Agglomeration Economies and Firm Performance: A Mixed Hierarchical and Cross-Classified Model

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Abstract

Recent empirical urban economic studies convincingly show that agglomeration economies can be considered to be one of the sources of the uneven distribution of economic activities and economic growth across cities and regions. At the same time, there is still little known about the importance of agglomeration economies for the performance of firms. This is remarkably, since the theories that underlie agglomeration economies are microeconomic in nature In this study, we focus on the determinants of the survival of new firms in the advanced producer services sector in the Netherlands. Employing a mixed hierarchical and cross-classified probit regression, we introduce a model of firm survival and employment growth that is specific to characteristics of the internal and external environment of the firm. Controlling for firm and sector characteristics, we find that location accounts for about 4% of the variance in new firm performance. We obtain a positive effect of industrialization economies and a negative effect of urbanization economies on new firm survival. Also, we find a positive effect of urbanization economies and a negative effect of localization economies on new firm employment growth. Yet, new firms with a larger start-up size tend to profit more from agglomeration economies than new firms with a small start-up size.

Keywords: agglomeration economies, new firm survival and growth, multilevel analysis
JEL classification: C21, O18, R1

1. The Firm in the 'New Economics of Urban and Regional Growth'

Urban areas and industrial clusters are the sites where innovative economic developments take place. Urban and regional planners as well as geographers and economists are interested in the forces that build up, shape and maintain these concentrations of economic activities (Van Oort 2004). Since the early 1990s, a large empirical literature has emerged in the field of regional science and urban economics examining whether spatial circumstances give rise to agglomeration economies – external economies from which firms can benefit through co-location – that endogenously induce localized economic growth (e.g. Glaeser et al. 1992; Henderson et al. 1995; Combes 2000; Rosenthal and Strange 2003, Brülhart and Mathys, 2008). As this literature tends to combine the traditional urban economics and regional science literature with new growth theory (Romer 1986; Lucas 1988), Glaeser (2000) marks this strand of research the 'New Economics of Urban and Regional Growth'. Many of the empirical studies that fall under this heading convincingly show that agglomeration economies can be considered to be one of the sources of the uneven distribution of economic activities and economic growth across cities and regions. In their survey of the empirical literature on the benefits of agglomeration, Rosenthal and Strange (2004) point out that the elasticity of productivity to city and industry size typically ranges between 3% and 8%. However, the effect of agglomeration economies on localized economic growth generally differs across sectors, space, and time (Rosenthal and Strange 2004; McCann and Folta 2008; De Groot et al. 2009).

At the same time, there is still little known about the importance of agglomeration economies for the performance of firms (Acs and Armington 2004; Martin et al. 2008). As most empirical research on agglomeration uses aggregated data with cities or city-industries as basic reference unit, these studies provide only limited insights and weak support for the effect of agglomeration economies on firm performance. Regional level relationships are not

necessarily reproduced at the firm level because when using aggregated regional-level data, information on the existent variance between firms is lost. Hence, if regions endowed with more agglomeration economies grow faster, it cannot automatically be inferred that firms in regions endowed with more agglomeration economies grow faster. In the social sciences, this problem is referred to as 'ecological fallacy' (Robinson 1950) or 'cross-level fallacy' (Alker 1969).

In addition, agglomeration effects found in area-based studies may also be purely compositional (cf. Macintyre et al., 1993). For example, in the economic and industrial organization literature it is often argued that large firms have a higher likelihood to grow compared to small firms because of internal economies of scale. Hence, fast growing locations may be a result of the concentration of large firms within that area and not of the localization externalities or external economies of scale in that are present at that location. To complicate issues even further, Baldwin and Okubu (2008) theoretically show that agglomeration of productive firms might simply be a result of a spatial selection process in which more productive firms are drawn to denser economic areas. For this reason, it remains unclear whether geographical differences are an artefact of location characteristics (e.g., agglomeration economies) or simply caused by differential business-economic composition. This endogeneity problem makes it even more difficult to draw inferences about firms when using cities or regions as lowest unit of analysis.

Hitherto, only few studies have used firm level data to assess the effect of agglomeration economies on firm performance. Audretsch and Dohse (2007) find that German firms located in a knowledge-based cluster grow faster than firms located in a region less endowed with knowledge resources. Henderson (2003) considers the productivity effect of employment density in a plant's own county versus neighbouring counties. Including industry and time fixed effects, he finds for the high-tech industry that a 10% increase of

employment in a plant's own county increases the productivity of a plant with 0.8%. Using French firm level data (both manufacturing and services), Martin et al. (2008) find that a doubling of the size of the own sector increases firm productivity by 4-5%. Baldwin et al. (2008) find similar results for the effect of own industry size (in terms of buyer-supplier networks, labour market pooling and knowledge spillovers) on firm productivity in five broad manufacturing sectors in Canada. None of the above-mentioned studies finds an effect of city size on firm productivity.

Although the lack of firm-level evidence in the agglomeration economics literature can mainly be ascribed to data limitations and confidentiality restrictions, its absence is nevertheless 'disturbing' because the theories that underlie agglomeration economies are microeconomic in nature (Martin et al. 2008). In other words, agglomeration economies do not directly foster regional economic growth, but only indirectly through their effect on firm performance. In this study we focus on the determinants of the survival of new firms in the advanced producer services sector in the Netherlands. Employing a mixed hierarchical and cross-classified logistic regression, we introduce a model of firm survival that is specific to characteristics of the internal and external environment of the firm. This external environment may consist of several components, such as its location, sector or club (location-by-sector). We add to previous studies by 1) explicitly disentangling the location effect from the firm and sector effect, by 2) analysing whether firms asymmetrically benefit from agglomeration economies, and by 3) focusing on new firm survival and employment growth. Controlling for firm and sector characteristics, we find that location accounts for about 4% of the variance in new firm performance. We obtain a positive effect of industrialization economies and a negative effect of urbanization economies on new firm survival. Also, we find a positive effect of urbanization economies and a negative effect of localization

economies on new firm employment growth. Yet, new firms with a larger start-up size tend to profit more from agglomeration economies than new firms with a small start-up size.

2. The Macro to Micro Link in Agglomeration Economics

2.1 Agglomeration Economies

The origin of the agglomeration economies concept can be traced back to the end of the 19th century. At the fin de siècle, the neoclassical economist Alfred Marshall intended to overturn the pessimistic (but influential) predictions on the co-evolution of economic and population development made by Malthus and Ricardo by introducing some form of aggregate increasing returns for firms. In his seminal work, *Principles of Economics* (Book IV, Chapter X), Marshall (1890) mentions a number of cost-saving benefits or productivity gains external to a firm, from which a firm can benefit through co-location with other firms engaged in the same sort of business. Marshall considered these *agglomeration economies* to be uncontrollable and unregulable for a single firm and, above all, to be immobile or spatially constrained.

Where Marshall (1890) mainly focussed on the role of local knowledge spillovers, and the existence non-traded local inputs and a local specialist labour pool, Hoover (1948), Ohlin (1933) and Isard (1956) allocated the sources of agglomeration advantages into internal economies of scale and external economies of scale in the form of localization and urbanization economies. Internal increasing returns to scale may occur to a single firm due to production cost efficiencies realized by serving large markets, and as such, there is nothing inherently spatial in this concept other than that the existence of a single large firm in space implies a large local concentration of factor employment. On the other hand, external economies are qualitatively very different.

Whether due to firm size or a large initial number of local firms, a high level of local factor employment may allow the development of external economies within a group of local firms in a sector. These are termed *localization economies*. The strength of these local externalities is assumed to vary, so that these are stronger in some sectors and weaker in others (Duranton and Puga 2000). The associated economies of scale comprise factors that reduce the average cost of producing outputs in that locality. Following Marshall (1890), a spatially concentrated sector can exert a pull on (and uphold of) a large labour pool including workers with specialized training relevant for the industry. Obviously, this reduces search costs and increases flexibility in appointing and firing employees. Moreover, a sectoral concentration of economic activity attracts specialized suppliers to these areas, which in turn reduces transaction costs. Finally, agglomerated firms all engaged in the same sector can profit from knowledge spillovers, as geographical proximity to other actors facilitates the diffusion of new ideas or improvements related to products, technology and organization.

On the other hand, *urbanization economies* reflect external economies passed to enterprises as a result from savings from the large-scale operation of the agglomeration or city as a whole, and which are therefore independent from industry structure. Relatively more populous localities, or places more easily accessible to metropolitan areas, are also more likely to house universities, industry research laboratories, trade associations and other knowledge generating institutions. It is the dense presence of these institutions, which are not solely economic in character but also social, political and cultural, that support the production and absorption of know-how, stimulating innovative behaviour and differential rates of interregional growth (Harrison et al. 1997). However, too densely populated areas may also result in a dispersion of economic activities due to pollution, crime or high land prices. In this respect, one can speak of urbanization diseconomies.

Finally, *industrialization economies* or *activity-complex economies* (Stutz and De Souza 1998; Parr 2005) derive from the vertical and horizontal integration of the local economy or the clustering of related activities (compare Frenken et al. 2007) and are based on backward and forward linkages between industries. These cost-savings derive from efficient information flows, the ability to coordinate activities with suppliers and customers more easily (Parr 2002), lower transportation costs, and the joint utilization of the local industrial infrastructure. In this, spatial proximity between the economic actors potentially lowers the threshold of face-to-face interaction, which is necessary to transmit knowledge between the different types of firms (Ponds et al., 2007).

Agglomeration economies through localization, urbanization and industrialization are more complex in nature though than Marshall originally presented. Quigley (1998) for instance describes some additional features of agglomeration economies that are embedded in the categorisation but not recognised for their individual value. These firstly comprise scale economies or indivisibilities within a firm, that are the historical rationale for the existence of productivity growth in agglomerated industries in the first place (Isard 1956). In consumption terms, the existence of public goods leads to urban amenities. Cities function as ideal institutions for the development of social contacts corresponding to various kinds of social and cultural externalities (Florida 2002). Secondly, a reason why agglomeration economies may provide greater economic efficiency growth arises from potential reductions in transaction costs (Martin and Ottaviano 1999). A logical outcome of the interaction between urban economies and knowledge-based service industries 0 that become more important recently - is the growing importance of transactions-based explanations of local economic productivity growth (Castells 1989). Thirdly, Quigley points at the application of the law of large numbers to the possibility of fluctuations in the economy. Fluctuations in purchases of inputs are usually as imperfectly correlated across firms, as the sales of outputs are across

buyers. As such, less inventory holding is required due to the greater possibilities for the pooling of supplies.

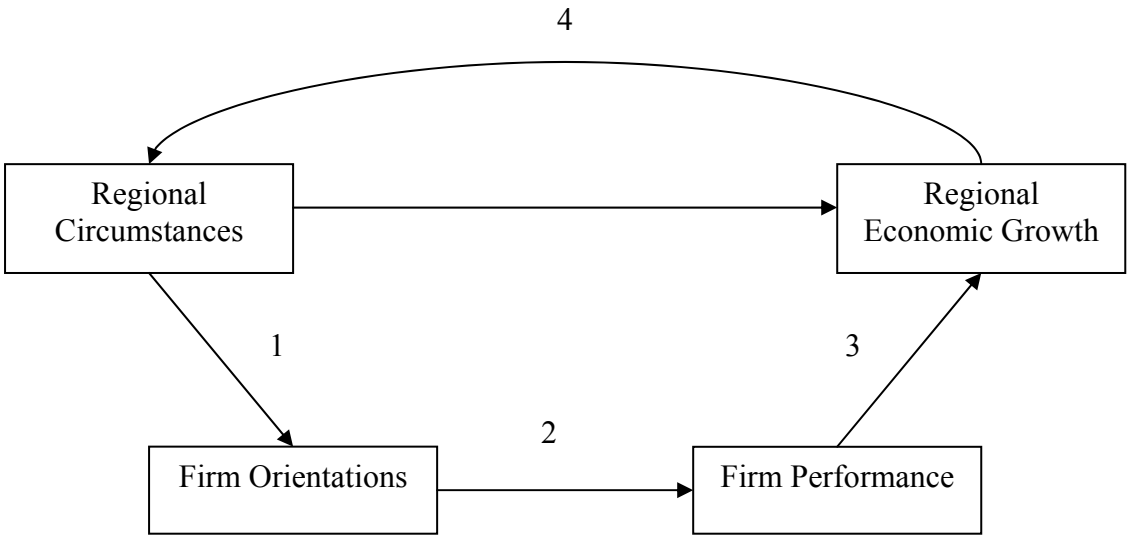
2.2. From Macro to Micro

Each of the features of agglomeration economies described above provides a possible rationale as to why regions characterized by agglomeration of economic activities will generally exhibit higher economic growth than regions without such features (McCann and Van Oort 2008). Despite the focus in the empirical literature on the relationship between agglomeration economies and regional growth as a macro-level phenomenon, it is obvious that the underlying theory of agglomeration contains both macro- and micro-level propositions (see also Rosenthal and Strange, 2004). Although these propositions begin and end at the urban or regional level, it actually recedes at the level of the individual firm. Coleman (1990) implicated this by of his bathtub model, entailing that system-level phenomena (e.g., agglomeration) influence system outcomes (e.g., regional economic performance) through their effect on firms' orientations and performance. In this, performance differences between regions cannot be perceived as a direct result of macro-economic differences between regions, but are a by-product of individual behaviour of firms.

Firms then are interest seeking agents, whose production function is partly determined by the region or city in which they are embedded through the opportunities (agglomeration economies) and constraints (agglomeration diseconomies) present in this external environment (Granovetter, 1985; Grabher, 1993). In turn, differences in opportunities and constraints across regions generate firm performance differences and hence regional performance differences. Yet, firms optimise their own performance but do not strive for regional growth. More explicitly (see Figure 1),

1. The region in which a firm is embedded generates opportunities and economic constraints for firms located in that region through agglomeration economies and agglomeration diseconomies (macro-to-micro transition).
2. Firms with more economic opportunities and less economic constraints (proposition 1) tend to perform better in terms of survival chances, employment growth or productivity growth (purposive action).
3. Regions with better performing firms (proposition 1 and 2) exhibit higher economic growth. Regional performance is here conceptualised as the weighted sum of the firms' performances (micro-to-macro transition).
4. The regional performance has in turn an effect on the regional circumstances, resulting in a feedback loop. In this fashion, the model can be linked to the evolutionary development of regions.

Figure 1: Macro- and micro-level propositions: effects of regional circumstances on regional economic growth.



Two general features of this theoretical model call for clarification. Firstly, the external environment of the firm not only consists of the location of the firm (physical environment), but also of other components such as the sector in which the firm is embedded (functional environment, cf. Lambooy, 1993). Firms nested within the same sector share for example the same technology and are to a large extent affected by the same product life cycle. Secondly, not all opportunities and constraints of firms are related to macro-level properties, such as initial firm size, age or entrepreneurship (Santarelli and Vivarelli, 2007). However, even when constraints and resources are firm-based, it often remains debatable to what extent their effect is independent of the external environment. In this paper, we focus on the first two propositions and examine to what extent the macro-micro link is existent in agglomeration economics. In other words, how important is location for the performance and survival of (which types of) firms.

3. Empirical Setting: New Firm Survival and Employment Growth in APS

In order to examine the relationship between agglomeration externalities and firm performance, we concentrate on the survival and employment growth of new firms in the advanced producer services sector. An obvious advantage of focusing on new firms is that these are less constrained by previous decisions, such as past capital instalments, which influences how they value the marginal worker and whether new employment is created (Rosenthal and Strange, 2003). In this fashion, we avoid endogeneity problems that are often present in analyses using 'old' establishments.

There are many indications from the empirical literature that new establishments tend to benefit from agglomeration. The potential of agglomeration for new establishments is not only considered in start-up rates and new establishment formation, but also assumed to be important for processes subsequent to entry such as employment and productivity growth

(Stam, 2005). Questioning whether these externalities bestow new entrepreneurial start-ups with any competitive advantage, Geroski (1995) puts forward that it is to be expected that growth and survival prospects of new firms will depend on their ability to learn from their environment, and to link changes in their strategic choices to the changing configuration of that environment. In line with this, Audretsch et al (2006) specifically find for new firms that opportunities for entrepreneurship, and therefore of knowledge-based start-ups, are superior when they are able to access externalities through geographic proximity to knowledge sources. Underlying arguments are that a new firm that must generate its own knowledge capital will be limited by scale and time. It has neither the resources nor the experience to generate ideas. But a new firm that uses external knowledge and ideas can leverage its own knowledge capital by standing on the shoulders of giants. In addition, for new firms the processes subsequent to the entry are important and survival is one of the main goals. In line with Audretsch and Mata (1995) we argue that survival (and later on growth processes) subsequent to the entry is at least as important as the entry process itself. The post-entry performance of firms sheds a light on the selection process of markets enabling some of the new entrants to survive and prosper, while others stagnate and ultimately exit.

Table 1: Sectors in APS used in analysis of new establishment

#	**Sector**
1	Warehousing and support activities for transportation
2	Publishing
3	Banks and insurance
4	Financial services
5	Real estate activities
6	Rental and leasing activities
7	Computer services activities
8	Information services activities
9	Legal services
10	Accounting
11	Market research
12	Advertising
13	Management consultancy activities
14	Architectural and engineering activities
15	Scientific and research activities
16	Employment activities

17	Office administrative, office and business support activities
18	Services to buildings
19	Telecommunication

Our selection of economic activities focuses on new firms in 19 advanced producer services sectors (see Table 1). Although we realize that agglomeration theory is originally based on the concentration of manufacturing, we argue that especially advanced business services are considered to profit form the concept of agglomeration, as these kind of activities involve economic activities which are intended to result in the creation, accumulation or dissemination of knowledge (Miles et al., 1995). Advanced producer services are characterised by their heavy reliance on professional knowledge, both codified-explicit and tacit-implicit. They can be considered a primary source of information and external knowledge; they can use their knowledge to produce intermediary services for their clients' production processes; and, they are typically supplied to business through strong supplier user interactions (Illeris, 1996; Muller and Zenker, 2001). The latter is supported in research by Bennett and Smith (2002), who find that customers of advanced producer services search a supplier within a radius of 25 kilometres.

4. Putting Theory into Practice: a Multilevel Framework

4.1. Exploring the macro to micro link

Whereas mainstream economics is still by and large concerned with single level models, in other disciplines (notably: sociology, geography, epidemiology) hierarchical or multilevel modelling, which allows for the simultaneous modelling of the micro- and macro-level, is becoming increasingly common practice. Recent overviews of area-based studies in relation to multilevel modelling can be found in Goldstein (2003) and Moon et al. (2005).

Following Jones (2003), there are two distinct advantages of multilevel models. First, multilevel models offer a natural way to assess *contextuality* or to what extent a link between the macro-level and micro-level is existent. Applying multilevel analysis to empirical work on agglomeration starts from the simple observation that firms that share the same external enviroment are more alike in their performance than firms that do not share the same external environment because of the common agglomeration externalities that are enjoyed. In this fashion, it can be assessed to what extent variance in the survival rates or employment growth of new firms can be attributed to between-firm variance, between-area variance, or between-sector variance (see also McGahan and Porter, 1998). Hence, we are able to assign the variability to the appropriate context (Bullen et al., 1997). Even though it is common in micro-economics to assess the impact of contextual variables on the individual level (see e.g., Henderson, 2003; Audretsch and Dohse, 2007), this still neglects the error terms at the contextual level and underestimates the standard errors of the parameters (Raudenbush and Bryk, 2002). This in turn can lead to spurious significant effects (Hox, 2002).

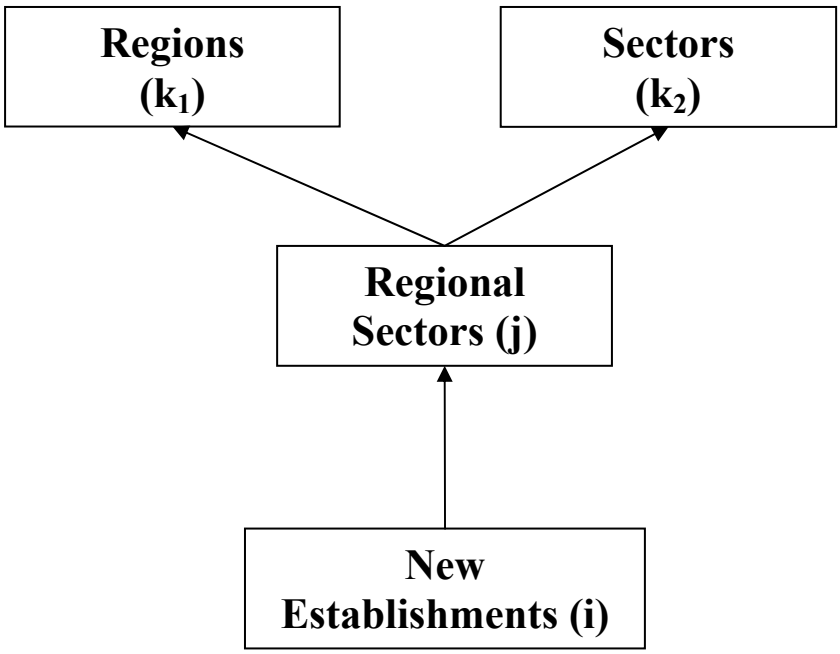
Second, multilevel analysis allows to incorporate heterogeneity into the model by having the possibility to let relations vary across contexts. Whereas 'standard' regression models are geared at modelling the mean, multilevel analysis explicitly focuses on modelling variances. For example, the effect of urbanization externalities may vary across small and large firms or across sectors. In a multilevel framework, it is possible to capture this kind of complexity by the inclusion of random coefficients (Snijders and Bosker, 1999).

4.2. A Mixed Hierarchical and Cross-Classified Model

Whereas multilevel analysis originally has been concerned with the modelling of hierarchically nested structures (e.g., firms in the same regions are also in the same country due to the nesting of the two levels), recently attention has been drawn to the modelling of

non-hierarchical or cross-classified structures as reality may in fact be more complicated. The external environment of the firm may consists of several components, like its region or sector. These classifications are non-hierarchical in nature as they are grouped along more than one dimension or cut across hierarchies (Goldstein, 2003): sectors are not nested in locations and regions are not nested in sectors. Hence, firms can be in the same sector, but located in different regions. Yet, all these different facets of the external environment of the firm may explain variation in firm performance and should therefore be simulatenously assessed in order to avoid underspecification of the model (Fielding and Goldstein, 2006).

Figure 2: A Mixed Hierarchical and Cross-Classified Model of the External Environment of New Establishments



In our model, we distinguish between three classifications: 1) labour market regions [40 NUTS3-regions], 2) sectors-by-regions (or clubs), and 3) sectors [19]. To begin with, firms may be affected by the region in which they are located. As indicated earlier on in this paper, these locational factors may be general (to which all firms in a given location are

exposed) or sector-specific (restricted to a subset of firms that are all nested within a given sector in that location). However, firms may also be affected by external factors that are not location-specific, but yet are common to all firms within a given sector. As the classification of clubs is intersected by the classification of the sectors and the classification of the locations, it cannot be independently estimated. Hence, we should disentangle the general location factors and the nation-wide sector-specific factors from the sector-specific factors that are spatially bounded. These sector-specific effects that are location-specific are assessed at the appropriate sector-by-area or 'club' level (cf. Gordon and McCann, 2000). Diagrammatically, we utilize a *mixed hierarchical and cross-classified model* as presented in Figure 2 in which we have a three-level model (with four classifications) with a random intercept for firms at the lowest level and random intercepts for regions, sectors-by-regions, and sectors at the higher levels.

More formally, we estimate the following base probit model for survival and employment growth (y_{ij}) of new establishments:

$$y_{ij(k1,k2)} = Binomial(n_{ij(k1,k2)}, \mu_{ij(k1,k2)})$$

$$probit(\mu_{ij(k1,k2)}) = X_{ij(k1,k2)}\beta + u_{0j} + v_{0k1} + v_{0k2}$$

, where $u_{0j} \sim N(0, \sigma^2_{u0j})$, $v_{0k1} \sim N(0, \sigma^2_{v0k1})$ and $v_{0k2} \sim N(0, \sigma^2_{v0k2})$ (1)

in which the probability of survival of firms or probability of employment growth $(\mu_{ij(k1,k2)})$ is explained by the single fixed intercept term β_{0ijk}, the average survival rate or employment growth rate and three separate random terms related to this intercept which mirror the remaining residual variation at the respective levels. Hence, the difference with a usual regression model is that we assume here that each region-by-section *j*, region *k*1 and sector *k*2

has a different intercept. Note the mixed hierarchical and cross-classified structure here, in the sense that the indexing structure $\mu_{ij(k_1,k_2)}$ refers to the i^{th} firm in the j^{th} club, that is nested in region k_1 and sector k_2. Using this null-model we can examine to which contexts variation in firm performance can be attributed.

In this, the Variance Partition Coefficient (VPC) can measure the extent to which the probability of survival and employment growth of new firms in the same club/region/sector resemble each other as compared to those from new firms in different clubs/regions/sector. This figure may also be interpreted as the proportion of the total residual variation in survival and employment growth that is due to differences between clubs, regions, or sectors. For example, the VPC for regions represents the percentage of variation explained by the region level differences for firm *i* in club *j* and sector *k2* (2).

$$VPC_{k1} = \sigma^2_{u_{0k1}} / (\sigma^2_{u_{0j}} + \sigma^2_{v_{0k1}} + \sigma^2_{v_{0k2}} + 1) \quad (2)$$

In which $\sigma^2_{u_{0j}}$ is the between-club variance, $\sigma^2_{u_{0k1}}$ is the between-region variance, and $\sigma^2_{u_{0k2}}$ is the between sector variance. In this, it is assumed that the probit distribution for the firm-level residual implies a variance of 1 (Goldstein, 2003).

4.3. Adding Predictor Variables and Accounting for Structural Instable Parameters

As yet, we only have partitioned the variability in survival of new firms over areas, sectors-by-areas, sectors, and firms. However, we can add predictor variables for these classifications, in order to see to what extent they explain the partitioned variability. More

specifically, the predictors (or fixed parameters) we add here contain measures related to the firm characteristics, region-by-sector characteristics and region characteristics. As we are mainly interested in the effects of regional and region-by-sector characteristics on firm performance, we include sector fixed effects (δ_{k2}) by means of dummy variables at the sector level. More formally (3),

$$y_{ijk1} = Binomial(n_{ijk1}, \mu_{ijk1})$$

$$probit(\mu_{ijk1}) = X_{ijk1}\beta_0 + \beta_{10}X_{pijk1} + \sum_{j=1}^{q}\beta_{q0}X_{qjk1} + \sum_{k1=1}^{r}\beta_{r0}X_{rk1} + \delta_{k2} + u_{1jk1}X_{pijk1}$$

$$+v_{1k1}X_{pijk1} + u_{0jk1} + v_{0k1}$$

$$\text{, where } u_{0j} \sim N(0, \sigma^2_{u0j}) \text{ and } v_{0k1} \sim N(0, \sigma^2_{v0k1}) \qquad (3)$$

In equation (3), the segment $\beta_{10}X_{1ijk1} + \sum_{j=1}^{q}\beta_{q0}X_{qjk1} + \sum_{k1=1}^{r}\beta_{r0}X_{rk1}$ contains the predictor variables X at the firm, club and regional level that enter the analysis, where q and r indicate the number of predictor variables included at the club and regional level respectively (with respect to the firm level, we only include firm size) and the β's denote the associated regression slope terms.

Equation (3) is a random intercept model as only the intercept varies across clubs and regions. However, regression coefficients may also vary across clubs and regions. Parameter estimates may be structural instable, in the sense that there is no fixed relationship between the dependent and independent variables, in the sense that intercepts and regression slopes may vary over observations. For example, the effect of localization, urbanization and

industrialization economies may vary over small and large firms. This can be modeled by means of a cross-level interaction between firm size (X_1) and the respective agglomeration economies. Including firm size as predictor variable at the firm level, we obtain the following equation (4).

$$y_{ijk1} = Binomial(n_{ijk1}, \mu_{ijk1})$$

$$probit(\mu_{ijk1}) = X_{ijk1}\beta_0 + \beta_{10}X_{1ijk1} + \sum_{j=1}^{q}\beta_{q0}X_{qjk1} + \sum_{k1=1}^{r}\beta_{r0}X_{rk1} + \delta_{k2} + \sum_{j=1}^{q}\beta_{q10}X_{1ijk1}X_{qjk1} +$$

$$\sum_{k1=1}^{r}\beta_{r10}X_{1ijk1}X_{rk1} + u_{1jk1}X_{1ijk1} + v_{1k1}X_{1ijk1} + u_{0jk1} + v_{0k1}$$

where $u_{0j} \sim N(0, \sigma^2_{u0j})$, $v_{0k1} \sim N(0, \sigma^2_{v0k1})$, $u_{0j} \sim N(0, \sigma^2_{u0j})$

In equation (4), $\sum_{j=1}^{q}\beta_{q10}X_{1ijk1}X_{qjk1} + \sum_{k1=1}^{r}\beta_{r10}X_{1ijk1}X_{rk1}$ represents the cross-level interaction between firm size and the club level variables and between firm size and region level variables respectively, while $u_{1jk1}X_{1ijk1} + v_{1k1}X_{1ijk1} + u_{0jk1} + v_{0k1}$ represents the random part of the model. In this, $u_{1jk1} + v_{1k1}$ are the random slope parameters that make the effect of firm size on the probability of survival or employment growth now dependent on the club and region in which the firm is embedded. The cross-level interactions that aim to explain the random slopes can be interpreted as the variation of the effect of the club and region variables across small and larger firms. In our analysis, we in particular focus on the interaction between firm size and the different agglomeration economies.

5. Data and Methodology

5.1. Data and Variables

Data on employment at the firm level was obtained from the LISA (*Landelijk Informatie Systeem Arbeidsplaatsen – National Information System of Employment*) database, an employment register which covers all establishments in the Netherlands for the period 1996-2006. For each firm, detailed information about its number of employees, economic activity (sector) and geographical position was available. Our first dependent variable, *SURVIVAL* (2000-2006) is a Boolean dummy variable measured at the level of the firm, which takes the vale 1 if a newly established firm in 2000 or 2001 survived the first five years of its existence. Our second dependent variable, *EMPLOYMENT GROWTH* is a Boolean dummy variable measured at the level of the firm which takes the vale 1 if an in 2000/01 newly established (and surviving) firm grows in terms of an increase in the number of employees in the first five years of its existence.

As indicated in our theoretical framework, we focus on three types of agglomeration economies: localization economies, urbanization economies and industrialization economies. *LOCALIZATION ECONOMIES*, or sector-specific scale economies, are defined at the location-by-sector level and measured as the concentration of own sector employment in the region under observation. *URBANIZATION ECONOMIES*, or economies available to all firms in a region irrespective of sector they are in, is defined at the region level and measured by the concentration of total employment and arising from urban size and density. Finally, *INDUSTRIALIZATION ECONOMIES* are defined at the regional level and defined as the concentration of knowledge-intensive manufacturing (NACE codes: 23, 24, 27, 29, 30, 31, 32, 33; Van Oort 2004), one of the most important customers of the advanced producer services sector. Of all these concentration variables, the natural logarithm is taken.

Besides indicators for the various agglomeration economies, control variables related to the firm, region-by-sector, and region are introduced. At the firm level we take *INITIAL*

FIRM SIZE into account, measured as the natural logarithm of the number of employees in the year of establishment. Size represents the economies of scale a (new) firm can have. Economies of scale, internal to the firm, refer to the fact that the unit costs of production are a decreasing function of output. With respect to the region-by-sector (club) level, *AVERAGE ESTABLISHMENT SIZE* (in a sector in a region) and *TURNOVER* (entrance and shake-outs) are introduced to control for competition and market structure. *AVERAGE ESTABLISHMENT SIZE* is measured as the natural logarithm of the number of establishment per worker in a regional sector. *TURNOVER* is measured as the natural logarithm of the number of entries and exits in the regional sector between 2000 and 2006 divided by the number of firms in 2000. Finally, we take *WAGES* as a control variable for localised growth potentials into account at the regional level (compare Gould, 2007 and Van Oort, 2004), which is specified as the natural logarithm of the average income per worker in 2000.

5.2. Estimation Strategy

The mixed hierarchical and cross-classified models specified in the previous section are estimated using the MLWIN 2.10 software (Rasbash et al., 2008). More specifically, we estimate six models. First, we estimate two random intercept probit models (equation 1) for survival and employment growth without including any predictor variables. From these models the VPCs (equation 2) can be derived, which serve as a tool to give an indication to what extent location matters by explicitly disentangling the between location variance from the between firm and between sector variance. These cross-classified probit models are estimated using the Markov Chain Monte Carlo algorithm using Gibbs sampling. Second, we estimate two random intercept probit models (equation 3), to assess the importance of the different types of agglomeration economies on new establishment survival and employment growth. Third, we estimate two random coefficient models to assess whether the effect of

agglomeration economies varies across firms of different sizes. Models 3 to 6 are estimated using a restricted iterative generalised least squares estimation (RIGLS) using a second-order PQL estimation (Breslow and Clayton, 1993; Goldstein and Rasbash, 1996).

With respect to the analyses on employment growth, we face the problem of panel attrition by non-survival. Especially since we know that new entry's are highly correlated with exit rates (Geroski 1995). Firms that do not survive, although, do inhabit information on the missing dependent variable. Possible disturbance in the estimations of the growth coefficients related to this selection bias occurs when characteristics of non-survival are related to firm growth. We control for this selection bias by applying a *two-step Heckman procedure*: first a probit estimate of survival from the whole sample (survivors and non-survivors) is made and second a growth estimation for the selected sample of survivors using the Inverse Mill's ratio (*LAMBDA*) obtained form the first step as a correction factor (Heckman, 1976). This ratio is a summarizing measure that reflects the effects of all unmeasured characteristics, which are related to firm survival, and catches the part of the non-survivors effect, which is related to growth. This means that the growth models are *unconditional* on survival. An important condition for this estimation procedure is that to avoid multicollinearity problems the selection equation contains at least one variable that is not related to the dependent variable in the substantial (growth) equation. In our analysis, we include *TURNOVER* at the club level as an indicator of sector-by-region differences in the chance to survive. Because this indicator has no clear theoretical and empirical relation with individual new establishment employment growth but a clear relation with new establishment survival, this variable is used as an instrument.

6. Empirical Results

6.1. Partitioning the Variance

As indicated in the previous paragraph, one of the advantages of multilevel modelling is the decomposition of the variance, in our case into three classifications: 1) regions, 2) sectors-by-regions (or clubs), and 3) sectors. In this, the Variance Partition Coefficient (VPC), measures the extent to which the probability of survival and employment growth of new firms in the same club/region/sector resemble each other as compared to those from new firms in different clubs/regions/sector. Although the VPC is mainly a descriptive tool, it provides insights to what extent the region or sector matter for the performance of firms compared to firm characteristics. In empirical research on firm performance, the use of variance decomposition analysis dates back to the work of Schmalensee (1985), who disentangled sector and corporate effects from business unit effects. In the present day and age, this has amounted in a large empirical literature in industrial organization, which particularly focuses on whether the firm or the industry is the appropriate unit of analysis (see e.g., Rumelt, 1991; McGahan and Porter, 1997). However, location remains and understudied factor in this type of analysis.

Table 1: Variance Partition Coefficients (VPCs) for Survival and Employment Growth of New Establishments

	Model 1 Survival	**Model 2 Employment Growth**
VPC (firm) - between firm variance	90.9%	93.7%
VPC (club) – between club variance	1.3%	0.8%
VPC (region) – between region variance	3.3%	2.5%
VPC (sector) – between sector variance	4.5%	3.0%
Total	100%	100%
N	46038	27133

Table 1 shows the proportion of the total residual variation in new firm survival and employment growth in the advanced producer services sector that is due to differences between clubs, regions, or (sub)sectors. From this table it can be concluded that firm

performance (survival and growth) is mainly affected by firm internal characteristics. More than 90% of the total variance is between firm variance. The between-region variance is round and about 3%, while the between-club variance is about 1%. Hence, it can be argued that the location effect explains about (3+1) 4% of the variation in firm performance. Although the external environment explains only a marginal amount of the variation in firm performance, it can still be argued that the region contributes to firm performance as a solitary factor taken into account the enormous between-firm heterogeneity (even within the advanced producer services sector). As we defined agglomeration economies as both regional (urbanization and industrialization economies) and club (localization economies) related, we argue that those externalities potentially (maximum) 'explain' round and about 3-4% of the variance in firm performance of new firms. In the next paragraph, we model the individual contributions of these agglomeration variables to both firm survival and employment growth

6.2. Agglomeration Economies and New Firm Survival and Employment Growth

Table 2 shows the results of our model estimates. Model 3 is the probit model on survival and model 4 the unconditional employment growth afterwards, the second step in a Heckman procedure (*HECKIT*). Although often it is assumed that larger firms also have more survival opportunities (due to downscaling possibilities), for new firms we do not find such an effect. It can be argued that our 'sample' of new firms mainly consists of smaller firms and that the heterogeneity of size in relation to survival is relatively low. This is in contrast with other studies, which find a positive relation between size and survival for incumbent firms (see for example Audretsch and Dohse (2007) and Raspe and Van Oort (2008)). With respect to employment growth of new firms, we find a positive and significant relationship between start-up size and post-entry growth. This is in line with arguments of 'economies of scale' as put forward in the literature, in which it is argued that small firms have to overcome costs

disadvantages contrary to larger firms. Due to 'internal economies of scale', causing a reduction in per unit costs over the number of units produced, efficiency advantages and hence growth potential emerge from larger firm sizes.

As in our study the magnifying glass is on the effect of the region on firm performance, we now turn to the effect of the agglomeration economies on new firm performance in the advanced producer services sector. From the previous section, it could be obtained that there exists a 'solitaire spatial effect' (controlled for possible endogeneity fallacies and holding on the micro-level of the firm). However, this effect of location on firm performance is complex in form. First of all, it can be obtained that the concentration of own sector employment (localization economies) does *not* have an effect on new firm survival, while it has a *negative* impact on the unconditional employment growth. An increase in the own sector employment of 1% decreases the probability of employment growth by 0.12 percentage points. Although the literature on externalities often assumes that especially smaller firms or new firms benefit more from external information sources (which are therefore size related, see Kelley and Helper 1999), we find an opposite effect: new firms do not profit from localization externalities related to specialization. This discrepancy can be explained by the fact that it may take a while before new firms (build up networks and) profit from this cluster effect.

The urban density effect, stemming from urbanization economies, on the other hand has a significant and positive effect on new firm employment growth. New firms located in urban dense regions generally experience higher employment growth. An increase in urban density of 1% increases the probability that a firm in the advanced producer services sector will grow in the first five years of its existence by 0.23 percentage points. However, at the same time we find a significant and negative effect of urban density on survival opportunities. Every 1% increase in urban density multiplies the probability of survival by a

factor of about 0.17 percentage points. From this, it can be concluded that new firms in the advanced producer services sector have more difficulties to survive in cities. Yet, when they succeed and survive, their growth rates are significantly higher due to this 'concentration of total employment' effect.

With respect to industrialization economies, we find that the concentration of knowledge-intensive manufacturing has a significant and positive effect on new firm survival, but *not* on new firm employment growth. For new firms in the advanced producer services sector, it is important to be located near a large amount of important buyers of their services since this market effect has an impact on the potential to stay in business.

What we can learn from our empirical tests is that although firm performance is enhanced by spatially bounded externalities, the different types of agglomeration effects work out quite differently for both survival and growth. Most robust and significant are the effects stemming from *urbanization economies*. Agglomerations in general serve as a mechanism of excluding those entrants that are unable to adjust successfully, but once they survived and are able to adjust to market demands, the same context promotes growth. This effect is controlled for more specific 'competition' factors, meaning that urbanization economies have their own impact.

Table 2: Multilevel 2SLS Probit on New Firm Survival and Employment Growth

	Model 3 - *PROBIT* Survival	**Model 4 - *HECKIT* Employment Growth**
Fixed part		
Intercept	4.041 (4.535)	-2.918 (3.870)
Initial Establishment Size (ln)	0.011 (.007)	0.291 *** (.027)
Localization Economies (ln)	0.002 (.034)	-0.119 *** (.030)
Average Establishment Size (ln)	-0.001 (.041)	0.158 *** (.041)
Turnover (ln)	-0.086 * (.051)	-
Urbanization Economies (ln)	-0.173 ** (.086)	0.239 ** (.112)
Industrialization Economies (ln)	0.155 ** (.067)	-0.054 (.095)
Wages (ln)	-0.313 (.446)	0.140 (.325)
LAMBDA		-0.813 (0.960)
Random part		
u_{ojk1}	0.015 (.003)	0.007 (.003)
v_{ok1}	0.028 (.007)	0.014 (.004)
Sector fixed effects	Yes	Yes
Observations	46038	27133
* p<0.10, ** p< 0.05, ***p<0.01		

6.3. Varying Effects of Agglomeration across Small and Larger Firms

Focusing on the effect of agglomeration externalities, we analyzed whether there is a positive relationship between agglomeration economies and firm performance in terms of new firm survival and employment growth. Yet, this relationship might not be a fixed relationship over all regions ('fixed' meaning that it does not vary over regions). We argue that some firms (based on firm-specific characteristics) can profit more than other, or that externalities only appear for some type of firms. In this section we therefore test for so-called 'cross-level

interaction effects': interactions between variables measured at hierarchically structured data on different levels (Hox 2002). We mainly focus on initial firm size, analyzing the possibility that agglomeration economies are mainly effective for the larger start-ups.

It appears that initial firm size indeed has a significant slope variance (the basic underlying condition for the existence of cross-level interaction effects). Table 2 shows the results of the random coefficient models where we allowed for the possibility that the effect of initial firm size can vary from region to region (regions have different slopes), including interaction effect on size and localization, urbanization and industrialization economies.

The random part in table 2 shows that the covariance between the region's intercept and slope, though, is significant and *positive*. This positive covariance suggests that a higher intercept is associated with a higher slope. In other words, larger firms perform better in some regions, or their counterpart smaller firms are less performing in some regions. The question now is whether the different agglomeration economies do influence this relationship. To test this, we take the cross-level interaction effects into account. Concerning employment growth, we find that the interaction-effect between initial establishment size and localization economies is significant, but *negative*, while the interaction-effect between initial establishment size and industrialization economies is significant and *positive*. The first means that especially *smaller* start-ups profit from proximity to a concentration of own sector employment, and not their larger counterparts. The latter means that especially *larger* start-ups profit from industrialization economies. Proximity to specialized buyers is profitable for growth, mainly for the larger new firms.

Table 3: Multilevel 2SLS Probit on New Firm Survival and Employment Growth

	Model 5 - *PROBIT* Survival	**Model 6 - *HECKIT* Employment Growth**
Fixed part		
Intercept	5.380 (4.327)	-2.450 (3.567)
Initial Establishment Size (ln)	0.041 ** (.019)	0.286 *** (.021)
Localization Economies (ln)	0.002 (.034)	-0.102 *** (.034)
Average Establishment Size (ln)	0.001 (.041)	0.142 *** (.042)
Turnover (ln)	-0.091 * (.052)	-
Urbanization Economies (ln)	-0.166 ** (.083)	0.192 (.123)
Industrialization Economies (ln)	0.158 ** (.065)	-0.054 (.095)
Wages (ln)	-0.449 (.425)	0.140 (.325)
LAMBDA		-0.470 (0.967)
*Est. Size * Localization Economies*	0.035 ** (.014)	-0.032 ** (.016)
*Est. Size * Urbanization Economies*	-	-
*Est. Size * Industrialization Economies*	-	0.066 ** (.027)
Random part		
u_{ojk1}	0.016 (.003)	0.022 (.007)
u_{ojk1}	0.008 (.003)	0.006 (.003)
v_{1k1}	0.036 (.009)	0.041 (.010)
v_{1k1}	0.009 (.002)	0.024 (.005)
Sector fixed effects	Yes	Yes
Observations	46038	27133

* p<0.10, ** p< 0.05, ***p<0.01
Insignificant cross-level interactions were omitted from the analysis

Overall we conclude that firm size (internal economies of scale) is important for firm performance: larger new firms have higher growth rates compared to smaller ones. But this

size effect is also differently related to agglomeration economies. The enhancing effect of external economies turns out to be effective for smaller new firms according to localization economies, and for larger firms according to industrialization economies.

7. Conclusions and Discussion

A large empirical literature examines whether spatial circumstances give rise to agglomeration economies – external economies from which firms can benefit through co-location – that endogenously induce localized economic growth. Many of the empirical studies convincingly show that agglomeration economies can be considered to be one of the sources of the uneven distribution of economic activities and economic growth across cities and regions. At the same time, there is still little known about the importance of agglomeration economies for the performance of firms. This absence is 'disturbing' because the theories that underlie agglomeration economies are microeconomic in nature. Agglomeration economies do not directly foster regional economic growth, but only indirectly through their effect on firm performance. In this paper we focused on the determinants of the survival and growth of new firms in the advanced producer services sector in the Netherlands to show this relationship. Previous studies do not capture this issue optimally.

Employing a mixed hierarchical and cross-classified logistic regression, we introduced a model of firm survival that is specific to characteristics of the internal and external environment of the firm. This external environment consists of several components, such as its location, sector or club (location-by-sector). Controlling for firm and sector characteristics, we find that location accounts for about 4% of the variance in new firm performance (survival and/or growth).

We do not find evidence for the widespread hypothesis that larger firms also have more survival opportunities. In line with arguments of 'economies of scale', in which it is argued that small firms have to overcome costs disadvantages contrary to larger firms, we do find a positive and significant relationship between start-up size and post-entry growth. The agglomeration externalities, defined on the regional and region-by-sector (club) levels, perform unevenly and complex in relation to survival and (subsequent) growth of new producer service firms. Localization economies do *not* have an effect on new firm survival, while it has a *negative* impact on the unconditional employment growth. The urban density effect stemming from urbanization economies, on the other hand, has a significant and positive effect on new firm employment growth, and a significant and negative effect on survival opportunities. New firms in the advanced producer services sector have more difficulties to survive in cities. Yet, when they succeed and survive, their growth rates are significantly higher in urbanised areas. With respect to industrialization economies, we find that the concentration of knowledge-intensive manufacturing has a significant and positive effect on new firm survival, but not on new firm employment growth. Introducing cross-level interaction effects in our models, we find that especially smaller start-ups profit from proximity to a concentration of own sector employment, and that especially larger start-ups profit from industrialization economies.

These outcomes have implications for policymakers: do not expect miracles. Regional and sectoral conditions have a significant but relatively limited impact on business service firms' survival and growth chances. Common and popular policies aiming at stimulating spatial producer service clusters (defined as clubs of region-sectoral specific concentrations) potentially enhance growth among the segment of the smallest start-ups only. Larger urban areas exhibiting potentially larger urbanisation economies have a more robust and distinctive impact on employment growth of new (surviving) business firms. This suggests that localized

policy measures should be refrained from areas outside these largest economic agglomerations.

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