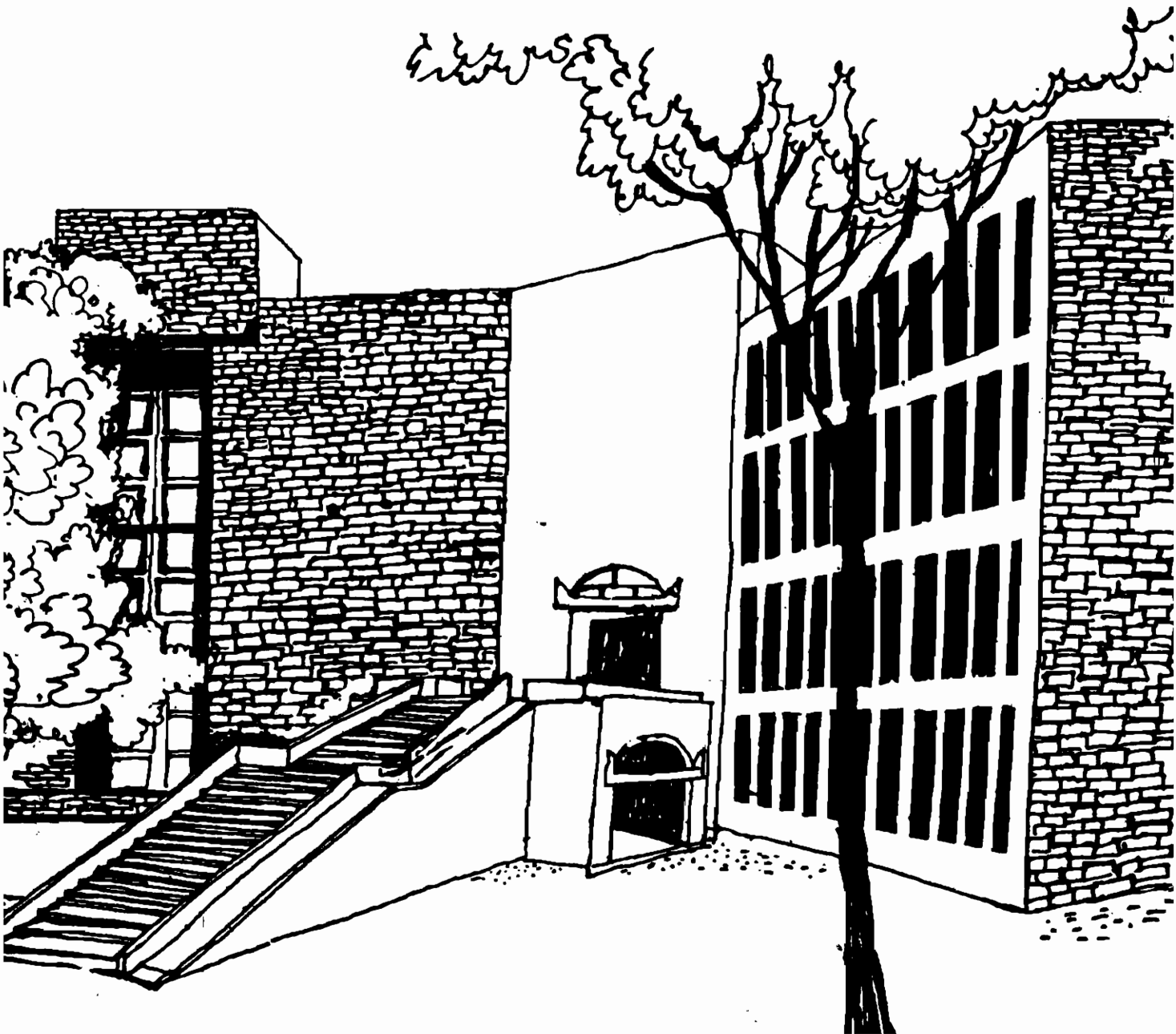# Working Paper
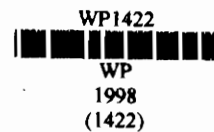
INTERNAL POLICY REFORMS AND EVOLUTION OF
MARKET STRUCTURE: A STUDY OF INDIAN
INDUSTRY

By

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Internal Policy Reforms and Evolution of Market Structure: A Study of Indian Industry

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Abstract:

The recent market reforms in developing economies have led to increasing presence of multinational firms which has significant implications on the evolution of the domestic market structure. This paper builds a simple theoretical model which considers firm level asymmetries in terms of time of entry, costs of production, and firm-specific intangibles under oligopolistic competition in explaining the evolution of markets in the context of the Indian industry. The main propositions of the model are empirically verified by econometric exercises based on firm level panel data for a set of industries. The results, for four of out of six industries studied, show that new entrant MNCs export at higher intensity than incumbents. Exports at the initial period helps new entrants to realize minimum efficient scale and subsequently adopt strategies towards enhancing domestic market shares. The results suggest a positive explanation of domestic market shares of firms by their relative technical efficiency in production. Increased competition from new entrant multinational firms is driving domestic firms to undertake deliberate technological efforts for enhancing production efficiency. Investment in research and development expenditure (in the host Indian market) appears to be more important for domestic firms than for new entrant multinationals for increasing technical efficiency in production.

JEL Classification: L13, F12

Key words: Incumbent; New entrant; Competition; Production Efficiency; Domestic Market Shares; Exports.

1.   Introduction

In the recent times, industrial structure in several developing economies have been subjected to competitive forces through rapid policy reforms. In India, as in several other developing economies, internal market reforms have eliminated policy based entry barriers first and trade policy reforms such as devaluation and reduction of import tariffs have been introduced at a later stage. Industrial delicensing and liberalisation of policies for entry of multinational corporations (MNC) were initiated in the mid-eighties and trade policy reforms in the early nineties. Competition from imports is being introduced in a gradual stage. This type of sequence to the internal and external reforms have important implications on the evolution of domestic market structure.

The industrial policy reforms have led to entry of quite a few MNCs into the Indian market. Entry of relatively efficient multinational firms is supposed to turn the domestic market structure into a competitive one and subsequently cause increase in production efficiency of firms and industries in general. Increase in the number of firms and overall production efficiency are expected to cause downward shifts in the supply curve and increase in exports (Patibandla, 1996). Porter (1990) shows the key role of competitive domestic market conditions in generating internationally competitive industries. For example, the Japanese success stories, e.g., cars, motorcycles, cameras, video-recorders and musical instruments, etc., are those industries in which domestic competition is intense.

An understanding of the dynamics of the evolution of domestic industrial structure from highly protected to a competitive one requires addressing questions such as: how incumbent firms which functioned under protected market adjust to new entrants ?; will the incumbency advantages of dominant oligopoly producers erode because of entry of more efficient multinational firms ?; does increase in the entry of new firms leads to competitiveness through higher production efficiency ?; does it lead to increase in concentration ?; and what

2

kind of strategies will firms adopt towards domestic and export markets under the changing domestic market conditions ? This paper attempts to answer some of these questions.

The analysis of the impact of multinational investment on the domestic market structure has to take into account of industry and firm specific factors such as the importance of knowledge specific capital versus physical capital. This is because the relative advantage of multinational firms in the host country arises from firm-specific intangibles associated with knowledge intensity of production (Caves, 1996; Dunning, 1988; Markusen, 1995). Entry of multinational firms into capital and knowledge intensive industries could lead to increasing investment in R&D and marketing by incumbent firms. Secondly, if multinational investment leads to knowledge and technology spillovers, average production efficiency of industries could increase. On the other hand, if multinationals cut into market shares of incumbent domestic firms, the production efficiency of incumbent firms could decline by making them to produce at sub-optimal scales (excess capacity). This, in turn, may push domestic firms to look for export markets given the limited size of the domestic market.[1] In other words, exports extend the market size, and are a result of domestic market rivalry. In order to compete in the domestic market and undertake exports, domestic firms have to make deliberate efforts at enhancing production efficiency.

This paper undertakes empirical analysis of these issues for a set of Indian industries. In India, as in most developing economies, the policy reforms are about a decade old and the dynamics of market evolution is still subject to quite a bit of fluidity. A few recent empirical studies, as to the knowledge of the author, have examined the issue of evolution of markets in developing economies that have been subjected rapid policy changes (Ghemawat and Kennedy, 1997 for Poland, Liu Lili, 1993 for Chile; Aitken and Harrison, 1993 for Venezuela). These studies look at the effect of policy reforms on market concentration and its explanation by

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[1] Aitken et al. (1994) report that Mexican manufacturing firms were significantly more likely to export when foreign firms were located nearby. The explanation is in terms of information and other externalities.

relative efficiency, R&D expenditure and advertising intensity, and the implication of entry of MNCs on the relative efficiency of domestic firms. This paper examines implications of firm specific advantages depending on time of entry, owner-ship related advantages in intangibles and cost of production on possible competitive strategies of domestic firms and MNCs and their implications on domestic market shares and exports.

Section 2 of the paper presents a theoretical framework which adopts a simple industrial organization theory of sequential entry of firms as a reference point in tracing out the evolution of the market structure in response to the policy reforms. Section 3 presents the empirical analysis which is based on firm level panel data drawn for a set of Indian engineering industries. The empirical exercise tests for the behaviour of firms in the post-reforms period of 1989 to 1996. The choice of the time frame is quite germane as the internal industrial policy reforms were initiated in the middle of 80s and this period had seen entry of quite a few multinational firms into Indian industries. Concluding remarks are presented in Section 4.

2.   The Model

We take the domestic and export markets segmented through import protection. This assumption is justified as most final goods industries have been subject to high import tariffs and quantitative restrictions: as of 1997, the average import tariff is 60 per cent on consumer goods and 30 per cent ad valorem on intermediate and capital goods, and there are about 2,700 products whose imports are still subject to quantitative restrictions. In order to keep the analysis simple, we ignore imports. On the basis of small country assumption, firms are price takers in the world market. Firms are strategically interdependent in the domestic market and they compete with capacities. Increase in the number of firms and increase in market shares of firms cause increase

4

in industry supply. Given the domestic demand curve (market size), increase in supply leads to increase in exports.[2]

We characterize the evolution of market behaviour of firms by introducing an initial asymmetry of time of entry into the market in terms of pre-reform and post-reform periods. While the industrial licensing policies were in practice, certain firms could corner the licenses.[3] These firms are the first entrants and would be in a position to derive the asymmetric advantage of first entry over new entrants in the post-reform period. In such a case, incumbent firms could retain a major part of the domestic market and make new entrants to behave as followers. This is captured by applying Spence-Dixit's (1980) model of entry. Take the duopoly case of firm *i* and firm *j*. In the first period (prior to the reform), firm *i* makes irreversible capital stock decision (capacity

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[2] Under oligopoly, when we take firms to compete with capacities a la Cournot, increase in nuumber of firms makes market price and supply to approach competitive level, benefiting consumers. But individual firm's efficiency declines, if we a take an 'u' shaped average cost curve. This is because as new firms enter, existing firms would contract their production, although less than proportionately to the increase in the supply of new entrants (as the reaction curves are downward sloping and their slope is less than one). In other words, existing firm's production moves backward on the declining average cost curves which results in production at sub-optimal capacities. This could be one of the reasons for the empirical finding of Aitken and Harrison (1993) for Venezuela that, while foreign investment raises productivity overall, the gains are internalized or captured by other foreign firms, with productivity in domestic firms actually declining. Increase in efficiency has to come from downward shifts in cost curves.   -

[3] A number of large firms in Indian industry used the licensing and MRTP (Monopoly Related Trade Practices) policies as an entry-deterrent strategy. The autotyre industry is a good example of where existing firms used the licensing policy as an entry deterring mechanism thereby maintaining their sway over the industry.

creation). In the second period (the post reform period), the new entrant (*j*) and the incumbent compete in Cournot quantity space. New entrant attempts to find profit maximizing output on the residual demand curve. The earlier investment by firm *i* in capacity or sunk costs alters the second period game in favour of firm *i* and it will be a Stackelberg leader in the second period.[4] Consequently, the first entrant *i* captures a higher share of the protected home market and makes firm *j* to behave like a follower on the residual part of the home market demand curve. If there is a time gap between the announcement and the implementation of industrial delicensing, it could induce incumbents to invest in additional capacity as in Dixit's model which provides them with a relative advantage in the post-entry period. We introduce an additional factor of firm specific intangible assets that provide domestic firms and MNCs with different relative advantages in the domestic market. The basic model is as follows:

We assume a homogenous commodity for starting. The linear inverse home market demand function is;

$$P = a - b \ (X) \tag{1}$$

$$X = x_i + x_j$$

$$P \geq P_w \ (1+t)$$

x_i refers to domestic sales and x_i^* refers to exports of firm *i*. P_w is the world market price and *t* is the tariff rate on imports and *P* refers to the domestic market price. In equilibrium, $P > P_w$.. The profit function of firms facing protected domestic market and competitive export market is:

$$\Pi_i = P() x_i + P_w x_i^* - c_i / 2 (x_i + x_i^*)^2 - e_i x_i \tag{2}$$

$$\Pi_j = P() x_j + P_w x_j^* - c_j / 2 (x_j + x_j^*)^2 - e_j x_j \tag{3}$$

e_i refers to intangible assets of firms which provides them with a firm specific relative advantage in the domestic market; higher the relative advantage associated with domestic sales, lower will be e_i. The premium

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[4] In other words, investment in sunk costs allow an established firm to commit to a preferred output.

on domestic sales can be viewed as arising from the condition that in equilibrium $P > P_w$: a firm having higher share of the protected domestic market will have higher profits. By equating the first order derivatives with respect to exports to zero, we obtain

$$x_i^* = (P_w/c_i) - x_i \qquad (4)$$

$$x_j^* = (P_w/c_j) - x_j \qquad (5)$$

The follower firm j takes x_i as given and solves;

$$\Pi_j = (a - bx_i - bx_j)x_j - c_j/2 (x_j + x_j^*)^2 - e_j x_j \qquad (6)$$

$$\partial \Pi_j / \partial x_j = (a - bx_i - 2bx_j) - c_j (x_j + x_j^*) - e_j = 0 \qquad (7)$$

From equation (5), we know that $x_j + x_j^* = (P_w/c_j)$. By substituting this into equation (7), we get;

$$x_j = (a - e_j - P_w - bx_i)/2b \qquad (8)$$

Equation (8) is the reaction function of a new entrant who believes incumbent's capacity choice does not change to its capacity decision, a la Cournot. As the incumbent firm behaves like a Stackelberg leader, the reaction function of j enters the profit function of firm i. By solving for the profit function of firm i, we obtain

$$x_i = (a - P_w + ej - ei_j)/2b \qquad (9)$$

By substituting equation (9) into equation (8), we obtain the equilibrium home market sales of the follower;

$$x_j = (a - P_w - ej + ei_j)/4b \qquad (10)$$

The exports of firms in equilibrium:

$$x_i^* = (P_w/ci_j) - (a - P_w + ej - ei_j)/2b \qquad (11)$$

$$x_j^* = (P_w/cj) - (a - P_w - ej + ei_j)/4b \qquad (12)$$

$$a > P_w$$

The implications of asymmetric advantages across domestic firms and new entrant MNCs on the their competitive behaviour can be traced by the following cases;

1. Asymmetry in time of entry and $c_i = c_j$, and e_i and $e_j = 0$ or $ei = ej$;

2. Asymmetry in time of entry and $c_i < c_j$ with e_i and $ej = 0$ or $ei = ej$;

3. Asymmetry in time of entry and $c_i > c_j$ with e_i and $ej = 0$ or $ei = ej$;

4. Asymmetry in time of entry and asymmetries in c_i and e_i (endogenous to the competition in the post-reform period).

In case 1, from equations *(11)* and *(12)*, we can observe that the new entrant firm has higher export orientation than the incumbent firm. The leader firm i, by the sheer advantage of being the first entrant, is able to capture a higher share of the protected domestic market.[5] If the incumbent's costs are sufficiently lower than the follower, as in case 2, the incumbent will have higher home market sales and also higher exports than the new entrant. This possibility may take place if there are strong learning economies in production, internal to a firm, which are exclusive to the first entrant firm.

Even in case 3, where the new entrant (multinational) firm has lower costs than the incumbent firm, the new entrant has a lower domestic market share and exports more than the incumbent firm. The intuitive explanation for this is that it takes time for a new entrant to dislodge an incumbent from the domestic demand curve. Exports, in the initial stage, help a new entrant to realize minimum efficient scale in production.[6] This

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[5] The dynamics of changes in domestic market shares and export intensity of firms can be seen through comparative statics of equilibrium by changing c_i and e_i.

[6] One of the possible reasons for higher export orientation of new entrant MNNs could be that they bring later vinatage technologies and products which are more suitable for export markets than products produced by

outcome may be more applicable to a new entrant MNC because the relative advantage of intangibles associated with export markets (international markets) is with MNCs rather than domestic new entrants.[7] One way a new entrant in the post entry period could increase domestic market share is by adopting strategies that enhance advantages arising from e_j. In other words, asymmetries in production costs across firms have implications only on exports but not on domestic sales. The intuitive explanation is that as firms face oligopolistic competition in the protected domestic market and are price takers in the export market, exports are undertaken to restrict domestic supply at higher price as a part of the price discriminatory behaviour (Patibandla, 1996).

An important component of strategic advantages in the domestic market arises from firm specific intangibles (asymmetries in $e_{i,}$). Some of these factors are exogenous and others are endogenous to the competition in the post-reform period. The exogenous components could be the incumbent's experience in dealing with market institutions specific to India accumulated in the pre-reform period, and the international reputation and brand names of new entrant multinational firms. If the incumbent firm's advantages of accumulated learning economies are in terms of their ability to deal with market conditions and institutions specific to India (the Indian bureaucracy, legal system and market institutions of contract formulation and enforcement), it provides them an additional advantage in the domestic market. Similarly, multinational firms enter the domestic market with international brand names and reputation which, in turn, may provide them with a relative advantage over domestic incumbent firms (for example, Honda motorcycle was well known in India prior to its' entry into the Indian market).

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incumbent firms. For example, in the Indian Light commerical vehicle industry, the domestic firm Bajaj Tempo produces lower end price elastic vehicles which are suitable for exports.

[7] This aspect is not brought out explicitly in the model.

On the production cost side, the multinational's superior technology which it acquired prior to entry into the Indian market and the incumbent's learning economies in production acquired in the pre-reform period can be taken to be exogenous factors. In other words, presumably multinationals have access to productive knowledge which is not available to domestic producers. As Caves (1996) and others have shown, multinational firms, apart from their superior production technology, possess intangible assets such as technological know-how, marketing and managing skills, export contacts, co-ordinated relationships with suppliers and customers and reputation. This, in turn, could provide them a significant relative advantage in the host developing economy's markets.

On the basis of the two period entry model, in the post-reform period, firms compete in Cournot quantity space in the domestic market. But the in post-reform period, competition can be both in capacities and prices for gaining or retaining market share and preventing further new entry. The ability of the incumbent and new entrant firms to cut prices depends on their relative efficiency (costs). The intensity of price competition depends upon the domestic market size (Sutton, 1991). If the domestic market size is growing more rapidly than the capacities created by the new entrants, competition can be less intense as new entry will be easier and all firms can make profits by increasing sales. If market size increases less rapidly than capacity creation, price and advertising competition can be intense for increasing or consolidating market shares at the cost of the rivals and further entry. A good example of this behaviour is the Two wheeler industry in India. Prior to the reforms, the Indian market was dominated by two major players whose capacities were a lot lower than the potential market (with long waiting periods from booking and delivery of vehicles). After the reforms, quite a few new entrants entered and also incumbents increased capacities as the market increased rapidly till the early nineties. The competition for market share became intense from the early nineties when the increase in the market slowed down. This characterization is valid to other industries such as televisions and automobiles.[8]

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[8] It is necessary to note that price competition is more intense in industries with standardized products than in industries with highly differentiated goods.

The exogenously given relative advantages of incumbents and new entrants in ci and ei s, determine their differential strategies. Asymmetries in c_i and e_i that are endogenously generated by firm's behaviour determine subsequent changes in the relative domestic market shares and export intensity. The competitive process in the post-reforms period induces firms to undertake technological and marketing efforts to shift both e_i and c_i in their favour. To recapitulate, multinational firms which enter with a relatively strong advantage in production costs, may have higher export orientation in the beginning and subsequently may make efforts at enhancing e_j. for dislodging the incumbents from the domestic market by advertising and building market distribution networks.[9] The new entrants may undertake both price cutting and advertisement for increasing and consolidating market shares in the beginning of their entry into the market.

A priori commitment to capacity or sunk costs (without an option of withdrawal in the second period) works as an advantage to the incumbent firm in Dixit's model as it has to make all efforts to safeguard its position in the second period. On the other hand, by taking the path dependency argument (David, 1985; Ghemawat,1991), the entry into the Indian market during the pre-reform period may be a source of disadvantage in the post-reform period if the new entrants come with superior technology and marketing practices. Dosi et al (1991) argue that a firm's accumulation of capabilities and assets is local, cumulative path dependent: the idea of path dependency implies that history matters, and that sunk costs are not bygone. They explain: ``...a firm's previous investments and its repertoire of routines (it's history) constrains it's future

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[9] In other words, if new entrant MNCs have superior techonology they will be in a better position to undertake price competition. In order to face the price competition, incumbent domestic firms have to undertake technological efforts at reducting costs. But in the initial period of operations, new entrants have to realize certain level capacity utilization to make use of their relative advantage in costs. This where exports helps in realizing the capacity utilization.

behaviour. This follows because learning tends to be local. That is, opportunities for successful new developments will be `close in' to previous activities...". In the pre-reform period, large oligopoly firms in most Indian industries were able to derive long run market power owing to the policy regime that heavily protected them from both internal and external competition. This, in turn, facilitated many firms to realize supernormal profits despite being highly X-inefficient in production (Patibandla, 1997). Consequently, the incumbent firms that got used to easy life might not be able to adjust efficiently to new market conditions in the post-liberalization period.[10] Furthermore, incumbent firms might be stuck with outdated technologies and capacities. If new entrants can leap-frog and bring in superior technologies and market practices in the post-liberalization period, incumbent domestic firms may loose out the advantage of being the first entrants. This will particularly be the case if the new entrants are multinational firms. This, in turn, will force domestic firms to alter their capacities and technology and look for export markets. In order to increase exports as a response to new entry, they have to reduce their costs.[11] Furthermore, entry of new firms increases domestic supply which, in turn, reduces the market price. To be able to supply at a lower price in the domestic market and competitive price in the export market, domestic firms have to make efforts towards improving production efficiency.[12]

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[10] If new entrants have the information that incumbents have higher costs, it gives fillip to their entry in the market.

[11] For example, in the light commercial vehicle industry, Tata Engineering and Locomotives Ltd company which is a major domestic firm has been making significant technological efforts to become a major exporter since last few years. It also invested in R&D in developing a new small car model in the Automobile industry. Similarly, in the Two wheeler industry, the Indian firm Bajaj Auto ltd invested in R&D to develop a four-stroke engine scooter which is more fuel efficient than new models brought in by MNCs.

[12] But here the qualifying statement is that if there are tariffs on imports, and if firms face protected domestic and competitive export markets, new entry may not lead to increase in domestic supply and decrease

12

The essential point is that the entry of multinational firms with superior technology, brand names, and managerial practices, and accumulated learning economies through their operations in multi-markets may erode incumbency advantages of domestic firms particularly in knowledge capital intensive industries. In such a case, subsequent market evolution could reverse domestic shares of new entrants and incumbents : while new entrants will become market leaders and incumbents may turn out to be followers.[13] This may induce domestic firms to undertake efforts to reduce costs and increase advertising expenditure and to look for export markets.

In order to enhance their cost competitiveness, domestic firms have to make deliberate technological efforts and increase R&D expenditure.[14] R&D investment may be made for reducing costs of production and for

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in domestic price below $P_w(1+t)$. If all firms are characterized to compete in Cournot quantity space, the increase in supply will be diverted to export markets in order to keep domestic price at $P_w(1+t)$ (Patibandla, 1996).

[13] For example, the multinational firms, Hero Honda company in the two wheeler industry and Maruti Suzuki in the automobile industry became major players within a short period.

[14] Dasgupta and Stiglitz (1988) show that under Cournot oligopoly with barriers to entry increase in the number of firms leads to reduction in R&D expenditure by firms but total industry level goes up. This is because as N increases, firms' profit levels (surplus) go down. In Indian industry this has to be seen in a different manner, because new entrants are more efficient multinationals. If high cost incumbents do not reduce costs, they could be eliminated by more efficient new entrants. Domestic firms that succeed in (R&D) reducing costs are the ones that will survive. If one looks at the qualitative evidence, many domestic firms in the T.V., automobiles and two wheeler industries which could not adjust efficiently to the reforms either exited or became very marginal players.

13

differentiating a product (both outcomes shifts a firm's reaction curve). Firms will also increase advertisement expenditure to enhance brand image and domestic market reputation (e_i). Firms in general may increase advertising expenditure as a response to new entry (especially in consumer goods industries). The increase in advertising expenditure may not only for competing with new entrants but also for making further entry more difficult[15] (Geroski, 1991).[16]

While incumbents increase investment in promotional (marketing and advertising) expenditure to safeguard their market shares in the face of new competition in the post reforms period, new entrant MNCs adopt promotional strategies that reduce their relative disadvantage in dealing with the local market and institutional conditions.[17]

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[15] The nature of response to changed (changing) environment may not be uniform across all domestic firms. Some firms which are used to stagnant (or predictable) environment of the pre-reform period may remain to be risk averse and prone to inertia. Some firms may simply go in for joint collaboration with multinational firms. Some firms may increase in-house R&D towards reducing costs and improving upon the product characteristics and also increase advertisement expenditure. The qualitative evidence shows that quite a few domestic firms have been resorting to joint collaborations with multi- national investment and introduce new products borrowed from developed countries rather than increasing in-house R&D.

[16] Advertisement expenditure might be more towards gaining an edge in the domestic market rather than increasing exports as we assume firms are price takers in the world market.

[17] As the relative advantage of incumbents in terms of accumulated knowledge of the local market and institutional conditions would be with managers, new entrants will try to hijack them from incumbents. A simple proof of this behavior is that since the early nineties, quite a few organizations specializing in head hunting have come up in India.

14

If there are significant technology and knowledge spillovers of foreign direct investment, domestic firms would benefit from this. Domestic oligopoly rivalry through lower costs and positive externalities of MNC investment lead to fall in overall costs at industry level which shifts the market supply curve downward and consequently increase in exports. [18]

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[18] The assumption of price taking in the world market may not hold for the explanation of export behavior of multinational firms. One has to extend the analysis to multimarket oligopoly behaviour as these firms produce in different countries simultaneously. Analysis of export behaviour of multinational firms has to consider underlying strategies of multinational firms in investing in domestic market which requires information on variables such as import tariffs, transport costs, domestic comparative advantage in factor (skilled labour) endowments, domestic market size and multi-market strategies of multinational firms. MNC firms, in specific industries, will be interested in exporting if locating production in India makes a substantial difference to cost of production arising out of India's comparative advantage which, in turn, provides them an advantage in international market oligopoly rivalry. If location of production in host market makes no significant difference to their relative costs, MNC's investment decision will be mainly to serve domestic market by overcoming tariff and transport costs. If capacity made in the Indian market is small, exports will not make a difference to the world market price as volume of exports will be low. Apart from this, investment in capital intensive technology industries is made at small scales, the production advantage through availability of inexpensive skilled labour in the Indian market may not be dominant. For example, given the relatively small size of the domestic market, the investment in automobile industry is generally made at sub-optimal scales. Recently, several multinational firms entered Indian industry through joint ventures (especially in the luxury car segment). India's share of world vehicles sales volume is about 1 per cent and now there are about 18 producers of cars. There is a critical minimum level of fixed investment that has to be made in capital intensive industries. Once investment is made in these industries (with the motive of serving the domestic market), small size of domestic market may force firms to export in order to extend the market size and realize

15

The above analysis is based on the assumption that domestic market demand curve remains unchanged. If domestic demand increases owing to some exogenous factors of increase in incomes, increase in supply owing to evolution of the market structure, new entry and increase in capacity does not lead to increase in exports as the domestic market absorbs increase in supply.[19]

3.   Empirical Analysis

The objective of the empirical exercise is to explain the behaviour of firms in the post-reform (post-entry) period rather than comparing the behaviour across the pre- and post-reform periods.[20] Some of the main propositions of the previous section are tested by examining the econometric explanation of firm level export intensity, domestic market shares by a set of variables such as relative production efficiency, advertisement intensity, ownership (domestic versus new entrant multinationals) and explanation of relative production efficiency by research and development expenditure. The propositions regarding price and advertisement

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optimal scales. This is especially true if there is no exit of firms despite overcrowding in domestic investment (i.e., new entrants do not adopt 'hit and run' strategies).

[19]   This is especially true when firms give priority to serving the domestic market over the export market which is captured by e_i in the profit functions.

Secondly, efficiency levels of firms and industries may depend not only on the micro level technological efforts but also on the industrial growth in general. In a growing domestic market, there could be significant external economies in production to firms. Apart from this, it also facilitates economies of scale in production which enhances the export competitiveness of firms.

[20] The pre-reforms behaviour of Indian oligopoly firms has been well documented in several studies (see Mookherjee, 1995; Ferrantino, 1992; Lall, 1987; Patibandla, 1997).

16

competition between incumbents and new entrants are tested by estimating demand functions and explanation of firm level price realization by relative production efficiency and advertisement intensity variables.

3.1   Data

The empirical analysis is based on firm level panel data for a set of Indian engineering industries. The time period covers 1989 to 1996. The data sources are the publications of the Centre for Monitoring Indian Economy and the Confederation of Indian Industry on the Indian corporate sector firms. We have studied six Indian industries in which there has been noticeable new entry of multinational firms. Since most MNCs have entered the Indian market through joint ventures, firms with 40 per cent and above equity are treated as MNCs. The six industries are:

1. Motor cycles (M)

2. Television sets (TV)

3. Television sub-assemblies (TVSB)

4. Light commercial vehicles (LCV)

5. Electronics process control instruments (EPC)

6. Diesel engines industry (DISL)[21]

3.2   Variables

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[21]   In the motor cycles industry sample, there are five firms out of which two are new entrant MNCs, in the TV industry the break is seven and two; for the television sub-assemblies industry sample the breakup is four and two; for the light commercial vehicles industry the breakup is seven and two, for the electronics process control equipment industry the breakup is five and two and for the diesel industry the breakup is five and two.

TE	relative production efficiency of firms in an industry, (see the appendix for a discussion of the measurement of TE).
DS	domestic market share of firms
E	exports
S	total sales turnover
ES	(E_i/S_i), export intensity of a firm
P	price realized by firms; (sales value/total quantity sold)
Q	quantity of output sold by firms
RDS	(research and development expenditure/value-added).[22]
IMS	(imports of raw materials, intermediate goods and capital goods/ total sales turnover)
D	dummy variable that takes value 1 for new entrant multinationals and 0 for incumbent firms.
ADS	(promotional expenditure/sales): promotional expenditure includes expenditure on advertising, distribution and marketing.
CV	cumulative value-added that captures learning economies in production
V	value-added
L	salaries and wages as labour input
K	rental value of capital,, $(TK*r) + DP$, where *TK* is gross fixed assets, *r* is the bank lending interest rate, and *DP* is depreciation.
Y	national income (net national product) at constant prices
GFA	gross fixed assets

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[22] This variable captures only a limited dimension of technological efforts of firms as it is based on the book value of R&D expenditure. Firms do undertake deliberate technological efforts on the shop floor towards improving efficiency with varying intensity which may not captured by this variable. The other drawback of this variable is that several Indian firms report R&D expenditure figures just to avail of the tax incentives.

The arguments regarding e_i of Section 2 are captured to some extent by the promotional expenditure variable (ADS) and also the ownership dummy variable (D). Promotional expenditure, which includes advertising, marketing, and distribution enhances domestic reputation. Multinational firms' international reputation is an intangible asset in the domestic economy. Incumbent domestic firms' accumulated experience of market and institutional conditions specific to the Indian economy is an intangible asset.

3.3.   The Hypotheses and the Results

Proposition: New entrant MNCs export at higher intensity than incumbents.

Table 1 presents the results for the explanation of firm level export intensity for the six industries. The signs of the estimated coefficients of variable (D) shows that except in the case of motor cycles and television sets, the new entrant MNCs have higher export orientation. Motor cycles and TV industries are consumer goods industries. The motor cycle industry is an interesting case as this is one-of the few industries that had been subjected to the entry of new MNCs since the mid 80s (early in the policy reform period) and has been subject to severe competitive pressures. As mentioned in the previous section, the industrial policy reforms such as removal of industrial licensing policies and liberalizing of entry of MNCs of the 80s led to increase in domestic demand by removing capacity constraints. Consequently, new entrants such as Honda and Suzuki have been able to become major players within a short period. Apart from this, the brand recognition of Honda and Suzuki in India is high (the relative advantage of new MNCs in e_i) which helped to establish themselves in the Indian market quite quickly. The growing domestic market makes entry and growth of new firms easier. As a result, new entrants did not have to depend on exports in the initial years for capacity utilization. As new entrants gain domestic market shares, incumbents are forced to increase their export orientation which can be supported by the result of negative association between domestic market shares and export intensity for these two industries. A similar explanation hold true for the TV industry.

Industries/ Independent Variables	M	TV	TVSB	LCV	EPC	DISL
Table 1: Explanation of Exports (EX)						
Constant	0.043 (3.7)*	0.09 (4.5)*	-0.0098 (0.37)	0.03 (3.0)*	0.021 (2.57)*	0.006 (0.15)
DS	-0.029 (1.46)**	-0.16 (2.15)*	0.069 (1.76)**	0.10 (2.38)*	0.13 (7.3)*	0.35 (3.15)*
D	-0.02 (2.3)*	-0.079 (2.4)*	0.111 (2.6)*	0.08 (2.5)*	0.052 (1.6)**	0.07 (1.2)
D x DS	-	-	-0.64 (1.85)**	-2.5 (1.71)**	-0.32 (0.8)	-0.73 (1.4)
R^2	0.14	0.14	0.22	0.18	0.67	0.31
F	2.9	3.8	1.96	3.2	1.8	4.6
N	40	52	25	49	30	34

Figures in the parentheses are 't' values.

* Significant at 0.01 level.

** Significant at 0.05 level.

The dynamics associated with changes in the domestic market share and its implications on export intensity is captured by the interactive variable ($D*DS$). In econometric estimations, the use of interactive variables can cause multi-colinearity which causes high standard errors and also may give wrong signs to the estimates. Because of this, we have used the interactive variables selectively for the samples: wherever it has shown lower multicolinearity. The negative sign of the estimate of the interactive variable in the case of TVSB and LCV industries in combination with the positive sign of the estimate of the domestic market share variable implies that as the new entrant MNCs gain domestic market share, their export intensity declines. This result is consistent with the theoretical arguments of the previous section.

Proposition: Promotional expenditure (advertising, marketing and distribution) is more important for new entrant (presumably more efficient) MNCs in gaining domestic market share. Assuming the incumbents are less production efficient than new entrant MNCs, increasing relative production efficiency is more important for incumbents for competing with new entrants.

Tables 2A and 2B present the results for the explanation of domestic market shares in linear and log linear forms. The estimated coefficient of relative technical efficiency variable (TE) is positive and statistically significant for all the six samples which implies higher production is crucial for gaining domestic market share.[23] This reflects the movement of Indian industry from a non-competitive environment of the pre-reform period to a more competitive market structure in the post-reform period. Firms with higher production efficiency are the ones that could charge competitive prices (price competition) and supply higher quality

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[23] In order to test for the validity of characterization of oligopoly competition in quantity space, the profits to sales ratio is regressed against domestic market shares for all the industries. The results show a highly statistically significant positive sign for the estimates. This means that the model used in Section 2 is a good proximation.

Table 2A: Econometric Explanation of Domestic Market Shares (DS)						
Industries/ Independent Variables	M	TV	TVSUB	LCV	EPC	DISL
Constant	0.11	0.036 (3.9)	0.47 (1.7)**	0.1 (1.5)**	-0.24 (1.3)	-0.03 (0.46)
TE	0.82 (3.19)*	0.09 (0.62)	0.84 (2.29)*	0.3 (4.2)*	1.24 (3.9)*	0.22 (1.5)**
ADS	-9.5 (6.2)*	2.8 (1.6)**	8.3 (3.7)*	-1.14 (0.9)	-8.56 (3.6)*	11.1 (4.5)*
D	-0.031 (0.10)	0.02 (0.08)	0.67 (1.8)**	-	-0.8 (4.7)*	0.007 (0.11)
D x TE	-0.78 (2.13)	-0.18 (0.28)	-1.04 (1.4)	-	-	-
D x ADS	0.43 (1.7)**	-3.0 (0.5)	-8.69 (2.8)*	-	33 (2.14)*	-12.9 (2.6)*
R²	0.63	0.19	0.68	0.1	0.51	0.6
F	11.5	2.09	83	1.2	6.6	15.0

Figures in the parentheses are 't' values.
*   Significant at 0.01 level.
** Significant at 0.05 level.

Table 2B: Econometric Explanation of Domestic Market Shares : Log Linear (Log DS)						
Industries/ Independent Variables	M	TV	TVSUB	LCV	EPC	DISL
Constant	-3.9 (4.1)*	0.5 (0.4)	6.6 (1.6)	-6.4 (12.9)*	-5.4 (5.0)*	-3.4 (8.1)*
Log TE	2.47 (2.7)*	0.91 (2.7)*	1.6 (1.97)**	0.6 (2.3)*	6.2 (5.0)*	0.57 (2.67)*
Log ADS	-0.96 (3.6)*	0.53 (1.47)**	2.42 (4.86)*	-0.15 (1.5)**	-1.16 (5.4)*	0.11 (1.6)**
D	1.9 (0.5)	-6.3 (1.5)**	-9.8 (4.5)*	-2.7 (1.7)**	3.8 (1.5)	-
D x Log TE	-2.28 (1.6)**	-2.1 (1.8)**	-2.0 (1.97)**	-	-5.2 (2.8)*	-
D x Log ADS	0.98 (0.93)	-0.76 (0.69)	-2.58 (3.7)*	-0.79 (1.6)**	1.5 (3.6)*	-
Log GFA	-	-	-	0.73 (18)*		0.7 (9.8)*
R^2	0.37	0.33	0.66	0.89	0.6	0.77
F	4.0	4.5	7.46	132	6.7	34
Figures in the parentheses are 't' values. * Significant at 0.01 level. ** Significant at 0.05 level.						

products. The relation between price and relative production efficiency and advertisement (product differentiation) is captured by the estimation of demand function which is discussed later.

In the case of LCV and DISL industries, the explanation of domestic market shares by *TE* and *ADS* becomes statistically significant only when we introduce gross fixed assets as an additional explanatory variable in explaining domestic market shares. One of the plausible explanation for this is that, in these industries, the technological conditions may necessitate investment in high fixed and sunk costs (the exogenous sunk costs argument of Sutton) and it is necessary to capture this dimension in the econometric estimation.

In the case of M, LCV, and EPC industries, the estimated coefficient associated with the promotional expenditure variable (*ADS*) has negative sign which is rather counterintuitive. One possible explanation for this can be derived from the advertisement fatigue argument: excessive advertising could be counter-productive. A more plausible explanation can be drawn from Sutton's argument of endogenity of advertisement expenditure by firms which causes a two-way causality between market shares and advertisement expenditure. In the post entry period, firms that lose market shares might be the ones that increase advertisement expenditure. As incumbents firms lose out market shares to more efficient new entrant MNCs, they would increase advertising expenditure in order to safeguard their market shares.

The interactive variables (*D*TE*) and (*D*ADS*) capture the strategic behaviour of incumbents and new entrants in gaining (protecting) market shares through higher production efficiency and promotional expenditure (the argument of e_i in the previous section). The positive sign of the estimated coefficient of the *TE* variable and the negative sign of the estimated coefficient of the interactive variable (*D*TE*) for the three industries, (M, TV and TVSB) implies that increase in efficiency is more important for incumbent firms in increasing (or safeguarding) their shares in response to increased competition from the entry of more efficient MNCs. The estimate associated with the interactive variable (*D*ADS*) is statistically significant in three cases, M, TVSB and EPC. In the case of M and EPC industries, the sign of the estimate is positive which implies that

increasing promotional expenditure by new entrant MNCs contributes positively to their domestic market share. In the case of the TVSB industry the sign is negative. In the television industry, in general, advertising appears to be relatively more important and there may not be a much of a difference between domestic and new MNCs in their advertising behaviour as it is a consumer goods industry. The results, in essence, indicate that increasing production efficiency is more important for incumbent firms while increasing promotional expenditure is more important for new entrants supporting the propositions of the model.

India's markets are considered highly price sensitive given the relatively low income levels. Ability of firms to undertake price competition depends on their relative production efficiency: firms with higher production efficiency could charge lower price. We tried to examine this issue by estimating demand functions for the industries which can be used to bring out the relation between price charged by firms and their relative technical efficiency of production and advertising intensity. Table 3A shows the results of the estimated demand function: national income variable (Y) is introduced to identify it as the demand function. Table 3B presents the results for the estimation of the inverse demand function in which the relation between price and relative technical efficiency is established. The results show high statistical significance and the signs of the estimated coefficients indicate that the equations are correctly specified (identified). In the case of M, TV, TVSB and EPC industries, the price elasticity of demand is greater than 1; in the case of motor cycle industry it is 2.03 indicating the importance of price competitiveness in India's markets. The income elasticity of demand is also very high in most cases indicating the importance of growing domestic market for sales. In the television industries, (TV and TVSB), the estimate of the advertising intensity variable is statistically significant and is of positive sign supporting the observation made earlier about the importance of advertising in consumer goods industries.

The results in Table 3A show that only in the motor cycles industry there is statistically significant negative association between price and relative technical efficiency. In other cases, the estimates shows a positive sign. One possible explanation for this is that firms that could realize higher efficiency are the ones that are able to

Table 3A: Demand Function: Log Linear (Log Q)						
Industry/ Independent Variables	M	TV	TVSUB	LCV	EPC	DISL
Constant	-37 (3.5)*	-3.6 (0.5)	14 (1.3)	-13 (1.14)	-30 (1.9)**	-30 (2.3)*
Log P	-2.13 (4.3)*	-1.06 (4.8)*	-1.64 (5.7)*	-0.99 (1.5)**	-1.07 (18.4)*	-0.92 (7.5)*
Log ADS	-0.10 (0.43)	0.66 (2.34)*	1.85 (4.0)*	-0.42 (1.33)	-0.65 (3.9)*	-0.025 (0.19)
Log Y	6.9 (4.0)*	1.6 (1.6)**	0.8 (0.48)	2.9 (1.35)	4.9 (1.96)**	5.4 (2.75)
R^2	0.40	0.37	0.66	0.17	0.93	0.68
F	7.6	9.5	13.0	3.2	120.0	21.0

Table 3B. Inverse Demand Function: Log Linear (log P)

Industry/ Independent Variables	M	TV	TVSUB	LCV	EPC	DISL
Constant	1.68 (4.7)*	3.0 (5.3)*	3.85 (1.75)**	3.5 (10)*	-0.01 (0.06)	3.7 (3.7)*
Log Q	-0.10 (2.16)*	-0.30 (4.6)*	-0.38 (2.16)*	-0.33 (3.5)*	-0.49 (14.6)*	-0.68 (6.68)*
Log TE	-0.42 (1.86)**	0.57 (5.57)*	-0.33 (1.1)	0.40 (2.6)*	0.02 (0.07)	0.44 (1.17)
Log ADS	0.22 (2.6)*	0.36 (2.9)*	0.88 (1.96)**	0.16 (2.3)*	-0.20 (2.0)	-0.081 (0.63)
D^2	2.82 (2.45)*	1.2 (1.0)	-0.04 (0.02)	1.5 (1.4)	5.8 (10.3)*	-
D^2 * Log ADS	0.81 (2.4)*	0.3 (0.91)	0.06 (0.11)	-0.5 (1.5)	0.24 (1.76)**	-
Log GFA	-	-	-	0.28 (3.9)*	-	-
R^2	0.42	0.62	0.70	0.48	0.98	0.61
F	4.9	15.5	9.1	6.5	107	16

produce higher quality products and are in a position to charge higher price. This is especially the case when a relatively efficient firm is able to realize higher quality product for a similar level of factor inputs employed compared to a relatively inefficient firm: a higher quality product fetching higher price will reflect in higher output value (price * quantity of sales) which, in turn, reflects higher technical efficiency in production. This is especially true when higher quality of output does not mean higher amount of inputs in comparison to a relatively inefficient firm.

As far as the advertising intensity variable is concerned, the estimates are statistically significant in most cases and have positive sign. The interactive variable ($D*ADS$) captures the issue whether higher advertising intensity by new MNCs (or domestic firms) leads to less price cutting. The estimate of the variable is statistically significant only in two cases, M and EPC. The positive sign of the estimates implies that new MNCs are able to realize higher price by undertaking advertising expenditure: higher advertising (promotional) expenditure helps in avoiding price cutting competition.

Proposition: Deliberate technological efforts in the form of investing in R&D for increasing production efficiency is more important for incumbent firms than for the more efficient new entrant MNCs.

Table 4 presents the results for the econometric explanation of relative technical efficiency in production by variables such as R&D intensity of firms. The *RDS* variable captures the deliberate technological efforts of firms for improving production efficiency in a competitive environment. In the case of TV and EPC industries, firms hardly invest in R&D (as reported in the published data). Another source of improving upon production efficiency in these industries is imports of raw materials, intermediates and capital goods. This appears to be especially valid for the television industry where domestic and new MNCs appear to depend on imports significantly. Therefore, in the case of TV and EPC industries, the import intensity variable is introduced as a substitute for the *RDS* variable in explaining *TE*.

Industry/ Independent Variable	M	TV	LCV	EPC
RDS	12.4 (3.2)*	-	6.5 (5.4)*	-
IMS	-	0.59 (1.6)**	-	-1.3 (2.57)*
CV	0.00021 (2.9)*	0.00013 (3.0)*	0.0001 (3.79)*	0.00012 (2.6)*
D	0.7 (5.9)*	0.12 (1.13)	0.54 (5.54)*	0.06 (0.39)
DxRDS	-14 (1.6**	-	-20 (1.35)	-
DxIMS	-	-0.92 (1.5)**	-	1.38 (2.2)*
R^2	0.20	0.19	0.18	0.59
F	2.9	2.8	2.4	9.19

Table 4: Econometric Explanation of Relative Technical Efficiency in Production (TE)

The results show statistically significant positive explanation of relative efficiency in production by the RDS variable. The statistically significant positive sign of the estimated coefficient associated with the dummy variables (D) in the case of M and LCV industries implies that new entrant multinational firms have higher production efficiency. An interesting aspect of the results is that the negative sign of the estimated coefficients associated with the interactive variables $(D*RDS)$ which implies that research and development expenditure is more important for incumbent firms to realize higher TE than for new entrant multinationals. This result supports the argument of Section 2 that new entrant multinationals enter the domestic market with superior technology (superior technology generated through R&D expenditure incurred in the home country) and do not have to invest in R&D in the host developing economy. Whereas domestic incumbent firms, in order to compete with new entrant multinationals, have to invest in technological efforts towards improving production efficiency. This is evident from qualitative evidence also that domestic firms like TELCO in the LCV industry and Bajaj Auto in the two wheeler industry have increased their R&D efforts during the last few years significantly.

In case of the TV industry, import intensity explains production efficiency positively and significantly. The negative sign of the estimated coefficient of the interactive variable $(D*IMS)$ implies that increase in imports for improving efficiency is more important for incumbent firms than for new entrant MNCs. This is a reasonable explanation as domestic firms in the TV industry compete with new entrant MNCs by increasing their import intensity of technology and intermediate goods. The results for the EPC industry are on the contrary: it appears imports are a major source of efficiency more for new entrant MNCs rather than for incumbent firms.

The cumulative value-added (CV) variable captures possible learning economies in production. The statistically significant positive sign of the estimate of the CV variable shows that learning economies are important in realizing higher production efficiency. In other words, it is important (especially for new entrants) to realize learning economies to gain production efficiency and consequently higher market shares.

24

4. Conclusion

The industrial policy reforms initiated in India in the mid 80s removed of industrial licensing and liberalized the entry of multinational firms. Entry of multinational firms into Indian industries has important implications on the evolution of the domestic market structure. This paper has adopted a simple industrial organization theory in tracing out the evolution of the domestic market structure by considering asymmetries in terms of time of entry and costs of production and firm specific intangibles under oligopolistic competition. The Spence-Dixit model of sequential entry is adopted as a reference point in tracing out the possible dynamics of evolution of the market structure. The propositions of the theory are empirically verified by econometric exercises on the basis of firm level panel data for six Indian industries for the period 1989 to 1996.

The model shows that, if there is symmetry in costs and intangible assets of firms, new entrants will behave as followers in the domestic market and will have higher export orientation. This is an important factor if the market conditions specific Indian markets are important. This implies that, apart from cost efficiency, learning related Indian demand conditions and institutions is important for new MNCs for penetrating the Indian market. The incumbent firms, however, are more familiar with the Indian market. For new entrant MNCs, exports at the earlier stages helps in realizing minimum inefficient scales as they make efforts at enhancing upon on their market share in the Indian market. If the domestic market is growing rapidly, entry and growth of new firms will be easier which implies exports by new entrants at the initial years will not be necessary. The results of the empirical analysis support this observation. In industries such as the motor cycles and television sets which have had a rapidly increasing Indian markets, new entrants show lower export intensity compared to domestic firms. In industries such as light commercial vehicles , television sub-assemblies, and electronics process controls, new entrant MNCs have higher export orientation. Secondly, if new entrants are

able to enter and establish themselves in the host Indian market quickly, incumbent firms may be pushed to increase their exports in order to extend the market size as they accommodate new entrants.

As recorded in several previous studies, during the pre-reform period a firm's ability to capture higher market share was dependent more on its lobbying abilities with government for licenses and other rent seeking activities rather than its relative production efficiency. The positive explanation of domestic market shares of firms by their relative technical efficiency in production, in all the six industries studied, is an evidence of increased competitive conditions of the domestic market after the reforms. The Indian market is generally observed to be highly price sensitive given the relatively low income levels. The results show that the price elasticity of demand is high in general. In the motor cycles industry, firms with higher production efficiency are able to reduce price to compete in the domestic market. The results also suggest that increased advertisement expenditure appears to help firms to protect high prices.

The positive explanation of relative production efficiency of domestic firms by research and development expenditure indicates that domestic firms have to make deliberate technological efforts towards improving their production efficiency in order to face increased competitive conditions. Deliberate efforts at enhancing production efficiency through investment in research and development appears to be more important for incumbents than the relatively more efficient new entrant MNCs (as a response to the increased competitive conditions).

One of the consequences of the increased domestic market conditions is increase in exports, especially by the incumbents. Increase in domestic competition through increase in the number of players and consequent increase in relative production efficiency results in expansion of total industry sales. Consequently, given the domestic demand curve (the domestic market size) and the competitive world price, firms, especially the domestic ones, may expand their exports as a price discriminatory strategy. This is particularly valid when the

domestic market continues to be protected from imports which provides an incentive for oligopoly firms to keep domestic price higher than world price through price discrimination.

There will be an overall general pattern of behaviour of firms across different industries because of importance industry-specific conditions. This paper shows a few important common behavioural patterns of incumbent and new entrant firms in Indian industries in the post reforms period.

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Appendix

Measurement of Production Efficiency

Firm level efficiency indices are measured on the basis of Farrell's (1957) production frontier approach. Recent developments in the efficiency frontiers literature show the derivation of plant-specific time-variant technical efficiency indices by using panel data. The production function defines the maximum possible output a firm can realize for a given level of inputs employed and the technology level. Farrell's method shows relative technical efficiency as the extent of deviation of output realized by a firm (for a given level of inputs employed) from the best practice in an industry.

The panel data techniques of measuring efficiency overcome several well known shortcomings of the estimates based on cross-sectional data (see Pitt and Lee, 1981). The panel data capture cross-sectional information of firms in an industry and also repeated observations over time for a given firm. This, in turn, overcomes the shortcomings of strong distributional assumptions about composed error terms. Furthermore, this method does not impose the assumption that technical efficiency is independent of factor inputs.

29

By taking the Cobb-Douglas functional form, we can represent the technology as follows;

$$Y_{it} = \alpha + \beta X_{it} + v_{it} - u_i \tag{13}$$

where Y_{it} is the observed output, X_{it} is a vector of K inputs: i index firm (i=1....N): t index time (1....t). a and β are the unknown parameters to be estimated. v_{it} represents random errors. u, (u, ³ 0) represents technical inefficiency with one-sided distribution which means that output must lie on or below the frontier.

The random error v_{it} is assumed to be identically and independently distributed across firms and time with identical zero mean and constant variance. It is also assumed to be un-correlated with factor inputs. The other error component, u_i, is assumed to be independently and identically distributed across plants with mean m and variance s_m^2.

We can rewrite the above equation (13) as

$$Y_{it} = (\alpha - u_i) + \beta X_{it} + v_{it} \tag{14}$$

Cornwell et al (1990) introduce a parametric function of time into the production function to replace the coefficient of plant-specific technical efficiency. The functional form is

$$Yit = Xit \beta + \alpha it + vit \tag{15}$$

where

$a_{it} = w'_{it} \, 0_i, \quad w' = (1, t, t^2), \quad 0_i = (0_{i1}, 0_{i2}, 0_{i3})$

and other variables are as defined before.

30

The model allows the rate of productivity to vary over time and firms. The production function can be estimated by OLS, which is referred to as the `within estimator' in the literature (Krishna and Sahota, 1991). The residuals of the estimated function are used in deriving the efficiency indices. OLS estimation of the production function can be justified in terms of the Zellner-Kmenta-Dreze proposition that, under the assumption of maximization of expected profits, the explanatory variables and the disturbance term are un-correlated. However, α'it is not consistent as T goes to infinity if factor inputs are correlated with firm and time specific effects. Under these conditions, the consistent estimators of α'it, as time goes to infinity, can be derived by estimating equation (3) using OLS directly (see Liu, 1993). The production function is estimated by the two input Cobb-Douglas functional form with value-added as output, and L and K as inputs. Table 5 provides the econometric results for the estimated production function for the six industries.

Table 5: Estimated Production Function (Log V)						
Industry/ Independent Variables	M	TV	TVSB	LCV	EPC	DISL
Constant	2.03 (3.4)*	326 (2.48)*	223 (1.0)	323 (2.9)*	152 (0.68)	177 (0.75)
t	-4.4 (3.5)*	-6.98 (2.45)*	-4.7 (1.0)	-6.9 (2.98)*	-3.2 (0.67)	-3.84 (0.75)
t^2	0.024 (3.6)*	0.037 (2.44)*	0.02 (1.0)	0.037 (2.97)*	0.017 (0.67)	0.021 (0.77)
Log L	0.16 (2.13)*	0.34 (2.7)*	0.69 (2.42)*	0.60 (5.7)	0.63 (3.4)	0.70 (5.2)*
Log K	0.77 (11.5)*	0.58 (4.1)*	0.37 (3.27)*	0.30 (2.3)*	0.30 (1.7)**	0.23 (1.6)**
R^2	0.96	0.89	0.84	0.96	0.96	0.89
F	254	95	26	332	186	61