Shades of innovation: is there an East-West cultural divide in the European Union?

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Abstract

Purpose – Innovation output around the world is concentrated in very few economies possessing the requisite skills, knowledge and market acumen to capitalize on emerging technologies. Within the broader European Union, Central and Eastern Europe countries persistently lag in innovation rankings compared to their Western Europe counterparts. The existence of cultural barriers to innovation has been offered as an explanation for the lag, in the sense that perceptions about innovation affect innovation performance. The purpose of this paper is to provide evidence-based analysis on whether there are divergent perceptions at the firm level between East and West.

Design/methodology/approach – The focus is on four countries with distinct socioeconomic profiles (Germany, Poland, Portugal and North Macedonia) for which innovation data of sufficient granularity exist. Using Probit analysis across the regressors of firm size, sector and innovativeness, a detailed picture of perceptions of innovation emerges naturally.

Findings – The analysis demonstrates that there is no discernible East-West cultural divide but rather a palette of shades regarding perceptions of innovation, entrenched in firm-level characteristics. Specifically, firm size colors perceptions of innovation and such perceptions in turn are moderated by whether a firm is involved or not in innovation activities.

Originality/value – A better understanding of innovation culture at the firm level is essential to drive policy interventions aiming to remove barriers to innovation. The results of this study provide sufficient clues for more refined interventions, both internal ("procedures") and external ("policies") to the firm, targeting well-defined size segments as well as addressing differently innovative and non-innovative companies.

Keywords Innovation barriers, Innovation management, Obstacles to innovation

Paper type Research paper

1. Introduction

Innovation output worldwide is mostly concentrated in very few economies that possess the requisite human capital, the creative know-how and the ability to implement quickly emerging technologies. For instance, most top science and technology clusters are in the USA, China and Germany (Tsakalerou and Akhmadi, 2021). The presence of a global innovation divide in an era where every country favors innovation increases the gap between developed and developing economies.

It has been theorized that the innovation divide is cultural, in the sense that perceptions about innovation affect innovation performance innovation (Ocampo-Wilches *et al.*, 2020). While this is often a circular argument (i.e. perceptions impact on innovation performance and, at the same time, innovation performance is a key determinant of established perceptions), the existence of "psychological" barriers affecting innovation performance has been a persistently valid concern (Büschgens *et al.*, 2013). For instance, a top-down, hierarchical culture that induces fear of consequences and thus neutralizes curiosity has been shown to be detrimental to innovation (Clark, 2020).

The existence of cultural barriers to innovation has been offered as an explanation for the persistent lag in innovation rankings of Central and Eastern Europe countries in comparison to their Western Europe counterparts (Hankiss, 2003). Indeed, While these formerly "Eastern Bloc" countries have made great progress in the past 30 years, their innovation development has been markedly inferior to that of the old member states of the European Union (EU). In principle, these countries show strong potential for innovation, with a highly educated workforce, a tangible legacy of applied research and an enviable proximity to a range of markets. Clearly, though their economic growth while transitioning to a market economy has not been based on innovation. While many have been members (or associated members) of EU for almost two decades and have profited from their integration into European networks and EU Framework programs, experts and statistics are still inconclusive on whether the gap between western and eastern economies has been narrowed (Varga and Sebestyén, 2013).

The innovation gap has persisted despite concerted efforts by the Council of Europe and the European Commission to study the impact of cultural factors on innovation and competitiveness (Council of Europe, 2011). The old adage that the greatest gap between East and West exists in the socio-economic sphere has lost most of its interpretive power, as there has been significant convergence in political culture, access to information and the rule of law over the years. The issue is extremely important as it affects a broader swath of countries including the former Soviet Republics of the South Caucasus and of Central Asia, such as Kazakhstan (UNECE, 2021).

The objective of this exploratory paper is to shed some additional light to the apparent innovation gap between East and West by focusing on perceptions of innovation and assessing whether there are divergent views on the obstacles to innovation. Grounding the analysis on a rich enough data set, such as EUROSTAT data from its series of bi-annual Community Innovation Surveys (CIS), does provide an increased level of confidence on the outcome.

CIS are designed to assess the innovativeness of different sectors and regions and executed by national statistical offices in the 27 EU member states (EU27), in the European Free Trade Agreement countries and in states with a candidate status for accession to the EU. Each CIS provides analytical data broken down by countries, type of innovators, economic activities and size classes. The public data release normally takes place two and half years after the end of the survey reference period. This paper is based on the EUROSTAT data (CIS 2016 results) that record such perceptions of innovation (EUROSTAT, 2019). (The CIS 2018 results, released in early 2021, are as yet incomplete on this issue.)

As a matter of choice, the presentation is based on a group of four countries with distinct socioeconomic profiles and diverse institutional models of work organization: Germany, Poland, Portugal and North Macedonia. Continental Germany (with its corporatist model of development and high levels of labor productivity) and Mediterranean Portugal (with its mixed model of development and moderate levels of labor productivity) represent the original EU12 members and the Eurozone; Poland, a later entry in the EU25 (but not the Eurozone) represents former Eastern European countries; and North Macedonia, a candidate country for accession to the EU represents the Balkan countries.

During the survey period, the share of enterprises with innovation activity across the EU28 was 51%. Germany (at 66%) and Portugal (at 65%) recorded higher proportions While North Macedonia (at 38%) and Poland (at 24%) lagged behind the EU28 mean.

CIS surveys typically have a section dedicated to perceptions of barriers to innovation with detailed information collected from a very large number of companies across Europe. In CIS 2016, 106,184 firms in Germany, 43,828 firms in Poland, 14,602 firms in Portugal and 2,400 firms in North Macedonia were polled on their perceptions of the obstacles to innovation. With roughly one out every four firms surveyed, the 167,000 firms in the sample form a rich and representative milieu of company sizes, sectors and locales. The primary objective of this paper is further delineated in comparing and contrasting perceptions of barriers to innovation across the four countries with a granularity that includes firm size, sector and innovativeness.

The paper is organized as follows. A concise literature review is presented in Section 2. The methodology of the approach, the econometric model employed and the results of the analysis are presented in Sections 3 and 4. The cross-country results are presented and contrasted in Section 5 with an informed discussion of the results obtained. Finally, in Section 6, the conclusions of the paper are summarized along with limitations and suggestions for future research.

2. Theoretical background and hypotheses

2.1 Barriers to innovation

The innovative performance of a firm is influenced by a multitude of factors which have a restrictive impact on the design, implementation and diffusion of innovation (Hueske and Guenther, 2015). In an attempt to draw science and technology policy implications, different economic and innovation studies have focused on identifying and assessing the importance of the obstacles hampering innovation. There is a broad consensus on the top obstacles to innovation which are often classified and grouped as external (arising when firms acquire resources or knowledge externally or face regulatory constraints) and internal (normally associated with difficulties in implementing internal changes in their organizational processes) to the firm (Akhmadi and Tsakalerou, 2020; Cinar et al., 2019).

Interestingly, these studies have been primarily based on surveys by major consulting companies of their key stakeholders and as such tend to reflect the views of a limited number of large enterprises (Kirsner, 2020; Seeger et al., 2019). On the other hand, policy interventions at the local, regional or national level routinely aim to support small- and medium-sized enterprises (Leckel et al., 2020; Radas et al., 2020).

Characteristic examples are the studies released by KPMG (most recently in 2018 and 2020) and Deloitte (most recently in 2015 and 2019) surveying large numbers of executives working in innovation, strategy and R&D and then recording the top-ten obstacles to innovation in terms of the most mentions received in their respective samples.

KPMG surveyed 215 managers and executives in strategy and R&D, so-called "corporate innovators", thus providing an overview of the perceptions and assessments of the obstacles to innovations from the managerial level of view (Kirsner, 2020). Deloitte surveyed 760 European companies in 16 European countries representing 20 major business fields (Seeger et al., 2019). Both studies present a broad consensus on the main barriers to innovation, with an almost exclusive focus on obstacles internal to the organization. It is readily apparent though that they diverge in the relative importance of the barriers involved, and that innovation remains a multi-faceted, interactive process between a firm and the context in which the firm operates.

For instance, the 2020 KPMG survey, while admittedly for large firms, includes an industry breakdown revealing the relative importance of obstacles may be moderated by

whether the firm is a manufacturing concern or a service-oriented enterprise, mirroring empirical evidence (Lorenz *et al.*, 2012).

A better understanding of the relative importance of the barriers to innovation is essential to drive regulatory, financial and organizational interventions aiming to remove them. Considering that policy interventions routinely aim to support small- and medium-sized enterprises, studies reflecting the views of a moderate sample of large enterprises have limited broad appeal. Based on prior evidence, the relative importance of the various barriers to innovation is mitigated by the size of the firm, a discriminant which emerges naturally as an issue of significance (Zanello *et al.*, 2016).

The limitations of fragmented snapshots of the innovation field are well-understood and there have been systematic attempts for a more in-depth and detailed analysis (Akhmadi and Tsakalerou, 2020). By recording information on a diverse range of issues related to innovation, the CIS emerged as the main innovation data source for Europe. Every CIS is conducted at the enterprise level, stratifying the sample by sector, size and region. Since the CIS aggregate national data, on occasion data on the barriers to innovation maybe missing for a specific country. For instance, barriers to innovation from Germany have been assessed and are present in CIS 2016 and 2012, but not in CIS 2018 or 2014.

Admittedly, CIS data reflect the perceptions of the firms surveyed and there are limitations in their interpretation. The power of the CIS lies in the sheer volume of data provided. For instance, over 100,000 firms were surveyed in Germany for CIS 2016. The actual barriers catalogued have evolved along with each new CIS, reflecting emerging trends on the subject. In CIS 2016, the barriers identified and assessed are presented in Table 1. The reporting of the data takes place in a binary fashion, by indicating the number of firms that consider a particular obstacle as "highly important" or "not relevant" at all (European Comission, 2015).

The key advantage of the list in Table 1, over the ones identified by KPMG or Deloitte, is that it covers obstacles both external (arising when firms need to acquire resources or knowledge externally) and internal (difficulties in implementing internal changes in their organizational processes) to the firm.

Furthermore, considering that firms in CIS surveys are classified as INNO or NON-INNO according to whether they had introduced or not innovation or conducted any kind of innovation activity during the reporting period, their perception of the obstacles is patently different (UK Innovation Survey, 2020).

INNO firms perceived these obstacles as hampering factors needed to be overcome, but which did not really slow down or stop innovation ("revealed barriers"). In contrast, NON-INNO firms perceived these obstacles as barriers prohibiting them from engaging in innovation ("deterring barriers"). Since revealed barriers and deterring barriers reflect distinctly different perceptions, they should be targeted differently by innovation policy

Code	Explanation
LFIN_IN	Lack of internal finance
LFIN_EXT	Lack of external finance (credit or private equity)
H_COST	Innovation costs too high
L_EMPL	Lack of qualified employees within the firm
L_PRTN	Lack of collaboration partners
L_SUBS	Difficulties in obtaining public subsidies/grants
U_DMND	Uncertain market demand for innovations
H_COMP	High competition in the relevant market

Table 1.
List of obstacles to innovation in CIS 2016

(UK Innovation Survey, 2020). Hence, all comparisons in this paper are performed across INNO and across NON-INNO firms separately.

In this broad context, the objective is to use CIS data to determine whether the impact of the parameters of firm size, sector and innovativeness on the obstacles to innovation unfolds differently across the East-West axis.

2.2 Community innovation survey
The raw CIS 2016 data collected for Germany, Portugal, Poland and North Macedonia represent a rich tapestry of 167,000 firms across all forms of enterprise (excluding agriculture, forestry and fisheries and the largely non-market service sectors such as education and health). In this paper, the data are painstakingly compiled by clustering the firms surveyed according to their:

- size class (enterprises with less than 10 employees were not surveyed);
- being non-innovative or innovative (that is, having introduced an innovation or having ongoing or abandoned innovation activities during the three years preceding the survey period); and
- sector of economic activity (excluding firms engaged in trade and architectural activities).

The economic activity sectors were recorded following the NACE rev.2 EU taxonomy and classified as *Production and Construction* (includes mining and quarrying, manufacturing, electricity, gas, steam and cooling and water supply and sewerage treatment) and *Services and Distribution* (water supply and sewerage treatment, transportation and storage, information and communication and financial and insurance activities) (UK Innovation Survey, 2020). For interpretive purposes, the notation PROD(uction) and SERV(ices) is used in this paper.

Table 2 lists the ordinal variable of size (and the ordered set of arbitrary values reflecting the coarse clustering of the underlying continuous variable) and the binary variables of innovativeness and sector of economic activity.

In Table 3, the descriptive statistics for each country are presented in summary form. (Percentages in Table 3 may not add up to 100 due to rounding.)

For all four countries, the distribution of the samples between SML, MED and LRG firms follows approximately a consistent 75%–20%–5% pattern which is fairly representative of the corresponding populations (European Comission, 2017).

Variables	Notes	Value
Size class:		
SML	10–49 employees	1
MED	50–249 employees	2
LRG	More than 250 employees	3
Innovative activity:		
NON-INNO	Not engaged in innovation	0
INNO	Engaged in innovation	1
Sector of economy:		
PROD	Production	1
SERV	Services	2

Table 2.
List of survey variables

In Germany and Portugal about 66% and 65% of the firms surveyed had introduced an innovation or had ongoing or abandoned innovation activities during the three years preceding the survey period (INNO firms). Only 38% of the firms surveyed in North Macedonia and 24% in Poland qualified as INNO under this criterion.

For CIS 2016, firms were asked to rate their perceived degree of importance of each of the factors in Table 1 hampering their innovation activity (or lack thereof). They were provided a four-point Likert scale, with the degree of importance ranging from "Not Important" and "Low" to "Medium" and "Highly Important."

The reporting of the results then occurred in a binary fashion, recording the number of firms that have a very definite position on each obstacle: either that it is "Highly Important" or "Not Relevant" at all (European Comission, 2015; Rammer, 2016). Removing opinions that were relatively uncertain or neutral towards a specific obstacle ("Low" and "Medium" importance) was a EUROSTAT choice to reduce noise in the data (Galia and Legros, 2004).

Sample category	Surveyed firms	% of total surveyed firms	Surveyed INNO firms	% of total surveyed INNO firms
Germany				
SML	75,855	71	45,387	60
MED	24,304	23	19,083	79
LRG	6,025	6	5,503	91
Total (all sizes)	106,184	100	69,973	66
PROD	*68,619*	*65*	*47,278*	*69*
SERV	*37,565*	*35*	*22,695*	*60*
Total (all sectors)	106,184	100	69,973	66
Poland				
SML	32,791	75	5,413	17
MED	8,881	20	3,531	40
LRG	2,156	5	1,371	64
Total (all sizes)	43,828	100	10,315	24
PROD	*31,927*	*73*	*8,062*	*25*
SERV	*11,901*	*27*	*2,253*	*19*
Total (all sectors)	43,828	100	10,315	24
Portugal				
SML	11,333	78	6,975	62
MED	2,818	19	2,108	75
LRG	451	3	385	85
Total (all sizes)	14,602	100	9,468	65
PROD	*11,582*	*79*	*7,422*	*64*
SERV	*3,020*	*21*	*2,046*	*68*
Total (all sectors)	14,602	100	9,468	65
North Macedonia				
SML	1,813	76	657	36
MED	480	20	185	39
LRG	107	4	57	53
Total (all sizes)	2,400	100	899	38
PROD	*1,619*	*67*	*596*	*37*
SERV	*781*	*33*	*323*	*41*
Total (all sectors)	2,400	100	899	38

Table 3.
Descriptive statistics of the sample across size classes and sectors of economic activity

Indeed, the advantage of a four-point Likert scale is that it does not force the participant to take a stand on a particular topic but allows a degree of agreement that can accommodate neutral or undecided feelings. The combination of a four-point Likert scale followed by an emphasis on the two extremes of the scale, places the focus squarely on the respondents that appear to have a clear and informed opinion (Baldwin and Lin, 2002).

An important caveat of the recorded data is that they reflect the respondent's perceptions regarding the barriers hampering innovation activity. As in all such surveys on innovation, it is expected that there is a correlation between the perception of the importance of an obstacle and its actual impact on the innovativeness of the firm, regardless of whether these are revealed or deterring barriers (UK Innovation Survey, 2020).

The percentages of firms that declared each criterion as of HIGH importance for them, relative to the total number of firms that expressed an opinion for the corresponding criterion, are plotted in Figure 1. In the Figure 1, the full sample of companies surveyed over all four countries is represented in six graphs:

(1) the TOTAL sample of 167,014 firms;
(2) the 90,655 INNO vs the 76,359 NON-INNO firms;
(3) the 121,792 SML, 36,483 MED and 8,739 LRG firms;
(4) the DE, PL, PT and MK firms;
(5) the 113,747 PROD vs the 53,627 SERV firms; and
(6) the firms across each sector of economic activity.

In all five graphs, the obstacles to innovation are ordered according to their relative rank for the TOTAL sample to facilitate comparisons: H_COST, LFIN_IN, L_EMPL, L_SUBS, H_COMP, LFIN_EXT, U_DMND and L_PRTN. This relative ranking holds true:

• for INNO firms and, to some extent, for NON_INNO firms;
• for SML firms but less so for MED and LRG firms; and
• for PROD and SERV firms.

The picture is bit more complicated across individual sectors and across the four countries.

Generally speaking, H_COST appears to be the top-ranked obstacle to innovation across the board, while L_PRTN appears to be the least important one. For all other obstacles, their ranking is influenced to some, or to a large, extent by the innovativeness of a firm and by its size, sector and location.

Figure 1 is of course a very rough first approximation of the relative ranking of the obstacles to innovation, primarily because it is not always the same group of firms that votes "HIGH" for the importance of each obstacle in their operation. Detailed analysis is needed to assess how the ranking is moderated by the factors enumerated above. In this context, the objective of this paper is to test the following hypotheses:

H1. The relative importance of an obstacle to innovation is moderated by firm size.

H2. The relative importance of an obstacle to innovation is moderated by the broad sector of its economic activity.

While controlling for the innovativeness of the firm and recognizing the impact of the country the firm operates in.

At a higher level, the testing of the two hypotheses will be checked across the East-West axis, by comparing the answers for Germany and Portugal ("West") to those of Poland and North Macedonia ("East").

The aim is to assess the association of the chosen regressors (size and sector) for each single barrier listed in Table 1, based on the premise that each obstacle has its own informative potential.

Given that a firm may face several barriers at the same time, the issue of considering all the barriers simultaneously has been raised in the past. It has been shown that while some interdependencies between the obstacles may exist, and thus multivariate regression could be the approach of choice (Galia and Legros, 2004), the results obtained by univariate and multivariate regression approaches were consistent (Iammarino et al., 2009). In fact, it has

been suggested that individual obstacles should be considered separately rather than grouped, so as not to disguise their different roles and distinct impact (Iammarino *et al.*, 2009).

At any rate, the choice of regression is driven by the nature of the questionnaire and the recording of the data. Indeed, in CIS 2016 only aggregate data are presented across size and economic classes. There is no provision in the data for knowing how *individual* companies perceive the importance of each obstacle (Rammer, 2016). In this context, the study of each of the two hypotheses proceeds using the joint modeling schema that follows.

3. Method

The objective is to estimate the probability *P(i)* of the event "firms in a specific class assess a given obstacle *i* as highly important or not." The underlying assumption is that the binary variable *P(i)* (with values of 1 or 0), is in fact a partially observed continuous latent variable *or,* at least, a set of discrete outcomes of a continuous variable that can be ordered by some criterion (Abbott, n.d.).

The eight obstacles to innovation are thus the *dependent* variables in the model. The i*ndependent* variables (regressors) are firm size and sector which can only take the values (SML, MED, LRG) and (PROD, SERV), respectively.

Most regression models for categorical dependent variables produce nonlinearities in the predicted probability metric necessitating the use of nonlinear probability models (NLPMs) for the analysis. NLPMs are regression models that employ a nonlinear transformation to obtain a model that is linear in its parameters. Among the best known NLPMs for the analysis of ordered, categorical, nonquantitative choices, outcomes and responses is the Probit model, which models the probability of a dichotomous or binary outcome as a linear combination of categorical predictors (Galia and Legros, 2004; Iammarino *et al.*, 2009).

For the case at hand, Probit regression is based on the assumption that the probability *P (i)* that obstacle *i* is highly important for a given firm can be computed as:

$$P(i) = \beta_{i0} + \beta_{i1}(size) + \beta_{i2}(sector) + u_i \tag{1}$$

where the regressor variables of size and sector take the values in Table 2; the regression coefficients β_{i0}, $\beta_{i1 \ and} \ \beta_{i2,}$ need to be computed; and u_i is a normally distributed random error term for each observation i (Abbott, 2022; Ai and Norton, 2003). While the sign and statistical significance of β_{i0}, $\beta_{i1 \ and} \ \beta_{i2}$ may be indicative of the underlying relationship, their absolute magnitude is difficult to interpret in substantive terms (Mize, 2019; Mustillo *et al.*, 2018).

Probit models are often used to report alternative metrics, such as *marginal effects* and *predictive margins,* that are easier to interpret. Marginal effects describe the expected change in the outcome for a unit change in one of the regressors while holding all other independent variables in the model constant at their mean or at other representative value (Abbott, 2022). Predictive margins (also called marginal predictions or adjusted predictions) are the expected probabilities of the outcome for specified values of the regressors and are better suited for problems with categorical variables (Williams, 2012).

The analysis in this paper thus proceeds based on the Probit model in (1) and the report of predictive margins reflecting the average adjusted predictions. Probit regression is performed separately for INNO and NON-INNO firms so as not to mix perceptions of revealed and deterring barriers (UK Innovation Survey, 2020).

4. Results

The Probit model in (1) was implemented with the STATA v16 statistical software. The analysis was performed with the statistical significance set at a two-sided p value of ≤ 0.05. Table 4 records the predictive margins (and their statistical significance) for each of the eight obstacles across the three class sizes and two broad sectors defined in Section 3. The margins are reported separately for INNO and NON-INNO firms.

For example, focusing on the upper part of Table 4, the probability that a small (SML) innovative firm will declare the lack of internal finance (LFIN_IN) as a very important obstacle is about 34% (0.344), while the same probability for a medium or large firm is 23% (0.231) and 17% (0.169) respectively. In the same vein, the probability that an innovative firm will characterize LFIN_IN as a very important obstacle is about 31% (0.308) if the firm is in the productions sector and 29% (0.285) if the firm is in the service sector.

A cursory examination of the margins reported in Table 4 reveals that H_COST is indeed the most important obstacle followed by L_EMPL and then LFIN_IN, in contrast to the graphs in Figure 1 where LFIN_IN is more important than L_EMPL. This observation is true for all possible combinations of innovativeness, size and sector, with the predictable exception of NON-INNO service firms.

The key issue at hand is to present the marginal effects in Table 4 in a way that will resolve hypotheses *H1* and *H2* and inform interpretation. Figures 2, 3, 4 and 5 serve this purpose.

Figures 2 and 3 depict the percentage of INNO and NON-INNO firms respectively assessing each obstacle as highly important across sizes classes. Figures 4 and 5 depict the percentage of INNO and NON-INNO firms, respectively, assessing each obstacle as highly important based upon whether they are in production or services.

H_COST appears to be the top-ranked obstacle to innovation while L_PRTN appears to be the least important one across the board, that is for any size, sector, or innovativeness. This clear outcome was observed early on through the analysis of the descriptive statistics of the sample (Figure 1). Naturally, Probit analysis leads to a more nuanced set of conclusions than the mere ranking of the obstacles to innovation.

The comparative overview of Figures 2 and 3 (or Figures 4 and 5) reveals that every obstacle appears to be more important for a non-innovative company than for an innovative one with the same size and similar sector of operation. When comparing individual obstacles across INNO and NON-INNO firms, the situation is a bit more complex. This justifies the choice made to perform Probit regression separately for INNO and NON-INNO firms as perceptions of revealed and deterring barriers are indeed different.

For INNO firms (Figure 2), the importance of every obstacle decreases as the size of the firm increases from SML to MED to LRG, with the notable exceptions of L_EMPL and U_DMND. The importance of these two obstacles decreases from SML to MED firms but then increases again for LRG firms (colored cells in Table 4).

For NON-INNO firms (Figure 3), the importance of only three obstacles (L_SUBS, U_DMND and L_PRTN) decreases as firm size increases from SML to MED to LRG. Three other obstacles (H_COST, LFIN_IN and LFIN_EXT) *increase* in importance as firm size increases and become quite prominent for LRG firms. The importance of the last two remaining obstacles (L_EMPL and H_COMP) decreases from SML to MED firms but then increases again for LRG firms. These results resolve the issue of hypothesis *H1* (**true**), as the relative importance of the various obstacles is indeed moderated by size even when controlling for innovativeness.

For INNO firms (Figure 4) and NON-INNO firms (Figure 5), the importance of every obstacle is higher for PROD firms compared to SERV firms. These results resolve the issue

TOTAL	LFIN_IN	LFIN_EXT	H_COST	L_EMPL
INNO firms assessing an obstacle as highly important across size classes:				
1 (SML)	0.344 [0.003] ***	0.240 [0.002] ***	0.523 [0.003] ***	0.400 [0.003] ***
2 (MED)	0.231 [0.004] ***	0.132 [0.003] ***	0.458 [0.005] ***	0.274 [0.005] ***
3 (LRG)	0.169 [0.006] ***	0.070 [0.004] ***	0.431 [0.009] ***	0.288 [0.009] ***
INNO firms assessing an obstacle as highly important across sectors:				
1 (PROD)	0.308 [0.003] ***	0.205 [0.002] ***	0.521 [0.003] ***	0.384 [0.003] ***
2 (SERV)	0.285 [0.004] ***	0.173 [0.003] ***	0.451 [0.004] ***	0.304 [0.004] ***
Observations:	46 297	47 294	43 328	37 700
TOTAL	LFIN_IN	LFIN_EXT	H_COST	L_EMPL
NON-INNO firms assessing an obstacle as highly important across size classes:				
1 (SML)	0.467 [0.004] ***	0.363 [0.004] ***	0.664 [0.004] ***	0.533 [0.005] ***
2 (MED)	0.475 [0.012] ***	0.377 [0.011] ***	0.688 [0.011] ***	0.497 [0.013] ***
3 (LRG)	0.604 [0.032] ***	0.548 [0.034] ***	0.866 [0.025] ***	0.537 [0.037] ***
NON-INNO firms assessing an obstacle as highly important across sectors:				
1 (PROD)	0.559 [0.005] ***	0.455 [0.005] ***	0.774 [0.004] ***	0.580 [0.006] ***
2 (SERV)	0.282 [0.007] ***	0.207 [0.006] ***	0.465 [0.007] ***	0.433 [0.008] ***
Observations:	13 626	12 877	12 425	10 125

Notes: Standard errors in brackets. * Significant at 10%; ** significant at 5%; *** significant at 1%

(*continued*)

Table 4.
Predictive margins:
firms assessing each
obstacle as highly
important across size
classes and sectors

TOTAL	L_PRTN	L_SUBS	U_DMND	H_COMP
INNO firms assessing an obstacle as highly important across size classes:				
1 (SML)	0.144 [0.002] ***	0.292 [0.003] ***	0.250 [0.003] ***	0.267 [0.003] ***
2 (MED)	0.082 [0.003] ***	0.207 [0.003] ***	0.177 [0.004] ***	0.180 [0.003] ***
3 (LRG)	0.048 [0.004] ***	0.151 [0.005] ***	0.211 [0.007] ***	0.135 [0.006] ***
INNO firms assessing an obstacle as highly important across sectors:				
1 (PROD)	0.136 [0.002] ***	0.275 [0.002] ***	0.260 [0.003] ***	0.264 [0.003] ***
2 (SERV)	0.081 [0.002] ***	0.217 [0.003] ***	0.149 [0.003] ***	0.161 [0.003] ***
Observations:	42 229	49 061	40 058	41 615
TOTAL	L_PRTN	L_SUBS	U_DMND	H_COMP
NON-INNO firms assessing an obstacle as highly important across size classes:				
1 (SML)	0.285 [0.005] ***	0.421 [0.005] ***	0.337 [0.005] ***	0.471 [0.005] ***
2 (MED)	0.290 [0.011] ***	0.409 [0.012] ***	0.333 [0.012] ***	0.385 [0.012] ***
3 (LRG)	0.212 [0.032] ***	0.368 [0.036] ***	0.269 [0.032] ***	0.488 [0.037] ***
NON-INNO firms assessing an obstacle as highly important across sectors:				
1 (PROD)	0.358 [0.006] ***	0.478 [0.005] ***	0.420 [0.006] ***	0.496 [0.006] ***
2 (SERV)	0.162 [0.006] ***	0.302 [0.007] ***	0.189 [0.006] ***	0.389 [0.007] ***
Observations:	11 235	12 847	11 491	12 441

Table 4.

INNO, SIZE

INNO, SECTOR

NON-INNO, SIZE
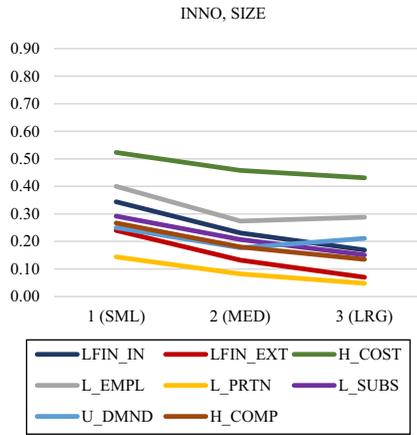
NON-INNO, SECTOR

Figure 5.
Percentage of NON-
INNO firms assessing
each obstacle as
highly important
across SECTOR
classes

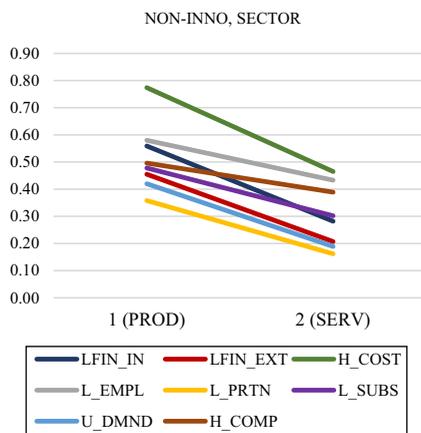of hypothesis *H2* (**true**), as the relative importance of the various obstacles is indeed moderated by the broad sector of operation even when controlling for innovativeness.

5. Discussion

The Probit analysis in the previous section of a diverse set of 167,000 firms generated a complex set of outcomes that were painstakingly tabulated and graphically presented. Naturally, the inherent noise in the data is due to how the primary data is collected across regions and industries. Aggregating the data can improve the signal-to-noise ratio at the expense of reducing the ability to fine-tune policy at the micro level. With this caveat in mind, the purpose of this section is to summarize the major trends that have emerged from the Probit analysis.

5.1 Innovativeness (or the lack thereof)

From Figures 2 and 3, it is apparent that every obstacle is more important for a NON-INNO firm than for an INNO firm of the *same* size and that the ranking of obstacles is very similar for INNO and NON-INNO firms. The temptation, however, to bundle firms together irrespective of their innovativeness should be resisted.

The responses of NON-INNO firms mostly reflect anticipation and not actual knowledge of the obstacles involved (UK Innovation Survey, 2020). Most firms with established operational norms and corporate structures are risk averse (Jalonen, 2011) and do not find the idea of innovation as "creative destruction" very appealing (Rhaiem and Amara, 2021).

The question remains whether the responses of NON-INNO firms help identify areas for intervention or simply serve as a battery of excuses for their conservative and inactive stance with respect to innovation. From the public policy perspective, enticing and facilitating firms to start innovating is a daunting task and does not avail itself to targeted interventions. Broad measures in support of innovation may of course help those firms that feel ready to take the step forward. In this context, the following trends focus exclusively on INNO firms.

5.2 Firm size matters

In principle, for INNO firms (Table 4 and Figure 2), the importance of every obstacle decreases as the size of the firm increases from SML to MED to LRG.

(The noted exception of L_EMPL and U_DMND, the importance of which decreases from SML to MED firms but then increases again for LRG firms, is exclusively due to the large German firms, as such an exception was not noted for firms operating Poland, Portugal or North Macedonia. This issue is probably systemic as CIS data are not normalized to account for differences in size or industrial structure of the corresponding economies.)

The obstacles to innovation are more important for SML and MED firms than for LRG firms, yet a significant percentage of them is involved in innovative activities. The descriptive statistics in Table 3 neither confirm nor disprove the Schumpeterian hypothesis that there is a close relationship between innovation and firm size, in the sense that only large companies can support the costs related to innovation (de Wit and Bosma, 2003; Laino, 2011). In fact, the long-term relationship between firm size and firm innovativeness maybe negative, except during times of specific technological booms (Degner, 2011). To this day, the relationship between firm size and innovativeness remains a puzzle (Knott and Vieregger, 2016) and the analysis in this paper does not purport to solve the puzzle but rather provide additional insight into the issue.

Small- and medium-sized firms (SMEs) are essential for the innovation economy and deserve active government assistance. Indeed, small firms historically performed better in terms of innovation measured against expenditure than large firms (OECD, 2020). Because of the heterogeneity of SMEs, policies to increase their innovative capacity must be targeted carefully. Most SMEs are technology followers. Yet, the minority of SMEs that are technology developers or new technology users play a crucial role in the early fluid stages of new technological developments and their validation.

While the ranking of the obstacles is relatively uniform across firm sizes, the biggest impact for SML and MED firms will be realized through policies addressing targeting primarily LFIN_EXT and L_PRTN and, to a lesser extent, LFIN_IN and L_SUBS.

5.3 East vs West
As for the main question posed in this study – whether there is an East-West cultural divide in perception of obstacles to innovation, Figure 6 (a) summarizes the predicted importance of the obstacles across the countries in a cumulative graph. It is apparent that there are very few discernible differences regarding the ranking of the obstacles across the four countries.
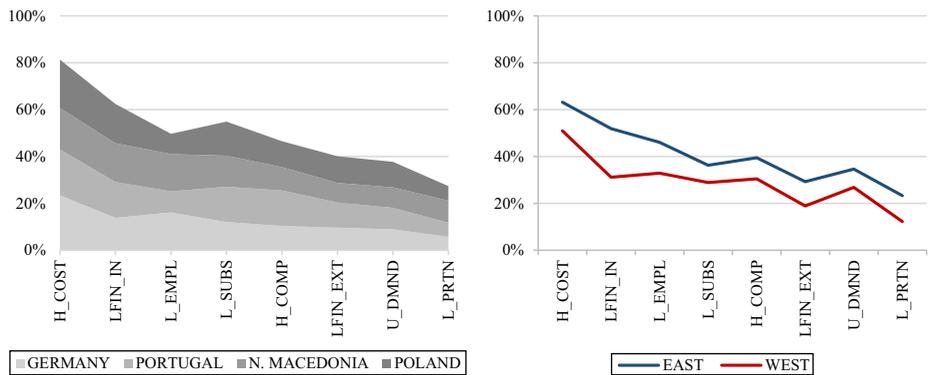

Figure 6.
Ranking of obstacles across countries

Notes: (a) Shades of innovation; (b) EAST vs WEST

Indeed, there is no divide but rather a palette of shades regarding perceptions of innovation that are entrenched in firm-level characteristics.

Figure 6 (b) created by averaging the results for the "East" (Poland, North Macedonia) and "West" (Germany, Portugal) demonstrates clearly that although "West" countries show lower predicted importance, the differences in the ranking of the various obstacles are minimal (mostly less than 10%).

As for the firms in different size classes or sectors, Figure 7 (a) and (b) demonstrate slightly more profound differences in the relative importance of the innovation barriers. For instance, large-sized firms of "East" tend to perceive the barriers closely similar to the "West" firms. (The same importance of 27% is observed/calculated for U_DMND.) Similar comments can be made about "East" firms engaged in service industry.

In summary, while controlling for the cultural divide of the firms, Figure 7 reaffirms the impact of the firm size class and sector on the perception of innovation barriers, and thus the true nature of *H1* and *H2*.

6. Conclusion
The objective of this study was to enhance the body of research on obstacles to innovation using data from the European CIS with their rich tapestry of company sizes, sectors and innovativeness, as an example.

EUROSTAT data from CIS 2016 (released in 2019), recording painstakingly the concerns of over 167,000 companies from Germany, Poland, Portugal and North Macedonia (EUROSTAT, 2019). Probit analysis of a nonlinear model examining eight independent obstacles across two regressors, company size and innovativeness, was performed and detailed.

It was demonstrated succinctly that *firm size matters* when examining the relative importance of the various barriers to innovation. Furthermore, it was shown that such importance is significantly moderated by whether a firm is involved or not in innovation activities. The obstacles that are more important across company sizes and innovativeness were identified and a discernible consensus on their relative importance was provided.

Ameliorating the impact of obstacles to innovation is essential at the firm level to improve performance and at the policy level to design effective interventions. Often firms attempting to enter the innovation arena for the first time are unaware of the relative
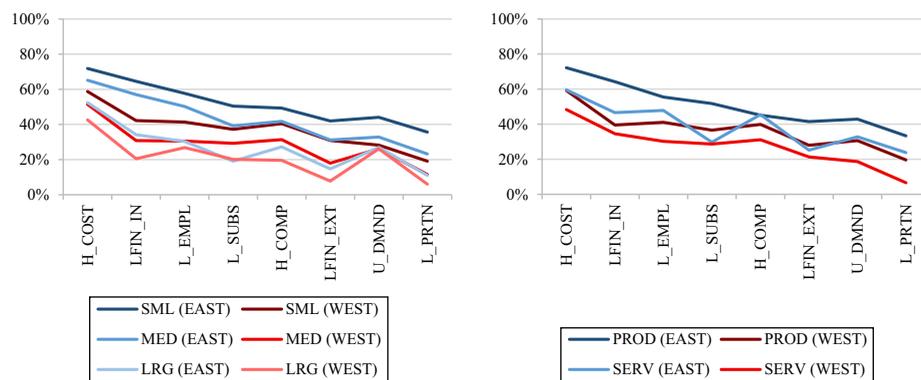

Figure 7.
Ranking of obstacles across countries, size classes and sectors

Notes: (a) EAST vs WEST across size classes; (b) EAST vs WEST across sectors

importance of the obstacles they face and tend to imitate practices of innovative ones without paying attention to their relative size.

A better understanding of the relative importance of the barriers to innovation is also essential to drive policy interventions aiming to remove them. Such interventions are broadly aimed and often have limited effectiveness. The results of this study provide sufficient clues for more refined interventions, both internal (procedures) and external (policies) to the firm, targeting well-defined size segments as well as making fundamental distinctions between innovative and non-innovative companies.

Germany, Poland, Portugal and North Macedonia are all European countries (from founding members and late comers to candidate ones). EU needs a step change in innovation capability to meet societal challenges and competitive pressures. Public policy initiatives can influence the focus and type of innovation. Horizon Europe with its pillars of Global Challenges, Industrial Competitiveness and Strengthening the European Research Area can be a key instrument to advance innovativeness. The results of this study demonstrate that supporting R&D beyond tax credits, that is through direct public funding, will help reduce the high cost of innovation and provide a major boost to firms large and small. Similarly, policies supporting STEM studies and graduate research will help in increasing of human capital that is needed for effective innovation.

The results presented demonstrate that the argument of an alleged cultural divide being the cause for the East-West innovation performance gap is challenged. The view that perceptions about innovation differ substantially due to societal norms is certainly outdated for the countries examined. Firm level discriminants appear to be broadly uniform across Germany, Poland, Portugal and North Macedonia. The transition to a market economy and the knowledge transfer in a globalized world has certainly had an impact and it is difficult to discern an East-West divide at least within the context of EU. Country specific differences in perception appear to be the result of a diffusion of firm-level factors reflecting earlier observations on the issue (Mikl-Horke, 2004).

As the study focused on a group of four countries with distinct socioeconomic profiles, diverse institutional models of work organization and distinct relationships with the EU and the Eurozone, it is expected that the results will be applicable more broadly. The question remains on whether the results of this study are representative of the situation beyond continental Europe to the South Caucasus and Central Asia. Future research will focus on similar analysis for countries from the Commonwealth of Independent States or the Association of Southeast Asian Nations.

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