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COMPETITION REGULATION IN TWO-SIDED MARKETS: THE INDIAN JURISPRUDENCE

- Akash Krishnan\(^1\) and V.K. Unni\(^2\)

Abstract

With the expansion of computing and the internet revolution, two-sided markets are fast becoming ubiquitous across all spheres of the 21st-century economy. The phrase ‘two-sided market’ at first sounds like a tautology, i.e., by default, all markets have two sides, a buyer side, and a seller side. Formally, it is defined as a market in which the volume of transactions between end-users depends on the structure and not only on the overall level of the fees charged by the platform. These businesses need to address the ‘chicken-egg problem’ and successfully get both sides on board. While these new forms of business have on the one hand reduced transaction costs, there is empirical and experimental evidence of these markets being highly concentrated, with a tendency to lean toward ‘winner takes all’ owing to network effects. Regulators across the globe are attempting to strike a balance between not curbing innovation on the one hand and at the same time, protecting consumer welfare. In this regard, we analyze 25 antitrust cases pertaining to two-sided markets in the Indian context to understand the jurisprudence in the country in the backdrop of a decade of existence of the Competition Commission of India (CCI). The cases traverse several industries namely radio-taxi, online marketplace, real estate, healthcare, entertainment, stock exchange, broadcasting, online search and academic publications. We argue that CCI with its non-interventionist policies, reflected by the number of acquittals at the prima facie stage, coupled with a liberal stance and low predictability falls in the ‘Market Discretionalists’ regulatory style category.

Keywords – two-sided market, network effect, antitrust, CCI

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I. INTRODUCTION

Uber, the world’s largest taxi company, owns no vehicles. Facebook, the world’s most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory. And Airbnb, the world’s largest accommodation provider, owns no real estate. Something interesting is happening.3

- Tom Goodwin4

With the expansion of computing and the internet revolution, two-sided markets are fast becoming ubiquitous across all spheres of the 21st-century economy. Examples include virtually all technology platform enabled businesses including digital payments, mobile app development platforms, digital e-commerce platforms, radio-taxi and cab sharing networks, hotel and tourism intermediaries, P2P lending platforms, among numerous others. To highlight its relevance, three of the five most valued companies in the world have adopted multi-sided platforms as their business model; Apple, Google and Microsoft (Evans & Schmalensee, 2016). Also, seven of the ten most valued start-ups have adopted this business model, including the likes of Uber and Airbnb (Ibid.).

The rise of two-sided markets5 has eliminated or reduced transaction costs across traditional markets that they have sought to organize, and often replace. On the one hand, they have often helped overcome market imperfections without recourse to regulatory bodies, making many of the initial justifications for regulatory interventions redundant and unviable (Koopman, Mitchell, & Thierer, 2015; Rogers, 2015). While on the other hand, there is also evidence that these markets are often tippy with ‘winner takes all’ scenarios, especially when customers single-home (Eisenmann, Parker, & Alstyne, 2006; Sun & Tse, 2007). Laboratory experiments have revealed that markets tip to a single platform in the case of vertical differentiation, whereas with horizontal differentiation, there is the coexistence of platforms (Hossain, Minor, & Morgan, 2011).

The rapidly growing literature on the economics of two-sided markets has firmly established that traditional models for regulating competition in single-sided product markets are unsuited, and often welfare-reducing when it comes to regulating two-sided markets (Armstrong, 2006; Evans, 2003; Evans & Noel, 2005; Filistrucchi, Geradin, Van Damme, & Affeldt, 2014; Rochet & Tirole, 2003, 2006; Wright, 2004). In this context, we wish to study the jurisprudence of competition regulation in India, specifically

3 Source: https://techcrunch.com/2015/03/03/in-the-age-of-disintermediation-the-battle-is-all-for-the-customer-interface/
4 EVP of Zenith Media, a US based corporation.
5 We use ‘two-sided markets’ and ‘multi-sided platforms’ interchangeably
focussing on cases dealing with two-sided markets. Though the Competition Commission of India (CCI) is of recent origin, it has been spurring with activity. The remainder of the article is organized as follows; Section II provides a brief overview of the recent developments in literature pertaining to two-sided markets. Section III outlines competition regulation in India and traces a gap in the literature in terms of an organized study of the cases dealing with two-sided markets. Section IV provides certain stylized facts about the 25 Indian cases that have been analyzed. Section V discusses how one-sided logic in two-sided markets may lead to serious consequences and other challenges in regulating these markets. Section VI briefly summarises the broad debates in antitrust regulation and these debates are contextualized to a two-sided setting. In Section VII, we attempt to summarise our key thoughts and takeaways. The Appendix at the end briefly discusses case facts of the 25 cases and the reasoning of their judgments.

II. TWO-SIDED MARKETS: AN OVERVIEW

The phrase ‘two-sided market’ at first sounds like a tautology, i.e., by default, all markets have two sides, a buyer side, and a seller side. Although the platform businesses had been in existence for quite a while, Rochet & Tirole (2003) in their seminal paper were the first ones to theorise this phenomenon of two-sided markets, building on literature primarily connected with ‘network effects’ and ‘multi-product pricing’, and borrowing from the former the notion of ‘noninternalised externalities among end-users’.

Formally, they define it as a market in which the volume of transactions between end-users depends on the structure and not only on the overall level of the fees charged by the platform (Rochet & Tirole, 2006). These businesses need to address the ‘chicken-egg problem’ and successfully get both sides on board. Some other scholars look for indirect network effects to term markets as two-sided (Evans, 2003; Filistrucchi et al., 2014). Indirect network effects are said to occur when the value obtained by a type of user increases/decreases with increase in the users on the other market side/type (s) (Evans, 2003; Haucap & Heimeshoff, 2013). Distinction is made between two types of indirect network effects, namely membership and usage network effects. The former refers to an ex-ante externality that accrues to agents of a side of a platform when they may be affected by the volume of participants on the opposite side, and the latter refers to the externality that arises from the other side’s willingness to trade ex-post of joining the platform.

Rochet & Tirole (2006) lay down conditions for two-sidedness; for a market it to be two-sided, it is necessary that there doesn’t exist a Coasean bargaining solution and it is sufficient that the price structure is non-neutral, i.e., the volume of transactions on the platform changes if prices are raised on one side and reduced on the other side by an equal amount. Two-sided markets could, in other words, be perceived as a mechanism to incorporate externalities by minimizing transaction costs (Evans, 2011). The necessary condition translates into the fact that if there was already a mechanism that would lead to efficient outcomes for two or more parties, then a platform would cease to exist. The sufficient condition translates
into the fact that the platform is able to extract surplus by asymmetric pricing to the two sets of customer types, with the customers being unable to reorganize/redistribute this asymmetry.

For instance, radio-taxis\(^6\) (refers to taxi services that can be booked by the customers via a mobile application and/or a phone call, availability of GPS enabled tracking and where payment can be made using cash/card and/or e-wallets) fit the description of a two-sided market. This is highlighted in FIGURE below, which highlights all the three agents - the cab aggregator, customers, and drivers.

FIGURE 1: RADIO-TAXIS AS A TWO-SIDED MARKET

Source: Authors

The cab aggregator charges a fare to the customer for the service, a part of which goes to the driver and the remainder is the surplus of the cab aggregator. There are both membership and usage externalities at play in the above setting. Firstly, the more the drivers that tie up with a particular aggregator, the more the customers that will flock to the aggregator, and vice-versa. This virtuous cycle can be sustained by the aggregator maintaining a critical mass both in terms of drivers and customers, and this is the membership externality. The usage externality stems from the fact that even after agents tie up to an aggregator, the frequency of their availability in the system would vary.

Evans & Schmalensee (2008) have broadly categorized two-sided markets based on their functions of matchmaking, building audiences and minimizing costs:

a. **Exchanges**: They comprise two sets of customers, buyers and sellers. The platform helps these customers search for feasible contracts. All ‘matchmaking activities’ fall under this category. Some businesses of this kind are stock exchanges, dating services, travel services, publishers, ticket services, etc. The indirect positive externalities are positive and generally run both ways in this case.

b. **Advertising-Supported Media**: This category consists of magazines, newspapers, free television and web-portals. It is common that one side is subsidised entirely or to a very large extent by the other side. Search engines like Google and Bing and social networking sites like Facebook are examples

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\(^6\) We adopt the definition of radio-taxi from the CCI order pertaining to Case No. 6 of 2015, M/s Fast Track Call Cab Pvt. Ltd. v. M/s ANI Technologies Pvt. Ltd.
of this category. Platforms derive their revenue mostly from advertisements in this category, and it is possible that too many advertisements cause an indirect negative externality to their customers. Since most of the revenue for platforms comes through advertisements, they focus largely on audience building, to attract advertisers.

c. **Transaction Systems**: This category primarily consists of credit cards like Master, Visa, American Express and e-wallets like PayTM, Google Pay, etc. The challenge, as in other two-sided markets, is for the card company to make consumers adopt their cards, and also ensure that merchants are willing to accept payments from customers through this medium. Interchange fee, the fee the entity that services the merchant pays to the entity that services the customer, has been the bone of much antitrust scrutiny. Card companies derive most of their revenue in the form of this interchange fee. On the customer side, most cards have negative payments in the form of loyalty rewards.

d. **Software platforms**: It connects users and developers. This category includes operating systems (like Windows, iOS, Android, etc.), telephone networks (Vodafone, Airtel, etc.) and video games (like Play Station, Xbox, etc.) to name a few. They are largely focused on reducing duplicative costs. An application programme interphase makes sure that existing codes are made available to developers such that they can focus on creating new applications, rather than each developer reinventing the wheel by duplicating their codes.

Hagiu & Wright (2015) have approached this literature on multi-sided platforms from a rather unique lens of control rights. They distinguish between marketplaces and resellers on the basis of residual control rights; these rights remain with sellers in the former case but cease to exist with the seller in the latter case. In this sense, this strand of literature is closely related to the literature on vertical integration and the theory of the firm.

For them, indirect network effects are neither necessary nor sufficient for multi-sided platforms. They state two key ingredients of multi-sided platforms; firstly, these platforms enable direct interactions between two or more distinct sides, and secondly, each side is affiliated with the platform. By ‘direct interactions’ they imply that the two or more sides retain control over the terms of the interaction. Direct interactions help them set multi-sided platforms apart from resellers and vertically integrated firms. By ‘affiliation,’ they imply that each side makes specific investments to interact directly with the other side. The investment could take the form of a fixed access fee (annual membership on a credit card), expenditure of resources (like getting familiar with the interphase of an application) or an opportunity cost (time spent in browsing and comparing prices on online platforms instead of visiting brick and mortar shops and making purchase through actual touch and feel of product).

For the purpose of this paper, we stick to the earlier notion of two-sided markets with its emphasis on indirect network effects, price structure and the absence of a Coasean bargaining solution. Network effects have had a huge role to play in antitrust policy in two-sided markets, and the strand of literature focussing
on control rights ignores this element altogether. Hence we adopt the former definition, as it is much more suited to our context.

In the next section, we provide an overview of the evolution of the Competition Commission of India (CCI), the Indian Competition Act (2002) which was amended in 2009, and select scholarship on pertinent issues.

III. COMPETITION REGULATION IN INDIA: A PRECURSOR

The Competition Act is a successor of the Monopolies’ Restrictive Trade Practices (MRTP) Act. The MRTP Act was based on regulating firms based on size and market share bright lines. It lasted for four decades between 1969 and 2009 and complemented the existing license-raj. One could argue that the MRTP Act was inspired by the Harvard Structure-Conduct-Performance (SCP) paradigm. Several factors were jointly responsible for paving the way for the repealing of the MRTP Act (as recommended by the Raghavan Committee), in favour of the Competition Act, that could account for all these changes, and provide a level playing field to both State-owned enterprises and the private sector; implementation of economic reforms, India becoming a signatory of the WTO in 1995 and institutionalisation of several sectoral regulators (Chaudhuri, 2016).

Bhattacharjea⁷ (2010) provides a vivid description of the chain of events that transpired during the transition from the MRTP Act to the Competition Act, which is as follows; The Competition Act was supposed to be passed in 2002, and Section 66 of the New Act provided for the repeal of the MRTP Act and the disposal of the pending cases of the MRTP Commission. Nevertheless, substantive sections of the Competition Act and Section 66 could not be brought into force because of a writ petition in the Supreme Court raised issues about the separation of powers between the judiciary and the executive in decisions regarding the composition of CCI.

There was a stalemate on the matter up until 1st of September, 2007, when the Parliament finally passed an amendment Act, leading to the creation of the Competition Appellate Tribunal (COMPAT), and so also Section 66, with an extension of the life of the MRTP Commission by two years to clear ‘Unfair Trade Practices’ pending cases, starting 2009. Eventually, in May 2009, most of the remaining provisions of the Competition Act were notified. At this point, the MRTP Commission through natural attrition had no chair and only two members, with thousands of pending cases. The Govt. claimed that it was unable to make suitable recruitments for the MRTP Commission, thereby repealing the extension for the MRTP Commission, and all the pending cases were transferred to the COMPAT and/or the National Commission under the Consumer Protection Act (COPRA).

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⁷ Prof. Aditya Bhattacharjea has been a prolific contributor to debates and perspectives on India’s Competition Policy. He is currently Head of Department, Economics, at the Delhi School of Economics (DSE)
There was further confusion when the National Commission expressed its inability to take up the pending ‘Unfair Trade Practices’ cases as the definition of a consumer was different in COPRA as compared with the MRTP. Therefore, all the pending cases were transferred once and for all to the COMPAT bringing to a close the four-decade legacy of the MRTP. In short, the enforcement of the Competition Act began in May 2009.

The crux of the Competition Act lies in three of its Sections. Section 3 deals with anti-competitive agreements (both horizontal and vertical). Section 4 looks at abuse of dominance by a single firm, whereas Section 5 and 6 are to do with regulations pertaining to mergers, acquisitions and amalgamations. Some of the improvements over its predecessor are as follows; firstly, the Act has jurisdiction over foreign cartels and foreign combinations likely to cause an appreciable adverse effect on competition (AAEC) which the MRPT Act wasn’t provisioned to do. Secondly, the Act allows for monetary penalties in the case firms don’t comply with CCI orders. For instance, CCI had imposed significant fines on the 10 cement firms that were involved in a cartel which was facilitated by the Cement Manufacturers’ Association (CMA) (CCI, 2016a). In a more recent order, Google was fined Rs. 135.86 crore for abusing its dominance for alleged manipulation of search results (CCI, 2018b). Thirdly, there exists a leniency clause to encourage firms to admit to being involved in a cartel, in exchange for immunity. Fourthly, CCI is actively involved in advocacy with its stakeholders in building an ecosystem to promote ‘fair competition for greater good.’

Coming to select scholarship on competition regulation and technology in the country, Basant & Morris (2000) underline the need for competition policy in the country to go beyond the then MRTP and also address competition issues that are intertwined with trade, investment and technology development, in the backdrop of India adopting globalisation as a mandate. The authors highlight the need for the Indian Govt. to harmonize legal infrastructure to suit the modern needs of competition in all spheres of the economy. Bhattacharjea (2003) points to India’s inconsistencies in the application of competition policy to international trade; the MRTP Act imposed injunctions on imports to protect domestic players initially, and the same was later revoked, only to be again permitted by one of the amendments of the Competition Act. The issuing of injunctions for imports is in probable violation of the WTO rules. The author comments about the modern antitrust regime being driven by ‘allocative efficiency’. While he is not entirely in favour of Posner’s ‘allocative efficiency’ approach with no equity considerations, he is sceptical about the quantum of redistributive outcomes that can be achieved through competition regulation. He provides possible ways to cook in equity considerations that are verifiable, like a blanket exemption to firms with a certain maximum turnover and market share to form agreements and the Govt. correctly identifying industries where collective action would produce better outcomes.

It is interesting to note that discussions regarding regulation needing change as a result of network effects had emerged in our country, roughly around the same time that it was being discussed in the more advanced economies. Morris (2003) foresaw some of the aspects of two-sided markets even prior to the
evolution of literature on two-sided markets. Although the author focussed on the ‘vast consumer side scale and scope economies’ specific to the IT industry (both hardware and software) to drive home the point that traditional antitrust regulation is unsuitable for the development of this industry, he was alluding to the network effects that operate on both the demand and supply side that are characteristic of two-sided markets.

There has been some work on telecom policy in the country. From the sector being perceived as a place for natural monopolies to the existence of competition both by foreign and domestic players, there has been a huge change that has transpired in the last two decades (Gupta, 2007; Parsheera, 2018). There has also been some debate regarding the role of CCI in the presence of sectoral regulators. Kathuria (2018) argues that competition authorities should intervene in markets with sectoral regulators only when there is a proven ‘gap’ in consumer welfare in the sectoral adjudication. The author makes a claim primarily in the context of the jurisdiction of CCI and TRAI (Telephone Regulatory Authority of India), against the backdrop of a case filed by Reliance Jio alleging the incumbent players (Airtel, Vodafone and Idea) of cartelization, with the case being filed with both the CCI and TRAI.

The recent case of CUTS v. Google (2018) received some attention from academics in the country. Pingali (2018) has reasoned that online search markets are characterized by ‘low switching costs and fast-paced innovation’, and therefore makes it difficult for any firm to undertake activities that harm consumers. The author also argues that CCI must ensure that the competition landscape in the specific industry has not changed from the time the complaint was first filed. Gouri & Salinger (2016) also remarked that innovation is the most important dimension of competition in the online search markets and that falsely labeling an innovation anti-competitive ‘would protect competitors but harm competition’. Krishnan (2018) traces the evolution of antitrust regulation in the online search space across jurisdictions and points out to the inherent search bias in online search as a result of it receiving revenues from advertising.

The paper we find closest to our work is that of Parsheera, Shah, & Bose (2017) which highlights the key competition issues in India’s online sector, characterized by strong network effects. They highlight the tendency of these firms to offer deep discounts to customers to grab market share on the back of access to funding. Some of the key differences between our approach and that of theirs are as follows; firstly, we undertake a systematic approach to understanding CCI’s jurisprudence by looking at the whole gamut of cases pertaining to two-sided markets. Secondly, we look at cases in the backdrop of literature pertaining to two-sided markets, considering network effects on both the demand and supply side, whereas they largely base their arguments solely on demand-side network effects.

There is a huge dearth of studies in the current context that have attempted to look at CCI; its jurisprudence although nascent, the Commission has had the image of being proactive and using economic
principles in its adjudications. The next section provides certain stylised facts about the cases that we consider in our analysis.

IV. INDIAN TWO-SIDED MARKET CASES: SOME STYLIZED FACTS

We analyze 25 cases across several industries, viz., radio-taxi, an online marketplace, healthcare, entertainment, real estate, broadcasting, academic publications and the stock exchange to understand the jurisprudence of cases pertaining to two-sided markets in a decade of the existence of CCI. To arrive at the whole gamut of cases that are of interest, we run a search on Manupatra\(^8\) using the following phrases: ‘two-sided market,’ ‘radio-taxi,’ ‘e-commerce’, ‘online platform’. We use an OR (union) operation to capture all possible combinations and filter out the false positives to arrive at all the cases of interest. In what follows, we represent certain stylized facts of the cases:

![Cases Across Industries](image)

**Figure 2: Cases and their Industry Spread**

The largest number of cases were recorded by the radio-taxi segment (10), followed by the online marketplace space (5). These two industries combined accounted for 60% of the total cases. Academic publications and Online Search accounted for 8% each of the total cases, while there was one case each spread across healthcare, real-estate, entertainment and stock-exchange.

Following Evans & Schmalensee (2008a), the classification of cases into the four categories are as follows:

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\(^8\) Manupatra is a legal repository that contains both Indian and international case files.
What becomes conspicuous is that Exchanges, consisting of radio-taxis, online marketplaces, online search, entertainment, healthcare, stock exchange and academic publication has the vast majority of cases (80%). These markets primarily perform the function of matchmaking. For instance, radio-taxi aggregators like Uber and Ola match customers with drivers, stock exchanges like NSE match buyers with sellers, and in the same fashion, online marketplaces like Flipkart and Amazon aid match buyers and sellers. Advertising Supported Media, on the other hand, operate on ‘grab the eye-ball phenomenon’. Usually, one side is subsidized by the other in this kind of a setup. For instance, online search has search users on the one hand that use the service for free, and are subsidized by the advertising side. Broadcasting players and real estate websites like MagicBricks and 99Acres function on this business model.

It would also be useful to look at the nature of cases that CCI receives and their spread across industry verticals:

<table>
<thead>
<tr>
<th>INDUSTRY</th>
<th>HORIZONTAL/VERTICAL AGREEMENTS (Section 3)</th>
<th>ABUSE OF DOMINANCE (Section 4)</th>
<th>COMBINATIONS (Section 5 &amp; 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio-Taxi</td>
<td>1</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Online Marketplace</td>
<td>4</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Online Search</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthcare</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broadcasting</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Real Estate</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entertainment</td>
<td>1</td>
<td></td>
<td></td>
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</tbody>
</table>

Figure 3: Case Spread among the 4 broad types of Two-Sided Markets
Table 1: Cases Brought to the CCI classified by category

It is to be noted that generally when cases are filed, they may contain more than one allegation, but in the table above, we have looked at locating the core allegation of the plaintiffs using our discretion. For instance, almost all Section 4 cases may also have Section 3 allegations, but these, in most cases are not the core of the case. Hence, in such an instance, we would record such a case only as a Section 4 case. The interesting point to note is that the incidence of Section 4 cases out-numbers the other categories by a huge margin.

<table>
<thead>
<tr>
<th>Category</th>
<th>PRIMA FACIE ACQUITTAL</th>
<th>ACQUITTAL POST DG(^9) INQUIRY</th>
<th>PENDING WITH DG</th>
<th>FINES IMPOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADIO-TAXI</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ONLINE MARKETPLACE</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REAL ESTATE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTERTAINMENT</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACADEMIC PUBLISHING</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEALTHCARE</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ONLINE SEARCH</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>STOCK EXCHANGE</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>BROADCASTING</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
<td><strong>4</strong></td>
<td><strong>2</strong></td>
<td><strong>3</strong></td>
</tr>
</tbody>
</table>

Table 2: Cases Classified as per the level of adjudication

Table 2 depicts the various stages at which the defendant was either acquitted or convicted (with the imposition of a fine). This table stands out in terms of the number of acquittals at the prima facie stage.

\(^9\) DG stands for Director General
which accounts for more than 60% of the total number of cases registered (16 out of 25 cases). This could be attributed to several reasons; firstly, it could be the case that the plaintiffs do not have an understanding of the provisions of the Competition Act, and thereby register cases that lack merit. Secondly, it may be possible that the Act lacks the teeth to detect and punish anti-competitive practices, or alternatively, CCI seems to be adopting a rather non-interventionist stance.

From our analysis of the cases in the Appendix, it doesn’t seem to appear that the plaintiffs are responsible for getting non-meritorious cases before CCI. Nextly, the Indian Competition Act has been inspired by the European Competition Act and is, therefore, a very modern and state of the art legislation, which does not lack in any provision for detecting an anti-competitive practice. This logically brings us to the third possibility, which is the claim we make in this paper.

The next section discusses the difficulties and challenges in applying traditional regulation in the context of two-sided markets. We substantiate our arguments by citing instances from Indian cases.

V. ONE-SIDED LOGIC IN TWO-SIDED MARKETS

Before analyzing the compatibility of traditional competition with two-sided markets, we broadly summarise the traditional path of competition assessment. The figure below briefly illustrates the four steps involved:

![Figure 4: Steps in Traditional Competition Assessment](image)

The first step is quintessential for the assessment as presumptions and standards of proof vary by the class of conduct. In a cartel investigation, post the market definition, one would immediately look for conduct that involves horizontal or vertical price fixing, as the former is a per se violation in most jurisdictions. In a merger scenario, one would juxtapose the price increase of the merged entity with potential efficiencies due to the merger, post the market definition.

In what follows, we look at difficulties posed by two-sided markets in the application of traditional regulation, primarily relating to relevant market delineation, identification of predatory pricing and determination of market power. We use Indian cases to justify and support our arguments, and also supplement with foreign case laws in certain instances.
A. Market Definition

Market definition is among the most important steps for antitrust and regulatory cases. For this purpose, the most popular method resorted to is what is referred to as the SSNIP (Small but Significant Non-Transitory Increase in Price) Test, also called the Hypothetical Monopolist Test. The rationale behind the test is to arrive at the smallest possible basket of goods that a hypothetical monopolist can use to increase prices profitably (based on the idea of cross-price and own-price elasticities) (Filistrucchi et al., 2014; Werden, 2003). This approach has often been criticized for being too mechanical and ignoring the empirical reality that constraints on market power tend to be a matter of degree, rather than a binary of “in the market” or “outside the market” (Evans & Noel, 2005). Such mechanical application ends up identifying certain imperfect substitutes as within the market while excluding certain other possible substitutes altogether\(^\text{10}\) (ibid.). However, such an approach is nearly ubiquitous in regulatory analyses. The roots of such approach lie in the preference for binary divisions and formal hierarchies that the new age sharing based markets stay away from (Crespo, 2016).

The SSNIP test becomes further complicated for the two-sided markets where the delineation of market becomes complex because indirect network externalities would imply that critical prices would influence not only the side where monopolist pricing is applied to but also a multiplier effect on the other side of the market, which would further lead to a multiplier effect (Evans & Noel, 2005). Filistrucchi et al., (2014) suggests that if the feedback effects arising out of indirect network externalities are ignored, there is a risk of defining the markets too narrowly. The authors recommend that while performing the SSNIP test, regulators should always take into account both sides of the market, but the type of two-sided market would determine whether one or two relevant markets need to be defined; they segregate two-sided markets into two-sided transactions versus the two-sided non-transactions market. The former refers to markets where the two sides interact with one another directly, as is the case in auction houses, online intermediaries like Amazon and radio-taxi services, while the latter involves a market where the two sides do not interact directly, like media. In the case of two-sided transactions market, only one market needs to be defined, while in the case of the two-sided non-transactions market, two markets need to be defined (ibid.). Rooney & Park (2007) reiterate this viewpoint by citing the fact that US case laws are in consistency with this approach.

The other question that needs to be addressed is whether traditional markets could be clubbed with these new business forms to form a single market or do they constitute two different markets. For instance, do the yellow cabs/autos plying on Indian roads constitute the same market as Uber and Ola in an Indian city? Also, in cities that have access to metros, are cab services substitutable by metros?

A point to be noted here is that at the prima facie stage, CCI does not make use of the SSNIP Test to determine the relevant market, and it is rather left to the judgement of CCI members. In Meru v. Uber\(^\text{14}\)

\(^{10}\) The cellophane fallacy is an extreme illustration of this
CCI delineated the relevant market as ‘services offered by radio-taxis and yellow taxis in Kolkata,’ while in *Fast Track Call Cabs v. ANI Technologies* (2015) the relevant market delineated was ‘radio-taxi services in the city of Bengaluru.’ Therefore, one notices that depending on the geographical market, the relevant product market category is altered without resorting to a more involved analysis in determining the market. Shifting the focus to Europe, in *Taxi Associations of Milan v. Uber* (2015), the defendant argued that Uber is only a web platform, and does not compete with taxis in the provision of transportation services (Amato, 2016). The Court of Milan ruled that Uber is part of the individual transportation market in Italy, and is in direct competition with the local taxis (ibid.). This issue has tremendous implications in the adjudication of a competition dispute.

In the context of online retail in India, in *Ashish Ahuja v. Snapdeal* (2014), CCI delineated the market to be retail sales in India, and remarked that “online and offline are just two different channels for the sale of a product.” Subsequently, CCI in *All India Vendors’ Association v. Flipkart* (2018) defined the relevant market as ‘services provided by online marketplace platforms’, which poses an issue of consistency with precedents. CCI seems to exercise discretion in its judgements without stating the economic reasoning behind the same.

An extreme view on defining markets is not defining them at all, as the market definition is in most cases arbitrary and even in the cases of it being non-arbitrary, non-market parameters rather than market parameters are used for the purpose (Markovits, 2012). This argument is especially relevant to two-sided markets because of the artificial construction of one or both sides of the market.

**B. Market Dominance**

In most regulatory cases, specifically investigating abuse of dominance cases, or merger inquiries, assessment of market power becomes a primary consideration for its underlying consequence on pricing power. It serves to limit the regulatory overhang to unnecessary issues as the business practices by entities that either lack market power or are unlikely to acquire it are often presumed benign (Evans & Noel, 2005). Often, market share is used as a proxy for market power. But, it runs into difficulties in the case of two-sided markets where pricing power on each side depends on the degree of competition on both sides (Evans, 2003). We have already seen the difficulties in applying market share as a proxy for market power because of the intrinsic challenges in market definition. An additional issue to grapple with emerges when the market definition includes the wider set of traditional taxis along with the emergent radio-taxi / cab-sharing platforms. Given the large degree of substitution and considerable competition between the older and newer business models, what is the threshold market share that can lead to dominance and deployment of unfair competitive practices vis-à-vis older business models? While a brightline estimate is difficult to arrive at, even a relatively small market share, say 10% (Rifkin, 2014), is often enough to tip the market in favour of the new platforms. The rationale is that some industries are characterized by low market shares,
and losing just a little share of the turnover has significant implications in altering the existing market structure (Henten & Windekilde, 2015).

In the cases considered for our analysis, 11 out of the 16 cases were acquitted at the prima facie stage as a result of not being able to establish dominance. CCI’s non-interventionist stance is evident in its handling of market share as evidence of dominance. In *Fast Track Call Cabs v. ANI Technologies* (2015), despite the defendant possessing a market share of more than 60%, CCI opined that since market shares are continually evolving and since this industry is nascent, the defendant did not hold a dominant position and closed the case.

Another issue that has repeatedly come up for debate and discussion is the notion of ‘collective dominance.’ The lack of the Indian Competition Act to account for collective dominance resulted in 4 out of the 16 cases that were acquitted at the prima facie stage. In *Meru v. ANI Technologies* (2017), which was registered across four cities, including Hyderabad, Delhi, Kolkata and Bangalore, this issue of collective dominance was raised by the plaintiff. The plaintiff argued that both Uber and Ola combined results in dominance in the market. CCI opined that its current Section 4 is not equipped to deal with issues of ‘collective dominance,’ and referred to the fact that its recommended amendment was stalled in the parliament, and since CCI is only permitted to interpret the legislation and not make changes to it, it can’t implement the change. Recognizing collective dominance is common across major jurisdictions like EU and Canada, and this becomes more so important in the presence of indirect network effects.

There are additional conceptual issues in conceptually linking consumer market share and implications of pricing power. It becomes especially important in merger inquiries, where an increase in the customer base on one side can enhance the value to users on the other side, thereby enhancing overall welfare even if prices were to rise on one side or in total (Evans, 2003). Further, an increase in market share concentration may not directly translate into an increase in pricing power as seen in the previous section.

<table>
<thead>
<tr>
<th><strong>Driving Force</strong></th>
<th><strong>Effect on Concentration</strong></th>
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<tr>
<td>Strength of indirect network effects</td>
<td>+</td>
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<tr>
<td>Degree of economies of scale</td>
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<tr>
<td>Capacity constraints</td>
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<td>Scope of platform differentiation</td>
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<td>Multi-homing opportunities</td>
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**FIGURE 5:** Determinants of Concentration in a Two-Sided Market (Source: *Evans & Schmalensee* (2008))

Besides the conceptual issues, highlighted above, the empirical reality indicates that a relatively small number of firms compete in two-sided markets. It is not uncommon to see monopolies, which raises questions about the relevance of market power estimates in such markets (Evans, 2003). Cooperation
among competitors to improve efficiency in the customer base is also not uncommon (Ibid.). Evans & Schmalensee, (2008b) have identified the determinants of such competition as indicated in Figure 5 above. The indirect effects on the demand side, and cost-side scale economies, resulting in high market concentration levels (Evans & Schmalensee, 2008b; Haucap & Heimeshoff, 2013; Roson, 2005). It is especially important when capacity constraints of the platform or scope for differentiation are limited, as is usually the case with most radio-taxi operators and online marketplaces (Ibid.). This is however not the case with online search. However, from a theoretical point of view, it is unclear whether competition among several platforms is more welfare enhancing than monopolistic markets (Haucap & Heimeshoff, 2013). Caillaud & Jullien (2003) have established that a monopoly platform can be efficient because it maximizes network effects. Further, even though some of these two-sided markets lean towards high concentration ratios, market position of a particular incumbent need not be long-lasting (Haucap & Heimeshoff, 2013). With low switching costs, as true of most radio-taxi markets and so also online marketplaces, the incumbent market leader or monopolist has to defend its position against continuous innovation and entry. As a result, it is not unusual to see a kind of Schumpeterian competition where one dominant player follows the other (Ibid.). In such cases, a mechanical application of market share rules to assess market power will not only be futile but possibly welfare reducing.

C. Abuse of Dominance

Most two-sided markets tend to be concentrated with a limited number of competing platforms (Evans, 2003; Rogers, 2015). As a result, a dominant player can acquire significant market power. But that itself is not a cause for worry, as welfare implications of market concentration are unclear, and given the low switching costs and the potential to easily replicate the technology advantage, the markets remain largely contestable (Haucap & Heimeshoff, 2013; Rogers, 2015). However, there is potential for abuse of market power on both the fronts – exploiting monopolist position to generate superior revenues vis-à-vis one or both sides of the market, and preventing contestability of markets through predation.

Predatory strategies are not impossible. Predation can clearly occur when a dominant player prices its total service at a level that fails to cover the costs of offering the full service, taking both the sides into account (Behringer & Filistrucchi, 2015; Fletcher, 2007). Fletcher (2007) further warns against the impact of asymmetric price structure in two-sided markets, in the sense that low-pricing behaviour on one side of the market may tend to prevent entry into both sides. For instance, certain smaller or newer firms may have less ability than the dominant incumbent to turn extra business on one side of the market into incremental revenues on the other, thereby preventing competition on both sides (Ibid.).

Armstrong & Wright (2007) also highlight that dominant platforms could try and ensure exclusive contracts on one side, and thereby block the rivals from adopting a “divide and conquer strategy” (Ibid.). Further, entities with significant market power can engage in business practices that could foreclose competition (Evans & Noel, 2005). For instance, data could potentially become a huge source of
competitive advantage for a particular player that could create significant entry barriers for a new entrant, as seen in the case of Google (Haucap & Heimeshoff, 2013; Lougher & Kalmanowicz, 2015). Accumulation of data, for instance of reviews and endorsements, could create lasting effects incentivizing both sides to stay on the platform (Lougher & Kalmanowicz, 2015). It also remains susceptible to potential abuse of the data advantage to favour certain interests, as was seen when Google abused its dominant position in a search engine to favour its subsidiaries (such as Google Maps or Google Travel) over competing platforms (Haucap & Heimeshoff, 2013). In the context of radio-taxi, the customer and driver ratings could be a source of enduring competitive advantage, also susceptible to manipulation. In the same vein, online marketplaces that gather data about consumer preferences and their willingness to pay could use the same to extract the entire consumer surplus. Further, a dominant platform could transpose its market power into other segments through leveraging of its proprietary data. It could block competitive access in the other market segments (Lougher & Kalmanowicz, 2015). However, in a fast moving technology world, it remains contentious whether it is even feasible to regulate data as a source of competitive advantage and a source of potential abuse of dominance (Haucap & Heimeshoff, 2013). It is often difficult to establish whether the particular advantage is a necessary incentive to support innovation, and thus a genuine business investment, or a source of abuse in related market segments to block out competitors. Moreover, it is difficult to establish how data is being abused to create unfair market conditions.

D. Identification of Predatory Pricing

One of the most common forms of abuse of dominance alleged against platforms is predatory pricing, defined as the price below average variable cost (as a proxy for marginal cost) (Evans, 2003). However, economists have shown that principles governing two-sided markets often differ substantially from the traditional industries, and pricing strategies are often a complex endeavor, precluding the possibility of a mechanical application of the conventional Areeda-Turner test 11(Evans & Noel, 2005; Wright, 2004). Firstly, two-sided markets face significant start-up problems that require them to subsidize users on one or both sides of the market. Often known as the “chicken-and-egg” problem, it requires sufficient number of users on either side to join the platform before the indirect network externalities can begin, failing which the business is likely to shut down (Evans, 2003; Evans & Schmalensee, 2016; Haucap & Heimeshoff, 2013; Roson, 2005).

Secondly, the price structure in two-sided markets is not neutral, and it is possible to enhance economic efficiency by charging one side of users a much higher price related to the other side (Rochet & Tirole, 2006). The optimal pricing depends on the price elasticities of demand on both sides, the nature and

11 The test used for assessing alleged predatory pricing behaviour in the US. Price less than marginal cost is considered predation. Due to the difficulties in arriving at marginal cost figures, average variable cost is used as a proxy for the same, and hence, price less than average variable cost is considered as predation (Areeda & Turner, 1975).
intensity of the indirect network effects between each side, and the marginal costs that result from changing the output of each side (Armstrong, 2006; Evans & Noel, 2005). Often, this entails pricing below the marginal cost, or even negative for customers on one side, while completely deriving revenues from the other side (Armstrong, 2006; Caillaud & Jullien, 2003; Evans, 2003; Rochet & Tirole, 2003; Weyl, 2010). It requires consideration of all prices and costs jointly for all the sides, failing which erroneous conclusions will be reached (Behringer & Filistrucchi, 2015; Evans, 2003).

Thirdly, the increase in competition need not result in a more efficient price structure. Even if competition may lower the overall price level, the price structure might just remain the same. In fact, in single-homing environments, an increase in competition among platforms can lead to an increase in the asymmetry of prices charged to the two sides (Belleflamme & Peitz, 2015; Wright, 2004). Fourthly, regulating platform prices may not be competitively neutral\textsuperscript{12}. Forcing a platform to reduce/raise prices on one side may not force its rivals to follow suit (Ibid.).

Fifthly, the indirect network externalities by themselves act as a barrier to arbitrary price fixing by a monopolist, as supernormal profits on one side can easily be dissipated on the other side, while also affecting the overall volume of transactions substantially (Evans & Noel, 2005; Wright, 2004). Similarly, collusion among different competitive platforms to fix prices can often lead to greater competition on the other side, thereby, only distorting the overall price structure (Wright, 2004). As such, two-sided markets have an incentive to seek the most efficient price structure and harness the indirect network externalities (Evans & Noel, 2005). Belleflamme & Peitz (2015) have demonstrated that there is no clear evidence of platform price regulation benefitting end-users in the context of credit card industry in Australia.

Thus, it is difficult to establish predatory pricing in the context of two-sided markets without holistically examining the impact on both sides of the market. Moreover, there seem to be strong inherent incentives to reflect the efficient price structure because of the network externalities. The link between customers on the two sides limits the extent to which pricing strategies on one side is profitable, thereby necessarily limiting market power (Evans & Noel, 2005).

E. Other Contemporary Challenges

In this section, we attempt to flag some of the recent complexities that have arisen in competition adjudication, which have largely been outcomes of the rapid technological changes taking place in the world we live in. We have identified below two broad themes, which are to a great extent representative of what regulators encounter; perfect price discrimination and technology-aided collusion.

\textsuperscript{12} A regulation is said to be competitively neutral when an intervention by a regulator mandating a firm to change its conduct does not impose an advantage on the rival unregulated firms. If the markets are sufficiently competitive, regulation is said to be competitively neutral in the context of traditional markets.
Perfect price discrimination refers to a firm usurping the entire consumer surplus, once it is aware of the willingness to pay schedules for all its customers, at various levels of consumption. With the advancement in technology, firms are able to collect data about consumer profiles and preferences, and are able to estimate the willingness to pay by individuals and customizing prices as per their predictive models, as has been observed in the case of Uber and price comparison websites like Expedia and Orbitz (Newcomer, 2017; Mohammed, 2017). These practices nevertheless come within the domain of legality. Price discrimination is often low on the priority list of the competition agencies, especially in the context of the final consumer (Ezrachi & Stucke, 2016).

There is a surprising lacuna in legal provisions to deal with the above practices across the globe, and with the ever-rising increase in technological intervention in developing business processes to utilize data about the consumer most effectively, the current trajectory may lead to an era where perfect behavioural price discrimination is the norm. The Robinson-Patman Act of the US and Article 102(c) TFEU of the EU are meant to ensure that an upstream firm does not provide dissimilar conditions to equivalent transactions between large and small downstream players.

Coming to technology-aided collusion, neo-classical economics says that a cartel is inherently unstable, as the dominant strategy for each player is to undercut the agreed price, thereby leading to the break-down of the cartel. But what if behaviour could be monitored closely, such that the incentive to deviate from the agreed upon action is low; this is made possible by powerful algorithms that can monitor and compare the prices of one’s competitors. In the US, the DoJ in 1994 settled accusations that six airlines used a jointly owned computerized online booking system, the Airline Tariff Publishing, to communicate and set collusive airline fares (Capobianco, 2017).

Ezrachi & Stucke (2016) use the term ‘frenemies’ to refer to a relationship between competitors, who collude at first and then compete for their share in the collusive outcome. The authors describe a possible situation wherein the super-platforms, Apple, Google, Facebook and Amazon, firstly collude with one another and then compete for their share of the spoils. The super-platforms collude not only among themselves, but also each collaborates with a host of other players. A possible version of this played out in the EU v. Google, Inc. (2017), wherein Google had been alleged to favour its own comparison shopping product, Google Shopping, in its general search results pages. The European Commission was concerned that users did not necessarily see the most relevant results, and this practice also disadvantaged vertical search engines. Therefore, Google favoured its own clientele in Google Shopping. Interestingly, Brin & Page (1998) highlighted this inherent contradiction between an efficient search engine and an advertising-based revenue model. While the cases against Google in EU and US may have been settled, this inherent

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13 With the world migrating to smartphones and tablets, the 4 listed firms above will assume immense importance in shaping the world (Ezrachi & Stucke, 2016)

14 They are specialized search engines. For instance, Zomato is an app for restaurants in India, while Trivago is a search specializing for booking and comparing hotel prices.
contradiction would undoubtedly create complexities in the future, and competition agencies would need to deal with not only the cure but also prevention of such phenomena, through better policy design and enforcement.

Another issue that came up in a few Indian cases was that of investigating the impact of common ownership on product market outcomes. For instance, in Meru v. ANI Technologies, the plaintiff pointed out the fact that there were 3 common investors between Uber and Ola, namely, Softbank, Sequoia Capital and Didi Chuxing. Also, SoftBank emerged as a substantial common investor, with a 20% stake in Uber (and the right to appoint 2 out of 17 of its directors), and 25% stake in Ola. CCI had itself pointed out that two theories of harm were possible in such a scenario; firstly, unilateral price increase that is unprofitable for a firm but beneficial for shareholders who hold stocks of the competitor firm could be resorted to as a joint strategy by the firms. Secondly, there is an increased incentive to resort to collusion, on account of common ownership. CCI acquitted four such cases at the prima facie stage due to the absence of empirical proof of common ownership, again signalling a rather non-interventionist stance. The Commission’s order reasoned as follows for acquittal at the prima facie stage; “However, recent empirical research does not suggest with certainty that common ownership is likely to generate anti-competitive effects in every market situation.” CCI reasoned non-violation of Section 3 stating that “there is no evidence furnished which could suggest that Uber and Ola have any role in decision for common investment in these two companies.” Section 4 non-violation was reasoned as follows; “even if contention of the informant is accepted that both Uber and Ola have secured a dominant position as a group pursuant to common ownership, the existence of dominance in itself cannot be held to be the basis to order investigation. Existence of alleged abusive conduct under the provisions of Section 4(2) of the Act is sine qua non to order investigation under the Act.”

VI. REGULATORY DEBATES

Since the implementation of the Sherman Act in 1890 in the US, the first piece of legislation to restrain anti-competitive trade practices in the world, several nations have now in place a Competition Law (Antitrust Law in the US) to regulate the conduct of businesses. The intent of these legislations have been discussed and debated for over a century now, and there is still ambiguity over best practices and a lack of consensus. The debate is multi-pronged; and perhaps at the most fundamental level, the question is if competition law is a tool to address equity or efficiency.\(^\text{15}\)

The dominant belief is that competition regulation must endeavour to maximize efficiencies in the economy (Bork, 1966; Posner, 2009). It must be emphasized that even in the efficiency school of thought, the consumer welfare standard is emphasized (Hovenkamp & Areeda, 2000). This school focuses on the maximization of the consumer surplus as a measure of consumer welfare. Bork (1978) in his famous

\(^{15}\)Efficiency is the maximization of the producer and consumer surplus in the economy through the utilisation of scarce resources
treatise ‘The Antitrust Paradox’ goes to the extent of saying that any other standard or objective apart from the maximization of consumer welfare would yield counter-productive outcomes. The majority of the jurisdictions the world over, including the likes of US and EU, have adopted this standard. Canada and South Africa are two countries known to embrace the total welfare standard, which would also imply a greater role for economic analysis in competition adjudication, as synergies and efficiencies may need to be quantified more precisely and juxtaposed with consumer welfare. A total welfare approach could then essentially mean that a merger could reduce consumer welfare, but the competition authority permits the same on the basis of the fact that the merger more than makes up through synergies.

The equity approach to competition law has contained in itself several strands; distributive justice by empowering consumers rather than large corporations (Lande, 1982; Salop & Baker, 2015) and protection of medium and small-scale businesses (Elzinga, 1977). Lande (1982) traces the intent of the Congress at the time of framing the Sherman Act to be one of protecting the consumers from exploitation by large corporations, and thereby prevent the adverse transfer of incomes from the relatively poor to the relatively rich. Salop & Baker (2015) claim that increase in producer surplus as a result of market power benefits the executives of the company and the shareholders and not so much the median consumer, and the authors go on to suggest certain measures to incorporate equity considerations in antitrust. Elzinga (1977) brings forth the issue of providing a level-playing field to small and medium enterprises such that they would be in a position to compete with large conglomerates, and competition law, apart from focussing on efficiency, has the above as the other major objective. South Africa and Indonesia are two emerging nations that have built into their competition regulation equity considerations to account for the historical socio-economic issues of apartheid and control by Chinese minority respectively (Fox, 2000).

The classic debate around regulatory philosophy assumes a special significance in the context of our current discussion. We have seen how two-sided markets are blurring boundaries between the producer, consumer, and intermediation service provider (Crespo, 2016). In this context, is there a need to question the notions of consumer welfare in efficiency considerations? Is there a need to bring in the concept of total welfare to holistically account for the two-sidedness of the market where both sides, i.e. the drivers and riders, customers and sellers, etc. could both be considered as “consumers” of the intermediation service? Would such an approach be better at handling newer sources of risk where potential predatory strategies on either of the side could potentially have spiral effects on both the sides as seen earlier (Behringer & Filistrucchi, 2015; Fletcher, 2007)?

Colomo (2018) has captured the crux of the debate in competition regulation today in this 2 x 2 matrix below. He starts off with a broad distinction between discretionalsists and legalists. The former is considered to belong to the school of thought that believes in getting every case right at all costs, even at the cost of consistency and predictability of enforcement. The latter acknowledges the fact that
enforcement errors in the form of false positives and true negatives are inevitable and that one needs to focus on consistency and predictability of enforcement.

Figure 6: Division in the Competition Law Community (Source: (Colomo, 2018))

It is to be noted that an effects-based approach is compatible with both a discretionalists and a legalist view of enforcement. Now coming to the four quadrants of the matrix, the author mentions that some economists focus exclusively on the question of whether the intervention will be welfare increasing or welfare-decreasing, and refers to this group as ‘welfare discretionalists’. There may be other scholars who focus on designing generalizable rules and standards, in order to get it right on the majority of occasions. They are not perturbed with the thought of getting things wrong on certain occasions, and instead, value consistency and predictability. This group is referred to as ‘substance legalists’.

‘Public interest legalists’ would provide public authorities with as much discretion as possible, even at the cost of economic principles. This group would consider ‘consumer welfare’ standard as a narrow benchmark, and they would believe in incorporating a broader range of economic and non-economic considerations. The ‘New Brandeis Movement’ belongs to this category. Khan (2018) sums up the movement in five agenda points as follows; firstly, anti-monopoly is a key tool in a democracy for ‘industrial liberty’. Secondly, Anti-monopoly would encompass all policies working in harmony to ensure a common goal, of which antitrust is, just one such policy. Thirdly, Khan clarifies that New Brandeisians don’t necessarily think that ‘Big is bad’ and it rather deals with not only the design of regulation but also the design of incentives for executives to ensure that they do not exploit their power. Fourthly, Khan stresses that the New Brandeis Movement focusses on structures and processes of competition rather than outcomes. Lastly, they believe that political economy is structured through law and policy rather than market forces. Ezrachi & Stucke (2018) point toward the Chicago School losing its popularity in the US and the New Brandeis Movement gaining momentum on the back of mounting evidence indicating greater concentration, greater profits and greater wealth inequality.

The last quadrant of the matrix in Figure 6 is ‘formal legalists’, a group that is sceptical about economic principles in competition, and places as much value on consistency and predictability as the ‘substance
legalists’. This group would be in favour of establishing ‘bright lines’ for identifying anti-competitive practices.

Categorizing major jurisdictions across the globe, Colomo (2018) points to the fact that regulators in EU traditionally followed the ‘public interest discretionalists’ path, but after the modernization of the antitrust machinery, they are now more on the ‘welfare discretionalists’ path. The US has been known to adopt the ‘substance legalist’ approach, modeled on the lines of the Chicago School.

In our opinion, CCI inherited from the MRTP Commission a ‘formal legalist’ path but realized that it had to change with the new economic order and has since looked to adopt the ‘welfare discretionalist’ path and has not been able to do so on account of low to medium economic reasoning. Its non-interventionist policies, reflected by the number of acquittals at the prima facie stage, coupled with a lack of internal consistency and predictability seems to give an impression that it is ‘stuck in the middle’ of the matrix between the two paths mentioned above.

Nevertheless, we believe that the above matrix isn’t able to capture India’s stance of high flexibility, low conviction rates and little to moderate economic reasoning. Also, the degree of economic reasoning is a rather subjective measure to capture data on for several reasons; firstly, there are several points of view in economics and it would be hard to give weightage to one type of economics over the other (should the current standard of ‘consumer welfare’ be given more weightage over the Harvard School and the New Brandeis Movement?). The larger question in this regard is whether ‘consumer welfare’ must be considered the only legitimate application of competition regulation, despite the fact that the New Brandeis Movement has exposed that decades of regulation based on ‘consumer welfare’ has resulted in greater mark-ups, greater profits and has not produced any evidence of an enhancement in consumer welfare standards globally. Secondly, even if one were to have consensus on the nature of economics that is considered legitimate, measuring the application of economics in judgements would be still quite a subjective call. A laden assumption running in the matrix is the degree of interventions (number of convictions). For instance, the formal legalist regimes will have the highest rates of conviction and the substance legalists will rank the lowest in this measure among the four categories. Public interest discretionalists will rank second in terms of conviction rates, followed by welfare discretionalists.

We construct a 3 x 2 matrix with degree of intervention and degree of discretion as the two axes. We argue that this is an improvement over Colomo (2018) for the following reasons; firstly, the degree of intervention can be captured by an objective measure (like the number of convictions) when compared to the degree of economic analysis, which would be a vague construct to measure. Secondly, our conceptualisation preserves the categories of Colomo (2018), and we are also able to account for newer categories and locate India’s jurisprudence better. We place India in the ‘market discretionalist’ category, characterised by low degree of intervention and a high degree of discretion. We have built our case by
detailing the number of prima facie acquittals, the non-adherence to precedents and increased flexibility exercised in judgements. This could also be attributed to low manpower and resources which the CCI functions with, mostly a handful, in comparison with a battery of hundreds of economists and lawyers in the Department of Justice and the European Commission.

![Figure 7: Categorizing regulatory styles across jurisdictions (Source: Authors)](image)

The other categories of Colomo (2018) fit neatly into our setup; Substance Legalists are on the one end of the spectrum (Chicago School, for instance), characterised by low levels of intervention and a low degree of discretion, while Formal Legalists are on the other end (Indian MRTP Act), characterise by high levels of intervention and low level of discretion. The ‘Brandeis Movement’ characterised by not only focussing on consumer welfare as a standard, but also incorporating elements of equity as an objective of antitrust have high levels of discretion and also high levels of intervention. Welfare Discretionals, a category that captures the regulatory style of EU, is characterised by moderate levels of intervention and a high degree of discretion.

**VII. CONCLUSION**

Two-sided markets have certainly revolutionized the way people do business. The higher the intensity of the transaction costs that it reduces, the higher the chances of it succeeding, with a critical mass on both sides and prospering on account of indirect network externalities. As more of these types of businesses crop up, the more the regulators need to assess whether their old tools of assessment would serve them for their purpose.

CCI, in a decade of its existence, has grown by leaps and bounds. There has been a spur of activity at the Commission. In our opinion, CCI inherited from the MRTP Commission a ‘formal legalist’ path but realized that it had to change with the new economic order and has since looked to adopt the ‘welfare discretionalist’ path and has remained unsuccessful in doing so. Its non-interventionist policies, reflected
by the number of acquittals at the prima facie stage, coupled with a high degree of flexibility and a low
degree of predictability place it in the “Market Discretionalist” category. This could also be attributed to
low manpower and resources which the CCI functions with, mostly a handful, in comparison with a
battery of hundreds of economists and lawyers in the Department of Justice and the European
Commission.

VIII. REFERENCES

http://doi.org/10.1525/sp.2007.54.1.23.


691.


Cambridge University Press.


Economics, 9, 7–48.


CCI. Builders’ Association of India v. CMA & Ors. (2016).


CCI. (2016c). *Case No. 96 of 2015: Meru Travel Solutions Private Limited (MTSPL) versus Uber India Systems Pvt. Ltd. & others.*

CCI. Vilakshan Kumar v. ANI Technologies (2016).


CCI. All India Vendors Association v. Flipkart (2018).


## IX. Appendix:

List of 25 cases used as part of the analysis:

<table>
<thead>
<tr>
<th>YEAR</th>
<th>PLAINTIFF</th>
<th>DEFENDANT</th>
<th>RELEVANT MARKET</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2015 (Case No. 6 of 2015)</td>
<td>M/S Fast Track Call Cab Pvt. Ltd.</td>
<td>M/S ANI Technologies Pvt. Ltd. (Ola)</td>
<td>Radio-Taxi Services in B’lore</td>
</tr>
<tr>
<td>2</td>
<td>2015 (Case No. 81 of 2015)</td>
<td>Meru Travel Solutions Pvt. Ltd.</td>
<td>Uber India Systems Pvt. Ltd.</td>
<td>Services offered by radio-taxis and yellow-taxis in Kolkata</td>
</tr>
<tr>
<td>3</td>
<td>2016 (Case No. 96 of 2015)</td>
<td>Meru Travel Solutions Pvt. Ltd.</td>
<td>Uber India Systems Pvt. Ltd.</td>
<td>Radio-Taxi Services in Delhi (CCI); Radio-Taxi Services in Delhi-NCR</td>
</tr>
<tr>
<td>4</td>
<td>2016 (Case)</td>
<td>Mega Cabs Pvt. Ltd.</td>
<td>M/S ANI Technologies Pvt. Ltd.</td>
<td>Radio-Taxi Services in Delhi</td>
</tr>
<tr>
<td>Case No.</td>
<td>Year</td>
<td>Parties Involved</td>
<td>Market Description</td>
<td>Order</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
<td>------------------</td>
<td>--------------------</td>
<td>-------</td>
</tr>
<tr>
<td>No. 82 of 2015</td>
<td>2016</td>
<td>Mr. Vilakshan Kumar Yadav &amp; Others M/S ANI Technologies Pvt. Ltd.</td>
<td>Radio-Taxi Services in Delhi</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>5</td>
<td>2018 (Case No. 25 of 2018)</td>
<td>Meru Travel Solutions Pvt. Ltd. M/S ANI Technologies Pvt. Ltd. (Ola), M/S Uber India Systems Pvt. Ltd.</td>
<td>Market for radio-taxi services in Hyderabad</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>7</td>
<td>2018 (Case No. 27 of 2018)</td>
<td>Meru Travel Solutions Pvt. Ltd. M/S ANI Technologies Pvt. Ltd., M/S Uber India Systems Pvt. Ltd.</td>
<td>Market for radio-taxi and yellow taxi services in Kolkata</td>
<td>Prima facie acquittal</td>
</tr>
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<td>9</td>
<td>2018 (Case No. 37 of 2018)</td>
<td>Samir Agarwal M/S ANI Technologies Pvt. Ltd. and Uber India Systems Pvt. Ltd.</td>
<td>Not Necessary</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>10</td>
<td>2014 (Case No. 17 of 2014)</td>
<td>Mr. Ashish Ahuja Snapdeal.com and Sandisk Corporation</td>
<td>Markets for portable consumer storage devices such as USB pen drives, SD memory cards and micro SD cards in India</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>11</td>
<td>2014 (Case No. 80 of 2014)</td>
<td>Mr. Mohit Manglani Flipkart &amp; Others</td>
<td>Indian Retail market</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>2</td>
<td>2016 (Case No. 34 of 2016)</td>
<td>Mr. Deepak Varma Clues Network Pvt. Ltd. &amp; Others</td>
<td>Indian Retail Market</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>Case No.</td>
<td>Year</td>
<td>Parties Involved</td>
<td>Market Description</td>
<td>Decision</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
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<td>----------</td>
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<td>14</td>
<td>2016</td>
<td>Confederation of Real Estate Brokers’ Association of India</td>
<td>The service for real estate brokers/agents in India</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>15</td>
<td>2016</td>
<td>Justickets Pvt. Ltd.</td>
<td>No relevant market required as abuse was not established</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>16</td>
<td>2018</td>
<td>All India Vendors’ Association</td>
<td>Online retail market</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>17</td>
<td>2018</td>
<td>Wal-mart International Holdings, Inc.</td>
<td>Indian Retail market</td>
<td>Combination approved without modification</td>
</tr>
<tr>
<td>18</td>
<td>2015</td>
<td>Ms. Bharti Verma</td>
<td>The market of services for providing subscription of e-journals to technical educational institutions as prescribed by AICTE in India</td>
<td>Prima facie acquittal</td>
</tr>
<tr>
<td>19</td>
<td>2012</td>
<td>Prints India</td>
<td>‘Publishing STM academic journals in English language’</td>
<td>Acquittal post DG inquiry</td>
</tr>
<tr>
<td>20</td>
<td>2012</td>
<td>Mr. Ramakant Kini</td>
<td>Provision of Maternity Services in by Super Speciality/High End Hospitals within a distance of 0-12 km. from the Hiranandani Hospital covering S,L,N,K/E,T &amp; P/S wards of Municipal Corporation of Greater Mumbai</td>
<td>Penalty levied</td>
</tr>
<tr>
<td>21</td>
<td>2018</td>
<td>Matrimony.com Ltd.</td>
<td>Market for Online Search Advertising Services in India</td>
<td>Acquittal post DG inquiry</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>Case No.</td>
<td>Party 1</td>
<td>Party 2</td>
</tr>
<tr>
<td>---</td>
<td>---------------</td>
<td>-----------------</td>
<td>----------------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>22</td>
<td>2018</td>
<td>(Case No. 30 of 2012)</td>
<td>Cuts (Consumer Unit Trust Society)</td>
<td>Google LLC &amp; 2 Others</td>
</tr>
<tr>
<td>23</td>
<td>2011</td>
<td>(Case No. 13 of 2009)</td>
<td>MCX Stock Exchange Ltd.</td>
<td>National Stock Exchange of India Ltd. (NSE) and DotEx International Ltd.</td>
</tr>
<tr>
<td>24</td>
<td>2016</td>
<td>(Case No. 70 of 2012)</td>
<td>Prasar Bharati</td>
<td>TAM Media Research Pvt. Ltd.</td>
</tr>
<tr>
<td>25</td>
<td>2018</td>
<td>(Case No. 30 of 2017)</td>
<td>Noida Software Technology Park Ltd.</td>
<td>Star India Pvt. Ltd. &amp; 2 others</td>
</tr>
</tbody>
</table>
Relationship between Cartels and Mergers & Acquisitions in Indian Cement Industry: A Firm Level Analysis

Neha Jaiswal¹, Pulak Mishra² and Indrajit Dube³

1. Introduction

The Indian cement industry has witnessed two sets of strategies in the past in the form of cartelization and mergers and acquisitions (M&A). Apparently, both the strategies help the firms to earn greater profitability. It is important to note that cartels are informal agreements and are per se anticompetitive, on the other hand, mergers and acquisitions are formal agreements subject to scrutiny beyond a certain threshold limit as specified under the Competition Act 2002.

The recent trend of the industry has recorded a large number of M&As with the majority of the deals being horizontal. While, the emerging oligopolistic market structure following M&A and cartelization by the firms in the industry have become a matter of greater concerns for the antitrust authority of the country, deepening of economic reforms and consequent growth of the infrastructure sector, have created new opportunities for the firms. It is, therefore, necessary to understand firms’ strategic reactions to regulatory interventions, especially through M&A. In this perspective, the present paper attempts to identify the factors that have influenced firms’ decisions for M&A in the industry. It is particularly important as the studies made in the past have shown that the strategy of M&A in many cases has been used as an alternative to escape from the penalties of cartelization by the firms. The paper intends to look into the determinants of M&A and precisely understand the relationship between M&A and cartels within the industry.

2. Literature Review:

Inter-linkages between the Cartelization and Mergers

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A group of firms which have agreed explicitly among themselves to coordinate their activities in order to raise market price through entering into some form of price fixing agreement is known as Cartel (Pepall et al., 2001). As per the Indian Competition Act 2002, cartel includes an association of producers, sellers, distributors, traders or service providers who, by agreement amongst themselves, limit, control or attempt to control the production, distribution, sale or price of, or, trade in goods or provision of services. Mergers and acquisitions can be referred to a set of activity undertaken when two or more entities come together to fetch positive returns from the synergistic gains. Under the Indian Competition Act 2002, the strategy of mergers, acquisitions and amalgamation are covered under an umbrella term Combination.

A swift change in strategy from cartelization to merger which ought to be seen in any industry has a history of its own. This change in strategy can be traced in various jurisdictions like in case of United Kingdom the Restrictive Trade Practices Act of 1956 had outlawed cartels which caused the beginning of the merger wave. The potential substitutable relationship between cartels and mergers is not very new. Rather, after cartelization was prohibited by the Sherman Act in the United States in 1890, companies started to merge with their rivals thereby contributing to the development of the first great merger wave (Bittlingmayer, 1985 and Mueller, 1996). In case of EU, cartels are prohibited subject to specific exemptions. Although, prohibiting cartels by law does not prevent existing of illegal collusion, the illegal cartels are found to be less stable than the legal ones, since illegal contracts cannot be enforced (Neumann, 1995).

As a result, after the banning of cartel by the Sherman Act the firms shifted to merger as an alternative strategy. As a result, in 1899 over 1200 firms disappeared owing to the consolidation process (Dankers and Bouwens, 2004). Studies in the past have made alternative stands on it; while Stigler, (1950) observes that the development of the antitrust law determines the choice between cartel and merger. On the other hand, there are studies showing no statistically significant relationship between the antitrust legislation and the consequent merger wave in case of Britain (Elliot and Gribbin, 1977).
Now, apparently both mergers and cartels helps the firms to earn greater profits still the first being permissible under the law while and the later being unacceptable. To understand this it becomes vital to understand the role of Competition Law as depicted in the diagram above. It is largely due to the efficiency and welfare enhancing defense which makes merger different from cartel. This stance is also supported by Mehra (2008) who have shown cartels and (horizontal) mergers as alternative arrangements to increase profitability and argues that the choice between the two forms is determined by factors such as the structure of industry, organization of firms, and existing antitrust laws. The study through a conjectural variation model shows that, in the absence of cartel fines, a firm always prefers a cartel to a merger when the latter does not involve any efficiency gains. She further shows that, when there is a perfect competition among the competitive fringe, firms do not have incentives to form a cartel and merge only if there are efficiencies involved.

The efficiency defense has a vital role to play for the existence of merger. The efficiency gains when interlinked with the alternatives available to the firms between cartel and merger also seem vital *i.e.*, a firm’s choice between cartel and merger depends on various factor. For example, in absence of a concrete antitrust policy a profit maximizing firm will find it convenient to form a monopoly through coordinated conduct obtained from cartel. The existence of cartel is mostly observed in absence of a concrete antitrust regime in place. Firms prefer cartels to merger as a way of extracting monopoly rents and in which the enforcement of a law against price fixing leads those firms to merge (Bertlingmayer, 1985).

Studies have also shown that firms might still prefer cartels over mergers due to the reduced capital requirements for cartels compared to mergers or expected diseconomies from merger. It is observed that such a behaviour can be rational (*i.e.*, profit-maximizing) as long as customers are
uncertain as to whether non-merged firms are operating as a cartel or not (Kumar et al., 2012). Neumann (1995) found that in case of German industries like cement, food processing, machine building, etc. adopted cartelist activities in order to attain monopolistic power only when mergers were not possible. Thus, a strong legal enforcement against cartels increases the relative cost of cartel as compared to merger. Consequently, firms resort to mergers. Evenett et. al., (2002), examining the pattern in duration for 1990s samples of international cartels, observe that joint ventures and mergers are among the different measures adopted by firms for survival, in cartel-prone industries where cartel formation is restricted.

Hüschelrath and Smuda, (2013) has studied the cartel cases decided by the European Commission (EC) between 2000 and 2011. The study finds an increase in merger transaction post the cartel breakdowns with an increase in horizontal mergers from the subset. Kumar et al., (2012) in his study found a key benefit of cartel formation versus merger is that a cartel can take advantage of customer beliefs that the policing action of competition is still in place. After the breakdown of cartels, anecdotal evidence often points towards an increased merger activity in the respective industries, thereby raising the question whether mergers must be considered as a potential “second-best” alternative to cartels (Langlais and Tropeano, 2013).

As cartels can only be considered as stable if most (larger) firms are participating in it, reduced incentives to merge can be expected. However, mergers might still take place (i) between cartelist, eg in order to discipline a cartel breaker, (ii) between cartelist and non-cartelist, eg in order to acquire a firm which refused to join the cartel, or (iii) between (smaller) non-cartel members, in an attempt to bundle powers against the cartel. (Hüschelrath and Smuda, 2013).

In case of India, it was only after 1984, the MRTP Act was amended to apply per se rule for restrictive trade practices, which included cartels and made it mandatory to register such agreements. However, a potential weakness of the Act was that the registration was left to the discretion of the parties. Further, the registration itself did not prevent the firms from carrying out such practices, unless it was decided by the Commission that the practice is “prejudicial to public interest” (De, 2005). Since, the coming of the Act in practice, it has developed a strong hold through its rich decisional practices. Therefore, in the present study the dynamic framework of Structure-Conduct-Performance along with the role of policy (i.e., Competition law) has been taken into consideration.
3. **Structure-Conduct-Performance of Indian Cement Industry Firms**

As discussed above the Indian cement industry is oligopolistic in nature. The table below rightly depicts the same. The table explains many of the crucial aspects of the industry like the level of concentration, entry and market position. The firms in the industry are highly concentrated with on an average only 1 firm having a market share of 16 percent (approximately) and 2 firms having a market share of 11 percent (approximately). The industry has not seen any significant entry as more or less the number of players in the market remains the same. Overall, the table depicts a concentrated market scenario with only few firms holding the top position through greater market share. The different measures of concentration computed in the form of Herfindahl-Hirschman Index (HHI), CR4 and CR10 also depicts the disparity of market concentration. More than, 55 percent of the market is held by top 4 firms, while more than 75 percent of the firm is held by top 10 firms in the industry. Thus, although the HHI is not being high still the market is highly concentrated. It also hints towards lacking of HHI in terms of a measure of concentration.

**Table 1 (a): Market structure of the Indian Cement Industry (20001-2015)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg No. of firms (%)</td>
<td>Avg Mkt Share (%)</td>
<td>Avg No. of firms (%)</td>
</tr>
<tr>
<td>1 &lt; Mkt Share &lt; 5</td>
<td>18 (78)</td>
<td>2.24</td>
<td>15 (72)</td>
</tr>
<tr>
<td>5 &lt; Mkt Share &lt; 10</td>
<td>2 (11)</td>
<td>7.43</td>
<td>4 (17)</td>
</tr>
<tr>
<td>10 &lt; Mkt Share &lt; 15</td>
<td>2 (9)</td>
<td>12.06</td>
<td>1 (7)</td>
</tr>
<tr>
<td>15 &lt; Mkt Share &lt; 20</td>
<td>1 (2)</td>
<td>16.47</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>23 (100)</td>
<td>21 (100)</td>
<td>23 (100)</td>
</tr>
</tbody>
</table>

Source: CMIE, Prowess

**Table 2 (b): Measures of concentration of the Indian Cement Industry (20001-2015)**

<table>
<thead>
<tr>
<th>Year</th>
<th>HHI</th>
<th>CR4</th>
<th>CR10</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1096.51</td>
<td>56.45</td>
<td>75.35</td>
</tr>
<tr>
<td>2001</td>
<td>1160.76</td>
<td>58.42</td>
<td>79.18</td>
</tr>
<tr>
<td>2002</td>
<td>1184.22</td>
<td>56.11</td>
<td>81.14</td>
</tr>
<tr>
<td>2003</td>
<td>1005.21</td>
<td>55.47</td>
<td>80.59</td>
</tr>
<tr>
<td>2004</td>
<td>1012.84</td>
<td>56.11</td>
<td>79.94</td>
</tr>
<tr>
<td>2005</td>
<td>1215.67</td>
<td>60.41</td>
<td>82.03</td>
</tr>
<tr>
<td>2006</td>
<td>1080.32</td>
<td>59.18</td>
<td>82.08</td>
</tr>
<tr>
<td>2007</td>
<td>982.58</td>
<td>56.55</td>
<td>80.68</td>
</tr>
<tr>
<td>2008</td>
<td>986.71</td>
<td>56.28</td>
<td>81.68</td>
</tr>
<tr>
<td>2009</td>
<td>946.62</td>
<td>53.32</td>
<td>83.14</td>
</tr>
<tr>
<td>2011</td>
<td>1147.03</td>
<td>59.25</td>
<td>86.13</td>
</tr>
<tr>
<td>2012</td>
<td>1202.28</td>
<td>58.42</td>
<td>86.18</td>
</tr>
<tr>
<td>2013</td>
<td>1220.36</td>
<td>59.82</td>
<td>86.34</td>
</tr>
</tbody>
</table>
One of the widely discussed objectives behind any M&A is the efficiency gains that are obtained through economies of scale through access to cheaper raw material due to increased size of purchases, better management, etc. In cement industry the production cost in terms of raw material, power and fuels and salaries constitute majority of the cost. The industry has been more or less consistent in terms of these types of costs. Adding to this is a long term over view shows an increase in the raw material expenditure within the sector. This can mainly be due to lack of domestic availability of raw material which has raised its import raising its overall cost. There is an overall decline in the power and fuels, salaries and wages and total production cost as a whole. Thus one needs to check whether this consistency and decline could actually be attributed to increase in M&A activity by the firms over the years or are due to any other factor. As seen in the table below the raw materials, power & fuels and salaries & wages forms major part of the cost of producing cement. It is seen that power & fuels forms majority of the cost incurred in producing cement.

Table 2: Costs incurred by the firms in the Indian Cement Industry (20001-2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>Raw Material/Sales (%)</th>
<th>Power &amp; Fuel/Sales (%)</th>
<th>Salaries &amp; Wages/Sales (%)</th>
<th>Total Cost/Sales (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>13.76</td>
<td>31.28</td>
<td>7.02</td>
<td>52.07</td>
</tr>
<tr>
<td>2001</td>
<td>11.01</td>
<td>26.67</td>
<td>6.30</td>
<td>43.98</td>
</tr>
<tr>
<td>2002</td>
<td>11.96</td>
<td>28.03</td>
<td>6.46</td>
<td>46.45</td>
</tr>
<tr>
<td>2003</td>
<td>10.62</td>
<td>25.43</td>
<td>5.14</td>
<td>41.19</td>
</tr>
<tr>
<td>2004</td>
<td>10.34</td>
<td>25.59</td>
<td>4.59</td>
<td>40.52</td>
</tr>
<tr>
<td>2005</td>
<td>9.53</td>
<td>22.67</td>
<td>4.24</td>
<td>36.44</td>
</tr>
<tr>
<td>2006</td>
<td>8.78</td>
<td>19.36</td>
<td>3.96</td>
<td>32.10</td>
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<td>2007</td>
<td>9.07</td>
<td>19.15</td>
<td>4.24</td>
<td>32.45</td>
</tr>
<tr>
<td>2008</td>
<td>9.98</td>
<td>22.39</td>
<td>4.75</td>
<td>37.12</td>
</tr>
<tr>
<td>2009</td>
<td>12.14</td>
<td>19.81</td>
<td>4.80</td>
<td>36.76</td>
</tr>
<tr>
<td>2011</td>
<td>13.51</td>
<td>22.14</td>
<td>5.36</td>
<td>41.01</td>
</tr>
<tr>
<td>2012</td>
<td>12.34</td>
<td>22.48</td>
<td>5.14</td>
<td>39.96</td>
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<td>2013</td>
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<td>21.67</td>
<td>5.38</td>
<td>39.96</td>
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<td>2014</td>
<td>13.23</td>
<td>21.20</td>
<td>5.63</td>
<td>40.06</td>
</tr>
<tr>
<td>2015</td>
<td>12.90</td>
<td>21.34</td>
<td>5.59</td>
<td>39.82</td>
</tr>
<tr>
<td>Average</td>
<td>11.47</td>
<td>23.28</td>
<td>5.24</td>
<td>39.99</td>
</tr>
<tr>
<td>TGR</td>
<td>1.08</td>
<td>-2.44</td>
<td>-1.04</td>
<td>-1.25</td>
</tr>
</tbody>
</table>

Source: CMIE, Prowess
Table 3: Selling strategies adopted by the firms in the Indian Cement Industry (2000-2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>Advertising/Sales (%)</th>
<th>Marketing/Sales (%)</th>
<th>Distribution/Sales (%)</th>
<th>Selling/Sales (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.62</td>
<td>2.55</td>
<td>15.12</td>
<td>18.29</td>
</tr>
<tr>
<td>2001</td>
<td>0.46</td>
<td>2.02</td>
<td>12.33</td>
<td>14.81</td>
</tr>
<tr>
<td>2002</td>
<td>0.56</td>
<td>1.93</td>
<td>12.01</td>
<td>14.50</td>
</tr>
<tr>
<td>2003</td>
<td>0.61</td>
<td>2.18</td>
<td>12.59</td>
<td>15.38</td>
</tr>
<tr>
<td>2004</td>
<td>0.75</td>
<td>1.86</td>
<td>12.74</td>
<td>15.35</td>
</tr>
<tr>
<td>2005</td>
<td>0.57</td>
<td>2.00</td>
<td>14.16</td>
<td>16.74</td>
</tr>
<tr>
<td>2006</td>
<td>0.56</td>
<td>1.77</td>
<td>13.28</td>
<td>15.61</td>
</tr>
<tr>
<td>2007</td>
<td>0.57</td>
<td>1.76</td>
<td>12.69</td>
<td>15.01</td>
</tr>
<tr>
<td>2008</td>
<td>0.58</td>
<td>1.88</td>
<td>13.06</td>
<td>15.52</td>
</tr>
<tr>
<td>2009</td>
<td>0.68</td>
<td>2.25</td>
<td>13.35</td>
<td>16.28</td>
</tr>
<tr>
<td>2011</td>
<td>1.04</td>
<td>2.34</td>
<td>15.09</td>
<td>18.46</td>
</tr>
<tr>
<td>2012</td>
<td>0.62</td>
<td>2.58</td>
<td>15.42</td>
<td>18.62</td>
</tr>
<tr>
<td>2013</td>
<td>0.63</td>
<td>2.51</td>
<td>16.11</td>
<td>19.25</td>
</tr>
<tr>
<td>2014</td>
<td>0.71</td>
<td>2.49</td>
<td>17.43</td>
<td>20.62</td>
</tr>
<tr>
<td>2015</td>
<td>0.65</td>
<td>2.41</td>
<td>18.03</td>
<td>21.09</td>
</tr>
<tr>
<td>Average</td>
<td>0.64</td>
<td>2.17</td>
<td>14.23</td>
<td>17.04</td>
</tr>
<tr>
<td>TGR</td>
<td>1.81</td>
<td>1.39</td>
<td>2.21</td>
<td>2.08</td>
</tr>
</tbody>
</table>

Source: CMIE, Prowess

Technological expenditure is also an important factor which helps to understand the structure of the market in a better manner. Market driven with high amount of competition makes technological expenditure as one of their vital strategy. As this helps them in two ways- firstly, it raises the efficiency in terms of increased output, better utilization of resources and having an edge over the competitors in terms of the better quality of the product. Secondly, increased technological advancement also helps to create a kind of barrier for new entry within the market. Although in a purely oligopolistic structure of market the cement sector has shown an increasing trend towards total technological expenditure. This implies the firms are driven with some amount of competition within the sector which would compel them to adopt cost reducing or higher value added product technique reflected in increasing technology expenditure. This increasing trend could also be due to raised M&A activities within the sector where the firms come together in order to raise their selling efficiency along with technological advancement.
Table 4: Technology strategies adopted by the firms in the Indian Cement Industry (20001-2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>R&amp;D/Sales (%)</th>
<th>Domestic Tech Pur/Sales (%)</th>
<th>Foreign Tech Pur/Sales (%)</th>
<th>Total Tech Pur/Sales (%)</th>
<th>Import of Capital goods /Sales (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.13</td>
<td>0.90</td>
<td>0.60</td>
<td>1.49</td>
<td>0.51</td>
</tr>
<tr>
<td>2001</td>
<td>0.13</td>
<td>1.28</td>
<td>0.89</td>
<td>2.17</td>
<td>0.83</td>
</tr>
<tr>
<td>2002</td>
<td>0.09</td>
<td>1.42</td>
<td>1.35</td>
<td>2.77</td>
<td>1.30</td>
</tr>
<tr>
<td>2003</td>
<td>0.08</td>
<td>1.34</td>
<td>0.46</td>
<td>1.80</td>
<td>0.43</td>
</tr>
<tr>
<td>2004</td>
<td>0.07</td>
<td>1.20</td>
<td>0.61</td>
<td>1.81</td>
<td>0.50</td>
</tr>
<tr>
<td>2005</td>
<td>0.07</td>
<td>1.31</td>
<td>0.95</td>
<td>2.26</td>
<td>0.88</td>
</tr>
<tr>
<td>2006</td>
<td>0.07</td>
<td>1.11</td>
<td>2.07</td>
<td>3.18</td>
<td>2.02</td>
</tr>
<tr>
<td>2007</td>
<td>0.06</td>
<td>0.91</td>
<td>3.29</td>
<td>4.20</td>
<td>3.24</td>
</tr>
<tr>
<td>2008</td>
<td>0.07</td>
<td>0.89</td>
<td>2.18</td>
<td>3.07</td>
<td>2.10</td>
</tr>
<tr>
<td>2009</td>
<td>0.06</td>
<td>1.21</td>
<td>3.00</td>
<td>4.20</td>
<td>2.91</td>
</tr>
<tr>
<td>2011</td>
<td>0.07</td>
<td>1.26</td>
<td>2.56</td>
<td>3.82</td>
<td>2.44</td>
</tr>
<tr>
<td>2012</td>
<td>0.05</td>
<td>1.13</td>
<td>1.09</td>
<td>2.22</td>
<td>1.00</td>
</tr>
<tr>
<td>2013</td>
<td>0.05</td>
<td>1.16</td>
<td>0.97</td>
<td>2.13</td>
<td>0.88</td>
</tr>
<tr>
<td>2014</td>
<td>0.07</td>
<td>1.43</td>
<td>1.11</td>
<td>2.53</td>
<td>0.81</td>
</tr>
<tr>
<td>2015</td>
<td>0.08</td>
<td>1.59</td>
<td>1.02</td>
<td>2.61</td>
<td>0.75</td>
</tr>
<tr>
<td>Average</td>
<td>0.08</td>
<td>1.21</td>
<td>1.48</td>
<td>2.68</td>
<td>1.37</td>
</tr>
<tr>
<td>TGR</td>
<td>-4.78</td>
<td>0.99</td>
<td>3.62</td>
<td>2.44</td>
<td>3.05</td>
</tr>
</tbody>
</table>

Source: CMIE, Prowess

Profitability rises with a decrease in cost. As observed in the table above over the years firms have increased total technological expenditure have tried to reduce their production cost causing a raise in its profitability. Firms have also been efficient in terms of raising their return on capital employed and net fixed assets. While the cement industry which has been over the years known for its high capital intensiveness over the years has declined its capital intensity. Technological advancement also facilitates exporting intensity of the firms as it makes them internationally competitive. The tables above are indicative of the fact that the Indian cement industry although has improved its technological base but still lacks in technological advancement to compete internationally. Moreover cement is a bulky commodity and thus transportation cost comprises a huge part of its cost. Thus, the plants within the sector are domestic in nature distributed in various geographical locations and catering the demand of that region. This can be one of the vital reasons for the industry’s incompetency to contribute in trade balance.
Table 5: Returns by the firms in the Indian Cement Industry (20001-2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>ROCE/Sales (%)</th>
<th>ROA/Sales (%)</th>
<th>PBITA/Sales (%)</th>
<th>PAT/Sales (%)</th>
<th>EXPORT/Sales (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>10.45</td>
<td>10.05</td>
<td>14.63</td>
<td>-5.38</td>
<td>1.43</td>
</tr>
<tr>
<td>2001</td>
<td>12.99</td>
<td>11.11</td>
<td>14.47</td>
<td>-3.03</td>
<td>1.59</td>
</tr>
<tr>
<td>2002</td>
<td>14.70</td>
<td>12.89</td>
<td>18.37</td>
<td>-1.64</td>
<td>1.81</td>
</tr>
<tr>
<td>2003</td>
<td>17.25</td>
<td>13.20</td>
<td>20.18</td>
<td>2.68</td>
<td>5.27</td>
</tr>
<tr>
<td>2004</td>
<td>17.79</td>
<td>14.07</td>
<td>19.28</td>
<td>4.50</td>
<td>6.48</td>
</tr>
<tr>
<td>2005</td>
<td>27.38</td>
<td>22.63</td>
<td>26.47</td>
<td>12.96</td>
<td>6.54</td>
</tr>
<tr>
<td>2006</td>
<td>34.26</td>
<td>32.41</td>
<td>31.08</td>
<td>17.21</td>
<td>5.30</td>
</tr>
<tr>
<td>2007</td>
<td>32.81</td>
<td>36.27</td>
<td>33.69</td>
<td>18.38</td>
<td>3.28</td>
</tr>
<tr>
<td>2008</td>
<td>24.11</td>
<td>27.95</td>
<td>30.16</td>
<td>15.03</td>
<td>3.27</td>
</tr>
<tr>
<td>2009</td>
<td>24.61</td>
<td>30.06</td>
<td>34.08</td>
<td>16.49</td>
<td>2.09</td>
</tr>
<tr>
<td>2011</td>
<td>17.69</td>
<td>19.60</td>
<td>25.25</td>
<td>9.78</td>
<td>1.26</td>
</tr>
<tr>
<td>2012</td>
<td>19.63</td>
<td>21.75</td>
<td>24.42</td>
<td>9.87</td>
<td>0.90</td>
</tr>
<tr>
<td>2013</td>
<td>18.37</td>
<td>20.74</td>
<td>22.95</td>
<td>8.88</td>
<td>0.67</td>
</tr>
<tr>
<td>2014</td>
<td>14.91</td>
<td>16.28</td>
<td>20.23</td>
<td>6.53</td>
<td>1.10</td>
</tr>
<tr>
<td>2015</td>
<td>14.03</td>
<td>14.87</td>
<td>19.50</td>
<td>5.13</td>
<td>0.92</td>
</tr>
<tr>
<td>Average</td>
<td>20.06</td>
<td>20.26</td>
<td>23.65</td>
<td>7.83</td>
<td>2.79</td>
</tr>
<tr>
<td>TGR</td>
<td>0.86</td>
<td>2.91</td>
<td>2.12</td>
<td>10.63</td>
<td>-7.19</td>
</tr>
</tbody>
</table>

Source: CMIE, Prowess

The economic transition of 1991 led to a strategic transition by the firms to compete in the new liberalized environment. Of such strategies M&A had a predominant role. Like any other industry the Indian cement industry also reacted to the consecutive wave of M&A and adopted it as one of its vital strategy. It could be largely due to the fact that creation of fresh Greenfield capacity requires a huge amount of investment. Additionally, to increase the geographic reach and access to raw material this will in turn help to overcome the demand and supply constraints. There lies limitation in terms of area for setting up of new business along with a gestation period of 3-4 years. Therefore, acquiring or merging with other firm provides a feasible solution for the players within this industry. In terms of the nature of deal the sector witnessed majority of the deals to be horizontal in nature. A rise in horizontal deal could imply that the firms concentrated more on raising the market share and raising profitability through efficiency gains which might be in the form of production reshuffling through utilizing the unused capacities, scale of economies and using the technological and innovative capacities of each other.

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5 In the present study the categorization of M&A deals into horizontal, vertical and conglomerate is based upon analyzing the details of the deal and sub-industry grouping of target firm, acquiring firm and selling firm. A horizontal deal is one in which both the firms sell homogenous or similar goods. On the other hand in a vertical deal a firm acquires or merges with either a consumer or supplying firm. While in a conglomerate deal apparently there is no relationship between the two entities.
Table 6: Mergers and Acquisitions deal within the Indian Cement Sector (20001-2015)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal (%)</td>
<td>2001</td>
<td>54 (54.55)</td>
<td>34 (34.34)</td>
<td>88</td>
</tr>
<tr>
<td>Vertical (%)</td>
<td>2001</td>
<td>32 (59.26)</td>
<td>16 (47.06)</td>
<td>48</td>
</tr>
<tr>
<td>Conglomerate (%)</td>
<td>2001</td>
<td>8 (14.81)</td>
<td>9 (26.47)</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2001</td>
<td>12 (22.22)</td>
<td>9 (26.47)</td>
<td>21</td>
</tr>
</tbody>
</table>

Source: Bloomberg database

Table 7: M&A deals approved by CCI since (2011-2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>Acquirer/Investor</th>
<th>Target</th>
<th>Nature of Combination</th>
<th>Penalty under cartel detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>Paris Cement Investment Holdings Limited</td>
<td>Lafarge India Private Limited.</td>
<td>Conglomerate</td>
<td>Yes (Target )</td>
</tr>
<tr>
<td>2013</td>
<td>JSW Steel Limited</td>
<td>Heidelberg Cement India Limited</td>
<td>Vertical</td>
<td>-</td>
</tr>
<tr>
<td>2013</td>
<td>Ultratech Cement Limited</td>
<td>Jaypee Cement Corporation Limited</td>
<td>Horizontal</td>
<td>Yes (Acquirer )</td>
</tr>
<tr>
<td>2014</td>
<td>Shree Cements Limited</td>
<td>Jaiprakash Associates Limited</td>
<td>Horizontal</td>
<td>Yes (Target )</td>
</tr>
<tr>
<td>2015</td>
<td>Holcim Limited</td>
<td>Lafarge S.A.</td>
<td>Horizontal</td>
<td>-</td>
</tr>
<tr>
<td>2015</td>
<td>UltraTech Cement Limited</td>
<td>Jaiprakash Associates Limited</td>
<td>Horizontal</td>
<td>Yes (Acquirer &amp; Target )</td>
</tr>
<tr>
<td>2015</td>
<td>Financière Lafarge S.A.S</td>
<td>Paris Cement Investment Holdings Limited</td>
<td>Horizontal</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Jaiswal et. al., 2018

The dynamic SCP framework takes policy as an essential part of it. As observed from the sections above there is an improvement in the various competitive strategies and performance of the firms within the market. With the given background, it is essential to consider the role of the implementation of Competition Act. The Competition Commission of India (CCI) has detected cartelized behavior among the firms within the Indian cement industry. The Builders’ Association of India had alleged Cement Manufacturing Association and other top performing eleven cement manufacturing companies\(^\text{11}\) in the year 2010 to indulge in anticompetitive activities. The Commission judged the case in respect of violation of section 3 (1) (a) and (b) of the Competition Act, 2002\(^\text{12}\). Therefore with the help of analyzing the factors mentioned in Section 19 (d) to (f) to establish the contravention of section 3(3) (a) and (b) stood established. The commission thus exercised its powers and penalized the parties imposing a penalty of Rs 6,300 crore \(i.e.,\) 10% of their turnover for all 11 firms respectively) and Cement Manufacturer

\(^{11}\) These eleven companies were ACC, Gujarat Ambuja Cements Limited (now Ambuja Cements Limited), Ultratech Cements, Grasim Cements (now merged with Ultratech Cements), JK Cements, India Cements, Madras Cements, Century Textiles & Industries Limited, Binani Cements, Lafarge India and Jaiprakash Associates Limited.

\(^{12}\) For details about the Section see Competition Act, 2002.
Association of India was fined 10% of its total receipt since 2009 to 2011. The industry depicts some peculiar competition sensitive characteristics of high level of concentration, cartelization and merger and acquisition. Therefore, the consequent part of the study tries to understand the relationship M&A and cartelized behavior of the firm.

4. Model Specification

The paper intends to look into the determinants of M&A and precisely understand the relationship between M&A and cartels within the industry. The studies in the past have shown that M&As have been used as an alternative strategy to that of cartel. It has also been understood that the determinants of M&A cannot be generalized for all the industries simultaneously. Thus, in the present industry along with the conventional factors related to structure-conduct-performance-policy cartel also marks its importance. In order to find the factors determining M&A activity within the cement industry and especially the influence of cartels, the functional model in the study uses the SCP framework of Scherer and Ross (1990). In the present model it is assumed that the strategy of Mergers and Acquisitions (M&As) is determined by a set of factors relating to structure of the market, its strategic choices and performance, and policies of the government. Accordingly, the following the functional relationship is assumed:

\[
M&A = f(MSZ, \text{CAR}, \text{SELL}, \text{NEXP}, \text{PROF}, R&D, VERT) \tag{1}
\]

Here, MSZ stands for market size, CAR for the firm associated with cartel, SELL for selling intensity, NEXP for net export intensity, PROF for profitability, R&D for in-house intensity and VERT for vertical integration. While market size represents the structural aspect of the market, cartel, selling intensity, net exports and vertical integration are included in the model to control conducts of the firms. On the other hand, profitability of firms is used as a proxy of their financial performance. These variables can also be seen as a proxy for policy related changes made by the government.

The dynamic structure-conduct-performance-policy model is acquainted to the problem of endogeneity bias. As discussed in the literature above the independent variables for example R&D

\[^4\] In the present paper, financial performance of the firms is measured in terms of their profitability.
intensity can be influenced by the M&A activities made by the firm. Studies in the past have shown that R&D intensity made by a firm is influenced by the M&A activities made by the firm. Similarly, net exports made by the firms may be caused due to the M&A activities made by the firm. As shown in the studies made by Mishra & Jaiswal, (2018). Thus, the above functional specification may suffer from the problem of endogeneity. Further, impact of many of the independent variables may not necessarily be instantaneous. For example, firms’ market share and their strategies like R&D, Net exports, selling intensity and profitability are likely to influence M&A only with a time lag. On the other hand, impact of cartel and market size is likely to be largely instantaneous. In order to control non-instantaneity in the specified relationships, a one-year lag is introduced in each of these four independent variables. Such lag structure is also expected to reduce possible endogeneity bias in the envisaged relationship. Hence, the above functional specification can be rewritten as,

$$M&A_{it} = f(MSZ_{it}, CAR_{it}, SELL_{i,t-1}, NEXP_{i,t-1}, PROF_{i,t-1}, R&D_{i,t-1}, VERT_{i,t-1})$$ (2)

As mentioned above, the present paper assesses firms’ M&A activities in terms their frequency of engaging into such activities. It is assumed that a firm makes two decisions, viz., whether to engage in the strategy of M&A, and if so, how upto what extent. The extent of M&A may depend on a different set of factors as compared to that influencing the likelihood of M&A. It is also possible that there are common factors that affect both incidence of M&A and its extent. The impact is examined at two levels – (i) incidence of M&A, and (ii) extent of M&A.

5. Probable Impact of the Independent Variables

**Market Size (MSZ):** Market size represents the total value of the industry including all the players in the market. An industry with greater market size is ought to have greater profits and market growth opportunities. This attracts new firms to enter into the market. Mergers and Acquisition facilitates the entry of new firms into the market. However, if the market is highly concentrated, innovation driven and possesses regulatory barrier, even a high market size won’t induce customers to enter into the market through M&A. Therefore, the impact of market size on the market depends on the nature of the industry and other players present in the market.
**Selling Intensity (SELL):** Selling intensity comprises of advertising, distribution and marketing expenditures made by the firms. A better advertising strategy helps the firm to disseminate information about its product to the consumers. This further gives the firm an opportunity to not only strengthen its position in the market but also to build a new image for its products. Studies, in the past have even shown advertising posing barriers to entry in the market. On the other hand, marketing and distribution also helps the firm to create a strong customer base through easy access and availability of the same and new opportunities. A mix of all the three i.e., advertising, marketing and distribution can facilitate the firm to have a grip over the existing and also attract new customers in the market. This may raise firm’s concentration in the market. In order to achieve the above, the target and the acquirer may adopt the strategy of M&A, where they can use access and complement each other’s selling strategy. An increase in concentration through this strategy may motivate firm to engage into M&A.

**In-house R&D Intensity (R&D):** In-house R&D enables the firm to develop capabilities which help firm to assimilate and exploit knowledge from the external environment (Cohen et. al., 1987). Innovation and in-house R&D induces firms to induce the level of M&A in the market, i.e., to compete in the market firms acquire or merge with firms having high R&D base. Studies have also shown that firms with high propensity of merging have lower R&D expenditure than those not participating in M&A activity (Danzon et al., 2007). Additionally, studies have also shown that R&D intensity of firms is negatively associated with propensity to acquire Duflos and Pfister (2008).

**Net Export Intensity (EXP):** Entry into international market is usually entitled to sunk costs in the form of gathering information or establishing marketing and distribution networks (Roberts and Tybout, 1997). This might in turn help the firm to have greater productivity and wider reach in the international market. In order to domestically replicate the international success, firms may induce the strategy of M&A positively. On the other hand, export intensive firms in order to cater the international market might not find M&A as a vital strategy. Based on this line of argument, one may expect the firms with higher net export intensity to have lower M&A intensity and vice-versa.
Profitability (PROF): The economic benefit earned in terms of profits earned is the ultimate goal of any firm to adopt the strategy of M&A. Andrade and Stafford (2004) also noted that profitability doesn’t play a significant role in firm’s decision on merger investment but it does impact non-merger investment positively. The profits earned by a firm on the one hand induce firms to engage in M&A activities. On the other hand, greater profits may also restrict firms, i.e., if a firm already enjoys greater market share and profits M&A may not incentivize the firm.

Cartel (CAR): These are form of agreement in which firms’ coordinate their activities in order to raise market price and earn greater profits. These agreements are not only related to price fixing but also activities such as bid-rigging (collusive tenders), output restrictions and quotas, allocation of customers, suppliers, territories, and lines of commerce (Crampton, 2003). A merger can also be seen as an alternative arrangement to increase profit mainly due to existence of antitrust law, nature of industry and organization of firms. Therefore, after cartel breakdown the firms may engage in M&A activities as an alternative to cartel to gain similar or increase the level of profits. Alternatively, post the cartel breakdown the firms may not choose M&A strong antitrust enforcement.

6. Methodology and Data
The strategy of M&A adopted by a firm can be divided into two parts, i.e., (i) will the firm adopt the strategy of M&A, and next is (ii) upto what extent it should be adopted. The incidence and extent of M&A are measured as follows:

(a) Incidence of M&A: It is measured as a dummy dependent variable. The variable takes the value “1” if a firm engages into M&A and zero otherwise.

(b) Extent of M&A: It is measured in terms of the number of times a firm engages into the strategy of M&A. The variable takes the value as per the given number of times a firm merges or acquires another firm.

In the present study to assess both these decisions made by the firm probit and tobit model are estimated. The Probit model will help to check the impact of cartel on the incidence of M&A. The Tobit model is estimated to examine the impact of cartel on the extent of M&A. The Tobit model captures the restriction on the values of dependent variable (Tobin, 1958). The given
models are estimated using panel dataset of 36 cement producing firms over the period of 2000-01 to 2013-14. The paper uses panel data estimation techniques for a set of 36 cement producing firms over the period from 2000-01 to 2013-14. Tobit and Probit models are estimated in this regard. Random effect models (REM) is estimated for Tobit and Probit models. In the REM, it is assumed that the intercept of a particular firm is a random drawing from a large population with a constant mean value. In other words, in the REM the intercept of a firm is expressed as a deviation from the constant population mean (Gujarati and Sangeeta, 2007). The deviation of firm specific intercept from population mean mainly as a sample of 36 firms is drawn from a large number of population.

The models are estimated by applying the maximum likelihood method of estimation. Since the dependent variable can be observed only when M&A by a firm takes place and 0 otherwise, there is a censoring of M&A at 0. To compare the pooled estimator with panel estimator a likelihood-ratio test is conducted. In order to check for multicollinearity problem variance inflation factors (VIF) are also computed. The present paper is based on secondary data collected from the Centre for Monitoring Indian Economy (CMIE), Mumbai, India. While detailed information on M&A are compiled from the Bloomberg, financial data are sourced from its Prowess database.

7. Results and Discussions

As discussed above in the present paper Probit and Tobit models are used to understand and examine the impact of cartel on incidence and extent of M&A. The summary statistics of the variables used in the regression models are presented in Table 9. Table 10 & 11 reports the regression results of the envisaged Probit model and Tobit model. It is observed that the LR-χ² is statistically significant for both the Probit and Tobit model. This means that both the models are statistically significant.

5 With this censoring of the dependent variable, the mean value of the error term becomes different from zero and application of OLS will, therefore, violate the basic assumption of the classical linear regression model that the expected value of the error term is zero. In other words, application of OLS method in such a situation will lead to biased estimator (Mishra & Jaiswal, 2017).
Table 8: Summary Statistics of the Variables Used in Regression Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Observation</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>M&amp;A Frequency</td>
<td>504</td>
<td>0.069</td>
<td>0.291</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>MSZ&lt;sub&gt;t&lt;/sub&gt;</td>
<td>500</td>
<td>0.079</td>
<td>0.022</td>
<td>0</td>
<td>0.123</td>
</tr>
<tr>
<td>CAR&lt;sub&gt;t&lt;/sub&gt;</td>
<td>504</td>
<td>0.250</td>
<td>0.433</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SELL&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>502</td>
<td>0.118</td>
<td>0.074</td>
<td>0</td>
<td>0.531</td>
</tr>
<tr>
<td>NEXP&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>504</td>
<td>0.028</td>
<td>0.096</td>
<td>-0.086</td>
<td>1.083</td>
</tr>
<tr>
<td>PROF&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>502</td>
<td>0.001</td>
<td>0.514</td>
<td>-9.502</td>
<td>0.956</td>
</tr>
<tr>
<td>R&amp;Di&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>502</td>
<td>0.000</td>
<td>0.001</td>
<td>0</td>
<td>0.011</td>
</tr>
<tr>
<td>VERT&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>502</td>
<td>0.004</td>
<td>0.002</td>
<td>-0.012</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Table 3: Regression Results of Probit Model

<table>
<thead>
<tr>
<th>II. Incidence of M&amp;A</th>
<th>Variable</th>
<th>IV. Coefficient</th>
<th>V. z-Stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-2.54**</td>
<td>-5.28</td>
<td></td>
</tr>
<tr>
<td>MSZ&lt;sub&gt;i,t&lt;/sub&gt;</td>
<td>13.97*</td>
<td>1.69</td>
<td></td>
</tr>
<tr>
<td>CAR&lt;sub&gt;i,t&lt;/sub&gt;</td>
<td>0.59**</td>
<td>2.09</td>
<td></td>
</tr>
<tr>
<td>SELL&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>-0.97</td>
<td>-0.42</td>
<td></td>
</tr>
<tr>
<td>NEXP&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>-2.15</td>
<td>-0.79</td>
<td></td>
</tr>
<tr>
<td>PROF&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>1.48*</td>
<td>1.69</td>
<td></td>
</tr>
<tr>
<td>R&amp;Di&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>-94.11</td>
<td>-0.75</td>
<td></td>
</tr>
<tr>
<td>VERT&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>-80.73</td>
<td>-0.94</td>
<td></td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-99.20</td>
<td>18.63**</td>
<td></td>
</tr>
<tr>
<td>LR χ² (7)</td>
<td>18.63**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Observations</td>
<td>499</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures in the parentheses indicate respective degrees of freedom
Likelihood Ratio Test for examining overall significance of the estimated model
**Statistically significant at 5 per cent level of significance
*Statistically significant at 10 per cent level of significance

Table 4: Regression Results of Tobit Model

<table>
<thead>
<tr>
<th>VI. Extent of M&amp;A</th>
<th>Variable</th>
<th>VIII. Coefficient</th>
<th>IX. z-Stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-5.22**</td>
<td>-3.96</td>
<td></td>
</tr>
<tr>
<td>MSZ&lt;sub&gt;i,t&lt;/sub&gt;</td>
<td>28.89*</td>
<td>1.63</td>
<td></td>
</tr>
<tr>
<td>CAR&lt;sub&gt;i,t&lt;/sub&gt;</td>
<td>1.18*</td>
<td>1.96</td>
<td></td>
</tr>
<tr>
<td>SELL&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>-2.02</td>
<td>-0.44</td>
<td></td>
</tr>
<tr>
<td>NEXP&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>-5.06</td>
<td>-0.86</td>
<td></td>
</tr>
<tr>
<td>PROF&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>3.15*</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>R&amp;Di&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>-191.57</td>
<td>-0.75</td>
<td></td>
</tr>
<tr>
<td>VERT&lt;sub&gt;i,t&lt;/sub&gt;-1</td>
<td>-166.67</td>
<td>-0.93</td>
<td></td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-131.21</td>
<td>13.12**</td>
<td></td>
</tr>
<tr>
<td>LR χ² (7)</td>
<td>13.12**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Observations</td>
<td>499</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures in the parentheses indicate respective degrees of freedom
Likelihood Ratio Test for examining overall significance of the estimated model
The result shows that in the probit model, the coefficient of MSZ, CAR and PROF are statistically significant. These variables are positively related to M&A. This largely implies that the incidence of M&A by a firm is significantly influenced by its market size, cartelized behaviour and profits earned by it and has a higher probability to engage in M&A. However, the coefficients of SELL, NEXP, R&D and VERT are not statistically significant. Hence, these variables have no significant impact on incidence of firms’ M&A in Indian cement industry.

In the Tobit model, on the other hand, the coefficient of MSZ, CAR and PROF are statistically significant and are positively related to M&A. The extent of M&A by a firm is significantly influenced by its market size, cartelized behaviour and profits earned and have a higher probability to engage in greater number of M&A. However, similar to probit model the coefficients of SELL, NEXP, R&D and VERT are not statistically significant. Hence, these variables have no significant impact on the extent of firms’ M&A activities in Indian cement industry.

The above results clearly show that the incidence and extent of M&A activities in the Indian cement industry is more for firms engaged in cartel, earning greater profits and market size. The result largely implies that mergers are seen as an alternative arrangement to cartel i.e., firms engaged in cartels post its detection have taken M&A as an alternative to cartel to gain similar or increase the level of profits Langlais and Tropeano (2012), finds that the extent that a tougher anti-cartel action triggers more mergers and vice-versa. The result indicates that the size of the cement industry has attracted greater number of firms to engage in M&A activities. This is largely to have greater profits and market growth opportunities. Lastly, the result also implies that greater profits have attracted firms to adopt the strategy of M&A. The paper also finds that selling strategy, net exports, R&D and Vertical integration does not affect the M&A behavior of the firms. This is largely important as all these factors conventionally are thought to influence the M&A behavior of the firm.
8. Summary and Conclusions

The present paper makes an attempt to understand and examines the impact of cartels on the M&A behavior of the firm. The impact is assessed at two levels, viz. incidence of M&A, and extent of M&A. The paper uses panel data estimation techniques for a set of 36 cement producing firms over the period from 2000-01 to 2013-14. The study finds that market size, cartel and profitability positively influence M&A. While other theoretically and empirically discussed determinants of M&A like Selling Intensity, Net Exports, R&D Intensity and Vertical Integration didn’t stand to affect the M&A activities of the firms. The findings of the present paper indicate towards the use of M&A as an alternative strategy by the cartel intensive firms in the Indian cement industry.

Thus, the result largely indicates that cartels have a significant role in the incidence and extent of M&A behavior of the firm in the Indian cement industry. Therefore, in an industry which is has shown both cartels and M&A as its vital strategy requires certain cautions to be taken care of. The Competition authority should consider the past behavior of cartel when cartel induced firms comes for M&A scrutiny. The authorities should take the prior collusion history of the industry into account during the merger control procedure. This should particularly be done in order to avoid the replacement market power and abusive behavior through the mode of M&A. The results are largely important in terms of understanding and revising the policy related dimensions of the industry. The cartel breakdown follows M&A is largely important to understand the whether the firms still continue to fetch the benefits such as price rise and practice abusive behavior through the shift from collusive behavior to unilateral conducts. The post M&A scrutiny particularly of the cartel induced firms is important in this regard. In this context, it is largely argued that the abuse of dominance behavior is captured through Section 3 and 4 of the present Competition Act. Still, keeping track of cartel induced firms M&A activity post combination is a vital step in this regard. This will particularly help the authority to identify whether the unilateral conduct causes any harm to the existing level of competition in the market.
Reference:


The nexus between Product Market Competition and Productivity Growth: Evidence from Indian Manufacturing Sector

1. Introduction

Competition in the product market improves the total factor productivity of the firm mainly through the allocative efficiency, productive efficiency and the dynamic efficiency channel. While allocative efficiency induces the firm for the efficient allocation of resources, productive efficiency induces the firm for efficient use of factors of production. Through enhancing the dynamic efficiency of the firms, there is increase in the innovation attitude of the firms and consequently, the improved productivity.

According to Schumpeter (1942) product market competition affects productivity through the channel of innovation. Increased product market competition reduces the ex-post monopoly rents of the firm and therefore, the intensity to innovate. As a result, increased competition reduces the productivity of the firm in the long run. The early endogenous growth theories of Romer (1990), Aghion and Howitt (1992) and the industrial organization literature assume that most of the innovations are made by outsiders or by new entrants that enhance the ex-post monopoly rents of the firm. But the new endogenous growth theories of Aghion et al. (1997) and Aghion et al. (2001) illustrate that the incumbent firms’ intensity to innovate depends on the net innovation rent. The net innovation rent being the difference between the post-innovation rent and the pre-innovation rent, competition reduces firm’s pre-innovation rent more than the post-innovation rent. As a result, these models predict that competition increases productivity of the firm by increasing the innovative activities of the firm. The agency theories of Hart (1983), Nalebuff and Stiglitz (1983), Willig (1987) argue that managers work at the sub-optimal level due to the principal-agent problem of the firm. Greater competition between firms provides managers the incentives to improve their enterprise’s performance to avoid bankruptcy, take-over, or other loss of control.

The study of the role of product market competition in influencing productivity growth of Indian manufacturing firms has assumed significance due to several reasons. Both the first and second
generation reforms have led to the intensification of product market by introducing new products and processes, abolishing trade restrictions, thereby reducing the transaction costs for entry and exit into the market. While studies on this issue are plenty in developed countries, it has been given the least attention in the developing region. In this context and in the context of limited studies on the issue in India, our sample of Indian manufacturing firms provides a thorough justification to be verified. Therefore, the basic objective of the paper is to understand the competition–productivity nexus in case of Indian manufacturing firms.

The remainder of the paper is as follows. Section 2 reviews the literature on the role of product market competition in productivity growth. Section 3 provides the empirical framework. Section 4 describes the data. Section 5 discusses the empirical results and the last section concludes.

2. Literature Review

Many theoretical and empirical studies have been carried out to examine the relationship between competition and productivity growth of the firm. This section presents review of the literature mostly of the empirical studies and the theoretical studies are given in the introduction section.

Investigating the impact of market concentration on innovative activities over the period of 1945 to 1983 Geroski (1990) has found that there is an inverse relationship between the concentration ratio and the innovative activities in U.K. Nickell (1996) takes a sample of 670 U. K. firms over the period of 1972 to 1986 and finds that there exists a positive relationship between product market competition and TFP growth. Using micro-econometric establishment-level data Blanchflower and Machin (1996) find that competition enhances labour productivity. Nickell et al. (1997) has found three channels such as the comparison of performance under information asymmetry, high price elasticity of demand and hard work for bankruptcy avoidance through which competition fosters productivity growth. Studies like Caves and Barton (1990), Caves(1992), Green and Mayes (1991), Blundell et al.(1999), Januszewski et al. (2002), Disney et al. (2003), Okada (2005), Funakoshi and Motohashi (2009), Ospina and Schiffbauer (2010), Reenen (2011), Lanau and Topalova (2016) confirm the existence of a positive relationship between product market competition and firm level productivity.
While Laffont (1998) has found that competition may not have positive impact on the developing countries’ productivity, Djankov and Murrel (2002) have found that product market competition has resulted in improved productivity in case of transition economies. Studies like Zitzewitz (2001), Bartel and Harrison (2005), Sekkat (2009) have highlighted the productivity slowdown in the absence of competition in U.S. and U.K, Indonesia and Egypt, Jordan and Morocco respectively. While some of the studies verify a linear relationship between product market competition and productivity growth, some other studies find a non-linear relationship between competition and productivity growth. Studies such as Scherer (1965), Scherer and Ross (1990), Aghion et al. (2005), Tingvall and Poldahl (2006) and Inui et al. (2012) illustrate the non-linear relationship between competition and productivity growth.

In case of Indian manufacturing industry Goldar (1986), Shrivastava (1996) and Ramaswamy (1999) find positive impact of product market deregulations on firm level productivity growth. Investigating the relationship between product market competition and productivity Kato (2009) has concluded that smaller is the market share of a firm, the higher is the productivity growth of the firm and the effect is more prominent in a less concentrated market. Pant and Pattanayak also (2010) in case of India find that the relationship between product market competition and firm level productivity is positive in nature.

From the above mentioned studies it is clear that some degree of competition is necessary for bringing out the innovative activities of the firm. In the Indian context, studies on the role of product market competition in productivity are quite limited (Kato, 2009; Pant and Pattanayak, 2010). Moreover, these studies have not examined the relationship between competition and productivity of firms on the basis of different dimensions like their R&D intensity or technological gap. Our study contributes to the literature in two different ways. We not only examine the relationship between product market competition and productivity growth of overall manufacturing firms but check their robustness by segregating them on the basis of R& D intensity, efficiency and technological gap. We also perform the industry level analysis to examine the nexus between competition and productivity at the industry level.
3. Empirical Framework

3.1 Variables

The dependent variable is the total factor productivity growth measured by using the Levinsohn-Petrin method (2003). The major explanatory variable in this paper is the product market competition analyzed through rent. While rent has been taken as the proxy for the product market competition at the firm level, inverse Herfindahl-Hirschman Index has been taken as the proxy for product market competition at the industry level. The relationship between product market competition and productivity can be negative or positive depending on the theoretical approaches.

Rent has been taken as the measure of firm level product market competition (Koke, 2001; Koke and Renneboog, 2005; Pant and Pattanayak, 2010). It is interpreted as an ex-post measure of the market power. The real motivation for using rent as the measure of product market competition is that less competitive environment enables firms to sell their products above the marginal cost. So, the firms earn higher rent after covering their expenses. This implies that rent from production activities will be less in a higher competitive environment. In this context, the relationship between rent and productivity will be the reverse of the relationship between product market competition and firm level productivity. Rent is calculated as total sales less labour, raw material, power and capital cost normalized by gross value added.

Apart from this, other variables like size of the firm (SIZE), age of the firm (AGE), disembodied technological intensity (DISEMB), embodied technological intensity (EMB), R&D intensity of the firm (RDINT), advertisement intensity (ADINT) and import intensity of raw materials (IMPT) have been included as the control variables. While comparing the list of variables of our study with the similar other studies, we find that while rent has been taken as the key explanatory variable in few studies (Koke, 2001; Koke and Renneboog, 2005; Pant and Pattanayak, 2010), the other corporate control variables have been used in accordance with the suitability of the study. Studies like Ospina and Schiffbauer (2010), Kato (2009), Pant and Pattanayak (2010) have used the corporate control variables such as size, age of the firm, technology of the firm, firm dummy variables to examine the relationship between product market competition and productivity growth. This is in concordance with our list of variables.
3.2. Model Specification

Assuming a linear relationship between competition and other firm specific control variables and firm level total factor productivity growth the model has been specified as follows:

\[
\text{TFP}_{it} = \alpha + \beta_1 \text{COMP}_{it} + \beta_2 \text{SIZE}_{it} + \beta_3 \text{AGE}_{it} + \\
\beta_4 \text{DISEMB}_{it} + \beta_5 \text{EMB}_{it} + \beta_6 \text{RDINT}_{it} + \beta_7 \text{ADINT}_{it} + \beta_8 \text{IMPT}_{it} + \varepsilon_{it} \ldots \ldots \ldots (1)
\]

Further, to analyze the impact of competition on the productivity at the industry level we have specified the model as follows:

\[
\text{AvgTFP}_{jt} = \Psi + \nu_j + \nu_t + \nu_1 \text{Comp}_{jt} + \eta_jt \ldots \ldots \ldots (2)
\]

where \(\text{AvgTFP}_{jt}\) is the average TFP at the industry \(j\) at time \(t\), \(\nu_t\) is the time dummy, \(\nu_j\) is the industry dummy and \(\nu_1\) is the regression coefficient. \(\text{Comp}_{jt}\) is the measure of competition at industry \(j\) at time \(t\) i.e. inverse of HHI. \(\eta_jt\) is the idiosyncratic error term of industry \(j\) at time \(t\).

We have also investigated the impact of competition on productivity dispersion in order to verify whether competition reduces or widens the TFP gap. Aghion et al. (2005) and Aghion and Griffith (2005) argue that the relationship between market competition and innovative activities depends on the technology level of the firm and market competition should widen the technological gap across firms. But whether there is widening or narrowing of technology gap needs to be empirically verified. For this, we have specified the following equation.

\[
\text{DISTFP}_{jt} = \Omega + \theta_j + \theta_t + \theta_1 \text{Comp}_{jt} + \Xi_{jt} \ldots \ldots \ldots (3)
\]

Where \(\text{DisTFP}_{jt}\) represents the dispersion of TFP defined as the standard deviation of the logarithm of TFP in industry \(j\) at time \(t\). \(\theta_t\) is the time dummy. \(\theta_j\) is the industry dummy. \(\theta_1\) is the regression coefficient. \(\Xi_{jt}\) is the error term. \(\text{Comp}_{jt}\) is the industry measure of competition i.e. inverse HHI. \(\text{DisTFP}_{jt}\) has been calculated as standard deviation of total factor productivity of the firms of the particular sub-industry for each year.

3.3 Methodology
The model (1) has been estimated using dynamic panel data methods using the system Generalized Method of Moments (GMM) technique. While the GMM estimation procedure was introduced by Holtz-Eakin, Newey and Rosen (1988) and has been developed consequently by Arellano-Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998), still the basic estimation procedure i.e. difference GMM has got several criticisms.\(^1\) Beck, Levine and Loayza (2000) argue that if the original model is conceptually in levels, differencing may reduce the power of tests by reducing the variation in the explanatory variables. Arellano and Bover (1995) suggest that variables in levels may be weak instruments for first-differenced equations. First-differencing may exacerbate the impact of measurement errors on the dependent variables (Griliches and Hausman, 1986). Arellano and Bover (1995) and Blundell and Bond (1998) argue that these shortcomings can be mitigated and GMM estimator can be improved by also including the equations in levels in the estimation procedure. We can use the first-differenced variables as instruments for the equations in levels in a stacked system of equations that includes the equations in both levels and differences. This produces a system GMM estimator. With the system GMM estimator, we obtain efficient estimates while controlling for time-invariant unobserved heterogeneity, simultaneity between the current values of the explanatory variables and past values of the dependent variables. We have reported the system GMM results in this study. Models (2) and (3) have been estimated using the OLS technique.

4. Data

Data for the study has been collected from CMIE Prowess. The time period for this study is from 1997-98 to 2016-17. We have chosen a sample of 596 firms from the total manufacturing companies for the analysis on the basis of their continuous nature. We have segregated the sample on the basis of their efficiency, R&D intensity and technological gap. The logic is that there exists a parallel line of research (see Foster et al, 2001) which not only focuses on the productivity growth but also on the micro-evidence that predicts the sources of productivity differentials across various producing units. They highlight the decomposition\(^2\) of aggregate productivity growth may be decomposed into within, between, cross, entry and exit effect. For the brevity of simplicity and data availability, the present study restricts its analysis of productivity growth decomposition into only within and between categories.

\(^{1}\)Cited from Wintoki et al. (2012)

\(^{2}\) Aggregate productivity growth may be decomposed into within, between, cross, entry and exit effect. For the brevity of simplicity and data availability, the present study restricts its analysis of productivity growth decomposition into only within and between categories.
productivity growth into within and between firm-effect components. The within firm-effect components describe that the reason behind productivity growth differential lies in the efficiency and intensity through which inputs are used in production. The effect of resource reallocation across existing firms resulting in high-productive firms through innovation and technological diffusion are captured by between firm-effect components. These components as the potential sources of productivity differential cannot be simply ignored in our study. That’s why after analyzing the nexus between product market competition and productivity growth, the present study considers it in two-ways. First, we consider the impact of within firm-effect component of productivity differential. For this, we consider the average efficiency score of firms and split the overall sample by relatively efficient and inefficient category (and so their effect on productivity via competition). Second, we diagnose the impact of between effect component of productivity differential by bifurcating the sample into R&D and non-R&D firms category representative of the innovation of the firm. Aghion et al. (2005) and Aghion and Griffith (2005) find that the innovative activities of the firm due to product market competition depends on the technology level of the firm. They argue that the productivity of the firms having less technological gap are likely to increase because of their increasing innovation activities. Third, we also bifurcate the sample on the basis of their technological gap (as firms of level and unlevel industries) to understand their impact on productivity growth. Here, we may expect that the nature of relationship among the variables may differ from sample to sample. This is because of the heterogeneity among the firms undertaken for the study. In order to capture the effect of heterogeneity, various sub samples have been taken in the study. The sign and the significance of the coefficients of different independent variables may change due to this heterogeneity issue and may remain unchanged otherwise.

We have given efficiency score to all firms with the firm having highest TFP ranked as 1. Similarly, all other firms are given the efficiency score. After giving the firms efficiency score, we have segregated the firms on the basis of average efficiency score as more efficient and less efficient firms. Firms having R&D activities are known as R&D firms. Firms which are not involved in any kind of R&D activities are known as non-R&D firms. Accordingly, there are 318 R&D firms and 278 non-R&D firms. We have also divided the sample as firms that belong to the level industries and un-level industries in order to check the robustness of the results. In order to segregate the firms under level and unlevel industries, we have taken the top 25% of the
firms in each sub-industry group and taken their average for each year. For that particular sub-industry group, the average figure of fifteen years has been calculated. The same exercise has been carried out for all the sub-industry groups. After getting the average productivity of all years of all the sub-industry groups, their median value has been taken as the base for deciding the level and unlevel industries. Industries having more than this median value are calculated as the unlevel industries and less than the median value are termed as level industries.

The level industries are those in which technology gap between the firms is small. On the other hand, unlevel industries are those where the technology gap between firms is high. Accordingly, in this study, basic metals, electrical equipment, machinery and equipment, other transport equipment industries are the level industries where the technology gap between the firms has been calculated to be less. Similarly, agro and food products industry, textiles, chemical and chemical products, pharmaceutical products and rubber and plastic are termed as unlevel industries.

5. Discussion of Results

This section has three parts. In the first part, we have reported the productivity estimates derived from Levinsohn- Petrin method (2003). In the second part we have reported the results of the impact of competition on firm level productivity growth and also discussed the robustness of the results through different subsamples. In the third part we have discussed the results of product market competition on the subsamples and hence verified the robustness of the results.

Table 1: Sample Selection

<table>
<thead>
<tr>
<th>Nature of Sample</th>
<th>No of Companies</th>
<th>Percentage to total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below efficiency</td>
<td>298</td>
<td>50</td>
</tr>
<tr>
<td>Above efficiency</td>
<td>298</td>
<td>50</td>
</tr>
<tr>
<td>R &amp;D firms</td>
<td>318</td>
<td>53.35</td>
</tr>
<tr>
<td>No R &amp;D firms</td>
<td>278</td>
<td>46.65</td>
</tr>
<tr>
<td><strong>Total manufacturing</strong></td>
<td><strong>596</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Author’s own calculations

5.1 Estimation of Total Factor Productivity

The estimated production function results reported in table 2 reveal that capital and labour are significant at the conventional level. The Wald's test of returns to scale implies decreasing
returns for the estimated production function as the null of constant returns to scale has been rejected. Using these results the total factor productivity of the firms is calculated.

**Table 2: Cobb-Douglas Production Function Estimation using Levinsohn-Petrin Productivity Estimator**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall manufacturing firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>LK</td>
<td>0.37 (10.11)*</td>
</tr>
<tr>
<td>LN</td>
<td>0.61 (2.54)**</td>
</tr>
<tr>
<td>Wald test p-value</td>
<td>0.12</td>
</tr>
</tbody>
</table>

**Notes:** 1. Z-test statistics are in parenthesis 2. Wald Test of Constant Returns to Scale. 3. Proxy variables: Power and fuel expenses; and raw material expenses

### 5.2 Impact of Competition on Firm Level Productivity

Before discussing the results we have reported the summary statistics, the correlation matrix of the variables used in the analysis to know how the variables behave. Table 3 presents descriptive statistics of all the independent variables used in the study.

**Table 3: Summary Statistics of the variables used in the study**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP</td>
<td>0.007</td>
<td>110.25</td>
<td>4.78</td>
<td>2.38</td>
</tr>
<tr>
<td>COMP</td>
<td>0</td>
<td>53</td>
<td>0.34</td>
<td>0.82</td>
</tr>
<tr>
<td>SIZE</td>
<td>0.26</td>
<td>13.62</td>
<td>5.95</td>
<td>2.48</td>
</tr>
<tr>
<td>AGE</td>
<td>0</td>
<td>4.89</td>
<td>2.72</td>
<td>1.48</td>
</tr>
<tr>
<td>DISEMB</td>
<td>-12.73</td>
<td>12.97</td>
<td>0.20</td>
<td>3.58</td>
</tr>
<tr>
<td>EMB</td>
<td>0.03</td>
<td>6.89</td>
<td>2.48</td>
<td>2.51</td>
</tr>
<tr>
<td>RDINT</td>
<td>0.04</td>
<td>5.27</td>
<td>1.94</td>
<td>2.92</td>
</tr>
</tbody>
</table>

**Notes:** This table presents descriptive statistics for all the variables used in the study. COMP is rent in this case measured as total sales less labour, raw material, power and capital cost normalized by gross value added. Size is measured as log of total assets. AGE is measured as the difference between current year and incorporation year. DISEMB is disembodied technological intensity measured by the ratio of royalties and technical know-how to sales of the firm. EMB is embodied technological intensity measured by the ratio of import of capital goods to sales of the firm. RDINT is R&D intensity measured by the ratio of R&D expenses to sales of the firm. ADINT and IMPT are advertisement intensity and import of raw materials intensity consecutively.

**Table 4: Correlation Matrix of the Variables Used In the Study**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Rent</th>
<th>SIZE</th>
<th>AGE</th>
<th>MB</th>
<th>EMB</th>
<th>RDINT</th>
<th>ADINT</th>
<th>IMPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIZE</td>
<td>0.02</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGE</td>
<td>0.01</td>
<td>0.72</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISEMB</td>
<td>-0.02</td>
<td>0.67</td>
<td>0.69**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMB</td>
<td>-0.01</td>
<td>-0.46</td>
<td>0.26</td>
<td>0.27</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RDINT</td>
<td>-0.02</td>
<td>0.34**</td>
<td>0.19</td>
<td>0.22</td>
<td>0.26</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADINT</td>
<td>0.01</td>
<td>0.24</td>
<td>0.16</td>
<td>0.18</td>
<td>0.12</td>
<td>0.05*</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>IMPT</td>
<td>0.001</td>
<td>-0.28</td>
<td>0.15</td>
<td>0.17</td>
<td>0.25</td>
<td>0.16</td>
<td>0.07</td>
<td>1.00</td>
</tr>
<tr>
<td>VIF</td>
<td>1.00</td>
<td>3.05</td>
<td>2.55</td>
<td>2.20</td>
<td>1.34</td>
<td>1.16</td>
<td>1.07</td>
<td>1.12</td>
</tr>
</tbody>
</table>

**Notes:** This table reports the correlation matrix between the independent variables used in this study. For variable explanation see notes in table 4.4. *** indicates significance at 1% level, ** indicates significance at 5 % level and * indicates significance at 10 % level respectively
Table 4 shows the correlation matrix of all the independent variables used in the analysis and the value of variance inflation factor (VIF). The correlation matrix shows that correlations between some of the independent variables are statistically significant. But the correlation between independent variables is either of low or of moderate degree which may rule out the multicollinearity problem. VIF statistics shows how the variance of an estimator is inflated by the presence of multicollinearity. As the extent of collinearity increases, the variance of an estimator increases. If the VIF of a variable exceeds 10, that variable is said to be highly collinear. Table 4 reveals that the variables used in the study are free from multi-collinearity problem.

Table 5: Impact of competition on firm level productivity of the overall firms

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP (-1)</td>
<td>0.87***</td>
</tr>
<tr>
<td></td>
<td>(49.85)</td>
</tr>
<tr>
<td>COMP</td>
<td>-0.03***</td>
</tr>
<tr>
<td></td>
<td>(-3.98)</td>
</tr>
<tr>
<td>SIZE</td>
<td>0.33***</td>
</tr>
<tr>
<td></td>
<td>(4.47)</td>
</tr>
<tr>
<td>AGE</td>
<td>-0.39***</td>
</tr>
<tr>
<td></td>
<td>(-5.39)</td>
</tr>
<tr>
<td>DISEMB</td>
<td>0.04***</td>
</tr>
<tr>
<td></td>
<td>(2.22)</td>
</tr>
<tr>
<td>EMB</td>
<td>0.02**</td>
</tr>
<tr>
<td></td>
<td>(1.89)</td>
</tr>
<tr>
<td>RDINT</td>
<td>-0.15*</td>
</tr>
<tr>
<td></td>
<td>(1.79)</td>
</tr>
<tr>
<td>ADINT</td>
<td>-0.16**</td>
</tr>
<tr>
<td></td>
<td>(-2.31)</td>
</tr>
<tr>
<td>IMPT</td>
<td>0.02**</td>
</tr>
<tr>
<td></td>
<td>(2.49)</td>
</tr>
<tr>
<td>AR(1) p-value</td>
<td>0.00</td>
</tr>
<tr>
<td>AR(2) p-value</td>
<td>0.98</td>
</tr>
<tr>
<td>Hansen test of over identification p-value</td>
<td>1.00</td>
</tr>
<tr>
<td>Diff-in-Hansen test of exogeneity p-value</td>
<td>1.00</td>
</tr>
<tr>
<td>No. of observations(N)</td>
<td>8330</td>
</tr>
</tbody>
</table>

Notes: 1. Numbers in parentheses represent the t-value.
2. ***, **, * represent 1%, 5% and 10% level of significance respectively.

Table 5 presents the GMM results of competition on firm level productivity growth across the whole sample of firms. The AR (1) p-value and AR (2) p-value from the GMM estimation results of table 5 indicate that while AR(1) p-value rejects the null hypothesis of first-order serial correlation, the rejection of null of second-order serial correlation is not possible. It means
that there is no first-order serial autocorrelation but there is second-order autocorrelation. Hansen test of p-values do not reject the null that our instruments are valid, thereby proving that we have valid instruments for GMM estimation. So, the results shown in the GMM estimation tables show that the procedure for GMM estimation is correct and the instruments are also valid instruments.

The results presented in table 5 reveal that lagged TFP has a positive impact on the productivity growth of overall manufacturing. As described above, rent has been taken as the proxy for competition. It is well known that rent activities of the firm are higher in a less competitive environment, so the existence of rent means competition is less in the firm. The results reveal that rent has a negative significant impact on the productivity growth of overall manufacturing. This indicates that there has been a positive and significant relationship between competition and firm level productivity of overall manufacturing of India. This is consistent with the agency theory that competition reduces agency problem between owners and managers. This is also consistent with the previous studies that competition has a positive impact on the firm level productivity growth (Alchian, 1950; Stigler, 1958; Holmstrom, 1982; Nalebuff and Stiglitz, 1983). While our results for India give a positive relationship between product market competition and productivity growth, comparison with other countries can give us the reality of the issue across the globe. As found by Okada (2005), Product market competition, measured by lower level of price-cost margin, has a positive impact on the productivity growth in Japanese manufacturing industries. Taking three alternative data sets, Aghion et al. (2008) find that the South African manufacturing industries have significantly higher mark-ups in comparison with the world. They also find the existence of a positive relationship between product market competition and productivity in South Africa. Bourlès et al. (2013) investigate the impact of competition in intermediate goods markets on productivity downstream. Examining the data on a panel of fifteen OECD countries and twenty industries between 1985 and 2007, they find that anticompetitive regulations have significantly curbed TFP growth over the past fifteen years, particularly for the productive firms. The results indicate that increasing competition in upstream sectors could increase TFP growth by 1 to 1.5 percentage points per year. Using the Australian workplace data Rogers (2004) finds out that competition increases productivity growth. But in the non-managerial workplace there has been no impact of competition on productivity growth.
The results from table 5 reveal that size is positively related with productivity which is consistent with the previous literature (Jovanovic, 1982; Malerba, 1992). Age has been negatively related to total factor productivity growth of overall manufacturing firms. It suggests that younger firms are more productive. It may be due to the fact that younger firms being more energetic and dynamic contribute to the productivity in a positive way. Both disembodied and embodied technology play a positive role in productivity determination suggesting the fact technology plays a very significant role in productivity improvement (Lall, 1987; Scott-Kemis and Bell, 1988). Both R&D intensity and advertisement intensity are negatively related with productivity growth of the firms. The negative role of R&D intensity on productivity could be because these firms are not driven by the innovation motive. Import intensity of raw materials is positively related with firm productivity, indicating that it works well as a competition channel in Indian context.

5.3 Robustness Check

Table 6. Impact of competition on productivity across different categories of firms

<table>
<thead>
<tr>
<th>Variables</th>
<th>R&amp;D firms</th>
<th>Non-R&amp;D firms</th>
<th>More efficient firms</th>
<th>Less efficient firms</th>
<th>Firms of level industries</th>
<th>Firms of unlevel industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP (-1)</td>
<td>0.86***</td>
<td>0.87***</td>
<td>0.85***</td>
<td>0.64</td>
<td>0.87***</td>
<td>0.81***</td>
</tr>
<tr>
<td></td>
<td>(36.07)</td>
<td>(40.48)</td>
<td>(45.78)</td>
<td>(3.29)</td>
<td>(36.93)</td>
<td>(16.71)</td>
</tr>
<tr>
<td>COMP</td>
<td>-0.52***</td>
<td>-0.01***</td>
<td>-0.12***</td>
<td>-0.003</td>
<td>-0.004**</td>
<td>-0.02***</td>
</tr>
<tr>
<td></td>
<td>(-5.49)</td>
<td>(-4.19)</td>
<td>(-2.19)</td>
<td>(-1.16)</td>
<td>(-2.36)</td>
<td>(-4.48)</td>
</tr>
<tr>
<td>SIZE</td>
<td>2.40***</td>
<td>0.18***</td>
<td>0.43***</td>
<td>0.08***</td>
<td>0.38***</td>
<td>0.41***</td>
</tr>
<tr>
<td></td>
<td>(5.62)</td>
<td>(4.67)</td>
<td>(4.03)</td>
<td>(4.57)</td>
<td>(2.67)</td>
<td>(4.36)</td>
</tr>
<tr>
<td>AGE</td>
<td>-0.54***</td>
<td>0.25***</td>
<td>0.55***</td>
<td>0.12***</td>
<td>0.37***</td>
<td>-0.15***</td>
</tr>
<tr>
<td></td>
<td>(-4.27)</td>
<td>(4.99)</td>
<td>(4.16)</td>
<td>(5.60)</td>
<td>(2.60)</td>
<td>(-4.36)</td>
</tr>
<tr>
<td>DISEMB</td>
<td>0.08***</td>
<td>0.009</td>
<td>0.05***</td>
<td>0.02*</td>
<td>0.08***</td>
<td>0.03***</td>
</tr>
<tr>
<td></td>
<td>(3.41)</td>
<td>(0.05)</td>
<td>(2.51)</td>
<td>(1.38)</td>
<td>(3.36)</td>
<td>(2.01)</td>
</tr>
<tr>
<td>EMB</td>
<td>0.002</td>
<td>-0.03*</td>
<td>0.11</td>
<td>0.06*</td>
<td>-0.06***</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(0.14)</td>
<td>(-1.82)</td>
<td>(0.83)</td>
<td>(1.86)</td>
<td>(-2.62)</td>
<td>(0.86)</td>
</tr>
<tr>
<td>RDINT</td>
<td>-</td>
<td>-</td>
<td>0.27**</td>
<td>-0.01*</td>
<td>0.61**</td>
<td>-0.15*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1.90)</td>
<td>(-1.77)</td>
<td>(2.01)</td>
<td>(-1.81)</td>
</tr>
<tr>
<td>ADINT</td>
<td>-0.36*</td>
<td>-0.01</td>
<td>-0.33***</td>
<td>-0.01</td>
<td>-0.60**</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(-1.85)</td>
<td>(-0.24)</td>
<td>(-2.05)</td>
<td>(-1.16)</td>
<td>(-2.28)</td>
<td>(-0.41)</td>
</tr>
<tr>
<td>IMPT</td>
<td>0.004*</td>
<td>0.03</td>
<td>0.11*</td>
<td>0.02*</td>
<td>0.08</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(1.34)</td>
<td>(0.25)</td>
<td>(1.59)</td>
<td>(1.41)</td>
<td>(0.55)</td>
<td>(0.65)</td>
</tr>
<tr>
<td>AR(1) p-value</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>AR(2) p-value</td>
<td>0.56</td>
<td>0.58</td>
<td>0.91</td>
<td>0.58</td>
<td>0.42</td>
<td>0.49</td>
</tr>
<tr>
<td>Hansen test of over identification p-value</td>
<td>0.96</td>
<td>1.00</td>
<td>0.91</td>
<td>1.00</td>
<td>0.87</td>
<td>1.00</td>
</tr>
<tr>
<td>Diff-in-Hansen test exogeneity</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.95</td>
</tr>
</tbody>
</table>
For robustness check, we have divided the firms on the basis of R & D intensity. Firms having R&D intensity are R&D firms. Firms having no R & D intensity at all are called as non-R&D firms. The results of robustness on the basis of R&D intensity are given in table 6. The results reveal that the relationship between competition and firm level productivity is in the same line in the case of both R&D and non-R & D firms as found from overall manufacturing firms. For other control variables the results differ somewhat between the R&D and non-R&D firms. Size is positive and significant in case of both R & D and non-R&D firms. While age plays a negative and significant role in case of R&D firms, in case of non-R&D firms, age plays a positive significant role. While disembodied technological intensity plays a positive and significant role for R&D firms, advertisement intensity is negatively related to productivity for R&D firms. But for non-R&D firms, advertisement intensity and import intensity of raw materials do not have any significant role. It is well known that competition affects productivity of the firm through innovation. So, testing for the robustness of competition and productivity provides a justification as R&D intensity ultimately affects the innovative attitude of the firms (Inui et al., 2012). Somehow, the magnitude of positive relationship between competition and productivity in the case of R & D and non-R & D firms is different which is evident from the results.

The robustness of results has been checked on the basis of efficiency rankings of the firms. The relationship between competition and firm level productivity for more efficient and less efficient firms is given in table 6. We find that the results are consistent with the baseline results of overall manufacturing firms. But for the less efficient firms, the relationship between competition and firm level productivity has not been consistent. Although there has been a negative relationship between rent and firm level productivity, it has not been significant. For other control variables the results are more or less consistent with the baseline regression. While size is positive and significant in case of both high and low efficient firms, age plays a positive significant role in productivity determination in case of high and low efficient firms. The results reveal that as the firms become old, their experience enables them to improve their productivity (Majumdar, 1997). Disembodied technology plays a positive and significant role in case of more
and less efficient firms, suggesting that technology is vital in case of these firms (Lall, 1987; Scott-Kemis and Bell, 1988). R&D intensity has negatively affected firm level productivity of both more efficient and less efficient firms. It may be because these firms are not guided by the innovation motives primarily. Overall, the highly efficient firms support the previous finding that competition affects productivity significantly in case of Indian manufacturing firms.

Further, in order to check the robustness we have defined certain industries as level industries. To identify level industries, we have measured the technology gap at the firm level in accordance with Inui et al. (2012). The technology gap at firm ‘f’ in industry ‘j’ is defined as the gap between the average lnTFP_{fj} within the top 25% of firms in the industry that firm ‘f’ belongs to and lnTFP_{fj}. Taking the average of the technological gap by industry, we have defined level industries as those where the average technological gap is lower than the median value. The results of the robustness at the industry level are given in table 6. The results reveal that competition has affected productivity positively in case of both level and unlevel industries. Although the magnitude is different in case of level and unlevel industries but the sign of rent is negative in case of both.

The control variables also differ to some extent in case of firms of both level and unlevel industries. Size plays a positive and significant role in case of both level and unlevel industries, indicating the fact that greater size of the firm leads to higher productivity growth. This is proved with the findings of Jovanovic (1982) and Malerba (1992) that due to the rigorous selection process, only more productive firms grow and survive in the industry and the firms which are small are bound to exit after sometime. Since the process takes a longer period of time, the positive relationship of size and productivity applies to age and productivity too. Age has been positive and significant in case of firms of level industries proving this argument. In case of unlevel industries, age has affected productivity of the firms negatively. It could be due to the fact that the positive effects of age on productivity such as learning by doing and Jovanovic-type of selection are outweighed by several negative effects. Disembodied technology has been able to affect productivity in case of both level and unlevel industries, indicating that technology is vital in order to enhance productivity (Lall, 1987). R&D intensity has negatively affected productivity in case of both level and unlevel industries. At the same time advertisement intensity has negatively affected productivity of the level industry. However, import intensity of raw materials has not been able to affect the productivity of both the industries. Overall, the
results suggest that product market competition has been able to influence the productivity of firms of both level and unlevel industries positively and significantly.

5.4 Industry Level Analysis

We have also measured competition at the industry level in order to investigate the impact of industry level competition on productivity growth. We have taken the average TFP of the manufacturing industry as the dependent variable. As Hirschman-Herfindahl Index (HHI) measures the market power or market concentration of the industry, we have taken inverse of HHI as the competition measure. The two-digit classification of industries as suggested by NIC, 2008, there are 24 sub-industries under Indian manufacturing sector. However, our sample size of 596 firms corresponds to only 10 sub-industries. Therefore, the total number of observation comes around 150 (15 years*10 sub-industries). The impact of competition on productivity at the industry level is given in table 7.

The regression results from table 7 reveal that there exists a positive relationship between industry level competition and productivity. This is in conformity with the agency theory. We have also taken the dispersion of TFP at the industry level in order to check that whether market competition widens or narrows down the technological gap across firms. The result of the impact of competition on productivity dispersion is also given in table 7. We find a negative relationship between industry competition and productivity dispersion. This indicates that greater market competition has been able to narrow down the technological gap between firms within the industry. On the basis of argument given by Aghion and Howitt (2005) and Aghion and Griffith (2005) that the relationship between market competition and innovative activities depends on the technology level of the firm, one expects that market competition should widen the technology gap between the firms for which the coefficient needs to be positive. But the result has been negative in contrast to the findings of Aghion and Howitt (2005) and Aghion and Griffith (2005). Rather, the finding is in support of the finding of Martin (2008) where an inverse relationship has been found between competition and productivity dispersion.
Table 7. Impact of competition on average productivity and dispersion (Industry level)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Average Total Factor Productivity (AvgTFP)</th>
<th>Productivity dispersion (DisTFP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-Statistics</td>
</tr>
<tr>
<td>Inverse HHI</td>
<td>14.94***</td>
<td>2.36</td>
</tr>
<tr>
<td>Constant</td>
<td>-9.81**</td>
<td>-1.62</td>
</tr>
<tr>
<td>Year dummy</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Industry dummy</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Observations (N)</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>F-statistics</td>
<td>764.71</td>
<td></td>
</tr>
<tr>
<td>Prob &gt; F value</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.91</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors’ own calculations

Note: ***, **, * represent 1%, 5% and 10% level of significance respectively.

6. Conclusions

This study examines the nexus between product market competition and total factor productivity growth of Indian manufacturing companies during the period 1997-98 to 2016-17. The Generalized Method of Moments results conclude that product market competition has a significant positive impact on total factor productivity both at the firm as well industry level. Our results are consistent with the agency theory that competition reduces the gap between owners and managers and thereby reduces the agency cost, which in turn helps to increase productivity. The results are robust to both R&D and non-R&D firms. Further, when the analysis has been extended to efficient and inefficient firms separately, we find that the positive competition – productivity relationship is confined to the case of more efficient firms only. It could be due to the fact that greater competition in the market enables the less technologically advanced firms to move to the frontier to catch up with the more technologically advanced firms. Further, segregating the industries on the basis of technological gap the results reveal that the positive relationship between competition and productivity is more prominent across the firms of unlevel industry than the firms of level industry. It implies that the industry where the technological gap between firms is more, competition has a larger positive impact on productivity than the industries where the technological gap is less among the firms. This could be due to the reason that in case of unlevel industries (where the technological gap is more among the firms) competition is intense among the firms, which result in greater productivity. Overall, our results
support the argument that greater product market competition has led to increased productivity of the Indian manufacturing firms. Overall, the role of product market competition in improving productivity growth of Indian manufacturing firms and industry seems to be promising. The results can have policy implications in the sense that in order to improve the firm productivity Government should take certain policy measures in the form of tax rebates, incentivizing the highly productive firms to sustain the competitive attitude of the firms.

References


Application of Economic and Quantitative Tools for Merger Analysis in India

By

Ramji Tamarappoo, Nathan Economic Consulting India Private Limited
Neha Malhotra Singh, Nathan Economic Consulting India Private Limited

10 February 2019
Merger analysis is an ex ante assessment of the impact of a proposed combination on the competitive process and on consumer welfare. While on the one hand, competition authorities must ensure that they do not stop a combination that could result in efficiencies that are likely to ultimately benefit the consumers, they have to do so keeping in mind that a combination cannot be unscrambled if a wrong decision is made. Therefore, the ideal approach for competition authorities is to focus on the anticipated effects of a proposed combination in a careful, balanced and robust manner and aim to address the question: “What is the market going to look like when the combination is implemented?”

Competition law jurisdictions around the world have considered and adopted – to varying degrees – analytical approaches and tools to determine the positive and adverse effects of a combination on competition (commonly referred to as an effects-based approach) rather than a “tick-the-box” approach (referred to as a form-based approach). These tools have been used to define relevant markets, assess pre and post combination concentration and market power, and possible effect on prices. While these tools are universal in terms of applicability, the application of and reliance on these tools/analytical approaches, and the threshold levels used vary across competition authorities.

The merger regime in India has been in place since 2011 and almost 569 merger filings were made to the Competition Commission of India (CCI) till May 2018.1 In this paper, we assess how the use of economic analysis and quantitative tools has evolved in merger assessments in India, and draw a comparison with practices in two of the advanced jurisdictions, the United States (US) and the European Union (EU). In addition, we identify the trends and the gaps that still persist in India, in terms of adoption of analytical approaches in merger analysis.

**Competition law frameworks for application of economic and quantitative tools in merger assessments: European Union, United States and India**

Effective application of economic tools and analysis in undertaking robust effects-based competition assessments requires an understanding on how the framework of the competition law allows for and even specifies the types of analysis that are to be conducted, their application, as well as their interpretation in assessing a combination. In this section, we analyse the prevalent competition law frameworks in the EU and the US, and compare it with India’s.

In the EU and the US, there is a main competition legislation which is supplemented by guidelines, explaining the broad merger philosophy, specifying the types of evidence acceptable, and proving clear economic frameworks for application of the merger regulations and also outlining various key analytical techniques and practices including certain thresholds (see Table 1 below).

Competition law in India is governed by the Competition Act 2002 and enforced by the Competition Commission of India (CCI). The merger control provisions of the Act

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1 Press Release May 2018, Competition Commission of India celebrated its 9th Annual Day on 20th May 2018. Competition Commission of India
(Regulations of Combinations – Chapter II, Sections 5 and 6) came into effect in 2011 through a government notification. However, there are no merger guidelines in India, and the Competition Act 2002 is the only constituent of the competition law framework in the country.

**TABLE 1: COMPARISON LAW LEGAL FRAMEWORKS IN INDIA, EUROPEAN UNION AND UNITED STATES**

<table>
<thead>
<tr>
<th>India</th>
<th>Europe Union</th>
<th>United States</th>
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| • Competition Act 2002  
  – Combinations Regulation under the Act were enforced in 2011  
  – Enforced by the Competition Commission of India (CCI) | • EC Merger Regulations - Council Regulation (EC) No 139/2004 of 20 January 2004 on the control of concentrations between undertakings  
  – Enforced by the European Commission (EC) | • Section 7 of the Clayton Act, Sections 1 and 2 of the Sherman Act, and Section 5 of the Federal Trade Commission Act  
  – Enforced by the Department of Justice (DOJ) and the Federal Trade Commission (FTC) |
| • Guidelines providing an economic framework for the application of the Merger Regulations  
  – Horizontal Merger Guidelines  
  – Non-horizontal Merger Guidelines  
  – Commission Notice on defining relevant market | • Guidelines outlining the principal analytical techniques, practices, and the enforcement policy  
  – Horizontal Merger Guidelines  
  – Non-horizontal Merger Guidelines |

In the paragraphs below, we outline key elements of the competition law framework in the EU and US, and compare it with India, for each of the three steps of merger assessment – defining the relevant market, assessing market power and concentration and assessing likelihood of anticompetitive effects as a result of the proposed combination.\(^2\)

**Defining the relevant product market**

In the EU, the EC Merger Regulations define the relevant product market based on demand side substitution, considering interchangeability or substitutability by the consumer, by reason of the products' characteristics, their prices and their intended use. However, the guidelines on relevant market definition also clearly mention the use of supply side substitutability in markets where its effects are equivalent to demand substitution in terms of effectiveness and immediacy. The guidelines also emphasize on evidence for substitution in the past.

Further, EU’s guidelines on relevant market definition mention the use of several economic and quantitative tools for relevant market definition including the hypothetical monopolist test with a threshold of 5%-10%, tests based on inter-temporal similarity in price movements, analysis of causality between price series, and similarity and/or convergence of price levels. Besides these, the EC is open to accepting other quantitative evidence that is able to withstand rigorous scrutiny. \(^3\)

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\(^2\) For simplicity, we will only discuss the Horizontal Merger Guidelines for EU and US in this paper and the Commission Notice on defining relevant market for EU

\(^3\) Commission Notice on the definition of relevant market for the purposes of Community competition law
In the US, relevant market definition is based on demand substitution, assessing the ability and willingness of customers to substitute one product with another in response to price and non-price (e.g. quality, level of service) changes. While the guidelines acknowledge the “responsive actions of suppliers” for competitive analysis, they consider it while assessing market participants, measuring market shares, and analysing competitive effects and market entry. Further, the US merger guidelines describe tools and principles, their application by the regulator, and acceptable evidence (e.g. evidence of switching time and cost) for defining the relevant product market - hypothetical monopolist test (SSNIP test – mostly use 5% price (or value added) increase), critical loss analysis, and SSNIP for targeted customers.4

India’s Competition Act 2002 defines the relevant product market based on demand side substitutability considering a list of factors including end-use or physical characteristics of products or services, prices, and consumer preferences.5 However, it does not specify any tools to define the market. The Act is also silent on supply side substitutability, although the CCI has accepted it for relevant market definition in some combination assessments in the past (discussed in the next section).

**Defining the relevant geographic market**

The EU defines relevant geographic markets by assessing the distribution of market shares between the Parties and competitors and an analysis of pricing and price differences at the national and Community or EEA level. Further, as the guidelines explain, demand (e.g. local/national preferences, purchase patterns) as well as supply (e.g. impediments faced by firms in developing sales on competitive terms throughout the EU region) substitutability across regions are considered important for defining the relevant geographic market. The guidelines also explain various economic and quantitative analysis for relevant geographic market definition including an analysis of current geographic purchase patterns, trade flows, switching costs, and chains of substitution. 6

In the US, relevant geographic markets are primarily defined depending on the location of suppliers if no price discrimination based on customer location is possible. If such price discrimination is possible, relevant geographic market is defined based on customer location. The SSNIP test is an important tool mentioned in the guidelines for both the cases along with evidence of transportation cost and ease of transportation, and influence of downstream competition.

In India, relevant geographic market definition takes into account, homogeneity of conditions of demand and competition for supply across geographies, considering a host of factors including regulatory trade barriers, local specification requirements, national procurement policies, distribution facilities, transport costs, language, consumer preferences, and need for secure or regular supplies or rapid after-sales services.

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4 Horizontal Merger Guidelines, US Department of Justice and the Federal Trade Commission, Issued on August 19, 2010
5 Other factors are exclusion of in-house production, presence of specialized producers, and classification of industrial products
6 Commission Notice on the definition of relevant market for the purposes of Community competition law
Assessing market shares and concentration

The EU and US have well defined tools and thresholds in their guidelines for assessing market power and concentration. The EU Horizontal Merger Guidelines mention the use of historic, current and future market shares for competition assessment (as required). They also clearly state that market shares are interpreted not in isolation but subject to likely market conditions. Further, based on “well-established case law”,7 the guidelines specify post-merger thresholds of (i) > 50% - may be evidence of dominance, however smaller firms can act as a sufficient constraint; (ii) <50% (40%-50% or <40%) - may also raise competition concerns in view of factors such as strength and number of competitors, capacity constraints or the extent of substitution of products of the merging Parties; and, (iii) <25% - presumed to not impede competition.8 The guidelines also establish the use of Herfindahl-Hirschman Index (HHI) as a measure of market concentration along with certain thresholds (see Table 2 below).

### Table 2: HHI Thresholds in EU and US Guidelines

<table>
<thead>
<tr>
<th>European Commission</th>
<th>US Department of Justice and Federal Trade Commission</th>
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</thead>
<tbody>
<tr>
<td><strong>Mergers unlikely to raise competition concerns if</strong></td>
<td><strong>Level of concern</strong></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>Post-merger HHI</td>
<td>Change in HHI</td>
</tr>
<tr>
<td>Less than 1,000</td>
<td>-</td>
</tr>
<tr>
<td>Between 1,000 and 2,000</td>
<td>Less than 250</td>
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<tr>
<td>Greater than 2,000</td>
<td>Less than 150</td>
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<td></td>
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</table>

The US Horizontal Merger Guidelines explain the regulators’ approach towards assessing market shares and concentration in conjunction with other market factors to determine if a merger may substantially reduce competition. Further, the guidelines clarify that market shares are typically based on historical data and may understate or overstate a firm’s future competitive strength depending on ongoing and/or future changes (e.g. technological advancements). Hence, it is important to consider such changes while interpreting market share and concentration numbers. The guidelines provide possible interpretations of market shares and concentration figures under various merger scenarios and also recommend appropriate indicators for their measurement in terms of future competitive significance in the relevant market. Additionally, they explain the need to include market participants who are currently earning revenue in the market as well those who are likely to enter quickly (rapid entrants) in the event of a small price increase by the incumbents (SSNIP), without incurring significant sunk costs. Similar to the practice in the EU, the US guidelines also mention HHI as a tool for measuring market concentration, and specify its thresholds in the context of merger assessments (see Table 2 above). The guidelines clarify that these

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7 The EU guidelines have identified these thresholds based on past case law
8 European Union Horizontal Merger Guidelines
thresholds are only a means to identify mergers that are likely to raise anticompetitive concerns and for whom it is important to undertake a more detailed assessment of other competitive factors.

The Indian Competition Act 2002 however specifies no tools (except market share), thresholds, or underlying approach towards assessing market power and concentration in merger assessments. It only lists “market shares” and “level of combination in the market” as part of the 14 factors mentioned under section 20(4) of the Act to assess the possibility of appreciable adverse effects on competition (AAEC) as a result of the proposed combination.

**Analysing the effect of the combination**

In the EU, the EC guidelines explain a number of factors to assess the likelihood of coordinated (reaching terms of coordination, monitoring deviations, presence of deterrent mechanisms) and/or non-coordinated effects (e.g. merging firms have large market shares, limited switching options for customers) as a result of the proposed merger. The guidelines also clarify that the list is not exhaustive and taken separately may not be decisive. Further, the guidelines explain several other factors for analysing anticompetitive effects such as countervailing buying power; market entry - likelihood, barriers to entry, timeliness, and sufficiency; possible efficiencies – merger specific, verifiable and creating benefits for consumers; and the failing firm defence.

The US merger guidelines provide detailed explanations about assessing unilateral and coordinated effects for industries with different product characteristics (e.g. differentiated goods, homogenous products) through various types of quantitative and economic analysis. For instance, for assessing unilateral effects the guidelines mention the use of diversion ratio, econometric models and merger simulations. Assessment of other factors such as presence of powerful buyers; market entry - ease, likelihood, timeliness and sufficiency; merger of competing buyers and the failing firm defence is also explained elaborately in the guidelines. The guidelines also allow for merger-specific verifiable efficiencies, but these are mostly accepted only if the merger is not likely to cause significant adverse effects.

The Indian Competition Act 2002 lists a set of 14 factors under section 20(4) to assess the possibility of appreciable adverse effects on competition (AAEC) as a result of the combination. The factors include an assessment of competition through imports, extent of barriers to entry, degree of countervailing power, ability to increase price significantly and sustainably, likelihood of removal of a vigorous competitor, extent of close substitutes, nature and extent of innovation and vertical integration in the market, and the failing firm defence. The factors also provide scope for adopting an effects-based approach, allowing for firms to demonstrate efficiencies as a result of the merger and weighing the benefits and adverse effects of the combination against each other. However, the Act is silent on the underlying approaches and possible economic analysis that it would consider appropriate to assess the impact of the combination under each of these factors.

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9 “relative advantage, by way of the contribution to the economic development, by any combination having or likely to have appreciable adverse effect on competition”

10 “whether the benefits of the combination outweigh the adverse impact of the combination, if any”
The discussions above indicate that while India’s Competition Act 2002 covers significant ground and provides for analysis of almost all important aspects of merger assessments, it does not provide any guidance on how it evaluates combinations (including economic and quantitative tools and their thresholds) or the underlying approach behind the assessments. This is usually done with the help of merger guidelines in advanced jurisdictions, the lack of which has left significant room for discretionary application and interpretation of the law and economic and quantitative tools for merger analysis in India. As a result, we see from a thorough review of the CCI’s orders under Sections 5 and 6, that there are several ambiguities and inconsistencies in the application of the law.

**Analysing the Indian jurisprudence**

An analysis of CCI’s orders, shows that it has accepted certain economic and quantitative tools that have been proposed by the Parties and has adopted them in its own assessments. Over time, some of them have become standard tools that have gained legitimacy among practitioners. However, there is a fair amount of ambiguity in terms of their application and interpretation, and this is compounded by the fact that there is no codified merger guideline as in the case of the EU or the US.

**Supply substitutability: Competition Act 2002 vs case law**

The Competition Act 2002 only mentions demand substitutability as the criteria for defining the relevant product market. However, the CCI has applied supply side substitutability for relevant product market definition while undertaking competition assessments for some proposed combinations. For instance, in the Linde - Praxair (2018) combination, while segmenting the retail market for helium, the CCI found that liquid and gaseous helium are not demand substitutable due to different characteristics and end uses. However, there is significant supply side substitutability as suppliers can use their trans-fill centres for vaporizing, compressing and filling helium into cylinders for gaseous supplies, as well as for repackaging liquid helium into dewars for liquid supplies. Therefore, based on supply substitutability, the CCI defined a single product market for helium without any further delineations.11 The CCI also used supply side substitutability in the Holcim - Large (2015) combination to consider all grades of ready mix concrete (RMC) as one market as they are manufactured using the same raw materials and in the same manufacturing plant. The various grades of RMC differ in terms of strength and applications and are clearly not demand substitutable.12

In our assessment, CCI was correct in applying supply substitutability to defining the relevant product market in the above instances. Supply side substitutability is also considered in the EU for relevant product market definition. However, unlike the EU, the CCI does not have any guidelines explaining when supply side substitutability will be acceptable, as it is not assessed by the CCI in all cases. Further, since supply side substitutability is not mentioned in the Act, its acceptability is left dependent on the current

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11 Linde Praxair - CCI order on Combination Registration No. C-2018/01/545, Linde Aktiengesellschaft/ Praxair Inc, (2018), Page 11
members of the CCI, who will change in the future and may choose to follow the Act in letter.

*Elzinga – Hogarty (E-H) test and catchment area analysis: Ambiguities in application*

The CCI has used the E-H test and catchment area analysis for relevant geographic market delineation in several merger assessments. However, the manner in which they were applied in certain instances, raises several ambiguities. In the Indusland - Royal Bank of Scotland (2015) combination, the CCI used data on the average distance travelled by customers - 15-20 kms - to avail banking services to define the primary service area of the Parties around their bank branches. Thereafter, the CCI acknowledged that the primary service area of other competitors may also have a similar 15-20 kms radius and significant overlaps with the Parties, resulting in a chains of substitution sequence. Customers in all areas forming part of the chain reaction will be sensitive to small changes in service charge and credit rates and hence can be part of one relevant geographic market. Thus, in light of this chain reaction and acknowledging the well-established connectivity in Mumbai, the CCI defined the relevant geographic market to be at-least Mumbai. 13

However, the CCI has been arbitrary in its application of the catchment area analysis in subsequent combinations. In the PVR - DT (2016) combination, the CCI rejected the application of the catchment area analysis and chains of substitution, stating that the characteristics of the market in this case are different and hence application of chains of substitution to widen the relevant geographic market to Delhi NCR or even Delhi is not appropriate. 14 Instead, considering the responses submitted by the competitors and distributors, the CCI concluded that the geographic market is more local than the city-level based on the following: (a) prices charged by multiplexes are different across the regions, and (b) there are differences in the clientele across regions (e.g. Hollywood films mainly run in South Delhi theatres). Given these arguments, the CCI divided the market into South Delhi; North, West and Central Delhi; East Delhi; Gurgaon; Ghaziabad; Faridabad; Noida and Greater Noida. 15 However, the CCI did not provide any quantitative or economic analysis it relied upon to delineate the market. There was also no clarity in the order regarding the rationale for clubbing North, West and Central Delhi into one market. Further, inconsistent with the Indusland - Royal Bank of Scotland order, the CCI ignored the argument on good transport connectivity in Delhi NCR proposed by the Acquirer.

In the Ultratech - Jaypee (2016) combination, the CCI rejected the relevant geographic market definition (as groups of states) submitted by the Acquirer based on the E-H Test at 90 percent threshold based on inter-state trade flows of cement as it found it to be too wide and not reflective of competitive constraints. The CCI undertook an independent application of the E-H Test and used different LIFO/LOFI thresholds for each state addition and relevant market. For instance, for overlaps in Andhra Pradesh, the CCI expanded the market to include Karnataka (threshold 11%) and Maharashtra (threshold 18%). The CCI did not add

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further states (as proposed by the Acquirer) based on an analysis of actual inter-state trade flows - finding the proportion of exports to total production across the states to be insignificant. However, the CCI did not define the thresholds for deciding ‘insignificance’. Similar ambiguities can also be seen in the application of the catchment area analysis and E-H Test in the Linde - Praxair (2018) and Holcim - Lafarge (2015) combinations.

The key point to note from this discussion is that there is no clarity on what kind of market characteristics allow for an application of the E-H test and catchment area analysis, and in what circumstances will these tests be given more or less weightage compared to other market characteristics and qualitative arguments. Of course, the Competition Act 2002 is silent on this, and the lack of guidelines leads to a fair amount of ambiguity and discretion in application.

**Market shares: What is considered to be significant?**

Market shares are mentioned as one of the factors listed under Section 20 (4) of the Competition Act 2002 for assessing the likelihood of AAEC as a result of the proposed combination. However, the Act does not specify any thresholds or guidelines on interpretation of the market shares. This provides significant room for discretion to the CCI to interpret the market shares as high or low or based on a form or effects based approach.

In the PVR - DT (2016) combination, the CCI estimated market shares in terms of number of screens in each relevant geographic market. For the Noida market, the CCI order said that the incremental market share as a result of the combination is 10.1% which is significant. However, the incremental market share for the north, west and central Delhi markets was 5.1% and found to be not significant by the CCI. Thus, it is not clear where the market shares transition from being insignificant to significant. In the Tata Steel - Bhushan Steel (2018) combination, the incremental market share for cold rolled coils and sheets based on installed capacity was between 5%-10% and found to be significant. Further, the order states that the combined market share of the Parties in this market is “only” 20%-25%. Even for galvanised products the incremental market shares based on installed capacity have been found to be significant at 5%-10%, however the order goes on to state that the combined market share of the parties is “only” 25%-30%. In the market for precision tubes, the CCI order states that the combined market share of the parties is in the range of 35%-40% (without mentioning the term “only”).

The question then is, whether, incremental market shares above 5% will be considered significant by the CCI? Also, does the CCI indicate by qualifying the combined market shares up to 30% by “only” that such combined market shares are not significant?
Furthermore, in which circumstances will incremental market shares be examined in detail and will become part of the calculus in the decision of the CCI in terms of the post combination market concentration?

While the CCI has not relied solely on market shares for undertaking assessments in the cases discussed in this section (for instance, low capacity utilization has been given significant weightage in the Tata Steel - Bhushan Steel combination assessment), it is important for Parties and practitioners to have some clear indication about when market shares are considered high or low by the CCI and the typical economic analysis that it relies upon in making such assessments.

*Measures of concentration: What are the thresholds?*

The Competition Act 2002 does not outline any measures of concentration. It only lists ‘level of combination’ as one of the factors for determining likelihood of AAEC as a result of the proposed combination under Section 20 (4) of the Act. However, the CCI has assessed market concentration using HHI and concentration ratio (CR) 4 in the past. In the Linde - Praxair (2018) combination, the CCI called analysis based on HHI as “standard concentration analysis”, and seems to have used EU thresholds of a concentrated market (HHI>2000). Similarly, the CCI used HHI analysis in the Vodafone - Idea (2017) combination as well, seemingly based on the EU thresholds - order states that “….with precombination HHIs exceeding 2000 in all telecom circles (except Haryana, Mumbai and Punjab)….”, although they do not clearly specify or acknowledge the thresholds. In the PVR - DT combination (2016), the CCI order clearly mentions the use of EU HHI thresholds for its concentration analysis. The CCI has also used HHI in the concentration analysis for the Ultratech - Jaypee (2016) combination, however it does not specify the thresholds used, but identifies changes in HHI as significant or insignificant across the various relevant geographic markets. However, while the CCI has used HHI extensively in several merger assessments, there are orders where the CCI does not mention HHI at all. For instance, in the JK Tyre - CIL (2016) combination order, there is no mention of a HHI analysis.

In some cases, CCI has also used the CR4 analysis (along with HHI) for concentration assessment of proposed combinations. For instance, in the Airtel - Telenor (2017) combination, the CCI found the retail mobile telephony services market to be concentrated with a CR 4 of more than 65% and the pre-merger HHI more than 2000 in all the

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22 Linde Praxair - CCI order on Combination Registration No. C-2018/01/545, Linde Aktiengesellschaft/ Praxair Inc, (2018), Page 21
overlapping circles. The CCI also used CR4 in the Ultratech - Jaypee (2016) combination to assess concentration in the market.

The discussion above outlines two key ambiguities regarding CCI’s concentration analysis in merger assessments - (a) When will HHI and CR4 be considered by the CCI to assess change in market concentration as a result of the proposed combination, and (b) What are the thresholds for interpreting such analysis?

So far we have discussed the ambiguity in application of various economic analysis and tools by the CCI. It is also worthwhile to look at the broader picture to assess whether the CCI is undertaking merger assessments based on a form-based or an effects-based approach. Recent case law suggests that overall the CCI is moving towards an effects-based approach, in line with the practice in advanced jurisdictions such as the EU and the US. In the Vodafone - Idea (2017) combination, in the relevant market for retail mobile telephony services, the CCI found that the incremental HHI was significant (ranging from around 400 Andhra Pradesh to 1500 in Kerala) in all the 14 circles where the combined market shares of the Parties was over 30%. However, the CCI considered various other factors in its assessment (e.g. fair distribution of spectrum, significant quantity of unsold spectrum to mitigate access issues, significant buyer power due to easy number portability) to conclude no likely AAEC in the market as a result of the proposed combination. Further, in the Tata Steel - Bhushan Steel (2018) combination, although the combined market share of the Parties was 35%-40% in the precision tubes relevant product market, the CCI found no likely AAEC based on analysis of other market factors including the presence of other significant competitors and availability of unutilised capacity which will make it possible for competitors to increase production as required and deter any anticompetitive action of the Parties post combination. However, there continue to be one-off cases where the CCI tilted towards a form-based analysis in its assessment of proposed combinations. For instance, in the PVR – DT (2016) combination, the CCI went too far to impose significant structural remedies (divestures) in the South Delhi market over and above the behavioural remedies already offered by the Acquirer (limiting expansion, price caps on food and ticket prices, quality commitments, commitment to not demand exclusivity from distributors), which were adequate to overcome competition concerns of the CCI. This was also the view expressed in the dissent note issued by some members of the CCI. In its decision, the CCI undermined the importance of other factors (besides market shares and HHI) such as presence of significant substitutes, low barriers to entry, strong industry rivalry (low occupancy ratios), and high bargaining power of distributors which would have made it

27 Airtel Telenor - CCI order on Combination Registration No. C-2017/03/494, Bharti Airtel Limited/ Telenor (India) Communications Private Limited, (2017), Page 3
30 Tata Steel and Bhushan Power - CCI order on Combination Registration No. C-2018/07/581, Tata Steel Limited/ Bhushan Power and Steel Limited, (2018), Page 8
very difficult for the Parties to undertake anticompetitive practices post combination, particularly amidst the behavioural commitments.31

Conclusion

Our research in this paper shows that India’s Competition Act 2002 has drawn extensively from practices in advanced jurisdictions and provides opportunity for analyzing the most critical factors for assessing proposed combinations in the country. However, as is mostly the case in India, there are limitations in implementation of the Act, primarily due to the lack of detailed merger guidelines (including thresholds). While the young CCI has made noteworthy efforts in adopting international practices for undertaking merger assessments – be it in terms of following an effects-based approach and/or applying economic and quantitative tools, the lack of merger guidelines has created significant scope for discretion by the CCI in application and interpretation of merger analysis. This has led to several ambiguities and uncertainties for the business community (particularly the private sector and foreign investors) who definitely need more predictability on the CCI’s assessment while considering future potential combinations. The use of guidelines (for instance, as in the case of EU) would have definitely made past assessments more predictable, consistent and clear for the Parties. For investors, it would have also added credibility to the assessment from a perception point of view, instilling greater confidence in the robustness and thoroughness of the CCI’s investigations. Perhaps in some cases, better application and interpretation of economic analysis and tools may have led to more appropriate decisions by the CCI. Further, the current situation, in the absence of merger control guidelines, carries the risk of a complete alteration in the approach towards merger assessments in India as members of the CCI change in future.

One can argue that these ambiguities arising in Indian case law are a result of the CCI’s commitment to adopting an effects-based approach due to which it does not consider thresholds or pre-determined predictable ways of undertaking analysis to be important. However, the CCI needs to clarify its position and suggest if practitioners and parties should infer its philosophy to merger analysis from past orders, particularly in the absence of any guidelines. If an open-ended approach is a way of allowing for flexibility in the Indian system, the CCI must make its orders very detailed and clear in terms of explaining its approach and methodology as well as the calculations.

31 PVR DT – CCI order on Combination Registration No. C-2015/07/288, PVR Limited/DLF Utilities Limited, (2016), Appendix A
Mergers and Innovation Portfolios*

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Abstract

This paper studies mergers in markets in which firms invest in a portfolio of independent research projects of varying profitability and social value. By investing in a project a firm engages in a contest with the rival firms and wins if it succeeds in generating the innovation, while the losing firms obtain zero profits. Investing in a project increases the marginal cost of investing in another project, which generates negative externalities across them.

We show that firms invest inefficiently for two reasons: first, because of competition, they put too much money on the most profitable project; second, because firms do not appropriate fully the social gains from an innovation, they tend to underinvest in socially desirable projects.

A merger internalizes two innovation externalities. A negative externality that arises because the investment of a firm in one project lowers the probability the partner firm wins the contest for that project. A positive externality because the investment of a firm in one project increases the marginal cost of that firm in the other project, which raises the likelihood the partner firm wins the contest for the alternative project.

We show that, when the winning firm appropriates all the social surplus from an innovation, then mergers are always welfare improving. In different words, if firms can perfectly price discriminate in the product market, a merger necessarily aligns the social and the private incentives. Otherwise, mergers may increase or decrease welfare, depending on how the appropriability of the social surplus from an innovation varies across markets.

Keywords: innovation portfolios, R&D contests, mergers

JEL Classification: L13, L22, O31, O32

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1 Introduction

Innovation is an essential activity for economic growth and welfare. It is then expected that economic policy be designed to protect and even encourage it. In particular, competition policy should prevent mergers that lessen innovation and permit those with a positive impact on investment. According to Gilbert and Greene (2015), during the 2004-2014 period, the US Antitrust Agencies invoked innovation-based concerns in about a third of the mergers they challenged. The European Commission appealed to an innovation theory of harm in the recent Dow/DuPont, GSK/Novartis Oncology and General Electric/Alstom cases.

There has been an important and large theoretical literature in economics starting with Schumpeter (1943) and Arrow (1962) studying the relation between competition and innovation. This literature, which is summarized by Vives (2008), has been somewhat inconclusive about how competition affects investment due to the variety of models analysed, with specific functional forms and modes of competition.

This literature, however, does not take into account the specificities of merger activity and therefore cannot be taken as an innovation theory of harm. In particular, a merger cannot be understood as a mere reduction in the number of competitors, or of the degree of product differentiation, in the market but as a transaction that results in that the partner firms coordinate their strategic decisions. As pointed out in a series of recent papers (see e.g. Federico, Langus and Valletti (2017, 2018), Motta and Tarantino (2016), Bourreau, Jullien, Lefouilli (2018), Denicolò and Polo (2018) and Gilbert (2018)), understanding the impact of merger activity on innovation necessitates a separate analysis. Specifically, because merging implies making decisions in a coordinated fashion a merger affects innovation incentives of the partner firms through at least two channels. First, there is an internalization of the innovation externalities. A firm that invests in R&D increases the likelihood with which it successfully innovates and this lowers the chance other firms appropriate the full gains from their innovation efforts. When firms merge they internalize this type of externality and correspondingly they tend to reduce investments. Second, a merger weakens competition in the product market. This may or may not increase the incentives to invest. Whether a merger ultimately increases investment incentives depends on the relative effect of these two effects.

Motta and Tarantino (2018) study mergers in a deterministic R&D model with product market competition. They analyze a simultaneous innovation and pricing game and show that absent spillovers or synergies, the reduction of output by the merged entity induces a reduction of cost-reducing investment, which harms consumers. Federico, Langus and Valletti (2018) obtain a similar result in a two-stage model of price competition with stochastic R&D and differentiated products despite the fact that in their model the reduction in the intensity of price competition following a merger favors innovation. Bourreau, Jullien and Lefouilli (2018) further zoom into the “market

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1See e.g. Romer (1990), Aghion and Howitt (1998), and Grossman and Helpman (1994).
2Empirically, the relationship between competition and innovation has not reached consensus either, with some authors finding it to be inverted-U shape (Aghion et al. (2005)) and others either increasing (Correa and Ornaghi (2014) and Beneito et al. (2017)) or even decreasing (see Hashmi (2013)).
power" or "price coordination" effect and show that this can be decomposed into two effects working in opposite directions, namely, a negative "margin expansion" effect and a positive "demand expansion" effect. They show that the overall impact of a merger on innovation incentives can be either positive or negative. However, they do not analyze consumer welfare implications.

The literature discussed above focuses on the total amount of money firms spend on innovation. Early work by Dasgupta and Maskin (1982) and Cabral (1994), however, recognized that often firms are engaged in multiple research projects at a time and investigated the extent to which the market provides firms with incentives to choose socially optimal research portfolios. This work, however, does not analyze the effect of mergers on the equilibrium investment portfolios. Our paper focuses precisely on this issue. We ask how mergers affect the investment portfolios of the partner firms and the market as a whole. In this sense, our work is in line with recent contributions by Letina (2016) and Gilbert (2018), which instead of looking at investment volumes look into the effects of mergers on the variety and diversity of R&D. Letina (2016) studies investments in a variety of equiprobable projects with different costs. He shows that a merger decreases the variety of developed projects and decreases the amount of duplication of research. Gilbert (2018) extends the model of Federico et al. (2017, 2018) and shows that absent spillovers mergers generally (but not always) decrease R&D diversity measured by the number of projects undertaken by the industry.

To study how mergers affect equilibrium innovation portfolios, we study a market in which firms can invest in two independent research projects. The projects vary in profitability, ease of innovation and social surplus. By investing in a project a firm engages in a contest with the rival firms. The winner of the contest appropriates the full rewards generated by the innovation, while the losing firms obtain zero profits. The key assumption we make is that the cost of investment function exhibit decreasing returns. This implies that an increase in the investment put in one project raises the marginal cost of investing in a different project, which signifies that there exist negative externalities across them.

We show that firms invest inefficiently for two reasons: first, because of competition, they put too much money on the most profitable project; second, because firms do not appropriate fully the social gains from an innovation, they tend to underinvest in socially desirable projects.

A merger internalizes two innovation externalities. First, there is the standard negative externality that arises because the investment of a firm in one project lowers the probability the partner firm wins the contest for that project. Second, there is a novel positive externality because the investment of a firm in one project increases the marginal cost of that firm in the other project, which in turn raises the likelihood the partner firm wins the contest for the alternative project. The tension between the positive and the negative externality determines the impact of a merger on the innovation portfolio of the partner firms.

In the special case in which the winning firm appropriates the full social surplus from an innovation, e.g. when the winning firm can perfectly price discriminate in the product market, mergers are always welfare improving. In such a special case, the only reason why the market equilibrium

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3See also Kwon (2009).
is inefficient is that firms’ portfolios are biased towards the most profitable projects. Even though the planner and the firms agree in which projects are more attractive, firms over invest in them because they ignore the business stealing externalities. In different words, while an individual firm only cares about its own probability of winning the innovation contest, the planner cares about any firm introducing the innovation. This makes the portfolio choice of firms inefficiently biased towards the most profitable innovation. We show that a merger, internalising the two externalities mentioned above, reduces the investment of the partner firms in the most profitable project. Despite the fact that the rest of the firms increase their investment in the most profitable project, the aggregate investment in that project decreases and correspondingly the market incentives and the social incentives get more closely aligned.

In the general case in which firms do not fully appropriate the social surplus of an innovation, depending on parameters, mergers can result in an increase or decrease in social welfare. The critical condition for a merger to be social welfare increasing relates the relative profitability of the different projects to the relative surplus appropriability. When the most profitable project is also the most appropriable, then a merger increases welfare by aligning the market and the social incentives. By contrast, when the most profitable project is the least appropriable, then a merger can decrease welfare by further desaligning the social and the market incentives. For this type of settings, our research supports the idea that competition authorities must deal with mergers on a case-by-case basis.

Our results carry over to the case in which firms decide on the budget they spend on research and how they allocate it across projects. The reason is that allowing firms to choose how much to invest in the projects does not alter the basic intuition that investing in one project increases the marginal cost of investing in the other project. Despite the fact that a merger results in lower aggregate investment, the fact that a merger can be a corrective device in regard to the nature of the innovation portfolio can make a merger socially desirable.

The rest of the paper is organized as follows. We introduce our general model in Section 2. The pre-merger market equilibrium is analyzed in Section 3. The effect of mergers for the case in which the winning firm can fully appropriate the social surplus is discussed in Section 4. To further understand the impact of mergers in situations of incomplete appropriability of the social surplus we impose further structure in our model in Section 5. This section also discusses the issue of incentive-compatibility of mergers. In Section 6 we demonstrate the robustness of our results. In particular, in Section 6.1 we study a more general model where firms not only decide how to allocate funding across projects but also how much money to invest in total. Finally, some concluding remarks are provided in Section 7.

2 The model

We consider a market in which n independent firms compete to introduce market innovations. The number of firms, n, is exogenous, reflecting barriers to entry. Firms engage in innovation contests to
introduce two types of innovations: $A$- and $B$-innovations. There are two innovations differing in terms of (i) the rewards the firm incurs for the innovator, denoted $\pi_i$, (ii) the intrinsic difficulty of successfully obtaining the innovation, denoted $\epsilon_i$, and (iii) the social gains the innovation creates, denoted $W_i$, $i = A, B$. Summarising, in terms of the returns to firms and society, each innovation is characterised by a triplet $\{\pi_i, \epsilon_i, W_i\}, i = A, B$.

An innovation may only be introduced by one of the firms; moreover, it may be the case that no firm succeeds at introducing an innovation. The probability with which an individual firm $i$ successfully introduces the $A$-innovation is denoted $p_i(x_i, x, \epsilon_A)$; this probability depends on the effort exerted by the firm $i$, denoted $x_i$, the efforts put in by the rival firms, denoted $x \equiv (x_1, x_2, ..., x_i, x_{i+1}, ..., x_n)$, and the intrinsic difficulty of the innovation $\epsilon_A$. Likewise, the probability with which an individual firm $i$ successfully introduces the $B$-innovation is denoted $q_i(y_i, y, \epsilon_B)$, where $y_i$ is the effort put in by firm $i$, $y \equiv (y_1, y_2, ..., y_i)$ the efforts exerted by the rest of the firms and $\epsilon_B$ the intrinsic difficulty of successfully completing the $B$-innovation path.

We impose certain assumptions on the success functions $p_i(x_i, y, \epsilon_A)$ and $q_i(y_i, y, \epsilon_B)$. Note that we write the mf of the $A$-innovation, the yapply to the $B$-innovation too.

**Assumption 1.**

*For the contest success function $p_i(x_i, y, \epsilon_A)$, and for every player $i$, it holds that:*

(a) $p_i(\cdot)$ is twice differentiable.

(b) $\sum_{i=1}^{n} p_i(x_i, y, \epsilon_A) < 1$.

(c) $\frac{\partial p_i(x_i, x_{i+1}, \epsilon_A)}{\partial x_i} > 0, \frac{\partial p_i(x_i, x_{i+1}, \epsilon_A)}{\partial x_j} < 0, \frac{\partial p_i(x_i, x_{i+1}, \epsilon_A)}{\partial \epsilon_A} < 0$.

(d) $\frac{\partial^2 p_i(x_i, x_{i-1}, \epsilon_A)}{\partial x_i^2} < 0$ and the cross partial derivative $\frac{\partial^2 p_i(x_i, x_{i-1}, \epsilon_A)}{\partial x_i \partial x_j} < 0$.

*The same assumptions apply to the function $q_i(y_i, y, \epsilon_B)$.*

These assumptions are standard in innovation contests (see e.g. Tullock (1980), Dixit (1987) and Skaperdas (1996)). Assumption (a) allows us to use calculus to address our research question. Assumption (b) makes our welfare analysis interesting. If the sum of probabilities over which firms successfully introduce an innovation is equal to one, then the welfare criterion is constant for any vector of firms’ investments, which is not very fascinating (more details later). Assumption (c) signifies that if a firm exerts more effort, the probability it successfully increases and the probability other firms succeed decreases. Moreover, an increase in the parameter $\epsilon_A$ lowers the probability that any of the firms innovates and therefore measures the difficulty of successfully completing the innovation path. Assumption (d) implies that the contest success function is strictly concave in own effort, which means that the probability of success exhibits decreasing returns. The cross partial derivative being negative points towards strategic substitutability of own and rival research efforts. This implies that the best-reply strategies of the firms are everywhere decreasing.

Each firm $i$ chooses an investment level $x_i \geq 0$ in the $A$-innovation path, and an investment level $y_i \geq 0$ in the $B$-innovation one. The cost of the total investment $x_i + y_i$ of a firm $i$ is given by the function $c(x_i + y_i)$ where $c' > 0, c'' > 0, c(0) = 0$. The non-linearity of the cost function assumption is key as our analysis: be use the two search proj ect st ore displaying the probability in proj ect one do not display the in the same proj ect c f. i, j = A, B, i \neq j$, if the cost function
were linear, the investment problem of a firm would be separable and the interesting externalities between projects that lead to our results would not arise. This element of our model breaks the separability of the payoff function of a firm into a payoff from a $A$-innovation and a payoff from an $B$-innovation. It is this lack of separability that is crucial in our contribution.

As discussed in Baye and Hoppe (2003), contest formulations are strategic equivalent to patent races. In that connection, our model can be seen as a model where firms compete to obtain innovations protected by patents. The winning firms are awarded patents with corresponding market rewards given by $\pi_A$ and $\pi_B$. As mentioned above, the gross rewards from these innovation efforts are independent from one another but the net rewards are not due to the fact that the marginal costs of putting effort in one project increase in the effort put in the other project.

We assume that firms pick their investments in the $A$- and $B$-innovation paths simultaneously. The focus of the paper will be on symmetric Nash equilibria (SNE), that is, equilibria in which similar firms make equal investments. Specifically, in the pre-merger market, a SNE satisfies $x_i = x^*$ and $y_i = y^*$, $i = 1, 2, \ldots, n$. In the post-merger market, the same holds for the merging firms on the one hand and for the non-merging ones on the other hand.

The payoff to a firm $i$ putting efforts $x_i$ and $y_i$ in the $A$- and $B$-innovation contests is:

$$u_i(x_i, y_i; x_i, y_i) = p_i(x_i, x_i, \epsilon_A)\pi_A + q_i(y_i, y_i, \epsilon_B)\pi_B - c(x_i + y_i)$$  \hspace{1cm} (1)

Firm $i$, taking as given the investment of the other firms, chooses its investment levels $x_i$ and $y_i$ to maximise the expected profits in (1). The maximisation problem of the firms is thus two-dimensional. To reduce the dimensionality of the problem, it is convenient to assume that firms are budget-constrained. In particular, we assume that:

**Assumption 2.**

Firms are budget-constrained; specifically, the total research budget of a firm is normalised to 1.

Assumption 2 means that $x_i + y_i \leq 1$. This, together with the monotonicity of the success probabilities (Assumption 1c), implies that we can reduce the dimensionality of the maximisation problem of the firms by setting $y_i = 1 - x_i$. In what follows, we perform an analysis of the effects of a merger on innovation under Assumption 2. Later in Section 6.1, we will show that this assumption can be dropped without any effect on the qualitative nature of our results.

### 3 Pre-merger market equilibrium

Assuming Assumption 2 holds, and with a slight abuse of notation, let $x_i$ and 1 $x_i$ denote the investments that firms other than $i$ put in the $A$- and $B$-innovation paths. The payoff to a firm $i$ putting effort $x_i$ in the $A$-innovation contest and, correspondingly, 1 $x_i$ in the $B$-innovation contest is:

$$u_i(x_i, x_i) = p_i(x_i, x_i, \epsilon_A)\pi_A + q_i(1-x_i, 1-x_i, \epsilon_B)\pi_B - c(1).$$ \hspace{1cm} (2)
The first order condition (FOC) for profits-maximisation for firm $i$ is:

$$
\frac{\partial p_i(x_i, x_i, \epsilon_A)}{\partial x_i}_{\pi_A} + \frac{\partial q_i(1 - x_i, 1 - x_i, \epsilon_B)}{\partial x_i}_{\pi_B} = 0.
$$

Equation (3) simply means that the marginal gains from investing in a project should be equal across projects. Note, that $\frac{\partial q_i(1 - x_i, 1 - x_i, \epsilon_B)}{\partial x_i} < 0$ because the probability with which a firm $i$ introduces a $B$-innovation decreases with its effort in the $A$-innovation.

**Proposition 1.** There exists a unique symmetric Nash equilibrium (SNE) denoted $x_i^* = x^* \in [0, 1]$ for all $i \in N$. The SNE is interior provided that $\pi_A \frac{\partial p_i(0, 0, \epsilon_A)}{\partial x_i} > \pi_B \frac{\partial q_i(1, 1, \epsilon_B)}{\partial x_i}$ and $\pi_A \frac{\partial p_i(1, 1, \epsilon_A)}{\partial x_i} < \pi_B |\frac{\partial q_i(0, 0, \epsilon_B)}{\partial x_i}|$, in which case it is given by the $x^*$ that solves:

$$
\frac{\partial p_i(x^*, x^*, \epsilon_A)}{\partial x_i}_{\pi_A} = \frac{\partial q_i(1 - x^*, 1 - x^*, \epsilon_B)}{\partial x_i}_{\pi_B}.
$$

**Proof.** Note that the payoff function (2) is strictly concave in firm $i$'s investment because the second derivatives $\frac{\partial^2 p_i(x_i, x_i, \epsilon_A)}{\partial x_i^2}$ and $\frac{\partial^2 q_i(1 - x_i, 1 - x_i, \epsilon_B)}{\partial x_i^2}$ are negative. The existence of equilibrium then follows from the Debreu-Glicksberg-Fan theorem because the strategy spaces are compact and convex sets, and the payoff functions are strictly concave in $x_i$ and continuous in $x_i$. Because our game is symmetric, there exists a symmetric equilibrium $x_i = x^*$ (see Hefti, 2017).

Uniqueness follows from the fact that the LHS of (4) is strictly decreasing in $x^*$, while the RHS of (4) is strictly increasing in $x^*$. Hence, given the conditions in the Proposition, they surely intersect once and only once at $x^*$.

We are interested only in interior solutions so we will assume from now on that the conditions for an interior equilibrium hold. The solution to (4) gives the best-reply function. It is easy to see that Assumption 1d implies that firms have decreasing best-replies. To see this, apply the implicit function theorem to the FOC (3) to obtain:

$$
\frac{\partial x_i}{\partial x_j} = \frac{-\frac{\partial^2 p_i}{\partial x_i \partial x_j}}{\frac{\partial^2 q_i}{\partial x_i^2} + \frac{\partial^2 q_i}{\partial x_j^2}} < 0.
$$

This means that firms invest in the $A$-innovation are strate & substitute by the same reason, firms invest in the $B$-innovation are strate & substitute.

The comparative statics of higher rewards from investing in the SNE are straightforward. A higher reward from the $A$-innovation shifts up the marginal gains from investing in it and correspondingly $x^*$ increases. A higher reward from the $B$-innovation raises the marginal gains from investing in it and correspondingly $1 - x^*$ increases so $x^*$ decreases. Because of Assumption 1c, $x^*$ decreases in the difficulty $\epsilon_A$ with which the $A$-innovation mate false and $\epsilon_B$. 

7
4 Mergers

Consider now that firms \(i\) and \(j\) merge. In such a case, the merged entity chooses investments \(x_i\) and \(x_j\) (and by implication 1 \(x_i\) and 1 \(x_j\)) to maximise the payoff:

\[
\begin{align*}
    u_m(x_i, x_j) = p_i(x_i, x_i, \epsilon_A)\pi_A + q_i(1 \times x_i, 1 \times x_i, \epsilon_B)\pi_B + p_j(x_j, x_j, \epsilon_A)\pi_A \\
    + q_j(1 \times x_j, 1 \times x_j, \epsilon_B)\pi_B.
\end{align*}
\]

The FOC for profits maximisation with respect to \(x_i\) is given by:

\[
\begin{align*}
    \frac{\partial p_i(x_i, x_i, \epsilon_A)}{\partial x_i}\pi_A + \frac{\partial q_i(1 \times x_i, 1 \times x_i, \epsilon_B)}{\partial x_i}\pi_B + \frac{\partial p_j(x_j, x_j, \epsilon_A)}{\partial x_i}\pi_A & = 0, \\
    \frac{\partial q_j(1 \times x_j, 1 \times x_j, \epsilon_B)}{\partial x_i}\pi_B & = 0.
\end{align*}
\]

(5)

The FOC for profits maximisation with respect to \(x_j\) is similar and therefore omitted. Non-merging firms continue to maximise the payoff in (4) and the corresponding FOC for an interior equilibrium is the same as that given in (3).

Inspection of the FOC (5) reveals that the merged entity internalises two externalities. On the one hand, the investment in the \(A\)-innovation of one of the merging firms, say \(i\), lowers the probability the partner entity \(j\) gets the \(A\)-innovation; on the other hand, the investment in the \(A\)-innovation \(x_i\) increases the probability the partner entity \(j\) obtains the \(B\)-innovation. The first externality is negative, pushing the merged entity to reduce \(x_i\) relative to the pre-merger market; the second externality is positive and therefore operates the other way around. The net effect is, in principle, ambiguous and may be towards more investment in the \(A\)-innovation and less in the \(B\)-innovation or otherwise. Our next result explores the effects of a merger on investments in the \(A\)- and \(B\)-innovation proj ected on the remaining firms on the \(\epsilon_i\) and \(\epsilon_j\) of an interior Nash equilibrium are in order.

To ensure that the equilibrium is interior, we need further regularity conditions. In what follows we assume that these conditions hold and we focus on comparing the pre- and post-merger equilibria of our model.

\footnote{For this, the Hessian matrix has to be definite negative. It is then needed that:

(a) \(\frac{\partial^2 p_i}{\partial x_i^2} > \frac{\partial^2 p_j}{\partial x_j^2}\) and \(\frac{\partial^2 q_i}{\partial x_i^2} > \frac{\partial^2 q_j}{\partial x_j^2}\)

(b) \(\frac{\partial^2 p_j}{\partial x_j^2} > \frac{\partial^2 p_i}{\partial x_i^2}\) and \(\frac{\partial^2 q_j}{\partial x_j^2} > \frac{\partial^2 q_i}{\partial x_i^2}\)

(c) \((\frac{\partial^2 p_i}{\partial x_i^2} + \frac{\partial^2 p_j}{\partial x_j^2} + \frac{\partial^2 q_j}{\partial x_j^2})^2 > (\frac{\partial^2 p_i}{\partial x_i^2} + \frac{\partial^2 p_j}{\partial x_j^2} + \frac{\partial^2 q_i}{\partial x_i^2} + \frac{\partial^2 q_j}{\partial x_j^2})^2 > 0.\)}
Proposition 2. Assume that a merger between firms $i$ and $j$ occurs. Then, compared to the pre-merger equilibrium, the merged firms will invest more in the $A$-innovation and less in the $B$-innovation if and only if at the pre-merger equilibrium of Proposition 1 it holds that:

$$\frac{\pi_A}{\pi_B} < \frac{\frac{\partial q_j(1, x^*, \epsilon_B)}{\partial x_i}}{\frac{\partial p_i(x^*, \epsilon_A)}{\partial x_i}}.$$  

(6)

The non-merging firms, by contrast, will invest less in the $A$-innovation and more in the $B$-innovation.

Proof. Evaluating the LHS of the FOC at the pre-merger symmetric equilibrium gives:

$$\frac{\partial p_j(x^*, \epsilon_A)}{\partial x_i} \pi_A + \frac{\partial q_j(1, x^*, \epsilon_B)}{\partial x_i} \pi_B,$$

where we have used the fact that $x^*$ satisfies 4. When this expression is positive, which, after rearranging is equivalent to condition 3, the payoff of the merged entity increases at $x_i = x^*$. This implies that, relative to the pre-merger situation, the best-reply of the merged entity shifts up. Because the best-replies are downward sloping, the result on the non-merging firms’ investments follows.

Proposition 2 suggests that, compared to the situation before a merger, the merging firms will put more effort in the $A$-innovation and less in the $B$-innovation provided that condition 3 holds. This condition governs the nature of the total externality exerted by the investment of a firm in the $A$-innovation path. This condition tends to be satisfied when the rewards to the $A$-innovation relative to the $B$-innovation are low enough. Moreover, inspection of the condition in Proposition 2 reveals that when $\frac{\partial^2 p_j(x^*, x^*, \epsilon_A)}{\partial x_i \partial \epsilon_A} > 0$, then the merging firms will put more effort in the $A$-innovation after a merger. Likewise, when $\frac{\partial^2 q_j(1, x^*, x^*, \epsilon_B)}{\partial x_i \partial \epsilon_B} < 0$, an increase in $\epsilon_B$ leads the merging firms to put more effort in the $A$-innovation path. Summarizing, when project $A$ has a low reward and the success probability is rather low, the negative externality exerted by the investment of a firm in the $A$-innovation path is weaker than the positive externality and the merging firms end up putting more effort in the $A$-innovation.

Whether a merger increases welfare or not is our ultimate research question. To explore this, we pose the social planner’s problem. Employing the usual welfare standard, the social planner picks a portfolio of investments $x$ to maximize social welfare:

$$W(x, 1, x) = \left( \sum_{i=1}^{N} p_i(x_i, x, \epsilon_A) \right) W_A + \left( \sum_{i=1}^{N} q_i(1, x, 1, x, \epsilon_B) \right) W_B,$$

(7)

where $W_\ell = \pi_\ell + CS_\ell$, $\ell = A, B$.

Compared to the payoff of an individual firm, this expression differs in two regards. First, the social planner cares about the market probability that the innovations are introduced, and not about the individual firms’ success probabilities. Second, the social value of an innovation $W_\ell$ differs in
general from the private reward \( \pi_i, i = A, B \). These differences constitute two distinct sources of inefficiency of the market equilibrium.

The first order conditions for social welfare maximization are:

\[
\left( \sum_{i=1}^{n} \frac{\partial p_i(x_i, x, \epsilon_A)}{\partial x_k} \right) W_A + \left( \sum_{i=1}^{n} \frac{\partial q_i(1, x_i, \epsilon_B)}{\partial x_k} \right) W_B = 0, \quad k = 1, 2, ..., n. \tag{8}
\]

It is instructive to suppose, for a moment, that the winning firm can perfectly price discriminate in the product market; or that the product market demand is rectangular. For these particular cases, only the first source of inefficiency is present because the winning firm extracts the whole surplus in the product market, i.e. \( \pi_i = W_i, i = A, B \). Despite this simplification, it is quite hard to derive the effect of mergers on welfare without imposing further structure on the model. The reason is as follows.

Compared to the pre-merger equilibrium, the problem of the merging firms is closer to the problem of the planner. Notice that the planner internalizes all the negative and positive externalities a firm imposes on the rival players when picking its investment. The merging firms, however, internalize only part of these externalities, concretely, the externalities imposed on the partner firm. In this sense, the problems of the planner and the merging firms are more aligned to one another than the problems of the non-merging firms and the planner. Therefore, everything else constant, a merger tends to move the investments of the merging firms towards the socially maximising ones.

Depending on how the investments of the non-merging firms change after a merger, the equilibrium allocation may increase welfare or not. If the non-merging firms react by changing their investments in a social welfare reducing manner, the ultimate effect will depend on the net impact on aggregate investment. It is hard to derive general conditions under which a merger will improve welfare, even in the simple case in which firms can perfectly price discriminate in the product market. For cases other than perfect price discrimination, it is even harder because, as argued above, an additional source of inefficiency is present. In order to address these questions, we proceed by introducing more structure in our model.

5 Tullock’s (1980) R&D contests

So far we have shown that a merger can result in a change in the firms’ innovation portfolios. However, we see that if condition 3 the merging firm increases, but non-merging firms decrease investment in A-innovation. On aggregate, the question that arises is whether collectively the market is more prone to deliver A-innovations after a merger or not, and how does it affect social gains. Another question of interest is whether a merger is incentive compatible. That is, do the merging firms in the post-merger equilibrium earn higher profits than in the pre-merger equilibrium? Finally, a relevant issue is how the non-merging firms are affected by the merger? That is, do non-merging firms benefit when other firms merge?

Addressing these questions in the general model of Section 2 is rather difficult because the
investments cannot be computed in closed form. In this section, we proceed by imposing additional structure on the model. Specifically, let us assume that the probabilities with which a firm $i$ succeeds to introduce $A$- and $B$-innovations are given by the Tullock (1980) case of success:

$$p_i(x_i, x_i, \epsilon_A) = \frac{x_i}{\sum_{k=1}^{n} x_k + \epsilon_A}$$

$$q_i(1, x_i, 1, 1, \epsilon_B) = \frac{1}{\sum_{k=1}^{n} (1, x_k) + \epsilon_B}$$

In the pre-merger market equilibrium, a firm $i$ maximises the expression:

$$u_i(x_i, x_i) = \frac{x_i}{\sum_{k=1}^{n} x_k + \epsilon_A} \pi_A + \frac{1}{\sum_{k=1}^{n} (1, x_k) + \epsilon_B} \pi_B.$$  \hspace{1cm} (9)

The FOC for an interior equilibrium is given by:

$$\frac{\sum_{k \neq i} x_k + \epsilon_A}{\left(\sum_{k=1}^{n} x_k + \epsilon_A\right)^2} \pi_A + \frac{n - 1 + \epsilon_B}{(n + \epsilon_B) \sum_{k=1}^{n} x_k} \pi_B = 0.$$  \hspace{1cm} (10)

Notice that the second order condition holds.

From proposition, existence of a unique symmetric equilibrium is guaranteed. The following result characterises the SNE, and provides conditions on the parameters under which the equilibrium is interior.

Proposition 3. (Pre-merger market equilibrium.) Let the parameters of the model satisfy the inequality:

$$\frac{\pi_A \pi_B}{2n\pi_B + \sqrt{\pi_A \pi_B (\pi_A \pi_B - 4\pi_B)}} < \epsilon_A < \frac{\pi_A (n + \epsilon_B)^2}{\pi_B (n + \epsilon_B)}.$$  \hspace{1cm} (11)

Then, there exists a unique (interior) SNE. In equilibrium, firms invest an amount $x^* \in (0, 1)$ in the $A$-innovation project, where $x^*$ is given by the unique solution to:

$$\frac{n - 1}{(nx^* + \epsilon_A)^2} \pi_A + \frac{n + \epsilon_B}{(n + \epsilon_B) (nx^* + \epsilon_A)} \frac{1}{(n - 1)x^*} \pi_B = 0.$$  \hspace{1cm} (12)

The rest of the budget, $1 - x^*$, is invested in the $B$-innovation project. The equilibrium investment $x^*$ increases in $\pi_A$ and $\pi_B$, and decreases in $\pi_A$ and $\pi_B$.

Second order condition is given by:

$$\frac{2(\sum_{k \neq i} x_k + \epsilon_A)}{(\sum_{k=1}^{n} x_k + \epsilon_A)^3} \pi_A + \frac{2(n - 1 + \epsilon_B - \sum_{k \neq i} x_k)}{(n + \epsilon_B) \sum_{k=1}^{n} x_k} \pi_B < 0.$$
Proof. Equation (12) simply follows from applying symmetry, i.e. \( x_i = x^* \) for all \( i \), in the FOC \( (10) \). Let us denote the LHS of (12) as \( h(x^*) \) and first notice that \( h \) is continuous and monotone decreasing in \( x^* \). In fact

\[
\frac{dh}{dx^*} = \frac{n(n - 1)x^* + \epsilon_A}{(nx^* + \epsilon_A)^3} \pi_A + \frac{n(n - 1)(n + 1)\epsilon_B}{(n + \epsilon_B)(nx^*)^3} \pi_B < 0.
\]

Moreover, note that

\[
h(0) = \frac{\pi_A}{\epsilon_A} n + \frac{\epsilon_B}{(n + \epsilon_B)^2} \pi_B > 0 \text{ if and only if } \epsilon_A < \frac{\pi_A(n + \epsilon_B)}{\pi_B(n + \epsilon_B - 1)}
\]

\[
h(1) = \frac{\pi_A(n - 1 + \epsilon_A)}{(n + \epsilon_A)^2} \frac{\pi_B}{\epsilon_B} < 0 \text{ if and only if } \epsilon_A > \frac{2n\pi_B + \sqrt{\pi_A\epsilon_B \pi_A\epsilon_B - 4\pi_B}}{2\pi_B}
\]

The previous three facts prove the statement that the equilibrium is interior.

To show that equilibrium investment \( x^* \) increases in \( \pi_A \) and \( \epsilon_B \) and decreases in \( \epsilon_A \) and \( \pi_B \), we apply implicit differentiation to Equation (12). We then obtain:

\[
\frac{\partial x^*}{\partial \pi_A} = \frac{\partial h}{\partial \pi_A} > 0, \quad \frac{\partial x^*}{\partial \epsilon_A} = \frac{\partial h}{\partial \epsilon_A} < 0
\]

\[
\frac{\partial x^*}{\partial \pi_B} = \frac{\partial h}{\partial \pi_B} < 0, \quad \frac{\partial x^*}{\partial \epsilon_B} = \frac{\partial h}{\partial \epsilon_B} > 0,
\]

where we have used the derivatives

\[
\frac{\partial h}{\partial x^*} = \frac{n(n - 1)x^* + \epsilon_A}{(nx^* + \epsilon_A)^3} \pi_A + \frac{n(n - 1)(n + 1)\epsilon_B}{n^2(1 - x^*)^2} \pi_B < 0
\]

\[
\frac{\partial h}{\partial \pi_A} = \frac{(n - 1)x^* + \epsilon_A}{(nx^* + \epsilon_A)^2} > 0
\]

\[
\frac{\partial h}{\partial \epsilon_A} = \frac{(n - 2)x^* + \epsilon_A}{(nx^* + \epsilon_A)^3} \pi_A < 0
\]

\[
\frac{\partial h}{\partial \pi_B} = \frac{(n - 1)(1 - x^*) + \epsilon_B}{(n + \epsilon_B)(nx^*)^2} < 0
\]

\[
\frac{\partial h}{\partial \epsilon_B} = \frac{(n - 2)(1 - x^*) + \epsilon_B}{(n + \epsilon_B)(nx^*)^3} \pi_A < 0
\]

The condition in the proposition ensures that corner solutions cannot be equilibria: if all firms invest solely in the \( B \)-innovation path, the condition ensures that the payoff of a firm strictly increases if the firm deviated by investing in \( A \)-innovations. In other words, the payoff \( (9) \) is strictly
increasing in a neighbourhood of zero. Likewise, suppose all firms solely invest in $A$-innovations, then the condition ensures that an individual firm would gain by deviating by cutting its investment in $A$-innovations and investing in $B$-innovation. In what follows we assume that the parameters of the model satisfy the condition in (1).

Because we analyze mergers in an $n$-player game, it is illustrative to follow the graphical tool devised by Deneckere and Davidson (1985) and build the "pseudo" reaction functions corresponding to our setting. Deneckere and Davidson plot the joint reaction function of the potentially merging firms against the non-merging firms on one hand, and the joint reaction of the non-merging firms against the potentially merging firms on the other hand. The crossing point between these two reaction functions depicts the pre-merger symmetric equilibrium.

Let firms $i$ and $j$ be the firms involved in a tentative merger. Let us define $x_m = x_i + x_j$ as the joint effort put by these firms in the $A$-innovation path. Likewise, let $x_{nm} = \sum_{k \neq i,j} x_k$ be the corresponding joint effort of the non-merging firms. Using this notation, we can compute the joint best-response function of the potentially merging firms against the non-merging firms as follows. First write the FOCs for firms $i$ and $j$ in this way:

$$x_i : \quad \frac{x_j + x_{nm} + \epsilon_A}{(x_m + x_{nm} + \epsilon_A)^2} \pi_A \frac{n}{(n + \epsilon_B)^2} \frac{x_j}{x_m} \frac{x_{nm}}{x_{nm}} = 0$$

$$x_j : \quad \frac{x_i + x_{nm} + \epsilon_A}{(x_m + x_{nm} + \epsilon_A)^2} \pi_A \frac{n}{(n + \epsilon_B)^2} \frac{x_i}{x_m} \frac{x_{nm}}{x_{nm}} = 0$$

and sum them to obtain:

$$\frac{x_m + 2x_{nm} + 2\epsilon_A}{(x_m + x_{nm} + \epsilon_A)^2} \pi_A \frac{2(n + \epsilon_B)}{(n + \epsilon_B)^2} \frac{x_m}{x_m} \frac{2x_{nm}}{x_{nm}} \pi_B = 0,$$

This expression defines implicitly the joint best response of firms $i$ and $j$ against the rest of the firms. Let us denote the LHS of (13) as $\gamma(x_m, x_{nm})$. By the implicit function theorem, the slope of the best response is:

$$\frac{\partial x_m}{\partial x_{nm}} \frac{\partial x_m}{\partial x_m} = \frac{2(x_{nm}+\epsilon_A)}{(x_m+3(x_{nm}+\epsilon_A))^2} \pi_A \frac{2(n+\epsilon_B)}{(n+\epsilon_B)^2} \frac{2x_{nm}}{x_{nm}} \pi_B < 0,$$

where the sign stems from the facts that $x_m < 2$ and $x_{nm} < n - 2$. So the joint best-response of the potentially merging firms is downward sloping.

We can construct the joint best-response of the non-merging firms in a similar way, that is, writing the FOCs of a typical non-merging firm as:

$$x_k : \quad \frac{x_m + \sum_{k \neq i,j} x_k + \epsilon_A}{(x_m + x_{nm} + \epsilon_A)^2} \pi_A \frac{n}{(n + \epsilon_B)^2} \frac{x_m}{x_m} \frac{\sum_{k \neq i,j} x_k}{x_{nm}} \pi_B = 0.$$
and summing across $\ell \neq i, j$ to obtain:

$$x_m + \frac{n}{n + \frac{3}{2} x_{nm} + \frac{\epsilon_A}{n + \epsilon_A}} \pi_A \left( \frac{n - 1 + \epsilon_B}{n + \epsilon_B} \frac{x_m}{x_{nm}} \right)^{\frac{3}{2}} = 0.$$  

(14)

This expression defines implicitly the joint best response of the non-merging firms against the potentially merging firms $i$ and $j$. Let us denote the LHS of (14) as $\beta(x_m, x_{nm})$. By the implicit function theorem, the slope of the best response is:

$$\frac{\partial x_{nm}}{\partial x_m} = \frac{\frac{\partial \beta}{\partial x_m}}{\frac{\partial \beta}{\partial x_{nm}}} = \frac{(n - 2)x_m + (n - 4)x_{nm} + (n - 2)x_A}{(x_m + x_{nm} + \epsilon_A) x_{nm}} \pi_A \frac{(n - 2) + \epsilon_B}{n(n + \epsilon_B)} \frac{(n - 2)x_m}{x_{nm}} \frac{(n - 4)x_{nm}}{x_{nm}^3} \pi_B < 0,$$

(15)

for all $n \geq 4$. Therefore, for $n \geq 4$, the two pseudo best response functions are decreasing and cross only once. The crossing point gives the pre-merger symmetric Nash equilibrium.

We represent these pseudo best response functions in Figure 1. In this figure we have the joint effort of the potentially merging firms, denoted $x_m$, in the vertical axes, while in the horizontal axes we have the joint effort of the non-merging firms, denoted $x_{nm}$. The best response functions are plotted for an oligopoly market with 4 firms, and for parameters $\epsilon_A = 4$, $\pi_A = 2$, $\epsilon_B = 1$ and $\pi_B = 1$. The crossing point is $x_m = x_{nm} = 1.084$, which signifies that each firm invests $x^* = 0.541$ in the $A$-innovation and $x^* = 0.459$ in the $B$-innovation path.

We now study the effects of a merger on the equilibrium allocation of investment efforts. Suppose firms $i, j \in N$ merge. The payoff to the merged entity is:

$$u_m(x_i, x_j; \cdot) = \frac{x_i}{\sum_{k=1}^n x_k + \epsilon_A} \pi_A + \frac{1}{\sum_{k=1}^n (x_k + \epsilon_A)} \pi_B + \frac{x_j}{\sum_{k=1}^n x_k + \epsilon_A} \pi_A + \frac{x_j}{\sum_{k=1}^n (x_k + \epsilon_A)} \pi_B$$

$$= \frac{x_i + x_j}{\sum_{k=1}^n x_k + \epsilon_A} \pi_A + \frac{2}{\sum_{k=1}^n (x_k + \epsilon_A)} \pi_B.$$

(16)
Inspection of the payoff in Equation (16) reveals that the merged entity is indifferent between putting effort in two research labs where the firm pursues A-innovations or just in one, and obviously the same applies to B-innovations. Correspondingly, let us define \( x_m = x_i + x_j \) as the total investment of the merged entity into the A-innovation path. The total investment of the merged entity into the B-innovation path is then \( 2x_m \). Non-merging firms continue to maximize the payoff in [14].

The FOCs necessary for an interior equilibrium for the merged entity and the non-merging firms are, respectively:

\[
\frac{\sum_{k \neq m} x_k + \epsilon_A}{(x_m + \sum_{k \neq m} x_k + \epsilon_A)^2} = \frac{n}{(n + \epsilon_B)} \frac{2 + \epsilon_B}{x_m} \frac{\sum_{k \neq m} x_k}{(n + \epsilon_B) \sum_{k \neq m} x_k} = 0, \tag{17}
\]

\[
\frac{x_m + \sum_{k \neq m, i \neq j} x_k + \epsilon_A}{(x_m + \sum_{k \neq m} x_k + \epsilon_A)^2} = \frac{n}{(n + \epsilon_B)} \frac{1 + \epsilon_B}{x_m} \frac{\sum_{k \neq m, i \neq j} x_k}{(n + \epsilon_B) \sum_{k \neq m} x_k} = 0. \tag{18}
\]

As before, the second order conditions hold so the existence of a Nash equilibrium is established by the same arguments as in Proposition [14].

After applying symmetry for the non-merging firms and setting \( x_{nm} = \sum_{k \neq i, j} x_k \), these FOCs simplify to:

\[
\frac{x_{nm} + \epsilon_A}{(x_m + x_{nm} + \epsilon_A)^2} = \frac{n}{(n + \epsilon_B)} \frac{2 + \epsilon_B}{x_m} \frac{x_{nm}}{(n + \epsilon_B) x_{nm}} = 0. \tag{19}
\]

\[
\frac{x_m + \frac{n}{2} x_{nm} + \epsilon_A}{(x_m + x_{nm} + \epsilon_A)^2} = \frac{n}{(n + \epsilon_B)} \frac{1 + \epsilon_B}{x_m} \frac{\frac{n}{2} x_{nm}}{(n + \epsilon_B) \frac{n}{2} x_{nm}} = 0. \tag{20}
\]

**Proposition 4. (Post-merger equilibrium)** If a merger occurs the merged entity increases investment in the A-innovation path if and only if \( \epsilon_A/\pi_A > \epsilon_B/\pi_B \).

**Proof.** To prove this result, we compute the difference between the FOC of the merged entity after the merger with that of a potentially merging firm before the merger and evaluate it at the pre-merger equilibrium \( x^* \). Because the FOCs of the non-merging firms remain the same, if this difference is positive we conclude that the merged entity invests more in A-innovation after the merger.

\[
\Delta(x^*) = \frac{\partial u_m}{\partial x_i}(x^*) - \frac{\partial u}{\partial x_i}(x^*) = \frac{x^*}{(nx^* + \epsilon_A)^2} \frac{2}{\pi_A} + \frac{1}{(n + \epsilon_B)} \frac{x^*}{n x^*} \frac{2}{\pi_B}
\]

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Using the first order condition evaluated at the pre-merger equilibrium \( \text{[2]} \), this difference can be rewritten as

\[
\Delta(x^*) = \frac{\pi_B((1 - x^*)\epsilon_A - x^*\epsilon_B)}{((1 - x^*)\epsilon_A + \epsilon_B)(n(1 - x^*) + \epsilon_B))^2}
\]

This difference is positive whenever \((1 - x^*)\epsilon_A - x^*\epsilon_B > 0\), which requires that

\[
x^* < \frac{\epsilon_A}{\epsilon_A + \epsilon_B}.
\]

(21)

In order to find the parameters under which this condition holds, we evaluate the FOC \( \text{[2]} \) at the value \(-\frac{\epsilon_A}{\epsilon_A + \epsilon_B}\), which gives:

\[
\frac{(\epsilon_A + \epsilon_B)(n + 1 + \epsilon_A + \epsilon_B)(\epsilon_B \pi_B - \epsilon_A \pi_A)}{\epsilon_A \epsilon_B (n + \epsilon_A + \epsilon_A \pi_B)^2}
\]

This expression is negative whenever \(\frac{\epsilon_A}{\pi_A} > \frac{\epsilon_B}{\pi_B}\). Because the FOC is a decreasing function of \(x^*\), this implies that the condition \( \text{[2]} \) holds. Therefore, the merged entity increases investment in the \( A \) innovation project. This concludes the proof.

\[\square\]

We illustrate Proposition \( \text{[4]} \) in Figure \( \text{[2]} \). This Figure builds on Figure \( \text{[1]} \) by adding the best-response of the merging firms after the merger, which is denoted by \( \pi_m(x_{nm}) \). Because the parameters of the model satisfy the condition in the proposition, the best-response of the merging firms after the merger lies above the best-response of the merging firms before the merger in a neighbourhood of the pre-merger equilibrium \( x^* \). Because the best-replies are decreasing, the post-merger equilibrium necessarily has the merging firms putting in a greater investment in the \( A \)-innovation \( x^*_m \) and the non-merging firms putting in a lower investment \( x^*_{nm} \).

![Figure 2: Post-merger market equilibrium](image)

When the parameters of the model violate the condition \(\frac{\epsilon_A}{\pi_A} > \frac{\epsilon_B}{\pi_B}\), the merger results in the merging firms putting less effort into the \( A \)-innovation path. This situation is illustrated in Figure \( \text{[3]} \). In this Figure we increase the parameter \(\epsilon_B\) to 2.5; the rest of the parameters remain the
same as in Figures 1 and 2. The graph on the left hand side shows the pseudo reaction functions in the pre-merger symmetric equilibrium. On right-hand-side graph we add the best-response of the merging firms after the merger. It can be seen that the best-response of the merging firms after the merger falls below the best-response of the merging firms before the merger in a neighbourhood of the pre-merger market equilibrium. As a result, post-merger, the merging firms cut investment in the A-innovation while the non-merging firms increase it.

![Graphs showing pre- and post-merger market equilibrium](image.png)

(a) Pre-merger  
(b) Post-merger

Figure 3: Pre- and post-merger market equilibrium

If \( \epsilon_A/\pi_A > \epsilon_B/\pi_B \), then the merging firms increase their investment in the A-innovation path, while the non-merging firms decrease it. What happens on aggregate?

**Proposition 5.** If \( \epsilon_A/\pi_A > (<) \epsilon_B/\pi_B \), aggregate investment in the A-innovation path increases (decreases) after a merger.

**Proof.** To prove this result, we make use of the pseudo reaction functions analysed above. In the pre-merger symmetric equilibrium, this total investment is equal to \( nx^* \), where \( x^* \) solves \([12] \). In the post-merger equilibrium, we have denoted the total investment in the A-innovation path by \( x_m + x_{nm} \). The change from \( nx^* \) to \( x_m + x_{nm} \) after the merger is determined by the slope of the joint best response of the non-merging firms, given by the expression \([20] \).

Under the condition \( \epsilon_A/\pi_A > \epsilon_B/\pi_B \), we know that \( x_m \) increases compared to \( (n-2)x^* \). Consequently, if the slope of the pseudo best-response of the non-merging firm is smaller than 1 then the increase in \( x_m \) is larger than the reduction in \( x_{nm} \) and therefore aggregate investment in the A-innovation path increases after the merger.

The slope of the pseudo best-response of the non-merging firms is given in \([15] \). This slope if smaller than 1 provided that

\[
\frac{(n-1)x_m + (n-3)x_{nm} + (n-1)\epsilon_A}{(x_m + x_{nm} + \epsilon_A)^3} \pi_A + \frac{n(n-3) + (n-1)\epsilon_B + 4 - (n-1)x_m - (n-3)x_{nm}}{(n + \epsilon_B - x_m - x_{nm})^3} > \frac{(n-2)x_m + (n-4)x_{nm} + (n-2)\epsilon_A}{(x_m + x_{nm} + \epsilon_A)^3} \pi_A + \frac{(n-2)(n-2 + \epsilon_B) - (n-2)x_m - (n-4)x_{nm}}{(n + \epsilon_B - x_m - x_{nm})^3} \pi_B.
\]

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which, after rearranging, is equivalent to

\[
\frac{1}{(x_m + x_{nm} + \epsilon_A)^2 \pi_A} > \frac{1}{(n + \epsilon_B \ x_m \ x_{nm})^2 \pi_B},
\]

which is always satisfied because the RHS is negative. As a result, total investment \(x_m + x_{nm}\) increases after a merger. \(\Box\)

Next, we study conditions under which a merger is beneficial for consumers. To do this, we define the social welfare criterion as the expected consumer surplus:

\[
W = \frac{X}{X + \epsilon_A} CS_A + \frac{n}{n + \epsilon_B} \frac{X}{X} CS_B, \tag{22}
\]

where \(X \equiv x_m + x_{nm}\) is the aggregate industry investment in the A-innovation path. Pre-merger, this aggregate investment is \(X^{pre} = nx^*\); post-merger, this is given by \(X^{post} = x_m^* + x_{nm}^*\). From Proposition 3, we know that \(X^{post} > X^{pre}\).

Note that the first summand in (22) is increasing in \(X\). The second summand, by contrast, is decreasing in \(X\). Because \(X\) increases after the merger, there is a tradeoff. The aggregate industry investment in the A-innovation path that maximises the welfare criterion is given by the solution to the following first order condition:

\[
\frac{\epsilon_A}{(X + \epsilon_A)^2 CS_A} - \frac{\epsilon_B}{(n + \epsilon_B)^2 CS_B} = 0. \tag{23}
\]

Let \(X_W^*\) be the unique solution to (23). We say that the market over- (under-)invest in the A-innovation when the aggregate investment exceeds (resp. falls short of) the social optimum. In the pre-merger market, over- (under-)investment occurs when \(nx^* > (<) X_W^*\).

Our next result provides conditions under which the pre-merger market equilibrium is distorted relative to the consumer surplus maximizing portfolio. For this purpose it is convenient to define the function:

\[
f(CS_A/CS_B; n, \epsilon_A, \epsilon_B) = \frac{CS_A}{CS_B} \left( \frac{n + 1}{n + \epsilon_B} \sqrt[\epsilon_A]{\frac{CS_{A/B}}{CS_{A/A}}} + \epsilon_A \left( \frac{1 + n}{n + \epsilon_B} \sqrt[\epsilon_A]{\frac{CS_{B/B}}{CS_{A/A}}} \right) \right) \]

**Proposition 6.** Suppose the social planner maximizes the expected consumer surplus. The pre-merger market equilibrium exhibits under-investment in the A-innovation and correspondingly over-investment in the B-innovation if and only if:

\[
\frac{\pi_A}{\pi_B} < f(CS_A/CS_B; n, \epsilon_A, \epsilon_B). \tag{24}
\]

The pre-merger market over-invests in the A-innovation and under-invests in the B-innovation if and only if the above inequality is reversed.
Proof. We first calculate the socially optimal investment in the A-innovation, \( X^*_W \), by solving equation (23):

\[
X^*_W = \frac{n + \epsilon_B}{1 + \sqrt{\frac{CS_B \epsilon_B}{CS_A \epsilon_A}}}.
\]  

We now rewrite the FOC (10) in terms of aggregate investment \( X \) in the A-innovation path as follows:

\[
\frac{\partial u_i(\cdot)}{\partial x_i} = \frac{n}{n} X + \epsilon_A \frac{1}{(X + \epsilon_A)^2} \pi_A \left( \frac{n}{n} X + \epsilon_B \right) \pi_B.
\]  

At the pre-merger market equilibrium \( X^* = n \epsilon^* \), this expression is equal to zero. We now evaluate it at the socially optimal aggregate investment, \( X^*_W \):

\[
\frac{\partial u_i(\cdot)}{\partial x_i} \bigg|_{X=X^*_W} = n \left( 1 + \frac{\epsilon_A}{\epsilon_B} + \frac{n}{\epsilon_B} \right) \left( \frac{\pi_B}{\pi_A} \cdot \frac{CS_B \epsilon_B}{CS_A \epsilon_A} \right) \left( 1 + \frac{\epsilon_A}{\epsilon_B} \right) \left( \frac{\pi_B}{\pi_A} \cdot \frac{CS_B \epsilon_B}{CS_A \epsilon_A} \right).
\]  

If the above expression is negative, it implies that \( X^* < X^*_W \); in other words, the market under-invests in the A-innovation path and correspondingly over-invests in the B-innovation path. Solving the inequality \( \frac{\partial u_i(\cdot)}{\partial x_i} \bigg|_{X=X^*_W} < 0 \) in \( \frac{\epsilon_A}{\epsilon_B} \) gives condition (24) in the proposition. If (27) is instead positive, then the market over-invests in the A-innovation path and under-invests in the B-innovation path.

Similarly, we derive conditions under which the industry’s innovation portfolio is biased in the post-merger market. For that purpose, consider the system of the FOCs for the merged and non-merged entities respectively:

\[
\frac{x_{nm} + \epsilon_A}{(x_m + x_{nm} + \epsilon_A)^2} - \frac{n}{(n + \epsilon_B)} \frac{x_{nm} x_m}{x_m n} = 0
\]  

\[
\frac{x_m + \frac{3}{2} x_{nm} + \epsilon_A}{(x_m + x_{nm} + \epsilon_A)^2} - \frac{n}{(n + \epsilon_B)} \frac{x_m (n/2) x_{nm}}{x_m (n/2) x_{nm}} = 0
\]  

Recollect that the total investment in A-innovation by the merged entity is \( x_m = x_i + x_j \), while the aggregate investment by all non-merging firms is \( x_{nm} = \sum_{k \neq i,j} x_k \). Summing up (28) and (n-2)* (29) we get:

\[
\frac{n}{n} \frac{x_{nm} + \epsilon_A}{(x_m + \epsilon_A)^2} \pi_A - \frac{n}{n} \frac{(n/2) x_m + \epsilon_B}{(n/2) x_m + \epsilon_B} \frac{\pi_B}{\pi_B} = 0
\]

The above equation is expressed in terms of industry’s aggregate investment in A-innovation, \( X_m = x_m + x_{nm} \). Our next result provides conditions under which the post-merger market equilibrium is
distorted relative to the consumer surplus maximizing portfolio. For that purpose, we define the function

\[
g(CS_A/CS_B; n, \epsilon_A, \epsilon_B) \equiv \frac{CS_A}{CS_B} \left( \frac{(n-2)(n+\epsilon_A) \sqrt{\frac{CS_B+\epsilon_A}{CS_A+\epsilon_B}} + \epsilon_A \left( 1 + \frac{1}{n} \right) \sqrt{\frac{CS_B+\epsilon_B}{CS_A+\epsilon_A}}}{(n+\epsilon_B)(n-2) + \epsilon_A \left( 1 + \frac{1}{n} \right) \sqrt{\frac{CS_B+\epsilon_A}{CS_A+\epsilon_B}}} \right).
\]

**Proposition 7.** The post-merger market equilibrium exhibits under-investment in the A-innovation and correspondingly over-investment in the B-innovation if and only if:

\[
\frac{\pi_A}{\pi_B} < g(CS_A/CS_B; n, \epsilon_A, \epsilon_B).
\]

The market over-invests in the A-innovation and under-invests in the B-innovation if and only if the above inequality is reversed.

**Proof.** The socially optimal investment in the A-innovation continues to be

\[
X^*_W = \frac{n + \epsilon_B}{1 + \frac{\epsilon_A \sqrt{\frac{CS_B+\epsilon_B}{CS_A+\epsilon_A}}}{\sqrt{\frac{CS_B+\epsilon_A}{CS_A+\epsilon_B}}}}.
\]

From equation (30) we have the following FOC

\[
\frac{\frac{n-2}{n} X + \epsilon_A}{(X + \epsilon_A)^2} \pi_A - \frac{\frac{n-2}{n} X + \epsilon_B}{(X + \epsilon_B)^2} \pi_B.
\]

Following the approach in proposition 3, the above expression at socially optimal aggregate investment, \(X^*_W\), to obtain the condition (31).

Propositions 3 and 4 show that the pre- and post-merger market equilibrium portfolio will in general deviate from the expected consumer surplus maximizing one. Further, they give conditions under which the bias is in favor of project A and therefore against project B in the pre- and post-merger market respectively. For fixed parameters \(n, \epsilon_A\) and \(\epsilon_B\), inspection of the conditions (24) and (31) reveals that what matters for the bias is the relation between the relative profitability to the relative consumer surplus of the innovations.

To understand this relation, figure 1 plots conditions (24) and (31) in the \(\pi_A/\pi_B - CS_A/CS_B\) space for fixed parameters \(n, \epsilon_A\) and \(\epsilon_B\). The horizontal line with intercept \(\epsilon_A/\epsilon_B\) divides the space into two regions based on profitability. Above the line, the A-innovation is more profitable and below it the B-innovation is more profitable. The two upward sloping curves represent conditions (24) and (31). For pairs of innovations above both the curves the pre- and post-merger market over-invests in the A-innovation and therefore under-invests in the B-innovation. Formally, the condition is

\[
\frac{\pi_A}{\pi_B} > \max \{ f(CS_A/CS_B; n, \epsilon_A, \epsilon_B), g(CS_A/CS_B; n, \epsilon_A, \epsilon_B) \}.
\]
Figure 4: Efficiency of the market equilibrium: surplus appropriability

Similarly, for pairs of innovations below both the curves (the above inequality is reversed) it is the opposite: the market under-invests in the $A$-innovation and thus over-invests in the $B$-innovation. For pairs of innovations that are above one curve, but below the other curve, a merger changes the market distortion. For instance, consider an innovation pair that satisfies the following inequality

$$f(CS_A/CS_B; n, \epsilon_A, \epsilon_B) < \frac{\pi_A}{\pi_B} < g(CS_A/CS_B; n, \epsilon_A, \epsilon_B).$$

In this case the pre-merger market under-invests, but the post-merger market over-invests in the $A$-innovation path. The opposite holds if the above inequality is reversed.

With the help of figure 4 and with the result of Proposition 5 at hand, we can determine the effects of mergers on social welfare. The upward sloping curves $f(.)$ and $g(.)$ along with the horizontal line split the $\pi_A/\pi_B$, $CS_A/CS_B$ space into six regions of market conditions. These regions can be classified in terms of relative profitability and over- or under-investment in the pre- or post-merger markets for $A$- and $B$-innovations.

As shown in Proposition 5 for pairs of innovations below (resp. above) the horizontal line a merger increases total investment in the $A$ (resp. $B$) innovation. Consider pairs of innovations in region I. For these types of innovations, the $A$-project is more profitable and has a higher total surplus appropriability. The pre- and post-merger markets over-invest in the $A$-project and under-invest in the $B$-project. It follows from Proposition 5 that, because $\pi_A/\epsilon_A > \pi_B/\epsilon_B$ or, equivalently, the $A$-project is more profitable than the $B$-project, a merger decreases investment in the $A$-innovation and increases investment in the $B$-innovation. Because for this region of parameters the pre-merger market over-invests the $A$-project, a merger increases social welfare. By a similar reasoning, a merger always increases social welfare for pairs of innovations in region IV.

Consider now pairs of innovations in region III. The pre- and post-merger market under-
invests in the $A$-innovation and over-invests in the $B$-innovation. Because the $A$-innovation is more profitable in this region, Proposition 3 implies that a merger further decreases investment in the $A$-innovation and increases investment in the $B$-innovation. Thus, a merger decreases social welfare. A similar argumentation allows us to conclude that a merger decreases social welfare provided that the parameters fall in region $VI$.

The impact of a merger or pairs of innovations falling in regions $II$ and $V$ depend on the other parameters of the model, that is $n, \epsilon_A$ and $\epsilon_B$. Note that for innovations in region $II$, the pre-merger market over-invests in the $A$-innovation project. Although a merger decreases investment in that project, the post-merger market under-invests in the $A$-innovation path. It is unclear what is better for social welfare: pre-merger over-investment or post-merger under-investment in project $A$. The same considerations apply to region $V$.

The following result summarises our findings:

**Proposition 8.** Suppose the social planner maximizes the expected consumer surplus. For any fixed $n, \epsilon_A$ and $\epsilon_B$, if the parameters of the model fall in:

(i) Region $I$ (resp. $IV$): a merger always increases social welfare by reducing (resp. increasing) investment in project $A$ and increasing (decreasing) it in project $B$.

(ii) Regions $III$ (resp. $VII$): a merger always decreases social welfare by further reducing (increasing) investment in project $A$ and increasing (reducing) it in project $B$.

(iii) Regions $II$ and $V$: a merger may or may not increase welfare depending on parameters.

Next, we discuss two specific economic insights.

5.1 Perfect price discrimination

In our model the winning firm monopolises the market and therefore its profits depend on the extent to which the innovator can extract consumer surplus in the market. Suppose the innovator is able to sell each product at the buyer’s reservation price. In other words, suppose the innovating firm can practise perfect price discrimination in the product market. In such a case, in both product markets consumers obtain zero surplus, that is, $CS_A = CS_B = 0$. Maximizing social welfare is then equivalent to maximizing the criterion:

$$W_{TS} = \frac{X}{X + \epsilon_A} \pi_A + \frac{n}{n + \epsilon_B} \frac{X}{X} \pi_B. \quad (34)$$

It is straightforward to derive the following result corresponding to propositions 3 and 7.

**Proposition 9.** Suppose that the winning firm can perfectly price discriminate in the product market so that $\pi_i = W_i$, $i = A, B$. Then, the pre- and post-merger market equilibrium exhibits under-investment in the $A$-innovation and correspondingly over-investment in the $B$-innovation if and only if:

$$\frac{\pi_A}{\pi_B} < \frac{\epsilon_A}{\epsilon_B}. \quad (35)$$
When the inequality is the other way around, the pre- and post-merger market equilibrium exhibits over-investment in the A-innovation and under-investment in the A-innovation.

The analysis around Figure 5 can easily be adapted to capture the case of perfect price discrimination. For this, we just need to focus on the 45 degree line in Figure 5. Consider any point \( (\hat{\pi}_A, \hat{\pi}_B) \) such that the pre-merger market exhibits over-investment in B-innovation, i.e. inequality (35) is satisfied. As the B-innovation path is more profitable, a merger decreases aggregate industry investment in B-innovation (proposition 5). The industry’s innovation portfolio in post-merger market is modified such that the distortion tends to decrease.

Figure 5: Efficiency of the pre-merger market equilibrium: perfect price discrimination

A similar argument holds for the point \( (\hat{\pi}_A, \hat{\pi}_B) \). The pre-merger market exhibits over-investment in A-innovation, i.e. the inequality sign in (35) is reversed. As the A-innovation path is more profitable, a merger decreases aggregate industry investment in A-innovation (proposition 5). Again, the post-merger market equilibrium tends to decrease the distortion. In conclusion, mergers always improve social welfare (total surplus) if innovators can perfectly price discriminate. Summarizing:

**Proposition 10.** Assume that the winner of a contest can perfectly price discriminate in the product market. Then, a merger increases social welfare.

### 5.2 Architectural innovations

An innovation is termed **architectural** if it results from changes in the manner in which the components of a product are linked to one another (the architecture of the product) without changing its core components (Henderson and Clark, 1990). The market value of such innovations is solely determined by improving the existing technology’s architecture to serve a new market. As the existing technology is sufficient for the new market, the innovator is the firm providing an architecture that best fits the requirements of the new market. Therefore, we model these innovations by assuming that the probability they happen to be introduced is equal to 1.
Suppose that one of the innovations is architectural, say, the $B$-innovation so that $\epsilon_B \to 0$. Hence, social welfare for this case is

$$W = \frac{X}{X + \epsilon_A} CS_A + CS_B. \quad (36)$$

Note that welfare increases monotonically in the aggregate investment made by the industry in the $A$-project (as long as there is an infinitesimal investment in the $B$-project).

Similarly as above, we can easily adapt our reasoning around Figure 3 to accommodate the case of architectural innovations. Observe that when $\epsilon_B \to 0$ the red horizontal line moves to infinity. This signifies that the $B$-innovation is always more profitable than the $A$-innovation. Therefore, the $\pi_A/\pi_B \quad CS_A/CS_B$ space can be classified into two regions. In Region I, the appropriability of total surplus is higher in the $A$-innovation market; in Region II, it is the opposite.

![Figure 6: Efficiency of the pre-merger market equilibrium: incremental innovations](image)

When $B$ is an architectural innovation the pre-merger market equilibrium necessarily exhibits over-investment in the $B$ and correspondingly under-investment in $A$. As the $B$-innovation is more profitable, a merger decreases investment in the $B$-project and improves welfare. This improvement is independent of total surplus appropriability. Our next result summarizes:

**Proposition 11.** Assume that the $B$-innovation is architectural and therefore is obtained with probability 1. Then, a merger always increases social welfare.

---

6If both innovations are architectural, welfare becomes independent of investment and then mergers do not have problem any longer a welfare dimension to discuss.

7If all firms refrain from investing in the $B$-innovation, then the aggregate probability of obtaining it is zero.
6 Extensions

6.1 Variable budget model

In this section, we relax the assumption that firms are research-budget constrained (Assumption 2). As described in Section 3, a firm $i$ that invests $x_i > 0$ in the $A$-innovation path and $y_i > 0$ in the $B$-innovation path has a payoff:

$$u_i(x_i, y_i; \pi_A, \pi_B) = p_i(x_i, y_i; \epsilon_A) \pi_A + q_i(y_i; \epsilon_B) \pi_B - c(x_i + y_i)$$

(37)

where $c(x_i + y_i)$ is the total cost of investment, with $c(\cdot)$ increasing and convex. The rest of the model assumptions remain the same.

In the pre-merger situation, a firm $i$ chooses $x_i$ and $y_i$ to maximize the payoff in 37. The FOCs for profits maximization are:

$$\frac{\partial p_i(x_i, y_i; \epsilon_A)}{\partial x_i} \pi_A = \frac{\partial c(x_i + y_i)}{\partial x_i} = 0$$

(38)

$$\frac{\partial q_i(y_i; \epsilon_B)}{\partial y_i} \pi_B = \frac{\partial c(x_i + y_i)}{\partial y_i} = 0.$$  

(39)

Equations 38 and 39 imply that the marginal gains from investing in a project must equal the marginal cost of total investment. Further, as the effect of a change in investments $x_i$ and $y_i$ on the total cost, $c(x_i + y_i)$, is symmetric, the marginal cost of investment is equal across projects:

$$c'(x_i + y_i) = \frac{\partial c(x_i + y_i)}{\partial x_i} = \frac{\partial c(x_i + y_i)}{\partial y_i}.$$  

(40)

From equations 38, 39 and 40 we have:

$$\frac{\partial p_i(x_i, y_i; \epsilon_A)}{\partial x_i} \pi_A = \frac{\partial q_i(y_i; \epsilon_B)}{\partial y_i} \pi_B = c'(x_i + y_i)$$

(41)

Recall that under Assumption 2, firms choose the optimal portfolio to equalize the marginal profits across innovations. When the firms are not budget-constrained, in addition to this requirement, the marginal profits from the $A$-innovation and the $B$-innovation must equal the marginal cost. Despite this difference, we will next show that this case yields results similar to those in Sections 3 and 4.

6.2 Pre-merger equilibrium

The bi-dimensional nature of the problem to be solved makes it difficult to analyze the existence of equilibrium. We follow an approach recently developed by Hefti (2017) that imposes regularity conditions on the payoff function that guarantee the existence and uniqueness of a symmetric equilibrium.

**Proposition 12.** There exists a unique symmetric Nash equilibrium (SNE) denoted $x_i^* = x^* \geq 0$.
and \( y^*_i = y^* \geq 0 \) for all \( i \in N \), and is given by the solution to:

\[
\frac{\partial p_i(x^*, y^*, \epsilon_A)}{\partial x_i} \pi_A = \frac{\partial q_j(y^*, y^*, \epsilon_B)}{\partial y_i} \pi_B = c'(x^* + y^*)
\]

The SNE is interior provided that \( \frac{\partial p_i(0, 0, \epsilon_A)}{\partial x_i} \pi_A > c'(y^*) \) and \( \frac{\partial q_j(0, 0, \epsilon_B)}{\partial y_i} \pi_B > c'(x^*) \).

Proof. See the Appendix. \qed

As we are interested only in the interior solutions, we assume henceforth that the conditions for an interior equilibrium hold.

### 6.3 Post-merger equilibrium

Consider now that firms \( i \) and \( j \) merge. In such a case, the merged entity chooses investments \( x_i, x_j, y_i \) and \( y_j \) to maximise the payoff:

\[
 u_m(x_i, y_i; x_i, y_i) = p_i(x_i, x_i, \epsilon_A) \pi_A + q_i(y_i, y_i, \epsilon_B) \pi_B - c(x_i + y_i)
 + p_j(x_j, x_j, \epsilon_A) \pi_A + q_j(y_j, y_j, \epsilon_B) \pi_B - c(x_j + y_j)
\]

The FOCs for profits maximisation with respect to \( x_i \) and \( y_i \) are given by:

\[
\frac{\partial p_i(x_i, x_i, \epsilon_A) \pi_A}{\partial x_i} + \frac{\partial p_j(x_j, x_j, \epsilon_A) \pi_A}{\partial x_i} = 0 \quad (43)
\]

\[
\frac{\partial q_i(y_i, y_i, \epsilon_B) \pi_B}{\partial y_i} + \frac{\partial q_j(y_j, y_j, \epsilon_B) \pi_B}{\partial y_i} = 0 \quad (44)
\]

The second summand of equation (43) (resp. equation (44)) is the negative externality firm \( i \) investment in the \( A \)-innovation (resp. \( B \)-innovation) exerts on its partner's chance of winning the contest for that innovation. The FOC for profits maximisation with respect to \( x_j \) and \( y_j \) are similar and therefore omitted.

Non-merging firms continue to maximise the payoff in (37) and the corresponding FOCs for an interior equilibrium are the same as those given in (38) and (39).

The intuition why the effect of a merger on investment levels in this case in which the firms are not research-budget constrained is similar to that in the main body of the paper follows from the following observation. Because the cost function is convex, the marginal cost of investment in the \( A \)-innovation increases with investment in the \( B \)-innovation. That is:

\[
\frac{\partial^2 c(x_i + y_i)}{\partial x_i \partial y_i} > 0 \implies \frac{\partial c(x_i + y_j)}{\partial x_i} > \frac{\partial c(x_i + y_i)}{\partial x_i}
\]

for all \( x_i, y_i, y'_j \) with \( y'_j > y_j \).

Therefore, if a firm increases its investment, say, in the \( B \)-innovation, then the marginal net gains from investing in the \( A \)-innovation go down and the firm will tend to decrease investment in such a project. As investment in the \( A \)-innovation decreases, firm \( i \)'s probability of winning the contest...
for the $A$-innovation also decreases, which exerts a positive externality on firm $j$. This cross-project effect is similar to that implied by Assumption 2.

The net effect of the internalisation of the negative and positive externalities due to a merger is ambiguous, and can therefore be towards either more or less investment in the most profitable and/or socially desirable type of innovation. Our next result explores this net effect. Before presenting it, a few comments on the existence of an interior post-merger Nash equilibrium are in order. Notice that the payoff of the merged entity is the sum of the payoffs of firms $i$ and $j$. The additive structure retains the properties of the payoff function, and hence the existence of an equilibrium can easily be established. To ensure that the equilibrium is interior, we need further regularity conditions. In what follows we assume that these conditions hold and we focus on comparing the pre- and post-merger equilibria of our model.

**Proposition 13.** Assume that firms $i$ and $j$ merge. Then, compared to the pre-merger equilibrium, the merged firms will invest more in the $A$-innovation and less in the $B$-innovation if and only if:

$$\frac{\partial p_j(x^*_i, x^*_i, \epsilon_A)}{\partial x_i} - \epsilon_A < c' \left( x^* + r(x^*, \pi_B, \epsilon_B) \right) - c' \left( x^* + r_m(x^*, x^*_i, \pi_B, \epsilon_B) \right)$$

(45)

The non-merging firms, by contrast, will invest less in the $A$-innovation and more in $B$-innovation.

**Proof.** See Appendix.

Proposition 13 suggests that, compared to the situation before a merger, the merging firms will put more effort in the $A$-project and less in the $B$ one provided that condition (45) holds. The LHS of inequality (45) is the negative externality firm $i$ imposes on its partner firm $j$ through its investment in the $A$-innovation. As $\partial p_j(x^*, x^*_i, \epsilon_A)/\partial x_i < 0$, the LHS is positive and represents the magnitude of this negative externality.

On the RHS of (45), we evaluate the pre- and post-merger investment in the $B$-innovation for a fixed level of investment $x^*$ in the $A$-innovation. Observe that if firms do not change their investment in the $A$-project, then a merger only internalises the negative externality arising from investment in the $B$-project. Therefore, the merging firm decreases investment in the $B$-innovation, that is:

$$r_m(x^*, x^*_i, \pi_B, \epsilon_B) < r(x^*, \pi_B, \epsilon_B).$$

Because the marginal cost function is increasing, the RHS of (45) is always positive. The RHS of equation (45) is analogous to the positive externality exerted by firm $i$ on firm $j$’s $B$-innovation path. In the variable budget model, this positive externality is exerted via the increase in the marginal cost of investing in project $B$. Proposition 13 suggests that the merging firms will invest more in $A$-innovation if this positive externality exceeds the negative externality.

Next, we study the effect of a merger on the total investment of the partner firms.

**Proposition 14.** Assume that condition (45) is satisfied. Then, the merged entity reduces total investment in the research projects. That is: $x^*_m + y^*_m < x^* + y^*$.
Proof. As usual, let \((x^*, y^*)\) and \((x_m^*, y_m^*)\) denote the pre- and post-merger equilibrium investments, respectively. These equilibrium investments satisfy the FOCs (33) and (43). Therefore:

\[
c'(x^* + y^*) = \frac{\partial p_t(x^*, x^*, \epsilon_A)}{\partial x_t} \pi_A
\]

\[
c'(x_m^* + y_m^*) = \frac{\partial p_t(x_m^*, x_m^*, \epsilon_A)}{\partial x_t} \pi_A + \frac{\partial p_t(x_m^*, x_m^*, \epsilon_A)}{\partial x_t} \pi_A
\]

Subtracting the two equations above gives:

\[
c'(x_m^* + y_m^*) - c'(x^* + y^*) = \frac{\partial p_t(x_m^*, x_m^*, \epsilon_A)}{\partial x_t} \pi_A + \left( \frac{\partial p_t(x_m^*, x_m^*, \epsilon_A)}{\partial x_t} \pi_A + \frac{\partial p_t(x_m^*, x_m^*, \epsilon_A)}{\partial x_t} \pi_A \right)
\]

When condition (45) of Proposition (13) holds, we have \(x_m^* > x^*\) and \(x_{nm}^* < x^*\). In such a case, assumption 1d implies \(\frac{\partial p_t(x_m^*, x_m^*, \epsilon_A)}{\partial x_t} < \frac{\partial p_t(x^*, x^*, \epsilon_A)}{\partial x_t}\) and assumption 1c means that \(\frac{\partial p_t(x_m^*, x_m^*, \epsilon_A)}{\partial x_t} < 0\). Together, these two inequalities imply that the marginal cost of the merged firm decreases post-merger:

\[
c'(x_m^* + y_m^*) - c'(x^* + y^*) < 0.
\]

As the function is strictly convex, \(c'' > 0\), this means that the total investment at the pre-merger level is less than the corresponding investment in the two independent firms. Therefore, the total innovation effort of the merging firms is decreased.

Proposition (14) implies that the increase in the effort put into the A-innovation is less than the decrease in the effort into the B-innovation when condition (45) holds. Hence, the total innovation effort of the merging firms is decreased.

From the point of view of the firms, the allocation of effort across projects is more efficient. The question is how the effort is shared against another. To understand this, consider the limiting case in which the slope of the cost function \(c(.)\) is close to zero up to the point where the total investment is 1, and the slope becomes very large approaching infinity. This situation is virtually equivalent to the one in the main body of the paper with the budget constraint set to equal 1. For such a case, the impact of the merger on the total investment ought to be negligible and the effort most of its total effort would be devoted to the portfolio adjustment. We have considered this in the next section.

As we depart from this limiting case, the decrease in the total investment by merging more significant. As we are aware of this, we expect that the new firms will be sufficiently steed that the cost function for a given investment level is dominated by the effort in its own space of the firm and the merger turns the firm into a new entity. A detailed analysis of the tradeoff between the investment in the new entity and the portfolio effort in more general situations is left for future research.
7 Conclusions

We have presented a model in which firms make investments in an innovation portfolio with two research projects. Putting money in a project signifies engaging in an R&D contest with rival firms. One project is more profitable than the other. When the winning firm appropriates the bulk of the social surplus generated by the innovation, which occurs when firms can perfectly price discriminate or when demand is quite horizontal, then in the pre-merger market equilibrium, firms over-invest in the most profitable project relative to the social optimum. In such a case, we have shown that a merger is always socially desirable.

In more general cases, the market bias depends on how the surplus the winning firm can appropriate varies across projects. When the most profitable project is also the most appropriable, then a merger increases welfare by aligning the market and the social incentives. By contrast, when the most profitable project is the least appropriable, then a merger can decrease welfare by further desynchronizing the social and the market incentives. For this type of settings, our research supports the idea that competition authorities must deal with mergers on a case-by-case basis.

We have argued that our results carry over to the case in which firms choose how much money to spend on research as well as how to allocate that money across projects. Allowing the firms to choose how much to invest in the projects does not alter the basic intuition that investing in one project increases the marginal cost of investing in the other project, which is at the heart of our analysis. Despite the fact that a merger results in lower aggregate investment, the fact that a merger can be a corrective device in regard to the nature of the innovation portfolio can make a merger socially desirable.

Appendix

Proof of proposition 12

Proof. To determine the concavity of firm $i$'s payoff, we calculate the Hessian for the payoff function.

$$
\text{Hess} \left( u_i(x_i, y_i; x, y) \right) = \begin{bmatrix}
\frac{\partial^2 u_i}{\partial x_i^2} & \frac{\partial^2 u_i}{\partial x_i \partial y_i} \\
\frac{\partial^2 u_i}{\partial x_i \partial y_i} & \frac{\partial^2 u_i}{\partial y_i^2}
\end{bmatrix}
= \begin{bmatrix}
\frac{\partial^2 p_i(x_i, y_i; y_i; \xi_i, \xi_A)}{\partial x_i^2} \pi_A & \frac{\partial^2 q_i(y_i, x_i; \xi_i, \xi_B)}{\partial y_i^2} \pi_B \\
\frac{\partial^2 q_i(y_i, x_i; \xi_i, \xi_B)}{\partial y_i^2} \pi_B & \frac{\partial^2 q_i(y_i, x_i; \xi_i, \xi_B)}{\partial y_i^2} \pi_B
\end{bmatrix}
= \begin{bmatrix}
c''(x_i + y_i) & \frac{\partial^2 q_i(y_i, x_i; \xi_i, \xi_B)}{\partial y_i^2} \pi_B \\
\frac{\partial^2 q_i(y_i, x_i; \xi_i, \xi_B)}{\partial y_i^2} \pi_B & \frac{\partial^2 q_i(y_i, x_i; \xi_i, \xi_B)}{\partial y_i^2} \pi_B
\end{bmatrix}
$$

The determinant of the principal minors are

$$
|L_1| = \frac{\partial^2 p_i(x_i, y_i; \xi_i, \xi_A)}{\partial x_i^2} \pi_A \ c''(x_i + y_i)
$$

$$
|L_2| = \left( \frac{\partial^2 p_i(x_i, y_i; \xi_i, \xi_A)}{\partial x_i^2} \frac{\partial^2 q_i(y_i, x_i; \xi_i, \xi_B)}{\partial y_i^2} \pi_A \pi_B \right) c''(x_i + y_i)
$$

29
As \( \frac{\partial^2 p_i(x_i, x_{-i}, \epsilon_A)}{\partial x_i^2} < 0 \) and \( \frac{\partial^2 q_i(y_i, y_{-i}, \epsilon_B)}{\partial y_i^2} < 0 \), by assumption 1d we conclude \( |L_1| < 0 \) and \( |L_2| > 0 \).

Hence, the Hessian is negative definite and the payoff of firms is strictly concave in the own strategy.

To find symmetric equilibria, a simplified approach, called the symmetric opponent (SOFA) heuristics is used. The SOFA attack is an arbitrary indicative player \( i \) and the symmetric is all opponents to play the same strategy \( \hat{s} \) i.e., \( \tilde{x}_i = (\tilde{x}, \tilde{x}, \ldots, \tilde{x}) \) and \( \hat{y}_i = (\hat{y}, \hat{y}, \ldots, \hat{y}) \).

Let
\[
\hat{p}_i(x_i, \tilde{x}, \epsilon_A) \equiv p_i(x_i, \hat{x}_i, \epsilon_A) \\
\hat{q}_i(y_i, \hat{y}, \epsilon_B) \equiv q_i(y_i, \hat{y}_i, \epsilon_B)
\]

A symmetric payoff function \( u_i \) and identical strategy set across players implies the existence of at least one symmetric equilibrium: \( x_i = x_j = x^* \) and \( y_i = y_j = y^* \) for all firms \( i, j \in N \).

To check for multiple equilibria, we follow the method proposed by Hefti (2017). We use index theory approach based on Poincare-Hopf index. However, applying the index theory to our bi-dimensional \( n \)-player game would involve a Jacobian matrix of dimensionality \( 2n \times 2n \). The SOFA condition allows us to reduce the dimensionality of the game to a two-player game. Further, based on Hefti (2017), we require to solve a \( 2 \times 2 \) Jacobian matrix.

First, we apply SOFA to the gradient of \( u_i \):
\[
\nabla u_i(x_i, y_i; \tilde{x}_i, \hat{y}_i) \equiv \nabla \hat{u}_i(x_i, y_i, \tilde{x}, \hat{y}) = \begin{bmatrix} \frac{\partial \hat{p}_i(x_i, \tilde{x}, \epsilon_A)}{\partial x_i} & c'(x_i + y_i) \\ \frac{\partial \hat{q}_i(y_i, \hat{y}, \epsilon_B)}{\partial y_i} & c'(x_i + y_i) \end{bmatrix}
\]

Next, evaluate \( \nabla \hat{u}_i(x_i, y_i, \tilde{x}, \hat{y}) \) at \( \tilde{x} = x_i, \hat{y} = y_i \) and calculate the Jacobian of \( \nabla \hat{u}_i \)
\[
J(x_i, y_i) = \begin{bmatrix} \frac{\partial^2 \hat{p}_i(x_i, \tilde{x}, \epsilon_A)}{\partial x_i^2} & \frac{\partial^2 \hat{q}_i(y_i, \hat{y}, \epsilon_B)}{\partial y_i^2} \\ \frac{\partial c'(x_i + y_i)}{\partial x_i} & \frac{\partial c'(x_i + y_i)}{\partial y_i} \end{bmatrix}
\]

If the \( D \left( J(x^*, y^*) \right) > 0 \), where \( \{(x^*, y^*) \mid \nabla \hat{u}_i(x^*, y^*) = 0 \} \), the unique solution exists.

\[
D \left( J(x^*, y^*) \right) = \left( \frac{\partial^2 \hat{p}_i(x^*, \tilde{x}, \epsilon_A)}{\partial x_i^2} \right) \frac{\partial c'(x_i + y_i)}{\partial x_i} + \left( \frac{\partial^2 \hat{q}_i(y^*, \hat{y}, \epsilon_B)}{\partial y_i^2} \right) \frac{\partial c'(x_i + y_i)}{\partial y_i}
\]

From assumption 1 we have \( \frac{\partial^2 \hat{p}_i(x^*, \tilde{x}, \epsilon_A)}{\partial x_i^2}, \frac{\partial^2 \hat{q}_i(y^*, \hat{y}, \epsilon_B)}{\partial y_i^2} < 0 \), while \( c''(x^* + y^*) > 0 \). Hence \( D \left( J(x^*, y^*) \right) > 0 \). This implies the existence of a unique equilibrium (see Hefti (2017)).

Observe that the equilibrium investments in \( A \)- and \( B \)-innovations are interrelated due to
the cost function. This dependency is established by a lemma 4 for the pre-merger situation and lemma 2 for the post-merger situation. These lemmas are necessary for proposition 1.

**Lemma 1.** There exists a unique response function at the SNE such that

\[ y^* = r(x^*, \pi_B, \epsilon_B) \]  

**Proof.** Define a function \( f : \mathbb{R}_+^n \times \mathbb{R}_+ \rightarrow \mathbb{R}_+ \) such that

\[ f(y_i, y_i, x_i) = \frac{\partial q_i(y_i, y_i, x_i, \epsilon_B)}{\partial y_i} \pi_B \frac{\partial c(x_i + y_i)}{\partial y_i} \]  

The function \( f \) is continuously differentiable as the second order partial derivatives of functions \( p_i(.) \) and \( c(.) \) are defined. Fix a point \( (y^*, y^*_i, x^*) \) where \( (x^*, y^*) \) is the SNE. The FOC in equation (39) gives

\[ f(y^*, y^*_i, x^*) = 0 \]

As \( \frac{\partial f(y^*, y^*_i, x^*)}{\partial x_i} = c''(x^* + y^*) \neq 0 \), by the implicit function theorem we exist an open subset \( U \) of \( \mathbb{R}_+^n \) containing \( (y^*, y^*_i) \) such that there exists a unique continuously differentiable function \( \eta : U \rightarrow \mathbb{R}_+ \) such that

\[ x^* = \eta(y^*, y^*_i) \]

Using the SOFA approach, we define \( \eta(y^*, \pi_B, \epsilon_B) \equiv \eta(y^*, y^*_i) \). As the function \( \eta \) is a one-one function, it is invertible. Thus, we get \( y^* = \eta^{-1}(x^*, \pi_B, \epsilon_B) \equiv r(x^*, \pi_B, \epsilon_B) \)

\[ \square \]

**Lemma 2.** There exists a unique reaction function for the merged firm at the SNE given by

\[ y_m^* = r_m(x_m, x_{nm}, \pi_B, \epsilon_B) \]  

**Proof.** Let investments made by the merging firms \( i \) and \( j \) in B-innovation be represented by \( x_m = (x_i, x_j) \), while the investments by non-merging firms is \( x_{nm} \). Similarly, \( y_m = (y_i, y_j) \) are investments made by the merged entity in I-innovation and \( y_{nm} \) by all non merging firms. Define a functions \( g : \mathbb{R}_+^n \times \mathbb{R}_+ \rightarrow \mathbb{R}_+ \) and \( h : \mathbb{R}_+^n \times \mathbb{R}_+ \rightarrow \mathbb{R}_+ \) such that

\[ g(y_m, y_{nm}, x_i) = \frac{\partial q_i(y_m, y_{nm}, \epsilon_B)}{\partial x_i} \pi_B + \frac{\partial q_j(y_m, y_{nm}, \epsilon_B)}{\partial y_i} \pi_B \]

\[ h(y_{nm}, y_m, x_k) = \frac{\partial q_k(y_{nm}, y_m, \epsilon_B)}{\partial x_k} \pi_B \]

As the second order partial derivatives of functions \( p(.) \) and \( c(.) \), the functions \( g(.) \) and \( h(.) \) are continuously differentiable. Fix a point \( (x_m^*, y_m^*, y_{nm}^*) \) where \( (x_m^*, y_m^*) \) are symmetric investments by the merged entities while \( y_{nm}^* \) is the symmetric investments by the non merging firms at the
post-merger SNE. The FOC in equation 14 gives

$$g(y^*_m, y^*_{nm}, x^*_m) = 0$$

Similarly, fix a point \((x^*_nm, y^*_m, y^*_{nm})\) where \((x^*_nm, y^*_{nm})\) are symmetric investments by the non-merging firms, while \(y^*_m\) is the symmetric investments by the merging firms at the post-merger SNE. The FOC for non-merging firms yields

$$h(y^*_{nm}, y^*_m, x^*_nm) = 0$$

As \(\frac{\partial g(y^*_m, y^*_{nm}, x^*_m)}{\partial x^*_i} = c''(x^*_m + y^*_m) \neq 0 \) and \(\frac{\partial h(y^*_{nm}, y^*_m, x^*_nm)}{\partial x^*_i} = c''(x^*_nm + y^*_nm) \neq 0\), by the implicit function theorem there exists an open set \(U\) of \(\mathbb{R}^+_n\) containing \(y^*_m, y^*_{nm}\) such that there exists a unique continuously differentiable function \(\eta_m : U \rightarrow \mathbb{R}^+_n\) and another a unique continuously differentiable function \(\eta_{nm} : U \rightarrow \mathbb{R}^+_n\) such that

$$x^*_m = \eta_m(y^*_m, y^*_{nm})$$

$$x^*_nm = \eta_{nm}(y^*_m, y^*_m)$$

As functions \(\eta_m\) and \(\eta_{nm}\) are invertible and following the procedure of lemma 1, we can show that a unique function \(r_m\) exists at the SNE such that \(y^*_m = r_m(x^*_m, x^*_nm, \pi_B, \epsilon_B)\) \(\square\)

**Proof of proposition 13**

**Proof.** Without loss of generality, consider the FOC of the merged firm \(i\) with respect to the investment in B-innovation (equation 43).

$$\frac{\partial p_i(x_i, x_i, \epsilon_A)}{\partial x_i} \pi_A + \frac{\partial p_j(x_j, x_j, \epsilon_A)}{\partial x_j} \pi_A \ c'(x_i + y_i) = 0$$

The above equation holds for the post-merger SNE

$$\frac{\partial p_i(x^*_m, x^*_m, \epsilon_A)}{\partial x_i} \pi_A + \frac{\partial p_j(x^*_m, x^*_nm, \epsilon_A)}{\partial x_j} \pi_A \ c'(x^*_m + y^*_m) = 0$$

We substitute \(y^*_m = r_n(x^*_m, x^*_nm, \pi_B, \epsilon_B)\) from lemma 2. Next, we evaluate the above FOC at the pre-merger symmetric equilibrium, \(x^*_m = x^*_nm = x^*\). Let

$$FOC_m(x^*) = \frac{\partial p_i(x^*, x^*_i, \epsilon_A)}{\partial x_i} \pi_A + \frac{\partial p_j(x^*, x^*_i, \epsilon_A)}{\partial x_j} \pi_A \ c'(x^* + r_m(x^*, \pi_B, \epsilon_B))$$

Following a similar procedure for the FOC of firm \(i\), with respect to the investment in B-innovation (equation 43), in the pre-merger situation. Let

$$FOC(x^*) = \frac{\partial p_i(x^*, x^*_i, \epsilon_A)}{\partial x_i} \pi_A \ c'(x^* + r(x^*, \pi_B, \epsilon_B)) = 0$$
The investment in B-innovation increases only if $FOC_m(x^*) = FOC_n(x^*) \quad FOC(x^*) > 0$ or

$$\frac{\partial p_j(x^*, x^*, \epsilon_A)}{\partial x_i} \pi_A < c'(x^* + r(x^*, \pi_B, \epsilon_B)) \quad c'(x^* + r_m(x^*, \pi_B, \epsilon_B))$$

References


Effect of mergers and acquisitions on innovations in agri-input companies: Theory and evidences

Subash, S.P1 and Md. Ejaz Anwer


Introduction

Agricultural inputs such as seed and pesticides are key for ensuring sustainability and food security (OECD 2018). Innovation in agricultural inputs ensures competitiveness of the sector. Reduction in innovation means lesser number of improved varieties and efficient pesticides, resulting in slower growth of productivity. Recent wave of mergers and acquisitions (M & A) by major six agri-input companies called ‘Big Six’; DuPont/Pioneer with Dow, Syngenta with ChemChina and Monsanto with Bayer, raised concerns regarding its effect on innovations. These companies can be grouped as biotech (seed) companies (Monsanto, DuPont Syngenta) and agro-chemical companies (Bayer, Dow and Chem China). Similar mergers between biotech and agro-chemical companies happened in the past but not in this extent. The current merger and acquisition would result in concentration of ‘Big Six’ to ‘Big Four’ companies in input industry. The increasing concentration of companies has given rise to three major questions, 1) Will increased concentration would lead to higher price for farmers, 2) would it reduce the innovation by lowering R & D in the sector, 3) would its result in lesser number of choice for farmers. Though studies (Bryant et al 2016; Maisashvili et al 2016) had explored the effect of M & A on prices, its effect on innovation is not explored.

There are two school of thoughts with respect to impact of M & A on innovation. Proponents of mergers argue that mergers would result in efficiency gains, which would result in lower prices and encourage innovation (Manne 2017, OECD 2018). On the other had those who are against M & A argue that it could results in concentration in the sector resulting in lower prices and lesser incentives for investing in R & D (Bonny 2017). They also argue these would result in entry barriers for smaller firms resulting in lesser choice, higher price and lesser innovation in long run (Fernandez-Cornejo and Just 2007). Though a large number of empirical studies had explored the effect, the results are unambiguous (detailed in the next session). Again there are fewer empirical evidence on M & A impact of innovation in agri-input sector.

Agri-input sector has been characterized by such mergers in the past. There have been three waves of such M & A of such mergers in seed industry (Schenkelaars et al 2011). The first wave of merger in 1930s were driven by development of hybrid seeds, second wave in 1970s were driven by emergence of intellectual property regime in plant breeding and third wave in 1980s were

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driven by biotechnology. The recent M & A in this sector is driven by multiple factors such as high cost of introduction of new agro-chemicals compared to profit margin in seed industry, falling price of agricultural commodities and resultant reduction in sales of seed and agro-chemicals, regulational hurdle in many countries and popularity of Genetically Modified Organisms and prospects of bio-economy derived from them (Bonny 2017). In seed and biotechnology industry, the structural changes are often driven by a mix of horizontal and non-horizontal/vertical combinations. Innovation has been a major driver of horizontal and non-horizontal mergers in last three decades (OECD 2018). A detailed picture of structural change happened in seed industry is given in OECD (2018).

In seed and biotechnology industry, the structural changes are often driven by a mix of horizontal and non-horizontal combinations (Fulton and Giannaks 2001). There are concerns regarding the increasing level of concentration in this sector. The industry is characterized by higher concentration due to its need for high investment in R & D and economies of scale. Currently these major firms are engaged in cross-licensing of technology (bt-technology), which has given rise to ‘non-merger mergers’ (Maisashvili et al 2016). The recent mergers would result in vertical integration and this would be able to provide integrated platforms and result in exclusive product ranges (eg: Round-up ready cotton; variety and pesticide) which could be anti-competitive.

Competition authorities in US and Europe are increasingly accounting the effect of M & A on non-price effects such as innovation (Haucap 2017). These authorities scrutinize mergers and acquisitions and could demand ‘remedies’. For example, in the recent merger of Dow-DuPont, European Commission (OECD 2018) asked them to divest in certain portfolio of pesticides and petro-chemical products due to concerns over its effect on innovation. Under guidelines of Competition Commission (CCI) of India on mergers and acquisitions, the factors influencing entry into relevant markets section 11.10 (d) & (e), the companies are required to provide details on restrictions created by the existing patents, details about the IPRs (CCI 2011).

Unlike empirical analysis of effect of prices, effect of innovation is difficult to capture. Few studies (Schimmelpfennig et al 2004; OECD 2018) had explore the relationship between M & A and innovation in seed sector. Schimmelpfennig et al (2004) explored relationship between firm concentration and R & D intensity showed an inverse relationship. A recent study by OECD (2018) based on historic data on effect of concentration on innovation shows no clear evidence of negative effect. In this study we explored the effect of M & A on innovation in agricultural input companies. First we looked into effect of M & A on ownership network of the ‘Big Six’ company and its ownership network. Secondly, we assessed the effect on M & A on acquiring and acquirer firms. Our study contributes to the growing literature in this regard.

**Methodology**
We used both ex-ante and ex-post assessment approaches to explore the effect of M & A on innovation. The effect of M & A on the ownership network and its effect on emerging genome
editing technology using an ex-ante approach and the effect of M & A on patents using ex-post approach.

**Network Analysis**

The most common measure in assessing the concentration HHI and CR and there are no prior quantitative measures to estimate control. Ownership relationship among firms are used as a proxy to understand its effect on corporate control (Vitali et al 2011). Mutual ownership of firms within the same sector could jeopardize market competition (O’Brien and Salop 1999; Gilo et al 2006). The mergers could allow previously independent competitors to coordinate their price and output decision competition (O’Brien and Salop 1999). Gilo et al (2006) showed that even passive partial ownership in rival firms could engage in tacit collusion. Studies on financial sector had shown that such integration among firms has an ambiguous effect on financial fragility (Allen and Gale 2000; Stigliz 2010). Rotundo and D’Arcangelis (2014) adjusted the HHI to incorporate the role of financial economic networks on market concentration. Anti-trust institutions (eg: UK office of fair trade) is monitoring the ownership network structures to understand the network dynamics (Vitali et al 2011).

To explore the effect of M & A on the ownership network and its effect on emerging genome editing technology using an ex-ante approach we used secondary data on ownership of firms (given in Howard 2009) and data on licensing of technology (Genome editing) to understand the ownership network in the pre and post of M & A scenario in agricultural seed industry. We used Gephi to visualized and quantitative measure the dynamics in the ownership networks and cross-licensing of genome editing technologies in pre and post scenario of the recent M & A by the ‘Big Six’ agri-input companies. Howard (2009) has visualized the seed firm’s ownership using network maps but had not done network analysis of M & A. To quantitatively capture the effects, we used degree centrality and closeness centrality measures. Degree centrality denotes the number of ties (co-ownership/subsidiary) a node (firm) has. More the number of ties, higher the level of centrality (importance) of the firms in the network. Mathematically the measure could be denoted as

\[ \sigma_D (x) = \sum_{i=1}^{n} a_{ix} \]

Where, \( \sigma_D \) is the degree centrality score for node x using an adjacent matrix A=(aij).

Closeness centrality measures the number of ties (co-ownership/subsidiary) between nodes with relationship to all other nodes (firm). Closeness centrality denotes the relative position of firm in the whole network. Lesser the closeness centrality measures better its influence on other firms. Its mathematically denoted as

\[ \sigma_C (x) = \frac{1}{\sum_{i=1}^{n} d_G(x,i)} \]
Where, \( \sigma_C \) is closeness centrality for node \( x \), \( d_{ij} \) is number of edges in the geodesics linking nodes i to j.

**M & A typologies**

To explore the effect of M & A on patents, we identified explored M & A done by major firms in agricultural sector in last three decades. We identified 56 M & A done by major firms such as Monsanto, Bayer, Dow, Dupont Pioneer, Syngenta, others and their subsidiaries (Details provided in appendix table A1). We analyzed data from 30 M & A (rest were dropped due to lack of clarity on the M & A or no patents registered by acquiring/acquired firms) We further categorized the M & A into different typologies. There are different types of typologies in M & A literature. They differ by the base of classification. A detailed review in this regard could be read in Angwin (2015). Needless to note that the concepts of mergers and acquisitions are primarily used as business terms and not legal terms (Coates 2014). Majority of literature on typologies in M & A focus on either pre-acquisition strategy or post-acquisition integration (Angwin 2015). The most established sort of typology is by Federal Trade Commission (FTC) of United States; M & A is classified as i) Horizontal, ii) Vertical, iii) Product extension, iv) Market extension, v) Conglomerate (see Table 1 for details). A more detailed diagrammatical visualization of the FTC typology by Larsson (1990) is given in appendix (see Figure A1).

**Table 1. Typologies of M & A**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Horizontal</td>
<td>Combination of firms with same product and markets</td>
</tr>
<tr>
<td>2</td>
<td>Vertical</td>
<td>Combination of firms with buyer seller relationship (Backward integration: A company acquires the suppliers of raw materials, forward integration: a company acquires the distribution channel of its products)</td>
</tr>
<tr>
<td>3</td>
<td>Product Extension</td>
<td>Combination of firms with different but related products</td>
</tr>
<tr>
<td>4</td>
<td>Market Extension</td>
<td>Combination of firms with same product but different geographical markets</td>
</tr>
<tr>
<td>5</td>
<td>Conglomerate</td>
<td>Combination of unrelated firms with no product market or buyer seller relationship</td>
</tr>
</tbody>
</table>

Source: Based on Angwin (2015)

**Analysis**

To measure extend of innovation we used patent owned by the firms as a proxy. Patent data is used as proxy for innovation in various reviewed studies (Haucap and Stiebale 2016; Ornaghi 2009). We collected data on patent published by both acquiring and acquired firms (collected from WIPO Patentscope database) for a period of five years before and after their M & A deals. As the number of patents varies across the firms, to make them comparable we normalized the patent published by each firm in to an index.
\[ P_{it} = \frac{X_{it} - MinX_{it}}{MaxX_{it} - MinX_{it}} \]

Where \( P_{it} \) is the patent index, \( MaxX_{it} \) is the maximum number of patents, \( MaxX_{it} \) is the maximum number of patents and \( X_{it} \) is the actual number of patents of \( i^{th} \) firm in \( t^{th} \) time. We used trend graphs to visualize and compare patent publication trends and statistically analyzed the mean difference in the patents published in the pre and post M & A period using Wilcoxon signed-rank test (a non-parametric equivalent of paired t-test). We also visualized the pre and post M & A patent index using bin scatter plots.

**Theories and empirical evidences on effect of M & A on innovation**

The relationship between market concentration as a result of M & A and innovation is not unambiguous (Haucap 2017). As discussed before, the theoretical justifications for positive side mostly rooted on efficiency justification. Economies of scale could enable firms to increase the R & D investment. Also technology is tacit knowledge, therefore cannot be transmitted easily from one to other (Larsson et al 1998). Firms having complementary knowledge thus can improve the strength of both the firms (Gerpott 1995). There are relatively few empirical studies which specifically looked into effect of M & A on innovation in agri-input sector. So we reviewed studies in general M & A and in few related sectors such as Pharma, Chemical and Information and Technology sectors (Table 2). The reviewed literatures show both positive and negative relationship.

**Table 2. Review of empirical studies on effect of M & A on innovation**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Article</th>
<th>Sector</th>
<th>Type of M &amp; A</th>
<th>Region</th>
<th>Effect on innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Haucap and Steiebale (2016)</td>
<td>Pharma</td>
<td>Horizontal merger</td>
<td>Global</td>
<td>Negative</td>
</tr>
<tr>
<td>2</td>
<td>Ornaghi (2009)</td>
<td>Pharma</td>
<td>M &amp; A general</td>
<td>Global</td>
<td>Negative</td>
</tr>
<tr>
<td>3</td>
<td>Szuecs (2014)</td>
<td>General</td>
<td>M &amp; A general</td>
<td>Global</td>
<td>Positive</td>
</tr>
<tr>
<td>4</td>
<td>Bertand and Zungia (2006)</td>
<td>General</td>
<td>M &amp; A general</td>
<td>OECD countries</td>
<td>Negative - domestic R &amp; D and positive - Cross border</td>
</tr>
<tr>
<td>5</td>
<td>Frey and Hussinger (2011)</td>
<td>General</td>
<td>Cross border M &amp; A</td>
<td>Europe</td>
<td>Cross border benefit</td>
</tr>
<tr>
<td>7</td>
<td>Phillips and Zhdanov (2013)</td>
<td>General</td>
<td>M &amp; A general</td>
<td>Global</td>
<td>Positive</td>
</tr>
<tr>
<td>S. No.</td>
<td>Article</td>
<td>Sector</td>
<td>Type of M &amp; A</td>
<td>Region</td>
<td>Effect on innovation</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------</td>
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<td>-----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>10</td>
<td>Sevilir and Tian (2012)</td>
<td>General</td>
<td>M &amp; A general</td>
<td>USA</td>
<td>Positive</td>
</tr>
<tr>
<td>13</td>
<td>Stiebale (2016)</td>
<td>General</td>
<td>Cross border M &amp; A</td>
<td>Europe</td>
<td>Positive</td>
</tr>
<tr>
<td>14</td>
<td>Sun (2014)</td>
<td>General</td>
<td>Technology Acquisition</td>
<td>China</td>
<td>Positive</td>
</tr>
<tr>
<td>15</td>
<td>Vyas and Narayanan (2016)</td>
<td>Pharma</td>
<td>M &amp; A general</td>
<td>India</td>
<td>Negative</td>
</tr>
<tr>
<td>17</td>
<td>de Man and Duysters (2005)</td>
<td>General</td>
<td>Alliance and M &amp; A</td>
<td>Global</td>
<td>Neutral or Negative</td>
</tr>
<tr>
<td>18</td>
<td>OECD (2018)</td>
<td>Agri-inputs</td>
<td>M &amp; A general</td>
<td>Global focused on Europe</td>
<td>Neutral/no effect</td>
</tr>
</tbody>
</table>

Haucap and Stiebale (2016) showed that the patenting activity and R&D investment of both the merged entity and its non-merging rivals in the sector declines substantially. Ornaghi (2009) studied the effect of mergers on R & D activities in Pharma and showed the merged companies on an average performed worse than the non-merging companies. Szuecs (2014) assessed impact of M&A on growth of R & D spending and showed substantial decrease in R & D efforts in the targeted firm after merging. Bertand and Zungia (2006) investigated the effect of cross-border M & A on R & D investments in OECD countries and showed that M & A negatively affected domestic R & D. On the contrary, another study by Frey and Hussinger (2011) found that M & A had helped in improving the technology competitiveness of the domestic firms. Similar results were also reported by Gudalupe et al (2012). Cassiman et al (2005) using an in-depth cases study showed both positive and negative effects and shows that rival firms reap little benefit from mergers. Various studies done by Phillips and Zhdanov (2013), Hoberg and Philips (2010), Sevilir and Tian (2012), Sun (2014), Stiebale (2016), showed positive effects, while other studies by Hsu et al (2013), Vyas and Narayanan (2016), Cloodt et al (2006) showed negative effect. Cloodt et al (2006) study on innovative performance of post-M&A acquiring firm in high-tech sectors had shown that non-technology M&A have a negative impact on innovation performance of the acquiring firm. They showed that acquired and acquiring firms have a curvilinear impact on innovations (it should be neither too unrelated nor too similar in knowledge base). Ahuja and Katila (2001) showed that
if larger companies focus on M & A on smaller targets for increasing innovations. Chakrabarti et al (1994) innovative performance declines if large companies take over smaller companies, on the other hand companies of equal size perform better. Similar finding was also observed by Hagedoorn and Dusysters (2002). De Man and Duysters (2005) reviewed the studies on effect of M & A on innovations and show that there is a negative or neutral relationship between M & A and innovations. They concluded that, though M & A lead to economics of scale due to lower innovation cost, M & A management plays a key role in innovation performance. A recent study by OECD (2018) on impact of recent M & A in agri-input companies showed no significant effect of M & A on innovation.

Results and Discussion

Ex-ante assessment

Effect of M & A on ownership network

The recent merger of companies started with the merger of Dow and DuPont in 2015. Dow is a agro-chemical company, while DuPont is a seed company (dominated by its brand Pioneer). Monsanto initially proposed to buy Syngenta in 2015, but the deal got cancelled due to lower price quote (Bonny 2017). Chem China (China National Chemical Corporation) started acquiring Syngenta on 2016. Chem China had invested little in agriculture R & D and its major investment was through Adama (it’s subsidiary), focused on generic agro-chemicals (pesticides). In 2016, Bayer announced acquisition of Monsanto. Bayer has equal share in sales from pharmaceuticals and consumer health and agriculture inputs. Bayer Crop Science derived from agrochemicals (herbicides and fungicides). Monsanto derived revenue from sales of seeds mostly from GM. All these M & A are currently approved by Competition Authorities across countries with several remedial measures. Adama and Syngenta had divested in their pesticide portfolios and similar disvestiture were done by Dow-Dupont. Bayer divestiture in its non-selective herbicides (Liberty), LibertyLink herbicide tolerance technology, global soybean, rapeseed/canola, and cotton seed (OECD 2018).

We visualized the ownership network of the seed companies based on data provided by Howard (2009). Companies positioned in the center are key companies and those in periphery occupies lesser significance in relation to importance. Figure 1 shows that Monsanto occupies key position in the ownership network of the company in the pre-M & A scenario. The figure shows that Monsanto followed by, Limagrain, Syngenta and ASI and center to the seed ownership network. ASI (American Seed Inc.) is also subsidiary of Monsanto. As discussed before these are the major seed companies. Companies such as Dow, Bayer, DuPont and BASF are predominantly agro-chemical companies.
Figure 1. Pre-merger ownership network of global seed companies

Note: Each nodes (circles) shows firms/companies and the line connecting them shows ownership linkage. Only major seed companies are shown in label. Force Atlas 2 Algorithm is used for network visualization.
Source: Authors visualization based on Howard (2009)
We visualized the same ownership network (Figure 1) after the merger (post M & A Scenario) of Bayer and Monsanto, Dow and DuPont (Figure 2). In the post M & A scenario, Bayer-Monsanto would position itself as a major seed company (Figure 2). Bayer-Monsanto’s other subsidiary such as ASI would also emerge as a strong player in the seed network pushing out other players such as Limagrain. The core of the network is so dense, and could be generalized as existence of rich-club phenomenon as observed in similar studies. This points to existence of super-entity among seed companies which could act as a bloc.

Other than the visualization of data network quantitative measure provides the effect of M & A in quantitative terms. The network quantitative measures (Table 3) show that Monsanto and DuPont got benefited by the merger. In case of Monsanto, through it already had large number of subsidiaries its relative position in the network (Closeness centrality measure) improved (reduced). Bayer also got benefited by acquiring larger number of subsidiaries. Dupont got both
larger number of subsidiaries as well as improved their relative position in the seed network. The emergence of Bayer-Monsanto followed by Dow-Dupont and Sygenta-ChemChina was also reported in other studies which used different approaches to visualize the effect. Fugile et al (2012) used Concentration ratio (CR 4) and Bonny (2017) used seed sale data to show the emergence of concentration.

Network measures are better than these measures to measure concentration as these capture the relative position and linkages between the firms. The increase in the relative network parameters means that the companies have higher control over other firms through its subsidiaries. One key limitation of the analysis we had carried out is that, the post-M & A networks are based on the recent M & A between the major companies keeping the company network reported by Howard (2009) as a base. The sector had seen lot of dynamics since then and due to the divestiture as a result of remedial measures suggested by Competition Commissions in various countries, the present company network is subjected to changes. Nevertheless, we assume that these changes may not have significant effect on the overall company network and its relative positions.

Table 3. Network analysis of M & A in seeds

<table>
<thead>
<tr>
<th>Company</th>
<th>Pre-M &amp; A Degree</th>
<th>Closeness centrality</th>
<th>Company</th>
<th>Post-M &amp; A Degree</th>
<th>Closeness Centrality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monsanto</td>
<td>35</td>
<td>0.614</td>
<td>Bayer-Monsanto</td>
<td>41</td>
<td>0.509</td>
</tr>
<tr>
<td>ASI</td>
<td>25</td>
<td>0.875</td>
<td>ASI</td>
<td>25</td>
<td>0.875</td>
</tr>
<tr>
<td>Limagrain</td>
<td>18</td>
<td>0.793</td>
<td>Dow-Dupont</td>
<td>18</td>
<td>0.743</td>
</tr>
<tr>
<td>Dow</td>
<td>14</td>
<td>0.710</td>
<td>Limagrain</td>
<td>18</td>
<td>0.793</td>
</tr>
<tr>
<td>Sygenta</td>
<td>14</td>
<td>0.525</td>
<td>Sygenta</td>
<td>14</td>
<td>0.525</td>
</tr>
<tr>
<td>Bayer</td>
<td>6</td>
<td>0.367</td>
<td>LandOLakes</td>
<td>5</td>
<td>0.857</td>
</tr>
<tr>
<td>LandOLakes</td>
<td>5</td>
<td>0.857</td>
<td>BASF</td>
<td>3</td>
<td>0.800</td>
</tr>
<tr>
<td>Dupont</td>
<td>4</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASF</td>
<td>3</td>
<td>0.800</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Degree of number of connections (co-ownerships), closeness centrality measure the

Effect on emerging technologies

As discussed before agri-input sector are R & D insensitive and the M & A in this sector is also driven by innovations. Howard (2015) had shown that the ‘Big Six’ companies were engaged in cross-licensing of transgenic technology. ETC group (2013) classified them as ‘Non-merger mergers’. The effect of such ‘Non-merger mergers’ on creating entry barriers for other small firms are discussed in various literature (Howard 2015; Maisashvili et al 2016). Similar cross-licensing agreements are emerging in case of genome editing technology such as TALENs, ZFN and CRISPR-Cas9. But unlike the transgenic technology, the key patents of genome editing technologies are with public institutions such MIT/Harvard/Broad and University of California (Egelie et al 2016). Among the private companies Dow-Dupont has patent applications in various areas of genome
editing technology. The key patent holder had provided exclusive licenses to start ups such as Editas, Addgene, Caribou Biosciences, CRISPR therapeutics (See Egelie et al 2016).

**Figure 3. Pre-merger cross licensing of genome editing technology**

We explored the cross-licensing agreement between the agri-input companies on genome editing technologies in the pre (Figure 3) and post M & A (Figure 4) of big six companies (Figure 3). The post-M & A scenario shows emergence closer networked group of cross-licenses. The companies which are outside the networks are again start-ups which are expecting acquiring from larger companies. Among the companies which acquired sub-licenses from key start-ups, unlike the pharma companies DuPont and Bayer were able to get exclusive licenses from Caribou Biosciences and CRISPR therapeutics respectively. DuPont got an exclusive license from Caribou Biosciences for field specific use in agriculture, while Bayer has a joint venture with CRISPR therapeutics. These
cross-licensing agreements are evolving with major company getting stakes in those start-ups and possess technologies to develop them into products, resulting in ‘Non-merger mergers’.

**Figure 4. Post-merger cross licensing of genome editing technology**

Source: IP Pragmatics (2016)
Ex-Post assessment of M & A on innovations

We looked into 30 M & A by agri-inputs companies and its subsidiaries in the last three decades (Details given in table 4). This include major agro-input companies such as DuPont and Monsanto acquiring companies such as Excel, Eli Lilly and Company, Agracetus, Dekalb, Cargill’s international seed business, Pharmacia and Upjohn, Seminis Inc, Emergent Genetics, Delta and Pine Land Company, Precision Planting Inc, San Francisco-based Climate Corp etc. with portfolios in seed, pharma and biotechnology. We looked into the nature of the merging companies, purpose and intentions behind M & A to group them into five M & A typologies (refer table 1).

Table 4. List of M & A companies and their typologies

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Year of acquiring</th>
<th>Acquiring company</th>
<th>Acquired company</th>
<th>Typology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1994</td>
<td>Eli Lilly and Company</td>
<td>Monsanto</td>
<td>Vertical (Backward)</td>
</tr>
<tr>
<td>2</td>
<td>1996</td>
<td>Monsanto</td>
<td>Agracetus</td>
<td>Vertical (Backward)</td>
</tr>
<tr>
<td>3</td>
<td>1998</td>
<td>Monsanto</td>
<td>Dekalb</td>
<td>Horizontal</td>
</tr>
<tr>
<td>4</td>
<td>1998</td>
<td>Monsanto</td>
<td>Cargill's ISB</td>
<td>Vertical (Forward)</td>
</tr>
<tr>
<td>5</td>
<td>1999</td>
<td>Monsanto</td>
<td>Pharmacia &amp; Upjohn,</td>
<td>Product Extension</td>
</tr>
<tr>
<td>6</td>
<td>2005</td>
<td>Monsanto</td>
<td>Seminis Inc</td>
<td>Product Extension</td>
</tr>
<tr>
<td>7</td>
<td>2007</td>
<td>Monsanto</td>
<td>Delta and Pine Land Company</td>
<td>Vertical (Backward)</td>
</tr>
<tr>
<td>8</td>
<td>2008</td>
<td>Monsanto</td>
<td>Dutch seed company De Ruiter</td>
<td>Vertical (Forward)</td>
</tr>
<tr>
<td>9</td>
<td>2012</td>
<td>Monsanto</td>
<td>Precision Planting Inc</td>
<td>Product Extension</td>
</tr>
<tr>
<td>10</td>
<td>2013</td>
<td>Monsanto</td>
<td>San Francisco-based Climate Corp</td>
<td>Product Extension</td>
</tr>
<tr>
<td>11</td>
<td>2018</td>
<td>Bayer</td>
<td>Monsanto</td>
<td>Product Extension</td>
</tr>
<tr>
<td>12</td>
<td>2012</td>
<td>DuPont</td>
<td>Bunge</td>
<td>Conglomerate</td>
</tr>
<tr>
<td>13</td>
<td>2001</td>
<td>Bristol Myers Squibb</td>
<td>DuPont</td>
<td>Vertical (Forward)</td>
</tr>
<tr>
<td>14</td>
<td>2013</td>
<td>Carlyle Group</td>
<td>DuPont</td>
<td>Vertical (Forward)</td>
</tr>
<tr>
<td>15</td>
<td>2016</td>
<td>Bayer AG</td>
<td>Panasonic Healthcare</td>
<td>Horizontal</td>
</tr>
<tr>
<td>16</td>
<td>2007</td>
<td>Bayer</td>
<td>Schering AG</td>
<td>Horizontal</td>
</tr>
<tr>
<td>17</td>
<td>2007</td>
<td>Eli Lilly and Company</td>
<td>Icos Corporation</td>
<td>Horizontal</td>
</tr>
<tr>
<td>18</td>
<td>2010</td>
<td>Eli Lilly and Company</td>
<td>Pfizer</td>
<td>Horizontal</td>
</tr>
<tr>
<td>19</td>
<td>2007</td>
<td>Eli Lilly and Company</td>
<td>Ivy Animal Health</td>
<td>Horizontal</td>
</tr>
<tr>
<td>20</td>
<td>1999</td>
<td>Eli Lilly and Company</td>
<td>DowElanco</td>
<td>Vertical (Forward)</td>
</tr>
<tr>
<td>21</td>
<td>2011</td>
<td>Monsanto</td>
<td>Beeologics</td>
<td>Product Extension</td>
</tr>
<tr>
<td>22</td>
<td>2013</td>
<td>Monsanto</td>
<td>Agradis</td>
<td>Vertical (Backward)</td>
</tr>
<tr>
<td>23</td>
<td>2014</td>
<td>Syngenta</td>
<td>Lantmänren</td>
<td>Vertical (Backward)</td>
</tr>
<tr>
<td>24</td>
<td>2014</td>
<td>Bayer</td>
<td>Algeta</td>
<td>Horizontal</td>
</tr>
<tr>
<td>25</td>
<td>2017</td>
<td>DuPont Pioneer</td>
<td>Dow Agrosciences</td>
<td>Horizontal</td>
</tr>
<tr>
<td>26</td>
<td>1991</td>
<td>Pioneer</td>
<td>Mycogen Seeds</td>
<td>Vertical (Forward)</td>
</tr>
<tr>
<td>27</td>
<td>1999</td>
<td>DuPont</td>
<td>Pioneer</td>
<td>Product Extension</td>
</tr>
<tr>
<td>28</td>
<td>1980</td>
<td>BASF</td>
<td>Wyandotte Chemical Company</td>
<td>Conglomerate</td>
</tr>
<tr>
<td>29</td>
<td>2012</td>
<td>Syngenta</td>
<td>Devgen NV</td>
<td>Vertical (Backward)</td>
</tr>
<tr>
<td>30</td>
<td>2004</td>
<td>Syngenta</td>
<td>Garst Seed Company</td>
<td>Vertical (Forward)</td>
</tr>
</tbody>
</table>

Source: Compiled by authors based on secondary sources

We looked into the trends of patents in the pre and post M & A scenarios in these companies. The trend graphs are pooled by typologies. The number in the top of the graphs refers to the serial number in table 4. Patent1_index is patent index of acquiring company and Patent2_index is the
patent index of acquired company. A vertical line is drawn as a cut-off period, year in which the M & A took place and the years are counted plotted as −5 to +5, where 0 is the cut-off period (M & A year).

**Horizontal M & A (Typology 1)**

Horizontal M & A’s are characterized as M & A among firms with same product and markets. In our study we could identify a total of 10 firms engaged in such M & A (See Figure 5). DEKALB a US based-global seed brand providing high yielding hybrid maize seeds sold 40 percent of its stock to Monsanto Co in 1996 [3]². In 2013, the Carlyle Group acquired DuPont performance coatings and created a new company called Axalta Coating Systems [16]. Axalta Coating Systems is a global supplier of coatings to the transportation and industrial sectors (The Carley Group, February 3, 2013). Panasonic Healthcare Holdings, Co., Ltd. (“Panasonic Healthcare”) was acquired by Bayer Aktiengesellschaft (“Bayer AG”); Bayer AG’s Diabetes Care business [17]. The acquired Diabetes Care business operate as a stand-alone company named Ascensia Diabetes Care that provides high-quality solutions and precision tools in diabetic healthcare. Ascensia Diabetes Care and Panasonic Healthcare manufacture, market and sell blood glucose monitoring meters and strips for people with diabetes in more than 125 countries (Business Wire, 2016). Bayer AG also acquired Schering pharma, a smaller rival (Arnum, 2007) [18].

**Figure 5. Trends in patent among horizontal M & A firms**

² The values in the square brackets corresponds to the graph number in figures.
Note: Patent1_index is patent index of acquiring company and Patent2_index is the patent index of acquired company. The number in the top of the graphs refers to the serial number in table 4. A vertical line is drawn as a cut-off period, year in which the M & A took place and the years are counted plotted as -5 to +5, where 0 is the cut-off period (M & A year). Please cross-refer the graph number in figures with the values in the square brackets in the text in each session for details.

Eli Lilly & Company Ltd. a pharmaceuticals firm working in both human and animal healthcare bought two other pharmaceutical ICOS Corporation [19] and Pfizer Inc (Animal Division) [20] in 2007 and 2010 respectively. They also acquired DowElanco [22] and Ivy Animal Health [21] in 1999 and 2007 respectively. Bayer acquired Algeta, another pharma company in 2014 [26]. Off late in 2017, Dupont Pioneer which is agro-chemicals and seeds acquired Dow Agrosciences, which manages similar portfolio [27]. We could observe a downward trend in patents among both acquiring and acquired firms in this case. This is in line with the existing understanding that horizontal merger would end up reducing the innovation as there is no incentive in innovation because of lesser competition.

**Vertical M & A (Typology 2)**

Vertical M & A’s are characterized by firms engaging in both backward integration (acquiring the suppliers of raw materials) and forward integration (acquiring the distribution channel of its products). Among the 30 M & A’s studied, 11 M & A’s belong to this typology (see Figure 6). Eli Lilly and Company (US-based Pharma Co.) acquired Monsanto’s POSILAC brand dairy product in 1994 (The New York Times, 2008) [1]. POSILAC bovine somatotropin is an FDA-approved animal pharmaceutical used by U.S. dairy farmers to increase productivity (Monsanto, August 20, 2008). The R & D helped in expansion of Eli Lilly animal healthcare division. In 1996, transgenic plant division of the Agracetus Company (which is a pioneer in biotech) was acquired by Monsanto (Monsanto, Undated) [2]. In 2006, Monsanto acquired Delta and Pine Land Company, a US based company involved in cotton genetics (Monsanto, 2006) [8]. Monsanto also acquired Stoneville and NexGen brands of Emergent Genetics Inc, a US-based leading cotton seed company (Monsanto, 2005). In 2013, Monsanto acquired Agradis, an agricultural biotechnology company [24]. Monsanto acquired all these companies to avail their R & D facilities and expand further in transgenic and genetic engineering segment. Similarly, Syngenta another agro-chemical company, acquired Devgen NV [32] and Lantmännen [25] in 2012 and 2014 respectively. These M & A are vertical (backward) M & As. Most of the M & A done by Monsanto (as acquirer) helped the innovation portfolio and there was an increase in innovation (patent count). These may not be true with other companies like Syngenta, were a dip in the patent count among acquiring company was observed. In 1998, Monsanto (US based company) acquired Cargill’s foreign seed (India based company) (Feder, 1998) [4]. This was intended as a value chain expansion (forward) in same industry. Monsanto in 2008 acquired a Dutch seed company De Ruiter, a vegetable seed dealer supplying vegetable seeds to the greenhouse industry in United States and Canada [9]. In 2001, New York-based Bristol-Myers Squibb buys DuPont Pharma a subsidiary of DuPont (The Wall Street Journal June 8, 2001) [15]. Pioneer acquired Mycogen Seeds in 1991 [28]. Similarly, Syngenta
acquired Garst seed Company which is involved in research, development, production, processing, marketing and sale of high-performance agricultural seeds [32]. In case of vertical forward M & A, no definite trends in patents were observed.

Figure 6. Trends in patent of M & A among Vertical M & A firms

Note: Same as figure 5.

Product Extension (Typology 3)

Product extension M & A’s are characterized by firms with different but related products. They would be able to bundle their products in the markets. Among the analyzed M & A’s, seven M & A fall under this typology (see figure 7). Monsanto Co and Pharmacia & Upjohn Inc. drug maker merged in 1999 (Stein, George and Chase, Brett, 1999) [5]. Monsanto also acquired Seminis, a global leader in vegetable and fruit seed industry (Monsanto 2005). In 2009, Monsanto acquired Precision Planting Inc, a technology-based solution company are reported to enhance the Monsanto’s Integrated Farming System (IFS) platform (Eckelkamp, 2012) [6]. Monsanto also acquired The Climate Corporation which provides a technology platform to farmers in 2013 [11]. In 2011, Monsanto also acquired Beelogics, a company doing R & D in biological tools for targeted control of pests and diseases [23]. DuPont acquired Pioneer in 1999, as a part of product extension strategy [29]. The recent merger by Bayer and Monsanto in 2018 could also be categorised in this
A positive trend in patents were observed among most of the firms in this typology and shows a dominant position of the acquired firm (Figure 7).

**Figure 7. Trends in patent among Product Extension M & A firms**

Note: Same as figure 5.

**Market Extension (Typology 4)**

Among the 30 M & A analyzed in this paper, there were no case of firms which belong to this typology. Two cases which were identified had announced their M & A but the process is not completed. Sumitomo Chemical Co., a Japanese conglomerate announced acquiring of Excel Crop Care Ltd in 2010 and plans to acquire further 30% stake in the company (Livemint, 2016). Excel Crop Care is a chemical manufacturing company based in India and Sumitomo plans to increase the its market share in agrochemical market both in India and worldwide (The Hindu, BusinessLine, Mumbai, June 6, 2016). Bayer, Germany-based agro-chemical and Pharma Company brought Auckland-based animal health Bomac Group to expand its animal health business in the Asia Pacific and Latin America (Bayer, 2010). Both these M & A are characterized by firm's interest to penetrate into newer markets (Typology 4). In both the cases, there was a dip in patent publication immediately after the M & A announcement. Sumitomo which acquired shares in Excel Crop Care was interested in its manufacturing capacity and might have focused on improving its in-house
capacity in later years as evident from the trend graph. Similar inference could be also drawn in case of M & A of Bayer-Bomac Group.

**Conglomerate M & A (Typology 5)**

Conglomerate M & A are characterized by combination of unrelated firms with no product market or buyer seller relationship. Only two such cases were observed among (seed figure 8). DuPont acquired soy ingredients giant Solae after buying out Bunge’s stake in their joint venture in 2012 (Ingredients Insight, 2012) [13]. With the acquisition of the full ownership of Solae, DuPont could enhance the speed of innovation, food formulation and nutrition science capabilities throughout a wide variety of specialty food ingredients. BASF acquired Wyandotte Chemical Company in 1980 [30]. In both cases a declining trend in patent was observed.

**Figure 8. Trends in patent among Conglomerate M & A firms**

![Graph showing trends in patent among Conglomerate M & A firms](image)

Graphs by M & A group

Note: Same as figure 5.

We visualized these trends graphs by typology using bin scatter plots. In the post-M & A phase, the patent trends among acquiring firms were only positive in case of product extension (Figure 9). While it was positive in case of both vertical and horizontal M & A among acquired firms (Figure 10).

**Figure 9. Bin scatter plot of patents among acquiring firms by typology**
Figure 10. Bin scatter plot of patents among acquired firms by typology
Comparing the average patents index scores of acquiring and acquired firms in pre and post M & A shows that there is a significant improvement in patents counts among acquiring and acquired firm in case of vertical M & A (Table 5). On the other hand, the effects were rather negative in case Horizontal M & A. Welfare effects of M & A depends on whether its horizontal mergers and non-horizontal merger (vertical mergers) (OECD 2018). In case other typologies, it was positive in case of product extension and negative in case of conglomerate. The generalization on conglomerate M & A should be drawn with caution as they are based on few M & A’s. These findings are in line with the existing theoretical understanding that Vertical mergers lead to efficient in R & D (OECD 2018).

Table 5. Effect of merger and acquisitions on patenting trends

<table>
<thead>
<tr>
<th>Typology</th>
<th>Average patent index of acquiring company</th>
<th>Average patent index of acquired company</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Horizontal</td>
<td>0.570</td>
<td>0.306</td>
</tr>
<tr>
<td>Vertical</td>
<td>0.334</td>
<td>0.643</td>
</tr>
<tr>
<td>Product Extension</td>
<td>0.360</td>
<td>0.557</td>
</tr>
<tr>
<td>Conglomerate</td>
<td>0.598</td>
<td>0.291</td>
</tr>
</tbody>
</table>

Note: Test statistics based Wilcoxon-sign rank test. Sign *** represent significance at 1%, ** represents significance at 5%. The cut-off year is excluded from the analysis. The distribution of the patents index across typology is provided in Appendix figure A2.

Source: Calculated by authors based on WIPO Patentscope data.

Bayer-Monsanto M & A and its effect on innovation in Agriculture

Recently, multi-national agricultural companies such as Dow-DuPont, ChemChina-Syngenta and Bayer-Monsanto have combined. This industry is characterized by high level of concentration due to high investment in R & D and need for economies of scales. Few inferences could be drawn of the Impact of recent merger and acquisitions on innovation in Agriculture based on above analysis. The Bayer-Monsanto M & A could be classified as mix of Vertical M & A and Product Extension M & A typology. So it could have both positive and negative impact on the innovation depending on the portfolio. Bayer had acquired license for advanced genetic engineering technologies such as CRISPR-Cas9, which could give the combined Bayer-Monsanto a leap in their product innovation beyond the existing Bt based technology. On the contrary the network analysis shows emergence of non-merger mergers. Large number of IPRs and emerging cross-licensing patterns among firms could lead to strong entry barriers. These cross-licensing could also lead to ‘Non-merger merger’; forming a situation similar to cartels in oligopoly (Maisashvili et al 2016). This could dis-intensive firms to innovate more. Such uncertain patterns are common among firms falling under this typology (Product Extension). The effects would be more evident at global levels compared to developing country like India (OECD 2019).
Conclusion

M & A provides firms an opportunity to reposition itself in the industry as a leader. Our analysis shows that such M & A could also lead to emergence of cross-licensing resulting in a ‘Non-merger merger’; a situation similar to cartels in oligopoly. The results show that the effect on M & A on innovation depends on the typology of M & A. The study suggests that the effect of M & A on innovations should be looked into by case by case basis and assessed based on the typology of M & A. The study also recommends using network measures together with other concentration measures and in-depth analysis in understanding the typology of the M & A to assess the effect of M & A.

References


CCI (2011), The Competition Commission of India (Procedure in regard to the transaction of business relating to combinations) Regulations, 2011.


Hsu, Po-Hsuan, Peng Huang, Mark Humphery-Jenner, and Ronan Powell. (2013), Cross-border mergers and acquisitions for innovation opportunities, University of Hong Kong working paper.


Sevilir, Merih, and Xuan Tian. (2012), Acquiring innovation, Indiana University working paper.


Appendix

Figure A1. A systematic framework for the FTC typology of M&A

<table>
<thead>
<tr>
<th>Production</th>
<th>Market</th>
<th>Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same</td>
<td>Horizontal M &amp; A</td>
<td>Market extension M &amp; A</td>
</tr>
<tr>
<td>Long-linked</td>
<td>Vertical backward M &amp; A</td>
<td>Vertical forward M &amp; A</td>
</tr>
<tr>
<td>Unrelated</td>
<td>Product extension M &amp; A</td>
<td>Conglomerate M &amp; A</td>
</tr>
</tbody>
</table>

Source: Larsson (1990)

Figure A2. Kdenisty plot of patent index by typology

Note: Patent1_index is patent index of acquiring company, Patent2_index is patent index of acquired company. Please refer table 1 regarding typology.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Company</th>
<th>Company Profile</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bristol Myers Squibb</td>
<td>Bristol-Myers Squibb Company discovers, develops, licenses, manufactures, markets, and distributes biopharmaceutical products worldwide. The company offers drugs in various therapeutic areas, such as oncology; cardiovascular; immunoscience; and human immunodeficiency virus (HIV) infection. Its products include Opdivo, a biological product for anti-cancer indications; Eliquis, an inhibitor targeted at stroke prevention in atrial fibrillation and prevention and treatment of venous thromboembolic disorders; Orencia, a biological product that targets adult patients with active rheumatoid arthritis and prostate-specific antigen; and Sprycel, a tyrosine kinase inhibitor for the treatment of Philadelphia chromosome-positive chronic myeloid leukemia.</td>
<td>[1]</td>
</tr>
<tr>
<td>2</td>
<td>Carlyle Group</td>
<td>The Carlyle Group LP operates as a diversified multi-product global alternative asset management firm. The Company advises investment funds and other investment vehicles that invest across a range of industries, geographies, asset classes, and investment strategies across business segments.</td>
<td>[1]</td>
</tr>
<tr>
<td>3</td>
<td>BASF</td>
<td>BASF Corporation operates as a chemical company. The Company offers chemicals, plastics, performance, and crop protection products. BASF serves customers worldwide.</td>
<td>[1]</td>
</tr>
<tr>
<td>5</td>
<td>DuPont</td>
<td>DuPont Pharmaceuticals Company is a pharmaceutical company. The Company develops and delivers drugs that are used to treat HIV, cardiovascular disease, central nervous system disorders, cancer, and inflammatory diseases.</td>
<td>[1]</td>
</tr>
<tr>
<td>6</td>
<td>DuPont Pioneer</td>
<td>Dupont Pioneer was founded in 2013. The company's line of business includes the manufacturing and production of agricultural chemicals.</td>
<td>[1]</td>
</tr>
<tr>
<td>7</td>
<td>Eli Lilly and Company</td>
<td>Eli Lilly &amp; Company Ltd. manufactures and distributes pharmaceuticals. The Company offers pharmaceutical products for both humans and animals. Eli Lilly serves the medical and health care industry.</td>
<td>[1]</td>
</tr>
<tr>
<td>8</td>
<td>Monsanto</td>
<td>Monsanto Company provides agricultural products for farmers. The Company offers business segments includes seeds and genomics. Monsanto produces a wide range of seeds and develops biotechnology traits that assist farmers in controlling insects and weeds, as well as provides other seed companies with genetic material and biotechnology traits for their seed brands.</td>
<td>[1]</td>
</tr>
<tr>
<td>S. No.</td>
<td>Company</td>
<td>Company Profile</td>
<td>Reference</td>
</tr>
<tr>
<td>-------</td>
<td>------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>9</td>
<td>Panasonic Healthcare</td>
<td>Panasonic Healthcare Indonesia PT provides medical equipments. The Company manufactures medical, surgical, ophthalmic, and veterinary instruments and apparatus such as beauty care, men's shaver and trimmer, hair dryer, and oral care. Panasonic Healthcare markets its services throughout Indonesia.</td>
<td>[1]</td>
</tr>
<tr>
<td>10</td>
<td>Pioneer</td>
<td>Pioneer Corporation manufactures and sells audio and video equipment for household, industrial, and automobile use. The Company produces and sells visual and music software and media such as DVDs and CDs. Pioneer also licenses its patented technologies for optical disk to other businesses.</td>
<td>[1]</td>
</tr>
<tr>
<td>11</td>
<td>Syngenta</td>
<td>Syngenta Ltd. manufactures and distributes agricultural chemicals. The Company offers plant breeding, crop protection, seed care, cereals, agronomy, sugar beet, vegetables, and grassweed management. Syngenta serves customers worldwide.</td>
<td>[1]</td>
</tr>
<tr>
<td>12</td>
<td>Siemens Healthineers</td>
<td>Siemens Healthineers AG operates as a medical technology company. The Company provides medical imaging, laboratory diagnostics, point-of-care testing, digital ecosystem, and reading solutions for health care applications. Siemens Healthineers offers its services worldwide.</td>
<td>[1]</td>
</tr>
<tr>
<td>13</td>
<td>Bemis Company</td>
<td>Bemis Company, Inc. manufactures flexible and rigid plastic packaging products. The Company's products are used in a variety of applications including food, medical, agribusiness, pharmaceutical, and personal care. Bemis markets its products to customers throughout the United States, Canada, and Europe, as well as Mexico, Latin America, and the Asia Pacific region.</td>
<td>[1]</td>
</tr>
<tr>
<td>14</td>
<td>Denka</td>
<td>Denka Co., Ltd. is a diversified manufacturer and supplier of chemical products, including basic chemicals, agrochemicals, Petrochemicals, pharmaceuticals, and construction materials. The Company's primary products include styrene resins, polyvinyl chloride, and other synthetic resins.</td>
<td>[1]</td>
</tr>
<tr>
<td>15</td>
<td>Roche</td>
<td>Hoffmann-La Roche Limited was founded in 1931. The Company's line of business includes the wholesale distribution of prescription drugs, proprietary drugs, and toiletries.</td>
<td>[1]</td>
</tr>
<tr>
<td>16</td>
<td>DuPont</td>
<td>DuPont Pharmaceuticals Company is a pharmaceutical company. The Company develops and delivers drugs that are used to treat HIV, cardiovascular disease, central nervous system disorders, cancer, and inflammatory diseases.</td>
<td>[1]</td>
</tr>
<tr>
<td>17</td>
<td>Wyandotte Chemical Company</td>
<td>Founded as Michigan Alkali by John B. Ford in 1890, Wyandotte Chemicals Company was acquired by BASF in 1969. At the time, it was the largest investment a German company had ever made in the U.S.</td>
<td>[2]</td>
</tr>
<tr>
<td>18</td>
<td>Monsanto</td>
<td>Monsanto Company provides agricultural products for farmers. The Company offers business segments includes seeds and genomics. Monsanto produces a wide range of seeds and develops biotechnology traits that assist farmers in controlling insects and weeds, as well as provides other seed companies with genetic material and biotechnology traits for their seed brands.</td>
<td>[1]</td>
</tr>
<tr>
<td>19</td>
<td>Pioneer</td>
<td>Pioneer Corporation manufactures and sells audio and video equipment for household, industrial, and automobile use. The Company produces and sells visual and music software and media such</td>
<td>[1]</td>
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<td>S. No.</td>
<td>Company</td>
<td>Company Profile</td>
<td>Reference</td>
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<tr>
<td>20</td>
<td>Dow Agrosciences</td>
<td>Dow AgroSciences LLC produces agricultural chemicals for pest control and plant nutrition. The Company offers a wide range of products such as insecticides, herbicides, fumigants, and other chemicals. Dow AgroSciences serves customers globally.</td>
<td>[1]</td>
</tr>
<tr>
<td>21</td>
<td>Monsanto</td>
<td>Monsanto Company provides agricultural products for farmers. The Company offers business segments includes seeds and genomics. Monsanto produces a wide range of seeds and develops biotechnology traits that assist farmers in controlling insects and weeds, as well as provides other seed companies with genetic material and biotechnology traits for their seed brands.</td>
<td>[1]</td>
</tr>
<tr>
<td>22</td>
<td>ICOS Corporation</td>
<td>ICOS Corporation of the United States develops biopharmaceuticals and small molecule pharmaceuticals. The Company focusing on the development and commercialization of treatments for unmet medical conditions, such as benign prostatic hyperplasia, hypertension, cancer, and inflammatory diseases. ICOS operates in the State of Washington.</td>
<td>[1]</td>
</tr>
<tr>
<td>23</td>
<td>Pfizer</td>
<td>Pfizer Inc. operates as a pharmaceutical company. The Company offers medicines, vaccines, medical devices, and consumer healthcare products for oncology, inflammation, cardiovascular, and other therapeutic areas. Pfizer serves customers worldwide.</td>
<td>[1]</td>
</tr>
<tr>
<td>24</td>
<td>Ivy Animal Health</td>
<td>Ivy Animal Health, Inc. was founded in 1999. The company's line of business includes the manufacturing, fabricating, or processing of drugs in pharmaceutical preparations for human or veterinary use. Ivy Animal Health: A privately held applied research and pharmaceutical product development company focused on the animal health industry. (Overland Park, Kansas, United States). Ivy Animal Health, Inc. operates as an integrated veterinary pharmaceutical company that develops, manufactures, markets, and distributes animal health products and services to improve meat production. The company operates through four divisions: Ivy Laboratories, VetLife, AgSpan, and Ivy Natural Solutions. The Ivy Laboratories division manufactures products, and performs research and product development functions. The VetLife division engages in marketing, technical services provision, and sales activities for beef cattle products. The AgSpan division manages databases, and production management programs and services.</td>
<td>[1]</td>
</tr>
<tr>
<td>25</td>
<td>DowElanco</td>
<td>Elanco operates as a global animal health company. The Company specializes in providing food and companionship for animals and various other social causes. Elanco's products include beef, dairy, swine, poultry, veterinary services, and safety measures.</td>
<td>[1]</td>
</tr>
<tr>
<td>26</td>
<td>Cargill's ISB</td>
<td>Cargill Corp is a multinational corporation. The Company is an international producer and marketer of food, agricultural, financial and industrial products and services.</td>
<td>[1]</td>
</tr>
<tr>
<td>27</td>
<td>Agracetus</td>
<td>The Agracetus Campus of Monsanto Company is a soybean transformation laboratory, the world's greatest. It has over 21,700 employees worldwide, and an annual revenue of US$11.365 billion reported for 2008.</td>
<td>[3]</td>
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<tr>
<td>S. No.</td>
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<td>28</td>
<td>Dekalb</td>
<td>Dekalb County Inc. provides medical services.</td>
<td>[1]</td>
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<tr>
<td>29</td>
<td>Seminis Inc</td>
<td>Seminis, Inc. develops, produces, and markets fruit and vegetable seeds. The Company develops seeds designed to reduce the need for chemicals, increase crop yield, reduce spoilage, offer longer shelf life, create tastier foods, and create foods with better nutritional content.</td>
<td>[1]</td>
</tr>
<tr>
<td>30</td>
<td>Delta and Pine Land Company</td>
<td>Delta and Pine Land Company, with its subsidiaries, primarily breeds, produces, conditions, and markets proprietary cotton planting varieties in the United States and other cotton producing nations. The Company also breeds, produces, conditions, and distributes soybean planting seeds domestically.</td>
<td>[1]</td>
</tr>
<tr>
<td>31</td>
<td>Dutch seed company De Ruiter</td>
<td>De Ruiter Seeds, Inc. supplies vegetable seeds to the greenhouse industry. The company provides rootstocks, tomatoes, cucumbers, peppers, and eggplants. It has vegetable dealers in the United States and Canada. The company is headquartered in Lakewood, Colorado with offices in Lakewood, Colorado; and Ontario, Canada. De Ruiter Seeds, Inc. operates as a subsidiary of De Ruiter Seeds Group B.V.</td>
<td>[1]</td>
</tr>
<tr>
<td>32</td>
<td>Precision Planting Inc</td>
<td>Precision Planting Inc. develops and markets planting technology for the agricultural sector. The Company offers monitoring systems, germination tools, and singulation tools. Precision Planting's software, hardware, and after-market production equipment helps farmers plant, harvest, and analyze data, as well as improve crop yield and productivity.</td>
<td>[1]</td>
</tr>
<tr>
<td>33</td>
<td>San Francisco-based Climate Corp</td>
<td>The Climate Corporation provides a technology platform to farmers. The Company offers tools to farmers for weather monitoring, agronomic data modeling, and high-resolution weather simulations to improve their profits, offers insurance, and manages crops.</td>
<td>[1]</td>
</tr>
<tr>
<td>34</td>
<td>Pharmacia &amp; Upjohn</td>
<td>Pharmacia &amp; Upjohn, Inc. was acquired by Pharmacia Corporation and integrated into Pfizer Inc. The Company was a global pharmaceutical group that researched, developed, manufactured, and sold pharmaceutical and healthcare products. Pharmacia &amp; Upjohn, Inc. also provided products for hospital care and diagnostics.</td>
<td>[1]</td>
</tr>
<tr>
<td>35</td>
<td>Seminis</td>
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<td>36</td>
<td>Delta and Pine Land Company</td>
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<tr>
<td>38</td>
<td>Dekalb</td>
<td>Dekalb County Inc. provides medical services.</td>
<td>[1]</td>
</tr>
<tr>
<td>39</td>
<td>Beeologics</td>
<td>Beeologics LLC offers research and development services. The Company researches and develops biological tools to provide targeted control of pests and diseases.</td>
<td>[1]</td>
</tr>
<tr>
<td>40</td>
<td>Agradis</td>
<td>Agradis, Inc. develops agricultural biotechnology products. The Company operates in the United States.</td>
<td>[1]</td>
</tr>
<tr>
<td>41</td>
<td>Bayer AG</td>
<td>Bayer AG produces and markets healthcare and agricultural products. The Company manufactures products that include aspirin, antibiotics, anti-infectives, cardiovascular, oncology, central nervous system drugs, over-the-counter medications, diagnostics, and animal health products, as well as crop protection products, plastics, and polyurethanes.</td>
<td>[1]</td>
</tr>
<tr>
<td>42</td>
<td>Mycogen Seeds</td>
<td>Mycogen Corporation is an agricultural biotechnology company focusing on the development of genetically engineered, pest-resistant crop seeds and environmentally safe bioinsecticides. Agrigenetics, Inc., a majority owned subsidiary doing business as Mycogen Plant Sciences, is the sixth largest crop seed company in the United States. The company also operates Soilserv, Inc., which provides custom crop-protection services to growers in California and Arizona. In 1996, 55 percent of Mycogen's stock was acquired by DowElanco, a subsidiary of Dow Chemical Co.</td>
<td>[1]</td>
</tr>
<tr>
<td>43</td>
<td>Lantmännen</td>
<td>Lantmannen ek for operates as an agricultural cooperative. The Company supplies seeds, fertilizers, plant protection pesticides, and farm equipment. Lantmannen serves customers in Sweden.</td>
<td>[1]</td>
</tr>
<tr>
<td>44</td>
<td>Devgen NV</td>
<td>Devgen is a biotechnology company which focuses on the development and commercialization of biotech and chemical solutions for crop protection. The Company also focuses on novel therapeutic concepts and preclinical drug candidates for treatment of diabetes, obesity, arrhythmia.</td>
<td>[1]</td>
</tr>
<tr>
<td>45</td>
<td>Garst Seed Company</td>
<td>Garst Seed Company is involved with the research, development, production, processing, marketing and sale of high-performance agricultural seeds.</td>
<td>[1]</td>
</tr>
<tr>
<td>47</td>
<td>Algeta</td>
<td>Algeta ASA operates in the pharmaceutical industry. The Company develops targeted therapies for patients with cancer based on its alpha-pharmaceutical platform. Algeta's compound Alpharadin is designed to treat bone metastases.</td>
<td>[1]</td>
</tr>
</tbody>
</table>