VULNERABILITY TO THE CONSEQUENCES OF BREXIT: EVIDENCE FOR POLISH AND SPANISH REGIONS

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Abstract: *After the announcement in June 2016 that the UK would leave the EU, studies analysing the consequences of this reversal in economic integration have proliferated, mostly presenting prospective consequences for the UK economy. But Brexit will necessarily also have consequences for non-UK European countries and their regions. Given the different character and intensity of regions' interconnections with the British economy, we assess Polish and Spanish regions' vulnerability to Brexit in the sphere of foreign trade. We rely on the conceptual framework originally presented by Turner et al. (2003) comprising: exposure, sensitivity and resilience, which together describe the overall vulnerability to a specific phenomenon. We fill the gap in the Brexit-related literature by applying the perspective of the regions of other EU countries, engaged in trade relations with the UK. We show that geography "still matters" and due to gravity, path dependency and FDI, some regions have developed relatively stronger commercial links with the British economy. We expected to obtain the taxonomy or 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 a few exceptions, in which several Polish regions are accompanied by one or two Spanish regions. The results show greater vulnerability of Spanish (more exposed but better prepared) than Polish regions (more sensitive). While Brexit is rather perceived as a national problem, its asymmetrical impact on regions' economy through the trade channel is a serious challenge for regional policy. It is therefore the role for regional institutions to monitor the vulnerability to the Brexit consequences and to facilitate adjustments to the exporting (and importing) companies that will be severely affected. They can be assisted in searching for the alternative export (import) markets.*

Keywords: *Brexit, consequences, international trade, regional trade, Poland, Spain.*

JEL Classification: *F14, R11, F15.*

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Introduction

In this paper, we focus on Poland and Spain in order to analyse the potential consequences at the sub-national level of a reversal of European economic integration. The latest Parliament Eurobarometer survey confirms citizens' growing support for European economic integration. In this survey (European Parliament, 2018), the 28 European member states (MS) have been positioned according to their views with reference to two dimensions. Firstly, 'the right direction' in their own country

and, secondly, 'the right direction' in the European Union (EU). The question asked is: 'At the present time, would you say that, in general, things are going in the right direction or in the wrong direction, in…? (Our country/ EU)'. According to this survey, Poland is in the group of countries with the most positive perceptions in both dimensions (i.e. things are going in the right direction in both Poland and in the EU). On the other side of the spectrum, the Eurobarometer shows that citizens in Spain believe that things are taking the wrong direction, both in Spain and in the EU.

The withdrawal of the United Kingdom (UK) from the EU will have consequences not only in the UK, but also in MS that have established commercial links with the UK in many spheres of economy, i.e. migration (Simionescu, Bilan, Smrčka, & Vincúrová, 2017). Therefore, it is worth analysing if citizens' perceptions are justified by vulnerability towards exogenous events at the European level (such as Brexit). Recently, Brakman, Garretsen and Kohl (2018), with the use of data on value-added exports and counterfactual 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. This estimation situates Poland as a country moderately vulnerable to Brexit, whereas Spain becomes highly vulnerable (in line with the results obtained by the European Parliament, 2018). Our study contributes to this literature by presenting a sub-national analysis on the impact of Brexit for vulnerability within the area of foreign trade in non-UK sub-national regions (in what follows, we refer to regions). Including the deep structural characteristics of regions' exports allows to thoroughly assess the Brexit consequences in the sphere of international trade and grasp inter-regional heterogenous Brexit repercussions. It constitutes the novelty of this research, as in other studies only general information on trade is used. Contrary to other studies, we do not limit our analysis to depicting exposure towards Brexit, but we also take into consideration regions' sensitivity and adaptive capacity. Structural characteristics of a particular region, through its high adaptive capacity, can mitigate the foreseen shock stemming from Brexit. Thus, owing to the proposed approach, we can assess Brexit aftermath more comprehensively. So far, the study exemplifies the case of two countries thereof, but definitely if statistical data would be available other studies may emerge.

We hypothesise that Brexit may have important and heterogeneous consequences for non-UK European regions. However, their scope and seriousness 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 the regional aspects of exporting, especially if done for a group of countries, is usually based on simulated data via input-output tables (Brakman et al., 2018; Chen et al., 2018). Alternatively, we propose the use of not-simulated, 4-digit CN data on regional exports. The regional dimension of Brexit consequences is predominantly assessed for the British regions (Los, McCann, Springford, & Thissen, 2016; McCann, 2018). We fill the gap in the Brexit-related literature by applying the perspective of the regions of other EU countries, engaged in trading relations with the UK. Our approach subscribes into the point of view of those economists, that are of the opinion that 'geography still matters' (Capello, Caragliu, & Fratesi, 2018; McCann, 2018; Nazarczuk, Umiński, & Brodzicki, 2019) and due to many factors (incl. gravity, path dependency, foreign direct investments – FDI) some regions have developed relatively stronger commercial links with the British market than others.

A two-country framework 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, and are not among the funding countries of the European Economic Community (EEC). Despite these similarities, there are relevant differences between them. These are related to their membership in the Eurozone (Poland so far did not introduce the euro, and accessed the EU in 2004, while Spain accessed in 1986) and the kind of peripherality in the EU (in the South, in the case of Spain and in the East, in the case of Poland). Both countries share a border with a big, important EU member, which is France for Spain and Germany for Poland. We treat Brexit as an exogenous 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 focus on foreign trade relations as the main channel transferring this shock.

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 (Felbermayr, Fuest, Gröschl, & Stöhlke, 2017). Otherwise, we focus on the character of trade relations. It is worth mentioning, however, that owing to the on-going and deepening uncertainties towards Brexit, any analysis focused on Brexit consequences (including ours) has a certain bias.

The study shows the nature of the heterogeneous consequences of Brexit for the regions of Spain and Poland. The Brexit's asymmetrical impact on regions' economy through the export channel is a challenge for the regional policy and place-sensitive policies are needed (Rodríguez-Pose, 2018), however, Brexit is rather perceived as a national problem. It is the role for regional institutions to monitor the vulnerability to the Brexit consequences and to facilitate adjustments of exporting companies that will be severely affected.

Spanish regions are more exposed to the Brexit consequences, i.e. more vulnerable, than Polish regions to the decreasing trade intensity with the UK. Otherwise, the regions of Poland are on average, more sensitive to the shock, which in the context of our research, relates to trade composition. As regards the adaptive capacity, systematic inter-country differences are seen, with Spanish regions being more prepared for the shock.

The remainder of the paper is organised as follows. The following section describes the theoretical background for the evaluation of vulnerability to Brexit. The paper proceeds by depicting the dataset, empirical strategy and hypotheses. Section 3 presents obtained results regarding the exposure to Brexit. Finally, it concludes by discussing 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 a reversal in economic integration, that is, a change of the trade regime from a customs union to a lower preferential scheme of trade relations. Thus, reversed trade creation and diversion effects are expected, which would justify making 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 and institutions (see, for example, Brakman et al., 2018; Brodzicki & Umiński, 2017; Head & Mayer, 2014; Martínez-Zarzoso & Márquez-Ramos, 2018).

We rely on the conceptual framework of vulnerability presented by Turner et al. (2003), further extended by Aversano-Dearborn, Beiglböck and Binot (2011). Originally, the vulnerability concept embraces three spheres: societal, economic and ecological. This three-element model comprises: exposure, sensitivity and resilience, which together (including their inter-connections) describe the overall vulnerability to a specific phenomenon. Our research does not pretend to show a broad spectrum of Brexit consequences for regions' economies. Instead, we focus on trade aspects of vulnerability, thus ecological and demographical factors are omitted.

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 durance of potential crises. Exposure is not constant in time, which 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 the 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 supressing 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.

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 focused on how foreign trade and openness affect vulnerability is proliferating (Fingleton, Garretsen, & Martin, 2015; Georgescu, 2015; Ayadi, Montigaud, 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, the literature devoted to the vulnerability of small states represents an inspiring approach that explicitly underlines the question of openness to trade (Briguglio, 2014, 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 polarised results, which to a large extent are different from the 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 in the spirit of that performed by Zaucha, Ciołek, Brodzicki and Głazek (2014). However, our main contribution in this regard is its adjustment to the needs of evaluation of the vulnerability of regions to Brexit in the area of foreign trade.

We propose the following approach to investigate the vulnerability of non-UK regions to Brexit. The regional vulnerability is a function of two components: the impact (IM_t) of Brexit and the regional adaptive capacity (AC_t) to the shock, caused by the UK's 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) exposure to the Brexit, and (ii) sensitivity to Brexit. The exposure is mainly conditioned on the intensity of trade relations with the UK; thus it can be proxied by the share of the UK in the 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 the 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 FDI), 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 the impact of the Brexit to regional economies equals:

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

where:
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 related to globalisation

(Bernatonyte, 2015; European Commission, 2008). Particular products' groups may have different elasticities towards trade cost changes (Márquez-Ramos et al., 2011), caused by an unknown Brexit scenario up until now. 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 a disproportionate larger negative impact of the 2008 crisis, than urban areas (Patton et al., 2016). The transmission of the external economic shocks to the rural areas also goes 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 the UK;

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

Following Briguglio (2004; 2014), we treat exports concentration as a vulnerability component, as they increase the vulnerability to Brexit. Export concentration reflects the character of the production base, which to a large extent is path dependent. Opposite to Briguglio et al. (2009), who argue that the small size of the economy significantly restricts an ability to diversify exports, we treat regions as small economies, and diversification chances stem from the entrance of new investors, especially with foreign capital that contribute to improvements in exports capacity. Many depend on the investment attractiveness and the character of the activity carried out 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. 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. A number of empirical studies show a positive correlation between export diversification and economic growth (Amin Gutiérrez de Piñeres & Ferrantino, 2000; Herzer & Nowak-Lehnmann D., 2006), however, Naudé, Bosker and Matthee (2010), after a thorough literature overview on the nexus between economic growth and exports specialisation vs. diversification, conclude that ambiguous conclusions can be formulated. For local economies, contrary to country level studies, export specialisation positively affects economic growth (Naudé et al., 2010) and export success (Nazarczuk et al., 2018). 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, the endogenous growth theory indicates the positive consequences of exports diversification through spillovers from high-tech products to other economy sectors (Herzer & Nowak-Lehnmann D., 2006).

The third vulnerability component, which is an adaptive capacity, encompasses regional heterogeneity in terms of the 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:

Qol_t – quality of regional institutions;

FDI_t – the intensity of the 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 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 the attraction of foreign owned entities (FOEs)

to the region, which reveal a superior export performance, compared to indigenous firms (Mayer & Ottaviano, 2008; Nazarczuk & Umiński, 2019; Nazarczuk & Umiński, 2018; 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.

The negative consequences of Brexit can also be offset by the advantages that the region possesses in terms of innovation capacity and human capital. Some of the innovative capacity is brought to the region by FOEs. Although many FOEs apparently do not reveal the superior innovativeness performance over the domestic firms in terms of innovation outlays, their privileged position stems from the initial technology transfer (also in the tacit form) resulting from the ownership component of the OLI (ownership, localisation, internalisation) advantages (Dunning & Lundan, 2014). Innovativeness positively affects productivity, which – according to firms' heterogeneity concept – translates into improved exports performance (Melitz & Redding, 2014). Innovativeness has many 'faces', it can manifest in a higher flexibility to adjust to the Brexit consequences, i.e. in finding new markets, new marketing strategies and new (or improved) products offered. The research depicting the positive influences of innovativeness on exports performance has been presented, for example, by Chuang (2000), Aw, Roberts and Xu (2011), Altomonte, Aquilante, Békés and Ottaviano (2013), Cieślik, Michałek and Michałek (2014) as well as DiPietro and Anoruo (2006).

Exporting requires human capital that is why exporters tend to agglomerate, as they benefit from sharing, learning and matching (Duranton & Puga, 2004). The process of firm's internalisation through knowledge development was provided by Johanson and Vahlne (1977). Examples in research analysing the positive correlation between firms' exports and human capital are Levin and Raut (1997), Grasjo (2008), Contractor and Mudambi (2008), Chuang (2000).

2 Data, Hypotheses and Empirical Approach

2.1 Data

The dataset used in the study is a compilation of data from a number of sources (Tab. 1).

Tab. 1: Data sources used in the study

Variables	Description	Source
■ Share of exports sent to UK ■ Share of agricultural products exported to the UK ■ Share of high-tech products exported to the UK ■ IIT of exports to UK	Regional trade data with country of origin and destination for NUTS-2 regions	DataComex (for Spanish regions, available at http://datacomex.comercio.es) and Customs Chamber (for Polish regions)
■ GDP ■ Quality of regional institutions ■ The share of population aged 24–65 with tertiary education	NUTS-2 Quality of Government (QoG) Institute's EU regional database	(Charron et al., 2016)
■ FDI/GDP Performance Index	The information of regions' FDI was obtained from the Spanish Ministry of Economy and Competitiveness and from the Central Statistical Office for Poland.	Spanish Ministry of Economy and Competitiveness; Central Statistical Office for Polish regions
■ Innovative capacity, related to the EU mean innovation capacity	Regional Innovation Scoreboard dataset	http://ec.europa.eu/growth/industry/innovation/facts-figures/regional

Source: own elaboration

Given the frequent missing data for two autonomous Spanish city-regions (Ceuta and Melilla), we exclude them from the final analysis. The sole analysis is run in a cross-section due to data availability and character of the exposure to the future exogenous shock. However, obtained results on the 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 to identify 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 a better understanding of the potential causes of Brexit to regions.

In the context of our research, trade is considered to be a prime platform of transmitting potential economic shock, caused by the UK leaving the EU. That is why we concentrate our attention on the sole trade-related effects for the regional economies of the two countries (Spain and Poland). Contrary to the majority of the empirical evidence, portraying comprehensive, but not-trade related consequences for the 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 increase of trade costs and 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 is used. It relies on vulnerability indices constructed for vulnerability to economic shocks (Aversano-Dearborn et al., 2011; Zaucha et al., 2014). The following selection of variables (Tab. 2), supplements the theoretical considerations on the vulnerability 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, which 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 utilised. The adopted approach stems from the lack of comprehensive similar studies in this field, basing on which the authors could know the relevance of each variables/components to the final and foreseen Brexit

Tab. 2: Variables used with their potential impact on the 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 the UK	+
	▪ Share of high-tech products exported to the UK	-
Adaptive capacity	Quality of institutions – EU Regional QoG 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

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

consequences. Moreover, other authors indicate potential problems stemming from the inappropriate usage of weighting schemes. Discretionary defined weights could be criticized for subjectivity and bias the results (Cordina, 2004).

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.

Next, using the synthetic index, we will test three hypotheses:

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

We treat regions as small open economies with clear comparative advantages profiles. Thus, these are the regional characteristics that matter more than country characteristics for export performance. Formulation of H1 means that we expect the regions of Spain and Poland being 'mixed' within the particular clusters of vulnerability. Therefore, the results of the taxonomy shall not be country-biased.

***H2**: Metropolises have the highest adaptive capacity to Brexit shock.*

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 the H2 hypothesis would acknowledge the role of inter-regional heterogeneity over the inter-country differences, observed in regional trade, affecting regional vulnerability. The metropolitan regions are better prepared to absorb economic shocks, that is, Brexit in our case. As nodes of globalisation, they accumulated knowledge and adjustments capacity to changes and challenges of the world economy.

***H3**: Regional exposure to Brexit is determined by idiosyncratic factors.*

The idiosyncrasy mentioned in H3 stems from the 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 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 the 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. In 2015, the mean exposition to Brexit among Polish and Spanish regions was almost the same (Tab. 3). Spanish regions anticipated slightly higher maximum values in this respect, which resulted in a higher inter-regional differentiation.

Tab. 3: The average share of regional exports to the UK by Spanish and Polish regions

Year	Mean	Min	Max	CV	Mean	Min	Max	CV
	Spanish regions				Polish regions			
2005	10.05	3.80	16.41	0.37	5.02	2.28	8.13	0.31
2008	7.94	3.37	13.42	0.33	5.49	3.25	8.12	0.30
2010	7.13	3.34	12.45	0.35	5.41	2.93	9.24	0.33
2013	7.24	4.53	12.47	0.32	6.00	2.79	10.45	0.30
2015	7.39	4.76	10.55	0.25	6.47	2.56	9.94	0.29

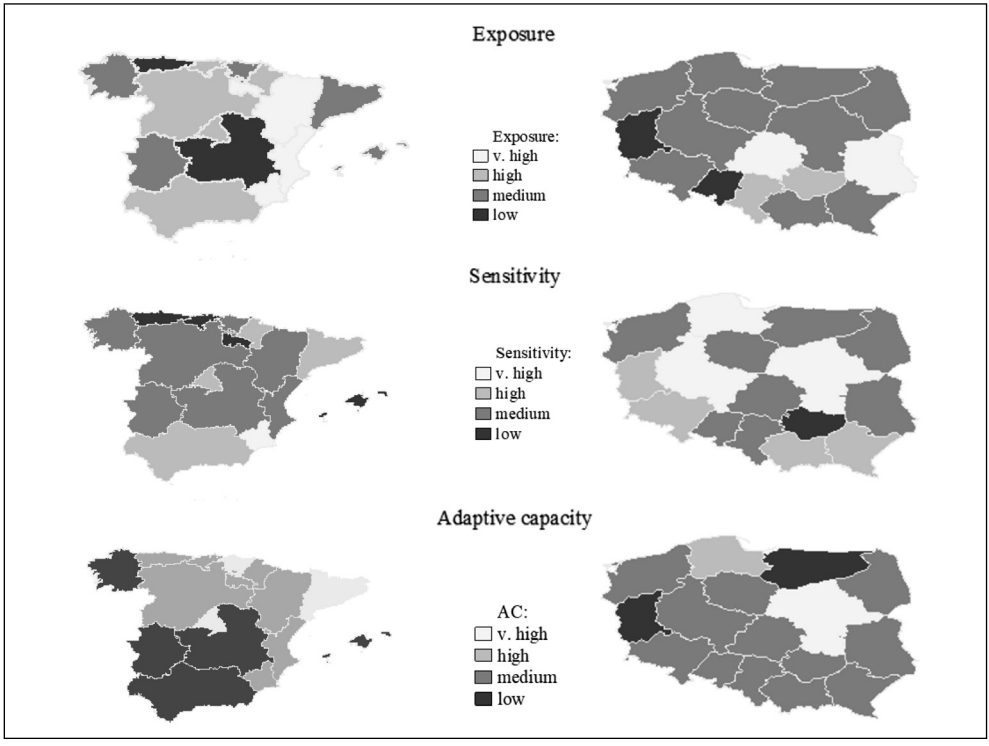
Source: own

Note: CV – coefficient of variation.

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: they both have a 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 Comunidad 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), it 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. The 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.

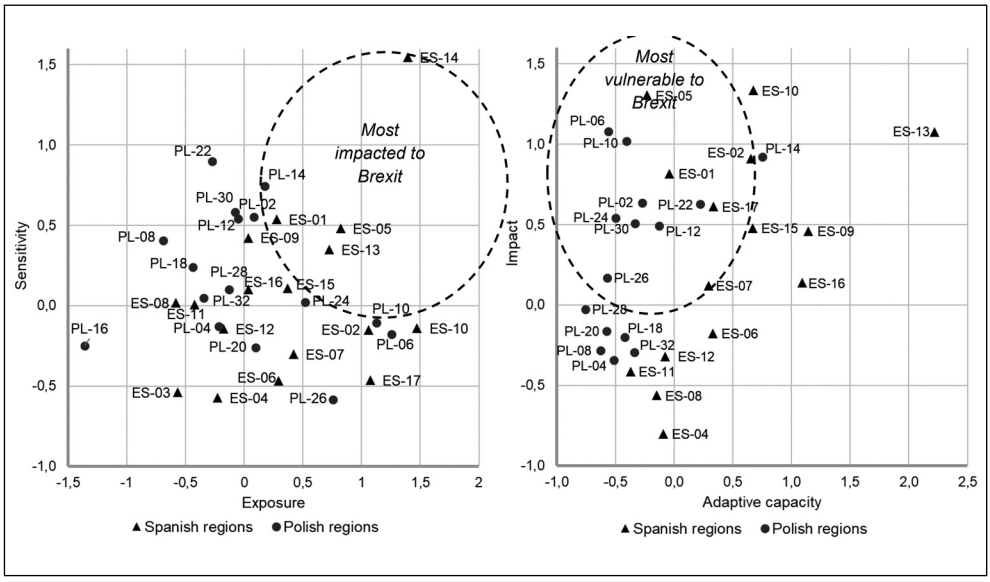
For further research, it would be interesting to find what are the factors making the regions having over that on average share of the UK in exports. In Spain it is a row of regions forming 'a belt' from La Rioja, through Aragon and Comunidad Valenciana to Murcia. In Poland, high and very high exposure is an attribute of regions forming 'the belt' starting from Lubelskie, through Swiętokrzyskie, to Lodzkie and Slaskie. The road network seems to play an important role

Fig. 1: Dimensions of vulnerability to Brexit



Source: own

Fig. 2: **The relations between sensitivity and exposure to Brexit (left panel) and the impact of Brexit and adaptive capacity (right panel)**



Source: own

Region codes: ES-01 Andalucia; ES-02 Aragon; ES-03 Asturias; ES-04 Illes Balears; ES-05 Canarias; ES-06 Cantabria; ES-07 Castilla y Leon; ES-08 Castilla-La Mancha; ES-09 Catalonia; ES-10 Comunidad Valenciana; ES-11 Extremadura; ES-12 Galicia; ES-13 Madrid; ES-14 Murcia; ES-15 Navarra; ES-16 Pais Vasco; ES-17 La Rioja; PL-02 Dolnoslaskie; PL-04 Kujawsko-Pomorskie; PL-06 Lubelskie; PL-08 Lubuskie; PL-10 Lodzkie; 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.

in this respect. Also, some learning by exporting experience and exporters agglomeration effects can matter, especially since agglomeration can be driven by the destination of exports (Cassey, Schmeiser, & Waldkirch, 2016; Koenig, 2009; Koenig, Mayneris, & Poncet, 2010).

As regards sensitivity (Fig. 1), 7 Polish regions have been classified as being highly or very highly sensitive to Brexit consequences and 5 in the case Spain. In case of 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 four regions is an increased trade openness, with the trade channel being the transmitter of impulses from foreign markets.

Interestingly, symptomatic results have been obtained with reference to their adaptive capacity, which is the highest for the two capital regions of Madrid and Mazowieckie and Catalonia, which reflects their superior position in many aspects (Fig. 1). Madrid and Mazowieckie are leaders in terms of the FDI/GDP performance index, which shall be treated with caution because of a capital city FDI registration bias effect. The three regions report high intensity of the 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 Catalonia 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 the remaining peripheral Polish regions are sensitive to globalisation. Generally, Spanish regions, have a higher adaptive capacity than the Polish ones. None of the Spanish regions have been classified as of low adaptive capacity.

Fig. 2 presents two relationships between: (i) sensitivity and exposure and (ii) impact and adaptive capacity. Circles indicate the regions of Poland and Spain that are mostly impacted by the consequences of Brexit (high, both sensitivity and exposure) and those, that are most vulnerable to Brexit (high impact and low adaptive capacity).

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

Finally, Tab. 4 summarises the relationship between impact and adaptive capacity; four classes of both categories have been distinguished. A key assumption of our research was that we focus on the regional level of exporting activity. By going beyond country characteristics and concentrating on sub-national regions, we expected to obtain the taxonomy or regions that is 'mixed' within the particular clusters of vulnerability. However, we reject our first hypothesis (H1) because clusters are mainly composed by Spanish or Polish regions, with few exceptions in which several Polish (Spanish) regions are accompanied by one or two Spanish (Polish) regions.

The capital regions of Poland and Spain (Mazowieckie and Madrid, respectively) together with Catalonia experience a relative high impact to the consequences of Brexit, while revealing the highest adaptive capacity that can mitigate the negative effects of Brexit. The superior position of Madrid, Mazowieckie and Catalonia supports our second hypothesis (H2), revealing the merits

Tab. 4: Impact of Brexit and adaptive capacity of regions

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

Source: own

Note: The grayscale represents the intensity of Brexit vulnerability. Thus, the regions with highest impact and lowest adaptive capacity will be mostly vulnerable to Brexit. On the other hand, the regions with highest adaptive capacity and lowest impact will be relatively resilient to this shock.

of metropolitan/central status and overall, high competitiveness.

Also, Pais Vasco falls into the category of "very high" adaptive capacity, while having a relatively low impact. Canarias represents a quite different position (very high impact and relatively low adaptive capacity). This could be an effect of remoteness of the Canary Islands, located near the African coast (see Fig. A1 of the Appendix A of the article by Márquez-Ramos, 2016). Two Polish regions (Warminsko-Mazurskie and Lubuskie) are in a special position: the relatively low impact is accompanied by a very low adaptive capacity.

The position of two 'belts' of regions (for Spain and for Poland) that reveal a relatively higher share of the UK in exports, supports our third hypothesis (H3). Further research is recommended to identify the factors behind 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 the regional level of the exporting activity. We expected to obtain the taxonomy or 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 a few exceptions in which several Polish regions are accompanied by one or two Spanish regions (or opposite).

In the spirit of Chen et al. (2018), we present the regional impact of potential Brexit consequences by constructing the 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 the Spanish regions mostly affected by the Brexit consequences will be: Comunidad de Madrid (0.94% GDP loss), Catalonia (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 support the above findings (note the differences in variables of interest) especially for Spanish regions and, to some extent, for Polish regions. They seem to signal the higher importance of regional adaptive capacity. Regions with a low adaptive capacity tended to obtain higher overall vulnerability in a series of cases for the Polish regions. To further analyse whether citizens' attitudes towards European economic integration are in line with vulnerability to (future and exogenous) shocks, surveys such as that of the Eurobarometer (European Parliament, 2018) should be conducted at the sub-national level.

This study presents a number of limitations. Firstly, it encompasses only trade relations, being the prime channel of transmitting Brexit to the regional economies of Spain and Poland. Other channels through which Brexit will affect the regions deserve attention, for instance the tension for the EU stemming from the 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 EU'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, 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. Finally, this study has focused on one trade dimension only: exports. However, it should be mentioned that importing activities are equally important and are key, for example, for firms' (and hence, regions') involvement in "complex" value chains. Brexit will suppose a disruption for those non-UK firms (and regions) in which UK firms (and regions) are relevant players in the EU production networks.

In the case of particular regions, depending on their characteristics, the influence of the particular components of sensitivity or adaptive capacity can be different. For instance, FDI might be performing a networking role in exporting activities, which is expected to mitigate the Brexit shock. Otherwise, in particular cases, it might 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 further examined, 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).

The Brexit's asymmetrical impact on regions' economy through the export channel is a challenge for regional policy, however Brexit is rather perceived as a national problem. In our view, its regional consequences are not treated with the necessary attention. It is also a challenge for regional institutions, as addressed by Billing, McCann and Ortega-Argilés (2019), especially for those regions having extraordinary trade links with the UK. The EU cohesion policy does not properly address the regional asymmetries in this respect. It seems, however, to be a more serious problem as cohesion policy does not properly address inequalities in regional exporting activity as such. It is an area of promising further research, in particular with respect to differences in regions' balance of exports and imports. As vulnerability to Brexit has its regional context, place-sensitive policies are needed (Rodríguez-Pose, 2018). It is therefore the role for regional institutions to monitor the vulnerability to the Brexit consequences and to facilitate adjustments to the exporting (and importing) companies that will be severely affected. They can be, for instance, assisted in searching for the alternative export (import) markets as well as in retaining the intensive trade links with the UK in the new trade regulatory framework after the UK will leave the EU.

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