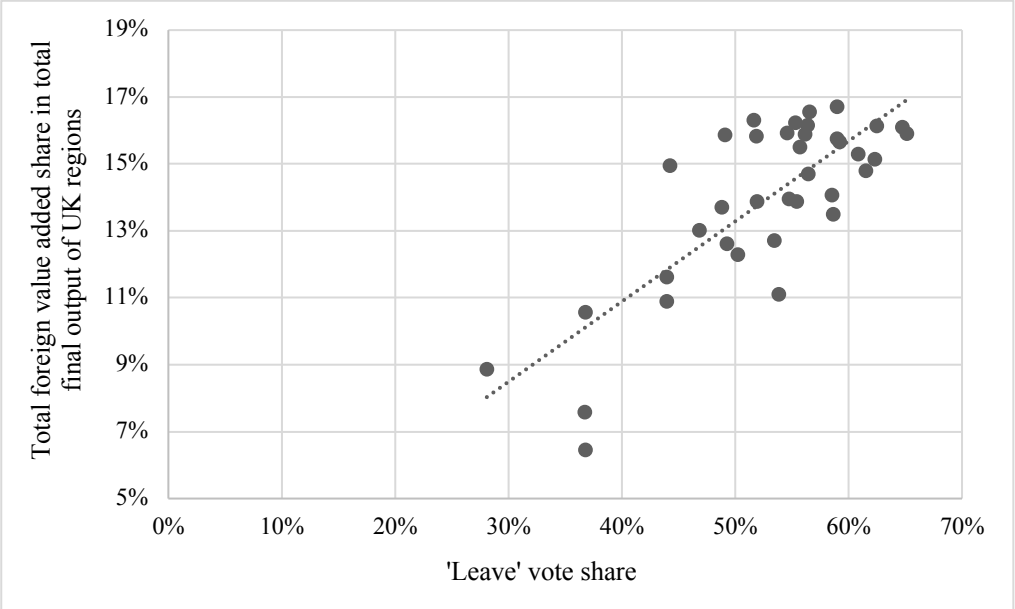
Notes: The values in the three leftmost columns indicate the weighted average foreign value added share in the final output of all industries within one UK region in 2010. The values in the three rightmost columns indicate the weighted average foreign value added share in the final output of manufacturing industries (industries 3 to 7 as indicated in Table A-1) within one region in 2010. The average shares are weighted with the final output values in 2010 of the respective industries considered. The average foreign value added shares of the UK as a whole, indicated in the last row, are weighted by the regions' final output values in the respective industries considered.
Source: Author's calculations using Thissen et al. (2017).

**Figure A-1: Foreign value added shares by non-EU regions in UK regions' total final output and 'Leave' vote shares**



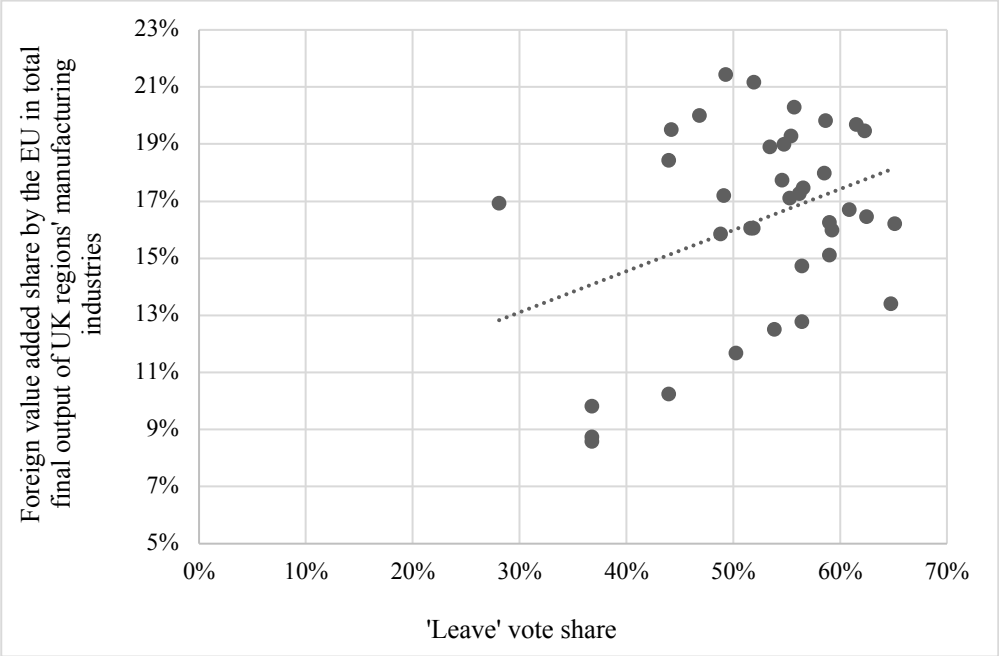

Notes: $R^2$=0.54. The average foreign value added shares in each region are weighted by the region's industries' final output values.
Source: Author's calculations using Thissen et al. (2017).

**Figure A-2: Foreign value added shares by non-UK regions in UK regions' total final output and 'Leave' vote shares**



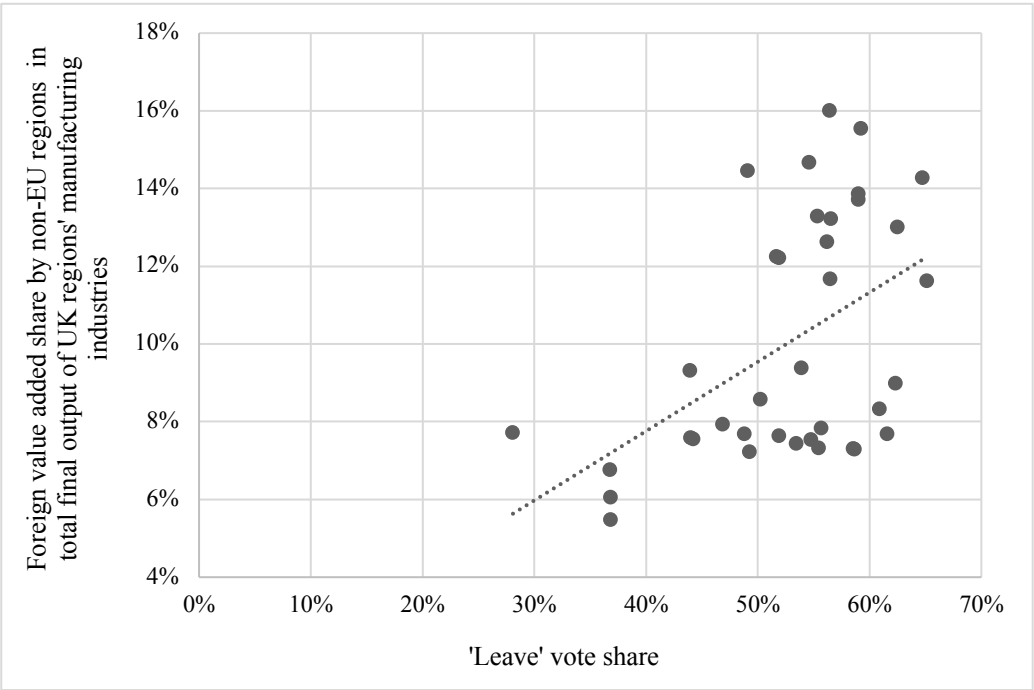

Notes: $R^2$=0.63. The average foreign value added shares in each region are weighted by the region's industries' final output values.
Source: Author's calculations using Thissen et al. (2017).

**Figure A-3: Foreign value added shares by EU regions in UK regions' manufacturing industries and 'Leave' vote shares**




Notes: $R^2$=0.13. The average foreign value added shares in each region are weighted by the region's manufacturing industries' final output values.
Source: Author's calculations using Thissen et al. (2017).

**Figure A-4: Foreign value added shares by non-EU regions in UK regions' manufacturing industries and 'Leave' vote shares**




Notes: $R^2$=0.24. The average foreign value added shares in each region are weighted by the region's manufacturing industries' final output values.
Source: Author's calculations using Thissen et al. (2017).

# 10 Appendix B

## 10.1 Computation of regional GDP dependence on foreign final demand

This section draws on Los et al. (2017) and explains the computation of regional GDP dependencies on final demand by the EU as shown in Figure 1 in the introduction.

Using the region of Lincolnshire as an example, the computation of the region's dependence on final demand by the EU compares Lincolnshire's actual regional GDP with a hypothetical situation. In the latter, final demand for goods or services by all non-EU regions and all other UK regions is set to zero. Thus, only trade flows of final and intermediate products that are dependent on final demand from EU regions outside the UK remain in the hypothetical situation. Hence, Lincolnshire's economic dependency on the EU (in %) can be calculated by dividing the hypothetical regional GDP due to the EU's final demand by the actual GDP value that considers all final demand.

First, the region's actual GDP is calculated. This is done by summing over all value added in one region-industry, i.e. all labor and other income. This gives us the row vector **w** as shown in Table 1. GDP per region can be derived by taking the sum of the respective industries per region from **w**. Second, GDP in the hypothetical situation is calculated. The column vector **f** is adjusted to $\mathbf{f}^{new}$ so that it only considers final demand by regions in the EU (except UK regions). To calculate the new hypothetical output levels per region-industry pair denoted by the column vector $\mathbf{x}^{new}$, we multiply the unchanged "Leontief inverse" **L** by the new column vector of final demand.

*(A-1)* $$\mathbf{x}^{\mathrm{new}} = \mathbf{L} * \mathbf{f}^{\mathrm{new}}$$

Value added coefficients **b** (1xMN)**,** indicating value added per unit of gross output, are derived by multiplying the sum of all value added in one region-industry (**w**) by the inverse of the diagonalized initial vector **x**. Using the unchanged value added coefficients **b,** the total value added ($\mathbf{w}^{new}$) changes due to the new output levels.

*(A-2)* $$\mathbf{w}^{\mathrm{new}} = \hat{\mathbf{b}} * \mathbf{x}^{\mathrm{new}}$$

Finally, the hypothetical GDP per region is derived by taking the sum of the respective industries per region from the row vector $\mathbf{w}^{new}$. Thereafter, the ratio of the hypothetical GDP and the actual regional GDP is taken to derive the share of GDP that is directly dependent on final demand by other EU regions outside the country under consideration. For Lincolnshire this value is 10.7%, implying that more than a tenth of all labor and capital income generated in this region is at risk of being affected by higher trade costs with the EU after the UK's exit from the trade union.