

Limited Entrepreneurial Attention and Economic Development

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ABSTRACT. Economic development depends on the allocation of entrepreneurial resources to efforts to discover new profit opportunities. Limited entrepreneurial attention is allocated between maintaining current activities and starting new activities. This paper addresses the problem of allocating limited entrepreneurial attention in a variety of contexts. The issues that are addressed are product improvement and new product development; the choice of career as an innovative entrepreneur, a managerial entrepreneur or a salaried employee; the venture capitalist's attention to current and new ventures and funds; the writing of internal contracts and market contracts and the supervising of current employees and hiring additional employees.

If we seek to explain the success of those economies that have managed to grow significantly, compared with those that have remained relatively stagnant, we find it difficult to do so without taking into consideration differences in the availability of entrepreneurial talent and in the motivational mechanisms that drive them on.
(Baumol, 1993, p. 5)

In my speaking to women's business groups, my favorite metaphor of the business owner is the man on "The Ed Sullivan Show" who balanced spinning dinner plates on the ends of tall sticks. Just as he had fifteen spinning, one would start to wobble and then another and then another.
(Anita F. Battina, *Inc.* May, 1993.)

1. Introduction

William Baumol argues in his new book that the amount of entrepreneurial activity in an economy during any period of time depends on two characteristics of the economy: the amount of entrepreneurial resources that exist and how those

resources are allocated among productive and unproductive activities. The allocation of entrepreneurial resources, as with any resources, is affected by the relative rewards to the various possible activities. These rewards themselves are dependent on the "rules of the game", such as property rights, patent protection, legal institutions, etc.

All entrepreneurial activity, productive and unproductive, involves the recombination of resources. However, productive activities generate new products and services. It is the creation of these new products and services which creates new jobs and promotes economic development. The more productive entrepreneurial activity there is, the faster the economy develops. However, one of the difficulties in analyzing the role of entrepreneurs in economic development is understanding what it is that entrepreneurs do and how to encourage more productive entrepreneurial activity.

As Baumol argues, not all entrepreneurial activity is virtuous, in the sense of being good for the economy as a whole. Some activities merely reallocate wealth. Entrepreneurs, however, will allocate their resources to those activities which reward them the most. Some of these activities may actually reduce the growth of the economy. It is not always obvious which activities are productive and which are unproductive. For example, consider efforts by the management of a public corporation to prevent hostile takeovers which threaten their positions. Golden parachutes, which are compensation packages for current management in the event of a hostile takeover, appear to be nothing more than a wealth transfer from stockholders to management. If this is true, then this in and of itself is not inefficient, but all resources expended in obtaining these contractual arrangements are wasted resources since they are diverted

Final version accepted on July 22, 1996

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from productive activities. However, as Baumol points out, the golden parachute may not be inefficient if it elicits more investment of management's entrepreneurial human capital in the firm because there is a guaranteed return to this investment. Therefore, the golden parachutes may or may not be productive.

Before we can promote productive entrepreneurial activity we must also ask how entrepreneurial resources are allocated. But what are these entrepreneurial resources that make these new products possible and promote the development of an economy? How much of these resources are there and what determines their allocation? Israel Kirzner (1979) argues that the essence of entrepreneurship is alertness to new profit opportunities. But to be alert to new opportunities requires that the entrepreneur allocate attention away from other matters in order to observe a new profit opportunity. A person who is completely absorbed in dealing with current activities may not notice a twenty dollar bill lying on the ground. Opportunities do not often just fall in a person's lap.

But this diversion of attention away from other matters implies that entrepreneurial activity has an opportunity cost: the neglect of other, perhaps more routine, activities. It is this opportunity cost and the entrepreneur's belief that there are profit opportunities to be alert to which determine the amount of entrepreneurial resources forthcoming, the amount of entrepreneurial activity, and the rate of development of the economy. And, as Baumol argues, it is the payoff structure of these new opportunities which determine how entrepreneurial attention is allocated among them.

Therefore, it is imperative to analyze the ways in which institutional arrangements and payoff structures affect the allocation of entrepreneurial resources. The thesis of this paper is that to analyze economic development, we must take into account the payoffs to and opportunity costs of limited entrepreneurial attention. My research has focused on the optimal allocation of limited entrepreneurial attention between current, routine activities and innovative activities, with a variety of applications. In this paper I will describe how I think this research relates to Kirzner's theory of entrepreneurial alertness and Baumol's theory concerning the allocation of entrepreneurial resources among productive and unproductive activities.

The importance of limited entrepreneurial attention has been recognized among economists for some time.¹ When Adam Smith writes, in 1776, about the incentive problems arising from the separation of management from ownership, he describes the attention requirements of overseeing a joint stock company. He provides a very graphic description of the demands on the attention of the primary decision-maker of any firm. Nicholas Kaldor in 1934 points out that limited attention implies a fixed input into the problem of coordinating activities, which includes the choice of which activities to engage in. John Commons observes in 1934 that a decision maker cannot do everything at once, but must devote his limited attention to the most important issue at any moment. Friedrich von Hayek argues in 1945 that the limits of attention, combined with the dispersion of knowledge, result in a limit to the feasibility of central planning. Kenneth Arrow points out in 1974 that the limited capacity for acquiring and using information implies a bottleneck in information processing and diminishing returns to increasing information resources. All of this implies that there is no such thing as free information. All information must be processed before it can be useful and the attention required for information processing has an opportunity cost.

Organization theorists have analyzed the implications of limited attention under the heading of 'span of control'. Chester Barnard, in 1938, following Commons, argues that one of the roles of organizations is to focus the attention of employees among alternative current operations to maintain coordination. The role of attention in gathering information is addressed by James March and Herbert Simon in 1958 when they describe the decision-maker who can do only one or a few things at a time and can attend to only some of the information available. Alfred Chandler points out in 1977 that, as firms grew during the industrial revolution, the limits to the span of control led to the development of professional management to routinize activities in order to maintain control as the firm increased in size.

My research has focused on developing an analytical (read, mathematical) model that captures the issues addressed in this more descriptive literature. This allows us to draw out more specific and detailed implications of limited attention. The

allocation of limited time has been modeled mathematically by others, starting with Gary Becker in 1965. However, in these models, the number of targets for attention is fixed. In my model, the number of targets among which attention is to be allocated is determined by the allocation of attention itself. This is because limited entrepreneurial attention can be allocated to acquiring additional activities. The issues that have been addressed by my research are the choice between current product improvement and new product development; the choice of career as an innovative entrepreneur, a managerial entrepreneur or a salaried employee; the allocation of a venture capitalist's attention between current and new ventures and funds; the choice between writing internal contracts with employees and writing market contracts with other firms and the choice between supervising current employees and hiring additional employees. The last topic concerns the optimal completeness of employment contracts, the internalization of transactions, monitoring intensity, performance standards, efficiency wages and promotions.

The quote at the beginning of this paper provides an analogy which makes the structure of the problem intuitively clear.² Imagine a juggler on the "Ed Sullivan Show" who is rewarded according to the number of plates she can spin on the tips of long sticks on a table. The plates are the targets of attention and the juggler allocates limited attention between respinning old plates and setting up new plates. Assume that there is an unlimited supply of plates and sticks (and table top). As soon as one plate is spinning, she can set up another one. However, as she continues to set up additional spinning plates, the first one starts to wobble, threatening to fall.

The choice the juggler faces is to either continue to set up new plates or to go back and try to respin old plates. The best course of action depends on two characteristics of these plates: their balance and their tendency to break if dropped. A balanced plate is easy to set spinning while an unbalanced plate cannot be spun successfully. Only a fraction of new plates, however, are balanced and spin successfully. The probability that a new plate is balanced affects the expected value of trying to spin a new plate. Plates that have already been spun successfully are balanced and

so can be easily respun. However, plates that have fallen may be cracked or even broken and no longer spinnable. The tendency of plates to break affects the expected value of trying to respin old plates. If plates break easily then the expected value of trying to respin old plates is low.

It turns out that there are two optimal plans of action. One is to continue to set up new plates and let the old ones fall and be freely discarded. This is optimal if most new plates are balanced and the breakage rate is high. The other alternative is to respin each old plate periodically and then try to set up a new plate when not respinning an old plate. This is the best course of action if few new plates are balanced and old plates do not easily crack or break. This reflects Kirzner's concept of entrepreneurial alertness. An entrepreneur who already has many activities (plates) to which to attend will not be alert to new opportunities because all attention is focused on current activities.

With this analogy we can now discuss the entrepreneurial problems to which this model has been applied and the implications of limited entrepreneurial attention. These applications include the innovation of entrepreneurial firms, the choice of career for entrepreneurs, the relationship between the entrepreneur and the venture capitalist and the hiring and monitoring of employees. I will close with a discussion of the allocation of entrepreneurial attention between productive and unproductive activities. All of these applications consider entrepreneurial firms and so assume that the entrepreneur's responsibilities are not delegated to employees. This effectively limits the amount of attention which can be devoted to the entrepreneurial activities. However, each application requires some modification of the basic model in order to more accurately represent the unique nature of each of these specific problems.

2. Innovation versus product improvement

In Gifford (1992a) the model is applied to the problem of allocating entrepreneurial attention between innovating new products and using product improvement to maintain the profitability of current product lines. Product lines represent the plates. In both cases the entrepreneur is actively involved in the decision-making and does

not delegate these decisions to others. The implication of the optimal allocation is that there are two best courses of action. The first is that the entrepreneur constantly attempts to innovate new products and discontinues products lines which are no longer profitable. The second is to improve each current product periodically and innovate only if no current product is being improved. The model has implications for the innovativeness of entrepreneurial firms and its dependence on monopoly profits and firm size, and the optimal firm size and rate of growth of the entrepreneurial firm.

In this model, the balance and breakage of plates represent two characteristics of innovation: opportunities for new inventions and opportunities for product improvement or process innovation. The first is called technological opportunity since it is usually technological breakthroughs which generate opportunities for innovation. The second has no common expression so I have adopted the term "durability" to reflect the current product's resistance to economic obsolescence.

The first implication of the optimal allocation of attention is that the entrepreneur conducts product improvement only if the durability of current products is sufficiently high relative to the degree of technological opportunity. This means that greater economic obsolescence, resulting in less durable products, increases the amount of entrepreneurial activity devoted to new product innovation. This obsolescence may be due to innovations from competitors which make successful improvements in the current product difficult. This can have a ripple effect through other firms. For example, the automobile made the horse-drawn buggy obsolete which in turn made the buggy whip obsolete.

Another implication is that the rate of new product innovation is dependent on firm size and monopoly profits only if the firm conducts product improvement as well as new product innovation. In this case, each current product line is improved periodically and as firm size grows, there is less time to devote to new product innovation. In addition, if current products are periodically improved, then greater monopoly profits means that current product lines do not have to be improved as frequently and so the firm can maintain a greater number of them. This implies

that new product innovation is increasing in monopoly profits. However, if the firm makes no attempt at improving current product lines, then all attention is focused on innovating new products and the rate of innovation is constant, independent of firm size and monopoly profits. In addition to the dependence of firm size on monopoly profits, the model also implies that, if current product lines are periodically improved, then the maximum firm size is less than if the entrepreneur conducts only new product improvement.

Therefore, improving current products because economic obsolescence is low diverts attention from innovating new products, which is the source of firm growth. In Acs and Gifford (1996), empirical tests of the results of this paper offer support for the effect of economic obsolescence of current product lines on new product innovation and its dependence on firm size and monopoly profits. However, new product innovation is not an end in itself. The generation of permanent jobs through the maintenance of product lines which are not subject to obsolescence also fosters economic wellbeing. The implication here is that growth has a cost: the neglect of other activities.

3. Innovator or manager

Gifford (1993) applies the model to the problem of the individual's choice of career between being an innovative entrepreneur, a managerial entrepreneur or a salaried employee. This choice will depend upon two characteristics of the individual: innovative ability and managerial ability. Innovative ability is the ability to recognize a new profit opportunity once attention has been focused on it. Managerial ability determines the entrepreneur's ability to manage the production of a product line once it has been introduced. A career as an innovative entrepreneur implies constant innovation while a managerial entrepreneur also allocates attention to managing current operations.

A career as an innovative entrepreneur is best if innovative ability is high and managerial ability is sufficiently low. A career as a managerial entrepreneur is optimal if managerial ability is high and innovative ability is low. This all appears perfectly obvious. However, as the wage rate of salaried employees rises, innovative entrepreneurs disappear but there will always be managerial entre-

preneurs for any wage rate. Notice that this is not socially suboptimal, since entrepreneurs are allocating their resources to the highest valued use, and there are no information or market imperfections which might result in inefficiencies.

However, one might want to extend this analysis and ask how entrepreneurial ability might be increased through training. Most business schools in the U.S. focus primarily on managerial training, as opposed to training entrepreneurs. Until now, with increasing numbers of middle management jobs available, this appears to have been the appropriate balance. However, a shift in focus may be advisable now that firms are downsizing and reducing the ranks of middle management. Most of the displaced middle managers will be looking at self-employment as an alternative.

In addition to predicting career choices, the model also predicts a diversity of the composition of R&D effort. The composition of R&D comes from the fact that innovating new products carries an opportunity cost embodied in the neglect of current operations. Firms with high entrepreneurial ability conduct only new product innovation, independent of monopoly profits and firm size. Firms with high managerial ability, facing the same technological opportunity and entry of competition, conduct both new product innovation and process innovation (or product improvement). For these latter firms, the new product innovation will be increasing in monopoly profits and decreasing in firm size and process innovation will increase with firm size. In addition, for these firms new product innovation and process innovation are inversely related.

Finally, this application reverses the direction of causation between innovation and firm size from that proposed in Schumpeter (1934). As Dosi (1988, p. 1153) states: "Big firms happen to grow big because they innovated successfully in the past and continue to do so in the present without, however, finding a differential advantage in 'bigness' as such." Rather than taking the size of the firm as exogenous and asking how that determines innovativeness, the model of limited entrepreneurial attention lets the size of the firm be determined by the entrepreneur's ability to increase its size through new product innovation.

4. The entrepreneur and the venture capitalist

Another important determinant of economic development is the availability of venture capital for high technology startup firms. However, financial capital is not the only resource required by venture capitalists. They also invest a great deal of time searching for and incubating new ventures. Gifford (forthcoming) models the allocation of a venture capitalist's limited attention between current ventures and acquiring new ventures. A venture capitalist (general partner) allocates limited attention (time) between evaluating new ventures and supervising and consulting with current portfolio ventures. The optimal allocation determines the optimal frequency of meetings with the entrepreneur and the optimal termination date at which the venture goes public. The opportunity cost of attending to an incubating venture is the foregone evaluation of new ventures. This opportunity cost implies that the venture capitalist wants to have fewer and less frequent consultations with the entrepreneur than is required to maximize the entrepreneur's return. This explains Bill Sahlman's observation that "[t]he seemingly irrational act of shutting down an economically viable entity is rational when viewed from the perspective of the venture capitalist confronted with allocating *time* and capital among various projects" (Sahlman, 1990, p. 507, footnote 12, emphasis added).

Since the model implies that the value of the venture to the entrepreneur can be increased with more attention from the venture capitalist, it is natural to ask if the entry of additional venture capitalists would supply these additional consultation services. However, the assumption of free entry does not mitigate the incentive problem between the venture capitalist and the entrepreneur but increases it. Entry of additional venture capitalists occurs when the price paid for venture capital services is greater than the zero profit price. Entry then reduces this price, increases the number of ventures held by any one venture capital fund but reduces the frequency and number of consultations which each venture receives. Therefore, we have a further divergence of interests with the entry of additional venture capitalists. However, entry does increase the average fund size and the upper bound on firm size and so the number of funded ventures.

Since the assumption of free entry does not remove the divergence of interests between the venture capitalist and the entrepreneur, but in fact increases it, we must ask whether this outcome is not, in fact, socially optimal. I show that maximizing the value of the firm to the entrepreneur is not socially optimal, while maximizing the venture capitalist's value is socially optimal. This is because the entrepreneur bears none of the opportunity costs of the venture capitalist, so these profits do not reflect net social gains. In addition, if investors have information costs and the venture capitalist is compensated for the operating costs of the venture fund through the carried interest and management fees paid by the limited partners, then the outcome above may be Pareto preferred to the outcome which results when there are no venture capitalists playing the role of financial intermediary.

The model implies that we should see contracts between venture capitalists and entrepreneurs which stipulate the venture capitalist's allocation of time to the venture or the date of the initial public offering (IPO). A possible explanation for the lack of such contracts is the inability to specify in advance what the appropriate amount of time and IPO date would be. As suggested in Holmstrom and Milgrom (1990), for multi-task agents, providing incentives for some measurable task, such as the number and frequency of the venture capitalist's consultations with the entrepreneur, can divert attention away from other, unmeasurable tasks, such as the quality of these meetings.

With the timing of the IPO, the decision to go public depends strongly on market conditions, so this decision cannot be made years in advance, either. Although market considerations are not included in the model above, they would only add a stochastic element to the IPO timing. In addition, if the venture capitalist remains actively involved in the venture past the date of the IPO, then the date of the IPO is not relevant to the analysis above.

There are several other implications of this model when ventures are homogeneous *ex ante*. As expected, increased opportunities for new ventures decrease the frequency and number of consultations between the venture capitalist and the entrepreneur. An increase in the share of the

venture going to the venture capitalist increases the frequency and number of consultations. In addition, an increase in the opportunities for new ventures increases the upper bound on the size of the venture capital firm and the long run expected firm size.

However, when we consider ventures with different rates of decline in profits, we find that a venture with a lower rate of decline in profits has less frequent consultations and a fewer number of consultations. In addition, the venture with the lower rate of decline pays a lower share of the venture's value to the venture capitalist in order to be funded. This implies that the venture capitalist's compensation is increasing in the amount of attention the venture receives.

If the venture capitalist manages several different venture funds then the limited partners of any one fund are in the same predicament as the entrepreneur of a single venture. The venture capitalist allocates limited attention between managing the existing funds and raising financial capital for new funds. Each fund's limited partners do not share all the consultation costs, just as the entrepreneur does not, and so the venture capitalist does not maximize the income of the limited partners. However, as before, this is not inefficient. It only means that the venture capitalist should be rewarded by each fund according to the amount of consultation resources it uses. This hypothesis is supported by Gompers and Lerner (1994) where they find that compensation based on asset value is being replaced with compensation based on consultation costs. In the latter case, venture funds with higher effort requirements to monitor the ventures also have higher compensation.

Recent research has shown that venture capital investments have tended toward later stages in the ventures' development. This results in safer investments with more rapid returns. An increase in investments in late-stage ventures and LBO's and a decrease in investments in start-ups between 1983 and 1987 suggest that the investment-based fee is diverting venture capitalists away from their proper role, "building companies" (Schilit, 1991, p. 59). This shift of investment capital has been attributed to the need to economize on the general partner's attention because these ventures require less of the general partner's assistance (Timmons

and Sapienza, 1992). These later stage investments include leveraged buyouts in which the company and its management are well established and the only service provided by the venture capitalist is financing.

If a more mature venture means that its deterioration rate is less, then this implies the venture receives less frequent attention and a fewer number of evaluations from the general partner. However, if mature ventures are less responsive to the general partner's efforts, then this also implies that attention is allocated to this venture less frequently and a fewer number of times. In either case, more mature ventures receive less attention. I show that if the limited partners prefer less mature investments to more mature investments and the general partner's share of the fund is small relative to the opportunity cost of time, then the general partner prefers more mature investments than the limited partners do. This is because the more mature investments receive less attention, the cost of which is born by the general partner but not the limited partners.

This analysis explains the complaints of entrepreneurs that venture capitalists are out for a fast buck. However, it also shows that this is not necessarily a bad thing. When the costs of the venture capitalist's time is taken into account, we see that it is socially optimal to refuse to maximize either the limited partners' or the entrepreneur's profits by allocating attention to other funds or ventures.

5. In-house or out-source

Since it is common to define entrepreneurial activity as any reallocation of resources which produces new products or service, we can apply the model to problems which are not as obviously entrepreneurial as the last three. One part of the process of innovation is the decision of what to create. Another part of this process is the decision of how to produce it. We turn next to the decision of whether to produce a product or service oneself, by hiring the necessary employees, or buy it from another firm through a market contract. And if produced in-house, then how are the employees to be monitored, motivated and compensated? These questions are not traditional questions of entrepreneurship. However, these questions must be

answered before a new product or service can be introduced and in each of these cases, attention is allocated between current activities and acquiring new activities. Since the definition of entrepreneurial activity covers the allocation of attention to acquiring any kind of new activity, writing contracts and hiring employees are also entrepreneurial activities. This section considers the problem of whether to produce oneself or to purchase goods over markets. Section 6 turns to the question of how to motivate employees if one chooses to produce in-house.

In Gifford (1994a) and (1994b), limited attention is allocated between writing new contracts with other firms and writing and directing internal employment contracts. In the first case, the entrepreneur interviews and negotiates new contracts which are carried out by other firms while in the second case, the entrepreneur hires employees who carry out the contract but also are monitored by and receive direction from the entrepreneur. This monitoring and directing of employees diverts attention away from writing new contracts.

There are two primary issues addressed by these papers: 1) which transactions should take place between firms (over markets) and which should take place within the firm, and 2) how much time should be spent writing these contracts, whether market or internal, in an effort to make them more complete. Following Coase (1937), internal transactions are those which are directed by the entrepreneur. Transactions within the firm are distinguished from those over markets by the coordination mechanism: "co-ordination is the work of the price mechanism in one case and of the entrepreneur in another" (Coase (1937, p. 389). Market transactions, once entered into, receive no further attention from the entrepreneur since they are directed by the price system. As noted by Hayek (1945), the advantage of transacting across markets is that markets allow us to "extend the span of our utilization of resources beyond the span of control of any one mind" and to "provide inducements which will make the individuals do the desirable things without anyone having to tell them what to do."

The model is extended here to determine the amount of time spent writing contracts. The performance of a contract, whether internal or market, depends on the completeness with which it is

written. The completeness of a contract depends on how much time is spent writing contingencies. Much of the economic literature on contracts assumes that comprehensive contracts which specify the required performance and compensation for all contingencies are impossible to write. The justification for this assumption is based on the combinatoric problem of listing all possible contingencies, the possibility of unforeseen circumstances, the imprecision of language, and the opportunity cost of time spent writing contracts. My model endogenizes the costs of writing more complete contracts, which is embedded in the neglect of other current contracts. This essentially formalizes the combinatoric problem of listing contingencies.

Both the type of contract and its completeness are shown to depend upon the entrepreneur's abilities to find new trading partners and to direct internal contracts. Think of contracts as the spinning plates. Then the ability to direct a contract is reflected by the ability of the juggler to respin old plates (resistance of the plates to breakage) and the ability to find new trading partners is reflected in the ability to spin new plates (proportion of new plates that are balanced). The completeness of a contract determines the rate at which profits from a neglected contract decline over time. This is reflected in the initial spin that a plate receives. The more time spent spinning the plate (writing the contract) the faster it spins (more complete the contract). The faster the initial spin (more complete contract), the longer the plate continues to spin unattended (better performance).

The two best courses of action are to either write only internal employment contracts and direct each employee's activities periodically or write only market contracts with other firms and let the other entrepreneur direct his or her employees. With this model I am able to show that the completeness of internal contracts is decreasing in the ability of the entrepreneur to direct the contract and increasing in the ability to find new trading partners. A higher ability to direct the employee as contingencies arise implies that they need not be included in the initial contract. The negative effect of the ability to direct the contract is intuitively appealing. If contingencies can be dealt with later as they arise then this

reduces the need to consider all contingencies in the initial contract.

The result that an increased ability to find new trading partners increases the completeness of the contract is counter-intuitive, since writing new contracts with other parties is an opportunity cost of spending more time on any one contract. Since this opportunity cost increases with an increase in the ability to find new trading partners, one would expect that the entrepreneur would spend less time writing any particular contract if this opportunity cost is higher. However, a more complete internal contract receives less frequent direction and so allows the entrepreneur to allocate more attention to the search for new trading partners which has a high probability of success. Thus the opportunity cost of attending to current contracts implied by the probability of writing a new contract manifests itself in more complete internal contracts and a reduced frequency of attending to them.

Optimal internal contracts are found to be less complete than optimal long term market transactions because contingencies can be dealt with as they arise. That is, market contracts take longer to write and are more complete, *ex ante*, than internal contracts. The intuition of this is that internal contracts can be less complete because they can be directed at future dates, whereas long-term market contracts are not directed at future dates and so more contingencies are included in the initial contract.

Internal contracts are optimal if the internal governance power (ability to direct contracts) of firms is sufficiently high relative to the governance power of the price system (ability to find new trading partners). This reflects Coase's argument that internal transactions are preferred if it is sufficiently difficult to "find the relevant prices" for market transactions. If prices are not posted or quality is not observable or enforceable, for example, finding suitable trading partners over markets may be sufficiently difficult to make internal contracts optimal.

Also, transactions are internalized if the number of market transactions which are replaced by the internal contract is not too large. Therefore, even if the entrepreneur's ability to direct an internal contract is greater than the ability to find another trading partner, market transactions are optimal if

the number of market transactions that would be replaced by the internal contract is large enough. This depends on the optimal amount of time to spent writing both internal and market contracts.

Transaction-specific investments introduce the other source of market transaction costs: opportunistic behavior by one party to extract quasi-rents from the party which has made transaction-specific investments. Limited attention implies that, if opportunism increases with transaction-specific investments, then the critical governance power of hierarchies above which transactions are internalized decreases. Internal contracts are preferred to long-term market contracts at a lower governance power of internal contracts if there are transaction-specific investments.

The another issue of the internalization of transactions addressed in my research is the size of the firm, as measured by the number of employees. As before, the bound on firm size, that is, the maximum number of internal contracts that can be directed by the entrepreneur, is bounded away from a larger firm size which would be more valuable if it could be attained instantaneously, that is, without allocating the entrepreneur's attention to writing the contract. Therefore, as hypothesized by Kaldor (1934), limited entrepreneurial attention implies a bound on firm size because it limits the number of contracts which can be acquired and coordinated.

This result of this analysis of contracts contradicts the accepted wisdom of the effect of transaction costs on the internalization of transactions. I show that the bound on firm size is increasing in the governance power of markets and is decreasing in governance power of internal contracts. If the governance power of markets is inversely related to transaction costs and the governance power of internal contracts is inversely related to what Demsetz (1988) calls management costs, then this implies that the bound on firm size decreases with transaction costs and increases with management costs, contrary to intuition and the assertion by Demsetz (1988) that an increase in transaction costs increases firm size. The negative effect of transaction costs on firm size is due to the fact that to internalize operations, say by acquiring another firm, requires one more transaction across markets: the purchase of the other firm. The positive effect of management costs on

the bound on firm size is due to the fact that the high management costs of maintaining operations implies a low opportunity cost of attending to writing new internal contracts. These counter-intuitive results arise again when I consider average firm size. I find that the average firm size is decreasing in market transaction costs; however, the number of firms is increasing in transaction costs. Therefore, transaction costs may increase or decrease both types of trades, internal and market. The number of market transactions is also decreasing in market transaction costs.

When I allow transaction costs to be determined by the allocation of attention, I can trace the evolution of the economy. Assuming that the governance power of markets increases with the number of market transactions, I find that there are two conditions which must be satisfied for economies to convert to markets. The exogenous increase in market governance power must be sufficiently large to increase the number of market transactions and to motivate the marginal firm to convert to markets and the market governance power must be sufficiently responsive to an increase in the number of market transactions to continue the process. Under these conditions, this exogenous increase in market governance power will lead to an purely market economy with no internal transactions. In addition, an economy with more entrepreneurs converts more easily to market transactions.

The hope is that this analysis can be applied to the problem of the transition from a command economy to a market system. If an economy lacks the kind of legal institutions that result in low transaction costs, then efforts to transform the economy to a market system may fail because transaction costs result in little trade over markets and so there are continued high transaction costs.

6. Employee monitoring, performance standards and compensation

Once an entrepreneur has decided to produce a new product or service, the next problem is to organize the production process. This requires acquiring all the necessary resources and hiring the necessary employees. The final application of the model of limited attention which I will discuss

is the problem of hiring, monitoring and compensating employees. This work explicitly models the entrepreneur's performance evaluations of employees when the cost of these observations is the opportunity cost of the entrepreneur's time, which is embodied in the neglect of potential new employees. This monitoring cost determines the optimal monitoring intensity, performance standard, and the existence of an efficiency wage.

The role of monitoring is critical to the literature on efficiency wages. The efficiency wage hypothesis (Leibenstein, 1957) states that the services rendered by a worker are a function of the wage received. This is used to explain the paradox of the coexistence of unemployment and a positive wage. Unemployment exists only if wages do not fall to clear labor markets and this can be due to imperfect monitoring. Firms pay more than the "going wage" to prevent shirking. However, if all firms pay wages above workers' opportunity costs, then the quantity of labor demanded is less than that supplied and unemployment is the result.

However, Carmichael (1990) suggests that the puzzle of wage rigidity remains unsolved by the efficiency wage models since most either assume rigid wages or imply wage inflexibility. Lang and Kahn (1990) assert that the assumption of monitoring costs implies efficiency wages. In the literature on efficiency wages, the independence of pay from performance is taken as exogenous and rationalized by the assumption of exogenous monitoring costs. To economize on these costs, performance evaluations are infrequent and a premium is paid to employees to motivate high performance between evaluations.

This payment of a "premium" (rent) generated by a wage higher than the opportunity cost to prevent shirking was first formally analyzed in Shapiro and Stiglitz (1984) but was suggested earlier in Klein, Crawford and Alchian (1978) as a method of preventing systematic opportunistic behavior. Krueger (1991) provides empirical evidence that monitoring costs affect compensation timing and generosity. Where monitoring is more difficult (company owned outlets) salaries are higher and rise more steeply with tenure than where monitoring is easier (franchisee-owned outlets).

The unique characteristic of the model of limited attention is that the monitoring costs are

endogenous. Preliminary results indicate that the optimal monitoring intensity, performance standard, and efficiency wage are chosen by the entrepreneur so that the employee's actual performance is above the performance standard, is increasing in the performance standard and is increasing in the wage rate. However, this requires a high measurement error and so infrequent monitoring and so efficiency wages. The high performance as a hedge against imperfect monitoring is an additional benefit of economizing on monitoring resources.

The main contribution of the model is the determination of the optimal monitoring frequency and wage and their dependence on the endogenous opportunity costs of attention. The frequency of monitoring has two implications. Less frequent monitoring delays the future date of performance evaluation and the consequences of effort and reduces the variance of the measurement error. Therefore, more frequent monitoring results in increased effort. This application is still in the development stage. However, earlier research on contracts implies that monitoring frequency is decreasing in the ability to hire new employees and is increasing in the ability of the entrepreneur to observe shirking. This implies that the wage is increasing in the ability to hire new employees and decreasing in the ability to observe shirking. This provides empirically testable hypotheses concerning the efficiency wage.

One issue to be addressed with this model of employee monitoring is the choice of compensation packages between performance pay, efficiency wages and promotions. Another issue is the effect of monitoring technology and employee skill on the choice of compensation package, firm size and the level of employment. These issues are all critical to economic development.

7. Productive and unproductive entrepreneurial activities

From the previous discussion, it is clear that the model of limited entrepreneurial attention is applicable to a wide variety of economic issues. The model addresses the question of whether to pursue a career as an entrepreneur, what type of innovation policy to follow, financing high tech startups, whether to produce in-house or out-

source and if in-house, how to monitor and motivate employees. Each of these issues concerns allocating attention between previously acquired activities and acquiring additional activities, making the number of available activities endogenous.

Another issue which also fits in this category is the allocation of entrepreneurial resources among productive and unproductive activities. As suggested in Baumol (1993), this allocation should depend on the structure of rewards from these two types of activities. However, Baumol criticizes mathematical models for being “mechanistic and automatic” and for displaying no “entrepreneurial imagination and initiative.” (p. 14) But purely descriptive models also seem to be lacking because of a version of the Heisenberg Uncertainty Principle: “description of such activities going beyond the sort of generalities that have already been offered here may be all but impossible. . . . The very process of describing them can transmute pioneering entrepreneurial undertakings into routine managerial activities” (p. 15).

There seems some hope in satisfying Baumol’s criteria for properly modeling entrepreneurial activity. It is not necessarily maximization models per se which preclude entrepreneurial activity, but static maximization. Since entrepreneurs do allocate a scarce resource, it seems plausible that “much of the standard theoretical apparatus remains pertinent” (p. 18). However, it is imperative that, since entrepreneurs create new activities, the choice set itself is endogenous and so the model must be dynamic. That is, these activities “affect productivity growth, but productivity growth, in turn, itself influences” these activities (p. 260).

The theory of the allocation of entrepreneurial attention satisfies these criteria: it is a stochastic discounted dynamic programming model which makes no attempt to nail down what exactly it is that entrepreneurs do with their entrepreneurial resources, but only analyzes how incentives affect the allocation of these resources. The discussion above implies that this allocation should depend not only on rewards but also upon the opportunity costs of these resources. In addition, although entrepreneurial activities can affect productivity, either positively or negatively, an increasing number of activities can strain entrepreneurial

resources. Therefore, productivity growth has a cost embodied in the need to continue to allocate entrepreneurial resources among a growing number of activities.

In Baumol’s suggested preliminary model of economic growth, he focuses on how entrepreneurial activity can be incorporated in a feedback model along with other ancillary variables, such as equipment investment and education, which directly affect productivity growth. Although this model is to be analyzed further in a forthcoming book, it appears to yield implications for the role of entrepreneurial innovation and transfer of technology (imitation) and the convergence of productivity growth. Entrepreneurial innovation enters into the model as the most developed country’s “autonomous rate of technological change” (p. 266). Entrepreneurial technology transfer is reflected in the dependence of a less developed country’s future income gap on its current income gap, relative to the most developed country. Depending on the relative sizes of the parameters, this model can generate a convergence of incomes across countries.

The model of limited entrepreneurial attention can contribute to this feedback model of development by analyzing how the autonomous rate of technological change and the rate of technology transfer depend on the entrepreneurs’ allocation of attention. Since the task of acquiring new activities can be accomplished through either innovation or imitation, the model can be used to show how these depend upon the parameters of the entrepreneur’s environment. Specifically, new product innovation (or imitation) is increasing in the level of technological progress, as suggested by Baumol. However, the rate of economic obsolescence and the level of technological opportunity are both low, then entrepreneurs also allocate attention to maintaining the profitability of these new products, and innovation is decreasing in firm size and increasing in monopoly profits. This in itself would generate a convergence of incomes in any one country, even the leader. If economic obsolescence and technological opportunity are high, then the rate of innovation is constant.

The model of limited entrepreneurial attention also sheds light on the number of innovative, as opposed to managerial, entrepreneurs that are available and how the supply of these two types

of entrepreneurs depends on their innovative and managerial ability and the wage rate. Innovative and managerial ability may themselves be influenced by education, one of the ancillary variables of empirical research in this area. A population of individuals trained in business schools may be especially capable managers, but perhaps untalented innovators. Training in engineering and science may generate more innovative entrepreneurs.

Much of our current productivity increases are due to firms in high tech industries which got their start as ventures in a venture capitalist's fund. My research has shown that there is indeed a divergence of interests between the venture capitalist and the entrepreneur in that the venture capitalist does not maximize the entrepreneur's profits. However, since the venture capitalist chooses the socially optimal amount of attention for each venture, this does not result in any inefficiencies. In addition, increased opportunities to fund successful new ventures increases the average size and the upper bound on the size of the venture capital firm and the venture capitalist's long run equilibrium share of each venture's value but also reduces the number and frequency of consultations between the venture capitalist and the funded entrepreneurs. Therefore, the divergence of interests of the venture capitalist and entrepreneur increases. However, this remains the socially optimal allocation of the venture capitalist's attention.

The last two applications of the model of limited entrepreneurial attention are apparently unrelated to the problem of development through innovation and technological transfers. However, both of these applications deal with problems faced by entrepreneurs in carrying out their roles in economic development. The contract papers illustrate the entrepreneur's dilemma of producing an intermediate product, say, or farming it out to another firm. The advantage of producing the input in-house is that the entrepreneur can oversee the production process to make sure it is done correctly. It is this ability to deal with contingencies as they arise that eliminates the need to write complete contracts initially. The disadvantage of in-house production is that it distracts the entrepreneur from other activities.

The advantage of out-sourcing the production of the intermediate product is that the responsibility for overseeing production is delegated to another firm, freeing the entrepreneur to devote time to other, possibly more important matters. The disadvantage of delegating this responsibility is that the other firm may not supply the exact same input as the entrepreneur would have produced himself. However, if the desired specifications of the input can be spelled out in advance this may not be a problem. But for many inputs, especially when the final product is still in the development stage, a considerable amount of learning goes on during production and adjustments are made in the input specifications. These advantages and disadvantages are reflected in the governance power of internal contracts and the governance power of markets. It is these two characteristics which determine whether production is via internal employment contracts or external market contracts.

The model can also be interpreted to illustrate the importance of Baumol's "rules of the game". Internal contracts may be preferred to market transactions because of the costs of opportunism in market transactions. Opportunism is basically a practice of not fulfilling the understood terms of the deal and getting away with it. The other firm may succeed in either producing an inferior product or charging higher prices because the "rules of the game" allow it or are too costly to enforce. These rules of the game include the ability to enforce the contract through the court system and the protection of property rights, including patents and copyrights. The ability of markets to provide trades which are not subject to opportunism is reflected in the parameter measuring the governance power of markets or the ability to find new (trustworthy or compliant) trading partners. Since both market and internal contracts must be written initially over markets, the "rules of the game" determine how much trade can actually take place and so affect the development of the economy.

We saw how the model of limited entrepreneurial attention can be used to explain the existence of efficiency wages and how they depend on the endogenous costs of monitoring due to limited attention. Since the existence of effi-

ciency wages implies equilibrium unemployment, they have apparent significance for economic development. The resulting unemployment may not be inefficient if it is due only to these monitoring costs. However, these monitoring costs are due to the principal-agent problem between the entrepreneur and employees which exists as a result of the inability of the entrepreneur to freely and perfectly monitor performance. These monitoring costs are wasted resources in the welfare sense because they are incurred only to prevent shirking or opportunism on the part of employees.

In this application, the “rules of the game” appear again as the ability to hire new (trustworthy or compliant) employees. As in the contract papers, this has an effect on the allocation of attention. Market institutions which make market transactions easily enforceable result in less attention allocated to monitoring employees and more to hiring additional employees. Greater ability to accurately monitor employees and enforce contracts also reduces monitoring and increases employment. Thus, in these last two applications we can see that improving the effectiveness of our court system and the protection of property rights can lead to greater production and employment.

Notes

¹ For a more detailed review, see Gifford (1992b).

² The model is formally developed in Gifford and Wilson (1995).

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