Impact of Firms' Technology Strategies on Market Competition: Experience from Selected Industries of Indian Manufacturing Sector during the Post-Reform Period

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Abstract

In India, the process of economic reforms during the last two and half decades have increased competitive pressures on firms resulting in adoption of a variety of strategies for their survival and growth. While the trends and patterns of these strategic responses in general have varied widely across the major industries of Indian manufacturing sector as well as over time, technology strategies seem to have undergone considerable changes in recent years in respect of both its nature and intensity. In this context, the present paper is an attempt to examine how the technology strategies on market structure of technology intensive industries of Indian manufacturing sector. Using panel dataset for selected industries of Indian manufacturing sector and applying the system generalized method of moments (GMM), the present paper finds that market concentration or firms' dominance is higher in industries where the market is already concentrated or dominated by a few firms, selling efforts are higher or financial performance is better. On the other hand, market is found to be less concentrated or dominated for industries that are more open to international trade. Importantly, it is found that both technology strategies and mergers and acquisitions do not have any significant impact on market structure. Thus, the findings of the present paper have important implications for fine tuning of policies relating to technology development, international trade and competition, especially in respect of their inter-relationships.

Keywords: Economic Reforms, In-house R&D, Foreign Technology Purchase, Mergers and Acquisitions, Market Concentration, India

(The views expressed in this paper are strictly the author's personal and do not have any association with Institute where he works The author is thankful to Mr. Aman Mahawar for his excellent support in compilation of the data. Usual disclaimers apply.)

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Introduction

The existing literature on competition is based on two predominant views, viz., the static and the dynamic view of competition. While the static view considers competition as *a state of affairs* leading to optimum allocation of resources for a given set of technological opportunities (Baldwin, 1998), the dynamic competition is generally seen as technology driven rivalry *for markets* rather than price and output-based competition *within market* (Schumpeter, 1950). Unlike the postulation of the static model of competition, where price (output) becomes the main (if not its only) choice variable, firms are engaged in a continuing dynamic process of competition. Such continuous dynamic process of competition results in creation and adoption new products and processes to gain a competitive advantage over the rivals (Kirzner, 1973; Shackle, 1971).

Evidences suggest that increasing pace of innovation since the 1980s has shortened the product lifecycles leading to dynamic competition among businesses, especially within the technology-intensive industries (Bettis and Hitt, 1995; Nault and Vandenbosch, 1996; Evans and Schmalensee, 2001). Hence, competition should be viewed as a dynamic process of rivalry where firms' technology strategies play a crucial role (Vickers, 1995)[2]. However, greater competition and consequent threats to survival and growth also force firms to develop and adopt new technologies. Furthermore, other strategies like advertising and business restructuring, and changes in public policies and regulations can also affect the nature and intensity of competition significantly, particularly when the players strive to influence market conditions strategically.

Although static competition is often favoured by the antitrust economists, dynamic competition relies on innovation to produce new products with new processes. It is argued that dynamic competition improves productivity, availability of new goods and services, and hence consumers welfare. All these are expected to deliver better products at lower prices. In addition, innovation based competition also helps in achieving allocative efficiency. This is very important considering that monopolistic markets are associated with misallocation of resources and hence loss of social welfare. The neo-Schumpeterian framework for antitrust analysis focuses on dynamic competition and puts less weight on market share and concentration in assessing market structure (Seedak and Teece, 2009)[3].

[2] According to Hayek (1948), competition is a dynamic process by nature.
[3] Instead, the framework emphasizes more on assessing potential competition and capabilities of firms (Seedak and Teece, 2009).

More importantly, firms can be at non-trivial operational risks if they lose in the technology race, especially in technology-driven competitive industries. Thus, technology competition is a critical determinant of industry dynamics. Evidences suggest that in-house R&D efforts have positive effects on firms' productivity (Cuneo and Mairesse, 1984; Griliches, 1984) and stock prices (Griliches, 1984; Pakes, 1985). Lack of tradability of innovation outcomes can play a crucial role in this regard (Dierickx and Cool, 1989). It is also found that innovation intensifies product competition and lowers the profits and values of the existing firms (Garleanu, et al. 2009). However, incapable firms with obsolete technologies may suffer with development or acquisition of new technologies by the rivals in the long-run (Greenwood and Jovanovic, 1999; Hobijn and Jovanovic, 2001).

However, while innovations have important strategic implications for individual firms and can influence the industries as a whole, all technological changes are not necessarily strategically beneficial (Porter, 1985). This is so because the strategies to cope with a changing competitive environment are associated with firms' capabilities (Barney, 1986; Cool and Schendel, 1988; Penrose, 1959; Wernerfelt, 1989), which are crucial for amalgamation of technologies, organisational capabilities, experiences and relationships (Fahy, 1996; Reed and DeFillippi, 1990). Further, standards can also affect the market competition during the course of innovation diffusion (Hawkins et al., 1995; Wonglimpiyarat, 2005). Hence, development of appropriate technologies is crucial for the firms to influence market structure.

Although competitiveness and performance of firms in an industry are largely affected by their technology strategies, the choice of technology itself is influenced by the regime in which the firms operate. Similarly, the mode of technology development is determined by several industry as well as firm level factors and policies and regulatory structure of the government. When competition increases and the required technology is less related to the core technology, firms prefer acquisition of the same from external sources (Kurokawa, 1997). On the other hand, TRIPS induced competition seems to have forced the firms towards in-house R&D (Pradhan, 2003).

Thus, there are two strands of views on impact of technology strategies on market structure, especially in the technology-driven industries. On the one hand, it is argued that technological competence of a firm enhances its competitiveness and thereby the likelihood of survival under competitive market conditions. This limits the scope for emergence of monopoly power. On the other hand, there are apprehensions that technology strategies,

especially of the larger firms may result in emergence monopoly power. However, in addition to innovation and technology, structure of market is also influenced by policies relating to international trade, particularly in respect of import of capital goods and other technologies and export of final goods.

In India, the process of economic reforms during the last two and half decades have increased competitive pressures on firms resulting in adoption of a variety of strategies for their survival and growth. While the trends and patterns of these strategic responses in general have varied widely across the major industries of Indian manufacturing sector as well as over time, the technology strategies seem to have undergone considerable changes in recent years in respect of both its nature and intensity (Basant and Mishra, 2016). It is observed that in-house R&D intensity has seen considerable growth in many of the industries. Similarly, foreign technology purchase intensity also shows an increasing trend over the years. In particular, purchase of disembodied technology from abroad has increased. Notably, while increasing emphasis on indigenous technology development through in-house R&D has important implications for market competition, such efforts in Indian manufacturing sector are still very low, particularly when compared with the intensity of foreign technology purchase. Further, emphasis on sourcing foreign technology vis-à-vis in-house R&D differs widely across major industries of Indian manufacturing sector[4].

On the other hand, increase in FDI inflows, particularly through mergers and acquisitions (M&A has widened the scope for equity linked transfer of foreign technologies. A considerable portion of FDI inflows especially since the late 1990s has taken the route of acquisition[5]. Given that the MNCs have superior production technology and management know-how (Ramstetter, 1999), such technology transfers can affect the structure of different markets[6]. It is also expected that technology externalities coupled with emerging competitive threats would force other firms to innovative new products, processes and practices for their survival and growth. Hence, there are possible complementarities between technology transfer and in-house R&D leading to greater competitiveness, especially of the domestic firms, and thereby restricting degree of sellers' concentration or dominance in the market.

All these raise an important question: How have firms' technology strategies affected structure of different markets of Indian manufacturing sector during the post-reform period?

[4] Details in this regard are available in Basant and Mishra (2016).
[5]According to Rao and Dhar (201), acquisition of shares by the foreign investors has been around two-fifths of the total FDI equity inflows into India during 2005-07.
[6]Besides, the MNCs also have established brands and sophisticated marketing networks which help them in greater market penetration.

Although there are some studies (e.g., Mishra and Behera, 2007; Mishra, 20015) that have attempted to examine the impact of firms' technology strategies (along with other factors) on market structure, they in general suffer from the problem of methodological limitations and choice of appropriate index of market structure. The present paper is an attempt to fill in this gap. Hence, the objective of the present paper is to examine the impact of firms' technology strategies on market structure. It is expected that such an effort would provide useful insights for fine tuning the policies relating to international trade and competition, and regulation of intellectual property rights, especially in respect of their interrelationships[7].

The paper is organized in five sections. The next section specifies the econometric model. Possible impacts of the independent variables on the dependent variable (different proxies of market structure) are also hypothesized in this section. The third section of the paper discusses the estimation techniques applied and sources of data used along with measurement of the variables. The regression results are presented and discussed in the fourth section. The fifth and final section of the paper summarises the major findings and highlights their policy and regulatory implications.

Model Specification

In the present paper, the econometric model is specified following the structure-conduct performance (SCP) framework based on Scherer and Ross (1990). Here, the SCP framework is preferred to other available alternatives[8] due to its consistent theoretical underpinnings for empirical analysis. Being based on neoclassical theory, the framework analyzes how firms' business strategies affect the structure of relevant markets. Given the recent developments in the framework, it is assumed that the structure of a relevant market is determined by its other structural aspects, firms' business strategies, their financial performance and policies and regulatory system of the government. Accordingly, the following relationship is envisaged:

$$STRUC_{it} = f(STRUC_{i,t-1}, MSZ_{it}, KIR_{i,t-1}, SELL_{it}, R\&D_{i,t-1}, FTP_{i,t-1}, M\&A_{i,t-1}, OPEN_{it}, PER_{i,t-1})$$

Here, size of the market (MSZ) and capital intensity (KIR) are expected to capture other structural aspects of a market, whereas selling intensity (SELL), in-house R&D intensity

[7]This is also necessary in the context of the amendments to the Indian Patent Act since the late 1990s that were expected to provide greater market power to the innovative firms and enhance their incentives to innovate.
[8]Some of the alternative approaches to industrial organization literature include the Marshallian School, the Austrian School, and the `Workable Competition' School, etc. See Reid (1987) for a discussion in this regard.

(R&D), foreign technology purchase intensity (FTP), and the number of mergers and acquisitions (M&A)[9] proxy for firms' strategic behaviour. On the other hand, trade openness of an industry (OPEN) and financial performance (PER) are included to capture the impact of trade related policies of the government and firms' business performance respectively. In addition to trade openness, some other independent variables also act as the proxies for various policy and regulatory changes by the government. For example, while the number of mergers and acquisitions are considered as partly the outcomes of the investment and competition policies, in-house R&D intensity and foreign technology purchase intensity are likely to capture the effects of policies relating to technology development including regulation of intellectual property. One may also expect capital intensity to capture effects of trade and technology related policies. Further, lagged dependent variable is also added as one of the independent variables to analyze the market structure in a dynamic context.

The present paper uses two alternative measures of market structure, viz., the Herfindahl-Hirschman Index of market concentration (HHI) and Index of market dominance to confirm robustness of the findings. Although the HHI is widely used to measure the degree of sellers' concentration in a market, it is found that the results vary across alternative additive measures (e.g., Mishra et al., 2011; Mishra and Rao, 2014). This so possibly because the additive measures provide weighted average of market shares as the measure of market concentration and the results are likely to differ depending on the weights used. Unlike the additive measures of market concentration, the dominance index, as suggested by Kwoka (1977), captures the distribution of market shares of different firms in an industry. More importantly, the dominance index is based on market shares of the immediate competitors instead of all the players in a market. Given that the distribution of market share in many industries of Indian manufacturing sector has longer tails, the smaller firms are unlikely to have any considerable impact on market structure. Hence, one may expect the dominance index to provide better insights on structure of a market.

Like market structure, the present paper also uses two alternative measures of technology strategies – (i) in-house R&D intensity and foreign technology purchase intensity separately, and (ii) the ratio of in-house R&D intensity to foreign technology purchase intensity. While the first measure captures the impact of technology strategies linearly, the second measure is expected to combine the impacts of different technology strategies in a non-linear fashion. Hence, the consistency in the econometric results is likely to make the findings more robust.

[9]In the present paper, no distinction is made between mergers and acquisitions as their effects are largely the same from an economic perspective.

Possible Impact of the Independent Variables:

The present paper estimates the above econometric model at industry level. However, a similar model can be estimated to examine the relationships at firm level as well. What follows next is a brief discussion on the possible impacts of the independent variables on the structure of different markets.

Lagged Market Structure ($STRUC_{t-1}$): Impact of firms' technology strategies on market structure is likely to depend on its initial level. One may expect the technology strategies to increase concentration or dominance further in the markets that are already concentrated or dominated by a few firms. This is so because the leading firms in such markets have the capacity to enhance their market power through innovation or technology acquisitions. There are evidences (e.g., Mishra, 2015) of direct relationships between the lagged and current degree of sellers' concentration in a market.

Current Market Size (MSZ_t): Larger markets are typically associated with more elastic demand (Barron et al., 2008), and hence have limited scope for increasing market concentration through technologies strategies. Further, larger size of a market is also likely to encourage entry of new firms (Ghosh, 1975; Bhattacharya, 2002). Thus, one may expect larger markets to be less concentrated or dominated. However, when the new firms enter into such markets through acquisitions, market structure may not change. On the other hand, a larger market may have greater degree of sellers' concentration when new entry is restricted, but there is no regulation on expansion of the existing firms. Impact of market size on structure of a market, therefore, depends on the relative strength of these diverse forces.

Lagged Capital Intensity (KIR_{t-1}): High capital intensity restricts entry of new firms and thus makes a market less contestable (McDonald, 1999). However, high capital intensity can also enhance firms' competitiveness and make the markets more competitive, particularly when the capital goods embody better technology. Thus, impact of capital intensity on market concentration is largely an empirical issue.

Current Selling Intensity ($SELL_t$): The present paper defines selling intensity as the ratio of advertising, marketing and distribution related expenditure to sales to capture impacts of strategies towards creation of entry barrier through product differentiation (Comanor and Wilson, 1967)[10], and building up marketing and distribution related complementary assets.

[10] High advertising intensity of existing firms may require the potential entrants to incur disproportionately high

Thus, it is expected that greater selling efforts would result in more concentrated markets[11]. However, informative advertising may not necessarily affect the structure of a market. Further, impact of selling efforts on market structure also depends on the nature of the respective industry.

Lagged In-house R&D Intensity ($R\&D_{t-1}$): Impact of firms' in house R&D efforts on market structure is not clear in the literature. On the one hand, innovation acts as an entry barrier (Mueller, 1990), and thus limits competition. On the other, it enhances firms' competitiveness and prevents emergence of monopoly power of other firms. Nevertheless, when the larger firms gain competitiveness through innovation, the small and inefficient firms can be wiped out from the market raising market concentration.

Lagged Foreign Technology Purchase Intensity (FTP_{t-1}): Like in-house R&D, foreign technology purchase is also expected to raise firms' monopoly power. However, when the firms rely heavily on foreign technology and there is lack of in-house R&D to complement the same, monopoly power may not sustain in the long run. Besides, lack of necessary technical manpower may also limit benefits of imported technologies. Impact of foreign technology purchase on market structure, therefore, depends on how these opposite forces empirically dominate each other.

Lagged Mergers and Acquisitions ($M\&A_{t-1}$): Following the findings in the existing studies (Mishra, 2015), it is hypothesized that mergers and acquisitions do not necessarily affect the structure of a market. This is so because impact of such business strategies on market structure depends on various other factors such as initial structure of the market, prior market shares of the firms involved in M&As, nature of the industry, scope for entry and exist and extent of import competition. In addition, other business strategies of firms such as advertising and innovation, public policies and regulations also play crucial role in this regard. Hence, impact of M&A on market concentration may vary depending on the strength of these diverse forces.

Current Trade Openness ($OPEN_t$): When a market is open to international trade, import of quality or cheaper products enhances market contestability. Removal on restrictions on can also facilitate import of capital goods and other technologies. However, if the importing firms are dominant players and the weaker ones fail to face the threats of competition from imports, market may become more concentrated. On the other hand, high export intensity and hence greater penetration in the international market through liberal policies may lower the degree

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advertising expenses to win over the incumbents and this may discourage entry.

[11]There are evidences of positive relationship between profit margin and advertising intensity (e.g., Scherer and Ross, 1990) as well as between expenditure on distribution and marketing and profitability (Majumdar, 1997).

of sellers' concentration in the domestic market (Chou, 1986). Thus, one may expect that liberal trade policies would make a market more competitive.

Lagged Financial Performance (PER_{t-1}): Firms with better financial performance have greater ability as well as willingness to grow. This may raise market concentration. On the other hand, better financial performance of incumbents may encourage entry of new firms, particularly in the absence of entry barriers. When the diverse effects are balanced, financial performance may not cause any significant change in market structure. For example, Delorme et al. (2002) find no statistically significant impact of profitability on market concentration.

Estimation Techniques and Data Sources

In the present paper, the above functional relationship is examined using a panel dataset of 31 technology intensive industries of Indian manufacturing sector over the period from 2003-04 to 2010-11. Selection of the study period is based on primarily three reasons, viz., significant involvement of the MNCs in M&A during 1995-2000, amendments to the Indian Patent Act (1970) since the late 1990s, and stable economic conditions and changes in macroeconomic policies since the early 2000s. Necessary data are sourced from the Prowess database of the Centre for Monitoring Indian Economy (CMIE). The details on measurement of the variables are given in Table 1.

Table 1: Measurement of the Variables

Variable	Measurement
Dependent Variables	
Market Dominance (DOM)	Following Kwoka (1977), the dominance index is computed by using the formula $D = \sum_{i=1}^{n-1} [S_i - S_{i+1}]^2$ Here, S_i stands for the market share of the ith firm ordered from the largest to the smallest. Larger gaps between consecutive shares indicate greater inequality or dominance. When the firms are of equal size, the index becomes regardless of their number.
Market Concentration (CON)	The present paper uses the Herfindahl-Hirschman

	Index as the measure of market concentration and this is measured by using the formula, $HHI = \sum_{i=1}^{n} S_i^2$ Value of HHI tending to unity indicates greater market concentration.
Independent Variables	
Current Market Size (MSZ_t)	Natural logarithm of current industry sales
Lagged Capital Intensity (KIR_{t-1})	Ratio of capital employed to industry sales in the current year
Current Selling Intensity ($SELL_{t-1}$)	Ratio of total selling (i.e., sum to advertising, marketing and distribution) related expenditure to industry sales in the current year
Lagged In-House R&D Intensity ($R\&D_{t-1}$)	Ratio of expenditure on in-house R&D to industry sales in the previous year
Lagged Foreign Technology Purchase Intensity	Ratio of expenditure on foreign technology purchase to industry sales in the previous year
Lagged Technology Intensity ($TECH_{t-1}$)	Ratio of expenditure on in-house R&D to foreign technology purchase in the previous year
Lagged Mergers and Acquisitions (MA_t)	Natural logarithm of total number of mergers and acquisitions during the last three years excluding the year under reference
Current Trade Openness ($OPEN_t$)	Ratio of current imports and current exports to industry sales
Lagged Financial Performance	Lagged profitability (i.e., ratio of profit before interest and tax to sales in the previous year)

Given that there are missing data at firm level and the present paper carries out industry level analysis, all the variables are measured as simple three previous years' moving averages with the year under reference being the starting year to make the data set more consistent over time. In addition, three years' moving averages also take care of the process of adjustment in business strategies and other aspects market dynamics. Besides, such averaging also reduces the problem of simultaneity bias between the dependent and the independent variables.

In the present paper, the dynamic panel data model of the following form is estimated to examine the impact of firms' technology strategies on market structure:

$$y_{it} = \alpha + \beta y_{i,t-1} + \sum_{j=1}^{m} \gamma_j x_{j,it} + u_{it}$$

The above model is estimated by applying the generalized method of moments (GMM). As compared to the method of instrumental variables (e.g., Balestra and Nerlove, 1966; Anderson and Hsiao, 1981; Bhargava and Sargan, 1983), the GMM estimators are expected to bring in more information on data (Ahn and Schmidt, 1995). The GMM estimators are also consistent and more efficient as compared to the Anderson-Hsiao (1981) estimators. In addition, the GMM estimators address the problem of autocorrelation, heteroscedasticity, specification errors, etc.

The dynamic panel data models uncover the joint effects of the explanatory variables on the dependent variable with adequate control for the potential bias due to endogeneity of the explanatory variables including the lagged dependent variable[12]. Furthermore, in such models, the presence of the autocorrelation problem and validity of instruments are tested by applying the Arellano-Bond (1991) test for auto-covariance and the Sargan test (1958) of over-identifying restrictions respectively.

Generally, the dynamic panel data models are estimated by applying the estimation techniques as propounded by Arellano-Bond (1991). However, a potential weakness of the Arellano–Bond (1991) dynamic panel data estimators (known as the difference GMM estimators) is the assumption that the necessary instruments are based on lagged values of the instrumented variable(s) and hence are 'internal', though the estimators allow for inclusion of external instruments as well. However, the lagged levels are often poor instruments for the first differenced variables, especially if the variables are close to a random walk (Arellano and Bover, 1995; Blundell and Bond, 1998). In the system GMM, as propounded by Arellano and Bover (1995) and Blundell and Bond (1998), the estimators include lagged levels as well as lagged differences of the variables. Thus, the Arellano-Bover/Blundell-Bond estimators augment the Arellano-Bond estimators by making an additional assumption that the first differences of the instruments are uncorrelated with the fixed effects (Roodman, 2006). Such introduction of more instruments improves efficiency of the estimators considerably.

Further, the Arellano-Bond estimator can perform poorly if the autoregressive parameters are

[12] Since industry is the unit of observation in the present context, endogeneity problem is unlikely to be acute as it normally is when firm or the line of business is the unit of observation (Salinger et al., 1990).

too large or the ratio of the variance of the panel-level effect to the variance of idiosyncratic error is too large. Under such circumstances, the system GMM estimators use additional moment conditions. Accordingly, they are expected to give better results, especially for the panel datasets that have many cross-sectional units but only a few time points (as it is in the present case). This method assumes that there is no autocorrelation in the idiosyncratic errors. However, it is based on the initial condition that the panel-level effects are uncorrelated with the first difference of the first observation of the dependent variable.

In order to overcome these limitations, the present paper applies the method of the system GMM as propounded by Arellano and Bover (1995) and Blundell and Bond (1998). Further, both one-step and two-step estimators are used. The two-step estimators are used for testing specification and overall significance of the estimated models. This is so because the two-step estimators yield standard errors that are asymptotically robust to both heteroscedasticity and autocorrelation. On the other hand, inferences on individual coefficients are based on the one-step estimators due to their asymptotic robust standard errors that are unbiased and reliable. In case of one-step estimators, the Sargan test over-rejects the null hypothesis of the over-identifying restrictions, whereas the asymptotic standard errors of the two-step estimators can be severely downward biased in small samples (Arellano and Bond 1991; Blundell and Bond 1998). Hence, the present paper uses both the one-step and two-step estimators to test significance of the overall model and the individual coefficients respectively. In the present paper, inclusion of one-year lagged value of dependent variable as one of the explanatory variables accounts for the dynamic effects[13]. Further, one-year lagged values of the independent variables are used as the instruments to control the endogeneity problem. In addition, growth and M&A are used as additional instruments to reduce such bias further.

Results and Discussions

As discussed above, the present paper estimates the specified regression model by applying the method of the system GMM. The summary statistics on the variables used in the regression models are presented in Table 2, whereas Table 3 shows the partial correlation coefficients of the independent variables with the dependent variable. It is found that the partial correlation coefficients in respect of market size, selling intensity, foreign technology purchase intensity, mergers and acquisitions, and trade openness are statistically significant

[13]The use of such dynamic models is favoured, especially, for panels that have a large number of cross-sectional units with a small number of time periods, as we have in the present case. This is so because their estimation methods do not require larger time periods to obtain consistent parameter estimates.

and positive. Further, statistical significance and sign of the correlation coefficients are consistent across the alternative measures of market structure[14].

Table 2: Summary Statistics of the Variables					
Variable	Number of Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
CON_t	264	0.2045	0.1762	0.0171	0.8018
DOM_t	264	0.0728	0.1164	0.0003	0.6618
MSZt	264	11.1770	1.0931	8.8075	13.5996
KIR_{t-1}	264	0.8493	0.3319	0.2545	2.1227
$SELL_t$	264	0.0639	0.0396	0.0120	0.1862
$TECH_{t-1}$	258	0.3521	0.7199	0.0031	9.6505
FTP_{t-1}	258	0.0272	0.0259	0.0015	0.1571
$R\&D_{t-1}$	264	0.0101	0.0436	0.0002	0.4182
$M\&A_{t-1}$	264	2.1137	0.9243	0.0000	4.6347
$OPEN_t$	234	0.0365	0.0304	0.0024	0.1451
PER_{t-1}	264	0.0504	0.0611	-0.3491	0.1864

The regression results are presented in Table 4 and Table 5. All the estimated models are statistically significant. Further, the Sargan test statistics suggest that none of the estimated models suffer from the problem of over identification of restrictions. Similarly, the Arellano-Bond test shows that the estimated models do not have any autocorrelation problem. As mentioned above, the robust standard errors of the one-step estimates of the individual slope coefficients are corrected for heteroscedasticity.

Table 3: Partial Correlation Coefficient between Independent and Dependent Variables				
	With Market Concentration		With Market Dominance	
Variable	Correlation Coefficient	Significance Level	Correlation Coefficient	Significance Level
MSZt	0.527	0.000	0.434	0.000
KIR_{t-1}	-0.086	0.203	0.038	0.577
$SELL_t$	-0.189	0.005	-0.165	0.014
$TECH_{t-1}$	-0.075	0.271	-0.054	0.423

[14] Further, the variance inflation factors (VIF) are also computed to examine if the estimated models suffer from severe multicollinearity problem. The low values of the VIFs suggest that there is no such problem in the estimated models.

FTP_{t-1}	-0.134	0.048	-0.116	0.086
$R\&D_{t-1}$	-0.084	0.217	-0.089	0.190
$M\&A_{t-1}$	-0.659	0.000	-0.479	0.000
$OPEN_t$	0.293	0.000	0.298	0.000
PER_{t-1}	0.067	0.322	0.040	0.560

However, the results differ marginally in respect of statistical significance of the individual slope coefficients between the model on market concentration and market dominance. When market concentration is considered as the dependent variable, it is found that the coefficient of lagged market concentration, lagged capital intensity ratio, current selling intensity, current trade openness and lagged financial performance are statistically significant. Further, while the coefficient of lagged concentration, lagged capital intensity, current selling intensity and lagged financial performance are positive, that of trade openness is negative. This means that industries with concentrated market, higher capital intensity, greater selling efforts or better financial performance of firms have more concentrated markets. On the other hand, market concentration is lower in industries that are open for exports and imports.

Table 4: Regression Results with Ratio of Value Added to Value of Output as Measure of Vertical Integration

Variable	Market Concentration as Dependent Variable				Market Dominance as Dependent Variable			
	Two-Step Estimates		One-Step Estimates		Two-Step Estimates		One-Step Estimates	
	Coeff.	z-Statistic	Coeff.	z-Statistic	Coeff.	z-Statistic	Coeff.	z-Statistic
Intercept	0.0339	0.89	0.0734	0.65	0.0691	1.28	0.1614	1.31
Lagged DV	0.8658	14.62**	0.8729	6.41**	0.8543	30.08**	0.8439	4.78**
MSZ_t	-0.0047	-1.42	-0.0078	-0.83	-0.0092	-1.93*	-0.0179	-1.81*
KIR_{t-1}	0.0364	6.58**	0.0424	3.07**	0.0224	4.54**	0.0274	1.30
$SELL_t$	0.7872	7.44**	0.8245	1.83*	0.6340	4.52**	0.9746	2.12**
$R\&D_{t-1}$	-0.2127	-1.11	-0.0895	-0.41	0.0430	0.13	0.3808	0.71
FTP_{t-1}	-0.0497	-1.13	0.0338	0.38	-0.0095	-0.26	0.0411	0.76
$M\&A_{t-1}$	-0.0074	-5.03**	-0.0090	-1.18	0.0006	0.48	0.0001	0.02
$OPEN_t$	-0.9426	-4.54**	-1.0036	-1.77*	-0.8299	-2.98**	-1.3666	-1.73*
PER_{t-1}	0.1073	3.63**	0.1239	1.79*	0.1037	2.73**	0.1909	2.44**
Wald–Chi^2		850.78**		552.00**		1183.47**		124.47**
Sargan Test for Over-Identification of Restrictions		14.67 (0.20)				14.39 (0.21)		
Arellano Bond		1.95		1.52		1.41		1.35

Test for AR (1)		(0.05)		(0.13)		(0.16)		(0.18)
Arellano Bond Test for AR (2)		-0.81 (0.42)		-0.63 (0.53)		-0.56 (0.57)		-0.14 (0.89)
Number of Observations		202		202		202		202

Note: (1) **statistically significant at 5 percent; *statistically significant at 10 percent
(2) Figures in parentheses indicate the level of significance of the corresponding test statistic.
(3) For one-step estimates, the z-statistics are computed using heteroscedasticity corrected robust standard errors.

In the models with market dominance as the dependent variable also, it is found that the coefficient of lagged dominance, current selling intensity, current trade openness and lagged financial performance are statistically significant. Furthermore, they have the same sign when market concentration is considered as the dependent variable. This implies that, like market concentration, market dominance is also higher in industries with dominated markets, greater selling efforts by firms or their better financial performance, and it is lower for industries where markets are more open to international trade.

However, unlike market concentration, market dominance is not influenced by capital intensity; instead it is negatively affected by the size of the market. Alternatively, extent of firms' dominance is lower in industries where the market size is large. Nevertheless, the regression results are largely consistent across the alternative measures of market structure. Similarly, statistical significance or sign of the individual coefficients are consistent across the alternative measures of firms' technology strategies indicating robustness of the findings.

Table 5: Regression Results with Ratio of Value Added to Value of Output as Measure of Vertical Integration

Variable	Market Concentration as Dependent Variable				Market Dominance as Dependent Variable			
	Two-Step Estimates		One-Step Estimates		Two-Step Estimates		One-Step Estimates	
	Coeff.	z-Statistic	Coeff.	z-Statistic	Coeff.	z-Statistic	Coeff.	z-Statistic
Intercept	0.0317	0.81	0.0709	0.63	0.06159	1.12	0.1610	1.29
Lagged DV	0.8661	15.09**	0.8739	6.49**	0.85059	31.41**	0.8413	4.82**
MSZ_t	-0.0046	-1.37	-0.0079	-0.83	-0.00839	-1.73*	-0.0178	-1.79*
KIR_{t-1}	0.0351	6.32**	0.0440	3.29**	0.02115	4.06**	0.0314	1.63
$SELL_t$	0.7887	7.83**	0.8587	1.81*	0.64871	4.64**	1.0010	2.11**
$TECH_{t-1}$	-0.0005	-0.29	0.0007	0.38	-0.00001	-0.01	0.0007	0.50
$M\&A_{t-1}$	-0.0077	-4.94**	-0.0086	-1.15	0.00013	0.10	-0.0007	-0.13
$OPEN_t$	-0.9187	-4.55**	-1.0391	-1.79*	-0.82498	-3.05**	-1.3941	-1.74*
PER_{t-1}	0.0974	3.55**	0.1306	1.88*	0.10133	2.53**	0.2033	2.43**
Wald–Chi^2		856.46**		537.59**		1127.81**		96.38**
Sargan Test for		15.07				14.03		

Over-Identification of Restrictions		(0.18)				(0.23)		
Arellano Bond Test for AR (1)		1.92 (0.05)		1.51 (0.13)		1.40 (0.16)		1.34 (0.18)
Arellano Bond Test for AR (2)		-0.78 (0.43)		-0.63 (0.53)		-0.58 (0.56)		-0.18 (0.86)
Number of Observations		202		202		202		202

Note: (1) **statistically significant at 5 percent; *statistically significant at 10 percent
(2) Figures in parentheses indicate the level of significance of the corresponding test statistic;
(3) For one-step estimates, the z-statistics are computed using heteroscedasticity corrected robust standard errors

Importantly, the present paper finds that technology strategies and number of mergers and acquisitions do not have any statistically significant impact on market structure. Such findings are consistent with that of Mishra (2015). Using Arellano-Bond dynamic panel data estimation techniques for a panel dataset of 34 major industries of Indian manufacturing sector over the period from 2001-02 to 2008-09, Mishra (2015) found that the number of mergers and acquisitions or technology strategies do not necessarily cause any appreciable adverse impact on market concentration. This is so possibly because impact of technology strategies or mergers and acquisitions on market structure also depends on several other factors relating to various structural of the market (other than market concentration or market dominance), business strategies of the firms (other than technology strategies), their financial performance and policies and regulations of the government. Accordingly, a set of diverse forces operate and the impact of firms' business strategies on market structure depends on how these diverse forces empirically dominate each other.

As regards the technology strategies, it is possible that although such initiatives enhance competitiveness, especially of the small firms, the large firms may lose their competitive edge in the long-run due to strategic conjectures by other firms. More importantly, the R&D base of most of the domestic firms is still very low due to their limited financial and intellectual capabilities towards development of indigenous technologies, and their overall technical change is adaptive in nature (Kumar and Siddharthan, 1994). Importantly, a large proportion of the small and the medium firms of the developing countries do not have in-house R&D facilities (Brouwer and Kleinknecht, 1993). However, when technology strategies result in capital formation, market concentration increases, though such development may not have any significant impact on market dominance. The present paper finds that market concentration is high in capital intensive industries possibly because high

capital intensity indicates large sunk costs and hence barriers to entry (McDonald, 1999). Besides, high costs of capital due to capital market imperfections make the small firms less competitive and restrict their market entry (Basant and Saha, 2005).

Similarly, mergers and acquisitions may not necessarily affect structure of a market. This is contradictory to the monopoly theory that firms raise their market power through such business trategies (Steiner, 1975, Chatterjee, 1986)[15]. However, there are also evidences (e.g., Weiss, 1965; Mueller, 1885; Mishra 2015) of either no significant change or decline in market concentration following integration of firms through mergers and acquisitions. Such business strategies may also fail to alter the marjet structure significantly due to efficiency gains, especially by the smaller firms. This eventually restricts increase in market concentration and emergence of monopoly power[16]. Further, the impact of mergers and acquisitions also depend on motive of the particular synergies (Banerjee and Eckward, 1998). For example, firms may engage in such combinations to increase their value (Bradley et al., 1988), enhance efficiency (Rhoades, 1998), or have excess cash debt capacity (Bruner, 1988).

The finding of the present paper in respect of selling strategies is consistent with that of many of the existing studies (e.g., Comanor and Wilson, 1974; Martin, 1979; Shepherd, 1982; Das et al., 1993). While product differentiation through advertising creates entry barriers and image advantages, emphasis on marketing and distribution helps in developing necessary complementary assets. However, the negative coefficient of trade openness suggests that liberal trade policies can enhance market competition. Greater exports make domestic market more competitive (Chou, 1986), whereas competition from imports reduces market concentration (Mishra and Behera, 2007), particularly when the impact of efficiency gains is larger as compared to exit effects.

Conclusions

In the context of rapidly changing market conditions and business strategies during the post-reform period, the present paper is an attempt to examine firms' technology strategies on market structure of different technology intensive industries of Indian manufacturing sector. Using panel dataset for selected industries of Indian manufacturing sector and applying the system generalized method of moments (GMM), the present paper finds that market

[15] Many of the existing studies found increase in market concentration following M&A (e.g., Hart et al, 1973; Hannah and Kay, 1977).

[16] The efficiency theory suggests that M&A help firms in reducing costs of operations through scale economies (Porter, 1985; Shelton, 1988).

concentration or firms' dominance is higher in industries where the market is already concentrated or dominated by a few firms, selling efforts are higher or financial performance is better. On the other hand, market is found to be less concentrated or dominated for industries that are more open to international trade. Importantly, it is found that both technology strategies and mergers and acquisitions do not have any significant impact on market structure.

Thus, there are three important aspects of these findings. First, neither technology strategies nor mergers and acquisitions have any significant impact on market structure. Second, capital accumulation raises market concentration. Third, market is more competitive in industries with liberal trade policies. The findings of paper, therefore, have important implications for fine tuning of policies and regulations in respect of technology development, international trade and market competition, especially in respect of their inter-relationships. However, the findings of the present paper are tentative and more robust conclusions in this regard require further scrutiny. Probably, firm level analysis would help in exploring the impact of firms' technology strategies on market structure more directly with robust findings.

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