

Innovation and Diffusion in Small Firms: Theory and Evidence

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ABSTRACT. The article provides an inventory of the strengths and weaknesses of small firms in a dynamic context. To do this it considers verbal accounts of the processes of innovation and diffusion, as well as quantitative studies testing cause-effect relations. It considers both economic and non-economic factors, concerning issues of motivation, perception and knowledge. First an overall summary is given of the characteristics of small business compared with large business, as a basis for an assessment of strengths and weaknesses. Perhaps the most important characteristic of small business is its diversity, and the article gives the conditions and sources of it. Other core characteristics are small scale, personality and independence of the small firm. From these, derived characteristics, strengths and weaknesses and core strategies can be inferred. From the perspective of the firm, strengths and weaknesses are subsequently analysed for the successive stages of innovation: invention, development, tooling/production, introduction to practice/market. Strengths and weaknesses in diffusion are analysed for the successive stages in the adoption process, as proposed by Rogers. Reference is made to theory and to empirical studies from the literature and from research by the present author.

1. Introduction

The article gives an inventory of strengths and weaknesses of small firms in innovation and diffusion. Two rather diverse approaches are combined. One approach is a process approach, in which we consider the stages by which innovation and diffusion take place, and the roles small businesses play. This approach is difficult to capture in econometric models, and yields a more verbal account. It allows us to develop theory and hypotheses. While econometric models lose out on the richness of process description, their strength

is that they allow us to test hypotheses concerning causes and effects more sharply. We consider both approaches: surveying both process descriptions and quantitative studies of innovation and diffusion.

For the process description we need to analyze the factors underlying the conduct of small business. Relevant characteristics include not only traditional economic categories but also cognitive and social dimensions (Nooteboom, 1988). The cognitive dimension, because when we consider innovation we should consider change of knowledge and preferences (usually taken as given, and determined exogenously, in mainstream economics); in other words learning. The social dimension, because diffusion takes place in a social system, and cognition is contingent upon social interaction (cf. Nooteboom, 1992a). In particular in small business obstacles due to limited knowledge, and the role of external contacts to overcome these obstacles, are highly relevant to issues of innovation and diffusion, as will be demonstrated.

In other words, we propose that particularly in studies of small business in innovation and diffusion, economics and sociology should be combined.

Taking such a broad approach, we cannot also guarantee completeness of the survey, in the sense that all the relevant literature is covered. That would also be too much for a journal article. Thus we make a selection, which admittedly is biased towards own research, conducted in the area of small business, innovation and diffusion over many years.

When considering strengths and weaknesses of small business, one can do so from the macro perspective of the contribution to welfare from the totality of small business, or from the micro perspective of the profitability and continuity of the individual small firm in its market. The present

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article only considers strengths and weaknesses on the firm level. Also, it focuses on innovation and diffusion, in a dynamic context, not on the merits of small business in a static context.

2. Definition

The definition and statistical demarcation of "small business" form a subject for perennial but seldom very fruitful debate and controversy. There are many perspectives from which the demarcation problem could in principle be approached. Because of the diversity of small business (to which I shall return), every simple (and workable) definition is subject to legitimate criticism. The "ideal" definition depends on one's perspective and the purpose of study. For the purpose of statistics, a pragmatic approach is to be recommended: take a simple definition that is statistically workable and theoretically has no more than a "ballpark" accuracy. Like the side of the road that people drive on, and like accounting principles, the merit of such a definition is not its theoretical validity but the simple fact that it is a convention that people adhere to, thus to prevent chaos in traffic and communication. In Europe we speak of "small and medium sized enterprise" (SME), with the boundary between small and medium size ranging, across different countries, between 5 and 50 persons engaged (in the Netherlands 10), and the boundary between medium sized and large business ranging between 50 and 500 persons engaged (in the Netherlands 100). Often the boundaries are drawn differently, with good theoretical justification, for manufacturing and services. While in consumer services a firm is considered "big" when it exceeds the 50 or 100 mark, in manufacturing it may not be considered "big" until it exceeds the 500 mark. Unless otherwise indicated, we taken the term to mean "small and medium sized enterprise" (SME), according to the Dutch convention: small enterprise up to 10 persons engaged; medium sized enterprise between 10 and 100 persons engaged.

It is important to note that characteristics of small firms can also arise in relatively independent units in large firms. In fact, this is increasingly so, as large business discovers the advantages of small scale, decentralized operation under present conditions of rapid change in markets. This is giving

rise to a quite voluminous literature on decentralization, "flat organizations", "chaotic organizations", etc. One can search for optimal conditions by trying to exploit the strength of small size by means of independence, and compensate for weaknesses of small size by means of limits to independence by forms of coordination. But note that coordination or partial integration can be implemented also between small independent firms. For this, consider the literature on "industrial districts" or "flexible specialization" (Piore and Sable, 1983; for criticism, see Amin, 1989). Of course, thereby they lose some of their autonomy. With more autonomy of units in large firms and more integration of small firms, large and small firms come to resemble each other more. So, in spite of the statistical definition given above, when in this article we consider small firms, we will in general consider small, relatively independent business units, so that the analysis may also apply to independent units in large firms, except in econometric studies, based on statistics, where we only have data according to the statistical definition.

3. Theoretical framework

There are reasonably systematic indications that small business plays only a limited role in major scientific and technological breakthroughs. But prosperity follows not from major inventions taken by themselves, but from their implementation, application, differentiation and adaptation along their "technical trajectories" (cf. Nelson and Winter, 1982; Dosi, 1984, 1988), in a fanning out of subsequent innovations of application and improvement. There small business has an important role to play, which is complementary to the role of large business.

To position this paper, we could say that it purports to establish a synthesis between the view of the early Schumpeter (1909), proposing an innovative role of "creative destruction" for small, new firms, and the views of the later Schumpeter (1939, 1943), proposing that innovation is primarily produced in large firms and concentrated markets.

Innovation and diffusion are taken here roughly according to Schumpeter, according to the sequence in Figure 1.

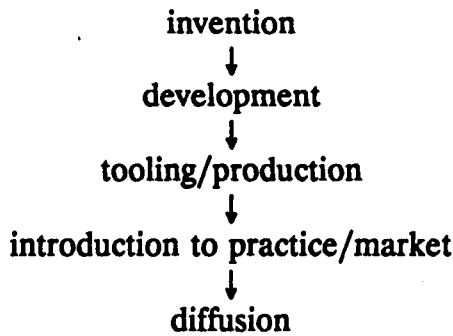


Fig. 1. Stages of innovation.

Diffusion is a process of dissemination in a social system, part of which is adoption by new users. According to Rogers (1983) adoption is a process with stages as indicated in Figure 2 (between brackets the terms which Rogers used previously, in this 1962 edition).

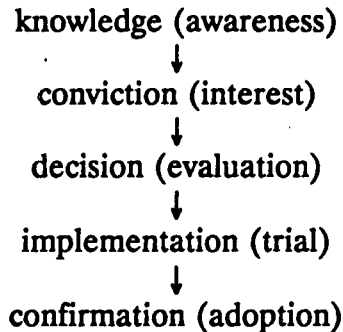


Fig. 2. Stages of adoption.

In the marketing literature the sequence of stages of Figure 2 is familiar more generally, in the buying process of consumers and firms (for a survey in the context of industrial buying, see Wind and Thomas, 1980).

We will analyze strengths and weaknesses of small business along the stages of innovation and diffusion. This requires some background on the relevant characteristics of small business. We make use of an earlier survey of the literature in Nooteboom (1987), supplemented with an update from more recent contributions.

The most striking and possibly the most important characteristic of small business, which is cause

of much confusion and misunderstanding, is its diversity. This is due not only to a spread across different industries and markets, which applies also to large business, but to a spread in conduct within industries which is greater than for large business. Rather than reproduce descriptive statistical evidence of this diversity, we focus on its causes. They are twofold: conditions that *allow* for diversity and sources that *produce* diversity.

4. Conditions of diversity

The conditions that *allow* for diversity lie in the extent to which managers or entrepreneurs are disciplined to adhere to common standards of profit or conduct. This depends on conditions of ownership and associated capital markets, in the "market for corporate control", on the "market for managers", and on conditions and regulations set by governments. To the extent that firms obtain capital from shareholders, they are subject to standards of profit in relation to risk, depending on the efficiency of stock markets,¹ and to pressures to realize opportunities for profit. The risk to management of not adhering to standards of profit or for missing opportunities for profit is that it may be replaced due to intervention by representatives of shareholders or due to takeover. The rigour of this discipline depends, among other things, on the openness to takeovers in the capital market. The discipline is not perfect, certainly not on the European continent, but it does exist.

Although there is much variation between countries, one can generalize that small firms mostly derive their capital either from banks or, particularly in the start-up stage, from private sources of the entrepreneur himself or friends or family. This allows for idiosyncrasy, and hence more variance, in demands on profit. Banks require repayment of debts; not maximal exploitation of profit opportunities. The demands on profit by family may be higher or lower than in capital markets. Often, demands on profit will be less, either because private owners assess risk and expected returns differently, because they have a more positive view of capabilities and opportunities. This may be justified, but it may also be due to wishful thinking, overestimation of own capabilities or underestimation of competitive threats.

In the trade-off between perceived returns and

risk there is likely to be both more and less risk aversion in small business. Rationally, one would expect owner-entrepreneurs to take fewer risks due to a lesser spread of risks than shareholders have, in their portfolio of shares, and a greater risk than faced by managers of large firms, whose income largely consists of more secure salaries. On the other hand, some providers of private capital, such as family or friends, may be willing to incur more risk for emotional reasons (love, friendship, loyalty). Often, risks are simply not perceived due to a certain myopia and single-mindedness of purpose. Also, in independent businesses profits and the wage of the entrepreneur and his family are perceived to constitute one mixed residual sum of money, whereby low profits or even losses may be sustained for considerable periods of time, at the expense of income and living conditions. Poor living conditions are acceptable particularly when there is simply no alternative for earning a living (unemployment and little or no social security). This income buffer for low profits provides scope for more risky ventures or more idiosyncratic goals or forms of conduct. To the extent that independent entrepreneurs are uninterested in a managerial career in large firms, they need not adhere to the demands on goals and conduct set by the capital market and the market for managers with the corresponding standards for acceptable conduct, as cultivated in circuits of boards of directors.

Finally, conditions arise from government regulations with respect to the environment, labour conditions, permits and demands on schooling, technical and safety standards, liability, zoning laws and other regulations for location and building, etc. These are often more lenient towards small business, either by policy design, in order to provide more scope for small business, or by default, because it is simply too costly to closely monitor and discipline the conduct of small firms. This also contributes to more scope for diversity.

5. Sources of diversity

The sources that *produce* diversity within the scope allowed for it, lie in the variance of backgrounds, motives and goals of entrepreneurship. As is well documented in the entrepreneurship literature, people resort to independent entre-

preneurship for a variety of reasons, which may be grouped in factors of "push" (discontent with present position), "pull" (attractiveness of self employment), and coincidence (generating a large random component).

Discontent can lie in the abhorrence of subjection to authority in the hierarchy of an employment relation, social maladjustment, impatience with the bureaucracy of a large organization, or a personal crisis (death in the family, divorce, mid-life crisis). For a well-known text on this, see Kets de Vries (1977). For a critical assessment of this and similar theories, see also Chell (1985). According to the "refuge hypothesis", people take refuge in entrepreneurship for lack of employment, either because overall employment opportunities are scarce, or due to lack of qualifications for available jobs, or due to discrimination in job markets, or due to psycho/social maladjustment to employment relations. A subsidiary hypothesis thus is the "social marginality thesis" (Cf. Stanworth and Curran, 1973; Scase and Goffee, 1980), to explain the pervasiveness of the entrepreneurship of refugees and ethnic minorities: people from many backgrounds in the United States; Chinese throughout the far east; Indians in the United Kingdom and Africa; Parsi's in India; Surinam people in Amsterdam.

Connected to the refuge hypothesis, there is a relation between entrepreneurship and social security: in many poor countries entrepreneurship is the only way to provide for oneself or for sick or old relatives. Perhaps less well known is the relation between economic cycles and the refuge hypothesis: in slumps unemployment drives people into self-employment, depending on the lack of unemployment benefits.² With respect to the long "Kondratieff" cycle there is also an hypothesis for an influx of small business at the low point, preceding the upswing, but this is based more on the pull factor of opportunity than the push factor of refuge (the so-called "swarming hypothesis"). Of course, the low points of short and long cycles may coincide, yielding a combination of both phenomena.

Important pull factors are the will to power, conquest and riches, and the will to creation. These are the factors that come to mind when one thinks of the Schumpeterian hero or the "real" entrepreneur as an agent of "creative destruction".

An important pull factor also is independence as a goal in itself: a large measure of freedom and independence in the setting of goals and the choice of location, method of production, hours and conditions of work, form of organization. Related to independence is the pull factor of personality: orientation towards personal values and goals, and relatively unstructured procedures and relations, with an emphasis on oral rather than written communication, and scope for improvisation and spontaneity. For many independents it is not a goal to innovate or to grow, but on the contrary to maintain a traditional way of life or work (craft-manship) or smallness for their own sake.

Small scale generally is both a condition and a result of independence and personality. The will to maintain independence restricts financial resources for growth and thus perpetuates smallness. One can maintain informality and personality only in a small scale operation. Clearly, small scale carries the disadvantage of diseconomies of several sorts, to which we will return later.

Coincidence is an important factor in both push and pull. For example in generating the personal crisis that triggers entrepreneurship. Or the example set by the successful entrepreneurship of someone who is taken as a "role model". Or the right opportunity that happens to occur at the right time: a potential customer who signals demand; an invitation to join a partnership; an inheritance as a source of capital; the availability of suitable premises. Also, many people ease into entrepreneurship, or are coerced into it, by inheriting the family firm.

The factors are also found in empirical research. In an international comparative survey of 2½ thousand entrepreneurs in 9 countries discontent with antecedent conditions (push) was found as the main reason in 29% of the cases in which the firm was not inherited, in Europe, and in 20% of the cases outside Europe (including a number of less developed countries). In Europe ambition (pull) was the third most important factor (11%). For the sample as a whole it came second place with 15% (Pompe, Bruyn and Koek, 1986). A study in the Netherlands in 1979 indicated that 30% of entrepreneurs in SME (less than 100 persons engaged) had a disposable profit income less than the legal minimum wage. After adjustment for differences in social security bene-

fits, holiday bonus etc., 45% of entrepreneurs had less than the comparable minimum wage (Boog and Kuiken, 1985). In a different Dutch survey conducted in 1978, of the 380 responding entrepreneurs younger than 50 years and established in business for at least four years, only 20% was found to be oriented towards expansion and growth (Van den Tillaart, H. J. M., H. C. van der Hoeven and F. W. van Uxem, 1981). Williams (1977) reported that in Australia about 10% of independent entrepreneurs conformed to the type of the "effective entrepreneur and efficient manager". A Dutch study of the behaviour of small business in the search for external information concluded that only 18% could be called "dynamic" (Nobin, 1983). Thus it seems a reasonable guess that between 10 and 20% of SME conform more or less to the ideal of the Schumpeterian hero. At first sight this is a very sobering result, but one should keep in mind that 10 to 20% of 98% of all firms (the share of SME in the Netherlands) still yields a large number of firms. Also, the Schumpeterian concept of entrepreneurship has its limitations. Innovation and diffusion also result from other, Austrian types of entrepreneurship: in the less radical adjustments of combinations of technology, products and markets, where more radical innovations are carried to their full utilization (cf. Nooteboom, 1992c).

Summing up: in small business there are conditions and sources that generate a large diversity of purpose and conduct. Radical innovation is to be expected only from a minority, which is nevertheless a significant group.

Now one may well ask what the sense is of generalized statements on small business, if its diversity is so great. There is a good reason to make an attempt at generalization, in view of the following policy dilemma. On the one hand, one would like a rich diversity of policy, tailored to the diverse needs of small business. On the other hand, in view of the limited capacity for collecting and processing external information, particularly on the part of small business, a diversity of institutions yields a problem. It makes the environment too complex and "sticky" for effective entrepreneurship, particularly in small business. To limit the complexity of institutions, we should aim for the highest level of generalization that is still warranted in view of diversity.

6. Market structure and small business conduct and performance

Several authors (Chell, 1985; Sandberg and Hofer, 1987) have criticized earlier small business research for trying to establish a direct relation between personal characteristics of entrepreneurs and the success or failure of their firms. Such characteristics do not determine outcomes directly, by themselves, but in interaction with "contingency factors" from the context in which the firm and entrepreneur operate and with the strategies they take. Different conditions allow for different actions, and yield different outcomes of actions. A given characteristics, or set of characteristics, may be beneficial in one configuration of context and action, and fatal elsewhere. This is illustrated in Figure 3.

In Figure 3 we have employed the terminology of Structure-conduct-performance derived from the literature on industrial organization, to establish a link between that literature and the literature on entrepreneurship. Note, however, that in accordance with modern industrial organization theory we allow for feed-back from conduct to structure and from performance to conduct and structure. Also, we add a sociological perspective on the determinants of characteristics of entrepreneurs/firms and their goals/values from experi-

ence with conduct and performance, whereas in economics such attributes are generally taken as exogenous; as given.

Relevant characteristics of the entrepreneur include various personal characteristics (cognitive, affective, conative). The term "firm" is added to indicate that it is not only the entrepreneur who matters, but also the team with which he/she works. Separate mention is made of values and goals, underlying preferences, and motives for entrepreneurship.

Note that under context-structure we mention not only the obvious items of technology and market (which include features such as economy of scope and scale, entry barriers, product differentiation etc.), but also institutions and lifecycle/stage. By institutions we mean not only things like courts, government, banks, employers and employee's associations and the like, but also the system of laws and regulations, the financial system, and underlying values and norms (concerning property, contract, profit, entrepreneurship, risk, work, etc.). North (1990) indicated the role of institutions in limiting transaction costs, for the sake of trade, in order to enable the division of labour on which prosperity depends. One can extend the argument to the design of institutions to compensate for effects of scale in transaction costs (Nooteboom, 1992b, 1993b).

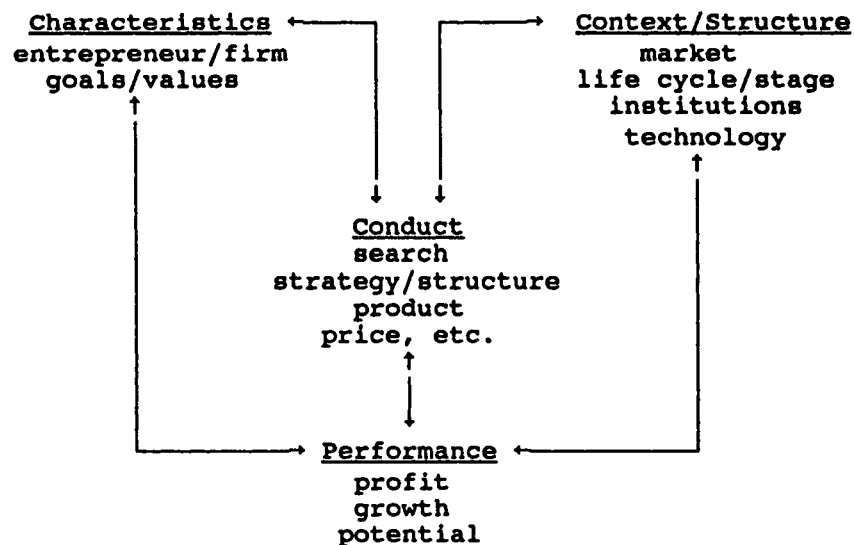


Fig. 3. Contingency.

By "life cycle" we mean the stage of development of the product or the market in which the firm is involved, since according to the well known theory of product life cycles different stages have different requirements. For example, towards the stage of declining growth or saturation there is more emphasis on economy of scale and price competition. By "stage" we mean the developmental stage of the *firm*, which may but need not be related to the life cycle of the product/market. Different developmental stages set different requirements for conduct and organizational structure. For example: as a new firm grows bigger (and its product becomes more settled in the market) there is a need for more formalization of procedures, functional specialization, and a need for the entrepreneur to delegate operational activities and concentrate more on strategy and organization.³

Under conduct we include not only the obvious items such as strategy and choice of product, price etc., but also structure and "search". By firm structure we mean organizational structure, procedures and routines. In the short term these may rather be seen as given conditions, or contingencies, but they can be adapted more easily than external conditions. By "search" we mean conduct in the acquisition of knowledge, including the use of external networks. As we shall see this is an important feature for small business, as a means to compensate for internal lack of expertise.

7. Strengths and weaknesses

Having said that one should take a contingency perspective, we nevertheless claim that when one ranges across diverse sectors, markets and other contexts, in spite of the diversity of small business and the complexity of conditions and interaction of causes, one can identify a meaningful overall characterization of small business, in terms of core characteristics, derived properties and resulting strengths and weaknesses. Different aspects have different weights in different circumstances and among different entrepreneurs, but they tend to play a greater or lesser role in a great many cases. The core characteristics, and their implications, are not simply personal characteristics of the entrepreneur, but combinations of such characteristics, contingency factors and forms of conduct. The present analysis is an extension of an

earlier analysis in Nooteboom (1987). There it was concluded that the core characteristics of small business were as already indicated in the discussion of motives and goals: independence, personality and small scale. From these core characteristics much else follows, including a summary of strengths and weaknesses, and core strategies, as indicated in Figure 4.

We should again emphasize that characteristics or traits by themselves do not explain behaviour. They contribute to the playing of roles or taking of actions for which the need or opportunity occurs depending on the circumstances (contingency perspective). Thus different characteristics may emerge in different circumstances, and a given characteristic may have different effects in different circumstances. Yet they do contribute.

The core characteristic of small scale is a characteristic of the firm, and speaks for itself, but it should be noted that economies of scale occur not only in production and management, as is widely known, but also in marketing (particularly in the set-up and utilization of channels of communication and distribution) and in transaction costs (which include costs of search, contact, contract and control of performance).⁶

The core characteristic of personality indicates a pervasive intertwining of private and business affairs: in housing (working and living at the same premises); capital (private/informal and public/formal sources); income (wage and profit are often perceived as a whole); labour, management, internal and external contacts (friends and family involved in the business); in motives (emotional and rational). This goes together with informality of authority, communication, and procedures (often oral and ill-documented).

The core characteristic of independence indicates relative freedom from the discipline of capital markets, allowing for more idiosyncratic goals and conduct, as already discussed.

The weights of the derived characteristics, and hence strengths and weaknesses, vary with conditions and with the capabilities, motives and goals of the entrepreneur, which vary as discussed before. As firms grow from small through medium-sized to large size, the characteristics wane or turn into their opposites. Notably, as a firm grows the entrepreneur will have to delegate more, bureaucracy grows, additional layers of hierarchy

CHARACTERISTICS

intertwined ownership and management → motivated management/commitment
 integration of tasks in worker;
 variation and improvization → motivated labour
 few hierarchical levels; short communication lines → no bureaucracy; internal flexibility; little filtering of proposals
 few and simple procedures; personal, → low costs and little distortion of internal communication
 direct, oral internal communication → capacity for customization
 personal and close relations with customers
 craftsmanship → unique or scarce competencies
 tacitness of knowledge → appropriability
 idiosyncratic perception → originality of initiative

STRENGTHS

↑
 ↑
 core characteristics

small scale
 personality
 independence

↓
 ↓

↓
 ↓
 core strategies

innovation or "niche" strategies
 new and/or customized products
 external networks

↑
 ↑

WEAKNESSES

idiosyncratic perception	→	unopposed misapprehensions
"tacit knowledge"	→	limited capacity for absorption of new knowledge/technology
craftmanship	→	technical myopia
few products and markets	→	little spread of risk, limited synergy
small volume of production	→	diseconomies of small scale
no staff functionaries	→	lack of functional expertise ⁴
lack of managerial time	→	ad hoc management, short term perspective
much authority and many functions in one hand	→	vulnerability to discontinuity of management and staff
few layers of hierarchy	→	limited career opportunities
low level of abstraction	→	lack of information
product- or technique orientation	→	errors in marketing and strategy
possible lack of finance	→	lack of means for growth ⁵

Fig. 4. Strengths and weaknesses of small business.

arise or formal procedures for planning, coordination or control are instituted, specialists appear, communication becomes more structured, formal and documented, and knowledge becomes more explicit (less tacit) and formal.

Note that small scale and little formalization does not yield only one type of organization. According to Mitzberg (1983) we might find a

"simple structure" with direct, centralized supervision by the owner-manager, but also an "ad-hocracy" with a more federative, decentralized structure and processes of mutual adjustment. On the side of large firms, bureaucracy is not of just one type. According to Mitzberg one might find a "machine bureaucracy" with much formalized planning to specialized and standardized tasks, or

a divisionalized structure with much formalized performance control. Among medium sized and large firms one might find a "professional bureaucracy" with a "core" of professionals with standardized skills and mutual adjustment. Tacit knowledge will be discussed in the next paragraph, where it is explained that it yields both a weakness, in lack of capacity to absorb new information, and a strength, in protection of unique knowledge or skills against copying by competitors ("appropriability").

Other characteristics also yield both strengths and weaknesses. The idiosyncrasy of entrepreneurial perception and interpretation can yield highly original ventures, which can be a strength, but may also yield gross misapprehensions, which can be a crucial weakness. Craftmanship can yield a unique technical competence, which may serve as a strong competitive advantage, but often it also yields technical myopia, with a fatal lack of attention to commercial or financial conditions.

As indicated in the figure, the strengths and weaknesses suggest appropriate core strategies: innovation yielding new products, where scale effects are not yet in force, or/and niche markets with customized products, where scale effects do not appear.⁷ Both strategies evade the weaknesses from small scale and mollify the weakness of limited spread of risk (because of more captive customers), lack of functional expertise and managerial resources (because of narrow focus and captive customers). Of course innovation requires that one break through the disadvantage with respect to new knowledge, while for the niche strategy this requirement is of less importance. Hence it is to be expected that the innovation strategy is only for the few, as observed. However, the strategy of employing external networks serves to compensate, to some extent at least, for the problems of absorption capacity: external contacts are utilized for the generation of awareness and the efficient acquisition of relevant specialized knowledge. We will return to this later, in the discussion of strengths and weaknesses in diffusion.

Both strategies of innovation and niche markets exploit the strengths in providing unique competencies and customized products, and the associated proximity to customers. Innovation further exploits the strength of motivated management

and labour, to survive the harsh times of making novelty work, and the strength of limited bureaucracy and internal flexibility. We will expand on this later.

8. Complementarity of large and small firms

The pattern of characteristics and corresponding strengths and weaknesses for large firms is virtually a reverse image of Figure 4: large firms tend to be strong where small firms tend to be weak, and vice versa. The difference between large and small business was summed up effectively by Rothwell (1985, p. 9; see also Rothwell, 1989): the advantages of large business are material (resources) and those of small business behavioral (motivation, flexibility).

It may help to look at this from a perspective of multiple causality: efficient, material, formal, exemplary, final and conditional causality.⁸ The carpenter (efficient cause) makes a chair out of wood (material cause) according to some technology or craftmanship (formal cause) and/or according to some design, model or prototype (exemplary cause), with the purpose of earning a living or making profit (final cause), under certain conditions concerning finance, ownership, management, competition and regulations (conditional cause). Small business tends to be strong in efficient, final and exemplary causes (labour, entrepreneurship, motivation, design, ideas), and large business in material, formal and conditional causes (resources, knowledge, science, method, control of external conditions). Our inclination to think that small business must be always and in all things either better or worse than large business may be a naturalistic bias inculcated by some intuition that causality has only one dimension.

The analysis points to a possible complementarity of small and large business: they are good at different things and in different ways, in different stages or aspects of innovation.

In a static framework of given technology and given consumer preferences, the role of large firms is that they provide efficiency due to large scale production. The role of small firms is that they inhibit cartels or other forms of collusion (since with many diverse firms collusion is difficult to set up and maintain); they undermine entry barriers based on threats of retaliation with a low price to

potential entrants in a monopolistic market (since a price reduction is not worth while at the large volume of the incumbent monopolist relative to the nibbling market share of the small entrant); they fill the market niches for specialized products that cannot effectively be filled on a large scale; they provide minimal standards (benchmarks) for evaluation of the performance of management and labour in large firms (cf. Hendrikse, 1988).

So far, the strengths and weaknesses are not yet tailored to innovation and diffusion, in the more dynamic framework of the present paper. That will come later, where we will identify the phenomenon of "dynamic complementarity" of large and small business.

A complication in the comparison between large and small business is that large business has not stood still: its focus has shifted from efficiency to quality, to flexibility and to innovativeness. Thereby, its organization has shifted from centralized hierarchy with tight control to central direction with incentives and subsequently to decentralization and divisionalization, with increasing autonomy of business units (Cf. Bolwijn and Kumpe, 1990). On the one hand this confirms the analysis: in attempts to become more flexible and innovative, large business has become more like small business. On the other hand, the fact remains that large business has become more like small business, and what then remains of the idea of complementarity? But important differences do remain. Differences in scale may have decreased in production units, but have remained on the corporate level: in management, R&D, finance and marketing. Differences in available knowledge and science base remain. Large firms face a paradox: to obtain similar advantages as small firms they must loosen control, but to obtain the advantages of size (economy of scale, scope and learning) they must maintain coordination and control. In large business decisions with strategic impact still have to pass scrutiny at the corporate level, performance is subject to the demands of the stock market and managerial conduct to the market for managers.

Another organizational development is that large firms increasingly contract out even crucial parts of production to often smaller suppliers, in sometimes lasting relations of great depth of interaction ("co-makership"). This also tends to

confirm the analysis: by this, large firms try to utilize dynamic complementarity.

Conversely, small firms may and do try to obtain some of the advantages of large size, without the disadvantages, by forms of partial coordination in networks of independent firms, yielding what is known as the arrangement of "flexible specialization". This yields advantages of scope while maintaining variety, selection efficiency and flexibility (cf. Piore and Sabel, 1983; Amin, 1989). But the strength of the arrangement derives from small firms retaining a number of the characteristics of small firms.

Summing up: while in several ways large firms seek to adapt their organization to obtain some of the benefits of small firms, and the converse applies to small firms, in many ways large firms remain large firms and small firms remain small firms, and the above analysis is confirmed rather than falsified.

9. Tacit knowledge

The concept of tacit knowledge is particularly important in the context of innovation and diffusion, since it has implications for the capacity to absorb new information. It probably requires some explanation.

The concept was proposed by the philosopher Michael Polanyi,⁹ and is related to his concepts of "subsidiary versus focal" awareness, and to the work on bounded rationality by Simon (1983) and others. To try to be rational in the sense of maintaining complete awareness, in a synoptic survey of all our objectives and all relevant knowledge and information, would defeat our purpose. We can be successfully rational only locally, with the focus of awareness on some subset of purpose and knowledge, with the rest in subsidiary awareness. One role of emotions in rationality is to call attention to different subsets of attention; to set the agenda of rationality, so to speak. Some knowledge is buried so deep as to be permanently subsidiary. This connects with the notion of categories of perception, thought and judgment that determine what we see, think and feel while we are not aware of them and would be unable to change them if we were. Perhaps beyond this lies instinct, determined by evolution which is even more fundamentally impossible to change, since it is

"hardwired". Such a layering of knowledge in different levels of subsidiarity or non-reflectiveness has survival value in evolution: it serves to focus on what is subject to change in a manner that might present a threat or opportunity, rather than on irrelevant change or conditions that are hardly ever subject to change.

Along the spectrum from intellectual reflection to fundamental categories of perception and thought lies tacit knowledge: knowledge that we have typically acquired in learning by doing and teaching by ostension rather than by abstract learning and teaching by explicit definition and explanation, and that has become something like "second nature". Like learning to speak our native language, to ride a bicycle and, for many entrepreneurs, to do business. We are not even aware that we have that knowledge, let alone that we could rationally consider an alternative way of doing things. We propose that particularly in small business much operating knowledge is tacit, and that this is connected somehow (in a way which I will not explore here) to the concept of craftsmanship.

Note that the problem of tacitness is additional to the problem that in small business there are fewer functional specialists. There are in fact three dimensions of knowledge: width, depth and tacitness. In small business knowledge tends to be shallow (undeep; no functional specialists) and tacit. Shallowness of knowledge can be compensated by supplementing it from external sources. In small business knowledge often also is narrow; when knowledge needed for some aspect of running a business is simply not taken into account. This may be the result of tacit knowledge about how the business is to be run.

The relevance in the present context is mainly that tacit knowledge sets an obstacle in Rogers' first stage of adoption: knowledge/awareness (cf. Nooteboom, Coehoorn and Zwaan, 1992; Nooteboom, Zwart and Bijmolt, 1992). If current practice is based on tacit knowledge, it is no use explaining what a novel technology could do. First one has to achieve awareness of how one is currently doing things before an alternative can be considered rationally. To the extent that knowledge in small business is more tacit than in large business adoption is more problematic for them. Next to the empirical evidence of lesser tacitness

(but certainly not absence of it) in large business, there is a theoretical argument: as tasks become more specialized, more people become involved and layers of hierarchy are added, knowledge has to become less tacit, more explicit, formal and documented, in order to establish the needed communication across a wider span of people. To the extent that due to decentralization large business has in some ways become more like small business, knowledge may have become more tacit there.

From the above exposition it follows that tacitness is not only a problem, but also has a positive side in protecting knowledge from leakage ("spillovers") to competitors, which ensures that rewards for innovation will accrue at least for some time ("appropriability"). When knowledge is tacit, it is more difficult to transfer and to copy. Furthermore, tacit knowledge is often also cumulative: it is based on skills that must be acquired in practice, and without the underlying skills it is not implementable. This mechanism of appropriation is important for small business because appropriation by means of patents is often more difficult or relatively costly. But it is not foolproof. When transfer to tacit knowledge requires transfer of the people in whom the knowledge is embodied, competitors or new entrants may buy into the new market by buying out the skilled people. When the knowledge is embodied in teams, or the firm more as a whole, and is cumulative, it is transferrable only by a complete take-over. And this is what we observe: often successful small innovators are taken over by less innovative large firms.

10. Innovative efficiency and intensity

The question whether large or small firms are more innovative has been a controversial issue ever since the work of Schumpeter. Schumpeter himself was contradictory in his judgments: in his early work he proposed that the small, independent new entrepreneur is the source of innovation, but in his later work he proposed that it is rather the large corporation that produces novelty.

Empirical research across many years has provided mixed evidence. Mansfield (1969) reported an empirical indication that the productivity of R&D in the largest firms is lower than in medium sized and large firms. The American "State of

Small Business" (1983) reported that small firms (less than 10 employees) produced two-and-half as many innovations as large firms per employee (Davis, Hills and Laforge, 1985, p. 3). On the basis of the innovation data base of the Science Policy Research Unit in Brighton, Wyatt (1985) claimed that the relative innovative efficiency (innovative output divided by input) of small firms is very much higher than in large firms. Although this is no doubt to some extent illusory due to a likely underestimation of the resources spent on R&D in small firms, as pointed out in Rothwell (1985, 1989), the indication still remains. In a study of innovation data attached to the U.S. Small Business Administration Data Base, Acs and Audretsch (1990) found a higher average rate of innovation¹⁰ among small than among large firms. Small firms were found to be more productive in innovations than large firms in industries with relatively low capital intensity, low concentration and a high level of innovation.

For lack of good measures of innovative output, much research has concentrated on inputs, in studies of R&D intensity. Intensity was mostly measured in the aggregate, as total R&D input (in R&D personnel or R&D spending) or R&D output, or some supposed proxy for it (in patents or a count of successful innovations), divided by total volume of resources (in people engaged, employees, sales, production or added value), for the totality of observed firms, by class of firm size. This measure of intensity was usually plotted against average firm size, by size class, to see what statistically significant relation appears. This has been done for several specifications: a linear, quadratic or third degree function (cf. Acs and Audretsch, 1993). The reason for this progression to higher order functions was that the empirical results varied a great deal. Thus Kamien and Schwarz (1982, p. 106) reported in their survey that the intensity of R&D sometimes increases with firm size, sometimes declines, sometimes remains constant, and sometimes first rises and then declines, and they concluded that "... the bulk of the empirical findings indicate that ... R&D activity, measured by either input or output intensity, appears to increase with firm size up to a point and then to level off or decline". A similar conclusion was given in the more recent survey by Baldwin and Scott (1987, p. 82): "Studies ... using

data from other industrialized countries largely confirmed the findings emerging from U.S. data, notably the lack of evidence of a clearcut causal relationship beyond a size threshold running from firm size to innovative activity."

In Nooteboom (1991a) it is argued that the variation of results could result from the fact that three questions are thrown together that should be kept apart. First there is the question of R&D participation: what percentage of firms, by class of size, participates in (internal or external) R&D. Second is the question of expense: how much does one spend in case of participation. Third there is the question of effectiveness: how does innovative output compare to inputs?¹¹ Separate models were proposed for participation and spending in case of participation, while taking into account a possible effect of firm size on R&D effectiveness. The model of R&D participation was submitted to an empirical test on the basis of an R&D survey conducted by Kleinknecht in the Netherlands, in 1984. The results show that small firms systematically participate less in R&D than large firms do. The explanation for this is that while expected returns increase with firm size, risk does not increase with firm size, or declines with increasing firm size. Then, accepting that it is rational to balance expected returns and risk, small firms rationally tend to participate less. However, the model of spending, estimated by Nooteboom and Vossen (1993) on the second R&D survey by Kleinknecht in 1989 and an R&D survey of American business in 1984 by Business Week, showed that when small firms participate in R&D they do so at a higher level of intensity (in relation to people employed or sales) than large firms. This applies equally for both data bases for all industries except high tech or "science based" industries, where there is no significant difference in intensity. Surprisingly, it also applies for "scale intensive" industries.¹²

Summing up, the overall evidence points to a lesser participation in R&D of small firms, but a greater intensity and a greater productivity when they participate.

11. The process of innovation

We now turn to an evaluation of strengths and weaknesses in the different stages of the innova-

tion process, as illustrated earlier (in Figure 1).¹³ A complication here is that in fact the innovation process is not so neatly linear as Figure 1 suggests. As investigated by Cooper (1983), the different stages occur in parallel, and iteratively. For example: market exploration, prototype development, initial design of production, and design of market introduction and distribution may occur simultaneously. So perhaps we should speak of aspects or dimensions rather than stages.

In the first stage (or aspect) of invention, the relative strengths and weaknesses of large and small business derive from Figure 4, summed up in Rothwell's statement that the strength of large business is material and that of small business behavioral.

The strength of large business lies in its deeper level of specialization (in people and equipment); abstract, science-based knowledge; economy of scale, scope (synergy) and experience; larger and cheaper financial resources; spread of risks. Note that economy of scale extends to transaction costs such as the search and processing of technical and commercial information from many diverse external sources, which are often difficult to find, access and grasp for non-specialists. Synergy here includes the possibility that research may yield results in unexpected areas, the use of which is greater as the scope of activities is wider.

The strength of small business lies in greater motivation, better survey of the entirety of a project, tacit knowledge in unique skills, more informal communication along shorter lines, less bureaucracy, greater proximity to the market and to own production.

This suggests that large and small firms will be good at different types of invention. Large business is likely to be better in the generation of fundamentally new and science based "high technologies" (Rosegger, 1980), which require large and specialized teams in laboratories with sophisticated equipment, prior to applications, and complex large applications of fundamental innovations. Small business is likely to be better at small scale applications of fundamental technologies, novel technology-product-market combinations, improvements in existing products, novel product-service combinations, etc. In other words: small business is likely to be more effective further downstream from fundamental, science based

technologies. Or, in different words perhaps, small business is likely to be better in application; in development and introduction to market.

Let us consider the empirical evidence. The classic empirical study of inventions by Jewkes, Sawyers and Stillerman (1958) reported that of 61 inventions during the first half of this century only 16 could be ascribed to large firms, and half of them were in the chemical industry (which appears to correspond with the type of research that we would expect large firms to better at). A study by Schmookler (published later, 1972) showed that inventions by operating men took place almost entirely in smaller businesses (Blair, 1972; see also Nooteboom, 1984; Weinberg, 1990).

The *decision* to develop an invention, to take it into production and to introduce an innovation to practice, is riskier for small business, due to the lesser spread of risk (due to narrower markets and fewer products). This is the case in particular for radically new products (implementing new technologies, performing new functions or existing functions in new ways), where no established market yet exists, whereby there is less scope for "demand pull", and the emphasis often necessarily lies on "technology push". Where small business is often weak in marketing there may be a lesser disadvantage here because there is little scope for marketing anyway. On the other hand one can argue that precisely for that reason marketing should be pursued more tenaciously. One, and perhaps the only, effective marketing approach for radically new products is to develop them in close interaction with one or a few innovative, trend-setting potential users (cf. von Hippel, 1988; Biemans, 1989). Such practices disturb the linearity of the innovation process: research, development and introduction interact and occur in parallel. Due to their small size, internal flexibility and proximity to customers, small business may have an opportunity here.

Because of their larger number of products and longer history (which is correlated with firm size), large firms may have more stakes in existing, older generation products, whereby they have an interest in postponing product development, in order not to cannibalize incumbent products. Large business could even produce patented inventions with the express purpose of blocking their entry into the market.

Weinberg (1990, p. 52) quotes a study by the Patent Foundation of George Washington University that showed that firms with more than \$100 million sales or more than 100 patents apply only 51% of their patents, compared with 49% for independent inventors and 71% for smaller firms.

In the process of decision making, small firms have an advantage due to lesser bureaucracy and fewer hierarchical layers, with more informal and less documented communication: decision making is faster and there are fewer filters to eliminate radical novelty. There is less risk that a proposal meets what Parkinson called the "abominable no-man" who is prone to veto anything with any risk (Scherer, 1980; Weinberg, 1990).

The American "State of Small Business" (1983) claimed that small firms bring innovations to market more quickly than large business (2.22 vs. 3.05 years). The greater chance of radical novelty to pass through can result in both resounding successes and calamitous failures: this contributes to the greater variety of innovation discussed before. Due to a lesser spread of risk, in small business, whereby failures in one area cannot be propped up by successes elsewhere, failures will quickly die. The successes will yield growth and procreation. Note that the advantages of small business in decision making indicate a *potential* for speed and risktaking, which will be actualized only in firms that are intent on innovation. As discussed previously this may amount to only 10–20% of small business.

In the processes of development, tooling and production the strengths and weaknesses of small compared with large business are very much as discussed in relation to invention. However, Weinberg (1990, p. 48) noted that with regard to the later stage of production: "... the reasons why a smaller enterprise will have more problems acquiring financing are less valid because the larger enterprise's possibilities of spreading risks and of cross-fertilization have decreased, relative to those in the phase of development, and because the objective security that the smaller firm can offer to its capital suppliers has increased. It is even possible that the production apparatus of a smaller enterprise is more easily re-saleable than of a larger one".

In the stage of introduction to practice we should distinguish between process innovation,

where the producer of the innovation is also the user, and product innovation, where the product is introduced to the market. In the first, small business is likely to be at an advantage due to the condition that the (internal) user is closer to the (internal) developer of the innovation, and may indeed be the same department or the same person. This prevents problems of mismatch, misunderstanding and the obstacle of the "not invented here" syndrome. In the introduction to market the capability of small business depends on the type of product and market. On the one hand we noted that small business is at an advantage due to greater proximity to and closer interaction with the customer. This is in force particularly in the case of custom-made products and personal services. In manufacturing it is more relevant in industrial markets, particularly in the supply of small batches or single items, where the customers are fewer and closer by than in consumer markets. In markets with many consumers, at a distance from the producer, the set-up and exploitation of market research, communication and distribution is required, where large business has an advantage due to economy of scale and scope (use of distribution and communication channels and brand names for multiple products).

The problem for small firms in surveying a wider market came to the fore in a survey in the Netherlands of R&D activities and problems perceived there, by Kleinknecht (1987a). Of enterprises with between 10 and 20 employees (enterprises with less than 10 were not included in the survey) 72% indicated "difficulty in foreseeing market demand" as a problem, as opposed to about 50% of enterprises with more than 500 employees.

A survey of the results indicates not so much that small business is always better or worse in innovation, but that large and small business may be good at different types or aspects or stages of innovation. More precisely: there is an indication of "dynamic complementarity": in subsequent stages of the life cycle of a technology or product group/type large and small firms are better at different stages, and take over from each other. Large firms are generally better at the production of fundamentally new basic technologies; small firms at their implementation in new products brought on to the market; large firms at the large

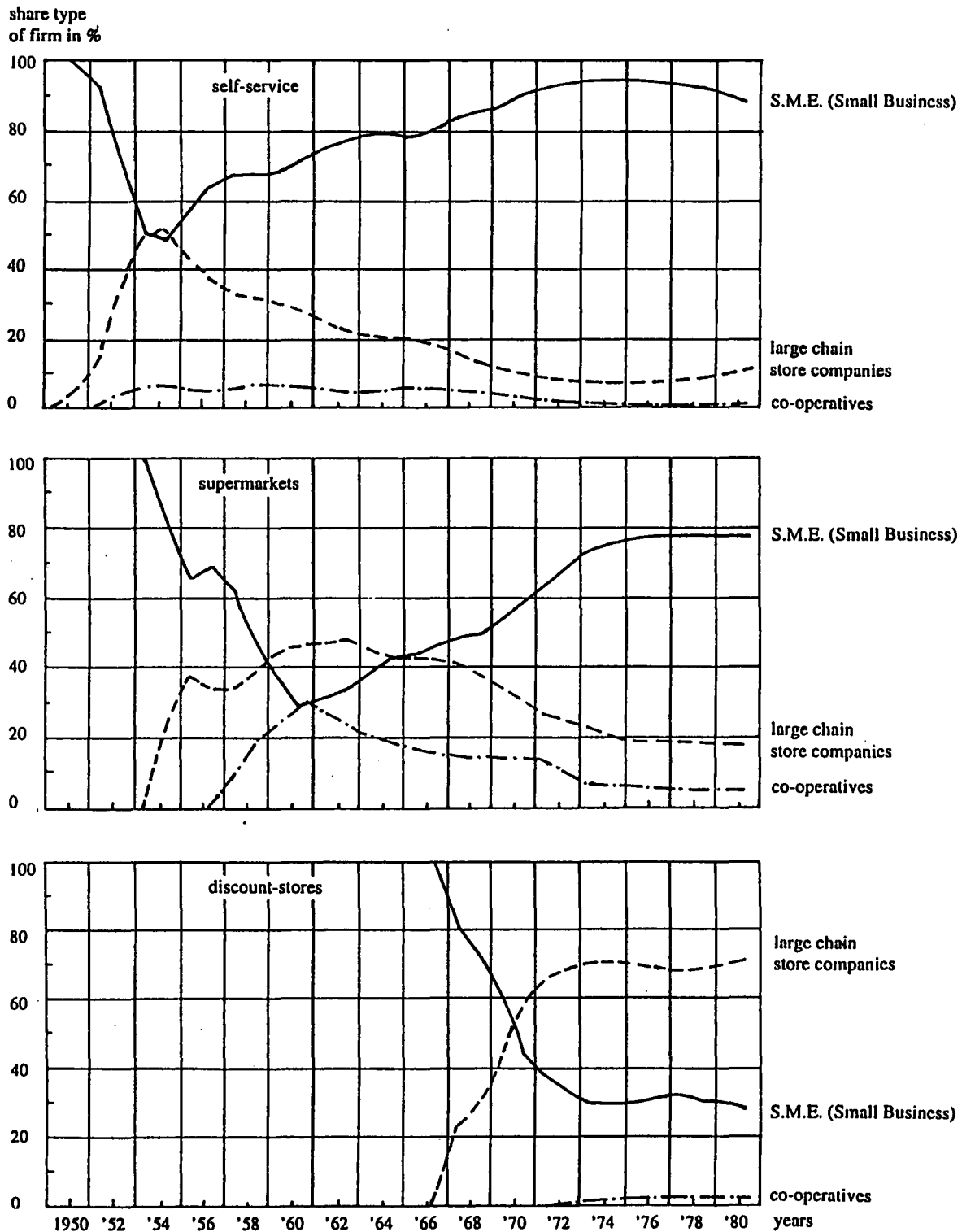


Fig. 5. Dynamic complementarity in the Dutch grocery trade.

scale, efficient production and marketing of the products; small firms at specialties for niche markets and at the provision for residual markets at the end of the life cycle.

This is illustrated in Figure 5, where market share is shown to start out higher for small firms, who are then surpassed by large firms, until in the decline phase large business moves out, leaving residual markets to small business. Thus small business is seen to provide both the market pioneers and the laggards. The dominance of large business in the phase of expansion is due to the growth of small innovators to large size, imitation by large business and the take-over of successful small innovators by large business.

Abernathy and Utterback (in Abernathy, 1978) expressed the similar idea that the nature of innovation changes in the course of development, with first a "fluid" state, characterized by many radical product innovations by often smaller, flexible production units or enterprises, followed by a "specific" state with emphasis on efficient production of given products, with incremental innovation, in more inflexible, larger, integrated units.

Freeman, Clarke and Soete (1982) proposed that fully developed industries, dominated by larger firms with their extensive R&D departments, reflect the ideas of the later Schumpeter, while at its inception an industry reflects the small scale innovation of the early Schumpeter. A similar hypothesis was also proposed by Davis, Hills and Laforge (1985).

Evidence for the pattern of dynamic complementarity is found in a number of studies: the development of CAD and semiconductor technology (Rothwell and Zegveld, 1985), microcomputers (Langlois and Robertson, 1990) and self service retailing (Nooteboom, 1984). Typically, the basic technology and opportunity arise in a large firm, but product/market opportunities are first taken by small business. The case of retailing was later used (in Nooteboom, 1985) for an empirical confirmation of the hypothesis that scale is small and profit margins are reasonable during the initial stage of the life cycle, scale is large and profit margin large during expansion, scale is large and profit margin lower during saturation, and scale small and profit margin low but stabilizing during decline.

12. Diffusion and networks

The empirical evidence of adoption by firms of innovations produced elsewhere is conflicting, but overall the indication is that small firms lag behind.¹⁴ To explain this we consider strengths and weaknesses along the stages of adoption proposed by Rogers (1983, see Figure 2).

We already noted before that in the first two stages of knowledge/awareness and conviction/interest, if current practice is based on tacit knowledge it is no use explaining to the potential adopter what a novel alternative technology could do. First one has to achieve awareness of how one is currently doing things before an alternative can be considered rationally. This may require a Socratic approach of "maieutics" (intellectual midwifery): resisting the temptation to tell how things should be done and coaching the apprentice to find out his own preconceptions and errors, in order to discover improvement himself. A successful method often is to bring entrepreneurs with similar (but not identical) activities together (in a symposium, as Socrates did) to exchange and discuss experience and views.

After the problem of awareness and interest is solved, the problem in the next stages of decision/evaluation and implementation/trial is that the small business entrepreneur is often not capable of evaluating the opportunity for his purpose, due to lack (shallowness, narrowness) of knowledge. If he is rational he will face this, with the conclusion that judgement has to be delegated to a greater or lesser extent. That requires trust in a dual sense: the other party (to whom judgment is delegated) has no interest in giving wrong advice (disinterestedness), and is capable of giving good advice (competence). The latter requires knowledge and experience with the relevant technology and its possibilities and impossibilities, given the specific conditions and priorities of the firm in question.

Tacitness of knowledge forms an important part of an explanation of the experience, well documented in empirical research, that transfer of knowledge and technology to small business is problematic, particularly when the sources and channels are scientific and formal. On the basis of the analysis one will expect small business to seek contacts, often with a personal touch, which can be trusted to be disinterested and competent. The

personal external network of the entrepreneur is an important business asset in the process of gaining awareness and finding help to assess opportunities, thereby compensating for cognitive weaknesses (cf. Johannisson, 1986).

The analysis explains what is found time and again in empirical studies:¹⁵ small entrepreneurs seek information first of all from direct daily contacts such as suppliers, customers, colleagues; secondly from frequent local contacts such as banks and accountants; thirdly from trade associations, trade journals, trade fairs; and last of all from central government authorities for counselling or knowledge transfer. Trust is often extended to already existing business relations with whom one has had long, frequent or intensive contacts, such as suppliers, customers, the bank manager, accountant, or to personal relations, because they are perceived to offer the best combination of disinterestedness and competence. Disinterestedness is large on the part of government institutions and academic institutions for technology transfer, but their competence to judge applicability and priority in the specific firm is often limited. Competence is often large among competitors, but their disinterestedness is in doubt unless the technology is still in a pre-competitive stage.

Networks function not only by direct but also by indirect contact. According to the classic diffusion models in marketing, mostly based on the mixed-effects model proposed by Bass,¹⁶ innovations spread by two effects: an autonomous or "external" effect on potential adopters, based on the inherent advantage of the innovation relative to existing substitutes, and a derived or "internal" effect due to the "contagion" of those who have not yet adopted by those who have, in analogy to epidemic models of contagious diseases. The latter effect by itself generates the well-known S-shaped logistic curve.

Contagion is usually understood to operate by direct contact ("word of mouth"). From sociology, Burt (1982, 1987) proposed his "structural theory of action", in which next to direct contact ("cohesion") there is also the effect of "structural equivalence": the example set by others may stimulate adoption not by direct contact but by their occupying positions in networks which are similar to the focal potential adopter, in the sense that

there are lines of contact with similar parties.¹⁷ Two firms are structurally equivalent to the extent that they serve the same (type of) customers and utilize the same sources (including possible intermediaries, advisors, associations etc.). One considerable merit of the approach is that network properties can be defined rigorously and transformed into measures. Thus a firm may adopt because close competitors have done so, without any direct contact with them or any of their direct relations. Of course information must reach the focal potential adopter by some path through the network, which will show up if the network is sufficiently extended and detailed. The effect is of great potential importance, particularly in view of the problem of limited ability to judge the merits of an innovation: nothing may be more convincing than successful adoption by a close competitor, while direct contact by word of mouth may be difficult or suspect due to the competitive nature of the relation. The upshot of the analysis is that networks are of great importance for small business to compensate for their lack of awareness and knowledge, and for producers of innovations or governmental agencies to stimulate adoption.

In the literature, much attention has been spent on diffusion of innovations in general, but only limited attention has been paid to models of the relation between adoption of innovations and firm size. Exceptions are David (1969) and Davies (1979), who both proposed models with a threshold firm size, below which the innovation is not profitable. Diffusion occurs because the threshold of profitability shifts downwards with improvement of the innovation. David's critical firm size arises due to the "lumpiness" of the investment involved in adoption (in his study: agricultural machines). Davies' critical size arose from a critical payback period which is a function of firm size and other firm characteristics.

In Nooteboom (1989a, 1993a) models of adoption are proposed which are similar to the model of R&D in Nooteboom (1991a). Probability of adoption increases with expected net returns and decreases with risk, where risk is the probability that returns will be negative because it takes too long to implement the innovation successfully. If returns increase with firm size while risk is constant or decreases with firm size,

as is likely, small firms can rationally be expected to lag in adoption.

The model of adoption was tested empirically on data on the adoption of computers in retailing, in the Netherlands, and stood up well to the data. The empirical test took into account possible differences between different types of trade ("industry" effect), a possible effect of the age of the entrepreneur, and the penetration level of computers in the trade as a proxy variable for experience and hence expected time required for successful implementation. The empirical results gave a good fit with significant and correct effects for firm size, age of the entrepreneur and penetration level. The relevance of the model here is that it explains the familiar lag in adoption by small firms as a trade-off between returns and risk.

13. Conclusions

Perhaps the most important aspect of small business is its diversity, due to a lesser compulsion from outside to conform to common standards of profit and conduct, and due to a variety of internal motives and goals of entrepreneurship. This aspect is related to the core characteristics of small scale, independence and personality. One aspect of this variety is that only a minority of 10–20% of small business is truly entrepreneurial in the Schumpeterian sense. But this still yields a large number of innovators.

The great variety of small business generates a great variety of innovative ventures. Risky ventures are filtered out to a lesser extent than in large business, due to fewer levels of evaluation in the hierarchy. Perception of risk is more limited due to absence of specialized staff and lack of outside criticism. Many ventures fail, and they do so efficiently, without too much delay, because due to their restricted scope of activities, small businesses cannot prop up failures in one activity with successes elsewhere. Also due to a lesser scope of activities, small business is also faced with fewer vested interests that hold innovation back.

The core characteristics of small scale, independence and personality yield derived characteristics, strengths and weaknesses and preferred "core" strategies. An advantage of smallness is a greater potential flexibility and closeness to the customer. A disadvantage is lack of economies of

scale, scope and experience. This yields a slant towards customization (low volume niche markets) and innovation (low volume temporary monopolies), where the advantages count and the disadvantages don't.

In the different stages (or aspects) of innovation, small business is often relatively strong in inventions aimed at application of basic technologies, in ventures to develop inventions and to implement and introduce the results, and the satisfaction of demand in small niches or in residual markets. This exploits the strengths of potential flexibility and closeness to customers. Large business is relatively strong in more fundamental research and invention and efficient production and distribution, which exploits effects of scale and scope. Thus small and large business play complementary roles along the life cycles of products or technical trajectories. One could claim that in this concept of "dynamic complementarity" a synthesis is found of the early Schumpeterian thesis of creative destruction and the later Schumpeterian thesis of increasing concentration from innovation by large corporations. Along the life cycle of a new product group, or a "technological trajectory", large and small firms alternate in their contribution to development. Large firms have better resources to produce new basic innovations. Small firms have better behavioural qualities to translate technology in a variety of new technology-product-market combinations. As the temporary monopoly of the innovator wears off, and price competition increases, larger firms are at an advantage to exploit economies of scale in the pressure on costs. In residual niche markets small firms again have an opportunity.

In R&D, small firms tend to participate less, but when they do they appear to spend more, per unit of firm size, and to be more productive. While this is likely to depend on the type of industry, the evidence is that it applies in most industries. Formal dynamic models indicate that a greater number of firms participating in development races stimulates higher development expenditures, thus yielding faster innovation. Thus there is evidence of the hypothesis of creative destruction while at the same time it is true that more basic technological innovations tend to emerge in large firms.

In the adoption of innovations, small firms tend

to lag behind. The lesser participation in R&D and the adoption lag of small business can be understood from a trade-off between expected returns and risk, with risk being independent of firm size, or declining with firm size, while expected returns increase with firm size.

Notes

¹ For an exposition see any university level textbook on financial management or financial markets; for example Neave and Wiginton (1981).

² One should control for this before concluding a long term trend towards more small business from a short term increase of its share in total employment.

³ For recent (but by no means the first) discussions of such stagetheories of organization and contingency, see Nooteboom (1989c) and Kazanjian and Drazin (1990).

⁴ Reference here is to specialized support in legal, marketing, public relations, personnel, strategic/planning, administration, control departments.

⁵ This is a point of some controversy. Some people deny the received wisdom that small business lacks funds for investment, on the argument that for projects with acceptable prospects there is sufficient funds from private sources if not from banks or the stock market. This depends on the country, and, of course, on what one means by "acceptable prospects". In Europe sources of finance have expanded in the form of more venture capital funds and government compensation for risks on the part of suppliers of capital.

⁶ For the theory of transaction costs, see Williamson (1975, 1985). For a treatment of effects of scale in transaction costs, see Nooteboom (1993b).

⁷ A combination of innovation and customized product is indicated either when growth is not an objective, in order to make the advantage of innovation sustainable, or when customization is necessary to acquire a customer as a partner to develop the innovation. The niche strategy may also be appropriate at the end of the life cycle of some product, to serve a residual market, which may be attractive due to a low price elasticity on the part of the "die-hards" that are determined not to follow the new trend in demand. For a discussion of issues of small firm marketing strategy, see Davis, Hills and LaForge (1985).

⁸ Taken from the philosopher Aristotle.

⁹ Not to be confused with the economist Karl Polanyi. For the work of Michael Polanyi, see Polanyi (1962, 1966, 1969).

¹⁰ The innovation rate is defined as number of innovations per 1000 employees, per four digit industry.

¹¹ This point is not entirely novel. Baldwin and Scott (1987, p. 86) discuss a study by Bound, Cummins, Griliches and Jaffe (1984), who indicate how empirical results can vary, depending on the inclusion of small or large firms in the sample: "What the previous researchers criticised by Bound et al. have observed is that relatively few smaller firms perform R&D, and not that the small firms that do engage in R&D spend less relative to size than their large competitors".

¹² The study employed Pavitt's (1984) classification of industry.

¹³ Among other sources I make use here of Weinberg (1990), who took a similar approach in his survey of the literature.

¹⁴ For surveys, see Stoneman (1983) and Baldwin and Scott (1987). For studies that are focussed especially on the firm size effect in diffusion, see David (1969, 1975), Davies (1979), Nooteboom (1989a, 1993a).

¹⁵ In the Netherlands, for example, a study of information seeking behaviour of small firms by the Netherlands Organization of Firm Information (NOBIN, 1983). See also Cannon (1985), Donckels and Degadt (1985), MITI (1984), Johnson and Kuehn (1987).

¹⁶ For a survey, see Mahajan and Wind (1986).

¹⁷ The relevance of the theory in the present context was pointed out to me and is being developed by Groen (1990).

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