

Vulnerability to the consequences of Brexit. Evidence for regions in Spain and Poland

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Abstract

Brexit will necessarily have consequences for European countries and their regions, stemming from uncertainty regarding its final shape and implications. Given the different character and intensity of regions' trade interconnections with the British economy; we aim at identifying Polish and Spanish regions' vulnerability to Brexit.

In the literature, vulnerability is conceptualised from many perspectives, as mitigation of environmental disasters' damages, climate changes or – in economic terms – as resilience. Our research contributes to the research on consequences of openness and is strictly focused on exporting activity.

We refer to the concept of countries' lumpiness in terms of exporting activity, and we treat regions as small open economies. Anchored in regional resilience theoretical and empirical approaches, our three specific objectives are: (i) depicting the intensity of trade links with the British economy, (ii) identifying basic structural characteristics of trade relations (incl. exports concentration ratios, intensity of intra-industry trade and high-tech products share), (iii) showing similarities between Polish and Spanish regions, as regards the Brexit vulnerability, in the sphere of regional exports. With the use of theoretical model of vulnerability, embracing such aspects as: (i) exposure (to Brexit), (ii) sensitivity and (iii) adaptive capacity, we construct an index of overall vulnerability. Exposure (share of exports sent to the UK) reflects the extent to which a region's economy may be affected by a shock. Sensitivity, proxied by trade openness, exports concentration and structure, mirrors the region's behaviour towards exposure to the crisis. Adaptive capacity defines the ability of a region to conform to the new (post-crisis) situation. It reflects the capacity to decrease the scale of potential impact/exposure to the crisis or ability to deal with its consequences and is determined by quality of institutions, FDI performance, IIT intensity, innovative capacity and human capital endowment.

Contrary to previous analyses, we do not utilise the estimated values of trade from the Input-Output databases, but instead use trade data obtained from statistical systems of Poland and Spain.

We believe that the implications stemming from this research are to a high extent universal, due to a two-country perspective. By proposing a method of determining the foreseen consequences, we anticipate other studies to emerge.

By going beyond country characteristics and concentrating on sub-national regions, we expected to obtain the taxonomy of regions that is "mixed" within the particular clusters of vulnerability. However, it is not the case, because clusters are mainly composed by Spanish or Polish regions, with few exceptions in which several Polish regions are accompanied by one or two Spanish regions (or opposite).

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Introduction

Brexit might have important consequences for EU member states (MS) however their scope and seriousness so far cannot be assessed precisely because the conditions on which it will take place are still being negotiated. The consequences are usually inquired at country level, while their regional dimension does not get the necessary attention. The research on regional aspects of exporting, especially if done for a group of countries, usually is based on simulated data via input-output tables (Brakman, Garretsen, & Kohl, 2018; Chen et al., 2018). Contrary to them, we use not-simulated, 4digit CN data on regional exports.

A two-country framework (Spain and Poland) is applied in order to obtain robust conclusions. Both countries are MS of the EU, similar in terms of population, number of NUTS-2 regions, similar geographical distance to the UK, are not the founding countries of the EEC (as they joined the EU later). Despite similarities, there are differences between them, related to the membership in the eurozone (Poland so far did not introduce the euro) and the kind of peripherality in the EU (in the south, in case of Spain and in the east, in case of Poland). Both countries share a border with a big, important EU member, which is France for Spain and for Poland is Germany. We treat Brexit as an economic shock that will influence regions' economies and will affect their welfare. The regional point of view is justified because the Brexit consequences will be place-based, dependent on the particular region character of trade relations with the UK. We concentrate on foreign trade relations as the main channel transferring this shock. Although from the macroeconomic perspective Brexit consequences will differ for the EU particular countries (Felbermayr, Fuest, Gröschl, & Stöhlke Daniel, 2017), when we take the regional perspective of an inquiry into foreign trade, the similarities between Spain and Poland's regions can be identified.

As regards the theoretical and empirical setting, basically we refer to the concept of vulnerability. In the literature, several similar terms are used: sensitivity, vulnerability, dose-response. Together with resilience, they constitute the vulnerability model that can be used as a framework for analysis of Brexit's consequences.

We do not aim at making the comprehensive inquiry into the Brexit consequences for the regions' economies, as is done for example in gravity models using trade data to assess the welfare effects stemming from changing the trade regime when the UK will leave the EU.

What we do – is concentration on one aspect – which is the character of trade relations, done with reference to several indicators such as: trade openness, export product concentration, share of agricultural products in export, share of high-tech products in export, quality of regional institutions, the intensity of FDI presence in a region.

The remainder of the paper is the following. In section 1, the theoretical background for the evaluation of vulnerability to Brexit is presented. Section 2, depicts the dataset, empirical strategy as well as the hypotheses. Stylized facts on the exposure to Brexit are shown in the section 3, while the last section concludes the paper and discusses the implications of the research.

1. Theoretical background

Several theoretical frameworks can be used to assess the consequences of Brexit for regions' economies when the foreign trade relations are looked into. Leaving the EU means changing of the trade regime from the customs union to less preferential scheme of trade relations. Thus, the reversed trade creation and diversion effects are expected, which would justify to make use of a "purely" international trade (customs union) theory. When the regional dimension is at stake, New Economy Geography (NEG) is recommended, as Brexit will translate into increasing trade costs, because a less favourable trade regime will be applied. Also, gravity-based estimations could be applied, as gravity in fact has become the most frequently used framework for trade analysis, including inquiries into changes of trade regimes (Brakman et al., 2018; Brodzicki & Umiński, 2017; Head & Mayer, 2014; Martínez-Zarzoso & Márquez-Ramos, 2018).

Our research does not pretend to show a broad spectrum of Brexit consequences for regions' economies. Instead, we use the conceptual framework of vulnerability presented by Turner et al. (2003), which was further extended to the needs of evaluation of vulnerability to crises by Aversano-Dearborn, Beiglböck, and Binot (2011). This three-element model comprises: exposure, sensitivity and resilience, which together (including their inter-connections) describe the overall vulnerability to a specific (Briguglio, 2004) phenomenon (White et al., 2005).

Given the three dimensions of vulnerability, the role of the first one is to indicate the exposure, which is the extent to which the economy may be affected by the incoming shock. It encompasses: economic agents, households or the whole economy, by describing their postures against intensity, frequency or duration of potential crises. Exposure is not constant in time, what reflects the changing trends in the global/national/regional economies. The sensitivity mirrors the region's behaviour towards exposure to the crisis (Aversano-Dearborn et al., 2011). Thus, it is mainly dependent on the regional-specific characteristics, which determine how the negative stimuli and threats impact the economy and society (Frazier, Thompson, & Dezzani, 2014). These can stem from specific composition of an industrial structure, trade characteristics and links with the global economy. Contrary to the above, the adaptive capacity (or resilience) is a force suppressing the extent to which a potential shock is mitigated. It defines the ability of a region to conform to the new (post-crisis) situation. Thus, it reflects the capacity to decrease the scale of potential impact/exposure to the crisis or ability to deal with its consequences.

Overview of the literature on vulnerability shows from how many perspectives it can be conceptualised, defined and assessed empirically, both at country, regional and even sub-regional level. There is an important strand of research focused on mitigation damages stemming from environmental disasters (Hagihara & Asahi, 2016), climate changes (Read, 2010) or physical/natural hazards (Frazier et al., 2014).

On the other hand, there is affluent literature on the purely economic aspects of vulnerability and resilience (Patton, Xia, Feng, & Hewitt, 2016; Röhn, Sánchez, Hermansen, & Rasmussen,

2015), in which research is focused on how foreign trade and openness affect vulnerability is proliferating (Fingleton, Garretsen, & Martin, 2015; Georgescu, 2015; Nassima, Montigaud Jean-Claude, Rastoin, & Tozanli, 2006; Röhn et al., 2015; United Nations, 2011)

From the perspective of the assessment of vulnerability of regions' economies to the consequences of Brexit, literature devoted to vulnerability of small states represents an inspiring approach, that explicitly underlines the question of openness to trade (Briguglio, 2014a, 2014b, 2014b, 2016a, 2016b; Briguglio, Cordina, Farrugia, & Vella, 2009; Briguglio & Vella, 2016; International Monetary Fund, 2013; Lewis-Bynoe, 2014).

The transposition of the vulnerability framework to the specific case of regions' exposure to Brexit yields very polarised results, which to a large extent are different from general crisis-vulnerability framework. Although, the main components of the vulnerability setting remain the same, their character shifts towards exposure to bilateral trade relations among regions' trade with the UK. Thus, within the general framework our analysis is similar to the ones run by Zaucha, Ciołek, Brodzicki, and Głazek (2014). However, our main contribution in this regard is the adjustment of it to the needs of evaluation of vulnerability of regions to Brexit in the area to foreign trade.

We propose the following approach to investigate the vulnerability to Brexit. The regional vulnerability is a function of two components: impact (IM_t) of Brexit and regional adaptive capacity (AC_t) to the shock, caused by UK withdrawal from the EU:

$$V_t = f(IM_t, AC_t) \quad (1)$$

where:

V_t – vulnerability to Brexit at (present) time t ,

IM_t – present impact of Brexit,

AC_t – adaptive capacity to Brexit.

Regions, due to their economic and trade-related diversification, including bilateral interconnections, will be heterogeneously affected by the impact of the shock. The latter, is dependent on: (i) the exposure to the Brexit, and (ii) sensitivity to Brexit. The exposure is mainly conditioned on the intensity of trade relations with UK, thus it can be proxied by the share of the UK in region's exports. The sensitivity, in the context of our research, relates to the composition of trade, that determines how the Brexit's negative effects would impact the regions' economy through the channel of foreign trade (Röhn et al., 2015). Hence, it encompasses the sectoral structure of the bilateral relations with UK and the overall trade openness of regional economies.

Given the persistent nature of trade relations, originating from historical legacy, past investments (including activity of foreign direct investments), strategic decisions, comparative advantages and the role of metropolises (Brodzicki & Umiński, 2017) – the present impact of the Brexit, is strongly conditioned on the past conditions, which cannot be immediately changed. That is why impact of the Brexit to regional economies equals:

$$IM_t = g(E_t, S_t) \quad (2)$$

E_t – exposure to Brexit,

S_t – sensitivity to Brexit,

g – symbol of a function of an unknown empirical form.

As it was noted above, the exposure to Brexit may be proxied by the share of exports sent to the UK, whereas sensitivity is the effect of the structure of the economy, established trade-relations, including its specific composition within the exporting activity or the role of international trade in regional economies:

$$S_t = h(TR_t, EX_t) \quad (3)$$

where:

TR_t – overall trade openness index,

EX_t – export product concentration to UK,

h – symbol of a function of an unknown empirical form.

Structural characteristics have crucial importance in the assessments of regional vulnerability to foreign trade changes as well as consequences of globalisation (European Commission, 2008). Particular products' groups may have different elasticities towards trade cost changes, caused by till now an unknown Brexit scenario. Therefore, we anticipate different behaviour of agricultural and high-tech products sent to the UK, given their specific role and importance to the UK economy and to Spanish and Polish regions' exports. Rural areas, and rural remote regions in particular, experienced disproportionate negative impact of the 2008 crisis, than urban areas (Patton et al., 2016). The transmission of the external economic shocks to the rural areas goes also through the trade channel.

$$EX_t = (s_AGRI_t, s_HT_t) \quad (4)$$

where:

s_AGRI_t – share of agricultural products in exports to UK,

s_HT_t – share of high-tech products in export to UK.

Following (Briguglio et al., 2009) and (Briguglio, 2014b), we treat exports concentration as a vulnerability component, increasing the vulnerability to Brexit. Export concentration reflects the character of the production base, which to large extent is path dependent. However we do not agree with (Briguglio et al., 2009) that the small size of the economy significantly restricts an ability to diversify exports. In case of regions, treated as small economies, diversification chances stem from the entrance of new investors, especially with foreign capital, that contribute to improvements of exports capacity. Many depends on the investment attractiveness and the character of the activity carried on by the new coming investors (assets creating vs. assets converting). Even if the structural characteristics of exports apparently do not change, much can happen inside particular sectors in the form of intra-industry adjustments. Serious competitiveness improvements, reflected in exporting activity, can stem from shifts between

horizontal and vertical intra-industry trade (IIT), including high quality vs. low quality vertical IIT components. Several empirical studies show positive correlation between export diversification and economic growth (Amin Gutiérrez de Piñeres & Ferrantino, 2000; Herzer & Nowak-Lehmann D., 2006), however (Naudé, Bosker, & Matthee, 2010) after a thorough literature overview on the nexus between economic growth and exports specialisation vs. diversification conclude that no unambiguous conclusions can be formulated. For local economies, contrary to a country level studies, export specialisation positively affects economic growth (Naudé et al., 2010). On the other hand, it is generally acknowledged, that diversification mitigates vulnerability too, for instance, commodity shocks, deteriorating terms of trade as well as fluctuations of prices. Moreover, endogenous growth theory indicates the positive consequences of exports diversification through spillovers from high-tech products to other economy sectors (Herzer & Nowak-Lehmann D., 2006).

The third vulnerability component, which is an adaptive capacity, encompasses regional heterogeneity in terms of reaction towards Brexit. The set of determinants affecting elastic and dynamic changes within the trade setting, involves the ability of taking actions that can mitigate an upcoming (foreseen) decrease in the demand from the UK.

The region's adaptive capacity is an outcome of a list of its determinants:

$$AC_t = i(QoI_t, FDI_t, Innov_t, HC_t) \quad (5)$$

where:

QoI_t – quality of regional institutions,

FDI_t – the intensity of FDI presence in a region,

$Innov_t$ – region's innovative capacity,

HC_t – the quality of human capital,

i – symbol of a function of unknown empirical form.

The inclusion of the quality of regional institutions as one of the adaptive capacity determinants is motivated by the fact, that the overall regional economy performance influences the business activity and exports in particular. Effective business environment institutions facilitate international trade, by reducing risk and uncertainty, that in export transactions (vs. domestic ones) is higher (Bojnec, Fertő, & Fogarasi, 2014; Handley & Limão, 2017; Martínez-Zarzoso & Márquez-Ramos, 2018). Export performance can also be positively affected by promotional activity, carried on towards region's firms (Gil, Llorca, & Serrano, 2008; Teixeira & Barros, 2014). Another aspect is attraction of foreign owned entities (FOEs) to the region, that reveal superior export performance, compared to indigenous firms (Mayer & Ottaviano, 2008; Zhang & Song, 2001). FOEs, according to Forsgren (2008) perform a networking function. Being in the network of relations, they have a capability of offsetting the negative consequences of Brexit, through switching to more intensive trade relations with non-UK partners.

2. The data, hypotheses and empirical approach

2.1. Data

The dataset used in the study is a compilation of the data from a number of sources. Regional trade data with country of origin and destination for NUTS-2 regions were obtained from DataComex (for Spanish regions, available at <http://datacomex.comercio.es>) and Customs Chamber (for Polish regions). The data were accompanied by NUTS-2 Quality of Government Institute's EU regional database (Charron et al., 2016), describing regional output, quality of regional institutions and the share of population with tertiary education. The information of regions' FDI were obtained from the Spanish Ministry of Economy and Competitiveness and from Central Statistical Office for Poland. Lastly, the remaining data were downloaded from the Regional Innovation Scoreboard dataset (<http://ec.europa.eu/growth/industry/innovation/facts-figures/regional>), embracing regional innovation capacity related to the EU mean innovation capacity.

Given the frequent missing data for two autonomous Spanish city-regions (Ceuta and Melilla), being the autonomous administrative territories of Spain located in Africa, we exclude them from the final analysis. The sole analysis is run in a cross-section due to the data availability and character of the exposure to the future exogenous shock. However, some stylized facts on potential exposure to Brexit are presented in-time to identify the changes in the scale of exports to the UK.

2.2. Empirical approach and hypotheses

Referring to the vulnerability concept, we aim at identifying the potential regional vulnerability to Brexit, with particular reference to regions' foreign trade activity. Thus, the authors set three specific aims in the study: (i) to set the analysis into the vulnerability concept theoretical foundations, (ii) to identify regions with diverse levels of vulnerability to Brexit, (iii) to provide better understanding of potential causes of Brexit to regions.

We believe that trade is a prime platform of transmitting potential economic shock, caused by the UK leaving the EU. That is why we concentrate our attention to the sole trade-related effects for regional economies of two countries (Spain and Poland). Contrary to the majority of the empirical evidence, portraying comprehensive, but not-trade related consequences for selected economies, we limit the analysis to the first-round effects of this shock. The latter, will be obviously dependent to a large extent on the reduction of bilateral trade among the UK and its trade partners.

In order to evaluate the potential vulnerability to Brexit, a synthetic vulnerability index, grounded in theoretical and empirical setting is used (see section 2). Within its structure, it heavily relies on similar vulnerability indices constructed for vulnerability to economic shocks (Aversano-Dearborn et al., 2011; Zaucha et al., 2014). The following selection of variables (table 1), supplements the theoretical considerations on the vulnerability to Brexit model, which are implemented in the vulnerability indicator. Their values were: (i) standardised to avoid the impact of different orders of magnitude as well as inter-country differences and (ii) the directions of variables' influence were corrected to avoid ambiguity. Thus, exposure and sensitivity are the two dimensions of the index increasing the vulnerability, whereas adaptive

capacity counteracts to some extent this vulnerability. No particular weighting scheme was adopted, what resulted in the equal influence of particular variables to the resulting particular dimensions of the vulnerability. Similarly, when the final impact is measured, being a conjunction of exposure and sensitivity, equal weights were utilized. The classes for particular dimensions of vulnerability were obtained with the following clustering scheme: group 1: $dim_i \geq \overline{dim} + SD_{dim}$; group 2: $\overline{dim} \leq dim_i < \overline{dim} + SD_{dim}$; group 3: $\overline{dim} - SD_{dim} \leq dim_i < \overline{dim}$; group 4: $dim_i < \overline{dim} - SD_{dim}$, where \overline{dim} is a mean value of particular dimension and SD_{dim} is a standard deviation of the indicator.

Table 1. Variables used in the study with their potential impact on Brexit vulnerability of regions

Dimension of vulnerability	Variables	Impact on Brexit vulnerability
Exposure	Share of exports sent to UK	+
Sensitivity	Trade openness index = (exports + imports)/GDP	+
	Export product concentration:	
	- Share of agricultural products exported to UK - Share of high-tech products exported to UK	+ -
Adaptive capacity	Quality of institutions – EU Regional Quality of Government index	-
	FDI/GDP Performance Index	-
	IIT of exports to UK	-
	Innovative capacity – EU Regional Innovation Scoreboard	-
	Quality of human capital – proxied by the share of population aged 24-65 with tertiary education	-

Source: own compilation.

Information: * share of regional FDI inflow in national inflow divided by the share of regional GDP in national GDP.

Justification of the use of the proposed variables:

1. Share of exports sent to UK – shows region's exposure to trade regime changes with the UK economy.
2. Trade openness index = (exports + imports)/GDP – beyond exposure to UK regime changes, also trade openness matters. For instance, although the share of UK in exports is high for a particular region, overall sensitivity of its economy due to low openness – is low.
3. Export product concentration – it can have unambiguous effect. On one hand product concentration improves competitiveness, especially if specialisation stemming from this concentration is rooted in region's smart specialisation. On the other hand, in case of an (external) economic shock, diversity reduces that shock, especially if it is asymmetrical in nature. Thus, in the analysis export concentration was divided into particular sectors.
4. Share of agricultural products exported to UK – agricultural products are exported predominantly by regions that are relatively less competitive. Agricultural products are sensitive to trade restrictions.

5. Share of high-tech products exported to UK – reflect higher competitiveness of a region, able to supply high-tech products. High-tech products are less sensitive to trade restrictions.
6. Quality of institutions – EU Regional Quality of Government index. Higher quality of institutions can facilitate adjustments stemming from the Brexit shock.
7. FDI/GDP performance index. FDIs – according to Forsgren (2008) – are networkers. If a company as an exporter and has a network of relations, it is expected to mitigate the Brexit shock.
8. IIT of exports to UK. Intra-industry trade – vs. interindustry trade – relatively less influences income redistribution in an exporting country. Moreover, if adjustments happen, if they are of intra-industry type, are less harmful/costly than of inter-industry type. IIT intensity was calculated with the use of the standard Grubel-Lloyd index.
9. Human capital (knowledge) facilitates exports.

By constructing the synthetic index, we will be able to test three hypotheses:

H1: There is a strong regional context of vulnerability to the consequences of Brexit, that goes beyond country's characteristics.

Formulation of H1 means that we expect regions of Spain and Poland being “mixed” within the particular clusters of vulnerability. Thus, the results of the taxonomy shall not be country biased.

H2: Application of regional perspective, enables to grasp universal regularities in the context of economic shock, which is Brexit, despite inter-country differences

Formulation of H2 brings our attention to the characteristics of particular regions, especially their metropolitan status, centrality vs. peripherality and overall competitiveness. Positive verification of H2 hypothesis would acknowledge the role of inter-regional heterogeneity over the inter-country differences, observed in regional trade, affecting regional vulnerability to the Brexit.

H3: Regional exposure to Brexit is strongly dependent on idiosyncratic factors related to path dependent export profiles.

The idiosyncrasy mentioned in H3 stems from path dependency of trade relations with the UK's economy, character of the export base (structural factors) and activity of particular, main enterprises in the region, also with foreign capital, having stronger than on an average trade links with the UK.

3. Regional vulnerability to Brexit

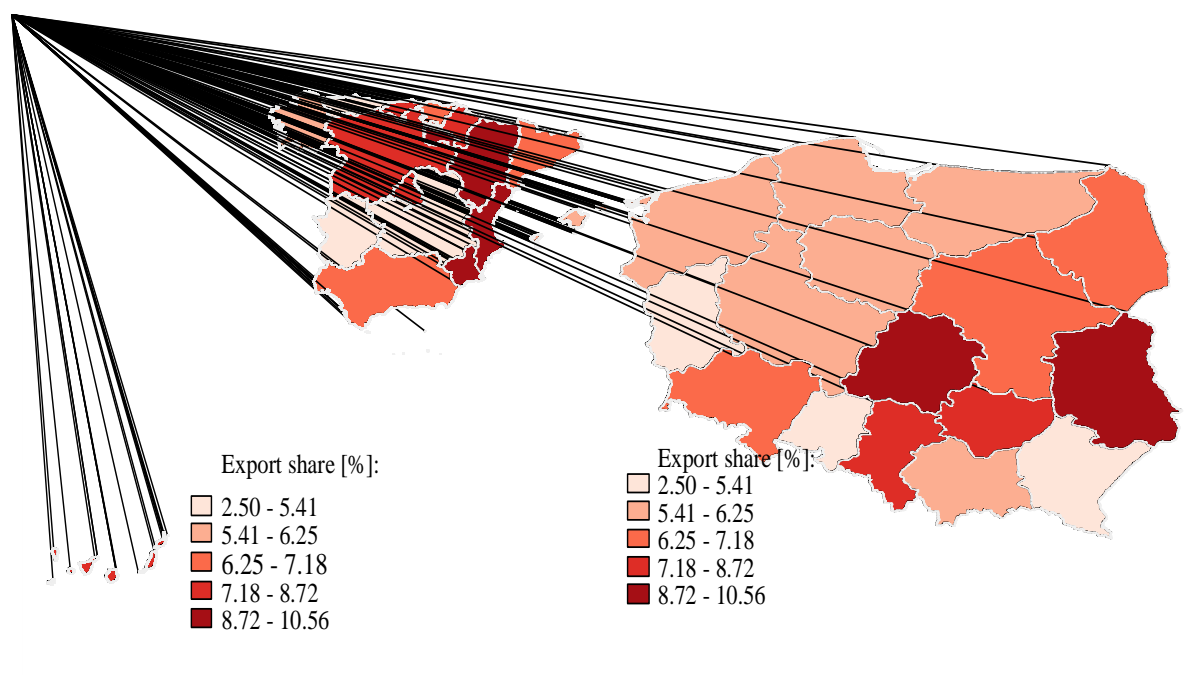
The first aspect of the vulnerability assessment is exposure, proxied by the share of the UK in total exports. The lowest exposure relates to Opolskie in Poland (2.6%). For Spain the lowest exposure relates to Extremadura (5.2%). The observed regularities among regions seemed to be quite persistent over time and among regions of different countries. Actually, only in the case of Spain between 2005 and 2015 one could observe reduction in the mean share of exports to

the UK (table 2). In 2015 the mean exposition to Brexit among Polish and Spanish regions was actually the same. Spanish regions anticipated slightly higher maximum values in this respect, what resulted in a higher inter-regional differentiation.

The highest exposures are observed for Lubelskie in Poland (9.9%) and two Spanish regions (Murcia and Comunidad Valenciana, 10.3% and 10.6% respectively). These regions share some interesting common characteristics: have relatively low GDP per capita level compared to the national average as well as to the EU average, Murcia and Lubelskie can be regarded as peripheral regions, however the question of peripherality shall be treated with caution. For instance according to Aversano-Dearborn et al. (2011) both Murcia and Com. Valenciana are regions well prepared for globalisation processes, while Lubelskie (as most of the Poland's NUTS-2 regions) represents a highly vulnerable to globalisation, peripheral region. Castilla-La Mancha for instance has the lowest exposure to the Brexit consequences in our ranking (the UK's share in exports is 4,7%), while by Aversano-Dearborn et al. (2011) has been ranked as a very sensitive to globalisation, peripheral region. One has to remember, while interpreting our taxonomy results, that we focus on exports, as a selected aspect of vulnerability to Brexit, and obviously exposure to intensive trade relations with the UK cannot be interpreted as exposure to globalisation. Poland vs. Spain comparison of exposure shows that only two Polish regions have been ranked as being very highly exposed, while for Spain there are 4 of them.

As for the further research it seems an interesting inquiry to find what are the factors that make the regions having over that on average share of the UK in exports. In Spain it is a row of regions forming "a belt" from La Rioja, through Aragon and Com. Valenciana to Murcia. In Poland, high and very high exposure is an attribute of regions forming "the belt" starting from Lubelskie, through Świętokrzyskie, to Łódzkie and Śląskie. The road network seems to play an important role in this respect (at least in Poland). Also some learning by exporting experience and exporters agglomeration effects can matter, especially that agglomeration can be driven by the destination of exports (Cassey, Schmeiser, & Waldkirch, 2016; Koenig, 2009; Koenig, Mayneris, & Poncet, 2010).

Fig. 1. The share of exports sent to UK in 2015 from Spanish (left panel) and Polish regions (right panel)



Source: own compilation. Five strata were selected according to equal division of the distribution.

Table 2. The average share of regional exports sent to the UK by Spanish and Polish regions

	Mean	Min	Max	CV	Mean	Min	Max	CV
Year	Spanish regions				Polish regions			
2005	10.05	3.80	16.41	0.37	5.02	2.28	8.13	0.31
2006	8.80	3.77	14.40	0.34	5.23	2.34	7.60	0.32
2007	8.50	3.57	14.26	0.35	5.55	2.58	8.22	0.32
2008	7.94	3.37	13.42	0.33	5.49	3.25	8.12	0.30
2009	7.36	3.04	13.11	0.41	5.48	3.14	9.16	0.32
2010	7.13	3.34	12.45	0.35	5.41	2.93	9.24	0.33
2011	7.29	3.62	12.53	0.43	5.68	2.93	9.55	0.35
2012	6.63	3.55	11.19	0.32	6.02	2.77	10.26	0.34
2013	7.24	4.53	12.47	0.32	6.00	2.79	10.45	0.30
2014	7.26	4.26	10.13	0.27	5.90	2.60	8.97	0.28
2015	7.39	4.76	10.55	0.25	6.47	2.56	9.94	0.29

Source: own compilation.

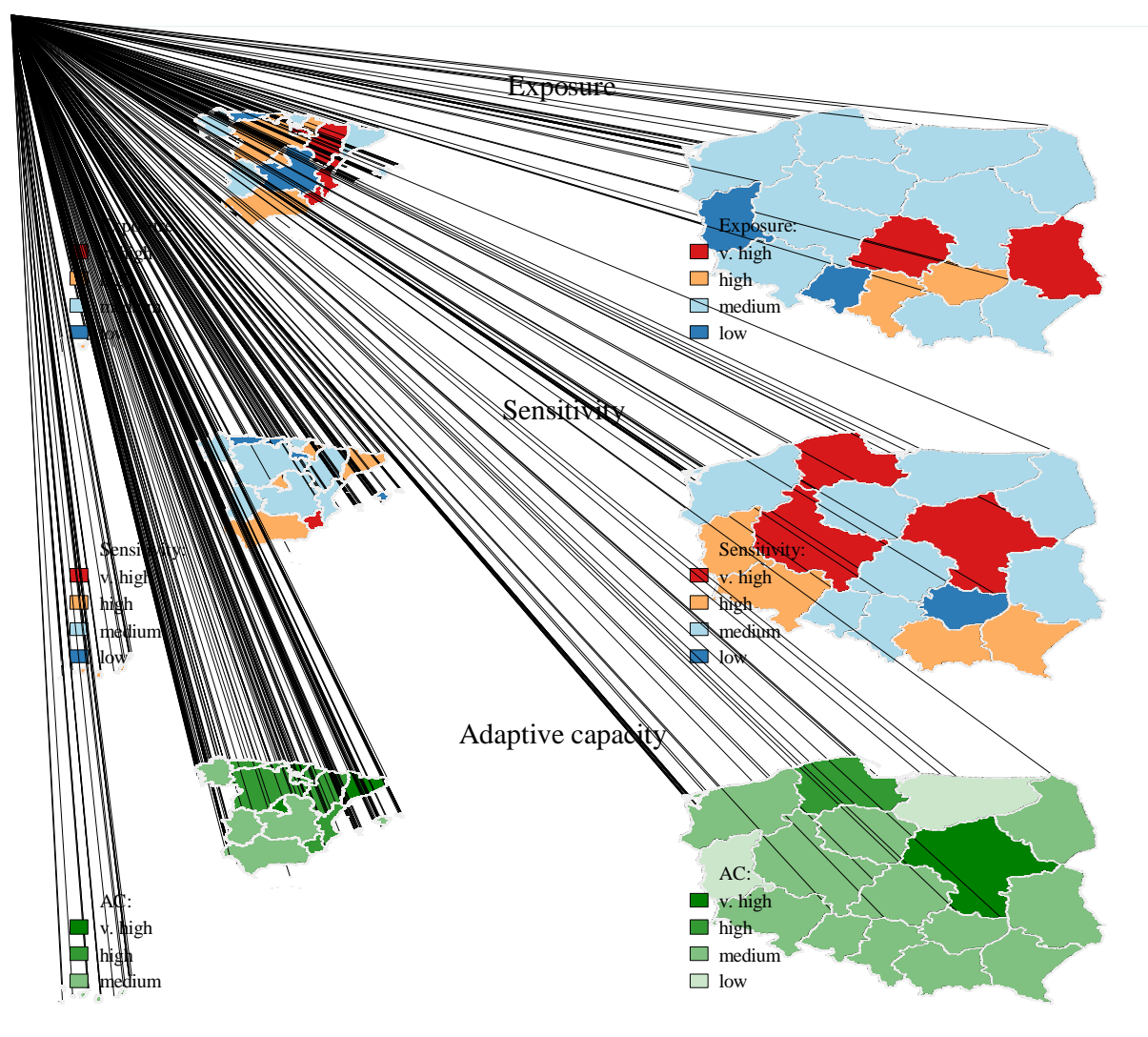
Information: CV – coefficient of variation.

As regards sensitivity (fig. 2), 7 Polish regions have been classified as being highly or very highly sensitive for Brexit consequences and 5 for Spain. As regards regions ranked as highly sensitive, in Poland these are three metropolitan, highly competitive regions: Mazowieckie, Wielkopolskie and Pomorskie, while for Spain it is Murcia. An important, common factor

shared by these for regions is high trade openness, with trade channel being the transmitter of impulses from foreign markets.

Interesting, symptomatic results have been obtained with reference to adaptive capacity, which is the highest for two capital regions which are Madrid and Mazowieckie and Cataluna, which reflects their superior position in many aspects. Madrid and Mazowieckie are leaders in terms of FDI/GDP performance index, which however shall be treated with caution because of a capital city FDI registration bias effect. The three regions report high intensity of IIT trade with the UK and high innovative capacity. The obtained results are in line with the taxonomy of Aversano-Dearborn et al. (2011), in which Madrid and Cataluna are the only regions of Spain classified as globalised regions of the knowledge-based economy. Mazowieckie is also unique, being the only Polish region ranked as oriented towards services, while all other Poland's regions are sensitive to globalisation, peripheral ones. Generally, Spanish regions, have higher adaptive capacity than the Polish ones. None of the Spanish regions has been classified as of low adaptive capacity.

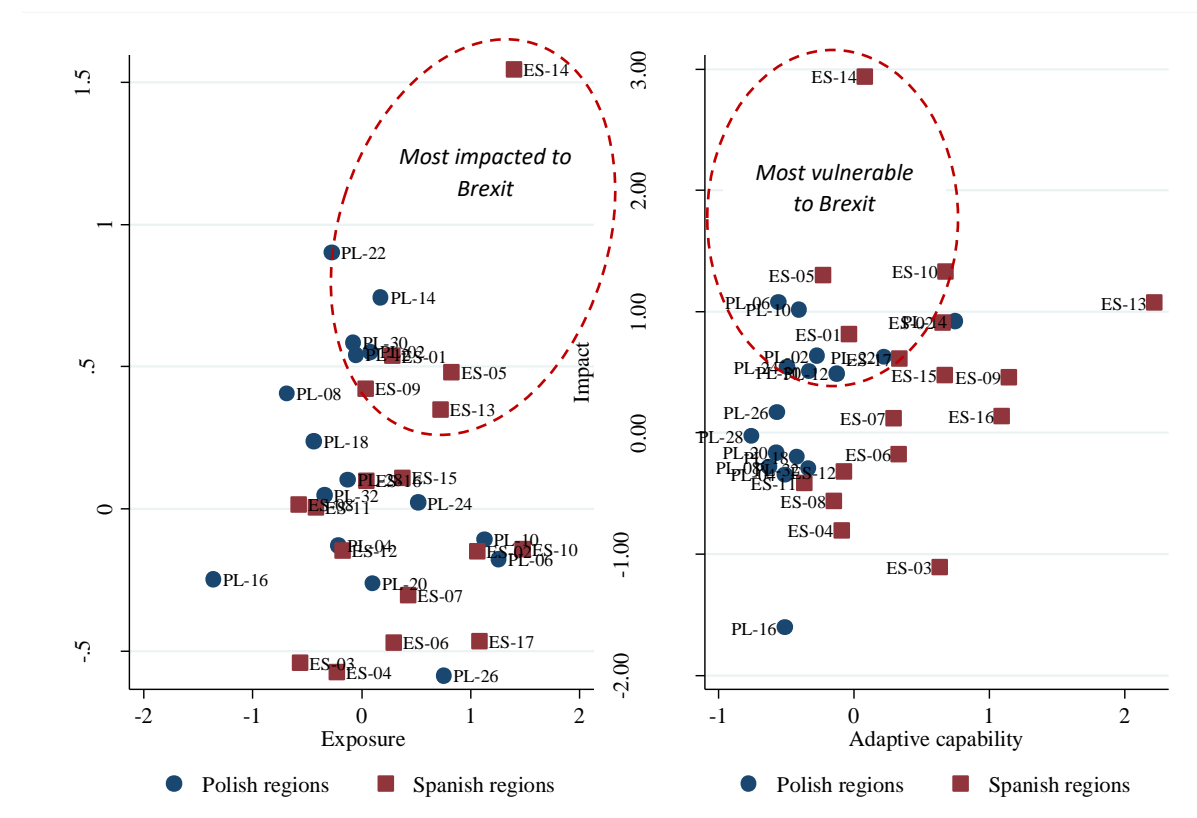
Fig. 2. Dimensions of vulnerability to Brexit



Source: own compilation.

Figure 3 presents two relations, (i) between: sensitivity and exposure as well as (ii) between impact and adaptive capacity. Circles indicate regions of Poland and Spain, that are mostly impacted to the consequences of Brexit (high, both sensitivity and exposure) and those, that are most vulnerable to Brexit (high impact and low adaptive capacity).

Fig. 3. The relations between sensitivity and exposure to Brexit (left panel) and impact of Brexit and adaptive capacity (right panel)



Source: own compilation. Region codes: ES-01 Andalucia; ES-02 Aragon; ES-03 Asturias, Principado de; ES-04 Balears, Illes; ES-05 Canarias; ES-06 Cantabria; ES-07 Castilla y Leon; ES-08 Castilla-La Mancha; ES-09 Cataluna; ES-10 Valenciana, Comunidad; ES-11 Extremadura; ES-12 Galicia; ES-13 Madrid, Comunidad de; ES-14 Murcia, Region de; ES-15 Navarra, Comunidad Foral de; ES-16 Pais Vasco; ES-17 Rioja, La; PL-02 Dolnoslaskie; PL-04 Kujawsko-Pomorskie; PL-06 Lubelskie; PL-08 Lubuskie; PL-10 Łódzkie; PL-12 Malopolskie; PL-14 Mazowieckie; PL-16 Opolskie; PL-18 Podkarpackie; PL-20 Podlaskie; PL-22 Pomorskie; PL-24 Slaskie; PL-26 Swietokrzyskie; PL-28 Warminsko-Mazurskie; PL-30 Wielkopolskie; PL-32 Zachodniopomorskie.

The results bring the following implications. A higher number of Spanish regions was exposed to the upcoming UK abandonment, whereas Polish regions were, on average, more sensitive to this shock, what may result in rather potentially similar impact on their trade reduction. In terms of adaptive capacity, a systematic inter-country difference, with Spanish regions being more prepared to the shock, was seen. Thus, the real trade-effects are difficult to foresee. They will, for sure, depend on the elasticities of particular dimensions of vulnerability, signalling unequal and yet-unknown role of particular forces exposing or diminishing the real vulnerability.

Table 3 summarises the relation between impact and adaptive capacity; four classes of both categories have been distinguished. The assumption of our research was that we focus on

regional level of exporting activity. By going beyond country characteristics and concentrating on sub-national regions, we expected to obtain the taxonomy of regions that is “mixed” within the particular clusters of vulnerability. However, it is not the case, because clusters are mainly composed by Spanish or Polish regions, with few exceptions in which several Polish regions are accompanied by one or two Spanish regions (or opposite). Thus, we reject the H1 hypothesis.

Capital regions of Poland and Spain (Mazowieckie and Madrid) together with Cataluna have relative high impact to the consequences of Brexit, while revealing the highest adaptive capacity that can mitigate the Brexit’s negative effects. The superior position of Madrid, Mazowieckie and Cataluna supports hypotheses H2, revealing the merits of metropolitan/central status and overall, high competitiveness.

Also, Pais Vasco falls into category of a very high adaptive capacity, while having relatively low impact. Canarias represents a quite different position (very high impact and relatively low adaptive capacity). This could be an effect of a relative high remoteness of Canary Islands, located near the African coast. Two Poland’s regions (Warminsko-Mazurskie and Lubuskie) are in a special position: relatively low impact is accompanied by very low adaptive capacity.

Table 3. Impact of Brexit and adaptive capacity of regions

Adaptive capacity	Impact				
		1 (v. high)	2	3	4 (low)
	1 (v. high)		Madrid; Mazowieckie; Cataluna;	Pais Vasco	
	2	Comunidad Valenciana,; Murcia;	La Rioja; Aragon; Navarra; Pomorskie;	Castilla y Leon; Cantabria;	Asturias;
	3	Canarias;	Lubelskie; Łódzkie; Śląskie; Andalucia; Dolnoslaskie; Malopolskie; Wielkopolskie	Swietokrzyskie; Podlaskie; Galicia; Kujawsko-Pomorskie; Zachodniopomorskie; Extremadura; Podkarpackie;	Balears; Castilla-La Mancha; Opolskie;
	4 (low)			Warminsko-Mazurskie; Lubuskie;	

Source: own compilation. Colours represent the intensity of Brexit vulnerability. Thus, regions with highest impact and lowest adaptive capacity will be mostly vulnerable to Brexit. On the other hand, regions with highest adaptive capacity and lowest impact will be relatively resilient to this shock.

The position of two "belts" of regions (for Spain and for Poland) that reveal relatively higher share of the UK in exports, supports hypotheses H3. Further research however is recommended to identify the factors beyond this idiosyncratic position as regards exports to the UK.

Conclusion and discussion

This study hypothesises important potential and heterogeneous consequences of Brexit for sub-national regions within European countries. To evaluate this in a scenario that is yet unknown, we have taken on board regional trade of two EU countries, Spain and Poland, and we have

focused on the analysis of three different aspects of vulnerability: exposure, sensitivity and adaptive capacity.

The prerequisite for the inquiry into Brexit's consequences was the focus on regional level of exporting activity. We expected to obtain the taxonomy of Polish and Spanish regions "mixed" within the identified clusters of vulnerability. However, it is not the case, because clusters are mainly composed by Spanish or Polish regions, with few exceptions in which several Polish regions are accompanied by one or two Spanish regions (or opposite).

Brakman et al. (2018) with the use of data on value-added exports and counter-factual gravity equations estimated in the hard Brexit scenario country-level effects for Poland at ca. 1.9% loss and Spain at ca. 3.3% loss. The presented data situate Poland as a country moderately vulnerable to Brexit, whereas Spain becomes highly vulnerable to these consequences. Our study enriches the analysis by presenting regional impact of vulnerability with different theoretical setting.

Similarly to Chen et al. (2018), we present regional impact of potential Brexit consequences by constructing vulnerability indicator. However, we do not rely on estimated data, but instead utilise real trade-based information. Also, the scope of the analysis is different – exports vs. potential GDP and employment loss in the latter case. According to Chen et al. (2018) among Spanish regions mostly affected by the Brexit consequences will be: Comunidad_de_Madrid (0.94% GDP loss), Cataluna (0.95%), Comunidad_Valenciana (0.87%), Murcia (0.76%), whereas in the case of Poland: Mazowieckie (1.35%), Wielkopolskie (1.37%), Lubuskie (1.38%), Opolskie (1.38%), Warminsko-Mazurskie (1.37%). Our results to a high extent support the above findings (note the differences in variables of interest) especially for Spanish regions and to some extent for Polish too. They seem to signal the higher importance of regional adaptive capacity. Regions with low adaptive capacity tended to obtain higher overall vulnerability in a series of cases for Polish regions.

We are aware that the study experiences a number of limitations. Firstly, it encompasses only the trade relations, being the prime channel of transmitting Brexit to regional economies of Spain and Poland. Other channels through which Brexit will affect the regions deserve attention, for instance the tension for the UE stemming from UK not contributing to the EU budget. However, this dimension of Brexit consequences for regions could only be assessed within the political discussion on the next UE's financial perspective and its priorities as well with the debate on the future of the EU. Secondly, it uses the example of two countries to obtain generalised findings, however the final outcome of the Brexit may be different in other countries. Thirdly, the empirical methods to depict and identify different levels of vulnerability to Brexit are quite simple (although grounded in economic theory). Lastly, given the unknown final Brexit scenario, the real effects of Brexit may vary from the ones presented in this paper, giving e.g. different importance of particular dimensions of vulnerability (elasticities) to final economic effects. In case of particular regions, depending on their characteristics, the influence of particular components of sensitivity or adaptive capacity – can be different. For instance, FDI might be performing a networking role in exporting activities, that is expected to mitigate the Brexit shock, in particular cases might on a contrary be a factor bringing negative consequences, if investors are skittish and reallocate to other places. The sectoral composition of exports also matters (Felbermayr et al., 2017) and shall be examined in a more profound way, beyond only focusing on agriculture and high-tech products. We treat Brexit as a shock, bringing negative consequences. However, in particular cases, the shock might evoke an

“impact effect”, that will be positive in that sense, that new business opportunities will be looked for and the intensified efforts would be taken in order to find, for example, new markets or new business partners. This is indeed a challenge for regional institutions engaged in the promotion of exports, and a test for their efficiency (Teixeira & Barros, 2014).

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Appendix

Table A.1. Regional dimensions of vulnerability to Brexit

Region	Region name	i_exp	i_sen	i_ac	i_im	c_exp	c_sen	c_ac	c_im
ES-10	Valenciana, Comunidad	1,47	-0,14	0,67	1,33	1	3	2	1
ES-14	Murcia, Region de	1,40	1,55	0,08	2,94	1	1	2	1
PL-06	Lubelskie	1,26	-0,18	-0,56	1,08	1	3	3	2
PL-10	Łódzkie	1,13	-0,11	-0,40	1,02	1	3	3	2
ES-17	Rioja, La	1,08	-0,47	0,33	0,61	1	4	2	2
ES-02	Aragon	1,06	-0,15	0,65	0,91	1	3	2	2
ES-05	Canarias	0,82	0,48	-0,23	1,30	2	2	3	1
PL-26	Świętokrzyskie	0,75	-0,58	-0,57	0,17	2	4	3	3
ES-13	Madrid, Comunidad de	0,72	0,35	2,22	1,07	2	2	1	2
PL-24	Śląskie	0,52	0,02	-0,50	0,54	2	3	3	2
ES-07	Castilla y León	0,42	-0,30	0,29	0,12	2	3	2	3
ES-15	Navarra, Comunidad Foral de	0,37	0,11	0,67	0,48	2	2	2	2
ES-06	Cantabria	0,29	-0,47	0,33	-0,18	2	4	2	3
ES-01	Andalucía	0,28	0,54	-0,04	0,82	2	2	3	2
PL-14	Mazowieckie	0,18	0,75	0,75	0,92	3	1	1	2
PL-20	Podlaskie	0,10	-0,26	-0,57	-0,16	3	3	3	3
PL-02	Dolnośląskie	0,08	0,55	-0,27	0,64	3	2	3	2
ES-16	País Vasco	0,04	0,10	1,09	0,14	3	3	1	3
ES-09	Cataluña	0,04	0,42	1,15	0,46	3	2	1	2
PL-12	Małopolskie	-0,05	0,54	-0,13	0,49	3	2	3	2
PL-30	Wielkopolskie	-0,08	0,58	-0,33	0,51	3	1	3	2
PL-28	Warmińsko-Mazurskie	-0,13	0,10	-0,76	-0,03	3	3	4	3
ES-12	Galicia	-0,17	-0,15	-0,07	-0,32	3	3	3	3
PL-04	Kujawsko-Pomorskie	-0,22	-0,13	-0,51	-0,34	3	3	3	3
ES-04	Baleares, Illes	-0,23	-0,57	-0,09	-0,80	3	4	3	4
PL-22	Pomorskie	-0,27	0,90	0,22	0,63	3	1	2	2
PL-32	Zachodniopomorskie	-0,34	0,05	-0,34	-0,29	3	3	3	3
ES-11	Extremadura	-0,42	0,01	-0,37	-0,41	3	3	3	3
PL-18	Podkarpackie	-0,44	0,24	-0,42	-0,20	3	2	3	3
ES-03	Asturias, Principado de	-0,57	-0,54	0,63	-1,11	4	4	2	4
ES-08	Castilla-La Mancha	-0,58	0,02	-0,15	-0,56	4	3	3	4
PL-08	Lubuskie	-0,69	0,41	-0,63	-0,28	4	2	4	3
PL-16	Opolskie	-1,36	-0,25	-0,51	-1,61	4	3	3	4

Source: own compilation. *I* – indices, *C* – classes.