Talent and Information in the Production of Management:
A Note.

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Abstract

Management is a necessary factor in the centralized production of firms, alongside capital and labor, and one can model the production process by separating a production technology (the standard production function mixing capital and labor) and a managerial technology, as in Lucas (1978). Managers exert a multiplicative effect on production. More efficient managers produce more valuable output with a given amount of capital and labor than less efficient ones. Whatever managers do, they produce their managerial service more or less efficiently according to their talent for managing, the ablest ones then managing the largest firms. The distribution of firm size thus reflects the distribution of talent in the population. The latter, however, being given and most likely static, cannot explain significant changes in the distribution of firms' size that have characterized the last few decades (the downsizing trend). On the contrary, Lucas concludes that in the long run the growth of wages due to economic growth while profits tend to stagnate due to the increased volume of capital accumulated, creates incentives for managers to choose employment as wage earners rather than managerial responsibilities, thus shrinking the ratio of managers to employees and in consequence raising the average firm size. This is contradicted by the recent evolution in the structure of production, posterior to Lucas' evidence (that stops in the early 70s).

In this note I suggest that more can be said about the production of management and the changing firm size if we look at what managers do and especially their use of information. Moreover there are two distinct analytical ways to show how a growing abundance of information (the "information revolution" of the mid 1970s) determines an overall change in the distribution of firm sizes.

Keywords: Information, production of management, downsizing, information/output ratio.

JEL classification: D20, D80, L11, L22

I.   Introduction

Managers coordinate various activities within the firm and make all kinds of decisions (Lazear, 2004), replacing the decentralized production process coordinated by market exchanges with the centralized production process coordinated by administrative rule within the firm, as in Coase (1937). This was what happened during the big structural change that occurred with the second industrial revolution that took place by the end of the XIXth and early XXth century, and determined the emergence of the giant firms analysed by Chandler, Berle & Means and others (the "fordist" era). Since the main function of managers is to make decisions in the various fields of the firm's value chain (production proper, finance, personnel management, marketing, product choice and design) they require a lot of information, as more information means better decisions. Information is thus an essential factor in the "production of management", and indirectly in the production of the firm's product.

Coase described the economy of transaction costs that the hierarchically centralized process of firm production allows, as the main advantage of the centralized over the decentralized (market) process, the cost of gathering information being the main component of transaction costs. Focussing on the reason for the mere existence of firms he did not address, however, the related problem of diverse and optimal firm size and of their possible evolution.

(Rosa, 2000, 2006) shows the consequences of Coase's insight about the influence of transaction (information) costs both for the determination of firm sizes, and for the variations in optimal firm size when the cost of information is changing. This is because, in the centralized process of decision making of the firm's hierarchy, the information is concentrated at the top of the administrative pyramid where the decisions are made. For Simon (Administrative Behavior, p. 1) managing is deciding, which implies a concentration of decision making at the top of the pyramid.

The administrative pyramid is explicitly organized this way by the employment contract that specifies that subordinates have to obey the orders coming from above in the hierarchy. Since they do not have to decide much by themselves their information requirement is minimal. On the contrary the job of the manager is to decide in multiple domains. He must get a lot of information about final and intermediate products and various markets, and transforms (or incorporates) it into directives that he transmits to his employees. And since the labor contract expressly mentions the link of subordination, wage earners at all levels of the pyramid have to comply with the directives emanating from the top executive.[1]

In this process a huge amount of search for information (see Stigler for an early description of price search and information) is reduced because the specialized

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[1] In a more detailed analysis one can show as Sherwin Rosen did, that middle managers share in decision making and « enrich » the top manager's decisions. But this more complex model does not alter the understanding of the centralization process inherent in the firm's hierarchy. Lucas explicitly avoids that consideration of the firm's internal organization.

partners in exchange are already identified and do not change from period to period: they are the other employees in the firm. And the terms of within-firm exchanges are ultimately decided, in final analysis, by the manager. No supplementary information, nor bargaining, is necessary between two firm's employees. The total amount of information search is thus drastically reduced compared to the amount required in an economy-wide decentralized market production process, in which there are hundreds or thousands of potential partners in exchange. In the firm, the main usage of information for making decisions is that of the manager because he is the one who makes most of the decisions, due to the specialization of tasks inscribed in the labor contract.

The cost of this information is then spread over the volume of the firm's output. And the larger that volume, the lower the unit cost of production. Information is in fact a quasi public good within the firm boundaries, a club good (Buchanan) that should not be communicated to outside agents (the confidentiality clause in labor contracts).

It follows that the higher the cost of information, the wider should it be spread on large volumes of output in order to keep unit costs low. Thus, the higher the cost of information, the larger should the firm be.

Information is an ever present determinant of firm size, and in consequence, the evolution of its cost, its price relative to all the other prices in the economy (the general price level of Gdp output), determines the evolution of the sizes of all firms in the economy.

This is the basic reason why the spectacular fall of the price of information – the information revolution – explains the general downsizing of all hierarchical structures since the 1980s.

Modelling information in production

This mechanism can be modelled with the help of a "Coase-Rybczynski theorem" (Rosa, op. cit., Chapter 5). Large firms spread the cost of the manager's gathering of information on large output volumes, while small firms can only spread it on small volumes. It follows that considering the information input as a factor of production, alongside labor and capital, the small firms is using an "information-intensive" production process in that its ratio of information to output (information/output) is higher than that of large firms.

By the Rybczynski theorem a growing abundance of one factor of production determines an expansion of the sectors that use intensively that factor, and a contraction of the sectors where firms make a less intensive use of that factor. We can consider a broad category of small firms as constituting such a "sector", a sector not defined by their similar product but defined by their similar size and relative input use (information/labor and information/capital ratios). Small firms are characterized by an intensive use of managerial information in that their information/output ratio is high. On the contrary large firms in their "sector" have a low information/output ratio because the same quantity of managerial information can be

spread over large output volumes, and thus their information/labor and information/capital ratios are also low.

As a consequence the "sector" of large firms makes a less intensive use of information than the "sector" of small firms and the new abundance of information determines an expansion of the latter and a contraction of the former. This is precisely what has become apparent in the phenomenon of general downsizing in industrial organization since the 1980s.

Obviously, the division of the firms' population in two sectors only is an extreme simplification of reality. But it is easy to generalize the result of the Rybczynski model to several adjacent such "sectors," the size categories used in the industrial organization studies. The category of the smallest firms should expand more than the adjacent category (or sector) of small firms, which in turn should be expanding more than the next sector (category) of medium sized firms, and so on.

To conclude: when the information factor becomes more abundant in the economy the firms that use it more intensively should grow more than the firms that use it more sparingly, due to a "Coase-Rybczynski" effect. Large firms spread the cost of information on large volumes of output. Their information/output ratio thus is lower than that of small firms that use a similar amount of information to produce smaller output volumes. Small firms are thus more information-intensive than large ones, and should grow more than the large ones when the information factor becomes more abundant (by the Rybczynski theorem). Information impacts the dynamics of industrial organization and a growing abundance of information should increase the number, and reduce the size, of firms, creating more managerial jobs in the economy.

Cheaper information determines a downsizing of hierarchical structures and an increased recourse to decentralized market production. The reverse case was observed in the XIXth century when the English small arms manufacturing industry that relied on a number of individual specialists coordinated by the market, was competed out of markets by the American system of integrated corporations such as Colt and Remington employing salaried specialists as wage earners.

Complementing the Lucas managerial production model.

Another way to obtain the same result is by introducing information as a second factor in the Lucas "production of management function" or "managerial technology function", besides managerial talent. In his model, the standard production function is multiplied by the "talent" of the manager, which is the minimal form of the "production of management function". More talented managers obtain more valuable output (in terms of quality-price and quantity) per unit of capital and of labor that they use. As a consequence, the distribution of firm sizes will reflect the underlying distribution of managerial talent in the population, a result also obtained by Sherwin Rosen in a model of the internal organization of the firm's pyramid. More talented managers run the largest firms.

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For our purpose however the Lucas model is not appropriate because it implies that the general downsizing of firms of recent decades should be accounted for either by a general decrease of all managerial talent in the economy or by a general decrease of wages level since the 1980s.

These hypotheses are counterfactual.

We can nevertheless use Lucas general equilibrium framework of the job choice, and his concept of a "production of management function", to explain temporal variations in firm sizes, by introducing an information variable as an input in the management process, which is exactly what we did in the above, Coase-Rybczynski, analysis.

Information is an input that managers purchase and use in the production of the specific and specialized services that they supply to the firm.

Starting with the Lucas formulation, we can write the following managerial production function:

$$M = M (Kh, Info) \qquad (1)$$

With M the amount of managerial "production" or service,

Kh the talent level of the manager, or his managerial capital.

Info is the amount of information obtained by the manager from outside sources or by the work of his inside team of employees.

The production function of the firm then is:

$$Y = A.M(Kh,Info).X(K,L) \qquad (2)$$

Where A is a general technological factor, and X(K,L) is the traditional "managerless" production function.

Both the M( ) function and the X( ) function can be modelled as Cobb-Douglas or CES or translog depending on which specification is more adapted to the data. And the overall function of equation (2) that includes both the managerial production function and the traditional production function, could also be Cobb-Douglas or CES etc.

The choice depends in particular on the postulated elasticity of substitution between the "factor" management, and the "factor" production and the respective shares of each in total income.

In such a function, an increase in the information volume (a decrease of the cost of information) boosts the efficiency of managers of all talent levels. The firms' profitability is consequently increased and when managers share in the firm's profit

(they are then managers-entrepreneurs) the attractiveness of the job of manager is also increased. More wage earners choose to become entrepreneurs and their number, as well of course as the number of firms in the economy, increases, while the average talent of the total pool of managers decreases (due to the entry of less talented individuals). It follows that the average firm size decreases for a given total amount of capital and of labor in the economy. An increase in information availability increases the number of firms and managers, and decreases in consequence the average size of firms (in terms of number of employees, as well as of the stock of capital).

Another way to present the mechanism is that an increase in information availability, and of its use in the production of management, determines and increase in the management/production ratio.

But if the management is defined as the activity of the manager, and since there is only one manager in a single firm, by definition of the firm (see Lucas), then how could it be possible to increase the amount of management? One possibility is that the quality of management is increased and better decisions are made. Another possibility however is that the quantity of management <u>by unit of output</u> is increased. When the marginal productivity of managers is increased due to the increase of his information input, the ratio of the "management factor" to the "production factor " (or "operation factor" in the language of business economics) should be adjusted. One direct way to operate that adjustment is by reducing the volume of production output, the denominator in the M(   ) / X(   ) ratio. This means shrinking the size of the firm. More information and cheaper information leads to smaller firms.

If we simplify the above presentation as follows:

$$Y = M(Info).X(L) \qquad (3)$$

We assume that the manager's talent in M(   ), Kh is fixed, while the amount of capital in the "traditional" production function, K, evolves in step with the amount of labor, so that the ratio K/L is fixed and the function X ( ) can include only the labor factor L.

Pinfo and Plabor being the prices of information and of labor, the first order conditions for maximizing profits are:

$$Y'm / Y'x = Pinfo / Plabor \qquad (4)$$

Where Y'm is the marginal productivity of management, and Y'x is the marginal productivity of the firm's "operations".

The prices that figure in the right terms are the prices of the unique factors of production, respectively in the managerial production function M( ), and in the "traditional managerless production function" X( ).

When Pinfo falls exogenously, the ratio of marginal productivities on the left term should also fall. This implies a decrease of the marginal productivity of management (an increase in the quantity of management since marginal returns are decreasing) and an increase in the marginal productivity of "traditional production" (a decrease of

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the use of labor and capital for the same reason). Both happen when the size of the firm, in terms of the number of its employees, is reduced.

We thus come to the same conclusions than the ones obtained by the Coase-Rybczynski approach, but in a different analytical framework.

As a consequence, the conclusion by Lucas that the average size of firms should increase with the level of per capita income is <u>disproved</u> when the quantity of information grows more than the volume of output, raising the information/output ratio as in the Coase-Rybczynski theorem.

This result is empirically vindicated by the general downsizing of firms observed since the information revolution that began in the mid-1970s.

As a conclusion, an empirical test of the relationship between the increased volume of information, and decrease of its price as evidenced by the continuously falling cost of computers, telephones, and communications (internet), should provide evidence about, and explanation of, the general downsizing of firms in contemporary economies.

<u>References</u>

Chandler, Alfred D. <u>The Visible Hand</u> (Cambridge, MA: Harvard University Press, 1977).

Chandler, Alfred D. <u>Scale and Scope: The Dynamics of Industrial Capitalism</u> (Cambridge, MA: Belknap Press, 1990).

Coase, Ronald. (1937) The nature of the firm, *Economica*, 4, pp. 386–405.

Lazear, Edward. (2004), Balanced skills and entrepreneurship, *American Economic Review*, 94(2), 208-211.

Lucas, Robert E. Jr. (1978), On the size distribution of business firms, *Bell Journal,* 9, 509– 523.

Rosa, Jean-Jacques. <u>The Second Twentieth Century</u> (Grasset, 2000, Hoover Press, 2006).

Rosen, Sherwin. (1982), Authority, Control, and the Distribution of Earnings, *The Bell Journal of Economics* 13(2), 311-323.

Rybczynski, Tadeusz M. (1955), Factor Endowment and Relative Commodity Prices, *Economica*, vol. 22, n° 88, novembre 1955, p. 336-341.

Simon, Herbert A., <u>Administrative Behavior</u> (Third Ed.), New York, NY: The Free Press, 1976.

Simon, Herbert A., <u>The New Science of Management Decision</u>, New York, NY: Harper and Row, 1960.

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