Cluster and firms productivity:
the missing nexus

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aims

- Opening the agglomeration concept

- Consideration of the linkages between the two different levels of analysis: the micro-foundation of agglomeration economies

- Significance of the heterogeneity at both firms and spatial levels

- Application of multilevel model to economic data (micro/firm): MLM provides a practical tool to assess the extent to which a link exists between the macro level (region) and the micro level (firm)

- Introduction of agglomeration issues into multilevel approach

introduction

- Empirical studies in spatial economics have shown that **agglomeration economies my be a source of economic competitiveness** across regions (Dei Ottati, 2000). At the same time, agglomeration economies may affect the **irregular distribution of activities**.

- Different kinds of agglomeration economies are hypothesized to foster regional growth, however empirical researches highlight **ambiguous results** (Rosenthal and Strange, 2004; De Groot et al., 2009; Puga, 2010).

- Recent overview (van Oort et al., 2012) shows that the **heterogeneity issue** is a key element in term of scale of space, growth and aggregation definition. From our point of view, this should be introduced in firms' agglomeration studies, using hierarchical or multilevel model.

- **Multilevel modelling, which allows micro levels and macro levels to be modelled simultaneously**, is also suitable for reducing the ambiguity surrounding the agglomeration-firm performance relationship and for addressing spatial, sectorial and cross-level heterogeneity (Fazio e Piacentino, 2009).

Within this **new perspective** - that link firms agglomeration issues and multilevel approach -

we are interested in

the **importance of heterogeneity at both firm and regional levels**:

different types of agglomeration

may affect in various ways

the performance of different kinds of firms.

findings

- Addressing the **micro-macro level heterogeneity and interrelationships** (which types of firms profit from which types of agglomeration economies) is developed by **multilevel modeling** (MLM)

- The **importance of heterogeneity** -or cross level interaction- can be **explained efficiently using MLM**

- The **potential of multilevel model in agglomeration economies** and regional competitiveness studies is evident - and it should be more deeply investigated

Our application:

we use an application of multilevel model in Tessin (southern region of Switzerland)

as a context to analyze agglomeration economies and firm performance

based on firm level productivity.

main results

- Agglomeration economies are important within the regional competitiveness context (following a micro foundation approach);

however

- The **heterogeneity affects the relation** between firms' productivity and agglomeration economies:

  - *The relation between "urbanization economies" and firms' performance is qualitatively different for various levels of firm size*: ***only medium firms show a positive relation***
  - *The relation between "specialization economies" and firms' performance is qualitatively different for various level of firm size*: ***only medium firms show a positive relation***

- starting from the simple observation that "**agglomerated" firms share the same external environment (region**), **MLM provides a practical tool to assess the extent to which a link exists between the macro level (region) and the micro level (firm)**

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1. related literature review

AGGLOMERATION ECONOMIES

Starting from the pioneering contributions of Glaeser et al. (1992) and Henderson et al. (1995), the economic literature has shown an increasing interest on the theme of agglomeration economies – especially linked with regional competitiveness concept.

Focus on two main types of agglomeration externalities:

- MAR externalities (Glaeser et al., 1992);

- Jacobs externalities (Jacobs, 1969);

1. MAR (or specialization) Externalities

- They arise from the geographical concentration of firms belonging to the **same industry**, which:

  ✓ Allows communication and cooperation processes;

  ✓ Creates the basis for (i) the intra-industry transmission of knowledge, technology and information, (ii) the emergence of highly specialised markets for labour and intermediate inputs, (iii) the arising of forward and backward linkages in the production process.

- MAR (Marshall, 1920 - Arrow, 1962 - Romer, 1986) model: the industrial specialisation of a defined geographic area can promote knowledge spill-overs, incremental innovations and process innovations, thanks to the tacit transmission of information across agents.

2. Jacobs externalities

- They arise from the geographical concentration of firms belonging to different industries.

- Hence, from the **diversity and variety** of the regional economic structure.

- "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" (Jacobs, 1969, p. 59) =>

- => the variety of geographically concentrated industries, promoting the exchange and **cross-fertilisation** of existing ideas and technologies, facilitates radical innovations and product innovations.

- Idea of inter-industry transmission of knowledge.

	Type of externalities	Structure of the market	Transmission of spill-overs
MAR model (see Glaeser *et al.*, 1992)	Specialisation	Monopoly	Intra-industry
Jacobs (1969)	Diversification	Competition	Inter-industry
Porter (1990)	*Specialisation*	*Competition*	*Intra-industry*

empirical evidence

- Several works focus on the relationship between agglomeration and employment growth at the local level (using municipality as a unit).

- However, empirical results are inconclusive and often contrasting in assessing whether and how agglomeration produces positive, null or negative effects in terms of economic growth (Beaudry and Schiffauerova, 2009).

- Main contributions: Glaeser *et al.* (1992), Cainelli and Leoncini (1999), Combes (2000), Dekle (2002), Usai and Paci (2003), Cingano and Schivardi (2004), Paci and Usai (2008), Illy *et al.* (2011), Lasagni (2011).

- Main findings: in general, negative MAR externalities; less conclusive results on the impact of Jacobs and Porter externalities.

- A particularly novel feature in this literature is the **combination of traditional urban economics and regional science literature with new growth theory** (Romer, 1986, Lucas, 1988).

- The **MAR** models generally **predict a negative effect of local competition**, since the benefits of innovation cannot be fully captured and therefore innovative activities will be lower in a more competitive environment.

- **The missing link** that leads to the ambiguity in the research results on agglomeration economies may be the **relationship between agglomeration economies and individual firm performance**: although early studies examined the importance of firm-level performance in agglomerated contexts (Taylor and Asheim, 2001), until recently, the firm-level has not be treated systematically in urban and spatial economics (van Oort *et al.*, 2012).

- According to Martin *et al.* (2011), a remarkable issue in the literature relates to the fact that **many studies understand spatially bounded externalities as related to an enterprise's geographical (or network) context rather than to internal firm performance.**

2. the multilevel approach

- Many empirical studies on agglomeration use aggregate data, with cities or counties as the basic reference units. However, this approach can provide only limited insights of agglomeration economies' effects on firm performance.

- Regional-level relationships are not necessarily reproduced at the firm level because information on the variance between firms is lost when aggregated regional-level data are used (i.e. region with great number of agglomeration economies grows faster, this conclusion cannot be generalized to firms).

- Micro-macro problem known as "ecological fallacy" (Robinson, 1950) or "cross-level fallacy" (Alker, 1969). At the same time, strategic management literature addresses similar issues (Combes et al., 2008;Mion et Naticchioni, 2009 – spatial wages disparities; Baldwin and Okubu, 2006 – selection process of more productive firms)

- **MLM provides a practical tool to assess the extent to which a link exists between the macro level (region) and the micro level (firm)**

- In the **1980s** there were major developments in multilevel modelling by **statistical researchers**, especially those concerned with educational attainment (Aitkin and Longford, 1986; Goldstein, 1987).

- Building on the concepts of multiple regression model, it is possible to specify and estimate models at several different scales simultaneously, so that the parameters of a micro-model can be determined by a macro-model (Jones, 1991)

- This multi-level approach is highly flexible and allows a number of different technical and substantive problem areas (such as ecological fallacy, neighborhood effects and cross level inference) to be recast in a more meaningful and realistic framework

- Most importantly, multi level models do not oversimplify by forcing the world into one linear equation: they permit relationships to vary from place to place (and over time).

- Recently two branches of literature have focused on micro-macro relationships of firms in their relevant contexts using multilevel analysis (Goldstein, 2003; Moon et al. 2005):
    - *Urban economics, the connection between hierarchical multilevel model and standard spatial specifications*
    - *Strategic management, the interaction between firm performance and contexts (Beugelsdijk, 2007)*

- Our research considers aspects of specification and estimation of multilevel-models: beginning with simple regression and fixed parameters, the model is generalized to have slopes and intercepts that vary geographically in a TWO LEVEL MODEL
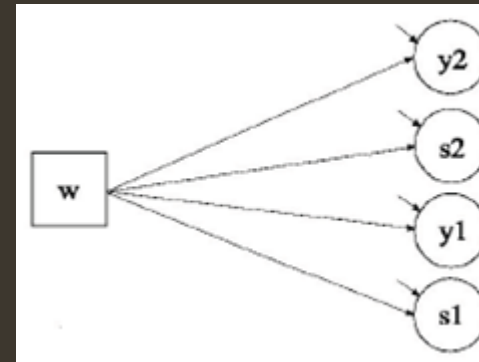
3. our model and data

- conceptual model
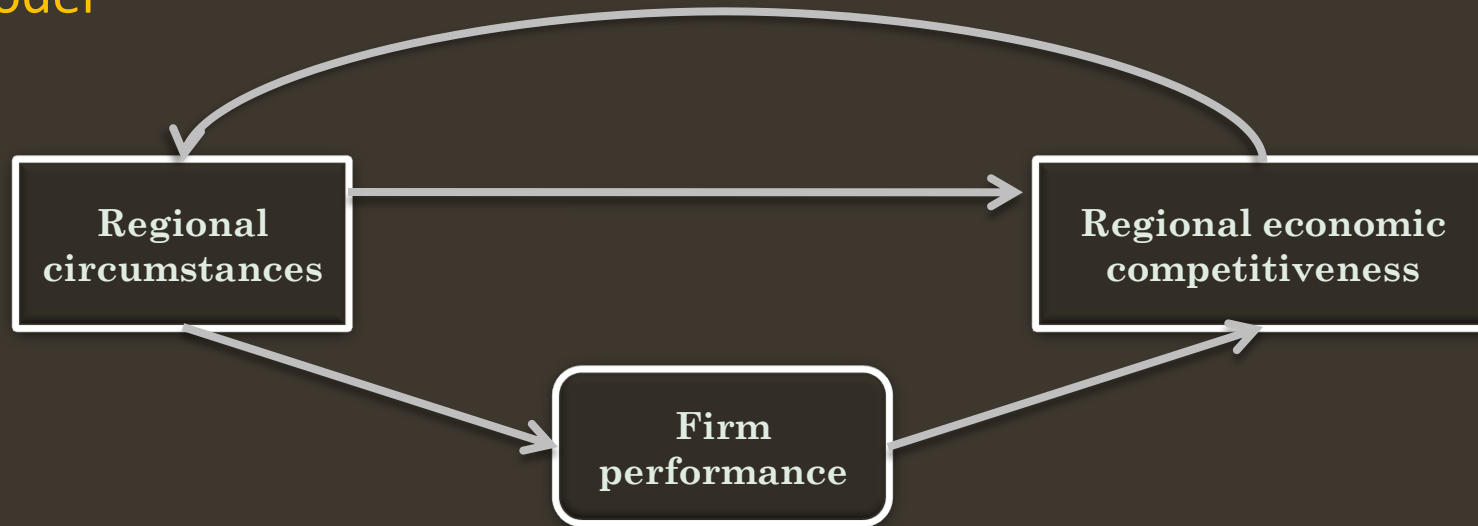
- multilevel model: two stages
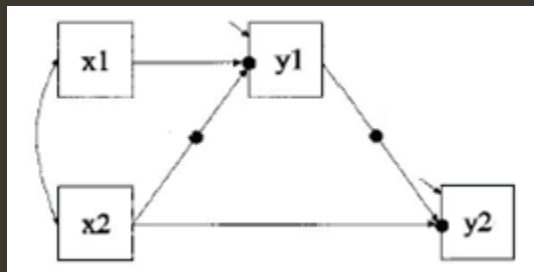
WITHIN REGION

BETWEEN REGIONS

We start from the **basic model at micro (firm) level** (1); we **insert the regional level** variables in "isolation" (2); we test firm and regional level variables **simultaneously** (3); finally we include **cross level interaction** (4).

- **four regions** in the Tessin Canton (Mendrisio, Lugano, Locarno e Bellinzona) - CH;
- target: 1200 enterprises → 24% response rate. Targeted at directors or owners at the establishment level.
- respondents: **288 firms stratified by sector, size and localization** (survey in 2012 – USI based on 2011 data).

Respondent profile

Size	Micro and small		Medium-large
Cycle of life	Starting point		Old
Investments	Low		High
Markets of revenues	Local		International
Innovation activity	low		high
Collaboration with research institutes and universities	low		high
R&D activity	low		high
Management strategy	Costs' control		Differentiation
Foresight activity	low		high

- **Firms' performance**: productivity in 2010 (added value of a firm per employee)
- **Firms' size**: revenues of the firms in 2010 (three classes 0-1.000.000 CHF; 1.000.000 to 15.000.000 CHF; + 15.000.000 CHF per year)

- Sector specification (NOGA08, 2 digit) selection of three sectors (importance, different structure)
- Age (life cycle) : two categories – young and mature -

- Two types of **agglomeration economies**:

a) "Urbanization"

$$JACOBS_{i,c}^{01} = \ln\left\{ 1 / \left[\sum_{\substack{j=1 \\ j \neq i}}^{J} \left(\frac{E_{j,c}^{01}}{E_c^{01} - E_{i,c}^{01}} \right)^2 \right] \right\}$$

b) Specialization (MAR externalities)

$$MAR_{i,c}^{01} = \ln\left(\frac{E_{i,c}^{01} / E_c^{01}}{E_{i,CH}^{01} / E_{CH}^{01}} \right)$$

4. main results

`Y= productivity of the firm`

| Variable	Model 1	Model 2	Model 3	Model 4
Firm level variables				
Size	0.29*** (0.02)		0.29***(0.03)	0.32*** (0.02)
Size 2	-0.19*** (0.00)		-0.19*** (0.00)	-0.04*** (0.01)
Sect-Chemicals/Pharma	0.10** (0.03)		0.10** (0.04)	0.10** (0.04)
Sect-Mechanical engineering	0.21 (0.06)		0.21 (0.06)	0.08* (0.02)
Sect-Textiles and clothing	-0.09** (0.04)		-0.09** (0.03)	-0.09** (0.03)
L.C. - young	0.08** (0.01)		0.08** (0.01)	0.08** (0.01)
L.C. - mature	-0.12*** (0.00)		-0.10*** (0.01)	-0.10*** (0.01)
Region-level variables				
Urbanization (Jacobs)		0.07 (0.04)	0.05 (0.03)	-0.09** (0.04)
Specialization (MAR)		0.11 (0.06)	-0.01 (0.06)	0.06 (0.06)
Cross-level interaction effects				
Size*Urbanization				-0.03** (0.01)
Size2*Urbanization				-0.01** (0.00)
Size*Specialization				-0.10** (0.03)
Size2*Specialization				-0.02*** (0.01)
Sect-Pharma*Specialization		0.01 (0.04)		0.06 (0.01)
Sect-Pharma*Urbanization		0.03 (0.02)		0.01** (0.00)
Constant	9.66*** (0.19)	9.21*** (0.32)	9.48*** (0.30)	9.33*** (0.30)
OBSERVATIONS	288	288	288	288
Number of regions	4	4	4	4
Industry fixed effects	yes	yes	yes	yes
R-squared region level	54.30%	26.50%	58.20%	59.90%
R-squared firm level	12.90%	0.90%	13.10%	14.20%
a)Standard errors in parentheses				
*p<0.100;**p<0.050;***p<0.001				

the effects of different types of agglomeration on firm performance are strongly and non linearly moderated by a firm's combinative capabilities

- MODEL 1: firm-level characteristics with a direct effect on firm performance (the performance effect is positive, but with diminishing returns for firms size).

- MODEL 2: we see that the two region-level variables (urbanization and specialization) have no effect on firms productivity when we evaluate their direct effect in isolation

- MODEL 3: the findings of model 1 and 2 remain confirmed when firm-level and regional-level variables are considered at the same time

- MODEL 4: (NB) shows a changed situation when cross level interaction effects are included→ the model fit improves at both regional and firm levels

- Observing the model 4 we see that: specialization (MAR) seems not significant, urbanization (Jacobs) is significant and positively correlated; the interaction between size and agglomeration effects is negatively related with firm performance;

- the interaction between "pharmaceutical" and urbanization effects is positively related with firm performance *(analysis under construction)*

## Results of the interaction effects between:

1) urbanization and productivity
Size*urbanization (-0.03)

2) specialization and productivity
Size*specialization (-0.10)
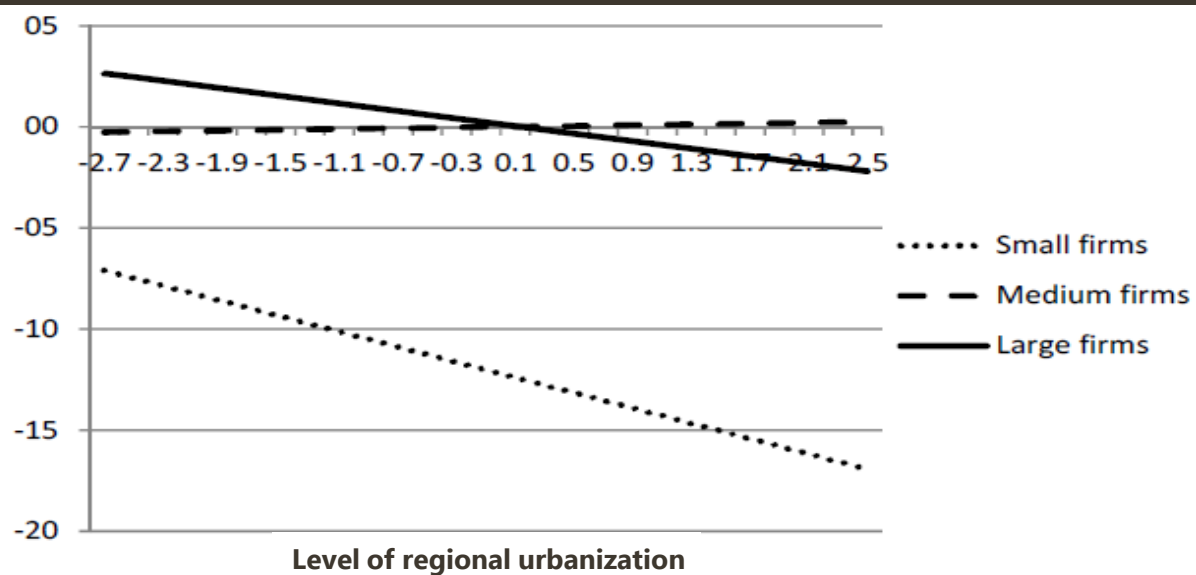
The relation between urbanization and performance is qualitatively different for different levels of firms size: the relation is positive for medium size, but negative for large and (especially) small firms.
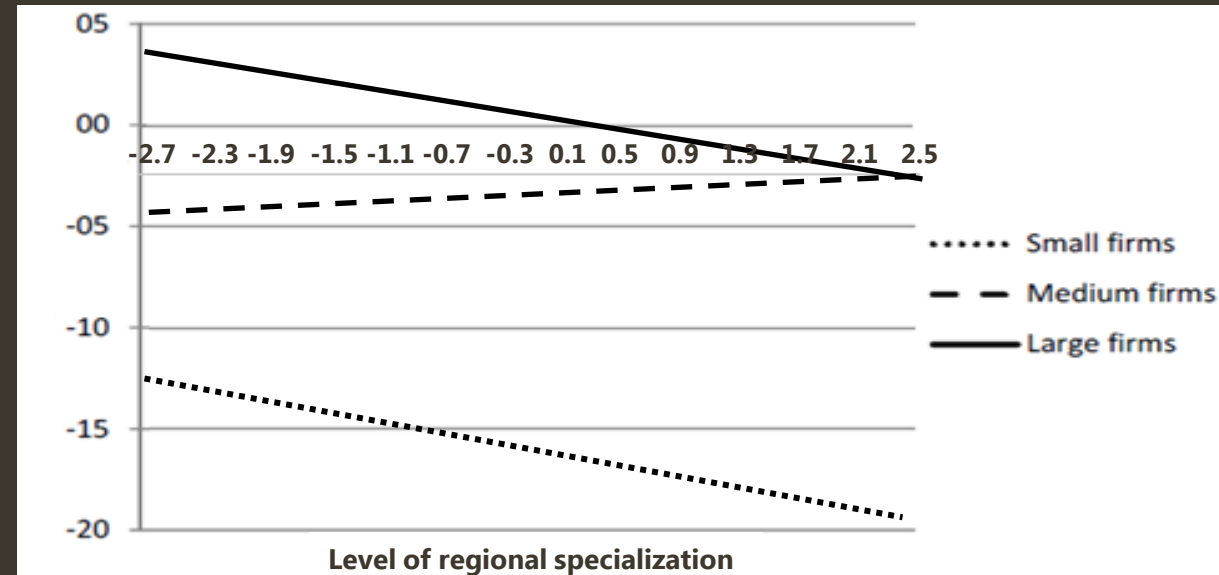
The relationship between specialization effect and firms' productivity is positive for medium firms, but negative for large and small firms (the negative intensity does not differ significantly)

4. conclusion

- The analysis suggests that the **specification of the model using Multilevel Analysis is the most useful in capturing the firm level heterogeneity in productivity** (confirming Fazio and Piacentino, 2010)

- The **effect of urbanization externalities on the firm productivity is positive** (the effect of MAR externalities is not significant)

- The observation of the **interaction effect** shows that the effect of urbanization and specialization externality may **vary across different firms size**: both the effects **are positive for medium firms**, but negative for large and (especially for) small firms (results in line with van Oort et al., 2012).

- The interaction between **urbanization economies** and **pharmaceutical** sector has a positive effect on **firm productivity**

- The results can explain why studies on a regional level find that outcomes of agglomeration economies and growth potentials can be ambiguous.

- The **Interclass Correlation Coefficient may be a useful tools to understand the firm productivity variance across different regions** (variation of the firm productivity: firm level characteristics and differences across territories).

limits and further research

- Multilevel analysis in spatial research: multilevel do not fully account for the spatial dependence present in data (it does not allow for the effect of neighboring regions on the performance of firm)
  - → spatially weighted independent variables in the model (Breslow and Clayton, 1993)
  - →conditional autoregressive multilevel model (Browne et al, 2001)

- This is a preliminary study based on small sample…:
  - →analyze the influence of interaction effects considering sectors specification and life cycle;
  - →test the model on larger sample (CH)
  - →test the model on different industrial organization system (i.e. Italy)

thanks for your attention

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