

DOCUMENTOS DEPARTAMENTO DE ECONOMÍA

Internal Management and Agglomeration in the Performance of Colombian Manufacturing Companies

> José Antonio Mola Ávila Miguel Atienza Úbeda



Vigilada Mineducación

Serie Documentos n.º 51

Marzo de 2023

ISSN 0121-2346

٠

Internal Management and Agglomeration in the Performance of Colombian Manufacturing Companies

•

José Antonio Mola Ávila Miguel Atienza Úbeda Serie Documentos, 51 Marzo de 2023

La serie *Documentos* del Departamento de Economía de la Universidad del Norte circula con el fin de difundir y promover las investigaciones realizadas en Uninorte, y también aquel resultado de la colaboración con académicos e investigadores vinculados a otras instituciones. Los artículos no han sido evaluados por pares, ni están sujetos a ningún tipo de evaluación formal por parte del equipo editorial.

Se autoriza la reproducción parcial de su contenido siempre y cuando se cite la fuente, y se solicite autorización a sus autores. Los conceptos expresados son de responsabilidad exclusiva de sus autores, y no representan la visión de la Universidad del Norte.



Vigilada Mineducación

Universidad del Norte Departamento de Economía Apartado aéreo 1569 Barranquilla, Colombia

Internal Management and Agglomeration in the Performance of Colombian

Manufacturing Companies

José Antonio Mola Ávila Department of Economics Universidad del Norte, Colombia Km. 5 vía, Puerto Colombia 081008 + 57-5-3509509, Ext 4868 E-Mail: jmolaa@uninorte.edu.co

Miguel Atienza Úbeda Department of Economics Universidad Católica del Norte, Chile Angamos 0610, Antofagasta 1240000 +56–55–355883 Email: miatien@ucn.cl

Key words: Resource Based View, Productive Resources, Corporate Management, Agglomeration Economies, Cumulative Causation.

Acknowledgment: We would like to thank the Regional Science Master's Thesis seminar students for their feedback. A special thanks also to Marcelo Lufín for his valuable insight during the creation of this paper.

Abstract

The study of agglomeration economies has traditionally neglected its relationship with a company's management practices. Using Penrose's (1959) resource—based theory and the general postulates regarding agglomeration economies, we show that the size of the agglomeration affects corporate management, the advantages of agglomeration economies depend on the quality and quantity of a company's productive services, and that corporate performance reinforces agglomeration economies. In order to verify this, we estimate a structural equation model for the Colombian manufacturing industry for the time period between 1995 and 2014. We analyze the relationship between the level of agglomeration and companies' management practices and how these affect profitability, value generation, and other performance related variables tied to management such as financing, liquidity and indebtedness.

INTRODUCTION

The analysis of agglomeration economies has tended to focus on its aggregate effect on business productivity, understanding these economies as external to the firm and related to the industry or the agglomeration itself rather than to specific characteristics of the firm (Andersson and Lööf, 2011; Folta, Cooper and Baik, 2006; Moretti, 2004; Parr, 2002; Pe'er and Keil, 2013). That means that the agglomeration effect over firm performance is homogeneous, being their main critique (Hansen and Wernerfelt, 1989; McCann and Folta, 2011), because this depends, for example, on the quantity and quality of productive services that each firm has and how these are managed (Penrose, 1959), and by the absorption capacity of the firm (Boschma, Eriksson and Lindgren, 2009; Cohen and Levinthal, 1990; Kogut and Zander, 1992; McCann and Folta, 2011; Todorova and Durisin, 2007). In this paper we analyze how agglomeration affects firm's management and how firms' productive endowments affect what is obtained from the agglomeration. Also, we show how corporate performance reinforces agglomeration economies, as Myrdal (1957) and Hirschman (1961) explained. We propose structural equation model in order to improve our understanding on how the interdependence between the endowment and productive capacity of the company and its environment works.

For that purpose we use Penrose's (1959) resource—based theory, considerated influential and seminal works in this topic (Kor and Mahoney, 2004; Rugman and Verbeke, 2002), and the literature pertaining to agglomeration economies. We selected Penrose's work for two conceptual reasons that make compatible both theoretical approaches, and let us to propose a more realistic theory. The first, the firm is time—variant through growth process (Nelson and Winter, 1982). Second, the companies not only alter the environmental conditions via their actions, but that they do so because they know they can adjust them to their convenience and because they know that their activities are not independent of the environment. However, Penrose focuses on identifying the sources of growth inherent to the firm, assuming a fix environment. This knowledge gap is addressed in our paper adding agglomeration economies effects on Penrose's theory.

Relaxing Penrose's assumption regarding the business environment as a fixed "image" is consistent with studies that found evidence of agglomeration effects once organizational characteristics of the company were controlled for (Hansen and Wernerfelt, 1989, McCann and Folta, 2011; Pe'er and Keil, 2013). However, these studies have neglected how the size of the agglomeration affects corporate management such as decision making and how they might benefit from agglomeration economies. This paper contributes to understanding how a

concentration of productive activity and population benefits corporate performance on profitability, value generation, financing, liquidity, and indebtedness. It also analyzes how this performance contributes to agglomeration through a process of cumulative causation, and a methodological approach consistent with our hypotheses.

The paper uses information from the Colombian Superintendence of Companies (Supersociedades) for manufacturing firms between 1995 and 2014. We test our hypotheses by means of a structural equation model which together represent the three hypotheses, as this methodology allows modeling complex causal relationships through feedback effects, interdependence in the observed data and the estimation of unobservable variables.

The Colombian case is of particular interest because the country has a complex urban system as compared to the rest of Latin America. The country has also seen an accelerated urbanization of the most populated areas over the last two decades which has resulted in a favorable environment in which to study the effects of agglomeration economies. Duranton (2016) found that the elasticity of wages with respect to the population of Colombian cities is 5 percent which presses the question of whether agglomeration economies also contribute to corporate performance through their practices and the accessibility to productive resources. The results of this study confirm the hypotheses.

Our paper makes three contributions. The first is the union of two interdependent conceptual frameworks that give rise to the hypotheses, showing how agglomeration and company' endowment work. The second is the methodological approach, which goes beyond the traditional analysis of agglomeration economies and business, using financial indicators as measures for a company's performance in terms of profitability, sales, capitalization and

resource management, to derive on a more complete diagnosis of the firm. The third contribution is the continuation of the analysis of the effects of agglomeration economies in Colombia, begun by Duranton's (2016) wage analysis.

The document consists of six sections. In the following section we describe the theoretical approach of hypotheses before moving on to the case study. In the fourth section we review the methodology and in the fifth, the results. The final section discusses and concludes.

THE PERFORMANCE OF FIRMS: MANAGEMENT AND AGGLOMERATION

This section describes the general aspects of Penrose's theory of the growth of firms and their relationship with the postulates on agglomeration economies. The articulation of these approaches leads to the formulation of our hypotheses.

The firm as a collection of resources

In *The Theory of the Growth of the Firm* (1959), Penrose developed her resource—based theory in which she sought to identify the conditions necessary for businesses to evolve and grow, and the principles that make this possible. Penrose's work begins with a critique of the neoclassical economics approach, which considers companies to be time—invariant and myopic to their environment. For Penrose, any theory of growth of the firm must explain different types of growth as well as the changes caused by both external and internal factors. Thus, it recognizes the relationship between the firm and the environment (the agglomeration) in which it operates, considering them part of a network of trade (Richardson, 1972). However, Penrose focuses on identifying the sources of growth inherent to the firm, assuming a fix environment. This is the key point that allows us to relate the theory of Penrose with the approach of agglomeration

economies. Penrose considers some external scenarios and recognizes the interdependence between the environment and the firm but she does not delve into the effects of the environment on the growth of the firm or vice versa (Penrose, 1952). This knowledge gap is addressed in our paper.

For Penrose, the firm is defined in terms of its role as an (autonomous) administrative organization that acquires and organizes human and other productive resources in order to profitably provide goods and services to the market. The aforementioned other productive resources include tangible physical resources such as the plant, equipment, land, intermediate goods, as well as the products manufactured. Human resources include administrative, financial, legal, technical, managerial, and skilled and unskilled labor. The firm aims to maximize its long—term earnings, seeking to yield positive dividends for its shareholders. Corporate growth results from maintaining and attracting investors and this leads to maximizing earnings.

Companies are able to grow to the extent that the quality and quantity of productive resources available increase. These resources provide the company productive services which are determined by administrative decisions (management) and the accumulated learning the firm acquires via its human capital. A firm's productive services are the different uses or functions of the productive resources. This means that a firm's management capacity depends on the quality of productive services that can be obtained from their productive resources.

Productive resources, besides providing productive services to the firm also provide productive opportunities, which are the profit—making possibilities that the managers and entrepreneurs have. These possibilities include new product developments or organizational changes. Here we highlight the entrepreneurial capacity of human capital to identify opportunities for profit, understood as a psychological predisposition, intuition or imagination.

Such productive opportunities (or investment options) have both an internal and external source. Regardless of the origin, the identification of these opportunities depends on a firm's knowledge as well as other productive services. Internal opportunities are accumulated through a learning process oriented at the efficient operation of the firm under a specific context (the environment or location) (Nelson and Winter, 1982), including creative destruction (Schumpeter, 1942). Similarly, external productive opportunities are perceived in terms of the quality of their productive services and are subjected to the same processes. That is, companies with better productive services can identify more productive opportunities within an environment.

This means that, similar to productive opportunities, firms externally acquire more and better resources and productive services in relation to the quality of the productive services that they already have. These include materials, human capital, new suppliers, financial resources and access to knowledge which the company acquires in order to promote its growth not in the pursuit of monopoly power but rather to exploit their productive opportunities. This is the inherent source of both growth for a firm and its own limitations, given that new services and productive opportunities push to be used which itself represents a limitation to growth. Nevertheless, Penrose warns that it is practically impossible to fully utilize each resource.

Firms are geographically concentrated so that they have the ability to access a certain variety of not only productive resources but also investors, knowledge, input suppliers and buyers. This understanding of a firm's actions is key to linking them with the benefits of agglomeration economies.

Each company has a limit to its growth potential due to the productive services being heterogeneous, even if the services originate from the same resource (water, for example), and

each company has its own knowledge and ability to use it. However, the potential for expansion for a firm depends on its ability to increase the amount of productive services that can be used for this purpose. Therefore, productive resources, which define the productive services, are those that determine the rate of growth of a company as well as the limit of that growth. In terms of the environment, Penrose states that in a scenario of intense competition where the conditions of supply and demand require constant adjustments, the growth of small businesses would be slow. By contrast, due to its market position, the management of a large company would not need to do as much in order to maintain its growth. Nevertheless, the more complex the expansion of the company, the greater the requirement for management services. In general terms, there is a maximum rate at which firms can grow. However, they do not grow indefinitely, mainly because when they are large they dominate the market. In this case, the environment will restrict opportunities to these large companies as well as to the smallest, those which could engage in activities that the large firms do not efficiently perform.

Although Penrose recognizes the effect of the environment on the growth of firms, it was not included as a crucial element in terms of its growth or behavior. However, as will be shown in the next section, Penrose's postulates can be further articulated in the context of agglomeration economies and the growth of companies. Therefore, we propose linking three interdependent aspects: the company, its resources and the environment to which it belongs.

Internal management and agglomeration

Marshall's (1890) initial postulates regarding agglomeration economies indicate that they are a result of the specialization of work generated by complementary activities and productive diversification (localization and urbanization economies) (Hoover, 1937; Jacobs, 1969). To the

extent that an increase in the concentration of the productive activity results in an increase in cheaper inputs, access to more business services, trade, transport and communication, thick labor markets, and knowledge transfer, it also leads to lower production costs. However, from a certain level of concentration, agglomeration diseconomies associated with congestion and increased competition arises.

Marshall's work inspired various other contributions aimed at understanding agglomeration economies in terms of conception, origin and classification. These contributions include Hoover (1937), Ohlin (1933), Meade (1952), Scitovsky (1954), Jacobs (1969), Willig (1979), Markusen (1996), Gordon and McCann (2000), Parr (2002) and Duranton and Puga (2004). While there is no global consensus for every topic discussed, there is a consensus in terms of the benefit associated with the concentration of productive activities and population. Specifically, the greater the agglomeration, the lower the cost of inputs, productive resources, and of accessing knowledge.

Within the literature on agglomeration economies, the work of Duranton and Puga (2004) stands out. These authors focused on identifying mechanisms that explain the origin of agglomeration economies and were able to formalize the postulates of Marshall (1890) using general equilibrium models. They identified three mechanisms that characterize the formation of agglomeration economies in any market: *Sharing, Learning* and *Matching*.

Duranton and Puga (2004) showed that the high concentration of various industries in one place results in a specialization of labor (*Sharing*), generating a large market of inputs at lower costs as well as savings in transportation. The high concentration facilitates increasing returns due to the indivisibilities in the production of some shared goods and services as well as

economies of scale due to increases in the scale of production (which is shared by all actors within the agglomeration). This generates a large number of input suppliers, increasing the chances of exchange at lower prices.

Learning is based on the generation, accumulation and dissemination of knowledge. The high concentration of productive activities and population improve the transfer of knowledge between companies, and expands the possibility of generating technological improvements for the more productive firms. This is because the transfer of knowledge requires physical contact between the agents involved. Knowledge can pass from one company to another through labor mobility. *Matching* is the mechanism by which areas with more companies and workers improve their chances that they find what they require be it inputs, ideas or workers. This means that concentration improves market efficiency since what is supplied is demanded, and vice versa.

These mechanisms indicate that the level of input costs, the ease of finding what is required and the training and dissemination of knowledge could improve with the level of concentration of the productive activities, resulting in a cost structure and an ease of developing and obtaining knowledge that vary depending on the size of the agglomeration. Therefore, each company is subject to the restrictions of its context. Penrose saw the environment (understood as the agglomeration) as offering a firm a certain quantity, quality and diversity of productive resources such as knowledge, services and productive opportunities. This is represented by the left side of Figure 1. The limit of the environment on the management of the firm lies in the acquisition of external productive resources, which offer services and productive opportunities, and is represented by the gray dashed line. Each company is exposed to the variety of productive resources offered in a moment of time, which leads to our Hypothesis 1. Hypothesis 1: The size of the agglomeration affects corporate management.

[Insert Figure 1 about here]

While agglomeration does offer a certain diversity, quantity and quality of productive resources, it does not guarantee that all companies achieve these benefits. According to Penrose, this depends on the quantity and quality of productive services that each firm has. Specifically, entrepreneurial and managerial skills that are developed over time and that the company channels to productive resources and opportunities coming from the environment. For example, the absorption capacity of a firm is linked to its prior knowledge, since a base level of knowledge is required to actually use it (Boschma, Eriksson and Lindgren, 2009; Cohen and Levinthal, 1990; Kogut and Zander, 1992; McCann and Folta, 2011; Todorova and Durisin, 2007). Similarly, attracting financial capital depends on the ability of the firm to convince lenders or shareholders that offering their resources to the company is the best option. The same applies to other productive resources, like input suppliers and buyers. Figure 1 shows how productive services at a moment of time incorporate external resources, which is represented by the dotted gray line.

Besides obtaining productive resources and knowledge (and subsequently productive services) from the environment, firms also see investment and productive opportunities there in relation to the quality and quantity of productive services they possess. This is summarized in the Hypothesis 2.

Hypothesis 2: The advantages of agglomeration economies are not homogeneous and depend on the quality and quantity of a company's productive services.

Firm's management decisions determine its performance. After each period of growth, and via a process of development, a firm has created new knowledge, more and better productive services, and has identified new productive opportunities (Nelson and Winter, 1982; Schumpeter, 1942). These developments are shared amongst the other actors within the environment based on strategic decision while they also increase the quality and quantity of the productive services to be used in the following period by the original firm. This in turn influences the agglomeration in which the firm is located, as illustrated by the blue lines in Figure 1.

A firm's "accomplishments" are also shared and accumulated within the environment. Companies operate more efficiently with the development process and are thus able to offer their goods or services at a lower cost and to promote and stimulate the production chain (both forwards and backwards)¹. In this way companies affect previous agglomeration economies through a process similar to the cumulative causation discussed by Myrdal (1957) and Hirschman (1961). This process involves the interplay of forces that drive the growth of the agglomeration, forces for both a virtuous and vicious circle of growth. Overall, these authors argued that the growth dynamics of agglomerations or concentrations (regions) are not random, but depend on the endowments of an area or agglomeration as well as the performance and accomplishments of the companies present there (Coleman, 1990).

Each company offers the goods and services that it produces, as well as the knowledge and productive services resulting from its human capital (the latter as something latent, as another company could hire him or her) to the environment, while obtaining the same productive

¹As noted earlier, the process of growth or development of a firm consists of increasing the use of the productive resources available.

resources (Richardson, 1972). In other words, a firm's performance contributes to the concentration in which it is located.

Hypothesis 3: Corporate performance reinforces agglomeration economies.

The three hypotheses proposed in Figure 1 are analyzed for the case of the Colombian urban system whose characteristics are presented in the following section.

THE COLOMBIAN URBAN SYSTEM

The Colombian urban system stands out as one of the most complex in Latin America owing to the significant number of large and medium cities that it has. Additionally, over the past two decades, the urbanization process has tended to focus on areas with higher levels of initial development which has resulted in a rapid development of the services industry amongst geographical areas.

In 2014, the population of Colombia was 47.66 million. 76 percent of those people lived in urban areas, a ratio similar to the rest of South America (74%) (DANE, 2011; World Bank, 2016)². In most cases, a single urban center tends to concentrate a significant part of a country's population. The Colombian urban system, however, has three large centers (Bogotá, Medellín and Cali) that concentrate approximately a quarter of the population. If we include the next two (Barranquilla and Cartagena), the total reaches approximately 30 percent of the population while the leading ten urban centers in Colombia represent just 36 percent of the entire population.

Colombia is administratively divided into 33 departments comprised of 1,122 municipalities. Figure 2 shows the municipal population in 2014, indicating the location of the

²The urbanization rate in South America was constructed using data from Argentina, Brazil, Bolivia, Chile, Ecuador, Paraguay, Peru, Uruguay, Venezuela and Colombia.

top ten cities. Bogotá, the capital, is the largest city with 7.8 million inhabitants, while Soacha, adjacent to Bogotá, is the tenth largest municipality with a population of 500,000 inhabitants. The rest of the population is distributed in smaller cities of less than 200,000 inhabitants.

[Insert Figure 2 about here]

Between 1995 and 2014, with the exception of Barranquilla and Bucaramanga, the ten major cities had a population growth above the national average (DANE, 2011). This went hand in hand with an increase in the rate of urbanization in the country, from 68.1 percent in 1990 to 76.2 percent in 2014. The high rate of urbanization in the ten major urban centers, where the municipality with the lowest level of urbanization was 94.5 percent in 2014 is of particular interest. The large increase in urbanization around municipalities with high levels of urbanization in 1990 is also evident³.

This increase in the concentration of the population around agglomerations that existed in 1990, as well as the complexity of the system of cities in terms of diversity of sizes in the urban hierarchy, make the Colombian case a relevant one to study. In itself, it represents an environment conducive to finding evidence of agglomeration economies given the high urbanization around major urban centers. Moreover, there is recent evidence of agglomeration economies in Colombia in the form of wages (Duranton, 2016). This opens the question of whether agglomeration economies also contribute to the performance of Colombian companies, via the management and via the productive resources that firms can access.

In addition to the increasing concentration, over the last two decades Colombia has experienced a rapid develop of the services industry that has been concentrated in the most prosperous and most populated areas of the country. This development has been associated with

³ Information available upon request to the authors.

services oriented towards improving productivity in areas with higher relative development (Medellín, Bogotá and Cali), that are characterized by having higher productivity in relation to the services that simply satisfy demand (present in less developed areas) (Bonet, 2007)⁴.

The most significant growth in the services industry for departments with larger cities may be due to the greater need for complementary and specialization services geared at improving the productivity of manufacturing companies. This may contribute to an increased performance of this sector through economies of urbanization. Manufacturing is the sector analyzed in this paper as in the majority of studies within this area (Andersson and Lööf, 2011 sector; DeCarolis and Deeds, 1999; Folta, Cooper and Baik, 2006; Henderson, 2003; McCann and Folta, 2011; Moretti, 2004, Pe'er and Keil, 2013; Shaver and Flyer, 2000).

DATA, MEASURES, AND METHODS

Data and sample sources

The study is based on year—end financial statements reported to the Colombian Superintendence of Companies (Supersociedades) between 1995 and 2014. This source is used for two reasons related to the theoretical approach: 1) it provides insights regarding a firm's performance over time (balance sheet); and 2) it facilitates the identification of changes via various annual performance indicators (income statement and cash flow). This database does not include all Colombian companies, but rather a group consisting of monitored (Act 4350 of 2006 and 2300 of 2008), controlled (Art. 85, Law 222 of 1995) and audited (Art. 83, Law 222 of 1995) ones. However, due to the nature of the source, there is all—encompassing information

⁴ Services aimed at improving productivity originate from the outsourcing of productive activities to companies that specialize in them. Services aimed at satisfy demand have a low productivity and little impact on the economy (Weller, 2004 cited by Bonet, 2007).

regarding the performance of management at different locations and points in time⁵. The sample of companies audited includes those that are large enough to be formally recognized.

In the analyzed period, an average of 17,045 companies reported their annual financial statements. 91 percent reported a positive operating income, and 97 percent a positive income (operational and non—operational). On average 21 percent belong to the manufacturing industry, which is equivalent to an annual average sample of 3,400 companies, distributed throughout the country. In relative terms, over time manufactures saw their percentage share in the sample decrease, from 25 percent in 1995 to 15 percent in 2014. This decline most likely implies a selection process of the most competitive firms and those with the greatest capacity to benefit from the agglomeration economies and from the creation of complementary services firms.

Table 1 shows the distribution of the total data (sample) and that which corresponds to manufacturing for the ten leading cities. The distribution between the sample and the analyzed group (sub—sample) differs for Bogotá and Itagüí, in that Bogotá concentrates fewer companies while Itagüí has a higher concentration. 85 percent of the companies in the sample are located in the ten leading cities, while 79 percent of the sub—sample is also located there. Unlike Europe and the US, the Colombian manufacturing sector continues to be concentrated in major cities, most likely due to agglomeration economies. Bogotá is home to 55 percent of the companies, representing a high concentration in relation to its population and its contribution to the national GDP, which averaged 25 percent⁶.

[Insert Table 1 about here]

⁵There are other official databases with limited information regarding the financial statements, or that do not permit you to track a specific firm over time or observe firms of different sizes. For example, the Annual Manufacturing Survey, the Annual Services Survey and the DANE Annual Business Survey, which is completed by the Colombian Financial Superintendence.

⁶ Although there is no database that allows us to verify the existence of sub-sampling or over—sampling, an independence in the sample for cities within sectors is evident.

For agglomeration economies measures we use departmental population data from National Administrative Department of Statistics (DANE, 2011). Also, we use population density and a market potential indicator proposed by Harris (1954), using data from gazetteer by Geographic Institute Agustín Codazzi and distance between departmental main cities reported on Google Map.

Analysis technique

We use a technique called Structural Equation Models (SEM) in order to test the hypotheses. The SEM, also called simultaneous equation models, is used to verify or identify relationships (correlations) between variables, in turn facilitating data analysis. These models also help to explore these relationships and to give them structure via the construction of indirectly measured (latent) variables, which due to their complexity and difficulty to observe are estimated using several variables such as Factor Analysis and Principal Components. They also allow us to validate conceptual models therefore verifying causal relationships.

In this document the SEM are used to test a conceptual model that represents the hypotheses. The choice of this technique rather than an econometric analysis is based on the SEM being able to model complex causal relationships through feedback effects, as well as interdependence in the observed data and the estimation of unobservable variables. Beginning with the theoretical model, the observed variables are used to measure (unobserved) latent variables using the correlations between them (Bowen and Guo, 2012; Kaplan, 2009). In our case, we estimate a latent variable that measures the management practices of the company (the productive services). A high value for this variable represents a higher level of productive services and vice versa.

Variables

In our structural model, some variables are both independent and dependent. Therefore, we do not present these two groups, but we explain how each one affects others. Productive resources variables capture aspects described in the theoretical approach in order to explain the level of productive services available to each company. These variables are human capital, plant property and equipment along with the knowledge available to the company (Toro *et al.*, 2015).

The measure for human capital corresponds to current labor debt, which are usually the unemployment insurance costs (proportional to wages), that are paid in February of the following year. While this variable is not proportional to the number of employees the company has, it does take into consideration the salaries, which we assume are associated with their productivity. The variable for property, the plant and the equipment, is the physical capital for each company. The knowledge variable is the sum of the balance sheets and indirectly reveals information regarding the research, development, and innovation activities of companies. Specifically, intangible assets are used as patents, trademarks, know—how, plant and equipment valuation, concessions and franchises, goodwill, rights and licenses.

The departmental population is used as a variable for the environment in order to measure agglomeration economies, since this paper is not intended to identify types of agglomeration (localization or urbanization) but rather their existence and their effect on management decisions. The departmental level variable is also superior to the municipal level in that it allows us to include groups of municipal districts with more companies and thus more data. It also allows us to capture the relocations of companies in nearby areas. In any case, the results do not change significantly when using the departmental or municipal level, as occurs in Duranton (2016). As

proof of robustness, the estimates are replicated by replacing population with a measure of population density and a market potential indicator proposed by Harris (1954), all traditional measures used in estimating agglomeration economies. Both productive resources and agglomeration variables are one—period—lagged, because the resources available at the end of one year are used by the company to operate and generate results the following year, as Figure 1 shows.

As performance variables, we used traditional financial indicators such as profitability, liquidity, activity and indebtedness⁷. These indicators reveal information regarding the results of the various strategies implemented by companies, or in terms of Penrose, "productive services". For example, how companies manage their working capital, how they are financed, sales levels, profit margins and value creation of the company (EBITDA).

Figure 3 depicts the causal relationships of the model to test, using the same colors used by groups in Figure 1. The variables in the circles are the standard errors for each estimated equation. The level of productive services of a company, our latent variable, is linked to the quality and quantity of labor as well as other productive resources that it has. This is represented by red arrows coming from the proxy for human capital, the level of property (plant and equipment), and the knowledge available to the company and going towards productive services (the latent variable). The level and quality of human capital, in addition to directly promoting productive services, also facilitates the creation and acquisition of knowledge, which in turn promotes the formation of productive services. Another point considered in the structural model is that the level of human capital and the physical size of the companies are positively related, as

⁷ To choose the financial indicator we use as selection criteria the Cronbach's Alpha.

larger firms have greater knowledge. This is represented by the bi—directional arrows between the error terms of the aforementioned variables.

[Insert Figure 3 about here]

The Hypothesis 1 indicates that *the size of the agglomeration affects corporate management*. The representation of this hypothesis is made by the causal relationships between the size of the agglomeration and the productive resources variables (gray arrows). This illustrates that the environment limits the management of the company through the acquisition of external production resources.

Meanwhile, the differential advantage of agglomeration economies (Hypothesis 2) is represented via the agglomeration of financial indicators through productive services. This means that obtaining the benefits from the agglomeration is channeled through productive services, meaning that it depends on the quality and quantity available to the company. Therefore, we expect that the higher the concentration, the better the performance; and the better the productive resources available to the company the more the benefits are enhanced. Thus the productive services and agglomeration economies are complementary in improving business performance.

The rest of the causal relationships in Figure 3 indicate that corporate performance depends on the level of productive services. These causal relationships are represented by olive colored arrows originating from the productive services variable and going towards the various financial indicators. The structural system estimate for Figure 3 was done considering that the data are nested at a company level.

Finally, the verification of Hypothesis 3 is done as a second step in estimating the structural model. The strategy consists of crossing a company's productive services forecasts with a lagged (10 years) departmental population variable. Specifically, the productive services quartiles for each department are estimated for the various years that are analyzed, and then they are connected one at a time with the corresponding lagged population. A positive relationship between the lagged population and the level of productive services is expected, which represents the highest concentrations enhancing the accumulation of productive services.

RESULTS

In Table 2, the description of the variables used in the analysis and the descriptive statistics are reported. The size of the sample is reduced as compared with Table 1 for three reasons: 3.95 percent of the cases had imbalances in the Balance Sheet and were thus removed; 8.72 percent of the remaining data (65,558) corresponded to companies that had changed departments over time and were thus removed; 7,406 records of the remaining data had no information regarding human capital, a key variable of productive resources, and were thus removed. The variables have fewer records due to missing data or outliers. The structure of the resulting data has no city or department bias.

[Insert Table 2 about here]

Our results are presented in the same order as the hypotheses. In Table 3, the direct effect of the proposed structural model are presented; in Table 4, the direct effect of the productive services on the firm performance; and in Figure 4, the relationship between the lagged population and the productive services of the companies. After describing the direct effects, we focus on the total effects (direct + indirect) of the analyzed variables on each dependent variable. We estimate three models, one for each measure of agglomeration economies: Model 1 uses population as a measure of agglomeration, Model 2 uses population density, and Model 3 uses market potential.

The first column of Table 3 is the variable that is explained by the variables in the second column (Figure 3 illustrates this relationship). The variable that measures the agglomeration economies is in bold. In the third, fourth, and fifth columns of Table 3 are the coefficients that result from using the environment variables as a measure of agglomeration (Model 1 to 3). Of interest is the significant effect that agglomeration has on the productive resources (human and physical) of the manufacturing companies, independent of the measure of agglomeration used, with high significance level (the p-values are lower or equal to 0.001). This result validates our first hypothesis.

Specifically, for Hypothesis 1, manufacturing firms in larger concentrations tend to be smaller. This means that areas of higher concentration have a greater presence of smaller companies as compared to smaller agglomerations. This result may be due to the effect of increased competition, as raised by Chinitz (1961) and subsequently verified by Rosenthal and Strange (2001, 2003) in the case of the US. In terms of human capital, we found that labor costs (human capital) are lower with increasing concentration (the p-value higher in our models is 0.001). This is an indirect result showing that the workforce in higher concentrations is more productive. We do not, however, find consistent correlation between the level of knowledge that a company has and the size of the agglomeration (for Model 1 and 3 the p-value-lower is 0.092).

[Insert Table 3 about here]

In terms of Hypothesis 2, there is evidence of a differential advantage for agglomeration economies. In essence, manufacturing companies benefit from being in larger concentrations. This advantage is evident in the positive relationship between the size of the agglomeration and

the level of productive services available to the company (the p-values in our models have are 0.000). The effect of the concentration on services is reflected in the various performance variables in Table 4. This table reports the coefficients of the causal relationship between the productive services and the performance variables in the first column. Each coefficient has a p-value equals to 0.000.

The results reveal that companies with higher levels of productive services have higher profit margins (a positive sign for all the variables of profitability), greater liquidity and a higher working capital. These companies also have a greater sales turnover, and they typically sell on credit and make their purchases with cash. This sales strategy is consistent with increased self—funding via company assets, less financial obligations and low debt levels, which are leveraged. The financial debts the company acquires are primarily short term. In addition, companies with higher productive services reported higher levels of operating leverage, which means that there is a positive relationship between operating expenses (sales and management) and the company's earnings.

[Insert Table 4 about here]

At this point it is worth noting the complementarity between the resources available to a company and the advantages offered by the environment for the creation of productive services, as shown in Table 3. In order to fully consider this, Table 5 presents the total effects of the structural model. These results consider the indirect effect of variables such as the population on the results and on the productive services. In general terms, the significance of the total effect is similar to that presented in Table 3 and Table 4.

[Insert Table 5 about here]

Knowledge has no significant effect on the variables (the p-value lower is 0.458), while human capital has a positive effect on the performance of companies, and a strong association with knowledge (the p-values are 0.000 in our models). The total effect of productive services is the same as what is reported in Table 4 (and is thus omitted). The size of the plant and equipment, human capital and the size of the agglomeration do have a robust effect on manufacturing companies' performance, corroborating the complementary effect between productive services and agglomeration economies (the p-value higher is 0.006 for Model 1 and 3, appertaining to variable of human recourses). The productive services, human capital and agglomeration signs are the same. The level of significant is lower for human resource. By contrast, the physical size of the company is harmful, which is evidence that larger companies have a lower performance (all p-values are 0.000). However, the magnitude is less than both that of the productive services and human capital of a company and the benefits from the environment.

According to Penrose, one of the objectives of a company is to attract capital in order to promote growth. Our results support this in that they show that companies with higher productive services obtain more capital from shareholders or owners (equity). Furthermore, the results indicate that this strategy is amplified within higher concentrations.

Finally, Figure 4 corresponds to Hypothesis 3 and relates the quartiles of the estimated productive services for each department in each year with a 10 year lag for the population variable (Model 1)⁸. There is evidence of a circular cumulative causation effect indicating that

⁸ The results for Model 2 and 3 are similar. They are not reported in the paper due to their length but are available upon request from the authors.

companies located in more populated areas in the past now have more productive services. This relationship is strong regardless of the quartile analyzed (the p-values of trends are 0.000).

[Insert Figure 4 about here]

In order to further examine the third hypothesis, Figure 4 is replicated for each department in order to see their individual evolution. The results are significant and similar to those reported in Figure 4. However, in three of the smaller departments the relationship is not significant (p-values higher to 0.100) which means that there has been no progress in terms of productive services. Another important aspect is that there is no evidence of an increase in the rate of growth of this variable as the size of the agglomeration increases (the confident intervals are equal to different levels of significance). In other words, departments with a similar size have differences in the increases of productive services as their population grows⁹.

DISCUSSION AND CONCLUSION

Previous analyses of agglomeration economies have focused almost exclusively on its aggregate effect on productivity, understanding the concept as related to the industry or to the agglomeration itself rather than specific characteristics of the firm. The analysis of how agglomeration affects management and how a firm's productive endowments affect what is obtained from the agglomeration, however, has been neglected. This paper makes three contributions in this regard. The first is the union of two interdependent conceptual frameworks that give rise to the hypotheses: Penrose's resource—based theory (1959) and the general postulates regarding agglomeration economies. We know that the impact of agglomeration economies is not uniform, but rather depends on the quality and quantity of productive services

⁹ The results of this analysis are not reported in the paper due to their length but are available upon request from the authors.

available to each company. Similarly, the evolving nature of corporate growth and how a firm both contributes to and benefits from where it is located is also considered.

The second contribution is the methodological approach, which is consistent with the proposed theoretical framework and also goes beyond the traditional analysis of agglomeration economies and business. The use of financial indicators as measures for a company's performance in terms of profitability, sales, capitalization and resource management provides a more complete diagnosis of their condition. The third contribution corresponds to the continuation of the analysis of the effects of agglomeration economies in Colombia, begun by Duranton's (2016) wage analysis.

The data from the Colombian manufacturing industry and the subsequent analysis present evidence in support of all three hypotheses. Hypothesis 1: companies in larger cities are smaller and spend less on wages since they potentially have more productive workers. Hypothesis 2: agglomeration economies enhance productive services, generating better performance. Finally, there is a positive relationship between the population and productive level services in the future, evidence of a circular cumulative causation process, our Hypothesis 3.

The results of this document serve as a starting point for changing how we study the effects of agglomeration on companies. For example, we might consider additional aspects of profitability or even business survival in order to account for how companies work, how they relate with their business partners (customers and suppliers), or in terms of capitalization and working capital administration. Taken together, these indicators would allow for a more complete diagnosis and understanding.

Future work in this area might also explore and break down the effects of agglomeration

economies. For example, how much is attributable to sharing, matching and learning and does it

result from complementary activities or is it exclusive to a sector. All this, while considering the

latent complementarity between what the environment offers and what the company offers.

REFERENCES

- Andersson M, Lööf H. 2011. Agglomeration and productivity: evidence from firm—level data, *The Annals of Regional Science*, **46**(3): 601–620.
- Bonet J. (2007). La terciarización de las estructuras económicas regionales en Colombia, *Revista de Economía del Rosario*, **10**(1): 1–19.
- Boschma R, Eriksson R, Lindgren U. 2009. How does labour mobility affect the performance of plants? The importance of relatedness and geographical proximity, *Journal of Economic Geography*, **9**(2): 169–190.
- Bowen N, Guo S. 2012. Structural equation modeling. Oxford University Press: New York.
- Chinitz B. 1961. Contrasts in agglomeration: New York and Pittsburgh, *The American Economic Review*, **51**(2): 279–289.
- Cohen WM, Levinthal DA. 1990. Absorptive capacity: a new perspective on learning innovation, *Administrative Science Quarterly*, **35** (1): 128–125.
- Coleman J. 1990. Foundations of social theory. Harvard University Press: Cambridge, MA.
- DANE. 2011. Estimaciones de población 1985–2005 y proyecciones de población 2005–2020 total municipal por área, Departamento Administrativo Nacional de Estadísticas.
- DeCarolis DM, Deeds DL. 1999. The impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry, *Strategic Management Journal*, **20**(10): 953–968.
- Duranton G, Puga D. 2004. Micro—foundations of urban agglomeration economies. In Henderson, V. and Thisse, J. (Eds.), *Handbook of Regional and Urban Economics*, 4: 2063–2117. Elsevier: Amsterdam, Netherlands.
- Duranton G. (2016). Agglomeration effects in Colombia, *Journal of Regional Science*, **56**(2): 210–238.
- Folta TB, Cooper AC, Baik YB. 2006. Geographic cluster size and firm performance, *Journal of Business Venturing*, **21**(2): 217–242.
- Gordon I, McCann P. 2000. Industrial clusters: complexes, agglomeration and/or social networks? *Urban Studies*, **37**(3): 513–532.
- Hansen GS, Wernerfelt B. 1989. Determinants of firm performance: the relative importance of economic and organizational factors, *Strategic Management Journal*, **10**(5): 399–411.
- Harris C. 1954. The market as a factor in the localization of industry in the United States, *Annals* of the Association of American Geographers, **44**(4): 315–348.
- Henderson JV. 2003. Marshall's scale economies, Journal of Urban Economics, 53(1): 1–28.
- Hirschman A. 1961. Transmisión interregional e internacional del crecimiento económico. In *La estrategia del crecimiento económico*: 184–200. Fondo de Cultura Económica: Mexico.

- Hoover, E. 1937. *Location theory and the shoe and leather industries*. Harvard University Press: Cambridge, MA.
- Jacobs J. 1969. The economy of cities. Random House: New York.
- Kaplan D. 2009. *Structural equation modeling: foundations and extensions* (2nd ed.). Sage: Los Angeles.
- Kogut B, Zander U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology, *Organization Science*, **3**(3): 383–397.
- Kor YY, Mahoney JT. 2004. Edith Penrose's (1959) Contributions to the resource—based view of strategic management, *Journal of Management Studies*, **41**(1): 183–191.
- Markusen A. 1996. Sticky place in slippery space: a typology of industrial districts, *Economic Geography*, **72**(3): 293–313.
- Marshall A. 1890. Principles of economics. Macmillan: London, U.K..
- McCann BT, Folta TB. 2011. Performance differentials within geographic clusters, *Journal of Business Venturing*, **26**(1): 104–123.
- Meade J. 1952. External economies and diseconomies in a competitive situation, *The Economic Journal*, **62**(245): 54–67.
- Moretti E. 2004. Workers' education, spillovers, and productivity: evidence from plant—level production functions, *The American Economic Review*, **94**(3): 656–690.
- Myrdal G. 1957. Economic theory and under-developed regions. Duckworth: London, U.K.
- Nelson R, Winter S. 1982. An evolutionary theory of economic change. Harvard University Press: Cambridge, MA.
- Ohlin B. 1933. Interregional and international trade. Harvard University Press: Cambridge, MA.
- Parr JB. 2002. Missing elements in the analysis of agglomeration economies, *International Regional Science Review*, **25**(2): 151–168.
- Pe'er A, Keil T. 2013. Are all startups affected similarly by clusters? Agglomeration, competition, firm heterogeneity, and survival, *Journal of Business Venturing*, 28(3): 354–372.
- Penrose ET. 1952. Biological analogies in the theory of firm, *The American Economic Review*, 42(5): 814–815.
- Penrose ET. 1959. The theory of the growth of the firm. Oxford University Press: Oxford.
- Richardson G. 1972. The organization of industry, *The Economic Journal*, **82**(327): 883–896.
- Rosenthal SS, Strange WC. 2001. The determinants of agglomeration, *Journal of Urban Economics*, **50**(2): 191–229.
- Rosenthal SS, Strange WC. 2003. Geography, industrial organization, and agglomeration, *The Review of Economics and Statistics*, **85**(2): 377–393.
- Rugman AM, Verbeke A. 2002. Edith Penrose's contribution to the resource—based view of strategic management, *Strategic Management Journal*, **23**(8): 769–780.
- Schumpeter J. 1942. Capitalism, socialism, and democracy. Harper: New York.
- Scitovsky T. 1954. Two concepts of external economies, *The Journal of Political Economy*, **62**(2): 143–151.
- Shaver JM, Flyer F. 2000. Agglomeration economies, firm heterogeneity, and foreign direct investment in the United States, *Strategic Management Journal*, **21**(12): 1175–1193.
- Todorova G, Durisin B. 2007. Absorptive Capacity: Valuing a Reconceptualization, *Academy of Management Review*, 32 (3): 774–786.

- Toro D, Mola J, Angulo V, Castro M, Gómez JM, Angulo, M. 2015. El impacto tecnológico de la innovación en la industria naval: el caso de COTECMAR, *Economía y Región*, **9**(2): 147–167.
- Weller J. 2004. El empleo terciario en América Latina: entre la modernidad y la sobrevivencia, *Revista de la CEPAL* 84: 159–176.
- Willig RD. 1979. Multiproduct technology and market structure, *The American Economic Review*, **69**(2): 346–351.
- World Bank. 2016. World Development Indicators: Urbanization. http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS [12 February 2016].



Note: * Human resources are productive resources. Skills, including productive opportunities or productive services move with these human resources.





Figure 2. Municipal population, Colombia 2014



Figure 3. Agglomeration and the growth of the firm: empirical model



a. 25th Percentile

b. 50th Percentile

c. 75th Percentile



Figure 4. Circular cumulative causation: Model 1

	Sa	mple	Manufactu	ring (sub—sample)
City	Firms	% of total	Firms	% of total
Bogotá	186,394	55	32,447	48
Medellín	32,292	9	6,716	10
Cali	26,231	8	4,469	7
Barranquilla	15,199	4	2,908	4
Bucaramanga	7,052	2	1,401	2
Cartagena	6,133	2	1,059	2
Itagüí	4,861	1	2,400	4
Manizales	4,121	1	1,120	2
Pereira	4,045	1	654	1
Cúcuta	3,415	1	551	1
Subtotal	289,743	85	53,725	79

Table 1. Sample and sub—sample for principle cities

Table 2. Descriptive statistics

Variable	Mean	S. D.	Min.	Max.	1	2	3	4	5	6	7	8	9	10
1 Net margin	0.016	0.166	-9.497	1.928	1.000									
2 Gross margin	0.307	0.152	-0.716	0.998	0.067	1.000								
3 Operating margin	0.054	0.149	-9.548	0.636	0.650	-0.010	1.000							
4 EBITDA	0.129	0.123	-0.500	0.844	0.222	0.000	0.347	1.000						
5 Current ratio	2.075	1.778	0.049	45.018	0.057	0.206	-0.002	-0.064	1.000					
6 Quick ratio	0.645	1.010	0.002	30.280	0.049	0.300	-0.029	-0.087	0.902	1.000				
7 Working capital	0.299	0.550	-19.535	0.978	0.151	-0.048	0.156	0.166	0.302	0.228	1.000			
8 Accounts receivable turnover	9.771	20.098	0.345	521.592	0.034	0.160	0.015	-0.035	0.039	0.133	-0.098	1.000		
9 Accounts payable turnover	17.517	41.035	0.020	829.365	0.013	-0.072	-0.008	0.041	0.131	0.145	0.042	0.069	1.000	
10 Total asset turnover	1.401	0.830	0.008	7.006	0.066	-0.319	0.142	0.509	-0.176	-0.195	0.113	-0.026	0.108	1.000
11 Leverage structure	1.268	1.602	-7.504	25.399	-0.037	-0.087	-0.015	-0.026	-0.163	-0.141	-0.102	-0.014	-0.008	0.134
12 Capital structure	0.437	0.632	-2.333	9.506	-0.056	-0.160	0.004	-0.005	-0.153	-0.143	-0.087	-0.038	-0.009	0.091
13 Total leverage	0.462	0.207	0.010	1.909	-0.121	-0.239	-0.052	0.003	-0.363	-0.327	-0.224	-0.065	-0.064	0.274
14 Financial leverage	1.436	2.551	-30.780	33.234	-0.007	-0.055	0.073	0.143	-0.054	-0.065	0.012	-0.014	-0.004	0.092
15 Operative leverage	4.104	9.690	-78.645	143.891	0.048	0.078	0.078	0.103	-0.022	-0.027	0.045	0.008	-0.011	0.124
16 Leverage concentration	0.823	0.219	0.032	1.000	0.025	-0.037	0.028	0.121	-0.112	-0.076	-0.039	-0.040	0.003	0.214
17 Coverage of interest paid	2.278	7.008	-132.498	353.188	0.220	0.104	0.292	0.295	0.079	0.069	0.094	0.028	0.048	0.069
18 Coverage of fixed costs	1.217	0.479	-1.488	6.882	0.308	0.019	0.452	0.496	0.033	0.001	0.159	-0.005	0.063	0.150
19 Log(Human resource t-1)	11.229	1.623	0.744	17.673	-0.012	-0.368	0.059	0.125	-0.208	-0.240	0.039	-0.088	0.014	0.234
20 Log(Property, plant and equipment t-1)	13.951	1.908	0.744	21.780	-0.003	-0.193	0.017	-0.061	-0.090	-0.094	-0.089	0.007	-0.078	-0.204
21 Log (Knowledge t-1)	3.508	5.494	0.000	19.474	-0.010	-0.080	0.021	0.024	-0.082	-0.085	-0.031	-0.017	-0.029	-0.017
22 Log (Population t-1)	15.347	0.593	12.616	15.853	0.014	0.134	0.007	0.052	0.031	0.043	0.030	0.003	-0.026	0.019
23 Log(Population density t-1)	6.479	1.849	1.500	8.484	0.001	0.166	-0.001	0.051	0.032	0.052	0.008	0.020	0.001	-0.010
24 Log(Market potential t-1)	15.746	0.471	13.629	16.252	0.010	0.138	0.008	0.066	0.031	0.045	0.026	0.014	-0.017	0.022
Variable	11	12	13	14	15	16	17	18	19	20	21	22	23	24
11 Leverage structure	1.000													
12 Capital structure	0.578	1.000												
13 Total leverage	0.627	0.513	1.000											
14 Financial leverage	0.043	0.095	0.081	1.000										
15 Operative leverage	0.014	-0.003	0.016	0.041	1.000									
16 Leverage concentration	-0.056	-0.182	-0.117	-0.004	0.032	1.000								
17 Coverage of interest paid	-0.066	-0.069	-0.124	0.008	0.059	0.060	1.000							
18 Coverage of fixed costs	-0.045	0.001	-0.085	0.125	0.022	0.059	0.366	1.000						
19 Log(Human resource t-1)	0.063	0.117	0.171	0.048	0.042	0.004	-0.034	0.050	1.000					
20 Log(Property, plant and equipment t-1)	-0.091	0.065	-0.106	0.005	-0.053	-0.198	-0.036	-0.020	0.445	1.000				
21 Log (Knowledge t-1)	0.040	0.116	0.086	0.043	0.000	-0.108	-0.025	0.027	0.225	0.189	1.000			
22 Log (Population t-1)	0.020	-0.035	0.013	0.002	0.024	0.050	0.018	-0.002	-0.018	-0.141	-0.020	1.000		
23 Log(Population density t-1)	0.024	-0.062	0.016	-0.015	0.022	0.052	0.024	-0.014	-0.050	-0.133	-0.046	0.639	1.000	
24 Log(Market potential t-1)	0.021	-0.045	0.014	-0.001	0.023	0.065	0.024	-0.001	-0.030	-0.147	-0.019	0.861	0.789	1.000

N=37,976

Table 3. Main results (direct effect)

	Model 1	Model 2	Model 3
<i>Productive services t-1 <-</i>			
Property, plant and equipment t-1	-0.006	-0.006	-0.006
	(0.000)	(0.000)	(0.000)
Human resource t-1	0.003	0.003	0.003
	(0.004)	(0.002)	(0.004)
Knowledge t-1	0.000	0.000	0.000
	(0.458)	(0.518)	(0.456)
Agglomeration t-1	0.009	0.003	0.016
	(0.000)	(0.000)	(0.000)
Knowledge t-1 <-			
Human resource t-1	0.747	0.741	0.747
	(0.000)	(0.000)	(0.000)
Agglomeration t-1	-0.194	-0.106	-0.192
	(0.092)	(0.003)	(0.179)
_cons	-1.904	-4.131	-1.851
	(0.313)	(0.000)	
Human resource t-1 <-			
Agglomeration t-1	-0.122	-0.065	-0.229
	(0.001)	(0.000)	(0.000)
_cons	13.101	11.648	14.829
	(0.000)	(0.000)	(0.000)
Property, plant and equipment t-1 $<$ -			
Agglomeration t-1	-0.512	-0.117	-0.656
	(0.000)	(0.000)	(0.000)
_cons	21.812	14.712	24.281
	(0.000)	(0.000)	(0.000)
Observations	37,983	37,983	37,976
Log pseudolikelihood	-1212713	-1256141	-1203647

Note: p-values in parentheses. Standard errors clustered by firm.

	Model 1	Model 2	Model 3		
Variable					
Net margin	1.000	1.000	1.000		
-	(constrained)	(constrained)	(constrained)		
Gross margin	0.497	0.498	0.498		
	(0.000)	(0.000)	(0.000)		
Operating margin	1.132	1.132	1.132		
	(0.000)	(0.000)	(0.000)		
EBITDA	0.837	0.838	0.838		
	(0.000)	(0.000)	(0.000)		
Current ratio	3.049	3.050	3.048		
	(0.000)	(0.000)	(0.000)		
Quick ratio	1.223	1.225	1.223		
	(0.000)	(0.000)	(0.000)		
Working capital	1.732	1.731	1.732		
	(0.000)	(0.000)	(0.000)		
Accounts receivable turnover	-6.796	-6.739	-6.795		
	(0.000)	(0.000)	(0.000)		
Accounts payable turnover	16.802	16.893	16.763		
	(0.000)	(0.000)	(0.000)		
Total asset turnover	2.285	2.284	2.285		
	(0.000)	(0.000)	(0.000)		
Leverage structure	-3.553	-3.557	-3.554		
	(0.000)	(0.000)	(0.000)		
Capital structure	-1.261	-1.265	-1.263		
	(0.000)	(0.000)	(0.000)		
Total leverage	-0.491	-0.491	-0.490		
	(0.000)	(0.000)	(0.000)		
Financial leverage	2.598	2.595	2.599		
	(0.000)	(0.000)	(0.000)		
Operative leverage	5.770	5.768	5.764		
	(0.000)	(0.000)	(0.000)		
Leverage concentration	0.323	0.324	0.324		
	(0.000)	(0.000)	(0.000)		
Coverage of interest paid	28.199	28.236	28.225		
	(0.000)	(0.000)	(0.000)		
Coverage of fixed costs	3.229	3.230	3.230		
	(0.000)	(0.000)	(0.000)		

Table 4. Effect of productive services t-1 on managerial practices (direct effect)

Note: p-values in parentheses. Standard errors clustered by firm.

	Model 1					Model 2				Model 3				
Variable	<- Property, plant and equipmen t t-1	<- Human resourc e t-1	<- Knowledg e t-1	<- Agglomeratio n t-1	<- Property, plant and equipmen t t-1	<- Human resourc e t-1	<- Knowledg e t-1	<- Agglomeratio n t-1	<- Property, plant and equipmen t t-1	<- Human resourc e t-1	<- Knowledg e t-1	<- Agglomeratio n t-1		
Net margin	-0.006	0.003	0.000	0.012	-0.006	0.003	0.000	0.003	-0.006	0.003	0.000	0.019		
Gross margin	-0.003	0.001	0.000	0.006	-0.003	0.002	0.000	0.002	-0.003	0.001	0.000	0.009		
Operating margin	-0.006	0.003	0.000	0.013	-0.007	0.004	0.000	0.004	-0.006	0.003	0.000	0.021		
EBITDA	-0.005	0.002	0.000	0.010	-0.005	0.003	0.000	0.003	-0.005	0.002	0.000	0.016		
Current ratio	-0.017	0.009	-0.001	0.035	-0.019	0.010	0.000	0.011	-0.017	0.009	-0.001	0.058		
Quick ratio	-0.007	0.004	0.000	0.014	-0.007	0.004	0.000	0.004	-0.007	0.004	0.000	0.023		
Working capital	-0.010	0.005	0.000	0.020	-0.011	0.006	0.000	0.006	-0.010	0.005	0.000	0.033		
Accounts receivable turnover	0.039	-0.020	0.001	-0.079	0.041	-0.022	0.001	-0.023	0.038	-0.020	0.001	-0.129		
Accounts payable turnover	-0.096	0.049	-0.003	0.195	-0.103	0.056	-0.002	0.059	-0.093	0.049	-0.003	0.318		
Total asset turnover	-0.013	0.007	0.000	0.026	-0.014	0.008	0.000	0.008	-0.013	0.007	0.000	0.043		
Leverage structure	0.020	-0.010	0.001	-0.041	0.022	-0.012	0.001	-0.012	0.020	-0.010	0.001	-0.067		
Capital structure	0.007	-0.004	0.000	-0.015	0.008	-0.004	0.000	-0.004	0.007	-0.004	0.000	-0.024		
Total leverage	0.003	-0.001	0.000	-0.006	0.003	-0.002	0.000	-0.002	0.003	-0.001	0.000	-0.009		
Financial leverage	-0.015	0.008	0.000	0.030	-0.016	0.009	0.000	0.009	-0.014	0.008	0.000	0.049		
Operative leverage	-0.033	0.017	-0.001	0.067	-0.035	0.019	-0.001	0.020	-0.032	0.017	-0.001	0.109		
Leverage concentration	-0.002	0.001	0.000	0.004	-0.002	0.001	0.000	0.001	-0.002	0.001	0.000	0.006		
Coverage of interest paid	-0.161	0.083	-0.005	0.327	-0.171	0.094	-0.004	0.098	-0.157	0.083	-0.005	0.536		
Coverage of fixed costs	-0.018	0.009	-0.001	0.037	-0.020	0.011	0.000	0.011	-0.018	0.010	-0.001	0.061		
p-values	(0.000)	(0.006)	(0.458)	(0.000)	(0.000)	(0.002)	(0.518)	(0.000)	(0.000)	(0.006)	(0.456)	(0.000)		
Property, plant and equipment t-1				-0.512				-0.117				-0.656		
				(0.000)				(0.000)				(0.000)		
Knowledge t-1		0.747		-0.285		0.741		-0.154		0.747		-0.363		
		(0.000)		(0.014)		(0.000)		(0.000)		(0.000)		(0.013)		
Human resource t1				-0.122				-0.065				-0.229		
				(0.001)				(0.000)				(0.000)		
Productive services t-1	-0.006	0.003	0.000	0.012	-0.006	0.003	0.000	0.003	-0.006	0.003	0.000	0.019		
	(0.000)	(0.006)	(0.458)	(0.000)	(0.000)	(0.002)	(0.518)	(0.000)	(0.000)	(0.006)	(0.456)	(0.000)		

Table 5. Structural model: total effects

Note: p-values in parentheses. Standard errors clustered by firm.

