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Innovation in risky markets. Multinational and domestic firms in the UK regions

by

Luisa Gagliardi[1,3] and Simona Iammarino[2,3]

[1]School of Social Sciences, University of Geneva

[2]Department of Geography and Environment, London School of Economics

[3]Spatial Economics Research Centre (SERC), London School of Economics

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Abstract

This paper analyses the relationship between firm engagement in innovation and perception of market risk. We conceptualise this relationship on the basis of different strands of literature, emphasising the relevance of ownership and location advantages. By exploiting a firm-level panel dataset based on the UK Community Innovation Survey for the period 2002-2008, we test whether heterogeneous innovation behaviours in relation to risk perception characterise multinationals (MNEs) and single domestic enterprises, and whether this relationship changes across regional contexts. Our results confirm previous empirical literature on the perception of obstacles to innovation: firm awareness of market risk is positively associated with the probability to engage in innovation activities. This result however is mainly driven by the behaviour of firms belonging to MNE groups. In addition, while MNEs react consistently regardless their regional context and industry, domestic firms' innovative behaviour is negatively affected by disadvantaged external conditions provided by less dynamic regions.

Keywords: Multinational Enterprises, Domestic firms, Risk perception, Innovation, Community Innovation Survey, United Kingdom.

JEL Codes: F23, O31, R11

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1. Introduction

Multinational Enterprises (MNEs) are nowadays considered the largest source of innovation and technology generation, transfer and diffusion (e.g. Cantwell, 1989; Iammarino and McCann, 2013). The literature assumes that MNEs possess more advanced technological capabilities than single domestic firms due to their access to superior knowledge (e.g. Caves, 1974; Dunning, 1980; Cantwell, 1989), stemming from both intra- and inter-firm innovation networks supporting and nurturing strong ownership advantages.

Studies for the United Kingdom show that MNEs (both foreign-owned and UK-owned) are in general more innovative than uni-national domestic firms (e.g. Dicken, 2007; Frenz and Gillies, 2007; Criscuolo et al., 2010). This evidence has been explained on the basis of the features of the UK national innovation system (NIS),[1] which tends to attract foreign MNEs from comparably advanced economies (Frenz and Gillies, 2007) and often characterised by the highest technological competences independently from the nationality of ownership (see the extensive review in Bellak, 2004). Yet, data also suggest that MNEs, particularly if they originate from advanced innovation systems, display on average a lower degree of risk-aversion. This in turn provides an alternative dimension channelling MNEs' attitude to engage in new innovation projects, and therefore their capacity to produce more innovations (Oulton, 1988). In this perspective, the superior innovative performance of MNEs is the result of both their higher technological capability, and the effect of their 'braver attitude' in terms of self-selection into risky, potentially highly rewarding, innovation projects.

This paper aims at exploring this latter concurrent explanation to MNEs successful innovation behaviours, which has remained largely under-investigated in previous research. We look at the relation between firm's innovation and the perception of market risk across firms that differ with respect to their ownership status. To this scope, the paper builds a conceptual framework that accommodates the relation between market risk perception and firms' innovation attitudes within the traditional Ownership-Location-Internalization (OLI) paradigm (Dunning, 1977, 1988). We focus on the role of ownership and locational advantages, and most importantly the interplay between the two, to understand how firms' innovative behaviour changes in response to perceived market uncertainty. To model the relation between perceived market risk and firms' innovation via ownership and localization advantages we conceptualize the notion of risk by looking at both the managerial and innovation literatures, in which the perception of market risk is assumed as directly related to firms' specific characteristics, and the hazard literature in geography. In this latter view, risk perception is mediated by a subjective component, predisposition to *damage*, given by the combination of the value of the assets exposed to the danger and the firm's propensity to suffer the damage itself; and an objective dimension, *hazard*, as the probability that a hazardous event of a certain intensity happens, which is highly context specific. Our conceptual framework suggests that (a) thanks to their distinctive ownership advantage multinational firms tend to react positively to

[1] The NIS has been defined as 'the network of actors and institutions in the public and private sectors whose activities and interactions generate, import, modify and diffuse new technologies' (see among others Freeman, 1987; Lundvall, 1992; Nelson, 1993; Edquist, 1997)

perceived market risk by raising their innovation efforts compared to single domestic firms; and (b) firms located in relatively stronger regional innovation systems (RIS) react more positively to perceived market risk by exhibiting a higher engagement in innovation activities.

To test empirically these hypotheses, we assembled a new panel dataset based on the UK Community Innovation Survey (UKIS) for the period 2002-2008 – never used in previous literature. Our data provide information on firms' innovative behaviour, proxied by the probability of UK-based firms to engage in innovation activities, completed, ongoing or abandoned, and the level of risk they perceive in the market. The results offer some interesting insights confirming our main premises. First, and in line with previous empirical literature on obstacles to innovation, firm awareness of market risk is positively associated with the probability to engage in innovation activities: this result, however, is mainly driven by the pro-active behaviour of firms belonging to MNE groups. Second, all firms located in stronger regional innovation systems tend to exhibit better innovative performance. This effect is particularly relevant in the case of domestic firms, whose innovative behaviour is more negatively affected by disadvantaged external conditions provided by less dynamic environments.

This analysis contributes to the existing literature on two main fronts. Starting from the conceptualisation of risk mentioned above, the paper first proposes a more nuanced explanation of MNEs' higher degree of innovativeness with respect to uni-national domestic firms. MNE high risk propensity provides incentives to both deepening innovation efforts and widening innovation project portfolios when confronted with uncertain and hazardous market conditions. As such, what is observed to be an MNE successful innovation output is partially due to their 'braver' attitude towards risky investments, as a direct consequence of their specific ownership advantages. Second, the paper offers an additional perspective on the spatial dimension of risk in the context of a specific national innovation system, the United Kingdom, and on how location advantages inherent to regional innovation systems (RIS) may influence firms' vulnerability in the same national context. Our conceptual discussion contributes to the ongoing process of adaptation of the OLI framework to global changes, shedding further light on the interplay between ownership and location advantages, a crucial dimension to be considered in an evolutionary policy perspective.

On the empirical side, we offer new evidence on the heterogeneous innovation behaviour associated to risk perception by different types of firms – single domestic enterprises versus MNEs; we also test whether firms react differently to market risk across regions classified on the basis of their innovative dynamism, and across industries according to their technology- or knowledge-intensity. Our results are robust to several limitations that apply to previous research in the field, including the role of unobserved firm-specific characteristics and broader endogeneity concerns.

The paper is organised in 6 sections. The following Section 2 provides a conceptualisation of risk by drawing on different literatures, and connects it with both ownership and location advantages of MNEs and single domestic firms; it also revises the empirical literature on firm perception of obstacles to innovation and extent of innovativeness, from which we extract some important methodological insights. Section 3 describes the data and presents descriptive evidence. The methodology and the discussion of endogeneity concerns and strategies for addressing them are reported in Section 4, whilst Section 5 discusses the results. Conclusions and implications are presented in Section 6.

2. Literature background

2.1 Understanding innovation in risky environments: the interplay between ownership and location advantages

For almost four decades the eclectic Ownership-Location-Internalization (OLI) paradigm – originally formulated by John Dunning (e.g. 1977, 1988) and subsequently updated by Dunning himself (e.g., 2009) and a number of other scholars – has provided the main analytical framework for examining the behaviour of multinational enterprises and its transformation over time. Theoretical and empirical contributions in a vast array of social sciences – i.e. from economics, to international business, managerial and sociological perspectives, or innovation studies – all subsumed in the OLI, have contributed to our understanding of the nature of ownership advantages, and its growing connections and interactions with internalization advantages (e.g. Castellani and Zanfei, 2004, 2006). However, the major changes in the global institutional and technological environment of the last decades have had important repercussions for the balance of the "three-legged stool" represented by the OLI (Dunning 1998 and 2009), affecting in particular the centrality of location advantages and, as a consequence, its interaction with both ownership and internalisation (e.g. Iammarino and McCann, 2013). Therefore, recent evolutionary views of technological change applied to MNE behaviour and strategy have paid growing attention to the interactions between ownership and location advantages, providing grounds for some significant advances in the field (e.g. Cantwell and Iammarino, 2003; McCann and Mudambi 2004, 2005). Ownership advantages are increasingly viewed as reliant on the ability to explore and select among a wide range of knowledge and quality sources highly localized and specific to national and regional innovation systems (e.g. Cantwell and Piscitello, 2002; Bathelt et al., 2004; Maskell et al., 2006).

The notion of RIS emerged as a territorially-focused perspective of analysis derived from the broader concept of NIS (e.g. Cooke, 1992; Cooke, et al. 1997; Asheim and Isaksen, 2002; Iammarino, 2005) and, in a global perspective, can be defined as 'the *localised* network of actors and institutions in the public and private sectors whose activities and interactions generate, import, modify and diffuse new technologies *within and outside the region*' (Howells, 1999; Evangelista et al., 2002). Indeed, the highly uneven spread of innovative activities across space, further exacerbated by MNE technological networks (Cantwell and Iammarino, 2003), has suggested that a sub-national geography could help better grasp location advantages and avoid the distortions and the loss of information of hypothesising NSI as homogeneous entities (Morgan, 2004). As Carlsson and Stankiewicz (1991: 115) aptly remarked "high technological density and diversity are properties of regions rather than countries." In the light of these views, the OLI paradigm offers a fertile ground for the analysis of firm's innovative behaviour under uncertain market conditions.

The literature on risk perception and innovation behaviour at the firm level is a reputable field of study in management and marketing sciences, and the conceptualisation of risk has long gained a coherent framework. Within the seminal conceptual model elaborated by Sitkin and Pablo (1992, 10) risk is defined as "the extent to which there is uncertainty about whether potentially significant and/or disappointing outcomes of decisions will be realized". The model maintains that the direct effects on risk behaviour operate indirectly via the mediating mechanisms of risk propensity and risk perception, which are in turn influenced by the objective or subjective characteristics of the

actors involved. In this context, risk perception is an inherently firm-specific dimension, which relates to its ownership advantages. Firms' perceptions of, and propensity towards, risk represent a major predictor of how they approach the decisions to undertake innovation investments.

In the international business and management literature such ownership advantages have been broadly framed into the concept of 'multinationality' and involvement in global markets and production and innovation networks. MNEs establish integrated networks of affiliates as a means of building a sustainable competitive advantage based on capabilities and dynamic improvements (e.g. Dunning and Narula, 1995; Zanfei, 2000; Frost, 2001; Veugelers and Cassiman, 2004), rarely available to the same extent to single domestic firms. Global economic and innovation activity heightens the probability that firms will prosper in dynamic and risky environments (e.g. Hamel and Prahalad, 1985; Ghoshal, 1987; Kim et al., 1993), providing risk spreading and management opportunities with respect to rising costs, competition challenges, skill shortages, demand and supply fluctuations, financial sources, etc..

Risk perception and propensity are thus likely to be higher for MNEs than for single domestic firms, affecting differently their decisions on uncertain investments in innovation activities. The first hypothesis we test is therefore whether 'multinationality' correlates with a more positive attitude to innovation investments in uncertain market conditions.

On the other hand, the conceptualisation of risk in the environment hazard literature in geography assumes that risk can be seen as a function of both *hazard*, or the probability of occurrence of a dangerous event of a certain intensity, and *damage*, which in turn results from the combination of exposure (i.e. value of the assets exposed to the danger) and vulnerability (i.e. predisposition to suffer the damage) (e.g. Gardiner and Quine, 2000; Cutter et al., 2000; Kron, 2005). This definition explicitly acknowledges that the degree to which populations are susceptible to hazards vary not only in relation to the nature and sources of the hazard, but "social factors also play a significant role in determining vulnerability" (Cutter et al., 2000, 713). Most importantly, the notion of risk employed in this framework assumes that the extent to which a population perceive external risks depends on both subjective evaluations on the potential extent of damage, which are specific to the actors involved, and objective environmental conditions, which apply to the probability of occurrence of a certain hazardous event in specific temporal and spatial contexts. This is an interesting observation for our purposes as it allows transposing the notion of risk from a purely micro perspective – that of the firm – to a macro (or meso) perspective – that of the innovation system. In other words, insights from the environmental hazard literature suggest that firms' perception and propensity over market risk depends on both the ownership advantages associated to 'multinationality' and distinctive locational advantages characterising different geographical innovation systems. As a consequence, the analysis of the relation between firms' innovative behaviour and risk cannot dismiss the role played by the interconnection between firm (ownership) and regional (location) characteristics: the external environment may contribute to shape firms' response to market conditions by interacting with their characteristics. In more dynamic regions – that is those regions not only able to generate and diffuse innovation through linkages among local actors, but also to integrate in global innovative networks – firms may be more prone to take the risks associated to innovation also under uncertain market conditions, to exploit emerging opportunities, penetrate new markets and minimize economic damages (e.g. Rodriguez Pose, 1999; Gordon and McCann, 2005; Tödtling and Trippl, 2005).

Thus, whereas in dynamic RIS firms may react to risk by sustaining innovative investment and increasing the value of their overall strategic asset exposure, firms located in less dynamic regions may show higher vulnerability and predisposition to suffer damage by reducing significantly their innovation efforts when aware of uncertain market conditions. Therefore, the second hypothesis we bring into the data is whether, given the specific 'ownership' advantage of each firm, the relationship between its innovative behaviour and perceived market uncertainty is mediated by the characteristics of the external environments, with a particular emphasis on the strength of regional innovation systems.

2.2 The empirical literature on firms' risk perception and innovation investment

Most of existing evidence on the relation between firm's innovative behaviour and market uncertainty comes from the related literature on firms' perception of obstacles to innovation (see, for a review, D'Este et al., 2012). This eminently empirical studies, based on data from innovation surveys such as the European Community Innovation Survey (CIS), have largely focused either on the factors that affect the firm's perception of the importance of obstacles to innovation (e.g. Mohnen and Rosa, 2000; Baldwin and Lin, 2002; Baldwin and Hanel, 2003; Galia and Legros, 2004; Iammarino et al., 2009), or on the impact of such obstacles – including risk perception – on the propensity to innovate (e.g. Arundel, 1997; Tourigny and Le, 2004; Mohnen and Röller, 2001, 2005; Savignac, 2008; Tiwari et al., 2007; Mancusi and Vezzulli, 2010).

As to the first approach, which focuses mainly on why firms perceive differently the obstacles to innovation and the extent to which individual obstacles are complementary, common results are that the greater the firm's engagement in innovation activities, the higher the importance attached to risk and other obstacles to innovation; and that the latter are perceived differently depending on firms' characteristics (e.g. small versus large firms). Less convergence emerges, however, with respect to other issues, such as the impact of foreign ownership: whilst Baldwin and Lin (2002) find no significant effect of the nationality of ownership on the probability to perceive obstacles to innovation, Galia and Legros (2004) show that affiliates of foreign MNEs are less affected by costs and finance obstacles than firms belonging to a national (French) group.

The second approach – which is closer to our empirical exercise here – focuses on the role of perceived obstacles and risk in affecting the probability to engage in innovation. Increasing attention in this area has been devoted to the issue of whether the firm's innovativeness and the perception of obstacles influence each other, thus to the presence of a possible estimation bias due to the endogeneity of the regressors (e.g. Mohen and Roller, 2005; Tiwari et al. 2007). In this vein, more recent studies – mostly focused on financial constraints to innovation – point out that the positive relationship between the perception of obstacles to and engagement in innovation can be attributed to a combination of several sources of bias (e.g. Savignac, 2008; Mancusi and Vezzulli, 2010), such as the presence of heterogeneous unobserved firm-specific factors (such as entrepreneurial behaviour or market opportunities) that may impact on both aspects of the relationship, or the simultaneous determination of the risk/obstacle perception and the decision to innovate.

Unobserved firm heterogeneity emerges as a particularly relevant point in this context. Indeed, in recent studies within the Schumpeterian tradition, innovation has been considered as cyclical, inasmuch as firms tend to reduce their innovative efforts in presence of uncertain and risky market

conditions (e.g. Francois and Lloyd-Ellis, 2009). However, other scholars have suggested that innovation may have a counter-cyclical effect implying that periods of economic instability, and therefore riskier, are a fertile environment for firms to innovate (e.g. Aghion and Saint Paul, 1998; Filippetti and Archibugi, 2011). Existing research has suggested that firms that are part of an MNE group tend to be less risk adverse and to invest more in innovation activities independently on their outcome (Dachs and Peters, 2012). This is supported by the findings of Iammarino et al. (2009), showing that the substantial difference in the perception of obstacles is between firms belonging to a MNE group (foreign and Italian) and single domestic firms, rather than between firms with different nationality ownership.

On the other hand, very few studies in this literature have taken into consideration the relevance of the geographical context in firms' perception of obstacles and innovation engagement, and most importantly how firm- and context-specific characteristics interact in shaping such relationship. Iammarino et al. (2009) show that, overall, firms located in the macro-regions of Northern and Central Italy tend significantly less to perceive obstacles to innovation as relevant than firms located in the South, confirming the typical Italian dualism. Interestingly, they also show that geographical specificities in the perception of the obstacles to innovation characterise only single domestic firms: such a perception in fact does not significantly differ across regions, unless the firm is a single domestic firm. To our knowledge, no study has focusses on the relationship between firm's market risk perception, in particular, and engagement in innovation activity across different types of firms – MNEs versus single domestic firms – and in different regional innovation systems.

3. Data

3.1 Data and main variables' construction

The present analysis exploits a novel database at the firm-level from the UK Innovation Survey (UKIS), the most comprehensive source of information on business innovation in the country representing the UK's contribution to the wider European Community Innovation Survey (CIS). The UKIS, which is conducted biennially, provides information on, among other aspects, innovative activities and performance, innovation-related investments, knowledge sources, cooperation for and obstacles to innovation. It is based on a representative sample of businesses with more than 10 employees, stratified across sectors of activity – both manufacturing and services – as defined by the Standard Industrial Classification of Economic Activities (SIC 2003), and regions as defined by the Governmental Office Regions (GORs) level in England, Scotland, Wales and Northern Ireland.

The data used in this study come from the balanced panel provided by the UK Office of National Statistics (ONS) and constructed by merging three waves of the UKIS, covering the period 2002-2008. The sample includes 4,050 business firms participating as respondents in all three consecutive waves:[2] of these, about 64% is part of a UK-based multinational enterprise group, including both foreign- and UK-owned,[3] whilst the remaining sampled firms are single domestic businesses.

[2] Sample statistics comparing key variables for the panel dataset used in this study with data from each UKIS original wave are reported in the Online Appendix (Table A.1) without evidence of substantial differences in the sample composition.

[3] Our data allow identifying firms that are part of a Multinational group: however, we do not have the possibility to distinguish between actual branches or affiliates as no information is available on the percentage owned. We are also able to distinguish between foreign- and UK-owned MNEs, but unfortunately due to the large number of missing values, the information on the nationality of ownership could not be exploited in the analysis.

Firms' innovative behaviours are investigated by adopting as dependent variable the category of *innovation-active* firms, defined by the ONS as those businesses that have engaged in any of the following activities (see also D'Este et al., 2007, 2012; Crescenzi et al., 2015):[4]

- Introduction of a new or significantly improved product (good or service) or process;
- Innovation projects not yet completed, or abandoned;
- Expenditure in areas such as: intramural (in-house) R&D; acquisition of R&D (extra-mural); acquisition of machinery, equipment or software; acquisition of external knowledge; training; all forms of design; marketing and advertising.

This classification of innovation-active firms assumes a broad perspective by taking into account both output- and input-based definitions of innovative behaviours, including firms with successfully completed innovation projects as well as those that have undertaken investments in innovation and yet have not introduced any new product/process. The dependent variable is constructed as a dummy that takes value 1 if a firm is defined as innovation-active in any of the three waves during the period 2002-2008, and 0 otherwise.

The survey provides also information on the major obstacles to innovation, a section of the CIS questionnaire replied by all firms, engaged or not in innovative activities. Firms are asked to report whether they have experienced any of the listed types of obstacles and, if so, to assess their importance.[5] This section of the questionnaire is used to construct the main regressor of interest in our analysis, which is a dummy taking value 1 if a firm has indicated as medium or high (2 or 3 in a scale ranging from 0 to 3) the categories of "Excessive perceived economic risks" and/or "Uncertain demand for innovative goods or services" as key constraints to innovation during the period under analysis.

UKIS data are also used to recover information on the share of skilled employees, i.e. those with a degree qualification; market orientation, distinguishing between exporting firms and those operating mainly on local and national markets; industrial sector of activity defined at 2 digits level; and GOR region.

A complete list of variables included in the analysis is reported in the Online Appendix (Table A.2).

3.2 Descriptive statistics and unconditional correlations

[4] Information on product innovation is recovered from the following question: "During the 3 year period, did this business introduce new or significantly improved goods; new or significantly improved services?"; information on process innovation refers to the following question: "During the 3 year period, did this business introduce any new or significantly improved processes for producing or supplying goods or services?"; information on innovation project not yet completed, or abandoned comes from: "During the 3 year period, did your enterprise have any projects to develop or introduce new or significantly improved products (goods or services) or processes that were abandoned or not yet completed?"; information on innovation expenditures comes from the question "During the 3 year period, did this business engage in the following innovation related activities?".

[5] Information on the obstacles to innovation comes from the following question: "During the 3 years period, how important were the following factors in constraining innovation activities?" Beyond those barriers used to construct our independent variable (excessive perceived economic risk and uncertainty of the demand for innovative products or services), the other listed in the CIS are: difficulties in financing innovation investments deriving from their excessive cost or from the lack of appropriate financial resources, scarcity of qualified personnel, lack of information on available technologies, and presence of incumbent firms with high market power. We use also these variables in our empirical estimation, see Section 4.

A descriptive analysis of our sample shows that about 67% of total firms are defined as innovation-active, that is firms that have engaged in any completed, ongoing or abandoned innovation project or investment over the period 2002-2008. The share of innovation-active rises to 69.2% in the case of businesses part of a multinational group, while it decreases to 62.8% for single domestic firms (Table 1). Interestingly, MNEs tend to score higher in all types of innovation-related activities: our data, while confirming MNEs' relatively better performance in terms of both completed and ongoing innovation projects, also highlight that they are more likely to abandon these ventures (Figure 1). This suggests that MNEs are overall more innovative and prone to self-select into challenging innovation projects. Relatedly, the share of firms perceiving risk and uncertainty in market conditions as key barriers to innovation is higher for innovation-active firms and for MNEs (Table 1), confirming their greater likelihood to attach substantial importance to innovation constraints (UK Data Archive, 2008).[6] Consistently, among innovation-inactive firms the share of those declaring to have been affected by market risk is significantly higher for single domestic firms than for MNEs, the former perceiving risk as an actual *deterrent barrier* to innovation, and a higher proportion of MNE groups, both national and foreign, reporting *revealed barriers* experienced while engaging in innovation processes.

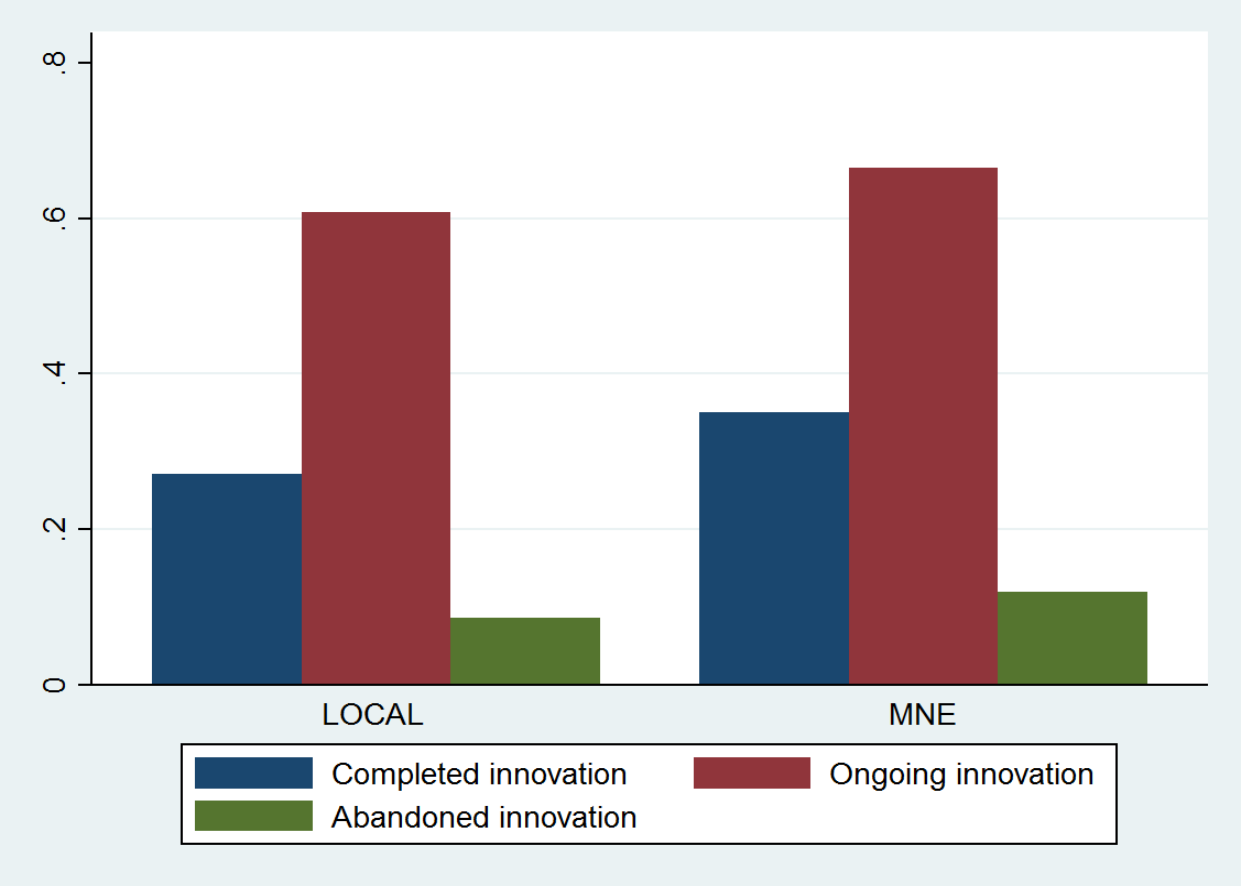
Table 1 - Firms' innovation status and perceived market risk

	MNEs			Single domestic firms			Total		
	No.	Share	Perceived Risk (%)	No.	Share	Perceived Risk (%)	No.	Share	Perceived Risk (%)
Innovation-active	5,361	69.24	51.59	2,770	62.85	48.48	8,131	66.92	50.53
Innovation-inactive	2,382	30.76	16.79	1,637	37.15	21.87	4,019	33.08	18.86

Source: authors' elaboration on ONS/CIS data

[6] UK Data Archive Study Number 6699.

Figure 1 - Innovation behaviour in the UK: MNEs and Single domestic firms



Source: authors' elaboration on ONS/CIS data

Table 2 presents the share of innovation-active firms by UK Governmental Office Region. The highest percentages are found in both West and East Midlands, traditionally a strongly manufacturing-oriented area of the country, and in the South East, the leading UK innovation core and one of the regional champions in Europe. In line with previous studies, London does not score among the regions with the highest share of innovation-active firms (e.g. D'Este et al., 2012; Gagliardi, 2015). Figure 2 provides a cartographic illustration of their spatial distribution distinguishing between MNEs and single domestic enterprises. Innovation-active MNEs are indeed mostly concentrated in the Midlands and the South East; however, for single domestic firms the share of innovation-active is significantly lower in leading regions such as the South East, while it remains in line with the MNE figures in the West Midlands, and it is significantly higher in the South West and Northern Ireland. These spatial patterns support previous findings pointing out that the spatial distribution of the location of MNEs, more than that of domestic firms, seems to conform to a hierarchy of regional innovation systems in the UK (Cantwell and Iammarino, 2000).

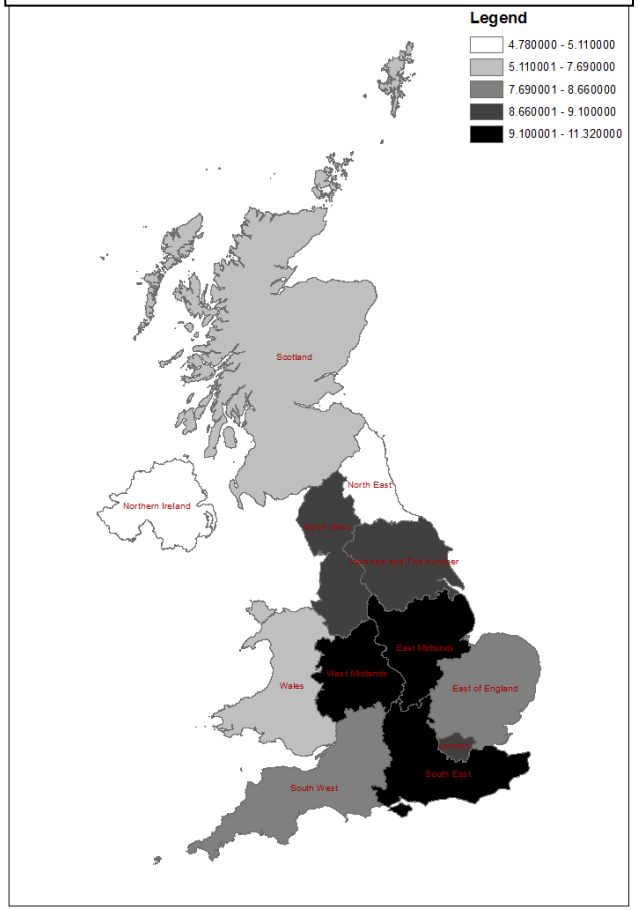
Table 2– Innovation-active firms across regions

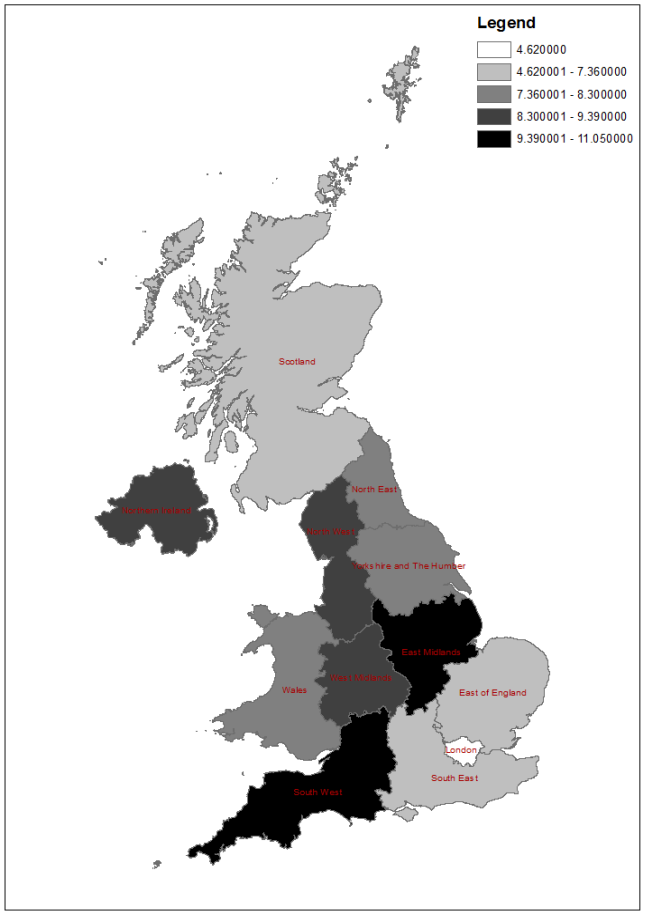
	TOTAL		
GOR	**Freq.**	**Percent**	**Cum.**
North East	486	5.98	5.98
Northern Ireland	526	6.47	12.45
Wales	582	7.16	19.61
London	611	7.51	27.12
Scotland	611	7.51	34.63
East of England	668	8.22	42.85
Yorkshire and The Humber	717	8.82	51.67
North West	740	9.1	60.77
South West	747	9.19	69.96
West Midlands	790	9.72	79.68
South East	808	9.94	89.62
East Midlands	845	10.38	100

Source: authors' elaboration on ONS/CIS data

Figure 2 - Innovation-active firms across UK regions – MNEs vs Single domestic firms

MNEs (% of innovation-active on total MNEs)

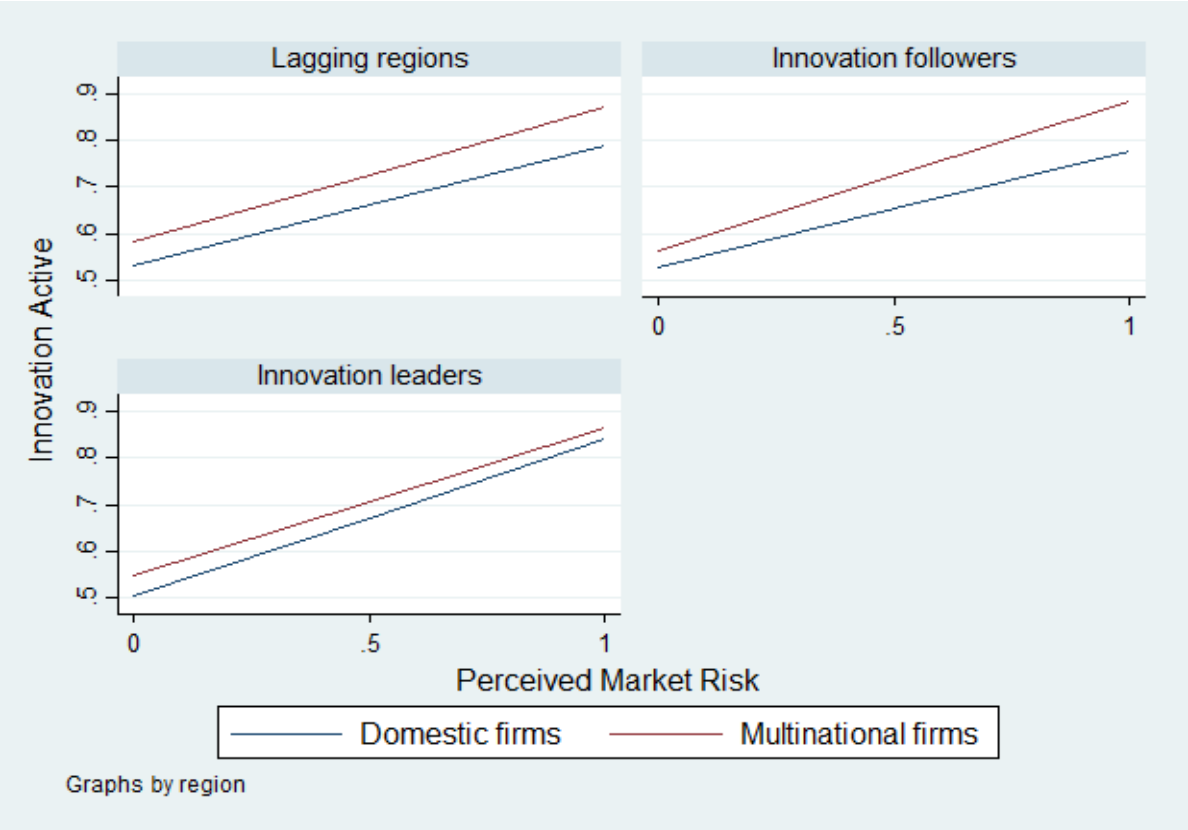




Single domestic firms (% of innovation-active on total domestic firms)

Figure 3 explores the unconditional correlation between firm's innovative behaviour and perceived market risk across firm types and regions classified accordingly to the strength of their regional innovation system: *lagging behind*, *innovation follower* and *leading*[7] RIS. Such a classification follows a RIS hierarchy similar to that adopted by Cantwell and Iammarino (2000) and coherent with the figures reported by the Regional Accounts of the UK Office of National Statistics for the period observed.[8] Whereas in leading RIS higher perceived risk is associated with a smaller gap in innovative performance between MNEs and domestic firms, the opposite is true in more disadvantaged and vulnerable areas. In fact, the differential between MNEs and domestic firms in their engagement in innovation becomes more accentuated the higher the perceived importance of risk as a barrier in both lagging behind and innovation follower RIS. This preliminary evidence can be read in the light of a relation between risk perception and innovation as mediated by both firms-specific ownership advantages and the characteristics of the external environment that make the probability of hazard and potential damage change across space.

Figure 3 – Innovation-active status and perceived market risk across regions by type of firm



Source: authors' elaboration on ONS/CIS data
Note: Two way linear prediction plot between the indicator for firm's innovation active status and perceived market risk.

[7] Leading RISs are London and the South East; innovation followers include West and East Midlands, South West, East of England and North West; lagging behind regions include North East, Yorkshire and Humberside, Scotland, Wales and Northern Ireland.
[8] Regional economic performance indicators (REPI) - Department for Business, Innovation & Skills (2012).

4. Methodology

4.1 The model

The analysis is based on a two ways panel data estimation approach allowing us to include both time and firm level dummies. The estimation equation takes the following form:

$$Innovation\ active_{it} = \alpha_i + \delta_t + \beta_1 Market\ risk_{it} + \beta X_{it} + \varepsilon_{it} \quad (1)$$

Where $Innovation\ active_{it}$ is the dependent variable constructed as a dummy that takes value 1 if the firm is innovation-active and 0 otherwise; $Market\ risk_{it}$, the independent variable of interest, is a dummy taking value 1 if a firm ranked as medium or high the role of risk as key obstacle to innovation; X_{it} is a vector of firm level controls that includes the number of skilled employees and whether the firm exports; α_i and δ_t are region and time fixed effects respectively; and ε_{it} is a well behaving error term. By adopting a two ways panel estimation approach we identify the impact of economic risk and demand uncertainty on innovation by exploiting the within-firm variation in innovative behaviours: thus, we look at whether changes over time in the firm's perception of risk affect its probability to engage in innovation activities.

The possibility to control for time invariant firm characteristics in equation 1 is a crucial advantage over previous research.[9] Perceived market risk as a key obstacle to innovation may correlate with unobserved firms' characteristics and therefore introduce a bias into the estimation. This is the case, for instance, if firms with a specific ownership structure or distinctive managerial practices are systematically characterized by a higher/lower perception of risk which may in turn drive the sign and magnitude of its correlation with the firm innovative behaviour.

For this purpose, we include in equation (1) an interaction term between the variable *Domestic* – a dummy that takes value 1 if a firm is a single domestic enterprise and 0 otherwise – and our regressor of interest. The interaction term allows us identifying whether single domestic firms behave differently with respect to MNEs (used as baseline category) in presence of uncertain market conditions. It is important to note that firms' heterogeneity in terms of ownership structure is a time invariant firm level characteristic that can be captured in the context of equation (1) by interacting the dummy for firm type with our time varying regressor for market risk. Therefore, for identification purposes, the component of the interaction referring to the variable *Domestic* is included in equation (1) by means of the firm level fixed effects.

Together with differences in ownership status we look at heterogeneity across space which may explain at least in part the sign and magnitude of the correlation when estimating equation (1) across the whole sample of UKIS firms. In particular, following the definition of risk proposed in

[9] It should be noted that equation 1 has been estimated using a linear probability model (LPM). This is because the inclusion of a large set of dummies to control for time invariant firm level characteristics makes it difficult for standard nonlinear estimation techniques based on maximum likelihood estimation approaches to converge. Checks using the xtlogit routine, which allows controlling for firm fixed effects, are reported in Table A.4 in the Online Appendix. The choice to prefer LPM techniques also responds to the relevance attached to endogeneity concerns. In fact, two-stage techniques for tackling endogeneity bases (see section 4.2) cannot be applied in a straightforward manner in the context of Maximum Likelihood (ML) or Control Function (CF) approaches. In case of any misspecification of the first stage the 2SLS approach would lose efficiency, while the ML or control function estimators would become inconsistent (Lewbel et al., 2012).

Section 2 above, we test whether the role of risk as key obstacle to innovation operates differently in *lagging behind*, *innovation follower* and *leading* regional innovation systems.

Finally, we classify industrial sectors as low-medium/low tech and medium-high/high-tech following the OECD definition[10] of technology intensity for manufacturing, and we distinguish between Knowledge-Intensive Business Services (KIBS) and other services following Schnabl and Zenker (2013).[11] This sectoral classification is used to perform some additional robustness checks on our main results.

4.2 Endogeneity concerns

Potential endogeneity concerns in the context of our estimation approach are of two types. First, the presence of omitted variables correlated with our regressor of interest, firms' perception of economic risk; second, the simultaneity between the main variables, as firms are likely to concurrently assess the degree of risk and the decision of whether to engage in innovation activities. This may be due to both the possibility that more successful and innovative firms are also endogenously more risk prone, and the likelihood that in faster growing regions firms develop simultaneously both a higher innovation and risk-taker attitude. This issue is exacerbated by the very nature of CIS data, which covers a three-year period in each wave. To deal with this concern we perform several tests.

First, we look at the correlation between perceived risk and the probability of firms' to carry out innovation activities in the period after the observed wave of the CIS, that is we restrict the analysis to those firms that were innovation-active in the previous period.

Second, we employ instrumental variable techniques to introduce a shifter to the firms' perception of risk, which is independent on whether or not they have been innovation-active over the three-year period corresponding to each CIS wave. For this purpose, we adopt two different instruments. The first one is constructed by looking at the number of plant closure in the same region and the same industry of the observed firm in the year after each survey period.[12] Firms that operate close to plant closure events may develop a greater awareness of risk. In addition, as we focus on plant closures in the year of the actual administration of the survey, when firms are expected to provide their answers in relation to the previous three years, such events are likely to exogenously increase the level of risk alleged by the firm at the point in which they are asked to fulfil the survey, independently on whether they have engaged in any innovation activity in the preceding period. As a second instrument, we exploit information on organizational change at the firm level in the period after each wave.[13] The introduction of significant organizational changes within the firm can

[10] https://www.oecd.org/sti/ind/48350231.pdf - OECD (2011).

[11] Medium/High-Tech industries are classified with respect to the NACE Rev 1.1 taxonomy and include: manufacture of pharmaceuticals (24.4), office machinery and computers (30), radio television and communication equipment and apparatus (32), medical precision and optical instruments, watches and clocks (33), aircraft and spacecraft (35.3), chemicals and chemical products (24 excluding 24.4), machinery and equipment n.e.c. (31), motor vehicles, trailers and semitrailers (35), transport equipment (35 excluding 35.1). Knowledge-Intensive Business Services include: computer and related activities (72), research and experimental development (73), other business activities (74).

[12] To recover information on plant closure we use data from the Business Structural Database (BSD), which provides information on basic characteristics, entry and exit for the universe of UK firms. As we do not have information for the year 2009 we restrict the analysis to the first two waves of CIS.

[13] Data on managerial change come from the UKCIS. Information comes from the section "Wider Innovation" with reference to the Implementation of new or significantly changed organizational structures (in terms of organization, strategy or management) during each reference period.

exogenously shift its perception and propensity over market uncertainty. Yet, as we focus on organizational changes after each relevant period, they are unlikely to affect ex post the innovative behaviour of the firm.

Third, we account for the possibility that the simultaneity between firm's innovation and perceived market uncertainty is driven by regional or industry specific trends. If this is the case, and when controlling for differences in firms' specific characteristics, both their innovative behaviour and their perception over market uncertainty is mediated by differences in their operational environment. In other words, firms in fast growing regions or industries tend to develop a more innovative and more risk prone attitude. To this scope we include in our main equation a control for both industry and regional trends.

5. Results

5.1 'Multinationality', innovation and risk perception

Results for the baseline specification estimated following equation (1) are presented in Table 3. Column 1 shows a positive and statistically significant correlation between perceived economic risk and the probability of firms to be innovation-active. Firms with a medium/high perception of risk as an obstacle to innovation show a probability to carry out completed, ongoing, and abandoned innovation projects that is 20% higher than firms reporting null or low perception of risk. This evidence suggests that risk awareness on average stimulates firms to invest in innovation as a way to prevent or reduce economic damages.

Column 2 includes the interaction term between type of firm – i.e. the dummy for single domestic firms – and our regressor of interest to test for the role of 'multinationality' as a key driver of the relation between innovation and risk perception. The interaction term turns out to be negative and significantly correlated to innovation, while the baseline regressor for perceived risk remains positive and statistically significant. In other words, whereas single domestic firms seem to reduce their innovative effort in presence of uncertainty, the positive relationship between perceived risk and innovation is driven by the behaviour of MNEs. The results remain robust to the inclusion of a control for the (log) number of skilled employees (column 3). Overall and in line with our first hypothesis, this finding supports the view that ownership specific advantages associated to 'multinationality' play a key role when it comes to the way in which firms perceive and react to market risk in terms of innovation behaviour.

Table 3 - Firms' innovative behaviour and perceived market risk

	(1)	(2)	(3)
Dep Var: (Pr) Innovation-active	FE	FE	FE
Perceived risk	0.204***	0.228***	0.205***
	(0.0109)	(0.0134)	(0.0132)
Perceived risk * Domestic		-0.0668***	-0.0605***
		(0.0228)	(0.0224)
Skilled employment			0.0656***
			(0.00449)
Constant	0.571***	0.570***	0.491***
	(0.00693)	(0.00693)	(0.00880)
Observations	12,150	12,150	12,150
Wave FE	YES	YES	YES
Firm FE	YES	YES	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' analysis

5.2 Locational advantages and the vulnerability of the external environment

Our baseline results suggest that MNEs are on average less risk adverse and more prone to invest in innovation activities independently on their outcome (e.g. Dachs and Peters, 2012). This behaviour is justified in the light of the distinctive ownership advantages associated to 'multinationality' (Dunning, 2010). On the other hand, our conceptual framework also emphasises the critical importance of the firm's RIS. The characteristics of the environment may shape the way in which firms react to uncertain market conditions by either stimulating engagement in innovation to exploit possible emerging opportunities, or discouraging further investments in innovation and enhancing vulnerability to potential damage in case of hazardous events.

To test whether our results are driven by the regional context we perform a number of checks. First, we re-estimated equation (1) across the subsamples of firms located in the 3 groups of UK RISs described above. Results reported in Table 4 show that the correlation between firms' innovative behaviour and perceived risks is positive and statistically significant in all regions, although with changes in the magnitude of the coefficient that rises monotonically alongside the ranking of regional innovation systems. Interestingly, however, while the significant and negative effect of risk perception on domestic enterprises relative to firms that belong to an MNE group persists in both

lagging behind and innovation follower regions, it disappears in the leading RISs. This result supports two important claims. First, contextual conditions matter as showed by the tendency of (all) firms to exhibit a more pro-active behaviour in regional contexts that are conducive to innovation. Second, they matter even more for domestic firms, which cannot exploit the ownership advantage associated to 'multinationality'. In strong RISs the gap between MNEs and domestic firms in terms of innovative behaviour is significantly smaller, suggesting that location specific advantages play a key role in mediating the relation between firm's innovative behaviour and risk, such that in more dynamic regions they can substitute for ownership advantages.[14] Overall, our findings claim for the concurrent role of ownership and location advantages in explaining the way in which firms confront market uncertainty.

Table 4: Regional innovation systems

	(1) Lagging behind RISs	(2) Innovation follower RISs	(3) Innovation leader RSIs
Dep Var: (Pr) Innovation-active	FE	FE	FE
Perceived risk	0.177***	0.213***	0.222***
	(0.0234)	(0.0195)	(0.0298)
Perceived risk * Domestic	-0.0684*	-0.0633**	0.0326
	(0.0371)	(0.0320)	(0.0633)
Skilled employment	0.0481***	0.0740***	0.0746***
	(0.00834)	(0.00656)	(0.00947)
Constant	0.532***	0.472***	0.469***
	(0.0156)	(0.0125)	(0.0214)
Observations	4,331	5,664	2,155
Wave FE	YES	YES	YES
Firm FE	YES	YES	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' analysis

[14] As additional related evidence, we also exploit the distinction between low/medium low-tech and high/medium-high-tech industries (for manufacturing), and between KIBS and other services (for services), assuming that domestic and multinational firms that operate in innovation-intensive industries are more likely to share similar advanced capabilities. In the Online Appendix (Table A.3, column 1) we interact a dummy that takes value 1 if the firm is active in a medium-high/high-tech or knowledge-intensive industries with our measure of perceived risk. The interaction term turns out to be significant and positively associated to innovation, supporting the view that economic risk operates as a stimulus rather than a deterrent to firm innovativeness in industries characterised by faster adjustments to technological and demand shifts.

5.3 Robustness checks

We perform a number of robustness checks on our baseline results, all reported in the Online Appendix. First, we re-estimate equation (1) by using nonlinear estimation techniques to check whether the results are driven by model specification. The estimates are coherent with previous findings (Table A.4, column 1). We then control for the robustness of our findings with respect to other typologies of obstacles to innovation (columns 2-6): lack of qualified personnel; information asymmetry with respect to technological or market factors; market structure, in terms of the presence of large incumbents; access to credit. Innovation obstacles are included one by one and all together simultaneously: consistently with previous results, all alternative innovation barriers turn out to be statistically significant, but they do not affect the magnitude and significance level of our core variables.

Second, we perform additional tests to shed further light on the role of 'multinationality' as a key determinant of firms' innovation behaviour (Table A.5). We check whether our results hold also when focussing on domestic firms that are more similar to MNEs in terms of international engagement (column 1).[15] We find that domestic firms presenting characteristic more similar to MNEs behave closely to MNEs (thus being less risk-adverse), providing an indication that what really matters is not ownership per se, but rather the specific ownership advantage that comes from the access to global infrastructure that channels global knowledge (e.g. Crescenzi et al., 2015). We also dig further into the ownership advantage by distinguishing between UK-owned and foreign-owned MNEs (column 2).[16] A positive effect of perceived market risk emerges with respect to both categories of MNEs when compared with domestic firms. Still, the effect appears to be more pronounced for foreign-owned MNEs. This evidence partly reflects the distinctive institutional features and policy choices of national systems of innovation – and also the variety of capitalism models that has characterised the evolution of the modern world economy. The UK has historically showed a strong specialisation in trade activities, developing over centuries a financial system targeted on supporting trade exchanges, rather than providing debt-financing for industrial firms and their internal innovation processes (e.g. Freeman, 2002; Iammarino and McCann, 2013). As a consequence, UK firms tend to innovate and grow more through Mergers & Acquisitions, rather than through internal R&D, and inter-firm innovation networks. This historical evolution mirrors a system of innovation very different from that of other comparable economies, such as Germany, where "highly effective inter-firm collaboration within a network of highly specialized buyer and supplier companies" have helped "develop a joint knowledge basis and support processes of 'learning-by-interacting'" (Bathelt and Gertler, 2005, p.4). This finding also emphasises the need for further research to uncover the very nature of the ownership advantages associated to 'multinationality'.

Third, we check for the consistency of our results against endogeneity concerns, which refer mainly to the risk perception regressor. Table A.6 in the Online Appendix reports the estimates employing

[15] Information on collaborations for innovation comes from UKCIS data, in particular from the question "Did your enterprise have any co-operation arrangements on innovation activities with other enterprises or institutions? The variable is a dummy that takes value 1 if the firm declares the involvement in collaborations patterns at the supranational level.

[16] Due to data limitations we are unable to exploit information for the country of ownership of foreign-owned MNEs.

the lagged measure of risk perception (column 1), and the IV approach discussed in section 4.2 (column 2, first stage reported in column 3). Results confirm the positive and statistically significant relation between perceived market risk and firm's innovative behaviour. Most importantly, the Hausman test supports the lack of substantial differences between the OLS and IV estimates arguing against the relevance of endogeneity concerns in our estimates.[17] Finally, Table A.7 controls for area and industry trends (column 1 and 2 respectively) without any evidence of substantial changes despite the very demanding specification that account for the endogenous evolution at the regional and industry level.

6. Conclusions

The evidence presented in this paper shows that risk awareness may push some firms to increase their strategic assets and reduce their vulnerability by investing in innovation as a way to prevent or reduce economic damages stemming from hazardous events of different intensity. Yet, we find a strong heterogeneity across types of firms in the way in which risk perception shapes their innovative attitude: whereas single domestic firms seem to reduce their innovative effort in presence of uncertainty, the positive relationship between perceived risk and innovation is mainly driven by the behaviour of MNEs.

The differential between MNEs and domestic firms in their engagement in innovation becomes more accentuated the higher the perceived importance of risk in both lagging behind and innovation follower RIS. This supports the view that the relation between risk perception and propensity to innovation is mediated by both firm-specific characteristics in terms of ownership advantages associated to 'multinationality', and the characteristics of the external environment. Similarly, economic risk operates as a stimulus, rather than a deterrent to firm innovativeness, in technology/knowledge-intensive industries, which are characterised by faster adjustments to technological and demand shifts. Therefore, more advanced and dynamic regional systems – because of both institutional and systemic features, and industry structures – provide greater incentives to (all) firms to increase their innovation exposure to overcome possible damage from hazards, independently of ownership advantages. Conversely, in weaker regional systems domestic firms confronting economic risk tend to decrease their innovation exposure, allegedly becoming even more vulnerable, while MNEs response remain proactive.

These findings have important implications for policy design. First, the critical importance of 'multinationality' and ownership advantages is confirmed by the fact that differences persist even after controlling for firm and industry characteristics. The reaction to risk is clearly related to the experience of firms: learning processes are much faster in MNEs, as they have the advantage of experiencing diverse international business cultures and institutional environments, leading to higher propensity to innovation as a measure to contain potential economic damages. Domestic firms are more slanted towards local markets, while MNEs are far more able to spread risk globally.

The importance of ownership advantages is however one only side of the story. If MNEs react to risk independently from their location context, the latter is critical in shaping the firm specific advantages of single domestic firms: in more innovation dynamics RISs and industrial sectors,

[17] With a p value of 0.1605 we fail to reject the null hypothesis of difference between the coefficient being not systematic.

firms' behaviours are closer to those of MNEs, and the difference with the latter becomes insignificant. On the other hand, firms located in weaker RISs tend to react to risk by decreasing the value of their innovation assets and becoming collectively more vulnerable, i.e. predisposed to suffer economic damages. In line with the risk management literature in environmental science, one strategy to reduce the damage would be to implement forms of risk sharing (e.g. through targeted and carefully designed incentives). As the hazard and damage components of risk, as discussed in Section 2, go beyond the micro-level, it can be argued that: "…loss reduction may be tackled by attempting to change the population vulnerability." (Gardiner and Quine, 2000).

Our results suggest that national innovation systems also matter. UK-owned multinationals and governments have tended to prioritize investment in support of internationalization over innovation capacity building, at least in relation to different national models, such as the German one. This is inevitably a direction for future research. The present analysis is unable to both identify the nationality of origin of the MNEs – which would give a more nuanced explanation of the 'variety of capitalism' modes of 'multinationality' – and the nature of activities undertaken in different regions by foreign-owned firms. MNE operations in more depressed and backward regions differ systematically from those undertaken in advanced, more dynamic RISs. This may be conducive to a bias, as firm location strategies are sensitive to the nature of activities that they undertake. As Cantwell and Mudambi (2000) point out, policies favouring foreign direct investment in backward regions tend to attract less innovation-intensive operations, with lower value creation. All we can say is that, in line with previous work (e.g. Crescenzi et al., 2015), public policies based on incentives for the attraction of foreign MNEs should be based on a careful diagnosis of the sectoral and institutional structure of weaker regional systems. In addition, these policies can by no means be disjoined from 'horizontal' support to single domestic firms' capacity building as well as to their embeddedness into effective regional and sectoral innovation networks.

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MNEs (% of innovation-active on total MNEs)

Table A.1: Key variables – Panel vs Single waves

Wave						
	Panel			Single waves		
	Innovation active		Perceived risk	Innovation active		Perceived risk
2004						
	Number	Share	Share	Number	Share	Share
	2,668	65.88	55.21	10,246	62.3	57.24
2006						
	Number	Share	Share	Number	Share	
	2,957	73.01	39.47	10,325	69.43	41.07
2008						
	Number	Share	Share	Number	Share	Share
	2,506	61.88	58.62	8,673	60.73	58.68

Note: Innovation active is a dummy that takes value 1 if the firm performed any completed, ongoing or abandoned innovation. Perceived risk is a dummy that takes value 1 if the firm ranks as high the "perceived economic/demand risks of innovation".

Table A.2: Variable List

Variable name	Description
Innovation-active	Dummy variable taking values 1 if the firm is innovation-active and 0 otherwise
Perceived risk	Dummy variable taking value 1 if the firm ranks as high the "perceived economic/demand risks of innovation" and 0 otherwise
Domestic	Dummy variable taking value 1 if the firm is a domestic enterprise and 0 otherwise
Skilled employment	(Log) number of employees with a university degree
National mkt	Dummy variable taking values 1 if the firm is active on the national market and 0 otherwise
European mkt	Dummy variable taking values 1 if the firm is active on the European market
International mkt	Dummy variable taking values 1 if the firm is active on the global market and 0 otherwise
High-tech/Know-intensive industries	Dummy variable taking values 1 if the firm operates in a medium-high- or high-tech manufacturing industry or in a knowledge-intensive service industry and 0 otherwise
Human capital barriers	Dummy variable taking value 1 if the firm ranks as high the "lack of qualified personnel" as obstacle to innovation and 0 otherwise
Information barriers	Dummy variable taking value 1 if the firm ranks as high the "lack of information on technology or market" as obstacle to innovation and 0 otherwise
Competition barriers	Dummy variable taking value 1 if the firm ranks as high the "market dominated by established businesses" as obstacle to innovation and 0 otherwise
Financial barriers	Dummy variable taking value 1 if the firm ranks as high the "difficulties in financing innovation investments deriving from their excessive cost or from the lack of appropriate financial resources" as obstacle to innovation and 0 otherwise
Innovation turnover	Share of turnover from new or significantly improved products or processes

Table A.3: Medium-high/high-tech + KIBS industries

	(1)	(2)
VARIABLES	FE	FE
Perceived risk	0.192***	0.192***
	(0.0151)	(0.0159)
Perceived risk * Domestic	-0.0598***	-0.0604**
	(0.0224)	(0.0270)
Skilled employment	0.0655***	0.0655***
	(0.00448)	(0.00448)
Medium/high-tech+KIBS * Perceived risk	0.0433**	0.0426*
	(0.0213)	(0.0256)
Medium/high-tech+KIBS * Perceived risk *		0.00193
Domestic		(0.0459)
Constant	0.491***	0.491***
	(0.00879)	(0.00879)
Observations	12,150	12,150
R-squared	0.094	0.094
Firm FE	YES	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A.4: Robustness checks

	(1) (Probit)	(2) (Human capital)	(3) (Information)	(4) (Competition)	(5) (Finance)	(6) (All obstacles)
Dep Var: (Pr) Innovation-active	FE	FE	FE	FE	FE	FE
Perceived risk	1.432***	0.181***	0.191***	0.193***	0.139***	0.125***
	(0.103)	(0.0135)	(0.0135)	(0.0136)	(0.0143)	(0.0148)
Perceived risk * Domestic	-0.532***	-0.0634***	-0.0625***	-0.0615***	-0.0655***	-0.0674***
		(0.0224)	(0.0224)	(0.0223)	(0.0223)	(0.0223)
Skilled employment	0.379***	0.0647***	0.0651***	0.0651***	0.0636***	0.0629***
	(0.0298)	(0.00448)	(0.00448)	(0.00449)	(0.00448)	(0.00448)
Human capital obstacles		0.0796***				0.0538***
		(0.0115)				(0.0123)
Information obstacles			0.0520***			0.00615
			(0.0118)			(0.0127)
Competition obstacles				0.0361***		0.0103
				(0.0116)		(0.0120)
Financial obstacles					0.120***	0.107***
					(0.0123)	(0.0123)
Constant		0.482***	0.486***	0.488***	0.472***	0.466***
		(0.00896)	(0.00892)	(0.00892)	(0.00894)	(0.00914)
Observations	6,042	12,150	12,150	12,150	12,150	12,150
Wave FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A.5: Robustness checks (2)

	(1)	(2)
Dep Var: (Pr) Innovation-active	FE	FE
Perceived Risk	0.197***	0.145***
	(0.0131)	(0.0183)
Perceived Risk * Domestic	-0.0524**	
	(0.0226)	
Perceived Risk * Domestic * International collaborations	-0.0236	
	(0.0326)	
International collaborations	0.156***	
	(0.0147)	
Employment with degree	0.0642***	0.0656***
	(0.00446)	(0.00449)
Perceived Risk * UK MNEs		0.0482*
		(0.0251)
Perceived Risk * Foreign MNEs		0.0754***
		(0.0269)
Constant	0.486***	0.491***
	(0.00878)	(0.00880)
Observations	12,150	12,150
Wave FE	YES	YES
Firm FE	YES	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A.6: Robustness checks (3)

	(1)	(2)	(3)
Dep Var	Innovation Active	Innovation Active	Perceived Risk
Perceived Risk	0.181***	0.752***	
	(0.0150)	(0.289)	
Employment with degree	0.0539***	0.0359***	0.0306***
	(0.00548)	(0.0113)	(0.0060)
Managerial change (t+1)			-0.0470***
			(0.0174)
Plant closure (t+1)			-0.1777**
			(0.7229)
Constant	0.509***		
	(0.0111)		
Observations	8,100	8,100	8,100
Wave FE	YES	YES	YES
Firm FE	YES	YES	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A.7: Robustness checks (4)

	(1)	(2)
Dep Var. (Pr) Innovation Active	FE	FE
Perceived Risk	0.206***	0.203***
	(0.0132)	(0.0131)
Perceived Risk * Domestic	-0.0609***	-0.0561**
	(0.0224)	(0.0224)
Employment with degree	0.0658***	0.0652***
	(0.00450)	(0.00451)
Constant	-14.77	0.803***
	(16.63)	(0.245)
Observations	12,150	12,150
Wave FE	YES	YES
Firm FE	YES	YES
Area trends	YES	NO
Industry trends	NO	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1