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Chandlerian Firms vs. Entrepreneurship

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ABSTRACT

This paper employs an original dataset for 146 US metropolitan areas to test some propositions that characterize two different models of organizing firms and industries: the managerial firm, epitomized by the work of Alfred Chandler, and the entrepreneurial system, recently highlighted by many authors. We discuss the reasons why, compared to the entrepreneurial systems, the Chandlerian world entails a lower spread of managerial salaries, greater product diversification, and a greater degree of products "exploitation" *vs* "exploration". If there are knowledge spillovers, the entrepreneurial model produces higher expected managerial salaries. By providing systematic evidence about their characteristics, our study contributes to our understanding of the nature, the comparative advantages, and the potential division of labor between the two models.

Keywords: Chandlerian Firms, Entrepreneurship, Diversification, Technology

JEL: L2, M13, J3

1. INTRODUCTION

In the early XX century the large integrated firm, as epitomized by Alfred Chandler (1990), made its appearance as a powerful new business model. This was a response to new conditions and opportunities, like the increasing capital-intensity of production, the complexity of technology, the possibility to expand geographically, and a general increase in the risk of business activities (see also Langlois 2003). Since the 1980s new entrepreneurial models, especially in technology-intensive industries and often located in specific regions, have also thrived. They are characterized by horizontal and vertical specialization, along with a propensity of managers, engineers, and skilled workers more generally to set up their own companies or to exhibit mobility of employment. Apart from classical examples, like the information and communication technology (ICT) industry (Baldwin and Clark, 1997) and Silicon Valley (Saxenian 1994), entrepreneurial models have become common in several sectors and regions (e.g. Bresnahan and Gambardella 2004).

In this paper we investigate and compare the characteristics of the Chandlerian *vs* entrepreneurial systems. There is an established literature on the managerial firm (see Radner 1992, for a survey) and entrepreneurship (e.g. Bhidé 2000; Shane 2001), but little has been done to compare the two.[1] Both models exist today, and our premise is that neither one is inherently superior. At the same time, industry characteristics explain only part of the story. For example, the software industry is organized in very entrepreneurial ways in many regions of the world (e.g. Ireland, Israel). Yet, in Germany an entrepreneurial software industry has never taken off (e.g. Engelhardt 2004), while SAP – a leading German software producer – is organized like a Chandlerian firm. There is also some hybridization. Many Chandlerian firms are taking advantage of incentive mechanisms and organizational patterns that mimic the entrepreneurial systems, while the latter have started taking into account the benefits of tighter internal organizations (e.g. Hamel 1999). Chandlerian and entrepreneurial systems may also reflect different stages of the industry life cycle, with the latter representing early stages of the industry. However, there are industries in which horizontal and vertical specialization persists, like biotechnology or laser (Powell et al. 1996; Klepper 1997) or there is even

[1] See, however, Chesbrough 2000; Audretsch and Thurik 2001.

horizontal and vertical disintegration, like semiconductors (e.g Macher, Mowery and Simcoe 2002).

In sum, the the conjecture that we would like to test in this paper is that the two models represent different ways of organizing firms and industries, which stem from different organizational and managerial attitudes and capabilities, partly independent of industry characteristics or the industry life cycle. To tackle this issue we focus on their impacts on the economy of the area in which the firms are located. This is an important question in and of itself because the presence of Chandlerian firms or entrepreneurial systems can seriously affect the local economies (e.g. Agrawal and Cockburn 2003). Moreover, it is one way to understand whether we can distinguish between two archetypical modes of organizing business activities.

We identified three realms that underlie differences between Chandlerian and entrepreneurial systems: the returns to the managerial function; the extent of product diversification; the degree of product "exploration" *vs* "exploitation". To summarize our discussion in the following sections, the Chandlerian firms tend to operate in less uncertain businesses, which reduce the uncertainty of their returns. This translates into less dispersed managerial salaries in these firms and therefore in the regions where they are present. In addition, the Chandlerian firms coordinate their internal activities. They exploit internal economies of scope to differentiate their products, and to avoid internal cannibalization between substitute products. As a result, they entail greater product or industry diversification in the region. This however comes at a cost. Time and resource constraints imply that if some managers coordinate, they cannot focus on launching or supervising products. By contrast, in the entrepreneurial systems, the firms are independent companies not coordinated by managerial labor. This also has a cost, viz. product duplications or substitutes. But a region with a larger entrepreneurial system will have fewer managers dedicated to coordination, which frees up managerial labor to be devoted to the supervision of products. To use the language of Levinthal and March (1993), this entails a greater degree of product exploration, viz. more products per managers.

The entrepreneurial system also has its peculiar trait. Especially in high-tech businesses, the firms in a cluster often enjoy inter-firm knowledge spillovers (see Tallman *et al*. 2004). As this increases the productivity of entrepreneurial activities, more managers and entrepreneurs will be attracted by them. This has two implications. First, it will raise the managerial salary in the region

because of the higher productivity of managers brought about by the spillovers. Second, as the entrepreneurial sector expands relatively to the Chandlerian sector in the region, all the Chandlerian implications are reversed. Thus, the managerial salaries are more dispersed, there is greater product specialization, and there are more products per manager.

We test all these implications by using data for 146 US metropolitan areas. We run four regressions that use the spread of managerial salaries, the average managerial salary, an index of sectoral diversification, and the ratio of trademarks (as proxy for products) to managers as dependent variables. Along with controls, we employ proxies for the presence of Chandlerian firms in the area, and for knowledge spillovers. We find evidence largely consistent with our predictions.

Our discussion so far also provides the motivation for a deeper understanding of the nature of the two business models. By highlighting their differences, we provide a basis to better disentangle their potential relationships and comparative advantages. The exploration provided by the entrepreneurial systems enhances potentially new products, yet without the Chandlerian firms there will not be enough diversification. At the same time, we highlight the alternative prospects faced by managers in the two realms. In this respect, we corroborate the conjecture that is often made that the new entrepreneurial systems imply higher but more dispersed managerial returns, while the Chandlerian firms "insure" their managers.

The next section presents our theory and hypothesis. Section 3 discusses our sample and variables. Section 4 presents our empirical results. Section 5 concludes.

2. THEORY AND HYPOTHESES

2.1 Coordination, Information, and "Conservative" Attitudes in Chandlerian Firms

Our theory hinges on some typical features of the Chandlerian firm. The first one is that they coordinate their business activities. This enables them to take advantage of economies of scope by exploiting potential synergies across products and businesses and to curtail negative externalities (e.g. substitution of the firm products by the customers). This is precisely the view that Chandler (1990) had about the managerial firm. The complexity of coordination is governed by dividing the firm in divisions, and by focusing each division on specific products or business operations. At the same time,

managerial economies of scope, as Edith Penrose (1959) also put it, are achieved by charging some other managers with the task of creating such economies among the integrated businesses of the firm, or by making sure that the division managers realize that they have to take into account the economic impact of their actions on other divisions. Thus, the Chandlerian firm holds meetings among the firm managers in the various divisions, and there are hierarchically higher managers who have the authority to resolve potential conflicts among the product or division managers. Both Chandler and Penrose emphasized that it is this managerial coordination that distinguishes the integrated corporation from a set of independent firms running their own businesses.

Another feature of the Chandlerian firms is that they exploit internal information about their businesses. This is related to coordination. To achieve the latter, each product or business activity has to know about other products, markets, or technologies of the firm (e.g. Loch *et al.* 2001). In addition, when launching new products the managers of the firm know whether such products could substitute other current products of the firm, or by contrast, they exhibit complementarities or economies of scope. This helps them better assess whether it will be profitable or not financing such new product projects. As a matter of fact, *ex-ante* project selection is one of the principal activities of the coordinating managers who can kill projects that will be unprofitable and allow only those that fit their product portfolio (e.g. Ghemawat 1991; Anton and Yao 1995). When the same businesses are run independently, such advantages from exploiting internal information and coordination are not enjoyed. Ultimately, this means that, compared to independent entrepreneurial firms, the product divisions of the Chandlerian company are better informed about the future uncertain profit of each business than if such businesses were not part of the same organization.

Finally, there is a wide literature suggesting that the Chandlerian firms are more conservative about launching new, and potentially more uncertain businesses. Several reasons have been advanced to explain such a conservative approach: a “rest on laurels” attitude due to the presence of old profitable lines of business or the fear to cannibalize them (Christensen 1997); organizational structures less conducive to creativity and novelty (Henderson and Clark 1990); strategic choices in entry timing (Mitchell 1991); agency problems (Holmstrom 1989); local learning process driving to over-investments in exploitation (Levinthal and March 1993). Along with *ex-ante* project selection

and coordination, this suggests that compared to the entrepreneurial systems, the Chandlerian firms tend to choose business activities with a more certain distribution of potential profits.

2.2 Chandlerian Organization: Not Just Size

Before discussing our Propositions, there is another point that we want to raise. In studying the growth of the modern corporation, Chandler had the large firm in mind. The question is whether being a large or very large firm is a necessary condition for exhibiting the characteristics of a Chandlerian company that we have discussed in the previous section. Of course, firm size matters in this context. The advantages of coordination and information processing are greater when there is bigness at the level of the firm, and so are the benefits from economies of scale and scope.

We maintain however that "Chandlerian-ness" is primarily an organizational model, a mode for governing firms, which is not just equivalent to size. For one reason, firm size depends on industry characteristics. Therefore, in different sectors firms can be of very different sizes, and a large firm in one industry can be small in another industry. Chandler had in mind the firms in capital-intensive sectors, which are larger on average than in other sectors. Yet, it is hard to think that the Chandlerian mode of organization is not present outside the relatively few capital-intensive sectors of an economy. At the same time, the advantages highlighted earlier – coordination, information processing, scale and scope – may accrue at different efficient scales for firms in different industries or possibly in different countries.

In sum, these attributes – as well as the conservative attitudes towards new trajectories – are correlated with firm size, but they are also partly associated with organizational features or learning processes that can be independent of it. This is because over time many firms have absorbed and adopted an organizational model that, since the 1920s or so, has proved to be rather successful. Thus, even relatively smaller firms have acquired such practices.

2.3 Main Propositions

The first implication that we want to highlight is on the dispersion of returns to the managerial function. By reducing business uncertainty, the Chandlerian firm can offer more secure salaries to their managers. This is because their greater ability to predict the profits of a given activity enables

them to commit to a given managerial salary for those operations. By contrast, the entrepreneurial system is tied to the fickle returns of their more uncertain businesses. Not only the entrepreneur, but also the managers of the entrepreneurial companies typically earn salaries that are linked to the firm profits (e.g. shares, participation to firm profits). The salaries of the Chandlerian managers are also associated in part to company earnings in the form of shares or else. But this only reinforces our argument. The greater predictability of the Chandlerian profits translates into greater predictability of the Chandlerian manager incomes. Moreover, the fraction of managerial incomes tied to company profits is unlikely to be larger than in the entrepreneurial firms. The entrepreneurs earn their entire incomes in the form of business profits, and the managers of the entrepreneurial companies are unlikely to be more insulated from the fortunes of their firms than in a well established corporation.

Proposition 1. *The presence of Chandlerian firms in a local economy implies lower dispersion of managerial salaries.*

The effect of Chandlerian organizations on the average managerial salary requires some additional discussion. One simple assumption would be that lower salary dispersion attracts skilled workers in Chandlerian firms. This would imply that other things being equal, the presence of Chandlerian firms implies lower managerial salaries, as the managers are willing to give up something in order to reduce their risk.

Another possibility is that there are differences in the managerial productivity of the Chandlerian firms that may stem from managerial competences, from the efficiency of the learning and other organizational processes, from the type of knowledge that the firm can tap. These differences can translate into different average managerial earnings across regions. However, one has to take into account the potential countervailing effects produced by the labor markets. In any region, managers can move across Chandlerian and entrepreneurial firms, and they can move from and to other regions. Yet, while the entrepreneurial earnings depend on the profit opportunity that the company, and its entrepreneur, has spotted and tries to seize, the salaries of the Chandlerian managers are likely to depend to a greater extent on the conditions of the labor market for managers. This is because the Chandlerian firms do not typically look for a particular worker, but act on the labor market

demanding "job functions", i.e. they look at an organization function requirement. A paradigmatic example is given by the two classical Chandlerian firms − Du Pont and IBM. In their web sites, the career opportunities are classified by very detailed job functions.[2] This means that the individual managers are substitutable among each other, which reduces their bargaining position vis-à-vis the firm. A larger supply of individuals who want to become managers in the Chandlerian firms is then likely to affect negatively the salary at which the managers are hired.[3] By contrast, when the same individual is an entrepreneur, her earnings depend only on the fortunes of her firms, and hence on her specific entrepreneurial ability. The same is true in good part of the managers of these firms.

In short, suppose that the Chandlerian firms in a region are on average more productive and hence the region exhibits a higher demand for managers than other regions. This produces a higher labor market salary, which attracts managers from the entrepreneurial sector and from other regions. The Chandlerian sector in the region expands (possibly at the expenses of the regional entrepreneurial sector). But the increase in the supply of managers can offset the increase in salary. Hence, other things being equal, regions with a larger and more productive Chandlerian sector do not necessarily face higher managerial salaries because the interaction between labor demand and supply work in opposite direction. Of course, there could be other explanations in this regard. However, one advantage of this explanation is that it is simple and consistent with stylized facts in the labor literature, especially that managers (and skilled workers more generally) tend to be fairly mobile.

Proposition 2. *The presence of Chandlerian firms in a local economy does not imply higher expected managerial salaries.*

Our next hypothesis is that Chandlerian coordination fosters product diversification. As a result, regions that entail a higher level of Chandlerian-ness will show higher product diversification. One reason is that coordination limits competition among the firm products. As noted, two product managers inside the Chandlerian firm are more informed about the other business. By contrast, two

[2] http://dupont.recruitsoft.com and http://careers.peopleclick.com/Client40.

[3] Of course, here we are talking about middle managers and not about the few top managers or executives for whom the decisions about salary offers is on a far more personal basis.

independent firms may not know that they are working on similar projects (especially before the products are launched on the market), or they may have very imprecise information about the characteristics of the other product, which makes it harder to differentiate the two goods. In addition, there is a "negative externality" explanation. Even when two products are developed by independent firms, they will make investments to differentiate them to escape competition. However, each product manager inside the Chandlerian firm would not only take into account the benefit of this investment on her product, but also on the other. The latter is not taken into account when choosing the differentiation effort by the independent firms. To fix ideas, consider two products A and B such that a technical modification on A will not affect A's profits, but would increase B's profits. The independent A producer will never make such an investment, while A's division manager, in a company that also has a division for producing B, will make it if the investment costs are smaller than the increase in B's profits. In short, the Chandlerian firm exerts greater efforts to differentiate their products.[4]

Apart from avoiding cannibalization, Chandlerian firms diversify to exploit synergies across product divisions. Firm diversification has been extensively explained by the literature with the realization of economies of scope stemming from internal knowledge spillovers (e.g. Henderson and Cockburn 1996), and several authors have highlighted the links among R&D, divisionalization, diversification and firm size (e.g. Argyres 1996). Among the others, Hounshell and Smith (1988) have provided an illuminating description of the role of Du Pont's R&D laboratory in fostering the firm diversification trajectories. A necessary condition to exploit scope economies is of course the *ex-ante* coordination that allows the recognition of possible project synergies.

Proposition 3. *The presence of Chandlerian firms in a local economy implies greater product diversification.*

[4] The reason why independent firms are more likely to run similar businesses compared to the Chandlerian system is even more apparent if one notes that many start-ups are spin-offs from large incumbent firms. As Klepper and Sleeper (2002) pointed out, the spin-offs bring with them knowledge that they acquired in the parent company. As they become independent, they are not constrained from running an overlapping or at least similar product business as if they were part of the same organization.

Our final implication stems from the fact that coordination is an activity that drains managerial resources. Given time and resource constraints, this means that fewer managerial resources, and fewer managers, can be devoted to the launch, management and development of specific products. To exemplify, in an entrepreneurial world *N* skilled workers bearing *N* product projects will become managers of their own projects. Thus, an entrepreneurial economy will produce *N* firms and products. Alternatively, if the *N* skilled workers coordinate to form a unique organization where they mutually reveal *ex-ante* all project information, and decide which projects to drop and which ones to run, we have a broad brush description of the classical Chandlerian organization with divisions and hierarchies. In this economy, there will be fewer than *N* projects or products because some of the skilled workers will have to spend time to coordinate and select the other projects rather than working on their own. Moreover, by definition the very *ex-ante* selection of potential projects aims at "selecting" (viz. reducing) the number of products of the firm, and we have discussed the more conservative attitude of the larger firms about new product trajectories. This reinforces the view that the Chandlerian firm has a bent towards launching relatively fewer products per managers, or to put it like Levinthal and March (1993), it has a bent towards "exploitation".

Proposition 4. *The presence of Chandlerian firms in a local economy implies fewer products per manager (exploitation)*

2.4 Marshallian Externalities in the Entrepreneurial Systems

There is an established literature suggesting that the entrepreneurial areas show increasing returns associated with Marshallian externalities (e.g. Audretsch and Feldman 1996). The typical explanation is that clusters of independent entrepreneurs share common knowledge that is available only to the firms in the clusters (Tallman *et al.*, 2004). Lampel and Shamsie (2003) use the term "industry capability", namely a pool of shared resources which the outsiders of a cluster cannot get access to. This cluster-based knowledge pool allows the firms to benefit from increasing returns that produce sustainable competitive advantages and non-standard returns (Sorenson 2003).

Knowledge spillovers produce unambiguous implications for the expected returns of the

managerial function. In the Chandlerian case, we argued that the ambiguity stemmed for example from the fact that labor market mechanisms offset productivity shocks that attracted Chandlerian managers to a region (Proposition 2). By contrast, in the cluster, a larger supply of entrepreneurs entails higher productivity of the managerial function because of the larger basis of entrepreneurial firms and projects for the spillovers. For example, knowledge spillovers may arise because of the circulation of information about research projects or products across the firms in the cluster, as implied by the mobility of managers or employees across firms or other factors. As more entrepreneurs are attracted to the region, there will be a greater number of projects or "experiments", and a greater amount of available information, which raises rather than diminish the returns of the entrepreneurs and their managers.

Dynamically, the premium in entrepreneurial earnings will attract even more managers from the Chandlerian firms in the region (e.g. spinoffs) or from other regions. The additional larger basis of firms and entrepreneurs further increases productivity and earnings. There are limits to this process. The entrepreneurial system may become congested by too many firms probably doing similar things as suggested by the specialization argument of Proposition 3. The excess competition or the congestion in the use of infrastructures may, after a point, reduce the productivity of the cluster and the entrepreneurial earnings. But as long as there are initial gains in managerial productivity, the expected managerial salaries increase – at least up to a point – and the entrepreneurial system expands vis-à-vis the Chandlerian system in the region. The Chandlerian managers will also benefit because the Chandlerian firms will have to raise the salaries of their managers to curb, at least in part, their outflow.

Proposition 5. *Local knowledge spillovers raise the productivity of the managerial function, and hence imply higher expected managerial salaries in the region. As they imply larger entrepreneurial systems, then by Propositions 1, 3 and 4, they also induce more dispersed managerial salaries, greater product specialization, and more products per managers.*

Since Marshallian spillovers and Chandlerian firms play a crucial role in our analysis, it is worth clarifying further how they influence our processes. Consider first two regions that are identical

in all respect, but one exhibits a greater presence of Chandlerian firms. According to Propositions 1-4, this region will have a lower dispersion of managerial salaries, greater business diversification, fewer products per managers, and no significant difference in the average managerial salary. By contrast, if we compare two regions that are identical but in extent of the knowledge spillovers, Proposition 5 suggests that the region with higher Marshallian spillovers will have a higher average managerial salary, as well as higher dispersion of managerial salaries, greater specialization, and more products per managers.

As another way to interpret our analysis, Table 1 depicts four possible types of regions, according to the four combinations of "high" and "low" levels of Marshallian spillovers and Chandlerian-ness. The framework that we have in mind is one in which a region can host three types of industrial activities: Chandlerian firms; entrepreneurial systems with knowledge spillovers or other externalities across firms (typically high-tech clusters); systems of "isolated" non-Chandlerian firms (e.g. small firms in traditional industries). The pure Chandlerian regions are those with high level of Chandlerian-ness and no Marshallian spillovers. In this case, the region exhibits lower risk, no salary effect, exploitation and diversification. The pure entrepreneurial cluster, with low Chandlerian-ness and intense Marshallian spillovers, will instead exhibit higher risk, salary premia, exploration and specialization. The "low-low" region, populated by "isolated" small firms, is our baseline case. The "high-high" regions will exhibit higher managerial salaries because of the premium induced by the spillovers. Whether the forces of the Chandlerian companies will prevail over those of the spillovers on salary spread, diversification and the exploration-exploitation trade-off is an empirical question depending on the actual strength of these opposite effects. We shall assess these effects in our empirical section. Our prediction, however, is that the Marshallian factors will prevail over the Chandlerian ones. One important reason is that the US job market is an open system and salary premia attract potential entrepreneurs from outside the US borders. Significant flows of high skill immigrants into entrepreneurial clusters suggest that the mechanisms that enhance their effects can be strong (Saxenian 2002).

[TABLE 1 ABOUT HERE]

3. SAMPLE AND VARIABLES

3.1 Sample

Our empirical analysis employs data on 146 US cities. We selected our sample to obtain a fairly wide variation between cities in the extent to which they are populated by Chandlerian vis-à-vis entrepreneurial companies. Specifically, we selected US cities from the locations of the firms that appear in Fortune list of the 500 largest US companies and the INC. list of 500 US fast growing start-ups.[5] Both lists are used extensively in the literature as references for the managerial firms and the start-ups. We registered all the cities in the two lists during three consecutive years, 1998, 1999 and 2000. We then selected the first 100 cities in each list after ordering them according to the number of start-ups or corporations respectively. Since a city could be in both lists, we ended up with a total sample of 146 cities.[6] The rationale of this criterion compared to alternative sample selections is that we wanted to have cities in which there was enough industrial activity to be meaningful for our analysis. Moreover, as noted, we wanted to have cities in which Chandlerian or entrepreneurial activities were somewhat more pronounced in order to rule out noisier observations in which the characterization of the city in one way or the other was less clear-cut.[7]

3.2 Dependent Variables: Salaries, Diversification and Products

For our sample cities, and for the same period 1998-2000, we collected from the US Bureau of Labor Statistics the wages and the number of employees under the occupational class "management occupations". This is a fairly wide class that includes many categories of managerial jobs, from CEOs to marketing managers, production managers and construction managers. We assigned to each city the wage data of the metropolitan areas (MAs) where the city is located according to the Metropolitan

[5] To be eligible for the 500 INC. list, a US company should: a) be privately held, not public or subsidiary, not a holding, regulated bank or utility; b) have at least a five years sales history with sales more than 200,000$.

[6] We also had to discard two cities because of missing values in some of the other variables.

[7] Our sample includes 66% of all the US metropolitan areas with population higher than 150,000. Among the excluded cities with more than 150,000 inhabitants, the three largest ones are Las Vegas, NE, Honolulu, HI and Long Beach, CA.

Areas definition of the US Bureau of Census.[8] From the same source, we collected data on the inter-quartile range of the managerial salaries in the city (difference between the 75th and 25th percentile), which we used as a measure of the spread of the managerial salary.

We then collected the stock of all the trademarks that were still alive (not abandoned or cancelled) in 2000 owned by firms located in the cities. Trademarks are combinations of "words, phrases, symbols or designs that identify and distinguish the source of the goods (or services)" (USPTO Documentation, http://tess.uspto.gov). The US trademark owners pay different types of fees for each class of goods/services for which a trademark is registered, and they have to prove periodically that they are using the trademark in the US market. The registration of the trademark is cancelled if they are not used commercially for five consecutive years after the registration date even if the owner is willing to pay the fees for it. This suggests that the trademarks are a good proxy for the product/markets in which the firms operate.[9] The front page of the trademark provides useful information – e.g. the owner's name and address, the date when a complete application was received by the USPTO (filing date), and a number that specifies the sector classification of the product or service registered. The USPTO classifies the trademarks in 48 product and service categories.[10] We downloaded all the trademarks whose owner's address correspond to one of our sample cities. The trademarks were then used to construct two indices: an index of product diversification in the MAs, computed as the Herfindhal of the shares of trademarks in the 48 product and service categories, and the ratio of trademarks to managers, as a proxy for the share of products per managers.[11]

There might be some concern that the trademarks are assigned to the cities in which the companies have their headquarters or legal representation, but not where the action takes place. The problem is not relevant for the many companies that have single locations, and that exhibit the same

[8] http://www.census.gov/population/estimates/metro-city/99mfips.txt.

[9] Moreover, trademarks have already been used in this fashion in the literature. See Seethamraju (2003) and Smith and Parr (2000).

[10] See US Trademark International Classification of Goods and Services manual (International Classification of Goods and Services -Nice Agreement), http://tess2.uspto.gov .

[11] Downloading all the trademarks for some large cities proved to be a Herculean job. For cities with more than 25,000 trademarks we then computed the diversification index by using only information on the product and service categories of a random sample of 20% of the universe of live trademarks at 2000. However, our trademark database accounts with more than 400,000 trademarks.

legal and operational location. Even in the case of large multi-location companies we found that the problem is less severe than we thought. We randomly checked a sample of large companies with the Mergent Industrial Manual (www.mergent.com) which provides data on plants, offices and other facilities for more than 2,000 top industrial corporations. The address of the headquarters in the trademark document did correspond to the presence of quite a few establishments and offices in the city. Moreover, since we are focusing on managers (and not for example on production workers) the company headquarter is the locus of a good deal of its managerial jobs.

3.3 Predictor and control variables

To capture the importance of Chandlerian firms *vs* Marshallian knowledge spillovers in our MAs, we used the fact that the two systems differ in the extent to which they rely on knowledge and competencies that are formed inside or outside the firms. As widely discussed in this paper, in the Chandlerian system a good deal of the knowledge-base and competencies of the firms are formed internally. To confirm this point further, Mowery (1983) observed that the increase of firm in-house R&D produced a growing importance of intra-firm specific resources of knowledge, especially for large firms. Moreover, the rigidity of the Chandlerian firms when facing radical changes has been interpreted as a consequence of their inward looking attitude (Henderson and Clark, 1990). By contrast, in the Marshallian type of system a good deal of the knowledge-base and competencies are formed externally in the cluster. As Saxenian (1994) put it, people thought they were employed "by the Valley" rather than by the individual firms.

Following a consolidated literature tradition (see Jaffe *et al*., 1993), to construct measures of internal and external knowledge spillovers, we collected patent data from the US Patent and Trademark Office website. We first downloaded all the patents granted in 1998-2000 in which the address of the assignee (indicated in the patent document) was one of the cities of our sample, and we matched them with the NBER US Patent Citation Dataset (Hall, Jaffe and Tratjenberg 2001). Like trademarks, a potential problem with attributing the patent to the city of the assignee is that in the case of large multi-location companies the patent may report the address of the headquarter or legal offices of the company, even if the research was carried out elsewhere. To avoid over-representation of the

patents assigned to these cities, our conservative approach attributed the patent to the city only if at least one of the inventors' addresses was in the same US State of the city.[12]

We then used the citations of these patents to construct our two measures. We first took the ratio between the total number of self-citations (i.e. citations to the same assignee) and the total citations made by the patents in the MA to be a measure of the importance of Chandlerian firms. We label this variable SELF. A larger value of SELF captures the idea that a larger share of the knowledge produced in the MA rests on previous knowledge by the same organization, as the presence of Chandlerian firms imply. As a confirmation of the fact that SELF is a good proxy for the presence of Chandlerian firms, in another paper (Gambardella and Giarratana, 2004) we find that the share of self-citations for the US States exhibits a significant positive correlation with some measures of the "fatness" of the right tail of the firm size distribution and with the intensity of firm departmentalization, measured by the ratio between number of firm subsidiaries and firm size (employees) in the same State.[13] Our measure of Marshallian knowledge externalities is the ratio between the citations made by patents in the MA to patents by unaffiliated assignees whose address is in the same MA and the total citations of the patents in the MA, with the same conservative rule that at least one inventor's address is in the same MA. This is a measure of how much the patents in the MA rely on patents granted to other institutions in the same MA. This variable, which we label REGIO, is a natural proxy for the importance of local knowledge spillovers.

As discussed in Section 2.2, the Chandlerian organizations need not be large firms. However, to check the role of firm size in the process, we collected for each MA the number of employees of all the companies with a lower bound of 1,500 employees. The rationale for the bound is that to capture the presence of large firms one needs information on the right tail of the firm size distribution in each MA. As a matter of fact, by using US Census data on the establishments located in our MAs, we found

[12] This does not rule out that there may be cities that host inventive activities by multi-location companies whose address as assignees is elsewhere. We inspected our data to check how serious this problem is, and found that it is not crucial. Note that we could not just select all the patents whose inventors were located in the city. This is because many inventors give their home address in the patent, and this can well be in MAs near the one of interest but not exactly there. Searching for all the inventors located in nearby MAs of all our patents would be quite hard. We were then forced to pre-select our patents by the address of the assignee, and then use the criterion suggested in the text.

[15] See Argyres (1996) for the rationale of this measure.

that the average employment was quite small and showed little variability across cities. This is because the overall average is determined by the very large number of quite small firms that exist everywhere. Moreover, the US Bureau of Census, which only provides data by employment classes, cuts the right tail at establishments with 1,000 employees or more. This prevented us from using these data. We used instead the database Icarus of Bureau Van Dijk, which contains the profiles of 1.4 million public and private US companies (www.icarus.bvdep.com). We experimented with two rough parameters of the right tail distribution: the average and the third moment of the firm size (employment) distribution of the companies with 1,500 employees or more. The third moment provides a better account than the average for the presence of quite large firms in the area. Of course, there is a robust correlation between SELF and firm size, as also documented by Hall *et al.* (2001). We can then assess whether measures of firm size in the MA captures the entire effect due to the presence of Chandlerian firms, or the impact of the latter is also determined by that part of the inward looking nature of the firms that does not depend on their size.

Finally, from several sources, we collected control data for each MA, particularly income per capita, and the share of population with a 4-year academic degree in 2000.[14] To control for inter-industry differences, we used the number of patents and dummies for the leading industry in the MA. The former controls for whether the MA hosts technologically intensive industries. The dummies denote the industry with the largest number of trademarks in the MA among the 48 USPTO trademark product and service categories.[15] Each industry dummy takes the value 1 for all the MAs in which the industry is the one with the highest number of trademarks (e.g. all the MAs in which "computers" is the industry with the largest number of trademarks).[16] Table 2 lists all the variables that we use in our empirical analysis. Table 3 provides descriptive statistics.

[TABLES 2 AND 3 ABOUT HERE]

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[14] The data are from www.economagic.com and www.epodunk.com,

[15] In the end only 11 of the 48 product categories are top trademark industries in at least one of the MAs in our sample.

[16] In collecting our data we do not control for firm parent affiliation. This may rule out some of the Chandlerian effects that are linked with the size issue.

4. EMPIRICAL RESULTS

We test our Propositions by running four OLS regressions. The dependent variables are the inter-quartile range of the managerial salary (SALRANGE), the average managerial salary (SALARY), our trademark-based Herfindahl index for product diversification (DIVERS), and the ratio between trademarks and managers (TMMG). As discussed in the previous section, SELF proxies for the Chandlerian-ness of the city and REGIO measures the importance of knowledge externalities. In all four regressions we use the sector dummies and the ratio between the number of patents and the GDP of the MA (PATGDP) as controls for industry characteristics (and for technologically intensive industries), and income per capita (GDPPOP) and the share of educated population (EDUPOP) as controls for city characteristics. We control for firm size by using alternatively the average (AVSIZE) and the third moment (MOM3) of the employment distribution of the companies with more than 1500 employees in the MA. We use a log-log specification. Since for some cities SELF and REGIO are equal to zero, we use the log of 1 plus the variable. The third moment of the size distribution MOM3 is typically negative. We then use $log(1 - MINMOM3 + MOM3)$ where MINMOM3 is the minimum of MOM3 in the sample.

Tables 4 reports our results where we alternatively use AVSIZE and MOM3. We experimented with several other specifications obtained by dropping some of the controls in Tables 4 or by using other controls drawn from our data sources – the unemployment rate of the MA, the share of PhDs in the population, the number of firms with more than 1500, 7000 or 15000 employees instead of AVSIZE or MOM3, or the coefficient of skewness, i.e. MOM3 over the standard error, again in lieu of AVSIZE or MOM3. All our results below, and particularly the impacts of SELF and REGIO, are robust to these alternative specifications.

[TABLE 4 ABOUT HERE]

The impact of SELF in our four regressions corroborates Propositions 1-4. This result is not affected by our use of AVSIZE or MOM3. A larger share of self-citations in the MA increases the spread of managerial salaries, and reduces both the Herfindhal for trademark diversification and the

ratio between trademarks and managers. As predicted, SELF does not have a significant impact on the expected managerial salary. The impact of REGIO corroborates Proposition 5. Knowledge spillovers induce a larger entrepreneurial sector, which in turn leads to a wider spread in managerial salaries, greater product specialization, and a greater degree of exploration as measured by a larger number of products per manager. Unlike SELF, REGIO has a positive a significant impact on the average managerial salary. Following our earlier remarks, even if the region attracts more managers or entrepreneurs, the spillovers prevent the higher supply from offsetting the increase in salaries.

The significance of SELF in spite of the inclusion of AVSIZE and MOM3 suggests that it is really the portion of SELF that is not correlated with size that matters for our results. We interpreted this to be the "inward looking" characterization of the Chandlerian system. Moreover, the impact of AVSIZE is statistically insignificant, while MOM3 is largely significant. This is not immediately relevant. What matters for our analysis is that SELF is still sizable and significant in spite of the inclusion of these variables. However, the significance of MOM3, which accounts for fatter tails, and not of AVSIZE, suggests that there is some effect associated with the presence of very large firms that is not captured by AVSIZE or SELF. In this respect, Table 4 shows that MOM3, while significant on the dispersion in salary, the diversification index and the trademarks per manager, has a smaller and not significant impact in the expected salary equation. This confirms that MOM3 behaves like SELF. That is, Chandlerian-ness is correlated with size, and particularly with the presence of some rather large firms. Yet, there is a part of it that is not correlated with size, and it is captured by our measure of inward-looking knowledge SELF.

Our evidence also supports our earlier prediction of the greater strength of the Marshallian spillovers vis-à-vis the Chandlerian firms. In a standard experiment, we kept all the other variables at their mean values. A standard deviation increase (from the mean) in SELF and REGIO in models I, III, V and VII of Table 4 produced an increase in SALRANGE of 3.3%, SALARY of 4.3%, DIVERS of 10.2% and TMMG 1.8%. The entrepreneurial spillovers seem to be stronger than the presence of Chandlerian firms. All the other covariates do not need any special discussion. They are employed just as controls, and our theory does not provide any *a priori* interpretation about them.

5. CONCLUSIONS

By employing a dataset for 146 US metropolitan areas, we tested some propositions that characterize two different models of organizing firms and industries: the Chandlerian managerial firm and the entrepreneurial system. Our evidence highlights that compared to the entrepreneurial systems, the Chandlerian world entails a lower spread of managerial salaries, greater product diversification, and a greater degree of products "exploitation" *vs* "exploration". If there are knowledge spillovers, the entrepreneurial model produces higher expected managerial salaries.

Our analysis suggests that different business models may arise not just because of differences across industries, but also in organizational and managerial attitudes and skills. This explains for example why the same industries may be organized differently in different countries or regions. The reason why this matters is that, as we found in this paper, different business models have comparative advantages. More generally, we were motivated by the observation that while many studies have focused either on the Chandlerian firms or on the entrepreneurial systems, still little work has been done to compare the two, to explain why both models exist and develop, and to deepen their implications and the potential division of labor between them.

Especially in terms of managerial returns, we highlight the alternative prospects faced by managers in the two realms. In this respect, we corroborate the conjecture that is often made that the entrepreneurial systems imply more dispersed managerial returns and wage premia only if Marshallian spillovers operate, while the Chandlerian firms insure their managers.

A better understanding of the division of labor between Chandlerian and entrepreneneurial systems is also an important topic for further research. In this paper we only found that these systems behave differently, and in potentially complementary fashions, but did not really investigate whether and how such a division of labor takes place. Another area for further research is the dynamics of the systems. With time series at the MA level, future research could investigate the evolution of industries and wage structures, focusing on regions where Chandlerian firms raised from shakeouts compared to those in which Marshallian clusters took place. Moreover, new analyses (possibly with additional data and different variables) could shed light on the correlations among different shapes of regional firm size distribution, organization "blueprints", and wage structures. This could also corroborate some of

the intuitions that we had to treat as speculations at this stage because of the cross-section nature of our study, like the downward pressures on managerial wages because of increase in their supply in regions where the Chandlerian firms are more efficient. But as researchers who aim at bridging the gap between different disciplines of economic and management studies, it was not marginal to us the deeper understanding of the interrelations among micro-behaviors, organizations and macro economic outcomes that we have hopefully highlighted with this study.

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Table 1: Impacts of Chandlerian-ness and Marshallian spillovers

	CHANDLERIAN-NESS	
	High	**Low**
High **MARSHALLIAN** **SPILLOVERS**	*Marshallian clusters & Chandlerian firms* Marshallian spillover effects dominate?	*Marshallian Clusters* i) Higher salary dispersion ii) Wage premia iii) Specialization iv) Exploration
Low	*Chandlerian world* i) Lower salary dispersion ii) No wage premia iii) Diversification iv) Exploitation	*Isolated entrepreneurs* Null condition

Table 2: Definition of Variables

Variables	Definition
Dependent variables	
SALARY	Average annual salary for the BLS occupational class "Managerial Occupations" in the Metropolitan Area (MA) in 2000 (in $)
SALRANGE	Interquartile range: Difference between the 75 and 25th percentile of the occupational class "Managerial Occupations" in the MA in 2000 (in $)
DIVERS	Herfindhal index computed across the 48 trademark sectors defined by the USPTO using the stock of existing trademarks in 2000
TMMG	Stock of trademarks in 2000 over average # of managers in the MA during 1998-2000. Managers from the BLS class "Managerial Occupations".
Predictor Variables	
SELF	Share of self citations over total citations made by the patents. (Patents granted in 1998-2000 to assignees whose address is in the MA and at least ne inventor's address is in the MA.)
REGIO	Share of citations to patents granted to unaffiliated entities located in the same MA over total citations made by the patents. (1998-2000 patents as above.)
Control Variables	
Sector Dummies	Dummies = 1 for the trademark sector with the largest number of trademarks in the MA
PATGDP	Number of patents over GDP (in million $) of the MA. Patents of the MA granted in 1998-2000; GDP in 2000.
EDUPOP	Share of population with a 4-year degree in 2000
GDPPOP	Annual GPD over Population in 2000 (in $)
AVSIZE	Average number of employees of the firms in the MA with more than 1500 employees (in 000)
MOM3	Third moment of the employment distribution of the firms in the MA with more than 1500 employees (in 000)

Table 3: Descriptive Statistics

Variable	*Mean*	*Stand.Dev.*	*Min*	*Max*
SALARY	75,555	9,398	53,243	101,114
SALRANGE	53,813	7,727	38,720	74,850
DIVERS	0.134	0.093	0.023	0.539
TMMG	0.062	0.147	0.001	1.346
SECTOR DUMMIES				
Chemicals	0.014	0.116	0	1
Cosmetics and Cleanings	0.021	0.142	0	1
Pharmaceuticals	0.021	0.142	0	1
Electrical and Scientific Apparatus	0.582	0.494	0	1
Paper Goods and Printed Matters	0.048	0.214	0	1
Clothing	0.048	0.214	0	1
Toys and Sporting Goods	0.021	0.142	0	1
Staple Foods	0.034	0.182	0	1
Advertising and Business	0.034	0.182	0	1
Insurance and Financial	0.041	0.199	0	1
Computer, Scientific and Legal	0.137	0.345	0	1
PATGDP	0.085	0.178	0.001	1.261
EDUPOP	0.239	0.070	0.084	0.377
GDPPOP	28,190	10,985	12,438	76,668
AVSIZE	21.864	6.150	11.136	67.956
MOM3	-276,006	488,679	-2,856,000	2110.3
SELF	0.063	0.063	0	0.304
REGIO	0.091	0.089	0	0.414

Table 4: Robust OLS results

	Dependent Variables							
	SALRANGE		SALARY		DIVERS		TMMG	
Models	I	II	III	IV	V	VI	VII	VIII
PATGDP	0.011 (0.253)	0.014 (0.146)	0.013 (0.097)	0.013 (0.110)	**0.078 (0.046)**	**0.097 (0.009)**	-0.047 (0.604)	-0.004 (0.964)
EDUPOP	-0.078 (0.221)	-0.058 (0.347)	-0.060 (0.286)	-0.054 (0.347)	0.310 (0.155)	**0.415 (0.043)**	-0.215 (0.701)	0.099 (0.851)
GDPPOP	**0.152 (0.007)**	**0.141 (0.011)**	**0.143 (0.005)**	**0.141 (0.005)**	0.106 (0.576)	0.045 (0.804)	**-1.696 (0.000)**	**-1.862 (0.000)**
AVSIZE	0.012 (0.811)	--	-0.051 (0.205)	--	0.131 (0.505)	--	-0.265 (0.494)	--
MOM3	--	**-0.017 (0.000)**	--	-0.007 (0.298)	--	**-0.092 (0.000)**	--	**-0.300 (0.000)**
SELF	**-0.467 (0.008)**	**-0.488 (0.005)**	0.009 (0.960)	0.026 (0.889)	**-1.838 (0.030)**	**-1.980 (0.022)**	**-6.644 (0.001)**	**-6.789 (0.000)**
REGIO	**0.706 (0.000)**	**0.705 (0.000)**	**0.480 (0.001)**	**0.464 (0.001)**	**2.448 (0.001)**	**2.460 (0.001)**	**4.492 (0.009)**	**4.345 (0.009)**
Sector Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Constant	**9.598 (0.000)**	**10.002 (0.000)**	**10.276 (0.000)**	**10.240 (0.000)**	**-3.690 (0.063)**	-1.304 (0.476)	**15.448 (0.000)**	**20.636 (0.000)**
Adjusted R-squared	0.22	0.25	0.20	0.19	0.15	0.19	0.23	0.31

Notes: N. of observations 146. P-values based on heteroskedastic consistent standard errors in parenthesis. P-values ≤ 0.05 in bold. All variables are in logs. Because SELF and REGIO can take the value zero, we used log(1+SELF) and log(1+REGIO). Since MOM3 can take negative values, we used log(1-MINMOM3+MOM3) where MINMOM3 is the minimum of MOM3 in the sample).