

Chapter 2

Allocation of Managerial Ability and Entrepreneurial Ability

2.1 Introduction

What does a manager do? How much does a manager's decisions change the fate of a firm? Is it worth paying a talented manager \$1,000,000? Although everybody agrees on the importance of a manager's ability in a firm, traditional economics is quite silent about the role of the manager in a firm.

This paper surveys theories and empirical studies about managerial ability. In particular, I am interested in the economic impact of the allocation pattern of managerial talent. Through this survey I will ask following specific questions.

1. What is the difference between entrepreneurial ability and managerial ability?
2. What is the predicted allocation pattern of entrepreneurial ability and managerial ability? Do data support these allocation patterns?
3. Does allocation of these abilities increase productivity?
4. How do the barriers to allocate these abilities into productive positions affect economic

welfare, economic growth and inequality?

5. How does IT change these allocation patterns?

2.2 Managerial Ability and the Size of a Firm

What determines the optimal size of a firm? Kaldor (1934) wrote,

“In order to determine, therefore, the optimum size of combination, it is necessary to assume that the supply of at least one of the factors figuring in the production function should be fixed, in which case the ‘optimum size’ becomes determinate as a result of operation of the law of non-proportional returns.”

If one unit of labor and one machine produces an output of N , then 2 units of labor and 2 machines must produce at least an output of $2N$, since we can always establish two identical plants. That is, a natural assumption for a production function should be constant returns to scale or more. But if it is so, we cannot determine the optimal size of a firm. If there is a profit of \$1 with 1 unit of labor and 1 machine, a firm can make more than or equal to a profit of \$ m with m units of labor and m machines. In order to determine the optimal size of a firm, at least one input must be a fixed component.

Classical discussions, Kaldor (1934), Robinson (1934) and Coase (1937), reached the same conclusion: a manager’s ability must be the fixed component of a firm and it limits the size of the firm. This intuition is clearly formalized by Lucas (1978). In Lucas (1978), what he called “talent for managing” is a fixed factor of production. I want to call Lucas’s “talent for managing,” managerial ability. I will denote it by h_m . Assuming heterogeneous managerial ability in society, Lucas derived the distribution of firm size.

Rosen (1982) and Oi (1983) can be interpreted as a variant of Lucas (1978). Rosen (1982) explicitly modeled hierarchy, which is implicitly inferred in the Lucas model, and explains an observable relationship between firm size and earnings. Oi (1983) divided an entrepreneur’s task into two parts according to Kaldor (1934): coordination and supervision. Since time spent doing a supervisory task is proportional to the number of workers employed,

in order to reduce the time for a supervisory task, an entrepreneur must try to substitute machines for workers. Oi (1983) claimed that this explains why a large firm has more capital/worker. These span of control models have several common assumptions:

1. There exists a exogenous distribution of managerial ability, h_m .
2. The production function F is increasing in h_m and exhibits decreasing returns to scale in inputs x , that is, $F(h'_m, x) \geq F(h_m, x)$ for any $h'_m \geq h_m$, and $F(h_m, \lambda x) \leq \lambda F(h_m, x)$ for any $\lambda \in R$.
3. Managerial ability h_m is complementary to every input.

Assumptions 1 and 2 provide the heterogeneity of firm size in an industry. If assumption 1 is violated, it is optimal to distribute the same amount of resources to each firm. Hence, every firm must be of identical size. If Assumption 2 is violated, it is optimal to distribute all resources to the most talented manager.

Assumption 3 is a simple description of the hierarchy in a firm. Since a manager is positioned at the top of the hierarchy, his decisions affect all inputs. Hence a market assigns the most talented person to a large firm by paying an extremely high wage for his talent. A large firm has an incentive to pay such a high wage, since the benefits from additional talent are higher than cost. This is the nature of complementarity.

These observations are consistent with the following stylized facts, which are summarized by Rosen (1982).

1. The distribution of firms by size within an industry is skewed to the right. The relative distribution of firm size exhibits a remarkable degree of stability over time.
2. The distribution of earnings, both within and across firms, is also quite stable and highly skewed. In fact, firm size and earnings distributions have similar functional forms and exhibit similar general appearances.
3. The earnings of top executive officers of large firms are enormous in magnitude and are positively correlated with firm size. The statistical relation between top executive pay

and sales is log linear and the elasticity is approximately .03 irrespective of industry and time period.

4. Earnings within firms are closely associated with rank, that is, compensation tends to rise with positions of greater authority and control within the organization.

These observations are repeatedly mentioned by researchers. Murphy (1998) surveyed the literature on CEO compensation. He notes a remarkable stable relation between the scale of firms and CEO compensation over time, across industries and across countries.

2.3 Entrepreneurial Ability and Managerial Ability

Different strands of literature emphasize different aspects of manager's ability. Based on rich empirical studies, Schultz (1975, 1980) emphasized that education raises the ability "to interpret new information and to decide to reallocate their resources to take advantage of new and better opportunities"¹ He calls it entrepreneurial ability. He claims that the demand for entrepreneurial ability is a function of disequilibria.

His point is consistent with several pieces of empirical evidence: a firm environment that changes demands that the manager be more educated. Welch (1970) found that 1) the rate of flow of new inputs increases the marginal productivity of education in the agricultural sector and 2) the availability of information about new inputs decreases the marginal productivity of education in the agricultural sector. Similar evidence was also observed in the manufacturing sector. Bartel and Lichtenberg (1987) found that the relative demand for educated workers declines as the age of plant and particularly of equipment increases, especially in R&D intensive industries.

There is other evidence that implies the importance of entrepreneurial ability. Ree and Shah (1986) showed that education increases the probability of self-employment. Bates (1990) showed that highly educated entrepreneurs are most likely to survive. In the CEO compensation literature, Smith and Watts (1992) and Gaver and Gaver (1993) found that

¹Schultz (1980).

growth firms pay significantly higher levels of cash compensation to their executives and have a significantly higher incidence of stock option plans than non-growth firms.

Although there is plenty of evidence that emphasizes the importance of entrepreneurial ability, it is rare to find a model of it². In fact, what is the main difference between managerial ability and entrepreneurial ability? The distinction between entrepreneurial ability and managerial ability may have a clear connection with the "allocative effect" and the "worker effect" of education discussed in Welch (1970).

"It seems plausible that the productive value of education has its roots in two distinct phenomena. Increasing education simply may permit a worker to accomplish more with the resources at hand. This 'worker effect' is the marginal product of education as marginal product is normally defined, that is, holding other factor quantities constant. On the other hand, increased education may enhance a worker's ability to acquire and decode information about costs and productive characteristics of other inputs. As such, a change in education results in a change in other inputs including, perhaps, the use of some 'new' factors that otherwise would not be used. The return to education is therefore considered as consisting of two effects: a 'worker effect,' and an 'allocative effect'."

Formally we want to distinguish entrepreneurial ability, h_e , and managerial ability, h_m , as follows:

$$\begin{aligned}
V(h_m, h_e) &= \sum_s \sum_z [F(z, h_m, l(s; h_e, h_m)) - wl(s; h_e, h_m)] q(s|z; h_e) p(z) \\
\text{where } l(s; h_e, h_m) &= \arg \max_{x \in X} \sum_z [F(z, h_m, l) - wl] \gamma(z|s; h_e) \\
\gamma(z|s; h_e) &= \frac{q(s|z; h_e) p(z)}{\sum_z q(s|z; h_e) p(z)}
\end{aligned}$$

where z is a random shock, s is a signal, which the entrepreneur can observe, w is the vector of input price, l is the vector of input, $F(z, h_m, l)$ is the production function, $p(z)$ is the probability of realization of z and $q(s|z; h_e)$ is the likelihood function of a signal s given z . Hence $\gamma(z|s; h_e)$ is a simple posterior probability given s , and $l(s; h_e, h_m)$ is a manager's

²One exception is Holmes and Schmitz (1990). They emphasized the division of labor between a manager and an entrepreneur.

best response given a signal s .

I simply assume that $V(h_m, h_e)$ is an increasing function of h_m and h_e . This means that managerial ability is the ability to increase the productivity of the production function; entrepreneurial ability is the ability to select an accurate likelihood function to predict profitability z . Hence entrepreneurial ability allows a manager to allocate resources towards more profitable uses.

Notice that the essence of managerial ability in Lucas (1978) can be captured in h_m when we assume that F exhibits decreasing returns to scale in l : h_m limits a firm's size. On the other hand, h_e cannot limit a firm's size. Although we can assume that h_e is a fixed component of a firm, it has nothing to do with the shape of the production function.

2.4 Accurate information, Risk and Flexibility

If entrepreneurial ability can be formalized as the ability to know what is accurate information about unknown parameters, the literatures on stochastic optimal decision problems may give us some hint about how to investigate the property of entrepreneurial ability.

According to the Blackwell theorem (1953), for any function F and density $p(z)$, $V(A_m, A_e) \geq V(A_m, A'_e)$ if and only if there exists $\phi(s'|s)$ such that

$$\begin{aligned} q(s'|z; A'_e) &= \sum_s \phi(s'|s) q(s|z; A_e), \forall s', z \\ \sum_{s'} \phi(s'|s) &= 1, \forall s \end{aligned}$$

Several economists have used this condition to analyze the demand for information. One of the first applications was Kihlstrom (1974, 1975). He showed that the demand for information is negatively correlated with the price of information.

Although the Blackwell theorem is powerful enough to apply to any production function, in the specific context, a more tractable measure is attractive. Nelson (1961) provided just such a measure. He defined a measure of accurate information as follows:

$$H(h_e) = 1 - \frac{\int \int (z - \int z \gamma(z|s; h_e) dz)^2 q(s|z; h_e) p(z) ds dz}{\int (z - \int z p(z) dz)^2 p(z) dz}$$

Now $H(h_e)$ is an increasing function of h_e .

Nelson (1961) showed that the accuracy of information is complementary to risk and flexibility. This indicates that the allocation pattern of entrepreneurial ability might be different than that of managerial ability. I will actually derive the different allocation pattern of entrepreneurial ability in the next chapter.

But here let me ask two different questions: how robust is this complementarity? Is the data consistent with the complementarity assumption?

Entrepreneurial ability and Risk: Risk demands accuracy of information. If we agree that a new environment creates a huge risk, as I showed in the previous section, we can find several pieces of empirical evidence that support this hypothesis. But, in fact, theoretically it is not so obvious. Gould (1974) showed that it is not generally true that risk increases the value of information. So any analysis must rely on a particular functional form. Kihlstrom (1974) showed that risk increases the demand for information that is distributed normally when there agents have CES utility functions. Bandit problems like in Miller (1984) typically show that an agent prefers to experiment with a risky bandit first since it provides a learning opportunity. This is one of the questions that demands much more theoretical work.

Entrepreneurial Ability and Flexibility: Jones and Ostroy (1984) found a very general condition under which a person with accurate information prefers to stay in a more flexible position in a two period framework. Demers (1989) showed that a person who expects to have more accurate information reduces investment if investment is irreversible. Irreversible investment is a particular form of inflexibility. This is quite intuitive. Even though you have great information, if you cannot change your decision, you cannot take advantage of this information.

Although theory shows a quite robust relationship between accurate information and a flexible position, there is no empirical investigation of this claim. This is one area that needs to be seriously considered.

2.5 Allocation of Manager's Talent and a Firm's Productivity

We showed that different specifications of talent might yield different types of allocation patterns. But how important is the allocation pattern?

Little work has been done in this area, but there is some research. Baldwin (1993) showed that turnover increases the level of efficiency. Caves (1998) reviewed the literature and concluded that productivity growth for an industry as a whole depends to an important degree on the redistribution of shares towards more productive units. Davis and Haltmanger (1999) documented that 60% of a 10-year increase in multifactor productivity for the average manufacturing industry can be accounted for by effects that involve the reallocation of output across production sites. Thus the empirical literature supports the importance of resource allocation for productivity improvement.

Several papers have more directly examined the effect of managerial turnover on productivity. Lichtenberg and Siegel (1987) found that

1. A low level of TFP increases the likelihood of ownership change.
2. There has been improvement in the TFP of manufacturing plants after changes in corporate ownership.

They interpret their results using a matching model between a manager and plant: if a match is bad, then TFP is low. This will attract ownership change. The new match will most likely be better than the previous match.

On the other hand, McGuckin and Nguyen (1995) found that

1. Ownership change is generally associated with the transfer of plants with above average TFP.
2. Transferred plants experience improvements in productivity.

They interpret their results using a synergy theory. If both firms have some complementary input, there is incentive to merge.

Both McGuckin and Nguyen (1995) and Lichtenberg and Siegel (1987) found a positive effect of ownership change on TFP improvement. This implies that ownership change allocates entrepreneurial talent to a more suitable position. But there is little consistency in results on the productivity of firms before ownership. McGuckin and Nguyen (1995) argued that the different results come from the use of different datasets. Actually, the Data in Lichtenberg and Siegel (1987) covered mainly very large firms; McGuckin and Nguyen (1995) covered all sizes of firms. In fact, McGuckin and Nguyen (1995) found a negative correlation between initial TFP level and the likelihood of ownership change when they restrict their dataset to only large firms.

Although all empirical literatures focus on the effect of turnover on productivity, as I will show later, entrepreneurial ability does not necessarily increase productivity, although this can be the case. Even if it is the case, what is the proper estimate of entrepreneurial ability? I will answer this question in chapter 4.

2.6 Allocation of Entrepreneurial Ability and Economic Growth

Allocation of talent may have a larger significance than an increase in productivity. Baumol (1990) investigated historical evidence and provided the following three hypotheses:

1. The social system, which determines the relative payoffs to different entrepreneurial activities, changes over time and across regions.
2. Entrepreneurial behavior changes according to variations in the social system.

3. The allocation of entrepreneurship between productive and unproductive activities has a large effect on the innovation of technology and dissemination of technological discoveries.

Murphy, Shleifer and Vishny (1991) provided one type of formal model that clarifies Baumal's hypotheses. It shows that 1) if a talented manager is misallocated to a declining industry, this reduces the growth rate and rent seeking rewards and also prevents a talented person from becoming an entrepreneur. They also provided evidence that countries with a higher proportion of engineering college majors grow faster, whereas countries with a higher proportion of students concentrating in law grow more slowly.

Hall and Jones (1999) also provided some additional evidence that supports these hypotheses: the differences in capital accumulation, productivity and therefore output per worker are driven by differences in social infrastructure: institutions and government policies that provide incentives for individuals and firms in an economy.

Different types of literature support a similar conclusion. Parente and Prescott (1994) claimed that barriers to the adoption of new technology considerably hamper a country's growth rate. Parente and Prescott (1999) showed that monopoly may be one such barrier.

2.7 Information Technology and Entrepreneurial Ability

Information technology changes the demand for skills. Many labor economists have documented that information technology and organizational change increase the skill premium. They might provide different assignment structures for ability.

Krueger (1993) investigated the direct impact of computers on wages. He found 1) that workers who use computers on the job earn 10 to 15 percent higher wages and 2) that the expansion in computer use in the 1980s can account for one-third to one half of the increase in the rate of return to education. Autor, Katz and Krueger (1998) also found that the rate of skill upgrading has been greater in more computer intensive industries.

Corresponding to Krueger (1993), DiNardo and Pischke (1997) argued that the corre-

lation between higher wages and computer use just reflects that higher wage workers use computers on their jobs, since the wage differential is associated not only with computer use but also with the use of pens. Doms Dunne and Troske (1997) support this view. They found that plants that adopt a large number of new technologies employ high wage workers both pre and post adoption.

What kind of skills does computer use demand? Bresnahan (1997) showed that

1. Computer decision making is a substitute for low- and middle-skill white collar work, but the computer is not a substitute for a high-skilled worker's job.
2. IT demands organizational change, so that it creates an organizational complementarity between IT and high-skilled workers (i.e., cognitive skill).
3. This organizational change demands interpersonal skills.

Murnane, Levy and Autor (1999) found that computers substitute mainly for routine tasks.

It seems that a person who has entrepreneurial ability demands information technology more than a person who has managerial ability. The intuition is that if you know which information is more important, you have more incentive to collect this information. Empirical studies also suggest that IT requires broad organizational change. This may also be consistent with the idea that accurate information is complementary with flexible organization.

Again, there is no clear evidence and theory. This is one field that needs more work.

2.8 Conclusion

In this chapter, I surveyed a number of different literatures' views on managerial talent. I have shown that there is a distinct difference between managerial ability and entrepreneurial ability. Managerial ability can be formalized as the ability to increase the productivity of

a firm, which limits the size of the firm; entrepreneurial ability can be formalized as the ability to know accurate information given unknown shocks.

I have also shown that these different abilities might have different allocation patterns. The aforementioned literatures focus on managerial ability and conclude that a talented person will be assigned to a large firm. But stochastic decision theory indicates that entrepreneurial ability should be allocated to a different firm, like a risky firm or a flexible firm. Clarification of this point is the main purpose of the next chapter.

I also show that the allocation of talent may have a huge impact on the productivity of firms, industries and economic growth. But I will also suggest that we need a clearer estimate of entrepreneurial ability. This is the main purpose of chapter 4.

Finally I will claim that the IT revolution changes the demand for skills. This is one of the next topics that needs to be investigated.