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Agglomeration, related-variety and internationalisation. Does a relationship exist?

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Agglomeration, related-variety and internationalisation. Does a relationship exist?

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Abstract: This paper uses a large sample of Italian manufacturing firms over the period 2004-2006, to investigate whether different types of agglomeration externalities affect firms' internationalisation modes. In addition to specialisation economies, Jacobs externalities are analysed following the recent contribution by FRENKEN *et al.* (2007) which distinguishes between related and unrelated variety. Econometric results show that agglomeration externalities – in particular, specialisation and related-variety – positively affect export, while they do not affect the multinational strategy. Moreover, results show that the impact of agglomeration externalities on firms' internationalisation decisions is higher for small sized firms.

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1. INTRODUCTION

Most empirical studies investigate how agglomeration externalities – i.e., spillovers arising from the spatial proximity of economic agents – produce benefits in terms of regional economic growth, attractiveness of foreign direct investments (FDI) and firms' innovativeness. Very few works focus on the role of agglomeration economies in affecting firms' internationalisation in the forms, mainly, of export activity and focus on industrial districts – which can be considered as a source of specialisation externalities.

This paper analyses whether and how firms' internationalisation choices are influenced by spatial agglomeration externalities: i) specialisation externalities arising from the spatial concentration of firms in the same industry (GLAESER *et al.*, 1992); ii) Jacobs externalities arising from the agglomeration of firms in different but related industries, that result from the cross-fertilisation of ideas favoured by this variety and relatedness of the local industrial structure (JACOBS, 1969; FRENKEN *et al.*, 2007). In fact, the internationalisation of firms may be influenced and favoured by both intra-industry and inter-industry knowledge spillovers: a firm can learn from the international experience of nearby firms and can acquire information on foreign markets due to its location in a highly agglomerated area.

Using a large sample of 4,329 Italian manufacturing firms for the period 2004-2006, multinomial models are estimated to test the impact on internationalisation modes of three different spatial agglomeration indicators: i) a specialisation index to capture localisation externalities (ANTONIETTI and CAINELLI, 2011); ii) a measure of related variety to capture Jacobs externalities (FRENKEN *et al.*, 2007); iii) a measure of unrelated variety to capture the portfolio-effect arising from the spatial concentration of firms belonging to different and non-complementary industries and which operates protecting the region from sector-specific shocks (FRENKEN *et al.*, 2007).

The paper is organised as follows: Section 2 provides a review of the main contributions on agglomeration economies, and presents the research hypotheses; Section 3 discusses the data, the

variables and the econometric methodology adopted in the empirical investigation; Section 4 presents and discusses the econometric results; and Section 5 concludes the work.

2. Theoretical framework

The economic literature identifies two main types of agglomeration economies: localisation economies and Jacobs externalities. Localisation (or specialisation) economies are those arising from the spatial concentration of firms in the same industry. The idea that firms belonging to the same industry can benefit from spatial proximity refers to the industrial district argument proposed by MARSHALL (1920) and formalised by GLAESER *et al.* (1992), also considering the contributions of ARROW (1962) and ROMER (1986), in the so called Marshall-Arrow-Romer (MAR) model. The model shows that the concentration of an industry in a spatially defined area can promote both knowledge spillovers among firms as well as incremental innovations and process innovations, facilitating the tacit transmission of information. Hence, according to the specialisation hypothesis, firms are expected to learn more from other firms in the same industry on the basis of intra-industry knowledge spillovers (VAN DER PANNE and VAN BEERS, 2006; FRENKEN *et al.*, 2007).

Specialisation economies are external to the firm but internal to the industry; Jacobs externalities (JACOBS, 1969) are external to both firm and industry and arise from the diversity and variety of the regional economic structure. JACOBS (1969, p. 59) argues that "the greater the sheer number of and variety of divisions of labour, the greater the economy's inherent capacity for adding still more kinds of goods and services". This means that firms can gain more from operating in a diversified environment than in a specialised one, and that the variety of geographically concentrated industries, promoting the exchange and the cross-fertilisation of existing ideas and technologies, facilitates radical innovation and product innovation. Hence, Jacobs externalities arise from the spatial agglomeration of firms belonging to different industries and sectors, and take the

form of inter- rather than intra-industry knowledge spillovers (FRENKEN *et al.*, 2007; BALTZOPOULOS, 2009).

So do firms learn more from collocation with firms in the same industry or from collocation with firms in other industries (BOSCHMA and IAMMARINO, 2009). This question remains a "black box": some researchers stress the importance and the positive role of localisation economies sustaining the hypothesis of the intra-industry transmission of knowledge (i.e. MAR externalities), others uphold the idea of the higher the level of variety in the local system, the higher will be the level of knowledge spillovers among firms (i.e. Jacobs externalities) and thus, the higher will be the overall level of innovation and growth.

An attempt to resolve this debate has been made in the literature on related variety, where it is not variety *per se* that matters, but the geographic concentration of firms in different, but complementary (i.e. related) industries (BOSCHMA and IAMMARINO, 2009; BOSCHMA *et al.*, 2010; CAINELLI and IACOBUCCI, 2011). FRENKEN *et al.* (2004) and FRENKEN *et al.* (2007) contribute to the analysis of Jacobs externalities by distinguishing between related and unrelated variety. This distinction is based on the idea that the transmission of knowledge requires a common and complementary competence base. As underlined by NOOTEBOOM (2000), the successful transmission of knowledge, information, technologies and innovations requires that the cognitive distance between two industries is not too large. This means that the levels of knowledge spillovers will be higher between industries or sectors that are related than industries or sectors that are unrelated.

Starting from this idea, FRENKEN *et al.* (2004) and FRENKEN *et al.* (2007) distinguish between related and unrelated variety considering their different economic effects. They argue that related variety represents a source of regional knowledge spillovers (i.e. knowledge spillover effect), while unrelated variety operates as a portfolio protecting a region from external shocks (i.e. portfolio effect). Hence, it can be stressed on the one hand that related variety occurs within sectors and that it represents the best measure to capture Jacobs externalities; on the other hand, that

unrelated variety occurs between sectors and that it represents a measure that captures the level of vulnerability of a region to sector-specific shocks.

Although the phenomenon of agglomeration economies has been widely investigated from an empirical point of view[1], only a few works analyse the role of agglomeration on firms' internationalisation, especially export activity. For instance, MALMBERG *et al.* (2000) analyse a sample of about 10,000 Swedish export firms in 1994 in order to study the impact of localisation and urbanisation externalities on firms' export performance. Their econometric results show that localisation economies do not affect export performance and that traditional scale economies combined with urbanisation economies have a greater impact.

Other studies on the impact of agglomeration economies on firms' export performance focus on the role of industrial districts as main source of local externalities. Industrial districts can be defined as local areas that are specialised in a particular industry; hence, they can be considered a source of MAR externalities. BECCHETTI and ROSSI (2000), for example, analyse a sample of 3,852 Italian manufacturing firms in the period 1989-1991 in order to investigate the determinants of firms' export activities. They find a positive effect of the geographical agglomeration of small and medium sized firms in highly specialised areas (i.e. the industrial districts), on both the probability of becoming an exporter and export intensity. Similar results are obtained by CHIARVESIO *et al.* (2006) and FEDERICO (2006). CHIARVESIO *et al.* (2006) study a sample of 764 Italian industrial district firms in 2004 and find that district firms are likely to be exporters. FEDERICO (2006) studies a sample of 122 district provinces, finding that 41.5% of firms export and only 27.7% participate in FDI. FEDERICO (2006) also analyse a group of 1,497 Italian firms, finding the existence of a "district effect" related to export activity but not FDI.

Another interesting contribution is BACCHIOCCHI *et al.* (2008), which uses a sample of 786 firms in 2005, operating in the Italian automotive supply chain, and located mostly in the Turin automotive industrial district. They investigate whether their internationalisation process is driven by FIAT off-shoring activities or can be explained by the agglomeration effects arising from

membership in an industrial district. Their econometric results show the robust role of agglomeration externalities as the driving forces of firms' internationalisation processes.

Empirical work on the relationship between agglomeration economies and firms' internationalisation modes focuses mainly on specialisation externalities, and generally finds a positive impact of agglomeration on firms' decisions to embark on export activities. This paper contributes to this strand of research by considering two other types of forces operating at the local level: related variety and unrelated variety.

Specialisation and related variety are assumed to favour the transmission of knowledge and information among firms respectively in the same industry and in different but complementary industries. These forces also facilitate the flow of information on foreign markets and international competition, thus reducing firms' uncertainty to operate abroad. In contrast, it is assumed that unrelated variety, which refers to the spatial concentration of firms operating in different and non-complementary industries, i.e. industries with no common cognitive base, does not facilitate the flow of knowledge among firms, confirming the idea that the belonging to a highly specialised area or to an area characterised by a high level of relatedness positively affects firms' decision to operate in foreign markets.

On the basis of the hypothesis of firm heterogeneity (BERNARD and JENSEN, 1995; MELITZ, 2003; HELPMAN *et al.*, 2004) and assuming the existence of different sunk costs that characterise exporting and FDI activity (HELPMAN *et al.*, 2004), it can be stated that the internationalisation strategies of firms differ according to firm-specific characteristics and also to other forces emerging from the local system in which the firm operates. Concerning the equity-based form of international investment, the (horizontal) FDI option is chosen mainly on the base of firm-specific characteristics because of its high sunk costs. Concerning export options, it can be assumed that they are influenced by other drivers such as specialisation and related variety.

In this context, the main research question is whether different forms of agglomeration economies are able to affect firms' internationalisation modes, and the two main research hypotheses are:

H_1: the higher the level of specialisation or related variety in the local system (i.e. the province), the higher the probability that firms will embark on export activities.

H_2: specialisation and related variety do not affect firms' decisions to realise horizontal FDI.

3. DATASET AND ECONOMETRIC MODELLING

3.1. The dataset

The data used in the empirical investigation come from the 10th Survey of Manufacturing Firms ("*Indagine sulle Imprese Manifatturiere*"), a survey which is administered every three years by Unicredit-Capitalia. The survey, covering the period 2004-2006, collects detailed qualitative and quantitative information on property and business relationships, the labour force, investments, internationalisation, innovation and R&D, market and finance. Moreover, it reports the balance sheet data of interviewed firms for the three years covered by the survey. The original dataset includes 5,137 firms.

The original sample has been cleaned first by removing firms whose main activity is in a non-manufacturing industry[2]. Hence, standard cleaning procedures have been adopted, removing: i) firms with incomplete information on internationalisation modes; ii) firms with no information on year of establishment and geographical location at province level; iii) firms with incomplete information on innovation and R&D activities; iv) firms with incomplete and inconsistent balance sheet data in terms of value added, labour force, intermediate inputs and fixed capital – the four terms of the Cobb-Douglas production function estimated in order to calculate firms' Total Factor

Productivity (TFP). Moreover, as in BENFRATELLO and RAZZOLINI (2008), few firms involved in FDI but not in exporting have been dropped. The final sample is composed of 4,329 firms.

Two internationalisation modes are considered: (i) exporting and (ii) horizontal FDI. Firms are classified into three categories according to their international involvement in the period 2004-2006. The first category refers to firms that serve only the domestic market; the second category includes firms that sell at least a part of their production in foreign markets (exporters); the third category includes firms that export and engage in horizontal FDI.

Table 1 shows the composition of the sample according to this classification. It emerges that the exporters category includes the majority of the firms in the sample; firms involved in exporting and horizontal FDI (denoted TNE) comprise less than 2% of the sample. The sample includes mainly exporters (60.31%) and domestic firms (37.79%).

Looking at the geographical distribution, more than half of the sample firms are located in the north of Italy – 42.87% in the North West area and 29.22% in the North East area – and only about 11.5% of firms are located in one of the southern regions or on an island. Moreover, considering both exporters and TNEs, it emerges that about half of internationalised firms are located in the northern area.

Firms are classified also into four size categories – micro, small, medium and large – according to the number of employees averaged over the three year period. More than half of the sample is composed of small firms, with micro and large firms together representing about 12% of the sample. Domestic firms and exporters are mainly small firms; TNEs are mainly medium sized firms.

Table 1: Sample distribution by geographical area of origin, size and internationalisation mode.

	Domestic firms		Exporters		TNEs		Total sample	
	NUTS-1 areas (a)							
	a.v.	%	a.v.	%	a.v.	%	a.v.	%
North West	654	15.11	1,165	26.91	37	0.85	1,856	42.87
North East	432	9.98	803	18.55	30	0.69	1,265	29.22
Centre	271	6.26	428	9.89	11	0.25	710	16.40
South	199	4.60	172	3.97	4	0.09	375	8.66
Islands	80	1.85	43	0.99	0	0.00	123	2.84
Total	1,636	37.79	2,611	60.31	82	1.89	4,329	100.00
	Size (b)							
	a.v.	%	a.v.	%	a.v.	%	a.v.	%
Micro (<10)	181	4.18	112	2.59	1	0.02	294	6.79
Small (10-49)	1,166	26.93	1,531	35.37	31	0.72	2,728	63.02
Medium (50-249)	258	5.96	803	18.55	33	0.76	1,094	25.27
Large (>249)	31	0.72	165	3.81	17	0.39	213	4.92
Total	1,636	37.79	2,611	60.31	82	1.89	4,329	100.00

Note: Percentage values are expressed on the cleaned total sample. (a) North West includes Liguria, Lombardia, Piemonte and Valle d'Aosta; North East includes Emilia Romagna, Friuli-Venezia Giulia, Trentino-Alto Adige and Veneto; Centre includes Lazio, Marche, Toscana and Umbria; South includes Abruzzo, Basilicata, Calabria, Campania, Molise and Puglia; Islands are Sicilia and Sardegna. (b) Number of employees defining the category is given in parentheses.

3.2. Econometric modelling

The firms in the sample are split into three categories according to their international involvement: non-internationalised firms, exporters and TNE – i.e. firms which both export and engage in horizontal FDI. The dependent variable in the models used to test the hypotheses defined in Section 2 is polytomous and refers to three possible and mutually exclusive outcomes: i.e., a value equal to zero ($y = 0$) if the firm is not internationalised, a value equal to 1 ($y = 1$) if the firm exports, a value equal to 2 ($y = 2$) if the firm both exports and engages in horizontal FDI:

$$Internationalisation\ mode = \begin{cases} 0, & if\ the\ firm\ does\ not\ internationalise \\ 1, & if\ the\ firm\ exports \\ 2, & if\ the\ firm\ exports\ and\ engages\ in\ FDI \end{cases}.$$

The TNE category has been defined following BENFRATELLO and RAZZOLINI (2008). Their empirical investigation aimed to test the hypothesis of firm heterogeneity is based on the 9th Survey of Manufacturing Firms. The questionnaire does not provide detailed and clear information about FDI, asking firms only whether they have or not engaged in FDI during the period 2004-2006. Hence, it is not possible to distinguish between horizontal and vertical FDI. However, the

questionnaire contains detailed information on production off-shoring; in particular, firms are asked about output produced in delocalised plants and its final markets. Hence, firms are considered as engaging in horizontal FDI if they produce in a foreign delocalised plant final products and if these final products are sold abroad directly rather than being re-imported to Italy as intermediate inputs or to serve the Italian market.

The best way to model this is via a multinomial logistic model. This model uses only variables that describe characteristics of the individual and not of the alternatives. The model can be specified as follows:

$$V_{nj}^{*} = x_{n}^{'}\beta_{j} + \varepsilon_{nj} \ ,$$

where $x_{n}^{'}$ is a set of exogenous variables which describe only the individual and are identical across alternatives, β_{j} is a parameter that differs across alternatives, and ε_{nj} are the error terms, which are independently and identically distributed. The observed choice y_{n} of an individual n can be expressed as

$$y_{n} = \begin{cases} 0 \ \ if \ V_{n0}^{*} \geq V_{ni}^{*} \ for \ all \ i \\ 1 \ \ if \ V_{n1}^{*} \geq V_{ni}^{*} \ for \ all \ i \\ 2 \ \ if \ V_{n2}^{*} \geq V_{ni}^{*} \ for \ all \ i \\ \vdots \\ J \ \ if \ V_{nJ}^{*} \geq V_{ni}^{*} \ for \ all \ i \end{cases} ,$$

and the probabilities for the J choices can be modelled as it follows (SCHMIDHEINY, 2007; WOOLDRIDGE, 2010):

$$\Pr(y_{n} = j | x_{n}) = \frac{e^{x_{n}^{'}\beta_{j}}}{\sum_{i=0}^{J} e^{x_{n}^{'}\beta_{i}}} \ .$$

Three different indicators are included in the regressions in order to test the role of agglomeration economies in affecting firms' internationalisation modes. Specifically, (i) a specialisation index to capture the knowledge spillovers arising from localisation economies, (ii) a measure of related variety to capture Jacobs externalities, and (iii) a measure of unrelated variety to

test the existence of a portfolio effect arising from the variety and the un-relatedness in a local industrial system.

The three agglomeration indicators are calculated using data on employment at different sector digit levels and at the geographical NUTS-3 level (i.e. at province level), from the Census of Industry and Services conducted by ISTAT (Italian National Institute of Statistics) in 2001 and 1991. Use of 2001 and 1991 employment data avoids the problem of simultaneity in cross-sectional analysis.

Following ANTONIETTI and CAINELLI (2011), localisation externalities are measured using a specialisation index (SI) *à la* Balassa, calculated on two-digit level employment data, for the $k = 1,\ldots,103$ Italian provinces. The SI of industry i in province k is calculated as follows:

$$SI_{i,k} = \frac{(l_{i,k}/l_k)}{(l_{i,IT}/l_{IT})} ,$$

where $l_{i,k}$ represents employment in industry i in province k, l_k represents total employment in province k, $l_{i,IT}$ represents employment in industry i in Italy, and l_{IT} represents total employment in Italy. The standardised SI (SSI) is used in the regressions and is constrained within the interval (-1,+1) (PACI and USAI, 2000; BRONZINI, 2004):

$$SSI_{i,k} = \frac{(SI_{i,k} - 1)}{(SI_{i,k} + 1)} .$$

Following FRENKEN *et al.* (2007), related and unrelated variety are calculated for the 103 Italian provinces using the entropy measure. This has the advantage that it can be decomposed at each sector digit level, thus allowing inclusion of entropy in the regression analysis without risk of collinearity. Unrelated and related variety are defined, respectively, as entropy at the two-digit level and as the weighted sum of entropy within each two-digit sector.

Hence, unrelated variety is given by:

$$UNRELVAR_k = \sum_{g=1}^{G} P_g \log_2(\frac{1}{P_g}) \ ,$$

where P_g represents the two-digit shares obtained by summing the five-digit shares p_i, assuming that all five-digit sectors i fall exclusively under a two-digit sector s_g, where $g = 1, \ldots, G$. High values of the index indicate high variety among the industries located in the same geographical area.

Related variety is given by:

$$RELVAR_k = \sum_{g=1}^{G} P_g H_g \ ,$$

where H_g is a measure of entropy, which can be defined as follows:

$$H_g = \sum_{i \in s_g} \frac{p_i}{P_g} \log_2(\frac{1}{p_i/P_g}) \ .$$

The regressions are performed clustering standard errors at province level (103 units): i.e. the geographical unit considered in the analysis (Table A.2 in Appendix reports some descriptive statistics and the correlation matrix of the agglomeration variables).

A set of other independent variables is introduced in the multinomial logistic models. Firms' Total Factor Productivity (TFP) is estimated as the residual of a two factor Cobb-Douglas production function by implementing the semi-parametric approach proposed by LEVINSOHN and PETRIN (2003). This method uses intermediate inputs as a proxy to control for unobservables, in order to solve the simultaneity problem between productivity shock and input choices. In logarithms, the production function assumes the form

$$lnY_{it} = \gamma + \alpha lnL_{it} + \beta lnK_{it} + \omega_{it} + \eta_{it} \ ,$$

where $i = 1, \ldots, N$ and $t = 2004, \ldots, 2006$ and where Y_{it}, L_{it} and K_{it} are, respectively, value added, labour input and capital input of firm i at time t; ω_{it} is a state variable indicating that part of

productivity known by the firm and η_{it} is a white noise component. Specifically, raw materials and consumption of services are used as proxy variable[3].

Firm-specific characteristics are also captured by size and age variables. Firm size is calculated as number of employees averaged over the period 2004-2006; firm age is calculated as 2006 minus the firm's establishment year and can be considered a proxy for accumulated experience. Both variables are included in the regressions in logarithmic form, and are expected to have a positive effect on the choice to internationalise.

A set of dummy variables is included to capture the belonging to a business group, membership to an export consortium, receipt or not of fiscal and/or financial incentives during the three year period and whether the firm invested in ICT during the period 2004-2006. Values are equal to 1 in the case of affirmative answers and equal to 0 otherwise for all these variables, which are expected to have a positive impact on both exporting and FDI, and especially the variable capturing belonging to a business group, which is expected to have a very significant impact on FDI.

Following recent empirical contributions on the determinants of firm productivity differentials under the hypothesis of firm heterogeneity (CASTELLANI and ZANFEI, 2007; CASTELLANI and GIOVANNETTI, 2010), variables concerning innovativeness and R&D activities are included in the regressions. Specifically, firm innovativeness is captured by three dummy variables for capturing whether in the three year period the firm introduced product and process innovations, product innovations or process innovations. Another dummy variable captures whether the firm invested in R&D activity in the three year period. All the variables for innovativeness and R&D activity are expected to have a positive sign and to be significant – especially in the case of TNEs.

Finally, 21 industry dummy variables aimed to capture industry-specific characteristics and 5 geographic dummies at NUTS-1 level (North West, North East, Centre, South and Islands) are included in the model.

In order to verify the goodness of fit of the estimated models, two different measures are used: the McFadden's R^2 – also known as the "likelihood ratio index" – and the Bayesian Information Criterion (BIC). The difference in the BIC measures indicates which model better generates the observed data. The idea is that the more negative the BIC measure, the better the fit. Hence, if $BIC_1 - BIC_2 < 0$, the first model would be preferred, and if $BIC_1 - BIC_2 > 0$, the second model would be preferred (LONG and FREESE, 2000). The variance inflation factor (VIF) is also used in order to check for multicollinearity: all values are lower than 1.52, thus demonstrating the absence of multicollinearity among regressors (OERLEMANS and MEEUS, 2005).

4. EMPIRICAL RESULTS

Multinomial logistic models are estimated for the whole sample and the sub-population of firms with less than 50 employees – i.e. for small firms. In all cases, agglomeration variables are added to the base econometric specification one at a time and then together[4].

Table 2 shows the econometric results for the whole population of firms. The first result of interest concerns the variable capturing firms' TFP. Its coefficients are positive and significant for both categories and, in particular, it is found a productivity *premium* of about 35% for TNEs compared to exporters. This result confirms the hypothesis of firm heterogeneity: in fact, firms engaged in exporting and horizontal FDI show higher levels of productivity than firms that are only exporters, which, in their turn, show higher levels of productivity than domestic firms – the productivity *premium* for exporters with respect to domestic firms is about 24%.

For the relationship between agglomeration externalities and firms' internationalisation modes, the assumption is that specialisation and Jacobs externalities both positively affect export by favouring the flow of information across firms on foreign markets and international competition (H1); they have no effect on FDI because it presents higher sunk costs than exporting and thus is linked mainly to firm-specific characteristics (H2).

The econometric results partially confirm the above hypotheses. The coefficients of the specialisation variable have the expected positive sign and are statistically significant for exporters, but not significant for TNEs. The coefficients of related variety and unrelated variety are not significant for either category. This is true if the agglomeration variables are included one by one in the regressions and if they are included together.

These results show that firms belonging to specialised areas embark on export activities also thanks to intra-industry knowledge spillovers coming from firms that are already internationalised, but that inter-industry spillovers do not increase the probability that a firm will become an exporter. On the other hand, these results confirm the idea that firms decide to undertake horizontal FDI on the basis of their specific characteristics: FDI involves fixed and sunk costs that only the most productive firms can sustain.

Some of the other results for the other explanatory variables are also interesting. Specifically, the coefficients of the variable for firm size are positive and highly significant for both categories, while the coefficients of the variable for firm age (which acts also as a proxy for accumulated experience) are statistically significant only for exporters, although they are positive for both categories of firms. This last result is in partial contrast to the idea that firms with longer experience and better knowledge of the market tend to respond to international competition by adopting more complex internationalisation modes.

As expected, the coefficients of the variable capturing membership in an export consortium are positive and significant for both categories, while the variable capturing belonging to a business group is highly significant only for TNEs. For the variable capturing fiscal and/or financial incentives, the coefficients are positive for both categories, but highly significant only for exporters.

In relation to firms' innovativeness, it appears that the introduction of both product and process innovations positively affects the choice to both export and engage in horizontal FDI, while the introduction of only product innovations is significant only for the decision to export. Moreover, the coefficients of the variable capturing the introduction of only process innovations are not

statistically significant, and they result negative for TNEs. Finally, the results show that FDI is positively affected by investment in R&D activities: in fact, the coefficients of the R&D variable are positive and highly significant for TNEs, and not significant for exporters.

Table 2: Determinants of the probability to export and to export and realise horizontal FDIs – all firms.

Dependent variable: Internationalisation mode										
	(Model-1)		(Model-2)		(Model-3)		(Model-4)		(Model-5)	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$SSI_{i,k,2001}$	...	...	0.412**	0.062	...	...	...	...	0.451**	0.107
			(0.143)	(0.396)					(0.141)	(0.399)
$RELVAR_{k,2001}$	...	...	...	...	0.404	-0.088	...	...	0.422	-0.409
					(0.210)	(0.750)			(0.223)	(0.793)
$UNRELVAR_{k,2001}$	...	...	...	...	...	...	0.397	1.220	0.440	1.377
							(0.291)	(0.773)	(0.255)	(0.923)
TFP	0.240*	0.591*	0.237*	0.588*	0.235*	0.588*	0.236*	0.583*	0.227*	0.576*
	(0.104)	(0.274)	(0.104)	(0.273)	(0.104)	(0.273)	(0.104)	(0.275)	(0.103)	(0.272)
Age	0.149*	0.202	0.154*	0.201	0.147*	0.204	0.150*	0.212	0.154*	0.219
	(0.062)	(0.130)	(0.062)	(0.130)	(0.062)	(0.132)	(0.062)	(0.132)	(0.061)	(0.134)
Size	0.413***	0.585***	0.406***	0.581***	0.417***	0.587***	0.412***	0.581***	0.409***	0.577***
	(0.051)	(0.124)	(0.051)	(0.124)	(0.051)	(0.124)	(0.051)	(0.124)	(0.051)	(0.125)
Group	0.037	0.875***	0.048	0.878***	0.037	0.869***	0.039	0.895***	0.051	0.890***
	(0.120)	(0.220)	(0.122)	(0.223)	(0.121)	(0.216)	(0.121)	(0.220)	(0.123)	(0.223)
Export Consortium	2.098**	2.869**	2.115**	2.881**	2.114**	2.856**	2.095**	2.851**	2.131**	2.833**
	(0.739)	(1.006)	(0.735)	(1.019)	(0.739)	(1.014)	(0.741)	(1.005)	(0.736)	(1.025)
Incentives	0.351***	0.558	0.345***	0.572	0.355***	0.547	0.352***	0.571	0.351***	0.562
	(0.081)	(0.312)	(0.082)	(0.309)	(0.080)	(0.309)	(0.080)	(0.312)	(0.081)	(0.305)
ICT	0.125	0.580	0.135	0.589	0.126	0.584	0.123	0.572	0.135	0.587
	(0.104)	(0.315)	(0.104)	(0.313)	(0.104)	(0.315)	(0.104)	(0.316)	(0.103)	(0.314)
R&D	0.108	0.581**	0.103	0.584**	0.110	0.577**	0.111	0.594**	0.109	0.587**
	(0.080)	(0.201)	(0.079)	(0.202)	(0.082)	(0.204)	(0.080)	(0.201)	(0.080)	(0.202)
Innovation	0.301***	0.858**	0.300***	0.867**	0.304***	0.861**	0.297***	0.842**	0.298***	0.855**
	(0.088)	(0.303)	(0.089)	(0.298)	(0.088)	(0.302)	(0.088)	(0.306)	(0.090)	(0.301)
Product Innovation	0.229*	0.139	0.224*	0.146	0.231*	0.136	0.228*	0.127	0.225*	0.128
	(0.095)	(0.449)	(0.095)	(0.451)	(0.095)	(0.449)	(0.095)	(0.450)	(0.095)	(0.453)
Process Innovation	0.229	-0.614	0.225	-0.604	0.233	-0.612	0.227	-0.634	0.225	-0.629
	(0.134)	(0.661)	(0.134)	(0.657)	(0.133)	(0.660)	(0.134)	(0.661)	(0.133)	(0.656)
NUTS-1 dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Obs.	4,329		4,329		4,329		4,329		4,329	
Log Pseudolikelihood	-2801.4965		-2794.6138		-2800.0788		-2799.9624		-2790.7432	
McFadden's R^2	0.135		0.137		0.135		0.135		0.138	
BIC	-29739.828		-29728.474		-29717.544		-29717.777		-29685.976	
Mean VIF	1.48		1.47		1.49		1.48		1.49	

Notes: * p<0.05; ** p<0.01; *** p<0.001. Standard errors are clustered at province level (103 units). Clustered robust standard errors in parentheses. Regressions also include a constant term. The base category is Domestic firms. Columns (1) refer to Exporters, columns (2) refer to TNEs. Coefficients and clustered robust standard errors for NUTS-1 and industry dummies are omitted, but are available from the authors upon request.

Analysis of the sub-population of small firms is interesting for two main reasons: first, small firms represent the largest part of the sample – about 70%; second, previous empirical evidence shows an increased importance of agglomeration externalities for micro and small firms in particular – see, e.g., BECCHETTI and ROSSI (2000) and DAMIJAN and KONINGS (2011).

Table 3 shows the results for the sub-population of small firms. In the complete model – i.e., the model that includes all the agglomeration variables – the coefficients of both specialisation and related variety are positive and highly significant for exporters, and not significant for TNEs, as in previous exercises. The coefficients of unrelated variety are positive and show small significance for TNEs only. This last result highlights that in order to engage in more complex internationalisation modes, the smallest firms need to be located in a highly diversified environment, that allows them to interact with different actors that can provide specific services as well as general economic activities.

These results highlight the greater importance of agglomeration externalities to small firms, which benefit more from location in a highly agglomerated area due mainly to their lack of resources and reduced organisational structure.

All the models shown in Table 3 are estimated including, besides the agglomeration variables, the same covariates included in the estimates for the whole population of firms. Results present some interesting differences. In relation to exporting, it seems that small firms' decisions to export are driven mainly by firm size, membership in an export consortium, the incentives received and the introduction of product and process innovations – both singularly and together. In relation to FDI mode, small firms' decisions to become multinationals are driven mainly by: productivity level, belonging to a business group, and introduction of both product and process innovations.

These results highlight the existence of an inverse relationship between the impact of agglomeration externalities on firms' internationalisation decisions and firm size. The smaller the firm, the greater the importance of being located in a highly agglomerated area. This result confirms previous findings.

Table 3: Determinants of the probability to export and to export and realise horizontal FDIs – small firms.

Dependent variable: Internationalisation mode										
	(Model-1)		(Model-2)		(Model-3)		(Model-4)		(Model-5)	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$SSI_{i,k,2001}$	...	...	0.545**	0.323	...	...	...	...	0.599***	0.283
			(0.166)	(0.599)					(0.161)	(0.662)
$RELVAR_{k,2001}$	...	...	...	...	0.901***	-1.209	...	...	0.971***	-2.455
					(0.247)	(1.234)			(0.250)	(1.660)
$UNRELVAR_{k,2001}$	...	...	...	...	...	...	0.306	3.089	0.287	4.768*
							(0.434)	(1.660)	(0.334)	(2.331)
TFP	0.166	0.801**	0.169	0.798**	0.152	0.800**	0.163	0.765**	0.153	0.750*
	(0.095)	(0.277)	(0.094)	(0.281)	(0.093)	(0.288)	(0.095)	(0.276)	(0.092)	(0.306)
Age	0.113	0.065	0.122	0.072	0.108	0.060	0.114	0.084	0.119	0.088
	(0.065)	(0.203)	(0.064)	(0.202)	(0.065)	(0.213)	(0.065)	(0.206)	(0.064)	(0.220)
Size	0.524***	0.329	0.521***	0.330	0.536***	0.298	0.525***	0.348	0.535***	0.317
	(0.085)	(0.338)	(0.084)	(0.341)	(0.084)	(0.342)	(0.085)	(0.341)	(0.083)	(0.343)
Group	-0.003	0.962**	0.017	0.975**	-0.004	0.931**	-0.002	1.017**	0.020	0.982*
	(0.143)	(0.362)	(0.145)	(0.370)	(0.145)	(0.361)	(0.143)	(0.362)	(0.147)	(0.390)
Export Consortium	2.037**	1.431	2.043**	1.430	2.092**	1.280	2.034**	1.378	2.094**	1.095
	(0.737)	(1.377)	(0.729)	(1.393)	(0.736)	(1.387)	(0.738)	(1.424)	(0.727)	(1.496)
Incentives	0.307**	0.757	0.297**	0.754	0.314**	0.748	0.308**	0.746	0.305**	0.700
	(0.112)	(0.441)	(0.114)	(0.445)	(0.112)	(0.442)	(0.111)	(0.441)	(0.114)	(0.444)
ICT	0.121	0.393	0.134	0.398	0.120	0.409	0.119	0.358	0.133	0.388
	(0.137)	(0.563)	(0.137)	(0.560)	(0.135)	(0.580)	(0.137)	(0.563)	(0.135)	(0.572)
R&D	-0.024	0.117	-0.026	0.119	-0.020	0.094	-0.021	0.148	-0.019	0.121
	(0.094)	(0.368)	(0.093)	(0.373)	(0.097)	(0.376)	(0.094)	(0.370)	(0.095)	(0.378)
Innovation	0.299***	0.904*	0.295***	0.904*	0.306***	0.864*	0.295***	0.901*	0.298***	0.853*
	(0.082)	(0.409)	(0.082)	(0.407)	(0.082)	(0.394)	(0.081)	(0.411)	(0.083)	(0.399)
Product Innovation	0.213*	0.080	0.203*	0.076	0.217*	0.101	0.212*	0.066	0.207*	0.114
	(0.102)	(0.750)	(0.101)	(0.753)	(0.102)	(0.733)	(0.102)	(0.757)	(0.101)	(0.738)
Process Innovation	0.385*	-0.414	0.379*	-0.422	0.396*	-0.430	0.385*	-0.452	0.389*	-0.506
	(0.155)	(1.115)	(0.155)	(1.110)	(0.155)	(1.119)	(0.155)	(1.089)	(0.156)	(1.071)
NUTS-1 dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Obs.	3,022		3,022		3,022		3,022		3,022	
Log Pseudolikelihood	-1969.6146		-1961.4195		-1963.8365		-1967.8343		-1951.5379	
McFadden's R^2	0.119		0.122		0.121		0.120		0.127	
BIC	-19412.617		-19404.966		-19400.132		-19392.137		-19376.647	
Mean VIF	1.45		1.45		1.46		1.46		1.47	

Notes: * p<0.05; ** p<0.01; *** p<0.001. Standard errors are clustered at province level (103 units). Clustered robust standard errors in parentheses. Regressions also include a constant term. The base category is Domestic firms. Columns (1) refer to Exporters, columns (2) refer to TNEs. Coefficients and clustered robust standard errors for NUTS-1 and industry dummies are omitted, but are available from the authors upon request.

To check the robustness of our results, the models in Tables 2 and 3 are estimated including agglomeration indicators calculated on 1991 employment data. This exercise allows to account for the dynamic nature of agglomeration economies (GLAESER *et al.*, 1992; HENDERSON *et al.*, 1995; NEFFKE, 2008), which is strictly linked to the life cycle of industries (NEFFKE *et al.*, 2011), and to test whether the strength of different sources of agglomeration externalities changes over time. It also allows to control for the presence of potential endogeneity (CAINELLI and IACOBUCCI, 2011), thus to ensure the correct direction of the causal relationship between agglomeration and firms' internationalisation decisions.

Table 4 reports the estimates of the complete models – i.e., the models that include all the agglomeration variables. These results show similarities to those obtained using the 2001 agglomeration variables. In the specification for the whole sample, only specialisation externalities have a positive and significant impact on firms' decisions to become exporters; they do not affect firms' decisions to engage in both exporting and horizontal FDI. The results for the specification for the sub-population of small firms suggest that both specialisation and related variety positively affect a firm's decision to become an exporter. Also, the inverse relationship between the impact of agglomeration externalities and firm size is confirmed.

Comparison between the results obtained using the 2001 and 1991 agglomeration variables highlights some changes in the magnitude to which different types of agglomeration externalities affect firms' internationalisation modes. In particular, both specialisation and Jacobs externalities have increased during the ten year period: the coefficients of the 2001 specialisation variable are higher than those of the 1991 variable, and the coefficients of the 2001 related variety variable show higher levels of significance than the coefficients of the 1991 variable.

These dynamics can be explained considering that firms tend ever more to externalise phases of their value chains, enabling more interactions with firms operating both in the same industry and in different industries. Hence, besides the well demonstrated, important role of intra-industry

spillovers, these results underline the increasing importance of inter-industry spillovers, especially for small firms.

Table 4: Robustness checks using 1991 agglomeration variables.

Dependent variable: Internationalisation mode				
	All firms		Small firms	
	(1)	(2)	(1)	(2)
$SSI_{i,k,1991}$	0.428**	0.106	0.576***	0.520
	(0.139)	(0.442)	(0.158)	(0.634)
$RELVAR_{k,1991}$	0.311	0.052	0.632*	-1.457
	(0.203)	(0.708)	(0.247)	(1.360)
$UNRELVAR_{k,1991}$	0.204	0.290	0.146	1.681
	(0.184)	(0.614)	(0.273)	(1.485)
TFP	0.225*	0.579*	0.154	0.751*
	(0.103)	(0.272)	(0.092)	(0.295)
Age	0.151*	0.202	0.115	0.076
	(0.062)	(0.132)	(0.064)	(0.218)
Size	0.413***	0.586***	0.535***	0.328
	(0.051)	(0.124)	(0.083)	(0.345)
Group	0.047	0.877***	0.014	0.988**
	(0.124)	(0.221)	(0.147)	(0.369)
Export Consortium	2.126**	2.876**	2.080**	1.263
	(0.737)	(1.021)	(0.731)	(1.476)
Incentives	0.355***	0.572	0.308**	0.735
	(0.081)	(0.307)	(0.114)	(0.439)
ICT	0.136	0.586	0.134	0.397
	(0.103)	(0.314)	(0.135)	(0.575)
R&D	0.108	0.586**	-0.022	0.122
	(0.081)	(0.203)	(0.096)	(0.379)
Innovation	0.303***	0.866**	0.302***	0.849*
	(0.090)	(0.303)	(0.083)	(0.395)
Product Innovation	0.228*	0.145	0.211*	0.086
	(0.095)	(0.451)	(0.101)	(0.741)
Process Innovation	0.226	-0.610	0.379*	-0.495
	(0.133)	(0.654)	(0.155)	(1.077)
NUTS-1 dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
No. Obs.	4,329		3,022	
Log Pseudolikelihood	-2792.761		-1955.4737	
McFadden's R^2	0.137		0.125	
BIC	-29681.94		-19368.776	
Mean VIF	1.51		1.49	

Notes: * p<0.05; ** p<0.01; *** p<0.001. Standard errors are clustered at province level (103 units). Clustered robust standard errors in parentheses. Regressions also include a constant term. The base category is Domestic firms. Columns (1) refer to Exporters, columns (2) refer to TNEs. Coefficients and clustered robust standard errors for NUTS-1 and industry dummies as well as specifications which include the agglomeration variables singularly are omitted, but are available from the authors upon request.

5. CONCLUSIONS

Using a large sample of Italian manufacturing firms for the period 2004-2006, this work empirically analyses whether firms' internationalisation choices are influenced by belonging to spatial concentrated areas from which knowledge spillovers and information flows arise.

First, it emerges that both specialisation and related variety have a positive and significant impact on exporting: this means that firms operating in specialised areas and firms in areas characterised by the presence of firms belonging to different but related industries, are able to acquire information about foreign markets and to internalise the experiential knowledge gained by already internationalised firms. Results suggest also that intra-industry spillovers play a greater role than inter-industry spillovers on firms' internationalisation decisions, although it seems that the importance of Jacobs externalities has increased over time.

Results show also that the FDI option is not influenced by forces external to the firm and internal to the local system: this means that firms generally do not engage in horizontal FDI as a consequence of an imitation process, because of the high fixed and sunk costs involved. An exception is represented by small sized firms, whose decision to engage in horizontal FDI is positively influenced by the diversity and un-relatedness of their local environment. It emerges also an inverse relationship between agglomeration externalities and firm size, i.e. the smaller the firms, the higher the impact of agglomeration externalities on their internationalisation decisions.

In summary, a better understanding of the influence of agglomeration forces on firms' internationalisation requires consideration of other forms of participation in international markets, in particular, non-equity forms. Moreover, a longitudinal analysis could help to determine the evolutionary dynamics of firms' internationalisation processes and how the impact of agglomeration economies changes over time.

APPENDIX

Table A.1: Sample distribution by industry.

Ateco 1991 two-digit level classification	No. of firms	
	a.v.	%
15 - Food and beverages	359	8.29
17 - Textiles	287	6.63
18 - Clothing	124	2.86
19 - Leather	156	3.60
20 - Wood	126	2.91
21 - Paper products	131	3.03
22 - Printing and publishing	150	3.47
23 - Cocke, oil refinery, nuclear fuel	14	0.32
24 - Chemicals	193	4.46
25 - Rubber and plastics	230	5.31
26 - Non-metals minerals	304	7.02
27 - Metals	161	3.72
28 - Metal products	687	15.87
29 - Non-electric machinery	629	14.53
30 - Office equipments and computers	19	0.44
31 - Electric machinery	178	4.11
32 - Electronic material	78	1.80
33 - Medical apparels and instruments	119	2.75
34 - Vehicles	62	1.43
35 - Other transportation	44	1.02
36 - Furniture	278	6.42
Total sample	4,329	100.00

Note: Percentage values are expressed on the cleaned total sample.

Table A.2: Descriptive statistics and correlation matrix of the agglomeration variables.

Variable	Unit	No. Obs.	Mean	Std. Dev.	Min	Max
[1]	Province	103	0.129	0.326	-0.973	0.923
[2]	Province	103	0.126	0.325	-1	0.927
[3]	Province	103	3.130	0.161	2.457	3.417
[4]	Province	103	3.148	0.196	2.606	3.494
[5]	Province	103	4.645	0.141	3.775	4.797
[6]	Province	103	4.660	0.190	3.511	4.874

	[1]	[2]	[3]	[4]	[5]	[6]
[1]	1					
[2]	0.951	1				
[3]	-0.063	0.047	1			
[4]	-0.031	0.074	0.950	1		
[5]	-0.045	-0.018	0.285	0.282	1	
[6]	-0.129	-0.057	0.483	0.468	0.920	1

[1] $SSI_{i,k,2001}$ [3] $RELVAR_{k,2001}$ [5] $UNRELVAR_{k,2001}$
[2] $SSI_{i,k,1991}$ [4] $RELVAR_{k,1991}$ [6] $UNRELVAR_{k,1991}$

NOTES

1. The empirical literature provides evidences on the relationship between agglomeration economies and (i) regional growth both in terms of employment growth and productivity (GLAESER *et al.*, 1992; DEKLE, 2002; PACI and USAI, 2006; FRENKEN *et al.*, 2007; NEFFKE, 2008; BOSCHMA and IAMMARINO, 2009), (ii) inward FDI (WHEELER and MODY, 1992; HEAD *et al.*, 1995, 1999; BARRY *et al.*, 2003; BRONZINI, 2007), (iii) innovation and technology adoption (ROSENBERG, 1982; HARRISON *et al.*, 1996; FELDMAN and AUDRETSCH, 1999; PACI and USAI, 2000; ANTONIETTI and CAINELLI, 2011), (iv) firms' vertical integration decision (HOLMES, 1999; LI and LU, 2009; CAINELLI and IACOBUCCI, 2011).

2. Industries are considered at the two-digit level of the Ateco 1991 sector classification (see Table A.1 in Appendix).

3. The TFP is estimated at firm level using the "levpet" Stata routine (PETRIN *et al.*, 2004). The balance sheet data used in the TFP estimation are: (i) value added deflated with the corresponding two-digit production price index as output; (ii) total cost of labour deflated with the corresponding two-digit wage index as labour input; (iii) the book value of tangible assets as capital input; (iv) raw materials and services consumption deflated with an intermediate consumptions index as intermediate input. All deflators are calculated using ISTAT data. Mean values over the period 2004-2006 of the estimated TFP (in logarithms) are included as regressors.

4. The three agglomeration variables are included in the regressions together in order to test the relative effect of different sources of agglomeration economies. This is possible because of the absence of correlation among the agglomeration variables; in fact, correlations are all < 0.47, when agglomeration indicators are calculated on both 2001 and 1991 employment data (see Table A.2 in Appendix).

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