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Agglomerations and firm performance: how does it work, who benefits and how much?

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Abstract: Agglomeration can generate gains. If it does, how does it work and how are those gains distributed across agglomerated firms? Despite the existence of an important body of research on this topic, the evidence is inconclusive. We examine the effect of *localization externalities* on a firm's innovativeness. By analyzing a large dataset of 6,697 firms integrated with another regional agglomeration-related dataset, we obtain results which show that (i) location in an agglomeration has a positive influence on a firm's absorptive capacity and innovativeness, and, (ii) firms benefit heterogeneously from being located in agglomerations, with benefits being distributed asymmetrically. Agglomeration gains exist but not all firms benefit equally: the least innovative firms gain the most.

Keywords: agglomeration, localization externalities, innovation, performance

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1 Introduction

The spatial concentration or agglomeration of economic activity leads to the emergence of externalities in the form of collective resource pools. These common pools constitute an importance source of external knowledge (Marshall, 1920) which enables and helps to sustain a firm's competitive advantage (Porter, 1998). In this paper we refer to agglomeration and the associated externalities as *production efficiencies*[3]. Scholars have suggested that localization is linked to increasing returns and better innovation because of access to *localization externalities* (e.g. Arrow, 1962; Marshall, 1920, Porter, 1998; and Swann, 1998; Feldman, 1994; Audretsch and Feldman, 1996). Localization externalities[4] are defined as the effects that the concentration of an industry in a region promotes knowledge spillovers between firms and facilitate innovation within that particular industry in that region. Localization externalities allow geographically concentrated firms in the same industry to learn from one other, to exchange ideas, imitation, business interactions, and to access external knowledge and resources without monetary transactions (Saxenian, 1994), that is, unintentional and uncompensated exchange of knowledge among firms (Malmberg and Maskell, 2002), thereby helping to configure a firm's specific capabilities and returns (Marshall, 1890:32; Saxenian, 1994). Claims of these effects have been supported by empirical observations of improved firm performance, in respect of innovativeness (Bell, 2005), financial performance (Kukalis, 2010), patent activity (McCann and Folta, 2011) or survival rates (Wang, Madhok and Li, 2014). Localization externalities are the focus of our study.

Despite substantial amounts of work on the relationship between localization externalities and firm performance, important issues (e.g. Baum and Mezias, 1992; McEvily and Zaheer, 1999; Decarolis and Deeds, 1999; Sorenson and Audia, 2000;

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[3] Consistent with Marshall (1920) and Porter (1998), our arguments focus on *production* externalities and their consequences for production technologies and costs of production. In contrast, *demand* externalities, refer to the benefits of a concentration of firms for sharing marketing or exhibition facilities; for unintentional knowledge spillovers for customers about possible suppliers; or for attracting customers drawn by a lowering of consumer search costss (e.g., Baum and Haveman, 1997). See McCann and Folta (2008) in Journal of Management Studies for a detailed discussion of different types of externalities.

[4] Marshall (1890), Arrow (1962), and Romer (1986) put forward a concept, which was later formalized by the seminal work of Glaeser et al. (1992) and became known as the Marshall–Arrow–Romer (MAR) mode

Kenney, 2000; Owen-Smith and Powell, 2004) remain unresolved and is far from conclusive. There are studies which have found localization has no effect or even negative effects on performance (e.g. Baum and Mezias, 1992; Sorenson and Audia, 2000; Beaudry and Breschi, 2003; Stuart and Sorenson, 2003; Gilbert et al., 2008; Lee, 2009;).

This study lies at an intersection between the fields of strategic management theory and economic geography, focusing on firm level innovativeness and the effect that agglomeration exerts on it. We focus on firm level innovativeness because it is a key organizational capability for sustaining competitive advantage, and because the promotion of an innovative capability is one of the agglomeration-related benefits (e.g. Harrison et al., 1996; Porter, 1998; Bell, 2005; Gilbert et al., 2008). Moreover, innovation arises out of interactive and systemic processes as found in communities of practice or dense networks (e.g. von Hippel, 1988; Kenney, 2000).

Our point of departure is localization externalities occurring in agglomerations, and our overall aim is to evaluate the role of those externalities on a firm's performance. In particular, this paper seeks to provide empirical evidence on (i) whether location in an agglomeration influences a firm's absorptive capacity and innovativeness, and (ii) whether agglomeration benefits exist, and if so are they equally or asymmetrically distributed across agglomerated firms. In fact, this paper will show the positive impact agglomeration has on innovation, and that all located firms increase their innovativeness. However, not all gains are equal. Our results reveal the existence of an asymmetric (inverted U-shaped) distribution of the gains from agglomeration, and that the possibility for gains is contingently moderated by a firm's innovation capability. Further, this paper's results suggest that firms operating in regions where their own-industry employment is strongly concentrated (i.e. agglomerated) invest more in developing absorptive capacity in order to access to and benefit from the available localization externalities. All firms gain from location in an agglomeration but knowledge-rich firms gain the least and contribute the most.

Our study advances the strategy literature by untangling localization externalities impact on a firm innovativeness, showing the mechanisms that link agglomeration and innovation and exploring potential asymmetric benefits in agglomerations and the differing groups of firms benefiting from them.

Just as for the Yale survey (Cohen and Levinthal, 1990), and other papers on innovation (e.g. Laursen and Salter, 2006), our study draws on a questionnaire survey of managers. The Community Innovation Survey (CIS) is a rich full-scale dataset covering 6,697 Spanish firms for the period 2004-2006 in order to test our predictions. Our work combines localization measures at the regional level with a large-scale data set on innovative activities in multiple industries, the scale of which means we are able to obtain evidence of a more general significance than can be found in studies of specific individual industries or small samples. Spain was selected for study because it is one of the two countries (along with Italy) with the highest proportion of agglomerations in Europe[5]. The paper is organized as follows. The following section addresses the integration and review of extant theory. The third section formalizes our hypotheses. Then, in the fourth, we elaborate on our data and our empirical design. In the fifth section, the results are presented, together with a discussion. Finally, conclusions are developed and some areas for future research are discussed.

2 Agglomeration Economies and Firm Performance

2.1 To be or not to be located in agglomerations

In short, we expect that (i) localization externalities will increase incentives for investing in innovation and building absorptive capacity in order to potentially access to those externalities and, (ii) firms accessing localization externalities and their external knowledge will increase and reinforce the combination of internal and external knowledge. Firms located in agglomerations with localization externalities, therefore, are more likely to improve innovativeness. The argumentation is as follows.

Agglomerations provide a knowledge-abundant context favoring inter-firm knowledge exchange (e.g. Tallman et al., 2004; Stuart and Sorenson, 2003). Knowledge spillovers signal opportunities for access to external knowledge (Yang et al., 2010). Therefore, knowledge rich context might activate the development of absorptive capacity because firms need to build such a capacity in order to profit from their rich environment. As Cohen and Levinthal's (1990) seminal contribution points out, the learning environment in which firms operate condition the propensity to invest in absorptive capacity. Thus

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[5] See Boix, 2009

they say: "g*reater technological opportunity signifies greater amounts of external information, which increase the firm's incentive to build absorptive capacity"* *(1990:142).* Therefore, we expect that a firm's location in regions where its own-industry employment concentration is strong provides an incentive to invest in absorptive capacity, attracted by the potential to access rich externalities. Thus, firms located in agglomerations are more likely than outsiders to increase their absorptive capacities in order to tap into cluster resources. In other words, assuming that agglomerations produce externalities, *ceteris paribus*, a firm located in a region characterised by a relatively high level of specialization in the firm's industry, is more likely to increase investment in absorptive capacity in order to gain access to those externalities. Put differently, an agglomeration can enable, activate and foster investment in absorptive capacity, whereas a firm's location outside an agglomeration will not activate investment in absorptive capacity, due to the weaker incentives offered by a poorer learning environment. Arikan (2009:671-673) points out the fact that firms in clusters have to develop absorptive capacity to maximize the potential gains that clusters offer. Similarly, Tallman and Chacar (2011) argue that localization externalities[6], which are deeply embedded, tacit, and inherently immobile (sticky), increases absorptive capacities for the local firms, because firms recognize the potential available knowledge. Thus, our first hypothesis can be stated as follows:

Hypothesis1a. *In agglomerations, externalities and a firm's investment in absorptive capacity complementarily influence a firm's innovative performance.*

Hypothesis1b. *Outside of agglomerations, externalities and a firm's investment in absorptive capacity do not complementarily influence a firm's innovative performance.*

Innovation is the result of a combination of internal and external knowledge. External knowledge from information sources affect innovation outcomes (Ahuja and Katila, 2001). As Cohen and Levinthal (1990:128) points out, "outside sources of knowledge are often critical to the innovation process….". Absorptive capacity enables a firm to generate new internal knowledge and also to access external knowledge. The combination of internal and external knowledge, and the exploitation of synergies between them, facilitates innovation (e.g. Arora and Gambardella, 1990; Kogut and

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[6] They refer to *communities of practice* in clusters and the firm's organization of resources in order to access to that local knowledge.

Zander, 1992). The term absorptive capacity not only describes a firm's ability to scan[7] or evaluate information from its environment, but also to the ability to integrate new external knowledge into a firm's internal innovation activities (Cohen and Levintahl, 1990). External knowledge is *realized* and integrated[8] into, a firm's repository of knowledge at the point the firm assimilates and applies the new knowledge (Cohen and Levinthal, 1990). The integration of internal and external knowledge is crucial to innovate (Rosenkopf and Nerkar, 2001). The level of absorptive capacity is therefore highly correlated with a firm's *innovation capability,* in the sense of the resource-based view (e.g. Teece et al., 1997). This idea is put forward in Escribano et al., (2009:98) who posit that *the way to isolate the role of absorptive capacity is by studying its moderating effect on the impact of external knowledge flows on innovation performance*, that is, by studying the effects of the complementary combination of internal and external sources of knowledge. Our argument posits that localization economies play a key role by facilitating a learning environment which offers more and better opportunities for a firm to access external knowledge (as above mentioned in the first hypothesis), integrate and combine it with its internally generated one.

In all, we posit that combining and integrating internal and external knowledge is facilitated by the existence of localization externalities. Agglomerations influence positively a firm's ability to combine internal and external sources of knowledge. This follows from the availability of abundant knowledge and opportunities to learn, access to which enhances a firm's internal knowledge and increases its absorptive capacity, leading in turn to a raising of the capacity to access more external knowledge. In other words, agglomerations have a positive effect on the process of the complementary combination of internal and external sources of knowledge, therefore, firms located in agglomerations are better able than outsiders to increase their innovation performance. Thus, a second hypothesis can be stated as follows:

Hypothesis 2. *A firm located in an agglomeration is better able than a firm outside an agglomeration to increase its innovative performance thanks to the positive impact that*

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[7] Scanning capability only refers to assessing external sources of knowledge, as Cassiman and Veugelers (2000) and Arbussa and Coenders (2007) state.

[8] In the sense of Zahra & George (*2002).*

localization exerts on the complementary combination of internal and external sources of knowledge.

2.2 Firms in agglomerations: asymmetric gains

We now focus only on firms located in agglomerations, and consider the heterogeneity amongst firms regarding the combination of internal and external knowledge above mentioned.

Asymmetry in firm learning capabilities leads to a corresponding asymmetric distribution of the benefits gained from accessing knowledge in an agglomeration. That is to say, there exist asymmetric relational rents. Our paper posits that due to existing knowledge heterogeneity amongst firms, and thus differing capabilities to access and integrate external knowledge, agglomerated firms do not gain equally from their rich environments. Recent evidence supports this statement (McCann and Folta, 2011; Rigby and Brown, 2013), indicating that those firms located in agglomerations which have a better absorptive capacity and innovation capability are better able to access and integrate external knowledge. Therefore, it follows that access to external knowledge is moderated by a firm's innovation capability (e.g. Cassiman and Veugelers, 2006; Cohen and Levintahl, 1990).

The strength of the above argument is clear, but it neglects the fact that knowledge-rich firms can also contribute to agglomerations through knowledge spillovers (Chung and Kalnins, 2001; Shaver and Flyer, 2000). The argument has been put forward that firms possessing superior technologies and knowledge have an incentive to avoid agglomerations because of the contributions they make to agglomeration externalities (Shaver and Flyer, 2000). In addition, firms in an agglomeration face increased direct competition (Baum and Mezias, 1992) and knowledge flows easily across located firms (e.g. Tallman et al., 2004), imitation is pervasive, and inter-firm worker mobility is a reality (e.g. Saxenian, 1990). Therefore, the competitive dynamics of firms in clusters need to encompass also firms' contributions to agglomerations by spilling over knowledge *involuntarily*. If contributions are taken into account, then the gain from externalities should be measured as the *net effect* of the benefits accrued from learning, on the one hand, and the costs of contributing, on the other hand. In fact, the net effect can even be negative (Baum and Mezias, 1992; Sorenson and Audia, 2000). The fact that knowledge-rich firms contribute more to agglomerations (Shaver and Flyer, 2000), and

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that knowledge-poor firms gain the most, means that knowledge-rich firms might experience negative net effects from location in agglomerated areas.

From the above we can posit that the extent to which a firm's innovative performance benefits from being located in an agglomeration is moderated by the firm's innovation capability and also by the net effect of contributing to and benefiting from the agglomeration. For knowledge-rich firms this suggests two possibilities: (i) a process of knowledge-rich firms accessing and internally integrating external knowledge, with resulting benefits worth more to them than the cost of any spillovers, producing for the firms overall positive net effects, and (ii) a process where knowledge-rich firms experience costs from spillover that amount to more than any benefits gained from accessing to and internally integrating external knowledge, producing for the firms overall negative net effects. The latter scenario might involve a net loss for knowledge rich firms, but would lead to a net gain for knowledge-poor firms which make low or non-existent knowledge contributions to the agglomeration, and so gain more than they lose. Thus, a sign cannot be predicted and a third hypothesis can be stated as follows:

Hypothesis 3. In agglomerations, the net effect on a firm's innovative performance of the positive integration of external knowledge and the occurrence of negative contributions (spillovers) is moderated by a firm's innovation capability and, therefore, there will be asymmetric gains for agglomerated firms.

3   Empirical Design

3.1   Data and sample

This study utilizes firm-level and regional variables from two different databases. The firm-level data comes from the Spanish CIS 2006, conducted in 2007 and covering the 2004-2006 period. This is a representative dataset used to provide information to Eurostat (European Statistics Office) about innovation in Spanish companies. It covers 24,045 firms. The method and types of questions in CIS are described in the Oslo Manual (OECD, 2005). The CIS questionnaire draws from a long tradition of innovation research and is extensively used in the UK, France, Spain, Italy and other countries. The filter-based structure of the CIS questionnaire requires firms to answer the full set of questions on innovation only if a firm is *innovatively active*, that is, the firm has either started innovative activities (subsequently abandoned or still to be completed) or introduced

innovative (technological product or process innovations) outputs. As a result, our empirical analysis is limited to examining the effects of introducing innovative activities by *innovatively active* firms (6,697 firms across 23 industries). We control the selection by using Heckman (1979)[9] and also test whether data suffer from common method bias using Harman's single factor test (Greene & Organ, 1973); that is, loading all variables into an exploratory factor analysis and examining the rotated factor solution. No common method variance is located.

3.2 Variables

The variables we have used for our analysis are the following: *Inno_product* is a dependent variable which indicates whether an enterprise has introduced a new or improved product or service during the research period. This variable is measured as a dummy variable and has a value of 1 if the firm has introduced a new or improved product or/and service during the studied period, and 0 otherwise. Another variable is *Abscap*, which refers to absorptive capacity and a firm's internal resources of knowledge, that is, the double face of absorptive capacity. In constructing this variable we have drawn on the work of Escribano et al., (2009), and also Lane et al. (2006) who emphasize the importance of human resources. Our *Abscap* variable is composed from a factor analysis that includes R&D internal expenditures, and the percentage of human resources devoted to R&D in relation to total employees. The resulting scores from a principal component analysis (PCA) represent the absorptive capacities. The two metric variables generating one single component from the analysis, through its scores, represents the dependent variable which explains 52.21 % of the variance (KMO = 0.7172, $p < 0.01$).

As usual in such analyses, we include control variables, such as Size, measured as the total number of employees, *Industry* classification, measured using 2-digit NACE-93 industry classification as dummies, and the OECD's classification of low-, medium- and high technology intensive industries.

External sources of knowledge are represented in our analysis by variables which measure the importance respondents gave for the innovation process of the use of external information sources (such as suppliers and customers). These measures capture

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[9] Two-step Heckman procedures check for potential selection problems when restricting the sample to innovative active firms. Thus, one inverse Mills ratio (*lambda* variable) is generated and used for controlling coefficients, not being significant. Available upon request.

the role of un-traded interdependencies or externalities from related industries within value chains[10] without monetary transactions (Saxenian, 1994). These variables arose from the question: *how important have the following information sources been for the innovation activities of your enterprise?,* (measured *on a four digit scale from 0 to 3)*

In the agglomeration literature emphasis is is put on the role of access to tacit knowledge through interactions (e.g. Marshall, 1920, Becattini, 1990). As such, this paper focuses on *untraded interdependencies* (Storper, 1995), including: learning from interactions with *Suppliers* and *Customers,* and/or through *Trade Associations and* participation in *Events.* By focusing on these four knowledge sources we address the external search strategies of firms and/or the external sources of knowledge they accessed[11]. Similarly to Laursen and Salter (2006) and with the purpose to use a single indicator for external sources of knowledge (due to methodological requirements below explained with the *logit* corrections on interactions) we constructed this variable in the following way. Each of the four sources are coded with either 1 when the firm in question reports that it uses the source to a high degree, and 0 in cases where there is only no, low, or medium use. Then, the scores for the use of the four sources are added up so that each firm gets a score of 0 when no knowledge sources are used to a high degree, while the firm gets the value of 4 when all knowledge sources are used to a high degree (Cronbach's alpha coefficient = 0.71). Hence, the variable capturing external knowledge (*External_sources* variable) captures both breadth and depth in the sense of Laursen and Salter (2006).

Firms in the CIS questionnaire are geographically placed on a regional basis according to the location of the enterprises' primary research and development facilities, at NUTS 2. We use the latter information in order to connect CIS data with a regional dataset

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[10] The paper usesuntraded interdependencies as a synonym for externalities, a typical procedure in the cluster literature (Storper, 1997).

[11] This is different from traditional approaches based on "buy" search strategies (Cassiman and Veugelers, 2006) or the forming of alliances (McCann and Folta, 2011) as measures of accessing specific types of external knowledge.

containing localization indicators. The database integration is carried out in a rigorous manner[12].

The regional level data comes from the INE (Spanish Statistics Institute), the same governmental body which administers the CIS itself. The specific source is the *2001 Census* of firms, which is presented using NACE-93 industry classification for each region (Spain comprises 17 regions plus Ceuta and Melilla, which are small cities in the Northern part of Africa not included in the study[13]). Geographically bounded localization externalities are measured by taking into consideration the region where a firm locates and its two-digit NACE-93 (European Industry Classification) measure of location quotient. Thus, each firm is given a unique LQ corresponding to the region where a firm locates and the concentration of its industry in that particular region. The location quotient is defined as $LQ = /Lij/Li)/(Lj/L)$ where Lij is the number of jobs in the industry i in a region j, Li is the total number of jobs in the industry i in the country, Lj is the number of jobs in a region j, and L is the total number jobs in the country. If the LQ is more than 1 the region is more specialized in an industry than the country average and so we would conclude that that industry benefits from Marshallian localization economies (Bergman and Feser 1999, Porter, 2003)[14]. Basing the LQs on 2001 information limits any possible simultaneity bias; whenever possible the regional indicators are measured before the reference period of the CIS data (2004-2006). It is important to note that the LQ measure is more comprehensive than one which just considers cluster size which would only refer to the number of firms in the cluster (e.g. Kukalis, 2010).

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[12] Overall, the location of firms in clusters is obtained by simply using a binary variable, whereby code one is assisgned when a firm is located in a cluster, and zero otherwise (e.g. Decarolis and Deeds, 1999; Bell, 2005; McCann and Folta, 2011; Folta, Cooper and Baik, 2006), albeit with some exceptions (Gilbert et al., 2008). This procedure does not address the different strengths of the agglomerations, to the extent that all agglomerations and their respective externalities are assumed to be equal. This is contrary to the cluster literature (e.g. Bergman and Feser 1999; Porter, 2003) where it is said clusters have different externality "strengths", depending on the *relative concentration* of employment (or number of firms) compared to industry concentration levels in the other regions of the same country (see Porter 2003).

[13] The regions are Andalucía 01; Aragón 02; Asturias 03; Balears 04; Canarias 05; Cantabria 06; Castilla y León 07;Castilla-La Mancha 08; Cataluña 09; Comunidad Valenciana 10; Extremadura 11; Galicia 12; Madrid 13; Murcia 14; Navarra 15; País Vasco 16; Rioja 17.

[14] We acknowledge Rafa Boix for this part of the paper

In addition, we also include other measures of potential externalities and control variables. In order to control other regional variables different to the localization economies, the variable *Diversity*, controls for Jacobian economies (Jacobs, 1960) in the regions, measured by the inverse of the Hirschman-Herfindahl index (IHHI), calculated for the jobs in all industries at the two-digit NACE-93 level for each region, using Census data for 2001. The higher the IHHI ratio, the more diverse is the region, and this should have positive effects for firms there. We also include a variable *Share of tertiary educated on residents* (*Education* variable) for each region, provided by INE and referring to 2001, in order to show other sources of externalities, beyond simply the effect of specialization. By controlling for these additional externalities it is possible to better isolate the individual contribution of the LQs. The study includes a total of 6,697 firms ranged over 23 industries. The LQs are calculated for a matrix of the 23 industries in 17 regions.

4 Results

Table 1 shows the descriptive statistics and correlation matrix. See table 1.

<p align="center">**Table 1 about here**</p>

Because our dependent variable (the introduction of product innovation) is binary, we have based our estimations on a *logit* model. Table 2 shows the logistic regressions in three specifications, presenting the Odds ratio and standard errors.

<p align="center">**Table 2 about here**</p>

In specification 1, table 2, basic results are shown. These provide solid evidence and are consistent with the general model. In short, the external sources (*External_sources* variable) are positive and significant (1.41 $p<0.01$), indicating that firms accessing external knowledge are 1.4 times more likely to introduce new product innovations than those which do not access external sources of knowledge.

The *Abscap* variable, which measures absorptive capacity, has a positive and significant effect (Odds ratio 1.235, $p<0.01$) on the introduction of innovative products, as predicted, confirming Cohen and Levinthal (1990).

Then, regarding control variables, Size is positive (1.504, $p<0.01$), meaning that the larger the firm, the greater the probability (1.5 more likely) of introducing innovative

products, on average. The *Med-technology* (technologically intensive firms) variable indicates that firms in the medium-technology industries are (1.67, p<0.01) 67% more likely to introduce innovative products than are low-technology intensive firms (baseline); while high-technology firms (*High-technology* variable) are 22% more likely. The findings for the *Diversity* variable (1.023, p<0.01) and the *Education* variable (1.017, p<0.01) indicate that the presence in the region of unrelated industries and educational qualifications (controlling for Jacobian externalities) are both positively related to the propensity to introduce product innovation. Lastly, the LQs are positive and significant (1.006, p<0.01), indicating that a firm's location in a relatively highly agglomerised region (a relatively high own-industry employment concentration in a firm's regional location) influences positively the likelihood of firms introducing product innovations, albeit that the effect seems small. See table 2.

Then, in specification 2, table 2, hypotheses 1a and 1b are addressed. The interaction *Abscap X LQs* relates to the first hypothesis (1a) and shows positive and significant (odds ratio 1.057, p<0.01) results, indicating that, in general, a firm invests more in developing its absorptive capacity when the environment offers more and better opportunities. A high geographic concentration of a firm's industry in a particular region incentivises it to invest in building absorptive capacity. In other words, the occurrence of localization externalities and enterprise investment in building absorptive capacity complementarily influence innovative performance. However, this result does not in itself confirm the first hypothesis. This is because (i) following Ai and Norton (2003), the nonlinear nature of the logit model means that the marginal effect on an interaction effect is not simply the coefficient (and associated odds ratio) of their interaction and, (ii) it is necessary to test that interaction under two conditions: firms located in, and firms not located in, agglomerations. Consequently, those magnitudes need to be corrected. In table 3 we split the sample into two groups (see McCann and Folta, 2011 treating the cluster size variable[15]). In fact, this division is rooted in recommendations from the cluster literature (e.g. Bergman and Feser 1999) which classifies regions with high localization externalities as those with LQs of more than one (LQs>1), while those regions having poor localization externalities are said to be those which have LQs of less or equal to 1 (LQs<=1). Subsequently, we proceed to apply Ai and Norton (2003) recommendations to

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[15] Econometrically it is also necessary due to the third order effect and its difficulty to be treated in logit regressions.

examine the interactions. Interactions are showed in figures 1 to 6. See table 3 and figure 1 to 6. In table 3 coefficients rather than odds ratios are shown for correction purposes.

Table 3 about here

Figures 1 to 6 about here

In respect of specifications 1 to 3 in table 3, their associated figures (1 to 6) show the real values correcting models in the table of results, using the coefficients. The vertical axis in those figures presents, for each of the observations, the magnitude of the interaction effect between the occurrence of agglomeration and absorptive capacity (*LQs X Abscap* variable), and the significance of that effect. Figures 1 and 2 present the general model, and figures 3 and 4 and 5 and 6 show the corrected size of the interaction effect when firms are, or are not, located in agglomerations, together with their associated significance tests. The horizontal axes in all figures show the model's predicted probability—taking account of the effect of all the covariates—that a given firm will introduce product innovation. Figure 1 shows that the strongest interaction effect between agglomeration and absorptive capacity occurs at the lower end of medium predicted levels of probability of being innovative (approximately 0.2 to 0.5), whereas the effect is less clear-cut for very high levels of the predicted probability of being an innovator. Figure 2 also shows that in the majority of cases the interaction effect is positive and significant at the two-sided 5% level. The effect is non- significant when the probability of being an innovator is high (more than 0.6).

Figures 3 and 4 show the size of the interaction effect between agglomeration and absorptive capacity (*LQs X Abscap* variable), and the significance of that effect when firms are located in agglomerations (LQs>1). As shown, when a firm is located in an agglomeration the interaction effect is positive and statistically significant, with the magnitude of the interaction being strongest when the levels of probability of being innovative range approximately from 0.3 to 0.6. There are some firms, with very high innovative capability, for which the interaction effect between agglomeration and absorptive capacity is negative, although the effect is not significant and the findings for these firms form only a minor part of the overall results.

Then, figures 5 and 6 show the size of the interaction effect between agglomeration and absorptive capacity (*LQs X Abscap* variable), and the significance of that effect, when firms are not located in agglomerations (LQs<=1). The size of the interaction is negative

and significant, except for firms with a very high innovative capability which are significant and positive, albeit these again constitute a minority of the results.

In summary, it can be stated that the poor learning environments outside agglomerations do not incentivise the building of absorptive capacity, whereas location in contexts with high knowledge abundance do incentives such investment. Therefore, hypotheses 1a and 1b are confirmed, highlighting the fact that, as predicted, localization externalities (LQs) incentivise positively investment in absorptive capacity, increasing thereby the probability of introducing product innovations. It is also very important to point out that firms with high innovation capabilities (0.6 to 1) are less influenced by whether or not they are located in agglomerations when it comes to building absorptive capacity. See table 3 and figures 1 to 6.

Table 4 about here

Figures 7 to 10 about here

In table 4, the second and third hypotheses are tested. We proceed in the same way as before, correcting the interaction effects with coefficients and dividing the sample into high and low agglomeration levels. First, addressing hypothesis 2, we proceed by examining the interaction between Abscap and external knowledge source variables (*Abscap X External sources* variable). This produces empirical evidence of positive and statistically significant results about the moderating effect of localization externalities on the combination of internal (Abscap) and external sources of knowledge. In table 4 coefficients are used in order to show graphically corrections, instead of odds ratios. Corrections are presented graphically in figures 7 to 10. For the sake of brevity we focus on the graphic correction effects of the interactions. Subsequently, when addressing only the LQs >1 firms (those located in agglomerations) the third hypothesis will be tested, as explained below.

Figure 7 (table 4, referring to LQs>1, specification 3) shows the size effect of the interaction between External sources and Abscap (LQ>1) when a firm is located in a region characterized by (relatively high own-industry employment) localization externalities. Then, figure 8 (table 4, referring to LQs>1, specification 3) shows the statistical significance of that size effect. The same effects are shown in figure 9 and 10 for the case of firms located in low externalization (LQs=<1) regions (table 4, specification 2, LQs=<1). A comparison of figures 7 and 8 with figures 9 and 10

illustrates the different effect that agglomeration exerts on a firm's innovative performance, showing that agglomeration externalities are important and matter for combining internal and external knowledge to increase returns. Results reflect the fact that for firms located in agglomerations there is a positive and significant interaction effect between External Knowledge and Absorptive Capacity (figures 7 and 8), whereas for firms not located in agglomerations the effect is not significant (9 and 10). Thus, it can be stated that a firm's location in an agglomeration reinforces and strengthens the complementary internal and external knowledge effect on innovation. See table 4 and figures 7 to 10.

Then, in table 4, for firms located in agglomerations (LQs>1, specification 3), and in figures 7 and 8, hypothesis 3 is addressed. Figure 7 shows for firms located in agglomerations the effect on their innovative performance of accessing and realizing external knowledge. That is to say, measurement of the effects on firms' innovative performance of combining internal and external knowledge produces a curvilinear (inverted U-shaped) graph, describing a picture of asymmetric gains thanks to the moderation effect on firms' innovation capabilities. Figure 7 highlights a key finding: that the strongest interaction effect occurs at the lower end of medium predicted levels of probability of being innovative (approximately 0.3 to 0.6), whereas the effect is less clear-cut for high levels of predicted probability of being an innovator. In particular, along the curvilinear (inverted U-shaped) graph shown in figure 7, three groups of firms can be identified: those firms gaining fairly well in innovative performance thanks to being located in agglomerations (innovation capability or predictive level of being innovative between 0.1 and 0.3); those which gain the most (between 0.3 and 0.6); and, finally, those still gaining but gaining the least (from 0.6 to 1). This last group of firms is the one with the highest innovation capability. Also shown is a group of very high innovation capability firms which suffer a loss in innovative performance thanks to being located in agglomerations; this can be seen in the negative values, albeit these are not statistically significant. This heterogeneity reflects and confirms the asymmetric gains referred to in hypothesis 3. Figure 8 also shows that in the majority of cases the interaction effect is positive and significant at the two-sided 5% level, with some exceptions at the very high end of the predicted probability of being an innovator. This curvilinear interaction, reflected in an inverted U-shaped graph, shows that the low and medium innovative firms gain the most. This means that, *ceteris paribus*, a relatively

high agglomeration of own-industry employment (LQs>1) benefits those firms with lesser probabilities to innovate, that is, the "weaker firms" or knowledge-poor firms.

Our results are in line with that part of the literature which has reported evidence of positive and significant links between localization and performance (Decarolis and Deeds, 1999; Bell, 2005; Folta et al., 2006; McCann and Folta, 2011; Laursen et al., 2012) and also with research arguing firms located in agglomerations experience asymmetric returns (McCann and Folta, 2011). Our evidence reveals that firms with higher innovation capabilities benefit the least, while the lesser innovative firms benefit the most. This supports a body of research which claims that "weaker" firms benefit the most from agglomerations (Gilbert et al., 2008; Canina et al., 2005; Shaver and Flyer, 2000). Lastly, in line with the findings of Cohen and Levinthal (1990), our work has empirically proven that enterprises' environment - localization externalities in our case - incentivize firms to invest in absorptive capacity.

The confirmation of our three hypotheses has served to highlight two important points. First, localization externalities shape a firm's innovativeness; this observation follows from our finding that a firm will invest in building its absorptive capacity when it is located in a region where the industry it belongs to is relatively highly concentrated (measured in terms of employment). This investment occurs because the firm is located in a rich and knowledge-abundant environment typical of agglomerations. In contrast, non-agglomeration-located firms have less incentive to build their absorptive capacity because of their poorer knowledge environments.

In general, it can be said the greater the number of externalities available (as indicated by higher LQs), the more firms will invest in absorptive capacity. But this relationship only holds up to the point where the firms with higher innovation capability are decreasingly influenced by an agglomeration effect. Also, in respect of the inverted U-shaped curve obtained from the *LQs X Abscap* interaction it should be mentioned that the shape of the two slopes offered, positive and negative, could be understood through the concept of firm "over-search" (Laursen and Salter, 2006; Katila and Ahuja, 2002). That is to say, the effect of agglomeration and its influence on building absorptive capacity is positive, but the positive influence declines once a certain point is reached thanks, perhaps, to increasing difficulties in deciphering and using all available knowledge. However, we leave this conjecture to future empirical research. It should also be pointed out that our

findings for hypotheses 1a and 1b are consistent with the literature on social capital and innovation (Laursen et al., 2012).

Second, localization externalities positively moderate a firm's probability to innovate by strengthening the complementary combination of internal and external resources development. That is to say, agglomeration reinforces internal and external knowledge complementarities (see hypothesis 2).

Third, across the firms located in agglomerations there are asymmetrical gains in innovativeness performance. This has been manifested in the inverted U-shaped graph pattern presented in this paper, which has shown that firms with weaker innovation capabilities gain the most from an agglomeration environment, while knowledge-rich innovative firms also gain, but less so (see hypothesis 3). This result means that agglomerations do matter but their influence on firms' innovativeness vary asymmetrically. This supports previous claims in the cluster (Hervas-Oliver and Albors-Garrigos, 2009) and management literatures (McCann and Folta, 2011). In general, our results also support the assertion of Acs et al., (1994) that small firms gain the most from agglomerations.

5   Discussion and Conclusion

The results of the study have found our three hypotheses to be correct. In all, it can be asserted that: (i) the combination of *localization externalities* and a firm's investment in absorptive capacity complementarily influence innovation; (ii) agglomerations strengthen the ability to combine internal and external sources of knowledge for innovation purposes and, (iii) in agglomerations, the effect on firms' innovative performance of being able to access and to realize external knowledge is curvilinear, showing asymmetric gains across enterprises due to the moderating effect of firms' innovation capabilities, such that the less innovative firms gain the most. In all, this paper's results confirm that regional localization externalities are important for explaining a firm's innovativeness, albeit with asymmetric results. These findings help us to understand the importance of the strategic behaviour of firms for measuring the effects of agglomeration and its related externalities on firm performance.

This paper contributes to the strategic management literature by providing new evidence on agglomerations and firm performance, showing the mechanisms that link

agglomerations and innovation and untangling how agglomeration benefits are distributed across firms. In particular, this paper provides evidence that agglomeration impacts positively on a firm's innovation performance, confirming previous findings of positive effects (Folta et al., 2006; Bell, 2005) but contradicting reports of negative ones (e.g. Gilbert et al., 2008; Sorenson and Audia, 2000). Our evidence that benefits are asymmetrically distributed amongst firms located in agglomerations   confirms the assertions from a body of works which have claimed that knowledge-rich firms gain the least (Sorenson and Audia, 2000; Shaver and Flyer, 2000; Canina et al., 2005; Gilbert et al., 2008); and contradicts others that have argued that knowledge-rich firms gain the most in agglomerations (McCann and Folta, 2011; Rigby and Brown, 2013). Our results do not show an adverse selection or a full negative net effect (Gilbert et al., 2008; Shaver and Flyer, 2000) but reveal asymmetric positive gains in two senses: (i) located firms all gain, and (ii) less advanced firms in terms of knowledge and innovation gain the most. But non-located ones did not gain from externalities: nor did they build their absorptive capacity, nor did they benefit from utilizing in a complementary fashion a combination of internal and external knowledge, vis-à-vis located ones.

This study has found that the benefits from externalities are asymmetrically distributed. This asymmetry is consistent with the view that the degree of benefit depends on a firm's learning capability and the ability to integrate external and internal knowledge. However, the fact that firms might also contribute to agglomeration externalities through knowledge spillovers also suggests a further possible explanation. Knowledge spillovers can result from technology spillovers, from imitation, from firms having common access to the same suppliers, or from competitors hiring one another's workers. Spillovers contributing to agglomeration externalities are thought to come from knowledge-rich highly innovative firms, rather than from small or knowledge-poor firms. In such a situation, it reasonable to suppose that the less innovative firms gain the most and that this contributes to the observed asymmetry in gains. This reasoning is complementary with that of Baum and Mezias (1992), and Baum and Haveman (1997), who argue that firms choose to *trade off* losses incurred from increased competition against gains from the benefits of agglomeration, manifesting the both (positive and negative) effects from agglomerations.

These conclusions have important implications for managers. In the light of our results, managers should understand the key importance of location and related localization

externalities: in an agglomeration context, all firms will gain, but the less knowledge-rich will gain the most. In practice, it means that managers establishing new enterprises should endeavour to select the most appropriate location. Then, managers should be active in networking, promoting and attending meetings, establishing social connections to regional firms and, overall, be conscious of the availability of external knowledge in geographical concentrations of their industry in certain regions. Moreover, managers need to understand the necessity to develop absorptive capacity if external resources are to be accessed, and be aware that potential knowledge leakages in the form of *spillovers* can be detrimental.

Our study has some limitations. First, the study is set in Spain. Spain is a technology-follower country (e.g. Hervas-Oliver et al., 2011), with investments in R&D being below the average for the European Union. This fact may temper the extent to which the results can be generalised as relevant to other countries. Second, this study is based on cross-sectional data. CIS data is not assembled on a panel basis because of the requirement to respect the anonymity of respondents. As Qian and Li (2003) pointed out, causality is difficult to determine at a single point in time. Thus, we claim correlation rather than cause-and-effect, and this is reflected in the way our hypotheses were formulated. Future research is needed on other countries that have available CIS data, and new variables that capture internal and external resources in a different manner to ours should also be considered. In addition, the continuous integration of theoretical perspectives may further enrich perspectives on agglomerations.

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Tables and Figures

Table 1 Descriptive statistics and correlation matrix

	mean	std. Dev.	min.	max.	1	2	3	4	5	6	7
(1) Size	3.657	1.168	0	10.518	1						
(2) Med_tech	0.496	0.500	0	1	0.102*	1					
(3) High_tech	0.109	0.312	0	1	-0.132*	-0.348*	1				
(4) Education	11.067	13.862	0	100	0.021	0.151*	0.202*	1			
(5) Diversity	45.096	8.757	24.451	54.420	0.046*	0.119*	0.059*	0.096*			
(6) Abscap	0	1	-0.437	59.742	-0.363*	-0.085*	0.250*	0.046*	0.047*	1	
(7) LQS	1.869	1.985	0	15.986	0.129*	0.061*	-0.048*	-0.017	0.201*	-0.035*	1
(8) External_sources	0.624	0.844	0	4	0.055*	0.030*	-0.008	0.055*	0.044*	-0.014	0.031*

* $p < 0.05$

Table 2. Logistic regression measuring the likelihood of introducing product innovations. Odds ratios are showed.

	Specification 1		Specification 2	
	Odds Ratio	Std. Err.	Odds Ratio	Std. Err.
intercep	.0564009**	0.009	0.056**	0.009
Size	1.504**	0.040	1.509**	0.041
Med_tech	1.671**	0.095	1.666**	0.094
High_tech	1.222**	0.119	1.231*	0.120
Education	1.017**	0.003	1.017**	0.003
Diversity	1.023**	0.002	1.023**	0.002
Abscap	1.235**	0.057	1.130**	0.065
LQS	1.006**	0.013	1.008**	0.014
External_sources	1.414**	0.045	1.411**	0.045
Abscap_X_ LQS			1.057**	0.024
Lr Chi squared	771.95		778.62	
Pseudo R^2	0.0835		0.0842	
log likehood	-4236.8		-4233.4	
N	6697		6697	

**$p<0.01$; *$p<0.05$; Low-tech is the baseline, also dummy variables
on Industry two-digit NACE classification proved to be significant.

Table 3. Logistic regression measuring the likelihood of introducing product innovations in relatively high and low density agglomerations.

	All		**(low) LQ<=1**		**(high) LQ>1**	
	Coef.	Std. Err.	Coef.	Std.Err.	Coef.	Std. Err.
intercep	-2.172**	0.109	-1.795**	0.221	-2.105**	0.133
Size	0.418**	0.027	0.415**	0.047	0.431**	0.031
Med_tech	0.545**	0.056	0.682**	0.101	0.414**	0.069
High_tech	0.247*	0.097	-0.006	0.172	0.254*	0.119
Education	0.023**	0.002	0.023**	0.003	0.023**	0.002
Abscap	0.137*	0.027	1.122**	0.183	-0.103	0.055
LQS	0.024	0.023	-0.822**	0.183	0.022	0.016
External_sources	0.346**	0.032	0.366**	0.055	0.338**	0.039
Abscap_X_LQS	0.058*	0.023	-1.210**	0.269	0.132**	0.030
Lr Chi squared	746.15		353.70		464.24	
Pseudo R^2	0.080		0.1101		0.077	
log likehood	-4249.723		-1429.4484		-2778.647	
N	6697		2318		4379	

**p<0.01; *p<0.05; Low-tech is the baseline, also dummy variables on Industry
two-digit NACE classification proved to be significant.

Figure 1. Interactions effects after *logit*. The Size Effect of the Interaction between agglomeration and absorptive capacity
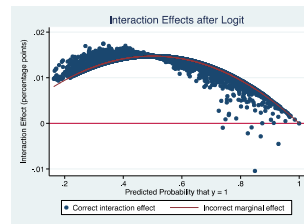

Figure 2. Z-statistics (significance) of the size effect of the interaction between agglomeration and absorptive capacity.
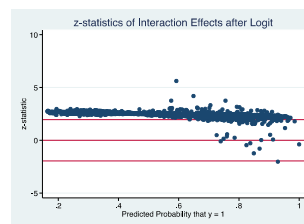

Figure 3. Interactions effects after *logit*. The Size Effect of the Interaction between agglomeration and absorptive capacity when LQS>1
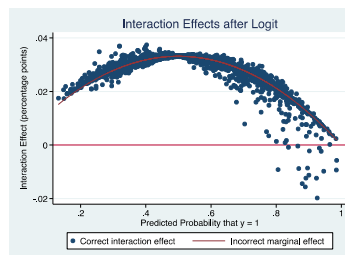
Figure 4. Z-statistics (significance) of the size effect of the interaction between agglomeration and absorptive capacity when LQS>1
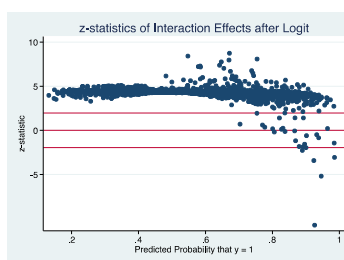

Figure 5. Interactions effects after *logit*. The Size Effect of the Interaction between agglomeration and absorptive capacity when LQS<=1
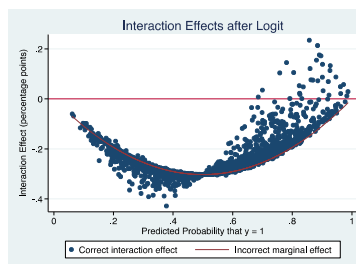

Figure 6. Z-statistics (significance) of the size effect of the interaction between agglomeration and absorptive capacity when LQS<=1
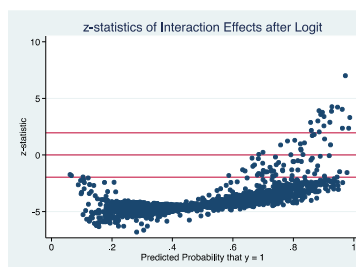

Table 4. Logistic regression measuring the likelihood of introducing product innovation in relatively high and low density agglomerations.

Variables/Specifications	Specification 1		Specification 2		Specification 3	
	All		**(low) LQ<=1**		**(high) LQ>1**	
	Coef.	Std. Err.	Coef.	Std.Err.	Coef.	Std. Err.
intercep	-2.149**	0.109	-1.772**	0.220	-2.074**	0.132
Size	0.412**	0.027	0.410**	0.047	0.422**	0.031
Med_tech	0.545**	0.056	0.673**	0.101	0.424**	0.069
High_tech	0.240*	0.097	0.028	0.169	0.259*	0.120
Education	0.023**	0.002	0.023**	0.003	0.022**	0.002
Abscap	0.117*	0.053	0.329**	0.084	0.037	0.036
LQS	0.020	0.013				
External_sources	0.355**	0.032	0.369**	0.055	0.350**	0.040
Abscap_X_External_sources	0.206**	0.053	0.112	0.083	0.250**	0.069
Lr Chi squared	755.3		332.91		457.2	
Pseudo R^2	0.0817		0.1036		0.0759	
log likelihood	-425.16		-1439.84		-2782.17	
N	6697		2318		4379	

**p<0.01; *p<0.05; Low-tech is the baseline, also dummy variables on Industry two-digit NACE ;
classification proved to be significant.

Figure 7. Interactions effects after *logit*. The Size Effect of the Interaction between External sources and Abscap (LQ>1) when agglomeration density is relatively high
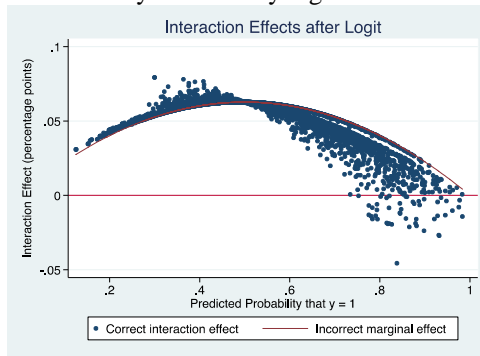

Figure 8. Z-statistics (significance) of the size effect of the interaction between external sources and Abscap (LQ>1) when agglomeration density is relatively high
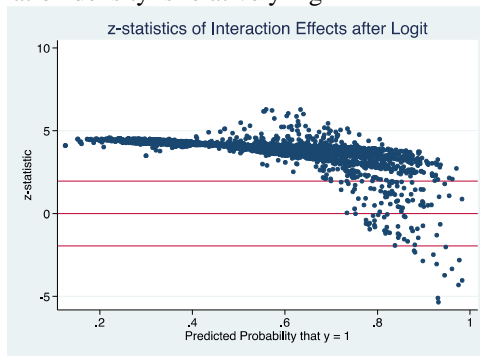

Figure 9. Interaction Interactions effects after *logit*. The Size Effect of the Interaction between External sources and Abscap (LQ=<1) when agglomeration density is relatively low
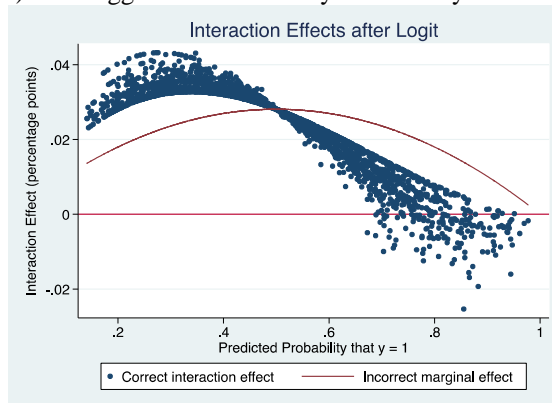

Figure 10. Z-statistics (significance) of the size effect of the interaction between external sources and Abscap (LQ=<1) when agglomeration density is relatively low