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Los, Bart; McCann, Philip; Springford, John; Thissen, Mark

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The mismatch between local voting and the local economic consequences of Brexit

Bart Los[a], Philip McCann[b], John Springford[c] and Mark Thissen[d]

ABSTRACT
The mismatch between local voting and the local economic consequences of Brexit. *Regional Studies*. This paper reveals that in the 2016 UK referendum regarding whether to remain in or leave the European Union, the regions that voted strongly for leave tended also to be those same regions with greatest levels of dependency on European Union markets for their local economic development. This observation flies in the face of pro-leave narratives that posited that the major beneficiaries of European Union membership were the 'metropolitan elites' of London. Economic geography dominated the observed voting patterns, and geography will also certainly dominate the post-Brexit economic impacts, but not necessarily in a way that voters anticipated or wished for.

KEYWORDS
regions; European Union; voting; trade; demand

摘要
英国脱欧的地方投票与地方经济结果之间的不同调。*Regional Studies*. 本文揭露 2016 年英国有关是否续留或脱离欧盟的公投中，强力投票支持脱欧的区域，同时也很可能是该地的在地经济发展对欧盟市场依赖程度最高的区域。此一观察当面拒斥了主张欧盟会员资格的主要受益者是伦敦'大都会精英'此般支持脱欧的叙事。经济地理支配了观察到的投票模式，而地理必将同时支配脱欧后的经济冲击，但不必然是透过选民所期待或希冀的方式。

关键词
区域; 欧盟; 投票; 贸易; 需求

RÉSUMÉ
Disparité entre le vote local et les conséquences économiques du Brexit. *Regional Studies*. La présente communication révèle que lors du référendum de 2016, au Royaume-Uni, qui devait décider si le Royaume-Uni souhaitait rester dans l'Union européenne ou la quitter, les régions qui votèrent le plus fort pour quitter l'UE sont également celles qui présentent une dépendance plus prononcée des marché de l'Union européenne pour leur développement économique local. Cette observation va à l'encontre des discours favorables au départ de l'UE, qui soutenaient que les principaux bénéficiaires de l'adhésion à l'Union européenne sont les «élites métropolitaines» de Londres. La géographie économique domina les tendances du vote, et la géographie dominera sans aucun doute, une fois de plus, les conséquences économiques du Brexit, mais pas nécessairement de la façon prévue ou souhaitée par les électeurs.

MOTS-CLÉS
régions; Union européenne; vote; commerce; demande

CONTACT

[a] b.los@rug.nl
Faculty of Economics and Business, University of Groningen, Groningen, the Netherlands.
[b] (Corresponding author) p.mccann@sheffield.ac.uk
University of Sheffield Management School, Sheffield, UK.
[c] john@cer.org.uk
Centre for European Reform (CER), London, UK.
[d] mark.thissen@pbl.nl
PBL Netherlands Environmental Assessment Agency, The Hague, the Netherlands.

ZUSAMMENFASSUNG

Die Diskrepanz zwischen dem lokalen Abstimmungsverhalten und den lokalen wirtschaftlichen Auswirkungen des Brexit. *Regional Studies*. In diesem Beitrag zeigen wir, dass es sich bei den Regionen, die im britischen Referendum von 2016 über den Verbleib in oder den Austritt aus der EU mit starker Mehrheit für einen Austritt votierten, tendenziell um dieselben Regionen handelt, die für ihre lokale Wirtschaftsentwicklung am stärksten auf die Märkte der Europäischen Union angewiesen sind. Diese Beobachtung steht im krassen Widerspruch zur Argumentation der Austrittsbefürworter, nach der die 'metropolitanen Eliten' von London am stärksten von der Mitgliedschaft in der Europäischen Union profitieren. Die beobachteten Abstimmungsmuster wurden von der Wirtschaftsgeografie dominiert, und die Geografie wird zweifellos auch die wirtschaftlichen Auswirkungen nach dem Brexit dominieren – allerdings nicht unbedingt so wie von den Wählern erwartet oder gewünscht.

SCHLÜSSELWÖRTER

Regionen; Europäische Union; Abstimmung; Handel; Nachfrage

RESUMEN

La discrepancia entre los votos locales y las consecuencias para la economía local del Brexit. *Regional Studies*. En este artículo mostramos que en el referéndum de 2016 en el Reino Unido sobre la permanencia o salida de la Unión Europea, las regiones que votaron con gran mayoría a favor del Brexit fueron en general las regiones con niveles más altos de dependencia de los mercados de la Unión Europea para su desarrollo económico local. Esta observación contradice los argumentos de los partidarios del Brexit que criticaban que los principales beneficiarios de la Unión Europea eran las 'elites metropolitanas' de Londres. La geografía económica dominó los patrones de conducta observados en la votación, y también la geografía sin duda dominará las repercusiones económicas después del Brexit, pero no necesariamente tal como los votantes lo habían previsto o deseado.

PALABRAS CLAVES

regiones; Unión Europea; votación; comercio; demanda

INTRODUCTION

What are the likely long-term impacts on UK regions of the vote to leave the European Union (EU)? This paper examines this issue by using uniquely detailed data on interregional trade, regional production and consumption, and investment demand. Our findings suggest that regions that voted strongly for leave tended also to be those same regions with greatest levels of dependency on EU markets for their local economic development. This observation flies in the face of pro-leave narratives that posited that the major beneficiaries of EU membership were the 'metropolitan elites' of London (Springford, McCann, Los, & Thissen, 2016a). In contrast, our analysis suggest that the regions that heavily voted for Brexit have potentially by far the most to lose from Brexit itself, while those regions that tended to vote remain ironically are likely to be much less adversely affected by Brexit.

In order to demonstrate these findings the paper is structured as follows. The next section provides a brief background to the geography of the Brexit vote; the third section describes the data and the empirical results; the fourth section discusses the problem of Brexit in the light of the UK's current economic geography; and the fifth section examines the potential impacts of possible alternative post-Brexit trading arrangements. The sixth section provides some brief conclusions.

BACKGROUND TO THE GEOGRAPHY OF THE BREXIT VOTE

Since the choice was made by UK voters in the referendum on 23 June 2016 to leave the EU, many commentators have been discussing the likely long-term impacts of the vote as well as the reasons for the vote. It has already been widely reported that citizens who were older, or lesser educated, or socially conservative or lower paid, were all more likely to vote leave, while those who voted remain tended to be on average more highly educated, younger, earning higher incomes and more socially progressive (Clark & Whittaker, 2016; Harris & Charlton, 2016).[1] Other factors are also likely to have been at work, and in particular there is one key feature that has emerged as being central to the whole issue, namely geography (Harris & Charlton, 2016), and in particular, economic geography (Bell & Machin, 2016; Clark & Whittaker, 2016).

Within England there were marked geographical differences in voting patterns. Remain votes dominated in London and in many parts of the home counties – a western arc around London from Cambridge to Oxford and down to Surrey – along with some of Britain's major cities such as Leeds, Manchester, Cardiff, Leicester, Bristol, Liverpool, Edinburgh and Glasgow. In addition, pro-remain voter preferences in both Scotland and Northern Ireland displayed markedly different patters to those in

England and Wales, suggesting that 'national' identity is also open for discussion. However, while explanations based on notions of national identity or sovereignty (Scruton, 2016; Goodhart, 2016) or psychology and values (Kaufman, 2016) provide some insights into the voting patterns in Scotland and Northern Ireland and England as a whole, cultural explanations regarding issues of identity and sovereignty cannot explain why the geographical patterns of the referendum vote were as they were within either England or Wales. The reason is that they were not simply questions of culture, identity or even geography, but rather of *economic* geography. Indeed, the findings from all the most detailed econometric work undertaken to date (Arnorsson & Zoega, 2016; Becker, Fetzer, & Novy, 2016; Goodwin & Heath, 2016; Joseph Rowntree Foundation, 2016; Zoega, 2016) all suggest that local economic conditions were the single most important factor driving the pattern of voting, interacting with the characteristics of the individuals making up that locality (Becker et al., 2016). Regions with larger shares of lower-skilled or manual employment, a greater historical role in manufacturing, and higher levels of unemployment were all more likely to vote leave (Becker et al., 2016). As such, the regions and localities that were perceived to have most benefited from globalization (Coyle, 2016; Field, 2016; *The Economist*, 2016a, 2016b), immigration and trade tended to vote remain, while those regions and localities that were perceived to feel most threatened by these phenomena voted leave (Zoega, 2016).[2] The geography of deprivation and prosperity both interacted with, and also overlaid, each of the other individual–specific explanatory variables (Goodwin & Heath, 2016; Joseph Rowntree Foundation, 2016). The interaction between individual–specific characteristics and the local economic characteristics revealed a pattern reflecting a 'geography of discontent'. In the most marked cases, many of the regions receiving the highest level of EU regional funds voted leave (Sheffield Political Economy Research Institute (SPERI), 2016).

On face value, the voting patterns appear to support the idea that it was indeed the 'metropolitan elites' who most benefited from the EU and globalization. Yet this influential argument was barely challenged during the referendum campaign, and the analysis below casts doubt upon it.

THE DATA AND EMPIRICAL EVIDENCE

In order to examine and test the veracity of the argument that Europeanization is largely synonymous with globalization and that EU membership really only favoured the London-based 'metropolitan elites', we employ the new data from the interregional extensions to the World Input–Output Database (WIOD). These are the most detailed data currently available regarding the economic and trade structure of UK and EU regions, and they allow us to calculate the overall economic impact of the UK's regional trade structures on the domestic economic performance of the different UK NUTS-2 regions.[3] The detailed data refer to the period 2000–10, and the methodology underpinning the data construction is described in Appendix A. The interregional extensions to the WIOD model allow us to calculate the share of local economic activity that is dependent on trade with the rest of the EU, including all those local supply chains comprising many firms which themselves do not actually export. The methodology incorporates all the evolving global value-chains involving multiple cross-border movements of goods and services, and allows us to accommodate all value-adding configurations issues ranging from the so-called 'Rotterdam Effect' (Springford et al., 2016a) all the way to the complex multinational activities of global companies, including their interactions with small and medium-sized enterprises.

Figure 1 links the actual leave votes[4] by NUTS-2 region with the level of economic dependence of the region on EU markets, defined as the share of local gross domestic product (GDP) which is driven by consumption and investment demand in the rest of the EU. The relationship is unmistakable. Regions that are more economically interdependent with EU markets tended to display a higher proportion of leave votes, as already predicted prior to the vote by Springford et al. (2016a) on the basis of social attitudes. In contrast, the regions that are the least dependent on EU markets for their domestic prosperity are precisely those regions which displayed the strongest pro-remain votes, namely London and parts of Scotland.

As we see in Figure 2, similar results are also found when we use local labour income shares rather than GDP shares. In other words, the regions that tended to vote leave are also those regions whose local wage–income shares are the most dependent on EU markets. Many of these regions are relatively economically weak and the size of these shares means that it is unlikely that within
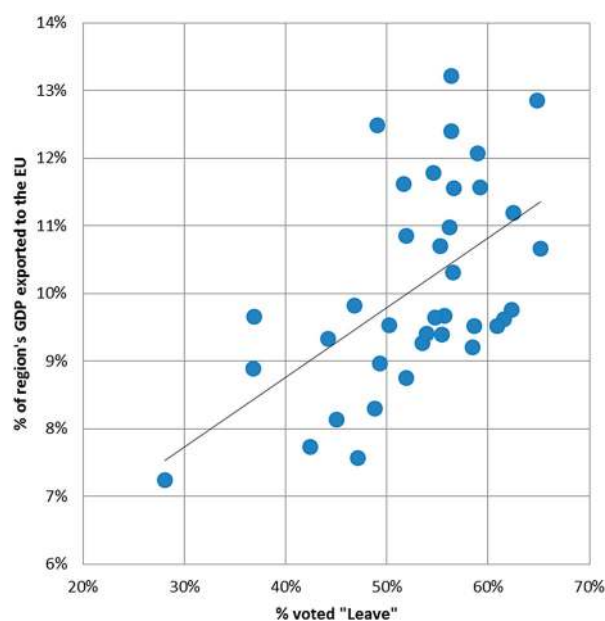

Figure 1. Relationship between the NUTS-2 regional votes for leave and the regional gross domestic product (GDP) share due to consumption and investment demand in the other European Union countries, 2010.
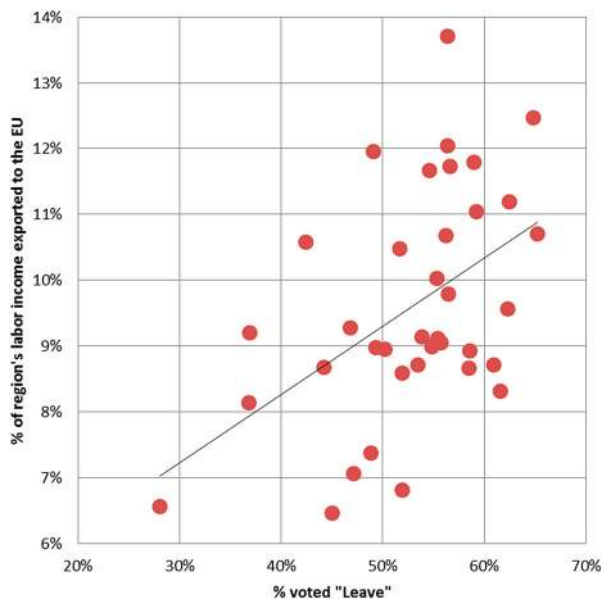Note: $R^2 = 0.31$.

Figure 2. Relationship between the NUTS-2 regional votes for leave and the regional wage-income share due to consumption and investment demand in the other European Union countries, 2010.
Note: $R^2 = 0.23$.

these regions only small elites (i.e., capital owners) benefit from EU demand.

The structure and workings of local supply chains that traverse different sectors, whereby local manufacturing industries tend to use local services as key inputs, means that the effect of EU demand also tends to be important for both local services industries and manufacturing industries. Figure 3 plots the level of UK NUTS-2 regional dependence on the EU for both sectors by region, after excluding London, whose enormous service orientation means that its supply-chain structure is very different to other UK regions. High EU dependence for local
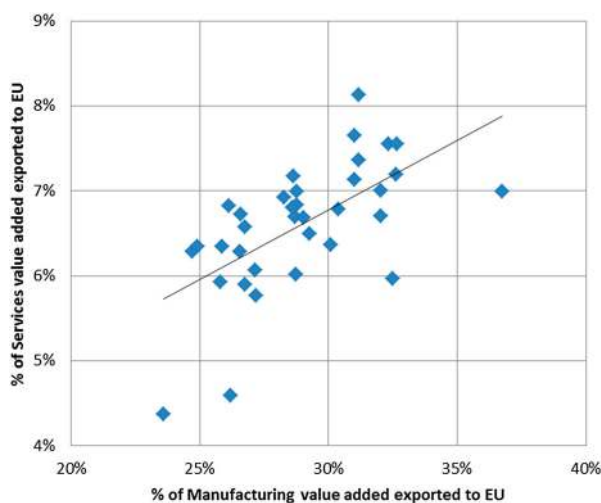

Figure 3. NUTS-2 regional dependence on European Union markets for local services and manufacturing (excluding inner and outer London).
Note: $R^2 = 0.38$.

manufacturing also tends to imply high regional dependence for local services. Although manufacturing is on average five times as dependent on EU markets than services (Table A1), the widespread focus on the impact of trade on manufacturing output and employment is mistaken.[5] Similar arguments also apply for primary industries such as agriculture.

The interregional trade extensions to the WIOD data demonstrate that the effect of EU trade on London as a whole accounts for little over 7% of its GDP, and London is therefore less dependent on EU markets than anywhere else in the UK (Figure 1 and Table A1). The values for the remote regions of Scotland are also relatively low, while all other parts of the UK display an economic dependence on EU markets which typically ranges between 25% and 100% higher than that of London, with almost half the UK regions being more than 50% more dependent on EU markets than London. Furthermore, the level of local dependence on EU demand has increased between 2000 and 2010 in 34 of the UK's 37 NUTS-2 regions, while it had fallen in only three regions, namely Inner London, Outer London and Berkshire–Buckinghamshire–Oxfordshire. In other words, while being part of the EU, over 90% of UK regions have experienced deeper integration with the EU since the millennium,[6] unlike London, which has become slightly less dependent on Europe.

If Brexit involves any significant trade-related ruptures, many of the UK's weaker regions will disproportionately face these shocks and bear these costs. In this paper we make no comment as to the likely scale of such effects. We simply examine the likely regional impacts of any such effects, were they to happen.

THE PROBLEM OF BREXIT IN THE LIGHT OF THE UK'S ECONOMIC GEOGRAPHY

The fact that London is much less dependent on EU markets for its economic prosperity than all other UK regions will come as a surprise to those who have become accustomed to hearing the arguments that only the 'metropolitan elites' of London were the real beneficiaries of the EU, rather than the more typical citizens in other parts of the UK. Yet, there are three major reasons why London is less dependent on the EU in comparison with other pro-Brexit UK regions.

First, London is genuinely a 'global city' with higher levels of global connectivity (Iammarino & McCann, 2013) on many different dimensions than almost any other city on earth (McCann, 2016). The level of exports per capita in London are the highest in the UK by a margin of 15% over any other UK region and some 23% above the UK average, while London's imports per capita are also the second highest of any UK region. Yet, the share of London's exports which is accounted for by the EU is almost 10 percentage points below any other UK region, while its share of exports to the rest of the world is some 10 percentage points higher than anywhere else in the UK (McCann, 2016). A such, even though London's trade

with the EU is greater than any other UK region, it accounts for a relatively smaller share of its GDP than is the case in any other English region.

Second, London's specialization tends to be in services, and especially in international financial services, whereas regions outside of London and the home counties are more specialized in manufacturing, agriculture and extraction industries, all of which tend to be more oriented towards EU markets, and their local service sectors tend to serve these other local EU-exporting industries. Nowhere in Britain has a major segment of its local service industries, which are even nearly as genuinely globalized, rather than Europeanized, as those in London.

Third, the London economy is much larger and more diverse on many levels than other regions, and is actually therefore also relatively more self-reliant and closed than other regions (McCann, 2016). Standard agglomeration argument imply that London businesses benefit from local spillovers and interactions, and indeed this is the case. The interregional extensions to the WIOD data demonstrate that some 37% of Inner London's and some 68% of Outer London's GDP are actually internally generated within Greater London, and again these are the highest of any UK region. Moreover, the fact that London's economy is so large and diverse also means that it is able to adjust to economic shocks better than other parts of the UK, as we have already witnessed in the years since the 2008 global financial crisis. In marked contrast, other UK regions that tended to display strong pro-Brexit votes tend to be relatively much more dependent on EU markets for their economic prosperity and viability, and their smaller scale means that they are also likely to be much less resilient in the face of any adverse post-Brexit trade-related shocks.

The obvious post-Brexit vulnerability of the UK's non-core regions is overlaid on what is already an extremely problematic UK economic geography. The UK economy is characterized by some of the worst interregional inequalities in the Organisation for Economic Co-operation and Development (OECD) (McCann, 2016) – inequalities which continue to rise. In many ways for the last 30 years, and across a range of different economic, social and institutional characteristics, the UK economy has been dislocating and decoupling internally into certainly two, or possibly even three, largely disconnected economies (McCann, 2016). These two largely separate economies are: London and its hinterland and the rest of the UK economy; and if we also separate Scotland on various institutional dimensions, then we have three economies within the UK. Interestingly, apart from the distinct case of Northern Ireland, this tripartite separation very closely reflects the geography of the 2016 referendum votes.[7] The very differing experiences of London and its hinterland from the rest of the UK are a result of the fact that the London economy has responded to modern globalization since the late 1980s in a totally different manner than other parts of the UK. The reasons for this are very complex and well beyond the scope of this paper, but they are examined in detail elsewhere (McCann, 2016). For the purposes of this paper, however, it is sufficient to note just a few key points which are pertinent to this discussion.

Firstly, London and its hinterland have become relatively more prosperous since the 1990s, while the rest of the UK economy has experienced entrenched and increasing difficulties, although Scotland on some indicators has also fared slightly better than the other English regions, Wales and Northern Ireland. The relatively prosperous parts of the UK are very similar in total population to the relatively deprived parts of the UK and in terms of GDP per capita. Over the last two decades the prosperous parts of the UK have out-performed the OECD and EU averages by an extent similar to which the weaker parts of the UK have underperformed these same averages. The result is that in comparison with our OECD and EU competitors, the UK is still in more or less exactly the same position as it was in both the early 1970s and the early 1990s (McCann, 2016). In real terms the UK's position as a whole has barely changed in 40 years, while at the same time the country become much more unequal both interpersonally and, especially, inter-regionally.

A key part of the problem is due to the fact that the London economy has largely failed to act as a 'motor' driving the UK economy as a whole forward. Many observers since the 1980s have assumed that a prosperous and resurgent London would catalyse growth across the UK, yet this has simply not happened. Instead the wider London economy has more or less disconnected itself from the rest of the UK beyond its own immediate hinterland (McCann, 2016). Many of the key drivers of the London economy nowadays operate largely independently of the rest of the UK economy (McCann, 2016), which from a governance perspective raises enormous challenges. Indeed, the extent to which the London economy is largely disconnected from that of the rest of the UK is observed in the WIOD interregional data. Further examination of the detailed interregional data[8] shows that for all other UK NUTS-2 regions, demand from London only accounts for between 0.7% and 4% of their local GDP. Moreover, this share has been falling between 2000 and 2010 in 25 regions, while it has increased in only eight regions, with two regions unchanged. For all non-London UK regions, the share of their local GDP which is accounted for by the EU demand is greater than the share which is accounted for by demand from London. Indeed, the ratio of dependence on EU demand to dependence on London demand varies between values of two to three for regions close to London up to four to five for more peripheral regions. It is not surprising that EU markets are more important to UK regions than London markets, given that the EU markets are some 33 times larger than the London markets, and only slightly further away from most of the UK regions than London.

THE DISTINCTION BETWEEN EUROPEANIZATION AND GLOBALIZATION

Part of the problem, and one which became clearly evident in the referendum campaign, is that many politicians and journalists have little understanding of the empirical

realities of modern globalization and the extent to which Europeanization, as a form of global regionalism, is quite different in nature to the kinds of genuine globalization of which London has been a major beneficiary. Images of globalization associated with out-sourcing of jobs to India and off-shoring of factories to China are not the dominant economic reality of most of the UK's regions. While London's financial services engage with markets all over the world every day, most of the firms in the rest of the UK's regions tend to engage with European value-chains rather than genuinely global value-chains. The share of UK domestic GDP which is accounted for by EU demand has remained remarkably stable between 1995 and 2011, although its composition has changed due to the UK's increasingly complex integration processes with EU global value chains (McCann, 2016; Springford, Tilford, Odendahl, & McCann, 2016b), a fact which is almost entirely hidden by observations of raw trade data. These deepening and increasingly complex relationships are, however, reflected by the fact that half the UK's inwards stocks of foreign investment and also half the UK's outward foreign investment stocks are with the EU (Allen & Dar, 2013). Crucially, as already mentioned they are also reflected by the fact that almost every part of the UK outside of London has become *more*, not less, integrated with the EU over recent years, with the major exception being London. On the other hand, London has benefited from inflows of human capital more than any other city in the world (OECD, 2011) and the majority of these human capital injections come from Europe (*The Economist*, 2015). Yet, these EU-dominated inflows help London compete globally rather than just across Europe. In contrast, the rest of the UK tends to compete on more of a pan-European scale. These changes reflect the realities of cross-border regionalism, which is the key defining feature of modern globalization (Iammarino & McCann, 2013),[9] whereby the deepening of economic linkages (regarding trade, investment, research and development (R&D), skills and labour mobility) is with neighbouring, not distant, countries, and this reflects the experience of more than 90% of the UK's regions. This worldwide phenomenon, namely of the deepening integration with neighbouring countries rather than distant countries, is a critical feature that was entirely ignored by the very few economists who advocated leave alongside pro-leave politicians campaigning for trade deals with countries outside of Europe (Sampson, Dhingra, Ottaviano, & Van Reenen, 2016). Indeed, and rather ironically given the UK geography of pro-Brexit votes, many pro-leave campaigners were not arguing for less globalization so as to protect economically weaker UK communities and regions, but precisely the opposite (Bogdanor, 2016). They were arguing for more globalization, albeit on the basis of new UK-specific trade deals rather than EU-directed deals, and ones which are to be more directed towards more geographically distant counties such as Canada, Australia, the BRICs (Brazil, Russia, India and China), and other emerging economies.

As Figure 4 clearly depicts, the contribution of EU markets to the GDP of the UK dwarfs the contribution of any
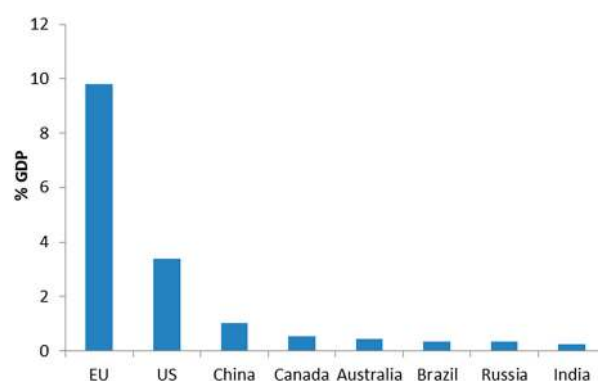

Figure 4. Share of UK gross domestic product (GDP) due to consumption and investment demand in the rest of the European Union and selected countries 2011.
Sources: World Input-Output Database (WIOD), November 2013 release; Springford et al. (2016b).

other countries, or of the UK's contribution to the GDP of the rest of the EU.[10] Even if new trade deals do lead to significant trade growth between the UK and other Commonwealth and BRICs countries, in all likelihood these will do very little to defray the impacts of any post-Brexit trade-related shocks associated with leaving the EU single market and customs union, simply because the contribution of these countries to UK demand is so small.

Of course, an obvious alternative response to all the empirical observations reported here is that a plethora of new trade deals with other non-EU countries plus a new 'bespoke'[11] deal with the EU will foster growth in all UK regions and in particular will help galvanize growth in the UK's lagging regions. However, at present this is largely speculative as there is almost no evidence in support of this argument. Indeed, the available evidence outlined above appears to point in the opposite direction (Ebell, 2016).

THE POTENTIAL IMPACTS OF ALTERNATIVE UK–EUROPEAN UNION TRADE RELATIONSHIPS

Yet, it may well be that our empirical approach is missing some other more specific technical trade-related issues that will heavily favour the UK's non-core regions in a post-Brexit environment. Therefore, in order to assess the extent to which the types of alternative UK–EU and UK–rest of the world trade options (House of Lords, 2016a) being mooted might be able counter the bias against the UK's weaker regions, it is necessary to consider the key features of these trade arrangements in terms of tariffs, standards, regulatory requirements and rules of origin.

There are a number of potential ways for a post-Brexit Britain to manage its trading relationships: membership of the European Economic Area (EEA – the 'Norway option'); a customs union, similar to the one the EU has with Turkey; a basket of bilateral agreements such as that which exists between Switzerland and the EU; a free-trade agreement such as the ones the EU has with countries ranging from South Korea to Canada; and finally trade with the EU

under World Trade Organisation (WTO) rules. These options would affect Britain's regions in different ways.

If Britain joined Norway, Iceland and Liechtenstein in the EEA, British firms would have largely unimpeded access to the single market. No tariffs would be charged on trade between Britain and the EU. UK regulations and standards would continue to be recognized by other EU countries. The UK would leave the EU's customs union, which would allow it to negotiate trade agreements with countries outside the EU. This is something of a double-edged sword: it would be possible for the UK to reduce costs of trade with the rest of the world. But an exit from the customs union would result in the EU applying rules of origin on UK exports with significant content imported from outside the bloc. The administrative costs of working out tariff payments on extra-EU imports can be significant (Cadot, Carrère, de Melo, & Tumurchudur, 2006). Rules of origin are used to determine the country of origin of a product, and therefore how much EU import duty is payable. Most imported content in UK exports comes from the EU (Ali & Dadush, 2011), so, overall, the costs are unlikely to be large. But they will be felt most in regions hosting non-European manufacturers that import components from their home country.

Alternatively, the UK could push for a Swiss-style relationship with the EU, based on bilateral negotiations and agreements. Switzerland's relationship with the EU rests on a series of bilateral sectoral agreements – 20 of them important, another 100 less so – but not all important sectors are covered. Switzerland has free trade in goods with the EU, but unlike the EEA it has no comprehensive agreement with the EU on services. Such a deal would limit the impact on the UK's regions that are closely integrated in EU manufacturing value chains – but it would impose more costs on London, and those regions that host back-office functions for City financial services firms, including many other UK regions. The UK's financial services industry would face the same challenges as its Swiss counterpart; Switzerland has no accord with the EU on financial services, except for a 1989 agreement on non-life insurance. Such an arrangement would impact on London and also other UK regions. If the City faced the removal of passporting rights then this is likely to impact on the overall taxation revenues generated by the Exchequer (House of Lords, 2016b; Oliver Wyman, 2016), revenues on which the UK's non-core regions are relatively more dependent.

A more limited free trade agreement, maintaining tariff and quota-free trade in manufactures, might prove more politically palatable than membership of the EEA or a Swiss-style relationship, since the UK might be able to end the free movement of labour and financial contributions to the EU – although it is unclear what the quid pro quo demanded by the EU for tariff-free trade would be. The UK might be able to regain power over regulations and standards, especially in the services sector. In all likelihood, UK firms would continue to manufacture to only one set of product specifications determined by the EU in order to avoid the costs associated with duplication. The UK would be subject to anti-dumping and origin rules, which would make it

harder for UK firms in regions closely integrated with the EU to fully participate in EU supply chains. Many of these regions are in the Midlands and North of England.

If the UK simply traded with the EU under the latter's WTO schedules, UK manufactures exports – and regions more closely economically dependent on the EU – would be hit hard. Estimates of the UK GDP losses of a reversion to WTO trade range from 2.6% to 9.1%, depending on the method used (Dhingra et al., 2016; HM Treasury, 2016; Oxford Economics, 2016).[12] For example, the EU is easily the biggest market for British car-makers (almost three-quarters of UK car exports were sold to the EU in 2015), and the country's car components industry is fully integrated into pan-EU supply chains. Indeed, a much higher proportion of UK exports to the rest of the EU take the form of intermediate goods than is the case for Britain's exports to the rest of the world. Such goods would be less competitive within Europe if they faced tariffs and rules-of-origin regulations, and UK goods exports to the EU would also be vulnerable to anti-dumping duties. This would severely impact on the UK's regions which voted for Brexit.

The various alternative possible trade options outside of the single market or the customs union would appear to be unlikely to improve the UK's overall trade position (Emmerson, Johnson, & Mitchel, 2016) or the UK's public finances (Emmerson & Pope, 2016), especially given the existing scale of UK–EU economic integration in comparison with the much lower levels of integration with other countries, as depicted in Figure 4. Moreover, the economic viability of the UK's non-core regions would all appear to be relatively more vulnerable to these options outside of the EU single market and customs union. However, there are some possible counter arguments that we have not yet addressed. One argument is that the post-referendum fall in sterling will make UK exports more competitive, enhancing the prosperity of the non-core regions. Similarly, a shift in trade patterns towards more distant markets may reduce the relative geographical advantage of southern regions and their ports (Winters, 2016b). However, the high level of integration of UK firms in EU global value-chains militates against this type of currency effect, because the fall in sterling simply means that the costs of intermediate inputs rise accordingly. Furthermore, these same arguments also circled following the fall in sterling in the wake of the 2008 global financial crisis, but there was no real improvement in the UK's long-run trade position (McCann, 2016; Springford & Tilford, 2016). A related argument posits that a loss of passporting rights in the City will hit the London economy hard, thereby reducing London house prices and narrowing the interregional wealth gaps. Again, however, similar arguments circled in the wake of the 2008 crisis, and yet since then the opposite has happened in that the interregional gaps have grown further. Moreover, if Brexit results in general UK-wide falls in house prices, then the overall effects on the economy are very hard to predict and deflationary shocks of this form are unlikely to be generally positive, because housing underpins so many other forms of consumption and investment, and our knowledge of the

UK links between property (real estate) markets and the wider economy is still so limited (McCann, 2016).

If Brexit does lead to adverse trade impacts and increased trade costs with Europe, then on the basis of all the data and arguments presented here it becomes very difficult to see how any post-Brexit UK-EU trade relationship which involves leaving the EU single market and the customs union will not weaken the viability of those regions which voted for leave in comparison with those regions which voted for remain.

FINAL THOUGHTS

There are still deeply divided views between those who were pro-remain and those who were pro-leave as to both the reasons for, and also the likely long-term impacts of, the Brexit vote. The great majority of economists see these as being adverse, posing major medium- and long-run economic challenges to the UK (Dhingra et al., 2016; Emmerson et al., 2016; Johnson, 2016; Matthes & Busch, 2016), and the fact that the widespread warnings of economists both within the UK and internationally went largely unheeded has led to some soul-searching amongst the profession (Campos, 2016; Miles, 2016; Wren-Lewis, 2016). As already mentioned, the various reasons put forward for the vote include issues of national identity or sovereignty (Scruton, 2016; Goodhart, 2016), psychology and values (Kaufman, 2016), votes against rising immigration (Goodhart, 2016), globalization (Coyle, 2016; Field, 2016; *The Economist*, 2016a), political elites in Europe (Tombs, 2016) or London (Street-Porter, 2016), or as a vote against domestic fiscal austerity (Berry, 2016; Chakrabortty, 2016), with public expenditure heavily unequal between regions (Harrop, 2016). These differing interpretations suggests that there was no single overriding reason for the leave vote, and the fact that those who felt left out by globalization appeared to have been joined by those who had most benefited from globalization, namely the older age cohorts (Willetts, 2016), makes the political issues facing the UK government even more complex. The empirical evidence of many recent papers, however, suggests that the local economic conditions interact with and overlay each of the individual–specific characteristics, giving rise to something of a 'geography of discontent'.

The legal and procedural complexity of the trade agreement landscape that the UK now appears to be facing is likely to be far more tortuous and time-consuming than most people understand (Bogdanor, 2016; Grant, 2016). Yet, whatever long-run outcome emerges from the UK's negotiations with the EU, the WTO and other countries, it is clear leaving the EU single market and customs union is likely to be very challenging for most of the regions that voted to leave, and potentially will lead to interregional inequalities which are even greater than they are now. Whichever way we look at it, the Brexit vote appears to have made the job of supporting and improving the conditions in the UK's more deprived areas more difficult. Coyle argues that the fact that new Conservative administration was swept in by a Brexit vote underpinned by the responses of the poorer communities means that it should further prioritize fostering economic growth outside of London and its hinterland (Coyle, 2016). On the other hand, suggestions regarding possible post-Brexit partial opt-outs regarding immigration or EU single-market access for key sectors in London or Scotland (*Financial Times*, 2016) are likely to push in the opposite direction.[13]

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

NOTES

1. See http://blogs.ft.com/ftdata/2016/06/24/brexit-demographic-divide-eu-referendum-results/.
2. Similar anti-globalization voting patterns according to a region's responses to globalisation are also evident in Germany (Dippel, Gold, & Heblich, 2016).
3. NUTS = Nomenclature des Unités Territoriales Statistiques. See http://webarchive.nationalarchives.gov.uk/20160105160709; and http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/eurostat/index.html/.
4. The referendum voting data were kindly supplied by John Burn-Murdoch who originally updated our Springford et al. (2016a) voting preference data for the *Financial Times* with the actual votes (see also http://blogs.ft.com/ftdata/2016/06/24/brexit-demographic-divide-eu-referendum-results/).
5. Other analysis also finds that the likely adverse effects of leaving the Single Market are similar across many sectors with wholesale and retail, manufacturing and services all being affected due to their high levels of dependency on EU markets (Centre for Economics and Business Research (CEBR), 2016).
6. As Winters (2016a) also explains, analysing a much longer period.
7. See http://www.bbc.com/news/uk-politics-36616028; and https://ig.ft.com/sites/elections/2016/uk/eu-referendum/.
8. The results are available from the authors upon request.

9.   As against empire-era globalization processes.

10.   The WIOD 2013 release demonstrates that the 2011 share of UK demand accounted for by the rest of the EU is 9.75% while the share of GDP in the rest of the EU accounted for by UK demand is only 1.6%. In other words, the UK is six times more dependent on the EU than the EU is on the UK (Springford et al., 2016b). The level of the UK's GDP dependence on the EU calculated from the WIOD is slightly lower than the 10.3% share calculated by CEBR (2016). However, if we calculate these relationships in terms of gross national product (GNP) rather than GDP, then at 10.5% the EU-related shares are even larger due to the fact that almost exactly half of the UK's inward and outward foreign direct investment (FDI) stocks are accounted for by the EU, and the UK displays a net outward FDI surplus with the EU (McCann, 2016).

11.   Various types of possible trade model options could be adopted, as outlined in this paper, although Theresa May's speech on 17 January 2017 suggests that the UK is seeking a uniquely customized arrangement rather than an off-the-shelf type of arrangement (BBC News, 2016).

12.   A recent working paper casts doubt on HM Treasury's model (Gudgin, Coutts, & Gibson, 2016).

13.   Scotland, at 9.0%, has a slightly below-average level of dependency on EU markets, while at 17.4% its level of dependence on markets in the rest of the UK means that it is twice as dependent on the rest of the UK than on the rest of the EU. Although Scotland's economic dependence on the rest of the UK had fallen by almost one-quarter since the Millennium, from 23% in 2000 to 17.4% in 2010, this is still likely to pose some challenges for Scottish independence narratives, but again it partly depends on the outcomes of the post-Brexit trade agreements (Fraser of Allander Institute, 2016). The quotation from Theresa May, 'The single market of the United Kingdom is worth four times as much to Scotland as the single market of the European Union,' would therefore appear to be incorrect by a factor of two (iNews, 2016).

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APPENDIX A

As a consequence of the increasing international fragmentation of production processes (e.g., Los et al., 2015) the dependence of a region on foreign demand for final products cannot be accurately estimated by relying on gross exports statistics alone anymore. If intermediate inputs are sourced outside the region in any stage of production, the value added generated in the region will be lower than suggested by gross exports (Timmer, Los, Stehrer, & de Vries, 2013). The value added in a country due to final demand elsewhere can also be underestimated, however. This happens if the region considered sells components, materials or business services to other regions, which then manufacture the final products that embody these intermediates and deliver these to other countries.

In order to arrive at reasonable estimates of regional dependence on (specific parts of) foreign demand for final products, a global input-output table with regional detail is required. The stylized set-up of such a table is presented in Figure A1.

This stylized global input-output table contains two countries (A and B) and a group of countries merged into the Rest of the World, ROW. A and B have been disaggregated geographically into two regions each (A1, A2, B1 and B2). For each of these regions, industry-level detail is available for two industries (I1 and I2). The rows refer to industries that sell, the columns to industries that purchase. The matrix **Z** contains the values of intermediate deliveries by all industries in all regions and countries, to all industries in all regions and countries. In a similar vein, the matrix **F** contains the values of deliveries to final users in each of the regions and countries. This final demand consists of household consumption, government consumption, gross fixed capital formation and changes in inventories. The sum of all sales by industries in regions and countries are represented by the (column) vector **x**. As **w'** is a row vector indicating value added by each of the industries in each of the regions and countries, double-entry bookkeeping implies that the sums of the values of purchase of intermediate inputs and value added as contained in **x'** equal the gross output levels in **x**.

The results documented in this report have been obtained on the basis of global input-output tables in which 40 countries (accounting for about 85% of world GDP) plus a composite 'country' labelled Rest of the World are represented. The countries are those included in the World Input-Output Database (WIOD; Timmer, Dietzenbacher, Los, Stehrer, & de Vries, 2015). All current EU members are included, apart from Croatia. Merging data in WIOD with data in Eurostat's regional economic accounts, a number of survey-based regional supply and use tables or input-output tables, and estimates of interregional trade based on transport statistics (Thissen, van Oort, Diodato, & Ruijs, 2013; Thissen, Lankhuizen, & Los, 2017), allows us to construct the regional trade details at the NUTS-2 level for all of the major EU countries. In total, 245 NUTS-2 European regions are represented, and for all regions and countries present in the data, 14 industries can be identified. An annual time series of global input-output tables with regional details have been constructed for the period 2000-2010.[1] Since all

			Country A				Country B				ROW		Country A		Country B		ROW	Gross Output
			Reg A1		Reg A2		Reg B1		Reg B2				Reg A1	Reg A2	Reg B1	Reg B2		
			I1	I2	I1	I2	I1	I2	I1	I2	I1	I2	FD	FD	FD	FD	FD	
Country A	Reg A1	I1																
		I2																
	Reg A2	I1																
		I2																
Country B	Reg B1	I1					**Z**								**F**			**x**
		I2																
	Reg B2	I1																
		I2																
ROW		I1																
		I2																
Value Added			**w'**															
Gross Output			**x'**															

Figure A1. Stylized global input–output table with regional detail.

cells in global input-output tables must be expressed in a common value unit, all transactions were converted to current euros (which implies that changes in regional dependencies on final demand from other EU countries could partly be due to changes in relative prices and exchange rate movements).

Our approach is extensively discussed in Thissen et al. (2017) and consists of the following three main steps. In the first step WIOD national supply and use tables are adjusted so as to obtain bilateral consistent trade corrected for re-export origin and destination flows. The trade matching has been done using quadratic minimization of the error relative to the trade flows found in the WIOD supply and use tables. In the second step the national supply and use tables are regionalized using the Commodity Balance method (Isard, 1953) in which national information is crossed with regional data available from Eurostat. Trade between regions within the same country are derived from the existing PBL data and the trade-geography interactions are underpinned by detailed data on freights flows, business travel and commuting behaviour (Thissen et al., 2013). The resulting first prior estimate is used in a constrained quadratic minimization of the relative and absolute error[2] of this prior in relation to the estimated data. The minimization is constrained in such a way that all cells of the regional supply and use tables add up over the regions to the national cells presented in the WIOD supply and use tables and are consistent with the *new information* on regional value added, fixed capital formation and household demand. In the third step we added additional information on regional use and supply coefficients to the quadratic objective function used in the second step. Regional supply and/or use tables were available for Scotland and Wales, 14 Spanish NUTS-2 regions as well as for five Italian regions NUTS-1, and 21 NUTS-3 regions in Finland. Finally, the multiregional input-output table is generated from the interregional supply and use tables.[3]

Our analysis is inspired by the trade in value added approach pioneered in Johnson and Noguera (2012). It uses matrix-algebraic expressions that represent the essential characteristics of input-output analysis (Miller & Blair, 2009). A basic insight from this field of analysis is that all gross output is ultimately caused by final demand. Hence, the point of departure are those columns in the matrix $\mathbf{F}$ that correspond to EU countries other than the UK itself. By summing over these columns (implicitly setting all final demand exerted by UK regions and non-EU countries to zero), a new final demand vector is found. We denote this by $\mathbf{f}^*$. If some UK regions export final products to regions elsewhere in the EU, $\mathbf{f}^*$ will contain positive elements for these regions. The production of the final products requires the production of intermediate inputs. These are equal to the elements in the vector $\mathbf{Af}^*$, in which $\mathbf{A}$ represents the square matrix with intermediate inputs required per euro of gross output. $\mathbf{A}$ is obtained by multiplying $\mathbf{Z}$ by the inverse of the diagonalized vector $\mathbf{x}$. If British regions sell intermediate inputs to industries in other EU regions that produce final products contained in $\mathbf{f}^*$, this will be reflected in $\mathbf{Af}^*$. Second-round effects are represented by $\mathbf{Af}^*$,

$\mathbf{AAf}^*$, third-round effects by $\mathbf{AAAf}^*$, etc. Under empirically mild conditions, the sum of these direct and indirect effects converges to the output levels $\mathbf{x}^*$:

$$\mathbf{x}^* = \mathbf{f}^* + \mathbf{Af}^* + \mathbf{AAf}^* + \ldots$$
$$= (\mathbf{I} + \mathbf{A} + \mathbf{A}^2 + \mathbf{A}^3 + \ldots)\mathbf{f}^* = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}^*$$

The matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is known as the Leontief inverse. The vector $\mathbf{x}^*$ gives the gross output levels of all industries in all regions and countries that can be attributed to final demand exerted by EU countries other than the UK. If these are pre-multiplied by a diagonalized vector of value added coefficients $\mathbf{v}$ (obtained by post-multiplying $\mathbf{w}'$ by the inverse of the diagonalized vector $\mathbf{x}$), the column vector $\mathbf{w}^*$ is found. This vector gives the value added in each industry in each region and country that can be attributed to final demand exerted by EU countries other than the UK. By summing over the elements of $\mathbf{w}^*$ that correspond to industries in a region of interest, the part of regional GDP due to demand by other EU countries can be estimated. Dividing this value by actual regional GDP as implied by the values in $\mathbf{w}'$ yields the reported shares of regional GDP caused by consumption and investment demand in the rest of the EU.

Table A1 presents results at the level of broad sectors. The columns labelled 'EU dependence' document the percentage of sectoral value added in a UK region that can be attributed to consumption and investment demand in the rest of the EU. Primary industries include agriculture, mining and energy supply. The columns labelled 'GDP share' show the percentages of regional GDP generated in the sector concerned. The final column of Table A1 provides the detailed provisional estimates for the total economic dependence of each UK region on EU demand. The higher is the % share the more highly integrated is the local regional economy with the rest of the EU economy. The level of EU economic integration for the whole UK economy is 9.5%, so regions with higher values than 9.5% are relatively more integrated with the rest of the EU than the UK is as a whole. Conversely, regions with a value lower than 9.5% are relatively less integrated with the rest of the EU than is the case for the UK as a whole.

Notes

1. Information on WIOD is available at www.wiod.org/new_site/home.htm. The ways these WIOD figures play out for the EU-UK relationships is examined in detail in Springford et al. (2016b) and McCann (2016).
2. See Thissen et al. (2013) for a discussion on the methodology to use both the relative and absolute errors in the minimization.
3. Since we have a non-square commodity-industry system (see Miller & Blair, 2009, pp. 211–213, for a discussion of these non-square systems) we determined the industry by industry matrix $\mathbf{A}$ of technical coefficients by multiplying the market shares matrix $\mathbf{D}$ (value of outputs per total output of an industry) and $\mathbf{B}$ (value of inputs per total output of an industry).

Table A1. Dependencies of UK NUTS-2 regions on EU consumption and investment demand, by sector.

	Primary Industries		Manufacturing		Construction		Services		Total Economy	
	EU dependence (%)	GDP share (%)	EU dependence (%)	GDP share (%)	EU dependence (%)	GDP share (%)	EU dependence (%)	GDP share (%)	EU dependence (%)	GDP share (%)
Tees Valley and Durham	17.3	7.9	26.6	13.0	2.2	6.8	6.3	72.3	9.5	100.0
Northumberland, Tyne and Wear	17.4	6.4	30.1	12.0	2.5	6.5	6.4	75.1	9.7	100.0
Cumbria	19.0	5.1	31.2	23.4	2.3	6.2	7.4	65.2	13.2	100.0
Cheshire	18.4	8.0	32.3	14.5	1.1	5.9	7.5	71.6	11.6	100.0
Greater Manchester	25.0	1.8	28.7	11.1	3.9	6.5	6.7	80.6	9.3	100.0
Lancashire	20.6	4.2	32.0	19.2	2.6	6.4	7.0	70.2	12.1	100.0
Merseyside	18.6	3.4	26.7	10.6	2.0	5.6	5.9	80.5	8.3	100.0
East Yorkshire and North Lincolnshire	18.2	7.2	32.6	20.4	1.9	6.2	7.2	66.2	12.8	100.0
North Yorkshire	17.4	9.0	28.8	15.3	1.9	6.0	6.8	69.7	10.8	100.0
South Yorkshire	19.4	4.5	29.3	12.5	1.7	6.4	6.5	76.6	9.6	100.0
West Yorkshire	17.3	5.7	26.1	12.7	2.5	5.7	6.8	75.9	9.6	100.0
Derbyshire and Nottinghamshire	16.4	7.6	24.7	13.1	2.0	6.6	6.3	72.7	9.2	100.0
Leicestershire, Rutland and Northamptonshire	18.6	6.7	31.0	18.5	2.4	5.6	7.7	69.2	12.4	100.0
Lincolnshire	17.0	6.9	26.8	18.3	1.3	6.5	6.6	68.2	10.7	100.0
Herefordshire, Worcestershire and Warwickshire	17.0	7.8	28.6	18.3	1.9	5.9	7.2	67.9	11.6	100.0
Shropshire and Staffordshire	18.3	4.5	28.8	18.3	2.1	6.1	7.0	71.1	11.2	100.0
West Midlands	19.6	4.5	26.6	12.3	3.2	5.9	6.7	77.3	9.5	100.0
East Anglia	15.7	7.4	25.9	13.2	2.6	6.1	6.3	73.3	9.4	100.0
Bedfordshire and Hertfordshire	17.9	4.0	28.7	11.3	1.4	6.8	6.0	77.9	8.8	100.0
Essex	18.5	4.7	29.0	12.8	2.0	7.4	6.7	75.1	9.8	100.0

Table A1. Continued.

	Primary Industries		Manufacturing		Construction		Services		Total Economy	
	EU dependence (%)	GDP share (%)	EU dependence (%)	GDP share (%)	EU dependence (%)	GDP share (%)	EU dependence (%)	GDP share (%)	EU dependence (%)	GDP share (%)
Inner London	19.5	2.5	43.2	1.8	4.6	3.2	6.3	92.6	7.2	100.0
Outer London	17.1	4.2	32.5	7.2	1.1	6.4	5.4	82.2	7.6	100.0
Berkshire, Buckinghamshire and Oxfordshire	17.1	6.6	32.0	10.3	3.1	5.3	6.7	77.8	9.8	100.0
Surrey, East and West Sussex	16.2	5.8	32.5	9.8	2.9	6.3	6.0	78.2	9.0	100.0
Hampshire and Isle of Wight	19.8	5.5	32.7	15.1	3.6	5.9	7.5	73.5	11.8	100.0
Kent	18.5	5.1	36.8	14.4	2.7	7.2	7.0	73.3	11.6	100.0
Gloucestershire, Wiltshire and North Somerset	20.7	6.2	31.2	16.5	3.9	5.5	8.1	71.8	12.5	100.0
Dorset and Somerset	17.6	7.0	28.6	16.9	2.4	6.0	6.8	70.1	11.0	100.0
Cornwall and Isles of Scilly	17.6	8.6	28.3	13.2	1.5	6.3	6.9	72.0	10.3	100.0
Devon	17.1	7.2	30.4	14.7	2.3	6.6	6.8	71.4	10.7	100.0
West Wales and the Valley	18.6	4.5	25.8	15.6	2.7	6.3	5.9	73.5	9.4	100.0
East Wales	17.4	6.1	24.9	14.8	2.4	6.1	6.3	73.0	9.5	100.0
Northeastern Scotland	15.2	8.1	26.2	11.7	0.6	6.2	4.6	74.0	7.7	100.0
Eastern Scotland	15.1	7.3	27.2	12.3	3.0	6.8	5.8	73.7	8.9	100.0
Southwestern Scotland	13.3	11.5	31.0	8.7	3.3	6.8	7.1	72.9	9.7	100.0
Highlands and Islands	14.8	10.6	23.6	15.3	0.3	7.0	4.4	67.1	8.1	100.0
Northern Ireland	15.0	8.2	27.1	13.5	1.1	6.4	6.1	72.0	9.3	100.0
United Kingdom	17.5	5.5	29.8	11.3	2.6	5.8	6.5	77.5	9.5	100.0