Competition, Sunk Costs and Financial Pressure
Implications for Firm Productivity

A Panel Study of Selected Manufacturing Industries

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I hereby affirm that the research for this dissertation titled "Competition, Sunk Costs and Financial Pressure: Implications for Productivity," being submitted to Jawaharlal Nehru University for the award of the degree of Master of Philosophy in Applied Economics was carried out entirely by me at the Centre for Development Studies, Thiruvananthapuram.

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Certified that this dissertation is a bona-fide work of Mr Gaurav Saroliya and has not been considered for any award of any other degree by any other university.

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Abstract of the Dissertation

Competition, Sunk Costs and Financial Pressure - Implications for Firm Productivity
A Panel Study of Selected Manufacturing Industries

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This study looks at the impact of product-market competition (negatively measured by rents normalised on value added), degree of asset specificity (defined as the ratio of production-specific assets to total assets) and financial pressure (measured by interest payments normalised on profits) on the level of total factor productivity (TFP) of a sample of Indian manufacturing firms in a fixed-effects panel data framework. The chief findings are: (1) Competition is related positively to the level of TFP, (2) asset specificity affects productivity negatively and (3) financial pressure has a depressing effect on productivity. The first two findings are in broad agreement with the theoretical arguments that relate competition and asset specificity with the level of productivity through their impact on managerial/worker-effort levels. The third finding is contrary to what theory predicts. We argue that on account of comprehensive financial restructuring in response to various institutional reforms, firms have been unable to use debt as an incentive mechanism.

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CHAPTER 1

Introduction

Transition economies provide an exciting context for analysing questions relating to industrial performance and growth, as the latter vary and evolve significantly in a scenario of policy and structural change. A lot depends on technological factors in determining how well a particular firm or industry can cope with the changing institutional structure. However, given the constraints imposed by technology, there are always some that perform better than the others.[1] This means that there is a lot more to firm performance than just technology. This has been well documented, for example, in the endogenous growth literature on economic growth (Lucas, 1989, Romer, 1990, Aghion and Howitt, 1997). In this introductory chapter, we look at some intuitive arguments for the implications of policy change and structural transition for firm performance in section 1.1 and the plausible relations between these implications and one important indicator of firm performance, namely productivity, in section 1.2.

1.1 Transition: Implications for Firm Performance

One particularly interesting and pertinent case of the type of institutional change mentioned above is a transition from a command-control regime to a market-oriented system. In the former, apart from the vagaries of external shocks, state action and dictate largely determine economic performance by way of regulation and controls of various kinds. Besides, if the state desires a particular firm or industry to be subsidised and supported, it will be so. Consequently, the relative performance of different sectors will be a function, among other things, of their relative abilities to find favour with the state, whether for just or arbitrary reasons.[2] However, in the case of a relatively market-oriented economy, the market will impose its discipline and performance will be more determined by the exigencies of the market and the ability of the economic entities to upgrade themselves commensurately with the changing technology and institutional environment. In the context of industry, the above notion translates into the question as to whether greater openness in the market will lead to greater efficiency and better productivity performance or not. One could intuitively argue that more openness would lead to more entry of new firms

[1] e.g. see Williamson (1985). In his example, two firms with identical technologies were reported to have turned in vastly different performance; one of them in western Europe was thriving, whereas the other in Eastern Europe was on the verge of bankruptcy.

[2] However, see Demsetz (1974)'s discussion of the self-sufficiency and interventionist theories of monopoly.

threatening to wrest the market share of the incumbent firms and thereby pressing the latter to be more efficient. Moreover, a larger number of players could lead to a greater flow of information and knowledge and thus more technological growth and innovation. In other words, in this view, more competition should increase efficiency and lead to higher productivity growth.[3] However, the rationale for this intuitive line of reasoning is not as straightforward as it would appear at first glance and depends crucially on the behavioural assumptions one makes about how the relevant agents respond to changes in their contractual and institutional environment. For one thing, the evidence on this matter, theoretical as well as empirical, is mixed and we are yet to find for this problem, as for many other economic problems, robust and generalisable results.

Secondly, whereas in a command economy, the state actively controls and regulates the amount of production capacity a particular decision-making unit can build, in a market economy, the firm itself decides the level of production capacity it ought to have. Now when a change occurs in policy and the previously existent restrictions on capacity built-up fall, then it is reasonable to expect investment activity in industry to go up, putatively to meet the "pent-up" consumer demand and to realise scale economies. However, when a firm's managers, who are better aware of the firm's investment opportunities, are free to choose capacity levels, which involves incurring huge sunk costs, then their decision may be guided by factors other than potential market demand and scale economies. The notion of specificity of assets[4] assumes significance. Managers may pile up assets specific to their own skills and talents and, therefore, in a way, become indispensable to the firm's organisation of production. This may cause them to reap quasi-rents in the form of greater slack.

Another important consequence of a transition to a relatively market-oriented institutional structure is the liberalisation and deregulation of financial institutions. This has one very important implication for industry. Whereas in a controlled system, a large part of the capital requirements of firms have to be met by internal finance or owner equity, in a liberalised system, firms can borrow funds. Consequently, the structure of the financial capital of firms also undergoes a major change. Arguably, there are significant implications of a changing capital structure on the performance incentives of a firm. In particular, interest

[3] It may be noted that the use of the term competition is not in the strictest economic sense in which it is identified with the pricing behaviour of equating price with marginal cost. This view utilises a more informal definition wherein more players than less represent more competition. To go a step further, one may suggest that our informal definition of competition is not significantly in conflict with the economist's formal definition.

[4] See Williamson (1985) and Tirole (1989) for a discussion of the role specificity of assets in a situation of incomplete contracts.

on debt, which is a legally mandatory payment, can bring pressure to bear on non-performing firms by way of reducing slack. In other words, in the presence of a relatively large amount of interest payments, there operates what is called the discipline-of-debt effect. We shall return to this point presently.

1.2 What is Productivity and what drives it?

Productivity, or more particularly total factor productivity, is far from a rigorously defined concept. Most typically, it is defined as the "residual" influence on the growth of output, after all tangible inputs have been accounted for. Alternatively, it is also understood mathematically as the ratio of output to a suitable index of inputs. Suppose we have a production function

$$Y = \theta f(K, L, M)$$

Where Y is total output producible from the inputs K (capital), L (labour) and M (materials). θ is what we call the (total factor) productivity parameter which is constituted of all the systematic residual influences on output other than the physical and material inputs. $f(.)$ is a function of K, L and M and represents the contribution of tangible inputs to total output. Thus, θ is a residual influence as well as the ratio of total output to an index of inputs, $f(.)$ in our case.

The magnitude and temporal behaviour of total factor productivity are ascribed to a multiplicity of factors and little effort is devoted to specifically characterising those factors and determining their relative significance in influencing the level and growth of productivity. This makes the interpretation of its sources imprecise and vague, not to speak of the problems in measuring it in the very first place.[5]

The most commonly described sources of productivity are investment in Research & Development (R&D) and physical and human capital, the level of worker skills, X-efficiency or managerial efficiency, etc. Furthermore, it is also believed in theory that productivity is closely related to the product-market structure. For example, there has been intensive empirical research on the relationship between market structure and R&D expenditures which, in turn, are instrumental in generating higher productivity growth (e.g. Griliches 1980, 1986, Levin et al 1985, Acs and Audretsch 1988). There is some evidence of a consistent relationship between R&D investments and various measures of

[5] For more on measurement issues in productivity, see Jorgenson and Griliches (1963)

productivity. This is essentially a growth effect. The causality runs from R&D expenditures to innovations of various kinds that lead to a higher rate of productivity growth. [6]Another rather interesting line of reasoning is one that distinguishes between the level and growth effects on productivity in response to a changing market structure (Nickell et al, 1992). It says that, whereas the growth of productivity is a consequence of more R&D activities and innovation, the level of productivity is determined by the effort of the workers and managers of the firm. Such a view is at once unorthodox and significant for a very important reason. It does away with the conventional practice of regarding the firm as just a production function. Moreover, it necessitates and affords a more comprehensive definition of a firm consistent with the emergent view of new-institutional economics which regards the firm as a governance structure, as a set of contractual relationships that could very well have been market mediated but for the lower transactions costs of organising them within a single administrative entity (Coase, 1937, Williamson, 1975, 1985).

Another way to look at this growth-level distinction is that the level of productivity represents the efficiency of the firm, graphically interpreted as the smallness of the distance of the firm's output from the production-frontier output with the same level of inputs. On the other hand, the growth of productivity represents the shifts in the frontier itself. So, in this explanation, whereas the efficiency of a firm is effort determined, the growth of its productivity is a function of active investment in the upgrade of technology and innovation by its management.[7,8] To place this distinction in the perspective of theory, one (effort) is a matter for agency theory, and the other (R&D and innovation) for endogenous growth theory. Very recently, there has been an attempt to uncover the implications of the former for the latter, especially in the context of productivity and the impact of product market competition on it. In fact, there is some belief and theoretical evidence that product-market competition, through the agency route, has an impact not only on the efficiency of the firm, but also on the technological growth by affecting the willingness and readiness of a firm's management to adopt new technologies and innovate (e.g. Aghion & Howitt, 1997, Aghion, Dewatripont and Rey, 1998). Thus, better handling of the agency problems could lead to not only a higher level of productivity, but also a faster rate of its growth. Besides, the

[6] Acs and Audretsch (1988) investigate the causality from R&D to innovation and Geroski (1989) tests the connection between innovation and productivity growth.

[7] Whereas earlier the terms efficiency and productivity were sometimes erroneously used synonymously, now there is broad agreement among economists regarding a neat distinction between the two (see Grosskopf, 1993). To be specific, whereas (in)efficiency is the distance from the frontier, productivity is efficiency plus technical change represented by the shifts in the frontier. See the discussion in Chapter 4, section 4.1 on this.

[8] It may be noted that any permanent rise in the level of productivity will induce a temporary rise in the rate of growth. A growth effect, however, implies a permanent change in the rate of growth which R&D and innovation are believed to achieve.

significance of more competition for the agency problems critically hinges on the its impact on managerial/worker incentives to supply greater effort and have more readiness to adapt and innovate.

Managerial incentives to supply effort are also a function of how well the managers of a firm are established in the firm's organisation of production and how well they are able to deter entry on account of the high sunk costs incurred by the firm.[9]There are several reasons why sunk costs might affect the efficiency of production organisation in a firm. We shall present a detailed discussion on the intuitive and theoretical arguments on the issue below.

Again, in the context of the agency problems of the firms, another important factor determining and affecting worker incentives to supply effort is the pressure of financial markets (Jensen 1986). With industrial growth, the size of the modern corporation grows and so do its capital requirements. The firm cannot afford to insulate itself from the financial markets and survive, for sufficient owner equity in a competitive situation is something extremely rare. With increasing dependence on financial markets, a firm would come under greater financial stress and that would arguably put pressure on the workers/managers to perform and, thereby, affect productivity. There is theoretical support for this view also. Besides, as we shall see in chapter 2, there are theoretical models that examine the interaction of product-market competition and financial market pressure in affecting firm performance.

The chief aim of this work is to study the relationship between the total factor productivity of firms and the three incentive influences, namely product-market competition, sunk costs and financial pressure. In chapter 2, we provide a formal statement of the objectives, scope and coverage of the study following a detailed review of the theoretical and empirical literature and an examination of the gaps in the literature on productivity in India.

[9] See Shleifer and Vishny (1988) for the first and Dixit (1980) for the second effect of high sunk costs.

CHAPTER 2

Institutional Change, Market Pressure and Firm Performance: A Review

In Chapter 1, we have overviewed the arguments regarding the implications of the agency problems of the firm for its productivity performance. Before we examine the theory underlying these arguments, it would be useful to take a bird's eye view of the agency problems of firms. Section 2.1 provides this. In sections 2.2, 2.3 and 2.4 we look at the theoretical evidence in regard to the relationship between productivity and competition, asset specificity (sunk costs) and financial pressure respectively. Section 2.5 looks briefly at the empirical evidence on these matters and section 2.6 tries to locate the perceived gaps in the existent productivity literature in India. In the end, section 2.7 gives a formal statement of the objectives of this thesis along with its scope and coverage.

2.1 The Agency Problems of the Firm

Agency problems of firms are no recent discovery. As early as in 1932, Berle and Means provided a detailed account of the problems generated by the separation of ownership and control in large modern corporations which often causes a misalignment between managerial interests and shareholder interests. The problem has been centre stage in corporate governance discourse to date.[1] The typical widely-held and traded corporation has a large number of small investors who are generally neither in a position nor particularly inclined to monitor the activities of the managers. Besides, any contract between the owners (shareholders) and managers of the firm is essentially incomplete by nature in that it may not be possible to include governing rules for all the possible contingencies in the future.[2] In such a situation, delegation of decision-making to hired managers is prone to informational asymmetries because managers are better informed of the firm's investment opportunities than outside investors. The knowledge of this fact may induce managers to use their informational advantage opportunistically to their private advantage. In the language of information economics, this is called moral hazard.[3]However, it is not clear whether this principal-agent conflict is necessarily detrimental to the interests of shareholders. The basic

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[1] See Shleifer and Vishny (1997) and Tirole (2001) for a discussion of the shareholder and stakeholder models of corporate governance.

[2] For more on the incomplete-contract view of the firm, see Grossman and Hart (1980, 1986), Hart and Moore (1990), Hart (1995) and Tirole (1999) among others.

[3] The pioneering work on moral hazard is by Ross (1973), carried forward by Mirrlees (1974, 1975), Harris and Raviv (1978), Holmstrom (1979) and Shavell (1979). For an excellent literature review on the subject, see Rees (1987) and Hart and Holmstrom (1987).

reason why a manager is hired for the job is his superior skill and that warrants him to have better information. Thus, it is natural for him to capture a substantial part of the residual control rights too. It is this discretion that, it is suspected, managers may misuse for expropriating wealth, e.g. through higher salaries, empire building, etc.

The question that has been debated recently in the corporate governance literature is how to solve this agency problem by inducing managers to maximise shareholder value. The classic theoretical solution for the problem of moral hazard and opportunistic behaviour is the provision of incentives. Mainly, two general strategies of incentive provision are identified to induce efficient production and foster firm performance. One is the "carrot method" covering the optimal design of incentive schemes for managers. Another is the "stick method" involving monitoring and supervision. Moreover, incentives can be provided by external factors like product-market competition and the market for corporate control or internal factors like debt levels and executive compensation levels.[4]

2.2 Product Market Competition, Agency Problems and Productivity

How does competition affect firm performance? The debate on the question is an old one. Adam Smith commented that "monopoly ... is a great enemy to good management" (1776, book 1, chapter 11). In recent times, among others, Richard Caves has remarked that economists have a "vague suspicion that competition is the enemy of sloth" (1980, p.88). But this is one side of the coin. It suggests that competition makes firms more efficient. There are as many detractors as there are supporters for this view. Take, for example, the debate between Schwartzman (1973) and Leibenstein (1973). The former argued that "there are neither logical reasons nor evidence to show that monopoly is less X-efficient than competition."[5] In response, Leibenstein derived a result in which competition is more X-efficient than monopoly.

In recent times, there have emerged two schools of thought on the relationship between competition and productivity. The first is the Schumpeterian prediction of competition affecting growth negatively. The Schumpeterian models of economic growth[6]

[4] It may be more reasonable to regard the effect of debt on incentives as an external factor. Firstly, the ability of a firm to choose debt for incentive purposes is a function of its capital requirements. If the firm is significantly short of owner capital, then debt is no more a matter of choice. Secondly, the interest rate too is institutionally given.

[5] The idea of X-efficiency was introduced first in Leibenstein (1966) and further developed in Leibestein (1969). For a critique of the theory, see Stigler (1976) and Frantz (1992).

[6] Some classic references to the Schumpeterian perspective on economic growth include Segerstrom, Anant and Dinopoulos (1990), Aghion and Howitt (1992), Corriveau (1991), Romer (1990), Grossman and Helpman (1991) and Young (1993)

are directly and explicitly concerned with research and development as the engine of growth by positing particular ways in which knowledge is created and used. Besides, they show how innovations affect individual markets and work out the consequences in terms of profit and loss generated by Schumpeterian creative destruction. These models offer a particularly convenient paradigm to study the impact on the incentive to perform innovative activities driving growth of diverse factors such as regulation, taxation, intellectual property regimes and various other non-economic factors. Lastly, and more importantly for our purpose, one may also look into the strategic interactions among innovative firms in the process of growth and examine how the intensity of competition affects the rate of productivity growth.

In the basic Schumpeterian model, there exists a trade-off between growth and competition. As noted by Aghion and Howitt (1997), "In a more competitive economy, where innovators could not anticipate as high a level of monopoly profits from their innovations, or for as long a time, innovation would be discouraged." In a relatively monopolistic market, there is more internal cash flow available to invest in R&D and less uncertainty about demand and general market conditions. Secondly, competition increases the elasticity of substitution between goods and reduces monopoly rents (Caballero and Jaffe, 1993). This also dampens the incentives to innovate. Conversely, the existence of future monopoly rents induces firms to adopt new technologies and innovate. Also, as Grossman and Helpman, (1991) show, competition facilitates imitation and hurts research and development(R&D). The latter, it is shown, bears positive externalities. The gains from an innovation can accrue not only to the individual firm that makes the innovation but also to other firms in the same industry, consumers and workers.

Before we move on, it would be instructive to note that the Schumpeterian prediction rests on the assumption that the managers of the firm maximise profits. On the other hand, there are the so-called Darwinian models that make the reverse prediction. As against the Schumpeterian models, these models are mostly based on a non-profit-maximisation assumption. They rather assume that the managers of a firm maximise their private benefits. This theory predicts that competition will have a positive effect on managerial incentives to supply effort, adopt new technologies and innovate. There are several theoretical arguments in favour of such a view, however, admittedly, some of them are not robust and yield reverse predictions in the face of alternative assumptions.

Firstly, there is the information argument. Competition changes the information structure of a firm's agency problem.[7] The idea is that when there are more players in the market, the correlation between a firm's performance and managerial/worker effort becomes stronger, especially given that random shocks to the cost functions of these firms are correlated. This enables external investors to better assess the performance of a firm's management, since comparison among competitors becomes more meaningful and easier. Besides, the owners have more ex-post information available regarding managerial effort. This serves to alleviate moral hazard.

Hart (1983) provides a model of managerial incentives which shows clearly how competition among firms may sharpen incentives. In his world, there are two types of firms in any industry, "managerial" (M), where there exists a principal-agent problem, and "entrepreneurial" (E), where the "principal" runs the firm. By assumption, all firms face common cost shocks. When marginal costs are low, E firms expand output, whereas the managers of the M firms deem it convenient to slack. Such behaviour is consistent with the assumption that managers are not "too responsive" to monetary incentives. If the proportion of E firms is higher, then industry output in good times (low cost) is higher, industry prices are lower and the potential for M firm managers to slack is lower as well. This result encourages an interpretation of more competition leading to less slack. However, the result is not robust. Scharfstein (1988) shows that the position is reversed if managers are highly responsive to monetary incentives. In that case, "competition" leads to more slack.

Another argument relies on the idea in Meyer and Vickers (1995:2.1) which utilises a model of implicit rewards discussed by Holmstrom (1982a).[8] The idea is that while current managerial effort does not influence current earnings, it may affect future market-based rewards through its impact on the market's estimate of the manager's ability. The market cannot observe effort or ability directly. But it can use the knowledge about the firm's output which depends on effort, ability and unobserved productivity shocks. Managers have an incentive to increase effort early in their career especially in the presence of competition because unobserved productivity shocks are likely to be correlated in the same industry.

It is also argued that competitive forces in the product market may raise the sensitivity of profits to the actions of managers. Thus, if competition makes profits more responsive to managerial effort, then owners have a greater incentive to ensure that managerial effort is kept high and, consequently, inefficiency is lower. Willig (1987) presents a model in a simple principal-agent framework wherein he shows that greater

[7] see Holmstrom (1982b), Hart (1983), Nalebuff and Stiglitz (1983), Mookherjee (1984)
[8] Holmstrom's analysis was a formalisation of the intuitive argument first presented in Fama (1980).

competition will have two effects the interaction of which will determine the consequences for effort. Firstly, competition will raise the elasticity of demand in the product market causing the firm's owner to induce the manager to raise effort. However, competition will also cause a fall in demand. This will have the opposite effect. Now greater competition will raise effort only if the demand-elasticity effect outweighs the demand-reduction effect. Schmidt (1997) also reaches an ambiguous result owing to two conflicting possibilities of greater competition. Whereas more competition may raise the probability of bankruptcy by putting pressure on profits, it may also progressively diminish the benefits of cost reduction as, after a point, it may not be possible to reduce cost owing to technological constraints. The first effect will raise effort and the second will decrease it, though Schmidt derives sufficient conditions under which competition will unambiguously raise effort.[9]

In a Schumpeterian-Darwinian growth context too there are theories that predict the possible effects of competition on the managers' willingness and readiness to adopt new technologies and innovate. Aghion and Howitt (1997) give four explanations for why, contrary to the conventional Schumpeterian prediction, competition may actually increase growth. Firstly, if there are barriers to entry in research, then competition, by reducing these barriers, will raise growth. Secondly, if managers do not maximise profits, but their own private benefit, then competition will reduce slack and increase growth. Thirdly, "a higher degree of product-market competition, by making life more difficult for neck-and-neck firms, will encourage them to innovate in order to acquire a significant lead over their rivals." The last explanation is based on a distinction between research and development. Whereas research opens up new windows of opportunity by inventing new product lines, development realises those opportunities by inventing concrete plans that allow the products to be produced. Aghion and Howitt show that the level of research, and therefore the rate of growth, are increased if developers become more adaptable, i.e. if the rate at which they are able to switch from developing old lines to developing new lines increases.[10] Also, an increase in the substitutability between new and old lines, which implies an increase in competitiveness between them, will induce developers to leave old lines more rapidly with the effect of inducing a higher level of research and growth.

Aghion et al (1998) explore the agency considerations that determine the incentive effects of competition on technological adoption by non-profit-maximising managers. One

[9] Specifically, he shows that, if managers are paid an amount exactly equal to their reservation utility, then competition will unambiguously raise effort.

[10] This is consistent with Lucas (1993)'s claim that the key to the success of some newly industrialised economies is their ability to move skilled workers from sectors where learning is beginning to slow down to those where new ideas can be more profitably developed.

main idea of their model is that by reducing the amount of slack a manager can afford while keeping his firm alive, competition combined with the threat of liquidation acts as a disciplinary device that fosters technology adoption and growth.

However, there are theoretical results implying that competition may not necessarily reduce slack. For example, it is argued that the incentive to prevent managerial shirking should be equally strong in a monopoly [Jenson and Meckling (1976)]. Further, there are arguments that show that competition, in fact, may affect productivity negatively. As we saw above, Scharfstein (1988) has shown that competition might reduce managerial effort if managers are responsive to pecuniary incentives. The idea is that competition would take away demand from the firm[11] and reduce managerial incentives to improve productivity. The argument is similar to that in Willig (1987). Horn, Lang and Lundgren (1994) and Martin (1993) also find an unambiguously negative influence of competition on managerial effort. Also, the effect of competition on incentive schemes and productive efficiency is shown to be a function of the specification of managerial preferences, the classification of agency goods and the bargaining equation between the owners and managers [Scharfstein (1988) and Hermalin (1992)].

2.3 Sunk Costs, Specificity of Assets and Productivity

Production capital is highly specific and potentially sunk so that it cannot be rented at any time. Sunk costs are incurred whenever the value of an irreversible investment exceeds its value in alternative uses (Sutton, 1991). Since investment decisions are typically made in an uncertain environment and costly to reverse once they have been implemented, most investment decisions entail an element of irreversibility and thus a measure of sunk costs. In general, sunk costs are associated with both tangible and intangible assets. These can be specific physical or knowledge capital as well as specific human capital in the form of investment in human skills (Schuler and Weigand, 2001).

Businesses that incur sunk costs expose themselves to substantial risk owing to the irreversibility of the decision and the need for such costs to be recouped in an uncertain future. If the business environment and technology change rapidly, then firms with highly specific assets will find it difficult to restructure their operations by selling off obsolete equipment and tapping resources to acquire the latest technology.[12] Thus, firms facing high

[11] This is the "business stealing effect" discussed by Mankiw and Whisnton (1986).

[12] Also, the degree of asset specificity matters for the decision regarding the financing of investment (Williamson, 1988). Highly specific assets have little liquidation value and cannot serve as collateral to external financiers (Shleifer and Vishny, 1992).

potential sunk costs have less flexibility and would be inclined to keep producing with outmoded production capital at the expense of efficiency. This might harm productivity performance. This is the likely direct effect of possessing highly specific production assets.

Sunk costs can have indirect effect on productivity through an influence on managerial incentives to supply effort. There are several theoretical reasons for the belief. Firstly, Dixit (1980) has suggested that sunk costs may deter product-market competition and, thereby, modify the incentive structure of the firm. Whereas incumbent firms have already committed themselves to an industry by investing in irreversible specific assets, potential entrants have not. Therefore, sunk costs impose an asymmetry between the incremental costs and risks encountered by the incumbents and potential entrants. A potential entrant's incremental cost will factor in the full amount of sunk costs which have been recouped by the incumbent to an extent. Besides, this asymmetry may give rise to entry-deterrent strategies like limit pricing.

Secondly, in the financial economics literature, asset specificity has been considered as a strategy of management entrenchment. Managers may invest in sunk costs to strengthen their hold on the production organisation of the firm. This might deter owners to replace the existing management in the event of underperformance (Shleifer and Vishny, 1988, 1997, Zweibel, 1996 and Fluck, 1999). The idea is that sunk costs may help managers to "entrench" themselves in the establishment relatively to the owners of the firm. Managers can use sunk investments as a strategic instrument and a credible commitment device. Moreover, if manager-specific knowledge is incorporated in the sunk investment, then managers can make themselves indispensable to the less informed shareholders and other stakeholders like lenders (Shleifer and Vishny, 1988), which might reduce managerial effort and productivity performance.

There are a couple of lesser arguments as well that hold that a high degree of asset specificity might reduce productivity. For example, it is argued that sunk costs might affect the choice of debt finance over equity since sunk investments may limit access to capital markets. Williamson (1988) has argued that a high share of specific assets lowers the prospects of debt financing. Therefore, sunk costs may blunt the impact of the posited discipline of debt effect.[13]Again, it is believed that sunk costs may harm the exercise of control through shareholders and stakeholders. Zeckhauser and Pound (1990) argue that monitoring by large shareholders will be difficult when assets are specific to the firm and its

[13] See the next section of this chapter for theoretical arguments for the discipline of debt effect.

management, since such firms have a closed information structure. Thus, high asset specificity might impede effective monitoring and lead to lower productivity.

2.4 Financial Market Pressure, Discipline-of-Debt Effect and Effort

Pay-outs to shareholders reduce resources under managers' control, thereby reducing the managers' power and making it more likely that they will incur the monitoring of the capital market which occurs when the firm must obtain new capital. This is on account of the fact that capital markets punish dividend cuts with large stock price reductions. Financing projects internally avoids this monitoring and also the possibility that fund will be unavailable or available at a high price. However, internal financing is not always sufficient and capital markets have to be inevitably resorted to in most cases. As the firm incurs more and more debt, its interest liabilities relative to its cash flow grow. This has a disciplining effect on managers.

Financial market pressure or the discipline-of-debt effect can be understood in terms of the impact of a debt-dominant capital structure on worker effort and productivity. Firstly, it's argued that debt servicing reduces the free cash available with managers, since interest is an obligatory payment, unlike dividend [Jensen (1986, 1988)]. Jensen (1986) defines free cash flow as the cash flow available in excess of that required to fund all projects that have positive net present values when discounted at the relevant cost of capital. Conflicts of interests between shareholders and managers over pay-out policies are especially severe when the organisation generates substantial free cash flow. It is noteworthy that it's the free cash flow available at managers' disposal that induces slack.

A higher proportion of debt in the capital structure of a firm may increase the probability of bankruptcy since lenders can withdraw their money in the event of the firm being unable to make timely interest payments [Jensen and Meckling (1976)]. Moreover, this effect has been examined in relation to growing product-market competition as well, e.g. in Aghion, Dewatripont and Rey (1998). They note, "In firms with high levels of outside finance, managers will mostly worry about preserving the private benefits of remaining in business, knowing in advance that the monetary returns from their efforts will mostly accrue to outside financiers. Then, if the private benefits of remaining solvent are sufficiently large, a deterioration of profit (e.g. as a result of an increase in product-market competition) will induce managers to work harder to survive such a deterioration. Lastly, creditors, through additional covenants in the indenture, may serve as effective outside monitors as well [Short (1994].

2.5 The Empirical Background

The above discussion on theory suggests that, with regard to the impact of a competitive market structure, there is a lack of agreement among theorists. Logically, there are arguments for a positive as well as negative impact. Therefore, it is largely an empirical question whether more competition induces firms to be more efficient and grow. More than examining the impact of competition on productivity, empirical evidence can provide critical reflection on the tenability or otherwise of the underlying behavioural assumptions made in the theoretical models discussed above (i.e. whether managers maximise profits or their own private benefit). On the other hand, we also saw that there is a fair amount of unanimity on the subject of debt having a disciplining impact on management. In this section, we shall take a brief look at the various empirical investigations in various contexts that have tested the propositions of the theories surveyed above.

We start first with evidence of a historical and non-rigorous nature. In the post Second World War era, the governments of eastern European countries repressed competitive forces and had low productivity levels. On the other hand, in Western Europe, competition was encouraged and handsome productivity gains registered. Secondly, as Porter (1990) has shown, that domestic competition has played a central role in generating international leaders. In his example, the Japanese success stories, e.g. cars, motorcycles, cameras, video recorders and musical instruments, are precisely those industries in which domestic competition is intense. On the other had, those Japanese industries in which domestic competition is weak have little international presence (e.g. construction, commodity chemicals and paper). Thirdly, as Graham, Kaplan and Sibley (1983) show in the context of the US airline industry, deregulation is generally followed by significant productivity gains.

We shall now turn to more rigorous econometric analyses. First of all, there are studies that investigate the relationship between competition and R&D investment which, as we saw earlier, feeds into knowledge and technology generation and growth (Griliches, 1986). Through a panel analysis to control for industry-specific technological opportunities, Geroski (1990) finds that concentration and other measures of monopoly power tend to reduce the rate of innovation and hence the rate of productivity growth. Also, recently, there have been comprehensive analyses of technical efficiency [see Caves and Barton (1990), Green and Mayes (1991) and Caves et al (1992). These studies make use of the stochastic frontier production function technique to obtain estimates of technical efficiency and then relate them to the variables of interest. The unifying theme of all these studies, apart from

the use of the frontier approach, is that they find reduced technical efficiency when market concentration rises above a particular threshold level. This result emerges in the context of many countries.[14] It may be noted that these studies are cross-section-based studies. However, similar effects of competition on the level of productivity are established by Haskel (1990) using industry data, and by Nickell, Wadhwani and Wall (1992) and Hay and Liu (1994) using firm-level data. In these studies, a fixed-effects panel data framework is used to analyse the impact of competition on the *level* of productivity (efficiency). They find that a rise in market concentration or market share is followed by a ceteris paribus fall in productivity. With regard to the productivity growth effects of competition, Nickell (1996) and Nickell, Nicolitsas and Dryden (1997) find strong evidence of a positive impact of competition, as measured by the number of competitors or rents normalised on value added, on productivity growth. Again, Van Wijnbergen and Venables (1993) find that the trade liberalisation and deregulation that was undertaken in Mexico in 1986-88 led directly to an increase in competition and a significant increase in productivity growth.

However, empirical support for the hypothesis of more competition leading to better productivity is not universal. In a panel analysis of 361 firms in a context of post-unification Germany, Schuler and Weigand (2001) find a positive relation between supplier concentration in the market and total factor productivity, which means that the link between competition and productivity may not always be positive. Dilling-Hansen et al (1997) in a study on the manufacturing sector on Denmark also find a negative influence of product-market competition on productivity.

Thus, we see that there is some empirical evidence too that competition leads to efficiency and productivity gains, though it is, like the theoretical evidence on the matter, not overwhelming. It is noteworthy that formal econometric analyses of the link between competition and productivity are rather few. There are two main reasons why more empirical results are warranted. Firstly, theory does not give definitive results. Secondly, as more and more economies embrace institutional reform to usher in market forces, greater will be the importance of such analysis for purposes of impact assessment.

Regarding the evidence on the impact of sunk costs, there is evidence that sunk costs deter entry and reduce the rate at which potential entrants respond to the positive profits of incumbents (Kesides, 1991, Mata, 1991). Worthington (1995) has found that high sunk costs indeed discourage debt financing which should weaken the discipline of debt effect. However, analyses investigating the supposed link between the degree of asset specificity

[14] This result is consistent with the finding in the management literature that competition induces companies to employ more efficient decision making structures. See, for example, Caves (1980)

and total factor productivity are hard to come by, especially in an environment where restrictions on the acquisition of production-specific assets have been recently removed.

Before we end this section, we shall take a look at empirical analyses on whether debt has a disciplining impact on managers, which should translate into higher productivity. This notion was initially associated with leveraged buy-outs (see Lichtenberg and Siegel, 1990). Direct evidence on the issue is pretty much one sided. Nickell et al (1992), Curcio (1994), Lang et al (1996) Dilling-Hansen et al (1997), Nickell et al (1997) and Schuler and Weigand (2001) all present evidence of the discipline-of-debt effect. These studies use various measures of financial pressure like interest payments normalised on profits (interest-coverage ratio), capital-gearing ratio, etc.

2.6 Productivity Literature in India: the Gaps

It's hard to find universally applicable generalisations in economics. Therefore, the lack of theoretical agreement on the issue of the effect of competition on productivity growth should come as no surprise to anybody. However, the fact remains that the research on the issue must continue as more and more economies face major institutional changes. Such work is especially pertinent in the context of industrialising economies in transition like India and for good reasons too. For one thing, it may provide credible suggestions for policy. For example further research can provide answer to the important question of whether an active competition policy is more conducive to growth or whether the state should give subsidies to large firms who may have more resources and inclination to innovate. Secondly, it may provide useful reflections on the state's current industrial policy and the success or otherwise of it. Thirdly, it may have significant implications for the state and direction of financial market reforms. Specifically, it may provide suggestions with regard to, for example, the interest-rate policy of the central bank. Very low interest rates could make debt cheap and weaken the discipline-of-debt effect.

In the context of India, a large number of productivity studies are available. It is noteworthy, however, that most of them are analyses of trends in the growth of total factor productivity (TFP) or its magnitude or, at best, the impact of trade liberalisation of TFP growth. Causal analyses of the determinants of TFP are, if at all, extremely hard to find. We shall take a look at some recent ones, especially those carried out in the context of industrial liberalisation. Ahluwalia (1991), through a comprehensive analysis of productivity in various industrial sectors, found evidence of a definite turnaround in the growth of total factor productivity after 1980, believed by many to be the tentative point of beginning of

industrial liberalisation.[15]Srivastava (1996) compared post-1985 productivity TFP growth rate to pre-1985 growth rate and found that the former was higher. Moreover, the result was robust to change of specification. Srivastava regards 1985 as the "watershed year" when wide-ranging and comprehensive economic reforms were instituted. Moreover, after the manner of Ahluwalia (1991), he ascribes the higher growth in TFP to the policy of liberalisation, though it is noteworthy that there are no policy variables in the analysis relating policy change to productivity. In recent times, however, there have been studies that relate variables capturing, for example, the change in trade policy on the growth of TFP. The results, however, are conflicting. Fujitha (1994) uses the change in the share of public enterprises in value added as an indicator of policy change and finds that liberalisation has had a positive impact on productivity growth. Das (2001) finds a positive impact on TFP growth of lowering of non-tariff barriers to trade. Goldar and Kumari (2002) find import liberalisation having a positive impact on TFP growth. Chand and Sen (2002 also find a positive impact of trade liberalisation in TFP growth. However, there are studies that find no or a negative impact of liberalisation on TFP growth. Examples include Balakrishnan et al (2000) who use a dummy variable to examine the post-liberalisation change in TFP and Nouroz (2001) who uses indicators of export expansion and import substitution. Whereas the former find a negative impact, the latter finds that difference of trade regime does not affect TFP. Krishna and Mitra (1998) find feeble evidence of a positive impact and their results are not very convincing.

So far, measurement issues and analysis of temporal behaviour of TFP in response to trade liberalisation have engulfed the Indian productivity research almost entirely. There has been no attempt to see, for example, how the changing market structure (monopolistic/oligopolistic to competitive or vice versa) in the post-reform period has affected total factor productivity. If the previously existent restrictions on industrial activity had fallen, then there must have been a significant alteration of the product-market structure in consequence of the reforms. Secondly, the issue of asset specificity in the context of total factor productivity has not been discussed so far. Also, there has been no systematic

[15] Ahluwalia's methodology of single-deflation value added has generated substantial controversy over the 1990s, See Balakrishnan and Pushpangadan (1994, 1995, 1996, 1998, and 2002), Rao (1996) and Pradhan and Barik (1998). These papers use double-deflation value added to estimate TFP growth and find it to be very low or negative during the 1980s. Goldar (2000) argued that the estimates of TFP growth using double deflation value added or the gross output function are sensitive to the choice of the base year. For example, the study by Balakrishnan and Pushpangadan (1994) used 1970-71 as the base year and found the growth of TFP very low or negative. However, another study by Trivedi et al (1997) used 1980-81 as the base and found a significantly positive rate of TFP growth during the 1980s. Goldar (2000) also notes that the estimates of manufacturing TFP obtained by Balakrishanan and Pushpangadan using price indices with base 1981-82=100 give a TFP growth rate of 3.91 per cent per annum, while the estimates with 1970-71=100 give a growth rate of –0.11 per cent per annum (both base on double deflation value added).

investigation of how the changing financial capital structure of firms affects their productivity performance. It is noteworthy that there has been substantial reform of the financial sector and India beginning 1992, which has continued to date. We shall have more to say on this in the next chapter.

In this section, we have seen that only a few studies are available that provide rigorous causal analysis of important sources of total factor productivity, though admittedly trade liberalisation indicators have been left to explain all variations in TFP. One important reason for the general paucity of causal analyses of TFP in India is that most productivity studies have used aggregate data which is not very amenable to an analysis of the sources of productivity. However, with a progressive tendency towards firm-level analysis, our knowledge of productivity sources should be significantly enriched. One particular type of analysis that will be especially interesting in the context of an industrialising country like India will be how more product-market competition, specificity of production assets and financial market pressure impact on total factor productivity of firms. This study takes a first step in analysing the impact of these factors on the productivity performance of a sample of firms from the Indian manufacturing sector.

2.7 Objectives, Scope and Coverage

2.7.1 Objectives: In the light of the foregoing discussion, we now make a formal statement of the objectives to this study below:

1. To attempt an overview of the changing patterns in product-market structure, acquisition of production-specific assets and financing behaviour of firms after the onset of economic reforms, especially for the five major industrial groups selected for the study mentioned in section 2.7.3 below.
2. To examine the impact of product-market competition, asset specificity and financial pressure on the level of total factor productivity of the firms.
3. To study the interactions among the three incentive influences. Particularly, we try to see understand how the observed behaviour varies with high competition and high asset specificity.

Chapter 3 serves objective number1 whereas the analysis required for objective 2 and three is presented in chapter 4.

2.7.2 Scope: The scope of the study is limited to an analysis of a sample of the Indian manufacturing sector. There are several reasons for choosing the manufacturing sector. Firstly, the manufacturing sector is the one that contains the largest number of companies

listed on the major stock exchanges of the country. This ensures the availability of the required financial-market information for our analysis. Moreover, the sector accounts for the bulk of the industrial output and employment. Secondly, most of the large corporations are in the manufacturing sector. It is noteworthy that agency problems are likely to be more acute in large rather than small companies. Thirdly, and most importantly, output measurement in not very controversial for manufacturing firms unlike, for example, service sector firms.

2.7.3 Coverage: Finally, within the manufacturing sector, our coverage of firms is confined to a limited number of industries at the 3-digit level of National Industrial Classification (NIC), 1987. The main reason for our limited coverage is the problem of data harmonisation between our three main sources of data, namely PROWESS (the corporate database of the Centre for Monitoring Indian Economy), the Annual Survey of Industries (ASI) and the Monthly Statistics of Foreign Trade published by the Directorate General of Commercial Intelligence and Services (DGCI&S), Government of India. Given the constraints of concordance, we have chosen five two-digit industrial groups for the purpose of this study, namely:

1. Rubber, Petroleum and Plastics
2. Non-metallic Mineral Products
3. Non-Electrical Machinery
4. Electrical Machinery including Electronics
5. Transport Equipment

Besides, we have taken data over time as well. We have chosen the period 1990-91 to 1997-98. The reason for not taking the data beyond 1997-98 is the new NIC, 1998 which is comprehensively different from the NIC, 1987. Although, concordance can be drawn between the two, the problem is that NIC, 1987 can be made to harmonise with NIC, 1998, but not the other way round. And, moreover, we have price indices available according to NIC, 1987. Hence the decision to stop at 1998.

This chapter has provided the theory underlying the research problem of this study. In Chapter 3, we examine the institutional setting for the problem. Specifically, we argue why the period we have chosen is suitable for the kind of analysis we do in Chapter 4, in the light of the broad indicators of competition, sunk costs and financing behaviour of the firms in the selected industries.

CHAPTER 3

The Institutional Setting for the Problem

As we mentioned in Chapter 2, the period of our study is 1990-91 to 1997-98 for reasons of data and matching already explained. However, it is important to state why an analysis of the impact of market competition, asset specificity and financial-market pressure on total factor productivity is important for India and particularly at this juncture. In this chapter, we shall examine the suitability of the Indian context for the type of productivity analysis that we intend to carry out (sections 3.3 and 3.4). Also, this is one of the stated objectives of the study. This wiil involve, *inter alia*, an examination of the product and financial markets in the post-reform period. But before that, in order to add some more perspective to our argument, we shall first briefly take a look at the evolution of the Indian manufacturing sector since Independence and the broad structural changes that have come about since the onset of industrial reforms beginning in the mid-eighties (sections 3.1 and 3.2).

3.1 Indian Industry: A Brief Historical Background

Since the first Industrial Policy Resolution of 1948 itself, Indian industry, particularly the manufacturing sector owing to its sheer significance for policymaking, has been in a state of perpetual flux. To begin with, a policy characterised by all-round state control was emphasised and promulgated. The main features of this protective policy were (1) a gigantic public sector having the key areas of the economy reserved for itself, especially heavy industry; (2) all-pervasive licensing for the private sector limiting its scope and growth; (3) aim of self-reliance, export pessimism and import substitution; (4) state control of large domestic firms; (5) a parallel thrust on the small-scale sector and industrial dispersal; (6) highly regulated and thus limited foreign direct investment; (6) slow rates of technology transfer and absorption; (7) and frequent and significant interventions in the factor markets by the state (Ahluwalia, 1991).

The Industrial Development and Regulation Act (IDRA), 1951, gave the state comprehensive control over the direction and pattern of investment, mainly through extensive industrial licensing.[1] With some exceptions, entry into all industries as well as the

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[1] Under the provisions of the Act, in order to set up a new unit, to expand capacity by more than 25% of the existing levels or manufacture a new product, an entrepreneur would have to apply for a license from a Licensing Committee. See Mookherjee (1995).

expansion of capacity were effectively regulated. Besides, there was control over the product mix and the technology. And lastly, there were additional criteria for the issuing of industrial licenses in the form of geographical location and the import content of the initial investment. Based on the Nehru-Mahalanobis strategy, the pattern of investment emphasised the development of heavy industry and the capital goods sector. The reallocation of resources away from the consumer goods towards the production of machine tools and capital goods over the thirty-year period of planned industrialisation in noticeable in Table 3.1.

Table 3.1: Shares of Use-Based Sectors in Industrial Production (% share)

Sector	*1956*	*1960*	*1970*	*1980*
Basic Goods	22.3	25.1	32.3	33.2
Intermediate Goods	24.6	25.9	20.9	21.3
Consumer Goods	48.4	37.2	31.5	30.5
Capital Goods	4.7	11.8	15.2	15

Source: Ahluwalia (1991)
Note: Basic goods include salt, fertiliser, chemicals, cement, basic metals, electricity and mining

An exception to the licensing requirement is the small-scale sector.[2] This was promoted with a view to fostering labour-intensive production in the consumer goods sector and to facilitating the spread of industrialisation to backward rural areas. On large firms, however, additional barriers to entry were placed with the promulgation of the Monopolies and Restrictive Trade Policy (MRTP) Act, 1970 and the Foreign Exchange Regulation Act (FERA), 1973. The so-called MRTP firms were prohibited from entering and expanding in any sector except those listed in Appendix 1 of the IRDA, for which, too, they had to obtain MRTP clearances, besides the usual industrial licenses.[3]

Regarding trade policy, the focus up to the seventies was on regulating the utilisation of foreign exchange reserves through the use of quota restrictions (QRs). This effectively meant that all categories of import were licensed too. The import of consumer goods was almost prohibited. All in all, the policy served the objectives of comprehensive import substitution and protection of the domestic industry.

[2] Small-scale firms were those having less than either 50 or 100 workers employed depending on the use of power or those with less than Rs 25 lakh of fixed assets.
[3] See Ahluwalia (1991) and Srivastava (1996) for more details.

At the close of the 1970s, a widely-held opinion was that the then-prevailing restrictive industrial policy regime was primarily responsible for a high-cost industrial structure, typified by obsolete technologies, sub-optimal capacity utilisation and, last but not least, low rates of productivity growth.[4] Scholars and experts were progressively growing suspicious of the worth of the import-substituting regime and advocated a more liberal one in its place (see Bhagwati and Desai, 1970; Little et al, 1970). So much so that, from the latter half of the seventies itself, there took place a substantial and portentous shift in the state policy which got furthered in the eighties (see Khullar, 1991 and World Bank, 1989). However, it would be instructive to note that the role played by the state in resource allocation was still an important one.

3.2 The Change of Policy

In 1985, however, a comprehensive policy change became a definite possibility with the then government instituting wide-ranging reforms, especially in relation to the licensing policy. Now, industrial licenses were no longer required for firms with assets below Rs 5 crore (Rs 15 crore from 1988) and located beyond at least 30 miles from urban areas (Mookherjee, 1995). Also, modernisation of equipment requiring a increase of up to 49 % of the licensed capacity no longer required an additional license. Besides, expansion of capacity up to a mandated efficient scale was permitted in some sixty industries where economies of scale were considered to be significant. In trade, a large number of items were freed from quantitative controls on imports and the rate structure on selected producer goods imports were rationalised in 1985.

These initial moves towards liberalisation were consolidated and made comprehensive by the 1991 new industrial policy ushered in by the new central government. Following are the main features of this policy reversal. Industrial licensing was abolished altogether, except for a select list of environmentally sensitive industries. The entire chapter III of the MRTP Act restricting growth or mergers of large business houses was eliminated. The list of industries reserved for the public sector was reduced from seventeen to six and the state began soliciting actively private investment for infrastructure development. Quantitative controls on producer good imports were largely abolished, import duties reduced sizeably and foreign exchange controls dismantled on most current account

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[4] Another phenomenon of the time that reflects this realisation among policymakers is the appointment of a series of committees to look into the problems of Indian economy. For example, PC Alexander (1977) and Abid Hussein (1984) on trade policy issues and Dagli committee (1979) on controls and subsidies.

transactions. The exchange rate came to be market determined following the substantial devaluation of the rupee between 1989 and 1991.

A number of reform initiatives in the financial sector were taken concomitantly. Until 1992, the Indian corporate sector had faced several constraints on its choice of sources of funds. Access to the equity market had been regulated by the Controller of Capital Issues (CCI), an agency under the Department of Company Affairs, which placed severe restrictions on firms' ability to raise equity through the equity route. Secondly, long-term debt requirements of firms had been largely furnished by public-sector development financial institutions (DFIs) like IDBI and IFCI which, either through direct lending or through refinance arrangements, virtually monopolised the supply of debt finance to the corporate sector (Bhaduri, 2000).

In May 1992, as part of a set of sweeping reforms in the equity market, the CCI was abolished and restrictions on access to the equity market softened considerably. Approval to access was now made conditional on only some technical requirement and not on the outcome of any formal approval process, as was the case earlier.[5]On the side of debt, however, institutional reform was much less significant. The DFIs still retained their hold over a major part of the debt market. But, there was some reform in the interest rate policy nevertheless. From now on, financial institutions were given greater freedom to determine their structure of interest rates.

New accounting and capital adequacy norms were imposed, the statutory liquidity ratio lowered with a view to providing funds to the private sector, deposit rates deregulated subject to a ceiling, lending rates rationalised and the banking sector opened to expansion and entry of private banks. New capital issues have been completely deregulated. Private mutual funds and foreign institutional investors have been allowed to enter the market.

3.3 The Nineties: The Suitability of the Period for the Analysis

Against this background of a remarkable transition from a highly controlled and regulated regime to a relatively market-oriented one, we shall try to characterise the institutional setting for our analysis in the light of the theoretical arguments developed in the chapter on theory. Specifically, we shall argue why we think this period is suitable for the kind of analysis we intend to do. Subsequently, we shall try to support our arguments with data.

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[5] See Gokarn (1996) for details and an analysis of the equity market reforms.

3.3.1 Free Entry, Falling Market Shares and Import Competition: First of all, with deregulation and decontrol, and with a market-friendly policy regime in place, it is reasonable to expect that there would have been more entry of new firms in the market subsequent on the reforms. It is instructive to note that the information argument for a more competitive market structure reducing slack rests on the notion of greater entry that leads to the possibility of greater and better comparison of performance in the presence of correlated exogenous productivity shocks (Nalebuff and Stiglitz, 1983). Over the relevant time period, it may not be unreasonable to suggest that exogenous shocks to the cost functions of firms in the same industry would have been correlated, given that most of the controls and restrictions had fallen by 1991. With the market being allowed to select the survivors, the performance of firms would have become more sensitive to the actions of the managers and workers. A closely related argument follows.

With more entry in an industry, the market shares of the incumbent firms would fall, unless there was such an increase in demand as would absorb the output of the entrants without affecting the demand for the output of the incumbent firms. It may be granted that such a perfect balance of forces is seldom possible in reality. Moreover, it is hard to think that there would be zero substitution between the products of entrants and those of incumbents. Thus, Willig (1987)'s demand-elasticity effect may operate. Moreover, if we assume that more entry would have put pressure on the market shares of the incumbents, then the threat of bankruptcy discussed by Schmidt (1997) becomes a credible one. It may be noted that bankruptcy proceedings in India are not so straightforward and in fact it is extremely difficult to send a firm out of business and redeploy its resources even if it becomes unviable.[6] Secondly, over the nineties, the market for corporate control in India has developed significantly and since the onset of the first wave of comprehensive reforms in 1985 there has been significant rise in the number of takeovers as we shall see presently. One might suggest that the threat of bankruptcy and takeover would have become graver with the onset of reforms and entry of new players.

Thirdly, with the removal of quota restrictions and lowering of tariff rates, imports would have offered competition, quite apart from the competition offered by new domestic and foreign entrants. Imports, especially those that are produced at a lower cost than domestically produced goods, pose a major threat of wresting the market share of

[6] The report of the Committee on Industrial Sickness and Corporate Restructuring (1993) gives details of the long and tortuous process of referring a sick unit to the Bureau of Industrial and Financial Reconstruction (BIFR) under the provisions of the Sick Industrial Companies (Special Provisions) Act, 1985, in the event of the unit going bankrupt and the delays in the BIFR's administrative process.

established firms. The recent invasion of many segments of the Indian market by cheap Chinese goods is a case in point.

3.3.2 Financial Pressure: Next, we come to the importance of testing the discipline-of-debt effect. With reforms in the financial sector, the avenues for external finance have increased for firms. Earlier, firms would mainly borrow from large development financial institutions like the IDBI, IFCI, ICICI, etc. However, with the reforms in the financial sector beginning 1992, it has become easier for firms to raise, for example, private equity in the market and to procure debt finance through the private-placement route. At the same time, it is also true that the real rate of borrowing has been significantly high over the best part of the nineties. Against this background, it would be really interesting to see whether debt has a disciplining effect (a positive impact on productivity) as theory predicts or, on the other extreme, a debilitating impact on the financial health of the firm (possibly leading to a negative impact on factor productivity, something that has not been considered in theory in a major way).

3.3.3 Investment Activity and Asset Specificity: Regarding specificity of assets, there are several reasons why we believe a higher specificity of assets may have been a major factor in determining the productivity performance of firms during our period of analysis. Firstly, as we saw in the previous section on policy change, licensing restrictions on capacity expansion have been taken off. The argument in favour of such a move was that, to meet the long pent-up demand in the economy and to realise full economies of scale in production, it was necessary to remove restrictions on capacity expansion. Thus, it would be interesting to see whether the subsequent rise in production-specific fixed assets, especially plant and machinery, has served to increase the productivity of firms. Secondly, there is the argument of entry deterrence by incurring huge sunk costs (Dixit, 1980). Firms may increase capacity to ward off potential competition from prospective entrants. If the suspected phenomenon has occurred in the case of India after reforms, then a natural line of enquiry is "What has been the consequence for the productivity of firms expanding capacity to deter entry?" It may be argued that if entry deterrence is successful in this way, then incumbent firms will be able to retain their market power and monopoly rents, which could induce slack and, thus, lower productivity.[7] Uchikawa (2002) has shown that there has indeed been an excessive built-up of capital assets and low utilisation of capacity in Indian industry after the 1991 policy change. Let's see now how the actual facts tally with our arguments.

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[7] See the theoretical arguments relating sunk costs to managerial effort and productivity in the previous chapter.

3.4 Indian Industry over the Nineties: The Facts

3.4.1 Growth and Competitiveness: In this section, we shall take a look at the data on Indian industry and especially on the specific industries for which data has been taken for the analysis, namely rubber and plastics, non-metallic mineral products, non-electrical machinery, electrical machinery and transport. Besides, in the light of the data presented in this section, we shall try to assess the validity of our arguments justifying the need for a causal analysis of the impact of market competition, financial pressure and specificity of assets on the total factor productivity of firms.

We start by taking a look at the broad indicators of the performance of the manufacturing sector in the post-reform period. Table 3.2 shows the manufacturing growth in the 1990s.

Table 3.2 Manufacturing Growth in the 1990s (%)

	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
IIP	8.9	0.8	2.2	6.1	9.8	14.1	7.3	6.6	4.1	9.2
NAS	6.1	-3.7	4.2	8.4	11.9	14	7.4	6.7	6.7	8.5

Source: Nagraj(2002)

Table 3.2 gives the growth rates as given by the Index of Industrial Production (IIP) and the National Accounts Statistics (NAS) published by the Central Statistical Organisation. Both show similar trends in manufacturing growth, though the actual growth figures are different. The broad picture of the manufacturing growth performance emerging from the figures above is one of the well-known J-curve behaviour (Nagraj, 2000). There is a drastic fall initially followed by an equally rapid recovery extending into sustained growth over the next four years starting 1993. Further, the table shows that growth peaked in 1996 and then fell for the next two years before it recovered again in 2000. It is noteworthy that our period of analysis is the period of the J-curve behaviour of manufacturing growth. Moreover, it stretches into the period of maximum growth and the fall thereafter.

These are, however, only the aggregate figures. One would also like to know how the various industrial sectors within manufacturing have grown after the policy change and more importantly whether the sweeping policy reforms of the 1990s have made any dent in the growth performance. Hence, next we take a look at the major industrial sectors at the two-digit level (NIC, 1987) of disaggregation. In Table 3.3, we have data on growth rates for three continuous periods, 1980-81 to 1998-99, 1980-81 to 1990-91 and 1991-92 to 1998-

99. It also shows the changes (rise or fall) in the growth rates of the major two-digit groups computed as the differences between the growth rates in the two sub-periods.

Table 3.3 gives us a mixed picture. Column 3 shows that over the two decades beginning 1980-81, there has been positive growth in almost all the sectors, though there are significant variations in the rates of growth among the sectors. With regard to change in growth from the eighties to the nineties, again, we have a mixed picture. Nine sectors have registered a fall, whereas ten have recorded a rise in the growth rate. Of particular interest to us are the industries that we have taken data for. Again, there is a mixed scenario. Whereas growth in rubber and non-metallic mineral products has slowed down after the reforms, it has increased for machinery and transport.

Now, we shall examine the question of competitiveness after the reforms. Balakrishnan et al (2002) have presented estimates of the change in market power of firms in the various industrial groups as measured by the mark-up of price over marginal cost. We present their estimates along with the changes in market concentration as measured by the Herfindahl index of industrial concentration estimated by us. Table 3.4 gives the direction of the changes in the two indicators only for the industries selected for the analysis.

Table 3.3 Growth Rates of GDP in the Registered Manufacturing Sector 1981 to 1999 (%)

(1) NIC Code	*(2) Industry Name*	*(3) 1980/1-98/9*	*(4) 1980/1-90/1*	*(5) 1991/2-98/9*	*(6) Change*
20-1	Food	8	10.1	9.3	Fall
22	Beverages	8.2	8.6	7.6	Fall
23	Cotton	2.5	3.6	2.8	Fall
24	Wool, silk	7.6	6.2	9.9	Rise
25	Jute	0.6	(-)1.8	4.1	Rise
26	Textile products	15.3	12	8.6	Fall
23-26	Textiles	5.4	4.4	6	Rise
27	Wood	1.3	4.9	(-)0.2	Fall
28	Paper	6.7	6.6	7.3	Rise
29	Leather	11.7	10	7.2	Fall
30	Chemicals	10.4	8.9	11.7	Rise
31	Rubber	11.8	16.6	6.8	Fall
32	N.M Minerals	8.3	10.6	4.2	Fall
33	Metals	7	4.2	15.9	Rise
34	Met. products	5.9	4.3	12.2	Rise
35-36	Machinery	7.2	7.2	8.7	Rise
37	Transport	7.5	4.9	16.9	Rise
38	Others	12.7	9.3	15.9	Rise
	Manufacturing	8.4	7.6	11	Rise

Source: Nagraj (2002)

Table 3.4: Estimated Changes in Market Power and Market Concentration

Industry	*Change in market power*	*Change in concentration*
Rubber, Plastic, etc	Fall	Fall
Non-metallic mineral products	Rise	Fall
Machinery	Fall	Fall
Transport	Fall	Fall

Source: Balakrishnan et al (2002) and our own estimates

Note: The estimates of Balakrishnan et al are for the period 1988-89 to 1997-98 with a dummy for the year 1991, whereas the reported changes in industry concentration are between the years 1990-91 and 1997-98

Table 3.4 shows that the two measures of competitiveness differ only for one industry, namely non-metallic mineral products. Whereas Balakrishnan et al (2002) show higher market power for the group, our computations of concentration suggest that concentration has fallen after the 1990s. It is instructive to note that our calculations of concentration are at the three-digit level and a three-digit level industry does not represent anything like a "market" (Nickell, 1996)[8]. On the other hand, the estimates of Balakrishnan et al are at firm level. Therefore, we shall recommend that their estimates should be given greater credence. Despite this conflict, there is still some evidence that the chosen industries have become more competitive after the onset of reforms as evidenced by the changes in the mark-up ratios of firms and the changes in industrial concentration.

Next, we come to competition from imports. Table 3.5 shows import-intensity figures for the selected industries.

Table 3.5 Trends in Import Intensity (%)

Industry	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*
Rubber, plastic, etc	40.02	40.69	37.10	35.12	30.68	31.97
Non-metallic minerals	11.05	9.29	1.97	1.94	2.46	2.30
Non-elect. Machinery	27.14	23.14	27.49	31.43	38.07	40.91
Electrical Machinery	10.22	8.17	10.32	15.18	14.29	17.69
Transport	10.51	5.75	6.54	17.15	11.06	7.76

Source: Computed using ASI and DGCI&S data, various issues

The data in Table 3.5 reveal no particular common trends in the penetration of imports in the post-reform period. Whereas, the intensity of imports has increased, on an average, for electrical machinery, non-electrical machinery and transport, it has fallen for rubber and non-metallic mineral products and the fall in the case of the latter has been particularly drastic from 1993 onwards. Thus, we may not have any particularly compelling *a priori* reason to believe that import competition may have had a significant impact on the performance of firms in these two industries, though admittedly import competition may have risen for the remaining three. Despite this mixed trend, we shall include import penetration in our analysis for the sake of completeness, especially given that we are analysing a period following comprehensive trade liberalisation.

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[8] However, as Nickell (1996) notes, the three-digit concentration ratios and the actual concentration ratios are likely to be correlated over time. Thus, our concentration measure is not a bad approximation for the actual measure, especially in an intertemporal sense.

Before we end the discussion on the issue of change in market competitiveness in the Indian economy after reforms, we shall look at two more issues of relevance, about which we have talked in the preceding section on the rationalisation of the problem. The first is the notion of the strengthening of the market for corporate control and the second, the issue of entry following the fall of various entry restrictions.

We begin with the implications for the market for corporate control in the aftermath of economic reforms. Table 3.6 gives the figures for corporate acquisitions from 1974-75 to 1994-95.

Table 3.6 Trends of Acquisitions 1974-75 to 1994-95

Time Period	*Non- manufacturing*	*Manufacturing*	*Total*
1974-1979	0	11	11
1980-1984	0	15	15
1985-1989	6	85	91
1990-1994	8	45	53

Source: Beena(2000)
Note: The data in the last time period are only for the years 1991 and 1992 owing to the unavailability of data.

The given data show a clear spurt in acquisitions after the first set of reforms in 1985 and, more importantly, the acquisition activity has happened almost entirely in the manufacturing sector. Moreover, the trend has continued well into the 1990s. It may be noted that the figures for the period 1990-94 are only for the first two years of the total period, during which the number of acquisitions in the manufacturing was larger than half the number for the previous four-year period. This suggests acceleration in the pace of acquisitions after the reforms.

Lastly, we shall look into the figures for entry after the reforms. Table 3.7 shows significant entry for all sectors under study except transport equipment. One particularly noteworthy feature of the entry trends in the chosen industrial groups is the spurt in the number of entrants immediately in the post-reform years of 1985 and 1991. 1992 is especially one such year in the case of, for example, rubber, electrical machinery as well as the entire manufacturing sector. With this, we also present data on what proportion of the existent firms in these industries were incorporated after the first wave of reforms in 1985. The column on percentage of entry in Table 3.8 gives the number firms incorporated after

1985 as a proportion of the total number of firms reported in PROWESS in different sector. The last columns gives the actual number of such firms.

Table 3.7: Number of New Entrants after Reforms

Industry	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*
Manufacturing	208	194	176	181	201	202	221	330	221	241	172
Rubber	29	16	12	20	17	11	19	34	16	19	14
N.M. Minerals	14	8	7	4	13	8	16	12	4	6	9
NE Machinery	11	9	6	10	7	8	8	7	7	9	9
El. Machinery	31	37	19	31	34	26	34	57	23	52	54
Transport	17	10	6	7	1	1	5	6	3	5	3

Source: Computed using PROWESS data

Table 3.8 Percentage entry after the Reforms (post-1985 till 1995)

Industry	*% Entry after Reforms*	*No. of Firms*
Manufacturing	45.86	5119
Rubber, Plastics, etc.	52.16	370
Non-metallic minerals	39.76	254
Non-electrical Machinery	29.45	309
Electrical Machinery	49.68	801
Transport	27.35	234

Source: Computed using PROWESS data

Table 3.8 provides evidence of significant entry after reforms in the manufacturing sector. Slightly less than half of all the existent firms for which we have data available have entered after the first set of reforms launched in 1985. This is indeed a significant number. The figures for rubber, non-metallic mineral products and electrical machinery are also very high, again suggesting that reforms have led to more entry.[9] However, the figures for non-electrical machinery and transport show modest entry.

Our analysis so far suggests that there is some evidence, though not overwhelming, that the market structures of the chosen industries may have become more competitive. For this we have seen the estimates of market-power indicators like the price-marginal cost ratios and concentration index which show a fall in the market power of most of the chosen

[9] The entry figures for non-metallic mineral products are consistent with our finding of lower concentration in the industry over the period of analysis. However, there still remains a conflict between our findings and those of Balakrishnan et al (2002)

industries. Furthermore, we have examined data on other facets of market competitiveness such as intensity of imports and entry, which present a mixed picture, though a significant rise in both for some industries cannot be denied. In addition to this, we have also seen data on the market for corporate control which shows a significant spurt in the number of acquisitions in the manufacturing sector in the post-reform period. The data seem to justify the reasons we advanced in the preceding section for our choice of the selected manufacturing industries for the specific time period we have chosen for analysis.

3.4.2 Financing Patterns of Firms: Now we shall take a brief look at the changing financing patterns of the listed firms.[10] The securities market in India is now a far more important source of finance compared to the traditional financial intermediaries for the corporate sector. It is set to dominate the future of corporate finance in India (NSE, 2001). The 1990s have witnessed emergence of the securities market as a major source of finance for trade and industry. Rather than depend on loans from development financial institutions and banks, an increasing number of companies have been accessing the securities market. Moreover, there appears to be a growing preference for direct financing (equity and debt) rather than indirect financing (bank loans) within the external sources. According to CMIE data, external sources accounted for about 77% of the funds raised. This fell to about 65% by 2000. A part of this period overlaps with our period of analysis too. This suggests that there have been some changes in the financing patterns of firms. The table below on the sources of funds for the corporate sector provides more information on the trends on financing patterns of the listed companies. The data show a significant increase in capital-market-based instruments to 53% in 1993-94 which, however, fell to 32% by 2000. Broadly, we may have some reason to believe that the reliance of the corporate sector on the securities market has increased following the financial sector reforms.

[10] It may be noted that most of our data is on the firms listed on the Bombay Stock Exchange for which we have firm-level balance sheet data.

Table 3.9: Sources of Finance for the Corporate Sector (%)

Sources	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Internal Sources	30.9	24.9	24.3	22.6	25.4	28.3	25.8	27.8	30.2	35.3
Retained Profits	8.2	7	5.4	10.3	14.4	15.8	7.9	6.7	-2.4	2.7
Depreciation	22.7	17.9	18.9	12.2	11	12.5	17.9	21.1	32.6	32.6
External Sources	69.1	75.1	75.7	77.4	74.6	71.7	74.2	72.2	69.8	64.7
Capital Market	10.7	14.4	25.3	41.3	33.8	15.3	15.1	20.8	15.8	20.6
Institutional Borrowing	33.7	26.5	32.7	13.8	21.8	31.6	40.2	31.8	22.4	11.1
Current liabilities	24.6	34.2	17.7	22.3	19	24.8	18.8	19.6	31.6	33

Source: *Economic Intelligence Service- Corporate Sector*, CMIE, various issues

The broad trend as evident from Table 3.9 is that external institutional borrowing has tended to fall over the best part of our sample period. Although it seems to have risen temporarily towards the end of the sample period, it falls again sharply towards the end of the decade. On the other hand, raising of funds in the capital market has been on the rise over the sample period, though it falls and stabilises towards the end of the decade. Current liabilities are not very important for the financial-pressure effect since they do not generate any long-term incentive effects. Lastly, we note that internal sources of finance have increased over the decade. This might suggest that firms have not used significantly debt as a disciplining device, or rather they were not able to owing to the very high levels of interest payments on older debt.

To add more micro context to the discussion, it would be useful to look at the trends of financing and indicators of financial pressure in the selected industries. We present data on two key financial ratios of firms, one, the debt-equity ratio and, another, the cash-coverage ratio defined as profits divided by interest payments. While the trends in the first will tell us in a relative sense how firms have substituted owner finance for borrowed finance and vice versa, the second will give us an idea regarding the financial solvency of the firms over the period of analysis. Both indicators are crucial in an analysis of a hypothesised discipline-of-debt effect on the efficiency of firms.

Table 3.10 Debt-Equity Ratios

Industry	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Manufacturing	1.99	1.91	1.53	1.24	1.20	1.34	1.4
Rubber	3.8	4.8	3.3	3.2	2.5	1.9	2.2
Non-met. Minerals	2.78	2.72	2.3	1.56	1.32	1.4	1.7
Non-elect. Machinery	2.55	2.54	2.06	1.65	1.46	1.31	1.22
Elect. Machinery	1.92	1.85	1.28	0.94	1.00	1.08	1.1
Transport	3.11	2.87	2.28	1.18	.957	1.02	1.02

Source: CMIE, *Industry: Financial Aggregates and Ratios* (June, 1999)

The falling debt-equity ratios for all industries in Table 3.10 indicate clearly that firms in the chosen industries as well as those in the entire manufacturing sector have indeed substituted equity for debt. The trend also lends support to our notion that firms have not used significantly debt as a disciplining device. We now take a look at the trends in the cash coverage ratios of the chosen industries.

Table 3.11: Cash-Coverage Ratios (profits/interest)

Industry	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Manufacturing	1.6	1.5	1.76	2.12	2.1	1.64	1.5
Rubber	1.21	.814	.849	.688	.983	1.03	.76
Non-met. Minerals	1.89	1.28	1.29	1.83	2.04	1.26	1.02
Non-elect. Machinery	1.6	1.54	1.66	1.88	2.07	2.25	2.03
Elect. Machinery	1.73	1.9	2.23	2.45	2.28	1.8	1.67
Transport	1.4	1.18	1.53	2.48	3.03	3.66	2.88

Source: CMIE, *Industry: Financial Aggregates and Ratios* (June, 1999)

The data in Table 3.11 indicate that the solvency of firms in almost all selected sectors has improved, though rubber industry might be a possible exception. For the overall manufacturing, solvency has improved consistently till 1996 till it fell in the last two years. This again points to a declining role of debt as an internal incentive-generating mechanism. Against this background, it would be interesting to see whether debt serves the purpose of sharpening managerial incentives to supply effort positively or not. We have seen that theory predicts a positive effect on effort and consequently on productivity. At the same time, our data suggest that the share of debt in the capital structure of firms has declined and

the solvency has improved. Such a scenario gives rise to the question as to how debt has affected the productivity of firms.

3.4.3 Fixed Capital Formation and Acquisition of Production-Specific Assets: In this sub-section, we shall take a look at the broad trends in capital formation and the acquisition of production-specific assets. In the main, we regard plant and machinery as the major constituent of the set of highly specific production assets. Other components of fixed capital like land and building and transport equipment can be used flexibly for other purposes also. However, the same is not true of plant and machinery. The costs incurred on account of purchasing production-specific plant and machinery are indeed sunk in nature because, as Shleifer and Vishny (1992) have noted, highly specific assets like plant and machinery have very little or zero liquidation value and cannot even serve as collateral for external finance. Therefore, for the purpose of this analysis, by the term production-specific assets, we shall understand plant and machinery.

We start by taking a look at the broad trends in capital formation in the selected industrial groups.

Table 3.12: Gross Fixed Capital Formation (Rs crore)

Industry	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*
Manufacturing	24292.6	30610.1	36041	27223.5	59522.5	69136
Rubber, Plastic, etc	1338.7	1949.6	2065.3	3032.0	2287.9	4191.8
Non-met. Minerals	879.8	834.5	1567.8	1996.2	2841.0	3531.0
Machinery	902.0	1879.2	2741.9	2683.7	4257.0	5140.0
Transport	887.2	956.5	1476.8	2006.2	1846.6	4183.4

Source: Annual Survey of Industries, various issues

The data in Table 3.12 reveal that there has been stupendous growth in the gross fixed capital formation of the entire manufacturing sector in general and the selected industries in particular. In almost all cases, the increase has been more than three times over the six-year period for which we have data. It is notable that our sample period covers all the six years.

In the light of our interpretation of plant and machinery being irreversibly sunk investments, it would be interesting to see how these have grown on an average as a proportion of the gross fixed assets. We present here results from our own sample data covering the five major industrial groups.

Table 3.13 Trends in the Mean Share of Sunk Investments in Gross Fixed Capital (%)

Industry	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Rubber, Plastics, etc.	69.52	71.3	72.1	72.1	72.8	72.01	74.6	73.8
Non-met. Minerals	73.99	72.5	72.0	72.8	75.4	74.9	74.1	75.8
Non-elect Machinery	66.07	67.4	68.5	67.85	68.97	69.6	68.14	67.7
Electrical Machinery	60.67	61.57	61.72	62.09	61.11	61.89	62.03	61.1
Transport	72.79	73.2	72.95	73.87	73.37	72.07	72.83	72.7

Source: Computed using PROWESS data

The general picture emerging from the data in Table 3.13 is that the average share of sunk investments in gross fixed capital has risen over the sample period, though with some fluctuations towards the middle of the time series. We also present our computations of production-specific assets as a proportion of total assets. We call this proportion the degree of asset specificity.

Table 3.14 Trends in the Degree of Asset Specificity (%)

Industry	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Rubber, Plastics, etc.	45.33	45.08	46.9	44.92	43.97	43.0	46.71	49.4
Non-met. Minerals	64.4	63.3	63.2	64.82	64.51	62.63	63.96	68.8
Non-elect Machinery	38.93	38.1	38.5	40.72	39.48	39.19	40.07	42.2
Electrical Machinery	27.98	28.36	29.08	29.5	27.63	27.10	28.37	29.6
Transport	46.46	46.51	46.58	47.43	43.66	42.9	45.15	48.0

Source: Computed using PROWESS data

Here too, the trend is a rising one. For all the chosen industries, the degree of asset specificity in 1998 is higher than in 1991, the first year of our period of analysis. The data provide some justification to the belief that after the removal of license restrictions, asset specificity has gone up in the selected industries.

To sum up the discussion, we have seen in this chapter that the relative configurations within the product, financial and "specific-assets" markets have undergone significant changes after reforms. Some industries have indeed grown more competitive as shown by the falling mark-up and concentration ratios. Besides, there has been significant entry of new firms in the entire manufacturing sector as well as the selected industry. In passing, we have also seen that acquisition activity has picked up after the reforms, which should exert additional external pressure which, in turn, would affect managerial/worker

incentives to supply effort. On the financial-markets front, we have observed a marked and growing preference for capital-market finance at the expense of institutional borrowing and a perceptible rise in internal finance too. Secondly, the role of debt in providing additional capital finance has gone down drastically over the sample period as reflected in the sharply falling debt-equity ratios of firms in the chosen industrial groups. We have observed in this regard that this could be evidence of financial restructuring during the period and firms may not have been actively able to use debt as a disciplining device. With regard to specific assets, we have seen a significant increase in gross fixed capital for all the industrial groups and a rise in the proportion of sunk investments as well. Lastly, there is some evidence that suggests that asset specificity has risen as well.

This chapter has provided the institutional background to the problem. Against this background the next chapter provides an econometric analysis of the impact of the three incentive factors, namely competition, debt and asset specificity, on the total factor productivity of the firms in the selected industries.

CHAPTER 4

The Analysis

The previous chapter served the first objective of our study, i.e. to examine the institutional setting for the problem we intend to analyse. This chapter provides the analysis itself. In section 4.1, we describe our methodology, clarifying some issues of conceptual significance. Then, in section 4.2, we come to the variables, their construction, the problems in their use and the rationale for their inclusion in the analysis. Section 4.3 gives a note on the sources of data and problems of concordance and coverage. Subsequently, we present our results and our interpretation of them in section 4.5 following a brief description of our estimation technique in section 4.4. Section 4.6 provides a discussion of our results and section 4.7 points out some limitations of our analysis. We sum up our results in section 4.8.

4.1 The Methodology

Before we come to issues of specification and data, it would be in order to clarify a few conceptual issues. Firstly, a firm, as interpreted in our frame of analysis, is not just a production function, typically interpreted as the production unit or plant. Rather we take a more comprehensive view of the firm in that we also include the governance structure surrounding the production unit within the purview of our definition of firm. Thus, in a productivity analysis such as ours, one may look at the contribution of not only physical inputs to output, but also "soft" factors like corporate governance structures, incentive schemes and, as in our case, the internal and external factors that affect the governance and managerial/worker incentives to perform in a firm. It is noteworthy that of late these governance and incentive factors have been considered as important determinants of firm performance.[1] Since our aim is to study the impact of these so-called "soft" factors along with that of the conventional factors, this more comprehensive definition of firm is more suited to our requirement.

Secondly, we are looking for the effect of external and internal factors on the *level* of productivity. As we noted in the second chapter, while the *growth* of productivity is affected by technological adoption, R&D activities and innovation, the *level* of productivity is primarily a function of the effort and efficiency of managers and workers of the firm. This effect is chiefly the concern of the agency-theoretic models that we have reviewed in our

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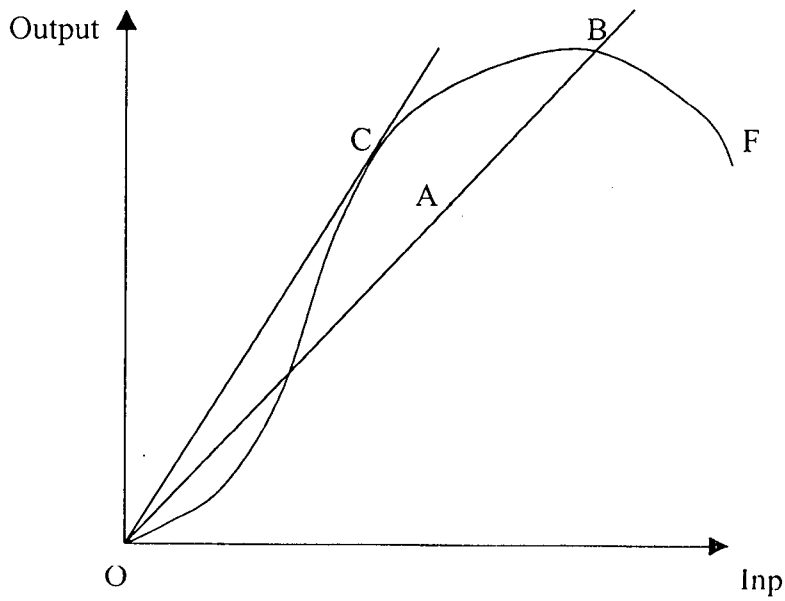
[1] See, for example, Short, 1994, Allen and Gale, 2000 and Lehman and Weigand, 2001.

chapter on theory. We believe that effort affects the efficiency and subsequently the productivity of firms in a significant manner. At this point, it may be instructive to note that there is a subtle difference between productivity and efficiency. Productivity of a production unit is the ratio of its output to its inputs. As Lovell (1993) observes, productivity varies due to differences in production technology, differences in the efficiency of the production process and differences in the environment in which production occurs. On the other hand, efficiency involves a comparison between the observed and optimal values of the output and inputs of a firm. The comparison can take the form of the ratio of maximum potential output obtainable from the given input, or the ratio of minimum potential to the observed input required to produce the given level of output (Lovell, 1993, Grosskopf, 1993). In both comparisons, the optimum is defined in terms of production possibilities and efficiency is purely technical. Thus, productivity is a much wider concept than efficiency. As Grosskopf (1993) notes, efficiency is in fact a component of productivity. This is consistent with Lovell's definition too. To better understand this productivity-efficiency distinction, we provide a graphical explanation of the two terms.



In the figure above, OCBF is the production frontier each point of which gives the maximum output that can be produced using a given level of inputs. The area enclosed by the production frontier is the production-possibilities set of the firm. Thus, the production frontier describes the limits to the existent level of technology. If a firm is operating on the upper bounds of its production possibilities set, i.e. on its production frontier, we say that the firm is technically efficient. Point B in the above figure is one such point. Any other point inside the set, say A, represents technical inefficiency, because the same output could be produced using fewer inputs or more output could be produced using the same level of

inputs as at A, if production were technically efficient. Now we come to the issue of productivity. Interestingly, while B is technically efficient and A is not, at both points, the productivity of the firm is the same and is given by the slope of the ray OAB. This phenomenon obtains because, quite apart from purely technical efficiency, productivity is influenced by organisational factors also (governance, incentives, etc). A point like C, where the ray from the origin is tangent to the production frontier, represents the point of optimal productivity where, besides being technically efficient, the firm has exhausted all scale economies. Lastly, we note that growth in productivity is determined by the sum of a movement towards the frontier (a technical-efficiency gain), a rise in the slope of the ray from the origin to the point of production (a gain in the level of productivity owing to greater efficiency and better production organisation) and a shift in the frontier itself (technical progress).

4.2 Empirical Model and Variables

For the purpose of this study, we use panel data techniques and for good reasons. Firstly, there is the problem of reverse causality. Some people have argued that higher productivity induced by competition, in the long run, may again result in a situation of market power.[2] For this reason, the interpretation of cross-section correlations may not be straightforward. It becomes important to assess the behaviour of such correlations over time. Secondly, when we talk of some factor alleviating slack, then it becomes important to see whether such an influence is persistent over time or not. What appears to be slack at a point of time may not be slack at all.[3] Therefore, the question of persistence of an influence and for many comparable units simultaneously over the same time period is very important for any judgement regarding the perceived influence. Again, this points to the suitability of a panel analysis. Thirdly, we are using several proxies in our empirical model which are discussed below. These proxies are assumed to be correlated with the true variables over time rather than at a point. In fact, in these cases we are essentially looking for time-series effects for different firms. Again, panel data provides the solution. Lastly, and most importantly, we are interested in changes in the levels of productivity for a cross section of firms and not just static productivity levels at a point of time for a widely heterogeneous set of firms. So, for the basic purpose of the study itself, panel data methods appear to be most

[2] See the discussion on this in Demsetz (1973) and Blundell et al (1998)

[3] For example, profits above the "normal" rate of return may have been a temporary result of cost reduction owing to greater efficiency.

suitable. Regarding the specification, we use the standard generalised (value-added) Cobb-Douglas production function in a fixed-effects (within-regression) panel-data framework[4].

Our basic production equation is as follows[5]:

$$y_{it} = a + \alpha_1 n_{it} + \alpha_2 k_{it} + \alpha_3 c_{it} + \alpha_4 fp_{it} + \alpha_5 as_{it} + u_i + \varepsilon_{it}$$

where

y_{it} = natural log of real value-added

n_{it} = natural log of labour input expressed in efficiency units

k_{it} = natural log of capital stock

c_{it} = natural log of a set of variables representing market competition

fp_{it} = natural log of financial pressure defined by interest normalised on profits

as_{it} = natural log of degree of asset specificity defined by plant and machinery normalised on total assets

u_i is a firm-specific effect and ε_{it} is the random error term assumed to be uncorrelated with the explanatory variables and with itself over time and a is a constant. i and t are firm and time subscripts respectively. The firm-specific effect has been included to capture the systematic effects not captured by the explanatory variables.[6] Capacity utilisation is an obvious example. Further, we note that we use output (value-added) as the dependent variable as total factor productivity feeds into output and after accounting for the contribution of physical inputs to value-added, whatever remains must operate through the total factor productivity. Thus, the coefficients of competition, financial pressure and asset specificity should be interpreted as their contribution to TFP.

Before we come to a discussion of the results of our econometric analysis, a discussion on the variables used and the problems associated therewith is in order. We discuss each in order.

4.2.1 Competition: For competition we use three different variables, namely concentration and import penetration computed at the three-digit-industry level and rent ratio computed for each firm. We shall now explain the rationale for using the three variables. The first two are market-structure related competition variables. Whereas concentration (an inverse measure of competition) captures the domestic market-structure effects, import penetration incorporates competition from outside. However, we note that there are several problems with using these variables. First of all, a three-digit industry is not a market. The correct

[4] The generalised function allows us to have fewer restrictions on the production function.

[5] The construction of all the variables is described in detail in the appendix.

[6] See Baltagi (1995) for a discussion of omitted variables in panel data.

concentration and import penetration figures would be those computed for the commodity categories in which different firms fall. Secondly, there are several other factors, quite apart from the existence of a few very large firms in an industry, that determine collusion within it for monopolistic gains, e.g. asymmetries in cost and the ability of firms to, as it were, hide their price changes (see Nickell, 1996). Our measures of market structure cannot capture these unobservable and omitted effects. Thirdly, our measures represent only actual competitiveness. But the fact remains that potential competitiveness also influences market power (Vickers, 1993). Lastly, our measures do not fully reflect foreign competitors. Import penetration is at best only a partial measure inasmuch as it reflects competition from imports. But it does not tell us whether the imports were direct purchases from outside or through foreign firms operating in India or through some other mechanism.

These problems indicate that our indicators of market power have little value as cross-section measures. However, we propose to use them as time-series measures, in which case the problems discussed above would get substantially alleviated. If we assume that the unobservable and omitted variables are stable over time, which is not an unreasonable assumption, then our measures and the true measure of market power are likely to be correlated over time.[7]Thus, it may be not be entirely valueless to use three-digit concentration and import penetration as time-series indicators of market power.

Our third measure of market power is (monopoly) rent, again an inverse measure of competition defined as profits minus capital costs normalised on value added[8]. The idea is that if a firm is competitive, then it will earn profits at a rate of return just enough to meet the expenses of the factors of production employed, including the entrepreneurial input. Anything that the firm earns over and above that rate of return (the weighted average cost of capital in our case)[9] must be characterised as supernormal profits or monopoly rents. In our interpretation, a firm is more competitive if it has fewer monopoly rents. This is our most important indicator of the impact of competition on productivity through the agency route. Firstly, it represents a direct agency connection between competition, slack and productivity. In theory, high rent firms will have more free cash flow and greater room for

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[7] We saw in chapter three that the changes in our measure of concentration and the changes in the estimates of mark-up ratio by Balakrishnan et al (2002) had the same sign for all chosen industries except one. This fact further justifies our assumption.

[8] This variable is similar to the one used in Nickell (1996) and Nickell et al (1997), however with a couple of differences. Firstly these studies use the average *ex-post* rents to examine the growth effects, whereas we use actual *ex-post* rents for each year to analyse level effects. Secondly, for cost of capital, the studies use a very crude version of Sharp's Capital Asset Pricing Model incorporating the risk premium only on equity. On the other hand, we use the standard weighted average cost of capital that factors in both debt and equity capital. (See Appendix on variable construction)

[9] See Appendix II for details.

slack. Secondly, it is a firm level measure, as against concentration and import penetration which are industry-level measures. Therefore, it will have greater randomness than the other two. Lastly, it is consistent with the strict definition of market power, i.e. the ability to set the price for one's product. If a firm sets an above-marginal-cost price, it will earn monopoly rents.

However, this measure too is not entirely free from problems. First of all, what we have here is a measure of *ex-post* rents available to shareholders. Theoretically, it would have been preferable to use the *ex-ante* rents available to managers, on which unfortunately we have no information available. The problem, however, is not so serious. Arguably, the *ex-post* rents will be highly correlated with the *ex-ante* rents, especially over time. Secondly, it may be argued that higher profits could also reflect efficiency obtaining on account of, for example, the ability of managers to cut costs and organise production better. To avoid ambiguity in interpretation, we shall explicitly control for the profitability of the firm, which reflects such efficiency, with a view to separating the efficiency and slack effects. A measure that takes account of this is the profitability ratio defined as the ratio of profits to sales.

4.2.2 Financial Pressure: For financial pressure we use the inverse of the cash-flow coverage ratio of a firm. Our measure of financial pressure is defined as interest payments normalised on profits. The rationale for the use of this measure is that the higher the amount of interest payments as a proportion of profits, the greater the extent to which interest payments reduce the amount of free cash flow (see Jenson, 1988). This should put pressure on the managers to take up the slack and organise production more efficiently. However, we must note that though a high proportion of interest payments can put pressure on managers to reduce slack, it can also be a sign of financial distress, i.e. it might suggest that the firm in question has a high probability of defaulting on debt. We have seen that the empirical evidence on this issue has been pretty much one sided. The studies we reviewed have found a positive influence of debt pressure on productivity. However, all the available evidence is in the context of industrialised countries and, to the best of our knowledge, we have no evidence from developing countries, especially those that have recently introduced sweeping policy changes in their real and financial markets. We have seen that the role of debt in the financing of Indian firms has come down drastically over the sample period, which is strong evidence of financial restructuring and altering financing preferences of firms in a scenario of policy change. Thus, the interpretation of our results should be against

the background of these policy developments and changing financing trends of firms discussed in the previous chapter.

4.2.3 Degree of Asset Specificity: To measure the degree of asset specificity, we use plant and machinery normalised on the total assets of the firm. As we have argued earlier, plant and machinery represent the true physical sunk costs of a firm in its production process as they have negligible liquidation value and few alternative uses. Our measure also provides a measure of substitutability between the production specific assets and other fixed (land and building, transportation equipment, etc.) and variable assets (cash, receivables, etc.) which are not specific to the production process in that they can be employed for other purposes at little cost. Therefore, it can serve as a reasonable measure of the degree of asset specificity. However, this measure has its limitations too, which we must not forget to discuss. For one thing, it is a very crude measure of asset specificity. For example, it is based on the assumption that all plant and machinery is owned and none of it is leased. Also, it takes no account of sunk costs incurred on account of development of technology and human capital. A true measure of asset specificity should take into account all investments that are irreversible in nature. But we have stated at the outset itself that we are interested in only those specific assets that directly contribute to production. That is precisely why we have used the term "production-specific assets" rather than just "specific assets". For the limited purpose of this exercise, our measure still serves a good purpose, especially as a time-series measure of the degree of asset specificity.

4.2.4 Additional Variables: The variables mentioned above are the main explanatory variables for our analysis. However, apart from these, we place some additional controls for finer information. Firstly, we include firm size measured by the average sales of the firm over the entire sample period. This is important because we have firms of different sizes operating at different scales of production. Secondly, we include the age of the firm measured from the year of incorporation.[10] Age is a useful index of learning-by-doing (see Arrow, 1962 and Romer, 1991). It will help us determine whether more experienced firms have better productivity on account of learning and at the same time control our results for the experience implied by age.

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[10] It may be noted that the year of incorporation and the year of commencement of operations may be different for some firms in PROWESS,

4.2.5 The full sample: For the full sample, we use a balanced panel. The rationale is clear once we recognise that a fixed-effects panel-data analysis of the impact of a set of variables on the *level* of productivity is essentially a search for a time-series effect. Admittedly, our time dimension is rather small, eight years to be precise. Correlations observed over yet smaller time series would have progressively diminishing validity, especially given that we are primarily interested in firm-specific effects. Secondly, a relatively long time series is also desirable on account of the reverse causality discussed above, which is again a long-period phenomenon. Interestingly, however, the reverse-causality effect works in the opposite direction, i.e. more competition leading to higher productivity leading to higher market power and so forth. In this context, Nickell (1996) has argued that if we observe a positive effect of competition on productivity, then we may have reason to believe that the actual effect is even stronger.

Lastly, wherever we can find a sufficiently long average time dimension, we also provide results for sub-samples split by the averages of certain key variables. It may be noted that these sub-samples are not balanced panels. Hence, we run regressions on sub-samples only if the average time-series length of a group is roughly five. Specifically, we run the same regression for high-rent, high-concentration, high-import-penetration and high-sunk-cost firms to examine the specific effects of explanatory variables confined to a restricted domain. Moreover, through such splitting of the main sample we examine the interactions among the various influences.

Our final specification is as follows:

$$y_{it} = a + \alpha_1 n_{it} + \alpha_2 k_{it} + \alpha_{31} conc_{jt} + \alpha_{32} imp_{jt} + \alpha_{33} rent_{it} + \alpha_4 pr_{it}\ \alpha_5 fp_{it} + \alpha_6 as_{it} + \alpha_7 age + \alpha_8 size + u_i + \varepsilon_{it}$$

where

$conc_{jt}$ = log of the Herfindahl index of concentration of the jth industry

imp_{jt} = log of import-penetration ratio of the jth industry

$rent_{it}$ = log of rent ratio computed separately for each firm

pr_{it} = log of profitability defined by the ratio of profits to sales

4.3 Data and Data Sources

Most of the data has been collected at firm level from the corporate database, PROWESS[11], of the Centre for Monitoring Indian Economy (CMIE). The balance sheet information extracted from PROWESS is on the following variables: sales, value of output,

[11] See Shanta and Rajakumar (1999) for a discussion of the problems associated with the database.

wages, gross fixed assets, total assets, profits before depreciation, interest and tax (pbdit), equity capital, total borrowings, total raw materials expenses, dividends, interest expenses and the year of incorporation of the firm. Secondly, to construct some variables, the details of which are provided in the appendix on variable construction, industry level data at the three-digit level (National Industrial Classification, 1987) has also been taken from the Annual Survey of Industries (ASI). These aggregates include total industry output, total emoluments and total mandays of employees. Lastly, import data has been extracted from the annual (March) issues of the Monthly Statistics of Foreign Trade published by the Directorate General of Commercial Intelligence and Services (DGCI&S).

It may be noted that our choice of the three-digit industries within the chosen two-digit groups has been constrained by problems of concordance and matching between the three main sources of data. The classification followed for the aggregation and classification of firms in industries is NIC, 1987, since this is the only feasible way of incorporating all the important variables that we have an *a-priori* reason to include in our analysis. To match trade data with ASI data, we have followed the concordance drawn by Debroy and Santhanam (1993) and to match PROWESS data with ASI data we have used the concordance table provided in Veermani (2001). Given the constraints imposed by the limitations of concordance, a total of twenty-five three-digit industries have been chosen in the five major two-digit groups. A complete list of the three digit industries has been provided in Appendix IV. Next, suitable price indices for the chosen three-digit industries were taken from the Index Numbers of Wholesale Prices in India published by the Central Statistical Organisation. It is noteworthy that, for reasons of matching, we have had to use groups to three-digit industries in some cases. The price indices in such cases were the weighted averages of the price indices for individual three-digit groups with industry outputs serving as the appropriate weights. However, in some cases, appropriate price indices were not available. Thus, we have used approximate indices for such three-digit groups. Lastly, for sorting and editing the data, several consistency checks were performed based on certain rules of thumb described in Appendix III.

4.4 A Note on the Fixed Effects Panel Data Estimator and Specification Issues

We have explained above the theoretical reasons for using the fixed-effects panel data estimator. Our argument is that since we are looking for firm-specific time-series effects, the fixed-effects estimator will provide consistent estimates in the presence of a correlation between the firm-specific effect u_i and the explanatory variables. The other

competing specification, namely the random-effects model is based on the assumption of no correlation between the regressors and the firm specific effect u_i which is assumed to be random. If this assumption is valid then the feasible generalised least square (FGLS) estimator to estimate the random-effects model will give consistent as well as efficient results. However, if the assumption is violated, then FGLS will give inconsistent results (see Greene, 2000). In such a situation, the fixed-effects estimator will give consistent results as u_i gets wiped out in taking differences from the group means. Some further explanation may be warranted on the issue. Given below are the estimation details of a simple cross-section time-series model. We discuss the implications of both specifications.

Suppose we have a model as follows

$$y_{it} = \alpha + \boldsymbol{x}_{it}\boldsymbol{\beta} + u_i + \varepsilon_{it} \qquad (1)$$

In this model, $u_i + \varepsilon_{it}$ is the residual. We are primarily interested in the estimates of $\boldsymbol{\beta}$. u_i is the unit-specific residual (for example, firm-specific in our case). It differs between the units, but, for any particular unit, its value stays constant. ε_{it} is the usual residual with the usual properties such as mean zero, uncorrelated with itself, uncorrelated with $\boldsymbol{x}_{it}$, uncorrelated with u_i, and homoscedastic.[12]

Now, regardless of the properties of u_i and ε_{it}, if equation (1) is true, then it must also be true that

$$\bar{y_i} = \alpha + \bar{\boldsymbol{x}_i}\boldsymbol{\beta} + u_i + \bar{\varepsilon_i} \qquad (2)$$

where $\bar{y_i}$, $\bar{\boldsymbol{x}_i}$, $\bar{\varepsilon_i}$ are the group means over time.

Subtracting (2) from (1), we must also have

$$(y_{it} - \bar{y_i}) = (\boldsymbol{x}_{it} - \bar{\boldsymbol{x}_i})\boldsymbol{\beta} + (\varepsilon_{it} - \bar{\varepsilon_i}) \qquad (3)$$

The above three equations provide the basis for estimating $\boldsymbol{\beta}$. Running OLS on equation (2) and (3) gives what are called the between and within (fixed-effects) estimators respectively. The random-effects estimator is a matrix-weighted average of these two

[12] In a more thorough development, we can decompose $\varepsilon_{it} = v_t + w_{it}$, assume that w_{it} is the standard residual and better describe v_t. See Baltagi (1995) for more on two-way error component models

estimators where the matrix-weights are functions of the variances of u_i and ε_{it}, σ_u^2 and σ_ε^2 respectively, and would typically be equivalent to the estimation of

$$(y_{it} - \theta \bar{y_i}) = (1-\theta)\alpha + (\boldsymbol{x}_{it} - \theta \bar{\boldsymbol{x}_i})\boldsymbol{\beta} + (1-\theta) u_i + (\varepsilon_{it} - \theta \bar{\varepsilon_i}) \qquad (4)$$

where θ is a function of σ_u^2 and σ_ε^2 . If $\sigma_u^2 = 0$, meaning u_i is always 0, then $\theta = 0$ equation (1) can be estimated directly using OLS. On the other hand, if $\sigma_\varepsilon^2 = 0$, meaning $\varepsilon_{it} = 0$, then $\theta = 1$ and the within estimator provides the estimates, which will be, as a matter of fact, an $R^2 = 1$ regression. However, these are extreme cases. The intermediate cases are more reasonable and realistic.

The fixed-effects estimator of equation (2) is based on a few assumptions. The estimates are conditional on the sample in that u_i are not assumed to have a distribution, but are instead treated as fixed and estimable. This statistical subtlety can lead to problems in making out-of-sample predictions (see Judge et al, 1985). However, that aside, the fixed-effects estimator has much to recommend it, as we shall see presently.

The random-effects estimator of equation (4) is more efficient, and especially in wide longitudinal data sets, the estimator has considerable virtue. However, it relies critically on the assumption of no correlation between the regressors and the individual effects u_i, assumed to be a random variable. There is no particular justification for the assumption and the random-effects framework may give inconsistent estimates owing to omitted variables.[13]The fixed-effects estimator, on the other hand, is robust to such correlation as, in taking differences from the group means, the individual effect gets cancelled and we get consistent estimates. It is noteworthy, though, that the fixed-effects estimator is not efficient.

In our particular case, we have an additional theoretical justification for using the fixed-effects model arising on account of the reverse-causality problem discussed in the beginning of this chapter. The random-effects estimator, as we just saw, is a weighted average of the within (fixed-effects) and between estimators. Clearly, the between estimator, being based on time averages of all groups, essentially provides a cross-section estimate. Now for a θ sufficiently large, i.e. a small variance of ε_{it}, the between effect would dominate the within effect and the results of the random-effects estimator would largely reflect cross-sectional relationships. Given the reverse-causality problem, this can be misleading. The fixed effects estimator avoids the cross-sectional effect of the between estimator and provides consistent estimates on this account also. Thus, we have another supportive

[13] See Hausman and Taylor (1981) and Chamberlain (1978)

argument based on theory to justify our choice of the fixed-effects estimator, though we do perform the formal Hausman specification test (Hausman, 1978) to test for the orthogonality between the "random" effects and the regressors. We now come to a few issues regarding estimation and the results of our analysis.

4.5 Estimation and Results

For the estimation of our productivity equation, we assume that all the explanatory variables are exogenous. Admittedly, this is a rather strong assumption. Endogenity in our model may arise on account of external shocks to the cost functions of firms. Such productivity shocks operate through the error term and may affect employment or capital intensity (Nickell et al, 1992). For example, if there are autonomous shocks to the intensity of effort on account of, for example, embodied technological improvement, then there will be a rise in output inducing a probable fall in employment. But the fact remains that such correlations are entirely spurious.

Endogenity may also arise in the model depending on what behavioural assumptions one makes about the agents' objective functions. If profit maximisation is the underlying behavioural assumptions, which means that the managers of the firm consciously choose the level of inputs to maximise profits, then the capital and labour inputs are indeed endogenous (Greene 2000). However, with alternative assumptions, one may assume away such endogenity. For example, it is argued that if firms maximise not the current profits, but the future stream of profits, then treating the inputs as endogenous may not be necessary (Griliches, 1967). Thus, possible endogenity is also a function, among other things, of the underlying behavioural assumptions.

In situations of endogenity of inputs, a useful remedy would be to use lagged values of inputs as instruments and then taking first differences of the variables to get an instrumental-variable estimates of the parameters. However, in this case the first three observations of each group are lost in taking lags and differences. Our time series is already short and losing three observations per unit would make any quest for time-series meaningless. We have a difficult trade-off here. We can either avoid spurious correlations and lose observations, or examine the hypothesised relationships with a "better" sample size and live with some endogenity. Given the primary purpose of this study, we decide in favour of the latter. We argue that the problems emanating from such endogenity would affect, in a relative sense, the coefficients of labour and capital only. However, we are primarily interested in the coefficients of the various incentive influences on productivity,

for which purpose, potential endogenity does not pose very serious problems. If our estimates of the coefficients of labour and capital inputs are not extremely "unusual", then possible endogenity may not be a very serious issue for our estimation.

With this prologue to our estimation exercise, we provide the results of our econometric analysis. We first provide, in Table 4.1, the preliminary results of the consolidated sample which includes information on all firms.

Table 4.1 Results of the Balanced Panel (Full sample)

R^2 (within) = .7418 — No. of Observations: 2752

Correlation (u_i, $X\beta$) = -0.8 — No. of Groups: 344

Hausman's chi-square = 855.03 — Avg Group Size: 8

y_{it}	*coefficient*	*Standard error*	*t-value*	*P>|t|*
n_{it}	0.7075	0.0202598	34.92	0.000
k_{it}	0.1780	0.0103898	17.14	0.000
$conc_{jt}$	-0.05017	0.0142763	-3.51	0.000
imp_{jt}	0.01057	0.0097455	1.08	0.278
$rent_{it}$	-0.019698	0.0121857	-1.62	0.106
pr_{it}	0.1211857	0.0197511	6.14	0.000
fp_{it}	-0.1013945	0.0090332	-11.22	0.000
as_{it}	-0.0714088	0.0176078	-4.06	0.000
age_{it}	0.0809344	0.0314822	2.57	0.010
sz_i	-1.235274	0.5290777	-2.33	0.020
constant	3.215350	2.207097	1.46	0.145

Firstly, the production function displays decreasing returns to scale. This is not an unusual result for Indian industry (see Mamgain, 2000). The signs of all other coefficients are what we would expect except for the financial pressure variable, which has a negative and statistically significant coefficient. Secondly, there is some evidence of a positive impact of competition on the level of productivity. The coefficient for industrial concentration is negative (as we would expect) and significant at any reasonable level of significance. However, regarding the rent ratio, we can have confidence of our result holding good in about 90% of the cases only. Import penetration has the expected positive sign, but the coefficient is not significant. Asset specificity also has the effect of lowering the level of productivity. The result provides evidence of learning by doing as indicated by

the positive coefficient for age, significant at 5%. Lastly, larger firms have, on an average, lower *levels* of total factor productivity as seen in the negative coefficient for firm size which is again significant at 5%. There is a high negative correlation (-0.8) between the individual effects and the regressors. But, as we have seen earlier, our fixed-effects estimator is robust to such a correlation.

For the regression in Table 4.1, we assume that there is zero autocorrelation in the error term ε_{it}. And the only correlation over time is due to the presence of the same individual across the panel. However, there is no particular reason for assuming so. In fact, this may be a very restrictive assumption if an economic shock this period affects productivity in the next period. Ignoring serial correlation of this kind produces consistent, but inefficient estimates and biased standard errors (Baltagi, 2001). We run the same regression again, but this time assuming a first-order autoregressive process [AR (1)] in ε_{it}[14], i.e.

$$\varepsilon_{it} = \rho\varepsilon_{i,t-1} + \eta_{it}$$

where $|\rho| < 1$ and η_{it} is the purely-random-independently-identically-distributed error term with zero mean and variance σ_η^2. The estimate of ρ is always obtained after removing the group means. The details of the method involved in estimating ρ can be found in Baltagi and Wu (1999). Additionally, we also provide an estimate of the Durbin-Watson coefficient of autocorrelation derived by Bhargava et al (1982).

The rationale for using a regression model with an AR (1) process in the error term is that it explicitly lets us take account of serial correlation in the error term. In the process, however, we lose one observation per group because the error term of the previous period explicitly enters the original regression equation. The results of the regression for the full balanced panel are given in Table 4.2. There is evidence of significantly high autocorrelation in the error term as show by the modified Bhargava et al Durbin-Watson statistic of autocorrelation. This time we have the right signs and significant coefficients for all the variables. Specifically, the other two competition variables, import penetration and rents, become significant after accounting for autocorrelation in the error term. All indicators suggest a positive impact of competition on the level of total-factor-productivity. However, we still have the "wrong" sign for the financial pressure variable. Further, asset specificity has the right sign and is significant at 5%. Thus, there is also support for the

[14] See Lillard and Willis (1978) and Lillard and Weiss (1979) for a discussion of the regression estimates with an AR (1) process in the error term.

agency hypothesis of highly specific assets having a negative impact of productivity. Lastly, we observe that whereas size continues to show a negative relationship with total factor productivity, the relationship for age now turns insignificant, though the coefficient retains the positive sign. Thus, the evidence of "learning" we found in the previous regression is after all no evidence.

Table 4.2: Results of the Balanced Panel with an AR (1) Error Term

R^2 (within) = .5161 — No. of Observations: 2394

Correlation $(u_i, X\beta)$ = 0.1577 — No. of Groups: 342

ρ = 0.599328 — Avg Group Size: 7

y_{it}	*coefficient*	*Standard error*	*t-value*	*P>|t|*
n_{it}	0.6748277	0.0236381	28.55	0.000
k_{it}	0.1557013	0.0167091	9.32	0.000
$conc_{jt}$	-0.0436095	0.0138654	-3.15	0.002
imp_{jt}	0.0348197	0.0106363	3.27	0.001
$rent_{it}$	-0.0336305	0.0116577	-2.88	0.004
pr_{it}	0.1181953	0.019846	5.96	0.000
fp_{it}	-0.0730443	0.0103871	-7.03	0.000
as_{it}	-0.0539678	0.0216338	-2.49	0.013
age_{it}	0.0218891	0.0812411	0.27	0.788
sz_i	-0.5056192	0.0644077	-7.85	0.000
constant	0.7978907	0.0607057	13.14	0.000

Modified Bhargava et al. Durbin-Watson = 0.947633

From now on, in all our regressions, we control for an AR(1) error term. Next we see the results for our split sample for high-rent firms, by which term we identify firms having higher than median levels of rents. Table 4.3 shows strong evidence of a positive impact of competition on productivity levels for high-rent firms. The effect in this case operates almost entirely through the agency route. Although concentration has a significant negative coefficient at 5%, for import penetration, we can have confidence in our result for only about 89% of the cases. Age of a firm, in this case, has a significant negative coefficient, which suggests that within the category of high-rent firms, recently-incorporated firms are more productive. Size still has a negative coefficient but not statistically significant. Lastly, financial pressure and asset specificity have the same signs as we observed for the entire sample.

Table 4.3: Results for High-Rent Firms (Unbalanced Panel)

R^2 (within) = .7161 — No. of Observations: 1085

Correlation $(u_i, X\beta)$ = 0.414 — No. of Groups : 244

ρ = 0.648009 — Avg. Group Size: 4.5

y_{it}	*coefficient*	*Standard error*	*t-value*	*P>|t|*
n_{it}	0.6824002	0.0364592	18.72	0.000
k_{it}	0.1399813	0.022914	6.11	0.000
$conc_{jt}$	-0.0444074	0.0203775	-2.18	0.030
imp_{jt}	0.0257544	0.0162787	1.58	0.114
$rent_{it}$	-0.2926469	0.0438651	-6.65	0.000
pr_{it}	0.4261406	0.0431612	9.87	0.000
fp_{it}	-0.0783292	0.014931	-5.25	0.000
as_{it}	-0.0572936	0.0264017	-2.17	0.030
age_{it}	-0.2230517	0.0911427	-2.45	0.015
sz_i	-0.0246292	0.0680381	-0.36	0.717
constant	-0.1766837	0.0361989	-4.88	0.000

Modified Bhargava et al Durbin-Watson = 0.908064

In further support of the above evidence we provide estimates of average labour productivity for high- and low-rent firms. It is noteworthy that if the agency problems are acute, i.e. if there is indeed slack and low effort in firms with market power, then the effect should show directly in labour productivity of such firms. Therefore, it would be interesting to compare labour-productivity figures for the two types of firms. Table 4.4 presents our estimates for the sample period. It clearly shows that labour productivity has been higher in low-rent firms for the entire sample period. This further lends credence to our finding that competition effects productivity improvements. A legitimate question to ask in the face of such an observation is whether the higher labour productivity levels for low-rent firms have been induced by their higher capital intensity. In Table 4.5, we present figures for average capital intensity for both types of firms. It shows no evidence, whatsoever, of a significant difference in capital intensity. If anything, the average capital intensity is actually higher for high-rent firms. The variation in the two figures over the sample period too has been quite comparable as seen in the almost equal standard deviation figures.

Table 4.4: Labour-productivity in High- and Low-Rent Firms

Year	*High-Rent Firms*	*Low-Rent Firms*
1991	0.32	0.44
1992	0.31	0.431
1993	0.32	0.418
1994	0.315	0.511
1995	0.33	0.471
1996	0.286	0.382
1997	0.391	0.435
1998	0.364	0.400

Source: Own estimates from sample data

Table 4.5: Average Capital Intensity for High- and Low-Rent Firms

Firm Type	*Capital Intensity*	*Std. Deviation*
High rent	0.1093	0.1190
Low rent	0.1001	0.1172

Source: Own estimates from sample data

We also run split-sample regressions for high-concentration, high-import-penetration, and high-asset-specificity firms. The results are provided in Appendix I. We shall provide only a summary here. In high concentration firms, there is evidence that competition plays a productivity-enhancing role through the agency route as is evident in the significant negative coefficient for rent. Also, the coefficient for import penetration is positive and significant, though not the one for concentration itself which, however, has a negative coefficient. Asset specificity has the wrong sign but is not significant. Size is negatively related to productivity levels and age is not a significant determinant of productivity. For high-import-penetration firms, the results are less mixed. All competition variables have significant coefficients with the expected signs and so does asset specificity. As in the case of high-rent firms, here too, age is negatively related to productivity. Size too has a negative coefficient, but that is not statistically significant. Lastly, in the case of high-asset-specificity firms, the competition variables have expected signs, but none of them is significant. Interestingly, the coefficient for size is positive and statistically significant, though, for age, we still find a significant negative relationship.

In all the regressions, the coefficient for profitability is positive and significant, whereas that for financial pressure is negative and significant. It is noteworthy that these two results are quite robust to sample splitting and model specification. Including profitability is just a control measure which we do to remove from rents the impact of efficient production management through, for example, cost cutting measures. However, financial pressure is one of our principal variables which we have included to test the hypothesised discipline-of-debt effect. We expected a positive sign, but facts tell us otherwise. The relationship between financial pressure and the level of total factor productivity is negative. This needs some explanation. The results for the high-concentration and high-asset-specificity firms also warrant a closer look. The next section provides a discussion of our results.

4.6 The Substantive Findings and Explanations

The major finding of our analysis is that both product-market competition and a high proportion of production-specific assets affect the level of total factor productivity. Firstly, there is evidence that competition affects productivity positively. The results of our main sample, those of the split sample for high-rent firms and the comparison between the labour productivity figures for high- and low-rent firms makes this abundantly clear. We also get supportive evidence from our other split samples, namely firms in industries having high concentration and high import penetration. Although concentration does not affect productivity significantly in high-concentration firms, variations in rent and import penetration are still significantly associated with variations in total factor productivity. Thus, there is broad support for the agency hypothesis that competition induces higher effort from non-profit-maximising managers/workers of a firm.

The only split sample for which none of the competition variables are significant is the one of firms with high asset specificity. This may be evidence of high sunk costs deterring entry, inducing slack and affecting productivity negatively. Arguably, firms having a higher proportion of sunk investments would also be those with higher domestic industrial concentration. Our argument derives additional support from the observed insignificant impact of specific assets in high-concentration firms. The average effect may also have been blurred by the existence of scale economies arising on account of incurring sunk costs for expanding production scales. In all other cases, however, we find a negative and statistically significant relationship between asset specificity and productivity which lends empirical support to the theoretical ideas developed in Chapter 2.

The only variable for which we find "robust" counter-intuitive results is financial pressure. Consistently, financial pressure is found to have a negative impact on the level of productivity. We can offer several tentative explanations, though we admit to the need for further rigorous and long-term analysis of the problem. Firstly, as we observed in Chapter three, the drastically falling debt-equity ratios of all the selected industries and for the entire manufacturing sector large is evidence of a significant process of financial restructuring. More particularly, firms have been substituting equity for debt for purposes of capital finance. This means that firms have not been using debt as an active disciplining device. To go a step further, one may actually suggest that firms have not been able to use debt as an incentive mechanism owing to excessive burden of interest payments, to which the rational response of all firms in the event of financial liberalisation has been comprehensive financial restructuring. To justify the foregoing statement we present figures for average and maximum financial pressure computed from our sample data.

Table 4.6 Mean and Maximum Financial Pressure in the sample (%)

Year	*Average*	*Maximum*
1991	71.80	4400
1992	61.92	3158
1993	76.87	4800
1994	51.52	346
1995	59.20	4393
1996	73.20	9000
1997	52.77	538
1998	76.24	3046

Source: Our own calculations using sample data

The figures in Table 4.6 are striking. On an average, more than 50% of the profits of the firms included in the sample have been used up in servicing interest payments and for some years the average has been as high as 77%. The figures for maximum % financial pressure are of course pathological cases, but still they add valuable context to our argument. Such high proportion of interest payments in the cash flow of a firm is more a sign of financial distress arising on account of institutional factors rather than any attempt by firms themselves to use debt as an incentive device. The most significant institutional factor is the exorbitantly high lending rates of all the development financial institutions

(DFIs) in the first half of the 1990s as compared to the 1980. In Table 4.7 we present figures for the prime lending rates of the major DFIs.

Table 4.7: Prime Lending Rates of the Major Development Financial Institutions (%)

Year	*IDBI*	*IFCI*	*ICICI*
1984-85	14.00	14.00	14.00
1985-86	14.00	14.00	14.00
1986-87	14.00	14.00	14.00
1987-88	14.00	14.00	14.00
1988-89	14.00	14.00	14.00
1989-90	14.00	14.00	14.00
1990-91	14.00-15.00	14.00-15.00	14.00-15.00
1991-92	18.00-20.00	18.00-20.00	18.00-20.00
1992-93	17.00-19.00	17.00-19.00	17.00-19.00
1993-94	14.50-17.50	14.50-17.50	14.50-17.50
1994-95	15.00	14.50-18.50	14.00-17.50
1995-96	16.00-19.00	16.00-19.00	14.00

Source: Handbook of Statistics on Indian Economy (2001), RBI

The data show a clear and significant spurt in the prime lending rates of the three major development finance institutions, namely the Industrial Development Bank of India (IDBI), the Industrial Finance Corporation of India (IFCI) and the Industrial Credit and Investment Corporation of India (ICICI). Whereas the lending rates remained almost unchanged throughout the latter half of the eighties, the broad trend in the nineties is one of a sharp rise in the beginning followed by a partial softening of the interest rates. However, the rates are much higher on an average than in the eighties. This provides additional support to our explanation that firms have actually suffered financial distress over the period of our analysis and, consequently, have been restructuring their financial structures in a major way.

The observed negative association between financial pressure and productivity could be a short-term phenomenon, more indicative of a temporary relationship for economies in transition rather than any long-term trend. It is possible that once the institutional scenario alters, we may observe a positive impact of financial pressure on productivity. Agency theory has so far not explained the case of distress financing and its implications for managerial effort and thus the productivity performance of firms. This is very much a

feature of economies in transition like India and needs to be factored into any theoretical development of the idea of the disciplining impact of debt.

4.7 Some Limitations of our Analysis

Before ending the discussion, we would like to point out certain limitations of our analysis. First of all, the cross-sectional coverage of our sample is limited. We have not taken data for a large number of other manufacturing industries and our time dimension is also relatively small, though enough to get panel data estimates. We have mentioned earlier the constraints that forced us to restrict ourselves to the chosen industries and the time period. Admittedly, the robustness of our results will be determined by their ability to stand the test of a larger sample.

Secondly, we have been unable to perform further specification tests for the fixed-effects model. Baltagi (2001) has pointed out that it is also important to test for the restrictions that a fixed-effects model imposes on the data. Chamberlain (1984) has provided a test for testing these restrictions. We have been unable to perform this test on account of limited computing resources. However, in almost all regressions, we have found high correlation between the individual effects and the regressors. Besides, the Hausman test too has indicated the suitability of a fixed-effects specification.

4.8 Summing Up

In this chapter, we have provided an econometric analysis of the impact of product-market competition, financial pressure and the degree of specificity of production assets on the levels of total factor productivity of a sample of firms selected from five major manufacturing industries. For this purpose, we have used a fixed-effects panel-data framework assuming controlling for first-order serial correlation in the error term. Our main findings are the following:

1. The overall effect of product-market competition, as indicated by industrial concentration, import penetration and monopoly rents of individual firms, is positively associated with the level of total factor productivity. This provides support for the agency hypotheses examined in Chapter two.
2. The degree of asset specificity is negatively related to productivity levels. The result we get is consistent across the different sub-samples except one, namely high-concentration firms where relationship is not statistically significant. We have pointed to the

possibility of the existence of scale economies for some firms in these industries which may blur the total impact of asset specificity on productivity.

3. Financial pressure affects productivity negatively. This is the only counter-intuitive result that we get. We have offered some tentative explanations like financial distress and restructuring preventing firms from using debt actively an as incentive mechanism. Moreover, we have hinted at the inability of agency-theoretic models to explain this phenomenon, typical of an economy in transition that is moving from a high to a low interest rate structure. We also suggest that it might just be a temporary phenomenon and we need evidence over a longer period of time to assess the validity of the theoretical claims.

CHAPTER 5

Summary and Conclusions

In the main, this study has served two broad objectives. For a start, it has overviewed the general trends in the product and financial markets and capital acquisition by firms for the five chosen industries, namely (1) Rubber, Plastics and Petroleum, (2) Non-metallic Mineral Products, (3) Non-electrical Machinery, (4) Electrical Machinery including Electronics, and (5) Transport Equipment. Next, it has examined the impact of product-market competition, degree of asset specificity and financial pressure on the level of total factor productivity of a sample of firms selected from the five chosen industrial groups, aggregated at the three-digit level of National Industrial Classification (1987). Prior to that, we also examined the theoretical arguments dealing with the links we later tested for in Chapter 4. We present a brief summary of all this in the next section followed by our conclusion.

5.1 Summary

In Chapter 2 we presented a detailed and critical review of the existent literature on the links between productivity on the one hand and market competition, sunk costs (specificity of assets) and financial pressure on the other. For the positive impact of competition on productivity, we saw that there are mainly two arguments. One is the information argument which contends that by changing the information structure of the agency problems of the firm, competition facilitates relative performance appraisal and thereby alleviates moral hazard. The other is the bankruptcy argument which holds that by putting pressure on profits and engendering in managers the fear of bankruptcy and the loss of their job and the quasi-rents associated with their job, competition activates managers to clean up their operations. The link between asset specificity and productivity is built around several theoretical arguments, namely (1) specific assets serving to deterring entry and creating monopoly power and thereby inducing slack, (2) managers entrenching themselves in the establishment by way of acquiring assets specific to their own particular talents and consuming "agency goods" like slack, empire building, etc. in the process, (3) specific assets discouraging the use of debt and alleviating the discipline-of-debt effect, and (4) high sunk costs inducing a relatively closed information structure. And, finally, the link between financial pressure and productivity is also built around the argument of bankruptcy threat arising from reduced free cash-flow on account of interest payments, besides the argument

of outside monitoring by lenders. The empirical evidence on the suggested link between productivity and competition is mixed, while that on the link between productivity and financial pressure and productivity seems to bear out the theoretical arguments. The evidence on the relationship between asset specificity and productivity is negligible. Of whatever is available, we have reason to believe that the theoretical arguments may indeed be valid.

In the same chapter, we also located certain gaps in the existent productivity literature in India. Particularly, we noted that studies in the context of India have been overwhelmingly concerned with issues of measurement and analyses of trends in the growth of total factor productivity. Analyses of causal relationships are rather few, and, of those that exist, a large majority has been concerned with the influences of trade liberalisation. Especially, there has been attempted no analysis of the links referred to above. From this realisation, we drew our rationale for the study.

Chapter 3 examined the institutional setting for the problem. Chiefly, it provided a broad overview of the general trends in the three markets and the rationale for the suitability of the analysis we later did in Chapter 4. For the chosen industries, we saw that there is some evidence of a rise in competition as indicated by changes in market power and concentration, a rise in entry of new firms, greater buoyancy in the market for corporate control and a rise in the intensity of imports for most of the selected industrial groups. In regard to the financing patterns, we saw that firms have generally discouraged external financing and the reliance on debt has gradually come down as shown by the falling debt-equity ratios. This is evidence of significant financial restructuring wherein firms have been substituting equity for debt. Finally, in the "production-specific-assets" market, we saw a tremendous increase in both gross fixed capital formation and the degree of asset specificity which we define as the ratio of specific to total assets of a firm.

Against this background we performed an econometric analysis of the posited links between the level of total factor productivity and competition, asset specificity and financial pressure using a generalised Cobb-Douglas production function in a fixed-effects panel data framework. Our main results are: (1) competition affects productivity favourably, (2) financial pressure has a depressing effect on productivity and (3) the relationship between productivity and asset specificity is negative. The first and third results are as we would have expected theoretically. But the negative coefficient for financial pressure has no theoretical explanation. We have attempted to explain this result in terms of its being indicative of financial distress followed by a restructuring of capital structure which has not let firms actively use debt as a disciplining device. We have thought it appropriate to feel

satisfied with this explanation on account of the significant evidence of financial restructuring found in Chapter 3 and the exorbitantly high rates of lending by the main development financial institutions. Also we saw that, on an average, financial pressure has been upwards of fifty per cent which is more than anything else indicative of extreme financial pressure which could have led to the counter-intuitive finding.

5.2 Conclusion

The most substantive finding of this thesis is the observed positive influence of product-market competition on the level of total factor productivity. We saw in Chapter two that neither theoretical opinion nor empirical evidence is one sided on the matter. The positive link has been found in the case of countries like the USA and the UK. But for others like Germany and Denmark, the opposite finding has been made. However, we have also noted that our sample is rather small given the size of the manufacturing sector in India. We have not been able to include data on a large number of manufacturing and service-sector industries. Besides, we have been unable to analyse the impact of many other external and internal influences that affect the managerial/worker incentives to supply effort, e.g. the ownership patterns, the existence of a dominant external shareholder, salary, bonus and stock options to managers, etc. The obvious difficulties to us have been posed by the problems of either getting the required data or harmonising the existent data drawn from different sources. Some limitations have also been imposed by the paucity of time. Given greater time and more comprehensive data, we would have liked to widen the scope and coverage of our analysis with a longer time dimension. It is noteworthy that, owing to a rather short time dimension, we have been unable to effect the kind of estimation improvements discussed in Chapter 4 to mitigate the problems of, for example, endogenity and long-term persistence of the observed patterns.

With regard to the other two incentive influences, namely asset specificity and financial pressure, we feel that we ought to have better and more refined measures, especially of asset specificity. Moreover, in case of financial pressure, it is important to ascertain whether what we observed was a short-run phenomenon, given that we have analysed an economy in transition where firms are undergoing comprehensive financial reforms, or whether there could be systematic institutional factors that could explain the negative relationship. This should call for more empirical investigation and a revision of the theoretical models in the light of such investigations.

Appendix I: Results of regressions on sub-samples

Results for high concentration firms

R^2 (within) = 0.6231 — No. of Observations: 1082
Correlation (u_i, $X\beta$) = 0.2892 — Avg Group Size: 6
ρ = 0.63465 — Maximum group size: 7

y_{it}	*coefficient*	*Standard error*	*t-value*	*P>|t|*
n_{it}	0.76177	0.0394368	19.32	0.000
k_{it}	0.168001	0.0250848	6.7	0.000
$conc_{jt}$	-0.0301001	0.0212636	-1.42	0.157
imp_{jt}	0.0579427	0.02284	2.54	0.011
$rent_{it}$	-0.0420836	0.016193	-2.60	0.010
pr_{it}	0.1903617	0.0291015	6.54	0.000
fp_{it}	-0.0659526	0.014739	-4.47	0.000
as_{it}	0.0243711	0.0286596	0.85	0.395
age_{it}	0.188787	0.129884	1.45	0.146
sz_i	-0.4519121	0.0875042	-5.16	0.000
constant	0.2120	0.05851	3.62	0.000

Bhargava et al modified Durbin Watson: 0.95136

Results for High Import Penetration Firms

R^2 (within) = 0.5543 — No. of Observations: 1040
Correlation (u_i, $X\beta$) = 0.4968 — Avg Group Size: 4
ρ = 0.57438 — Maximum group size: 7

y_{it}	*coefficient*	*Standard error*	*t-value*	*P>|t|*
n_{it}	0.6112297	0.0458821	13.32	0.000
k_{it}	0.204995	0.0301711	6.79	0.000
$conc_{jt}$	-0.0558403	0.0216258	-2.58	0.010
imp_{jt}	0.0792768	0.0194144	4.08	0.000
$rent_{it}$	-0.039919	0.0188889	-2.11	0.035
pr_{it}	0.1155368	0.0317376	3.64	0.000
fp_{it}	-0.0694923	0.0171582	-4.05	0.000
as_{it}	-0.2074644	0.0376126	-5.52	0.000
age_{it}	-0.2888282	0.1057859	-2.73	0.006
sz_{it}	-0.0143761	0.0832437	-0.17	0.863
constant	-0.303293	0.064192	-4.72	0.000

Bhargava et al Modified Durbin Watson: 1.095

Results for High Asset Specificity Firms

R^2 (within) = 0.6945 — No. of Observations: 1054

Correlation (u_i, $X\beta$) = 0.2235 — Avg Group Size: 5.4

ρ = 0.5911 — Maximum group size: 7

y_{it}	*coefficient*	*Standard error*	*t-value*	*P>|t|*
n_{it}	0.606085	0.0369544	16.4	0.000
k_{it}	0.23164	0.0261112	8.87	0.000
$conc_{jt}$	-0.001395	0.020406	-0.07	0.946
imp_{jt}	0.0219142	0.013383	1.64	0.102
$rent_{it}$	-0.0116104	0.0148222	-0.78	0.434
pr_{it}	0.0759473	0.028133	2.7	0.007
fp_{it}	-0.0601228	0.0148887	-4.04	0.000
as_{it}	-0.1262569	0.04244	-2.97	0.003
age_{it}	-0.5481341	0.09967	-5.5	0.000
sz_{it}	0.1603404	0.0654317	2.45	0.014
constant	0.06574	0.04635	1.42	0.156

Bhargava et al Modified Durbin Watson: 0.95829

Appendix II: Variables Constructed

Output: We have used a valued-added production function in which gross value added, deflated by the appropriate output deflator at the three-digit level if National Industrial Classification (NIC), 1987, appears as the dependent variable. It may be noted that PROWESS also reports a figure for gross value added which is the sum of profits, wages and other rents. But this is not an appropriate measure for our purpose since many expenses like R&D expenditure and bad debts are written off against profits. Therefore, we have calculated gross value added by taking the difference between gross output and material inputs for which data are separately available in PROWESS.

Labour: We don't have data on man-hours or number of workers at firm level. However, we have data for total emoluments for each firm, total emoluments for each three-digit industry and the total man-days of employees. Data on the last two industrial variables are available from the Annual Survey of Industries. Using these data we have constructed the labour variable in average efficiency units. First, at industry level, we divide total emoluments by total man-days of employees to get average labour in efficiency units. Next,

we divide the total emoluments of each firm in the same three-digit industry by the figure for average labour in efficiency units. It is instructive to note that, for constructing the labour input in this way, we make a rather strong assumption that the wage rate is the same for all firms in an industry.

Capital: The estimation of capital or capital stock poses the all-too-familiar problems for which there still don't exist any perfect solutions. The main problem is presented by the problem of estimating the rate of depreciation and appropriately accounting for vintage (Ahluwalia, 1991). If it were possible to have a measure of the true rate of depreciation, then we could reliably estimate the net capital stock. But the measures we have available are either accounting measures that the mostly driven by tax considerations (depreciation often being tax-deductible) or based on certain rules of thumb. On this account, it appears more advisable to use gross capital stock and that is what we have used for our analysis. PROWESS gives data for gross fixed assets at historical cost, gross of depreciation. To account for vintage, we generate a capital stock series at replacement cost. The capital stock has been deflated by the wholesale price index of gross fixed capital formation at 1993-94 prices available from the National Accounts Statistics published by the Central Statistical Organisation.

We use 1997-98 as the base year and the entire capital stock series has been generated backwards. Let the denote the capital stock in the base year t by k_t. Then the stock for other years has been generated as follows

$$k_{t-1} = k_t - I_t,\ k_{t-2} = k_{t-1} - I_{t-1}, \text{ and so on.}$$

But before this we need to have the capital stock at replacement cost in the base year. For this we have to revalue the capital stock in the base year. We do not have any perfect method for doing so and we can get at best a good approximation. The method we have employed is based on a set of assumption stated below:

1. No firm has any capital stock in the base year 1997-98 of a vintage earlier than 1977-78. For firms incorporated after 1977-78, it is assumed that the earliest vintage dates back to the year of incorporation.
2. The price of capital has changed at a constant rate, π, from 1977-78 or from the date of the firm's incorporation, whichever is late, up to 1997-98, the base year. Values for π were constructed using the wholesale price indices for gross fixed capital formation taken from the National Accounts Statistics. We have used the exponential trend growth rate.

3. Investment has grown at a constant rate, g, for all firms from either 1977-78 or the year of incorporation of the firm, whichever is later. Here, we have used the exponential growth rate of gross fixed capital formation of the registered manufacturing sector. The data have been taken from the National Accounts Statistics.

Using these assumptions, we estimate the revaluation factor R^G for the base year gross capital stock using the method described below.

Let GFA_t^h *and* GFA_t^r be the gross fixed assets at historical and replacement cost respectively and It be the real investment at time t. By definition and using the assumptions made above

$$GFA_t^h = P_t I_t + P_{t-1} I_{t-1} + \ldots$$

$$\text{Or, } GFA_t^h = P_t I_t \left(\frac{(1+g)(1+\pi)}{(1+g)(1+\pi)-1} \right)$$

And,

$$GFA_t^r = P_t I_t + P_{t-1} I_{t-1} + \ldots$$

$$\text{Or, } GFA_t^r = P_t I_t \left(\frac{(1+g)}{g} \right)$$

Now, let's define

$$R^G = \frac{GFA_t^r}{GFA_t^h}$$

So that

$$R^G = \frac{(1+g)(1+\pi)-1}{g(1+\pi)}$$

This is the result if it is assumed that the capital stock dates back infinitely. However, and more realistically, if we assume finite vintage of, say, t years, then we can derive the revaluation factor as follows:

$$GFA_t^h = P_t I_t + P_t I_t \frac{1}{(1+g)} \frac{1}{(1+\pi)} + \ldots$$

The sum of this geometric series is equal to

$$P_t I_t \left(\frac{(1+g)^{t+1}(1+\pi)^{t+1}-1}{[(1+g)^t(1+\pi)^t][(1+g)(1+\pi)-1]} \right)$$

Similarly,

$$GFA_t^r = P_t I_t + P_t I_t \frac{1}{(1+g)} + \ldots$$

$$= P_t I_t \left(\frac{(1+g)^{t+1} - 1}{(1+g)^t g} \right)$$

So,

$$R^G = \frac{[(1+g)^{t+1} - 1](1+\pi)^t [(1+g)(1+\pi) - 1]}{g[(1+g)(1+\pi)]^{t+1} - 1}$$

Rent ratio: Rent ratio is rents normalised on value added. Suppose R is rents, P is the net profit before depreciation, interest and tax, and C the cost of capital, then

$$R = P - C$$

Cost of capital is weighted-average cost of capital, adjusted for the rate of depreciation and the risk-free rate of return, times the capital stock (gross) estimated as explained above. The weighted average cost of capital is a weighted average of equity and debt cost of capital. Equity cost of capital is calculated as follows:

$$C_{equity} = \frac{div}{EC} * 100$$

where *div* is the dividend paid out on the total paid up equity capital *EC*. Debt cost of capital is calculated as follows:

$$C_{debt} = \frac{in}{debt}(1 - tax) * 100$$

where *in* is the interest paid on total borrowings, *debt* is the total borrowings and *tax* is the rate of corporate tax (interest being a tax-deductible payment) assumed to be 40% for all firms. The adjusted weighted-average cost of capital is calculated as follows:

$$C = \theta C_{equity} + (1 - \theta) C_{debt} + \delta - rr$$

where $\theta = \frac{equity}{equity + debt}$, δ is the rate of depreciation assumed to be equal to 7% for all firms and *rr* is the risk free rate of return taken to be the average return on the 365-day treasury bills floated by the Reserve Bank of India over the entire period of analysis. The calculation is based on the assumption that investment has grown at a constant rate over the entire period of analysis for all firms.

Appendix III: Data Editing Rules

The data we have used has passed through several checks for quality and consistency. For this we have followed some general rules based on theoretical consistency, our requirements for variable construction and common-sense. Following are some rules of thumb that we have generally followed:

a) *Missing and Unacceptable Values:* Wherever we find missing or unacceptable (e.g. zero, negative, etc.) values for the key variables, e.g. output, wages, gross fixed assets, etc. we delete the entire observation.

b) *Consistency:* Many variables in our analysis are causally related, e.g interest and debt, dividend and profit, output and input variables (wages and gross fixed assets). Entire observations have been deleted in the event of any observed inconsistencies between the values of these pairs of variables. Some examples include zero debt and positive interest, positive output and zero wages or capital assets and so forth.

c) *Variable construction requirements:* For constructing the rent variable, we need the weighted average cost of capital discussed in Appendix II, for which we need data on both dividends and interest along with that on equity and debt. Given these requirements, we had to delete observations whenever we found zero values, for example, for dividend for the entire period accompanied with consistently high profits. Similarly, in the case of interest.

d) *Balanced Panel:* For the full sample, we have chosen to have a balanced panel which requires data on the selected firms for the entire sample period. Given this requirement, firms for which observations were missing for some years were left out of the sample.

Appendix IV: List of Industries included in the analysis

The following table enlists all the three-digit industrial groups along with the NIC code for which we have drawn data for our empirical analysis.

NIC Code	*Name of Industry*
310	Tyre and Tube
312	Rubber Products n.e.c.
313	Plastic Products n.e.c.
320	Refractory and Structural Clay Products
321	Glass and Glass Products
324	Cement, Lime and Plaster
350	Agricultural Machinery
351	Construction and Mining Machinery
353	Industrial Machinery for Food and Textile Industries
354-359	Other Industrial and Special Purpose Machinery
356	General Purpose Non-electrical Machinery
357	Machine Tools
360	Electrical Industrial Machinery
361	Insulated Wires and Cables
362	Accumulators, Primary Cells and Batteries
364-388	Electric Fans, Domestic Appliances + solar energy items
366	Television Receivers, Radio Apparatus, etc.
367	Computers and Computer-based systems
373-74-79	Motor vehicles + transport equipment & parts n.e.c.
375	Motorcycles and Scooters
376	Bicycles and Cycles Rickshaws

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