Trade Reform, Vertical Contracts and Innovation in a Developing Economy

Dibyendu S. Maiti[•] and Werner Bönte[♦]

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Abstract

Recent ongoing literature focuses that technological development and globalization are transforming the internal organization of the firm and present study seeks to address this issue as an impact of trade reform in developing economy. It is interesting that a large part of producing activities in developing economies like India is undertaken by informal producers, mostly those who are vertically related to formal producers. Moreover, during the post-reform period in India vertical separation has increased by buyers giving more subcontracts to informal producers through mutually contractual relationships. How informal producers survive and what the economics of informal contracts are, is still under-researched. An upcoming trend of tying up of powerful downstream producers to small upstream intermediate producers is observed with informal assistance to upstream innovation efforts during the post-reform period. Trade reform policy in India enhances vertical separation in order to reduce the bureaucratic costs inside an integrated firm. If a powerful buyer transfers the burden of price cuts to the upstream firm, this invariably squeezes his own profit as a feedback, because of reduction of upstream innovation effort. When a power buyer assists upstream innovation, it not only helps upstream innovation effort, but also benefits surpluses for both supplier and buyer.

Key Words: Vertical Contract, Innovation, Tariff cut, subcontracting
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Corresponding Address:
RBI Research Officer
Centre for Studies in Social Sciences, Calcutta
R-1 Baishnabghata Patuli Township
Kolkata - 700094, West Bengal, India
Phone: +91 (0)33 2462 7252 / 5794 / 5795
Fax: +91 (0)33 2462 6183
Email: dibyendu@cssscal.org

[•] Research Officer, RBI Endowment, Centre for Studies in Social Sciences, Calcutta, West Bengal, India and Max Planck India Fellow, Max Planck Institute of Economics, Jena, Germany
[♦] Associate Director, Max Planck Institute of Economics, Jena, Germany

1. Introduction: Context, Theoretical Backdrop and Literature

A large part of economic activities of industrial sector in a developing economy takes in informal sector[1] or unorganized sector, unlike a developed economy and a quite a large number of literature focuses the increasing trend of this sector in recent years. Without understanding of the dynamics of this sector the issue of industrialization could not be properly understood of the economy. It is widespread in those economy that an economic agents are engaged in production and related activities at a very low scale and vertically linked either themselves or to the formal sector. Those economic activities mostly fall under informal sector, not due to illegal activities, but their economic activities are not properly accounted regularly. We mean 'informal' here as essentially the non-criminal production of goods and services that utilizes unorganized workers at market-determined contracts with no restrictions on profitable retrenchment. There is increasing attention to research on the organizational characteristics and typology of informal producer, and contractual dynamics of upstream and downstream market. Moreover, most of developing economies experiences deregulated policies and gradually is opening up trade restriction during last two decades. The way contracts for production is executed between upstream and downstream firms in developing economic world should also be affected. The present study attempts to look at the impact of trade reform on vertical contractual relation, essentially which could explain the cause of informal sector expansion, both theoretically and empirically in the basis of contemporary Indian experiences.

Recent literature highlights that technological developments and globalization are transforming the internal organization of the firm. New technologies, especially information technology, are creating a shift from the old integrated firms towards more detailed organizations and outsourcing (Breshanan, 1999; Acemoglu *et al.* 2005). Moreover, the grater competitive pressures created by both globalization and advancement of information technology favor smaller firms and more flexible organizations that are conducive to innovation (Feenstra, 1998; Feenstra and Hanson, 1999). Contemporary literature on industrial organization discusses on increasing

[1] Agenor (1996, 2005) refers that the share of informal employment in developing economy is as high as 70-80 per cent in these countries. For example in India the proportion is a high as 90 per cent when agriculture is included as a major section of the informal sector.

fragmentation of production process and subcontracting specially in the context of the corporate sector and multinational firms. A verity of terms have been used in literature to refer to the phenomenon of vertical non-integration, namely the slicing of the value chain, international outsourcing, fragmentation of production process, vertical specialization and global production sharing etc. Most of the existing literatures focuses the contractual issues from the perspective of global transaction and does not give much attention on the impact of trade reform, major agenda of developing world during last two decades and so, on the vertical relationship of production process within the economy. The study seeks to address this gap and asks two important issues: what is the impact of trade reform on vertical contracts and formal-informal transaction? How does it affect the upstream innovation effort?

Issues on the vertical contracts or integration corroborate one of the most ongoing debates in the industrial organization literature that what determines the size of firm and what the boundary of the firm is. Mostly organization theory favors the vertical integration of production process in order to reap scale advantage, to minimize transaction cost, to get rid off double marginalization problem and agency problem. Then what determines the size of the firm? Broadly three approaches are dominant in the literature, viz., technological approach, transaction cost approaches and property right theory, and approaches are to some extent complementary to each other.

In the neoclassical theory of firm, the size of the firm is determined by cost minimization (Mas-Colell *et al.*¸1995). The problem is thought of as consisting of two stages. In first stage, firms minimize total costs subject to output reaching a particular amount and in second stage, the level of output is chosen to maximize profits. However, the approach ignores the incentive problems inside the firm by treating the firm as perfectly efficient 'black box'. Emphasizes the importance of incomplete contracts and ex post opportunistic behavior (hold up) on ex ante relationship-specific investments (Coase, 1937; Williamson, 1975, 1985), transaction cost approach then considers the firm is determined by the extend of these costs in the market. By vertical integration it circumvents the potential holdup problems under high degree greater of specificity while the holdup is more costly. At the same time, it incurs a 'governance cost' to get quality output inside the firm and severity of 'governance cost' determines the size of the firm

(Alchian and Demsetz, 1972 and Williamson, 1985). Property right theories further extent these arguments identifying both costs and benefits of integration under the power of ownership structure when contracts are incomplete (Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995). The incentives to investment of a particular party are increasing in the share of surplus that accrues to that party. Under relation-specific investments, the benefit of integration is that increases the incentives of the integrating firm to make that are particularly specific to the integrated firm. On the other, the cost of integration is that it reduces the incentives of the integrating firm to make investment that are particularly specific to the integrating firm.

Second issue regarding the relationship between vertical integration and innovation still is debatable. Scholars strongly take place two opposite views. One view is that growth of large businesses is either necessary or inevitable. Large vertically integrated firms are best position to develop and exploit innovations acquiring economics of scale (Lazonick, 1991). On the other hand, it also argues that small firms are more flexible and thus better adapted to engendering and adopting innovations from geographically concentrated firms (Sebal and Zeitlin, 1985; Best, 1990). A high degree of rivalry among firms is inevitable in order to be successful in international market stands a more intermediate view has been staked (Poster, 1990). An inverted-U shaped relationship is between competition and innovation is more recent view (Acemoglu *et al.*, 2005, Aghion *et al.,* 2005; Aghion *et al.,* 2006). According to this view, a moderate increase in product market competition will reduce a producer's incentive to integrate by improving the outside options of her non-integrated suppliers and hence raising their incentive to innovate. Too much competition will raise the producer's incentive to integrate, however, by allowing non-integrated supplier's to capture most of the innovation surplus.

While key insights of these theories are difficult to verify, it is customary to use these theoretical backdrop to examine variant industrial structure in both developed and developing world. One of the upcoming trends due to trade liberalization is focused in the trade literature that market share reallocations towards more foreign firms through vertical subcontracting or outsourcing (Feenstra, 1998; Jones and Marjit, 2001; Jones and Kierzkowski, 2001; Bernard *et el.,* 2003, Grossman and Helpman, 2002; Marjit and

Raychowdhri, 2004). Antras (2003), and Antras and Helpman (2003) suggest that the choice between intra-firm and market transactions is significantly affected by both the degree of standardization of the good being produced abroad and also by the domestic firm's resources devoted to product development. While a lot of studies address the international subcontracting and outsourcing arising out of trade reform, less attention is given to the internal dynamics of the domestic firms of developing economy. However, there is increasing evidences on flexible production on a small scale vertical specialization for downstream final producer and trader in the developing world including Latin America, Asia and Africa (Rutten and Upadhya, 1997, Ypeij, 1998).

For developing world, vertical contractual relationships between formal and informal manufacturers and among the informal agents are still relatively under-researched. Partly the reason may be the lack of proper information on informal sector and partly due to understanding of potential role of informal sector in development process and by and large, it is treated always a tradition sector. Any related issues on innovation and technical diffusion, hence, of this sector have been neglected. If it is really so, how does the sector still survive at a lower scale of production in a global economy? However, an increasing focus has been observed to recent studies on the vertical relationship and its organizational dynamics in developing world. Largely the argument behind the existence is the cost of formal sector. The relative size of informal sector, largely through vertical contracts, varies across countries as result of the cost of formality, which can be divided into costs of accessing the formal sector (e.g., registration) and cost of remaining in the formal sector (e.g., taxes, compliance with labour regulations – non-wage benefits, social securities, and firing compensation – and bureaucratic requirements (Braun and Loayza, 1994; Loayza, 1994; Dessy and Palage, 2003; Ihring and Moe, 2004, and Agenor, 2005). There is an upcoming evidence of the strong prevalence of subcontracting to the informal sector of developing economics. For example, in India, evidence suggests that high firing costs for permanent employees increase firms' incentives to hire workers on temporary contracts. Legislation is passed in the mid-1970s in India making it illegal for a firm with more than 100 employees to lay off workers without the authorization of the state government. Regulation such as these encourages the use of casual labor and subcontracting (Basley and Burgess, 2004).

Moreover, Goldberg and Pavnick (2003) and Marjit, Ghosh and Biswas (2006) look at the asymmetric impact of trade reform on the informal sector. Marjit, Ghosh and Biswas (2006) argue that for an erstwhile-protected sector, the size of the informal segment can expand or contract depending on the type of reform. It is also observed that as an impact of reform workers crowd informal sector while rise and fall of informal wage could depend on the extent of capital movement (Marjit, 2003; Marjit, Kar and Beladi, 2006). One of the ways of capital movement is explained through subcontracting (Marjit and Maiti, 2006). Moreover, Maiti and Marjit (2006) argue that under more trade exposure during post-reform period an export competing firm is willing to shift his effort more towards marketing activities from producing activities, whereby a part of producing activities is being given subcontract to tied producers. Interestingly, Andrabi, Ghatak and Khwaja (2006) observe subcontracting features of tractor buyers in Pakistan, where buyers offer differential treatment to their supplier of same products, where tied suppliers – those that choose higher levels of specific investments – receive lower and more unstable orders and lower prices. Specific investments raise surplus within the relationship but lower the seller's flexibility to cater to the outside market. Higher quality suppliers have a greater likelihood of selling outside and so this cost is greater for them. Therefore even if a buyer typically prefers high types, some low type suppliers might be kept as marginal suppliers because of their greater willingness to invest more in buyer-specific assets. Further empirical examination shows that the more tied suppliers are indeed of lower quality. To contradict their argument we provide empirical evidence in this paper that even a powerful buyer prefers to be tied to specialized tied supplier. Under this tied relationship, specific upstream supplier receives assistance on innovation efforts which invariably raises surplus of both buyer and sellers during post reform period.

With this theoretical backdrop we examine the impact of trade reform on vertical contracts, formal-informal contractual relationship and upstream innovation. Interestingly, the agents in informal sector largely produce goods and services for vertically downstream formal firm, either as finished or semi-finished items. In competitive framework of small producers with limited capital endowment and certain skill in a developing economy, one powerful buyer has incentive to reap the benefit from upstream innovation in intermediate production. We take the empirical evidence of the

extent of vertical relation and nature of vertical relation from National Sample Survey report in 2000-01 and it is supplemented by the field level study on production organization during post reform period in India. We observe that not only high presence of vertical transaction particularly among the informal segment and between formal and informal segment, but also this tendency has sharply increased during post reform period. It is interesting to note that while doing vertical transaction final producer or trader contractor provides assistance to upstream intermediate supplier in the form of designing and advancing key raw material, where supplier largely holds fixed assets and skill themselves. Since a perfect competitive upstream firm realizes to engage himself in innovation to survive in the market, a part of the innovation surplus is taken care by a powerful buyer. As buyer is forced to cut down the price of final product and shifts burden of tariff cut to the supplier, the upstream firm invariably reduces innovation effort, which not only squeezes own profit but also the buyers' too. Recognizing the fall of profit due to cutting down upstream innovation effort, even a powerful buyer ties up to upstream firm and helps upstream innovation to raise his profit and try to cope with market.

The rest of the paper is organized as follows. In section 2, we provide ample evidence of vertical transaction through subcontracting and its features during post reform period. In section 3, we construct a model to show the impact of tariff cut on the possibilities of vertical integration and non-integration taking into consideration upstream innovation. Finally, section 4 provides some concluding remarks.

2. Vertical Contracts: Evidences

2.1 Secondary data

Information on vertical contracts and kind of industrial relation is not well documented. Annual Survey of Industries, Government of India, major source for industrial accounts, does not cover the required information. However, recent survey rounds of National Sample Survey on unorganized sector in 2000-01 report highlight certain information on organizational characteristics. At the outset of the study, we should clear the meaning of unorganized sector. While most of economies use the term

'informal sector[2]', India defines it as 'unorganized sector'[3]. An enterprise falls under the unorganized segment not because of illegal or underground activities, but are not cover by regular accounts. Statistical information system could not cover the accounts from all section of emprises regularly. Moreover, de-licensing policy, an agenda of economic reform, relaxes the necessary licensing requirement for an entrepreneur for any economy activity from any authorized agency. National Sample Survey organization (NSSO) regularly publishes the report on unorganized manufacturing every after five year, while first-ever it covers organizational characteristics on last two survey reports namely 55th report in 1999-2000 and 56th Round in 2000-01. We do not make any strict distinction between informal and unorganized sector, and we concentrate on 56th NSS report in order to highlight interesting feature on vertical relations in the production process. We observe (i) high present of vertical contracts or subcontracting activities of small scale rural-urban producers for master enterprises or traders just as principal-agent relationship, (2) increasing tendency of vertical contracts through fragmentation of production process during post reform period, and (3) tying up to upstream innovation effort by the downstream firm for assisting design of the products and procuring key raw materials.

According to NSS report[4] in 2000-01, more than 30.7% enterprises in unorganized sector work under contractual assignments for producing activities for their

[2] In India, the term 'informal sector' has not been used in the official statistics or in the National Accounts Statistics (NAS). The terms used, are '**organized**' and '**unorganized**' sectors. The *organized sector* comprises of enterprises for which the statistics are available regularly from the budget documents or reports, annual reports in the case of Public Sector and through Annual Survey of Industries (ASI) in case of registered manufacturing. On the other hand, the *unorganized sector* refers to those enterprises whose activities or collection of data is not regulated under any legal provision and/or which do not maintain any regular accounts. Non-availability of regular information has been the main criteria for treating the sector as unorganized. This definition helps to demarcate organized from the unorganized. For example, units not registered under the Factories Act 1948 constitute unorganized component of manufacturing on account of activity not regulated under any Act. However, the enterprises covered under ASI do not fall under the purview of unorganized sector (55th NSS Round, Report No. 456/55/2.0/1, pp. 2).

[3] The National Sample Survey Organization conducted the first ever nation-wide survey on informal sector non-agricultural enterprises during 55th round (July 1999 - June 2000). In this survey, all unincorporated proprietary and partnership enterprises have been defined as **informal sector** enterprises. This definition differs from the concept of unorganized sector used in National Accounts Statistics. In the unorganized sector, in addition to the unincorporated proprietary or partnership enterprises, enterprises run by cooperative societies, trusts, private and public limited companies (Non ASI) are also covered. The informal sector can therefore be considered as a subset of the unorganized sector (55th NSS Round, Report No. 456/55/2.0/1, pp. 2).

[4] See 56th Round, NSS report No 478.

master enterprises or traders, and it varies from about 4.8% to 59.4% across major states in India. Delhi and West Bengal account for high incidence of contracts which are respectively 58.4% and 57.1% enterprises on unorganized sector. The size[5] of enterprise in this sector varies from household unit to factory unit. Moreover, about 80% enterprises work solely on contract with master enterprises or contractors. This clearly suggests the high presence of subcontracting or vertical contracts in the industrial structure in India. Among the contractual enterprises, 79.6% units take subcontract solely from master enterprise/contractor, 8.9% units from mainly contractor, and 10.8% mainly/solely from customer (Table 1).

It is interesting to note that 90.2% enterprises self-procure their specific equipment (fixed assets) for specific work while 93.9% enterprises take their raw materials from master enterprise/contractor. While an enterprise receives raw materials they are guided by the specific design for quality upgradation of products. About 89.1% units receive the specified design from the contractors/master enterprises for their skill upgradation and/or innovation effort (Table 2).

2.2 Primary Data

Since available secondary data does not focus on the dynamic of organizational relation, we look at the large-scale field level survey data from West Bengal, a major province of eastern India. The study conducts survey of 356 enterprises of six industries from 4 different regions designed by stratified random sample in 2001-02.

West Bengal is purposively selected for its high growth of informal sector and craft-based industries during post reform period. Districts in West Bengal are grouped into two strata, namely by the degree of industrial advancement or backwardness, on the basis of the percentage share of total workers engaged in manufacturing. This cut-off point is arrived at so that an equal number of districts can be located to the both sides of this benchmark. In stage I, two sample districts are drawn from each stratum based on

[5] As per unorganized manufacturing, enterprises are separated into three categories, namely OAME, NDME and DME. The OAME is own account manufacturing enterprise that is operated with the help of members of the owner household while NDME and DME are non-directory manufacturing enterprises and directory enterprises respectively that are operated with hired worker 1-5 and more than five on fairly regular basis (56th Round NSS Report No. 478).

random sampling without replacement. Nadia and Midnapore are located at the advanced strata of the sample districts, and Bankura and Purulia are situated at the backward strata. In stage II, we select two groups of industries, namely industries common to all sample districts, and industries that are specific to a certain district. Two industries, one from the common group and another from district-specific group, for each sample district are randomly selected. Our selection of common industries includes handlooming and the brassware industry while the district-specific industries include clay works in Nadia, hornware in Midnapore, conchshells in Bankura and lac works in Purulia. Then sample blocks (regions) of sample industries are drawn from the selected districts randomly in stage III from a specified list of block for respective industries. Sample villages or a cluster of villages from each sample block are drawn randomly for respective industries. In stage IV, sample artisans/units have been selected with mindful of the respective production organization. On the basis of the above sample design, 356 units or proprietor households, representing independent (149 units), tied (162 units) and cooperative (45 units) production units, are selected for detailed survey for 2001 to 2002. Details of the survey are reported in Marjit and Maiti (2006) and (Maiti and Marjit, 2006).

On the basis field level survey, it clearly reveals the organizational transaction of subcontracting to specific tied producers. Clearly, there are specialized producers on specific jobs of a particularly production process and/or specialized on specific products. For example, six distinct stage of work in the production process, viz. dubbing, drying, rolling-I, rolling-II, weaving, knitting and packing, are observed in weaving industry largely, and the production stage very across regions, types of products and type of fibre used. Production stages of *tangail* sharee[6] in Nadia district is slightly differ from that of *tasar* and *baluchari* Sharee at Bankura and Purulia district. In *tasar* fibre, artisans adopt certain additional steps for fibre from *resham* sheed. One large unit does work all steps at their workshop, but is giving particular stages of work for specified tied units or also giving to produce particular types of products at the contractual basis parallel to the workshop. Tied artisans are offered at piece rate basis, and take raw material from their master enterprises, contractors or traders. They own specific fixed assets, tools and equipments of production themselves for their activities. The tied artisan, specialized on

[6] Specific designed cloths for South Asian woman.

specific jobs, takes raw materials from master for those jobs and gives back processed goods to the master. In other words, a master enterprise/trader gives a certain stage of work, S_1, of the production process to those, who are specialized tied producers, on this at the price rate basis, and again give other set of intermediate producer for second stage work, S_2, and so on. The master also gives contract for specialized products, type 1, 2, … . At the same time, the master maintains parallel in-house production hiring workers, but there is trade off between in-house production and subcontract. Similar features are also observed for other sample industries, but we do not want repeat here.

Moreover, tiedness to their master and contractor for specified jobs in contractual agreements, sharply increase from 21.07 percent in 1991 to 45.51 percent in sample units (Table 4). This reveals that the master enterprise/trader prefers more subcontracting to the fragmented producer, in stead of producing at in-house during post reform period. In other words, vertical fragmentation of labor process increases more during this period. Tied producer works at small scale and hired limited labor occasionally at the informal contracts.

In spite of increase in tiedness and fragmentation of production process, a kind of technological diffusion and innovation of products has taken place to cater to changing taste and preference during 1991- 2001 and the study enlists the types of innovation and nature of technological change in the production process from the sample units (Table 5 and Table 6). It should be noted that all new types of products are not newly invented; rather the types of goods are produced to a large extent to cater the new sources of demand. Although each unit does not change the products, but design of products and use of raw materials have been changed continuously enriching use value as well as aesthetic value of the products. Secondly, different types of tied producers take different raw materials according to their capability and also receive knowledge of the product design from their master at the time of receiving contracts.

Given structural backwardness of developing economy, one risk-neutral small producer is constrained by the limited capital endowment[7] to keep in innovation for competitive work, and is able to overcome through getting contract with ample assistance

[7] See Table (3a) and Table (3b). Table 3(a) suggests that 50% units face shortage of capital and 23% units feel sever competition from larger units. Table 3(b) suggests that very limited units receive loans and other assistance.

to their innovation in the form of information on design and types of products. Since master enterprise/contractor takes advantage from upstream innovation, he also prefers to tie up with a group of small producer.

3. A Model:

An economy consists of two groups of firms, viz., upstream and downstream firm, who are vertically related in the production process and upstream firm does innovation. We are interested to look at the dynamics of vertical contracts between markets as an impact of trade reform (more specifically reduction of tariff[8]) and innovation effort at the upstream market. Detail of the market is discussed in below.

3.1 Upstream Firm

A large number of firms works specific jobs for the intermediate goods production or produces specific products, and supplies it to the downstream market at market determined contractual price. At upstream market, firms engage in monopolistic competition. One agent easily enters in the upstream market with a small amount of capital endowment[9] for input supply, but faces uncertainty to cater the products into market and prefers to take the help from principal for those activities. Largely, small firms are tied to vertical contract on informal arrangements. Given his limited assets he has two options, either to be tied to vertical contract from principal or could be employee at the integrated firm. Let us take the cost function of an upstream firm is convex and given by

$$C(q_i) = Aq_i + \frac{c}{2}q_i^2, \qquad \forall_i, i = 1,.....,n \qquad (1)$$

where $A > 0, c > 0$ are exogenous parameters.

One upstream firm decides the quantity of production and supply to the downstream market for final production depending marginal cost. The upstream profit function can be written as

[8] Look at the Table 7 for extend of tariff reduction in recent years.

[9] More the 50% enterprise in unorganized sector face capital scarcity and 93% enterprise do not receive any financial help in 2000-01 (56th NSS Round, Report No. 578).

$$\pi_i = p_i q_i - Aq_i - \frac{c}{2} q_i^2 \qquad \forall_i, i = 1,.....,n \tag{2}$$

The upstream firm is price taker and solves the quantity production given the price.

3.2 Downstream Firm

A downstream firm produces final goods taking finished or semi-finished goods from supplier and sells it directly to the market. He has good reputation and marketing network to cater the finish products, and mostly belongs to the formal sector. At the downstream market, there is one firm, say, who purchases all intermediate inputs from large number of upstream firms and hence enjoys monopsony power over the input market. The firm has two options, either to vertically integrate or to subcontract to the tied producers. Since developing economy experiences restrictive trade policies to protect the domestic firms, which ensures monopoly power of the firm given the skew asset structure of the economy. Let, the monopsonist sales the product, Q_m, at the market price, P_m, which is exogenously given, directly to the consumer. The cost of the monopsonst is the amount of spending for purchasing input, q_i, at the input price, p_i. For simplicity we are assuming 1:1 technological relation between final good and input. We assume that downstream firm does not incur any additional cost. So, the profit function of buyer is

$$\pi_m = P_m Q_m - p_i q_i \tag{3}$$

Given the market power, the buyer actually sets the price for supplier. It should be noted that the price of final goods includes the tariff rate before the trade reform.

3.3 Upstream Innovation

Innovation helps the firm to survive in the competitive market and hence it is very important for upstream firm and downstream firm. But, innovation is difficult for upstream firm due to paucity of capital. Informal sector may not have proper R&D investment, but have innovation effort in the form of changing in design of the products and better raw materials etc. Any way, through the process of innovation each firm can either reduce the marginal cost of production[10] or upgradate the quality of product. Note

[10] Mookherjee and Ray (1991) take similar argument.

that only upstream firm innovate and buyer can take the advantage from upstream innovation exercising monopsony power. To make it simple, we concentrate only cost reducing effect of innovation. However, we can relate the quality upgradation through innovation in terms of cost reduction. Each upstream firm can reduce its marginal costs through process innovation. Let us take the cost function of upstream firm is convex and given by

$$C(q_i) = (A - x_i)q_i + \frac{c}{2}q_i^2, \qquad \forall_i, i = 1,.....,n \tag{4}$$

where $A > 0, c > 0$ are exogenous parameters and x_i is the reduction of marginal costs due to its innovation effort. Increasing marginal costs of production ensure that firms in the upstream market can earn a producer surplus to cover fixed costs. Standard literature suggests that the cost of innovation is also convex and can be written by:

$$F(x_i) = \frac{\gamma}{2}x_i^2, \qquad \forall_i, i = 1,.....,n \tag{5}$$

Where $\gamma > 0$ is an exogenous parameter.

While monopsonistic power could reduce the upstream price, we examine the decision between integration and non-integration, and his rationale behind the financing innovation effort to the upstream tied firms. Given this simple framework, we can write simple lemmas.

Lemma I: (i) In absence any integrating cost, vertical integration always would be first best solution, $\pi_I > \pi_{NI}$ ***, (ii) If integration cost, say,*** $Z > (\pi_I - \pi_{NI})$ ***, non-integration be preferable.***

We start with no innovation effort of upstream firm and equilibrium transaction between buyer and supplier can be solved by two stages game. In first stage, given the final good prices monopsony solves the input price for maximum profit. In second stage, given the input price supplier solves the equilibrium quantity of supply. We solve the game by backward induction method. In backward induction game, at first, upstream firm derive the quantity of supply at give input price.

$$\max_{q_i} \pi_i = p_i q_i - Aq_i - \frac{c}{2}q_i^2 \tag{6}$$

Given p_i, the equilibrium output quantities with be solved from (6),

$$q_i = \frac{p_i - A}{c}, \qquad q_i = q_i(p_i), \quad q_i^{p_i} > 0 \tag{7}$$

Note that the equilibrium production at the upstream market depends positively on the price of the intermediate goods. Now the equilibrium input price is determined by the buyer, by solving the monopsonist profit, given P_m.

$$\max_{p_i} \pi_m = (P_m - p_i)q_i \tag{8}$$

$$p_i^* = \frac{1}{2}(P_m + A), \qquad p_i = p_i(P_m), \quad p_i^{P_m} > 0 \tag{9}$$

Note that input price is positively related to final good price and it is half of final price as $A \to 0$.

Substituting (9) into (7), we get

$$q_i^* = \frac{P_m + A}{2c} \tag{10}$$

Now substituting (9) and (10) into (8) and (6) for equilibrium profits for both buyer and suppliers, we get

$$\pi_m^* = \frac{(P_m - A)^2}{4c} \tag{11}$$

$$\pi_i^* = \frac{(P_m - A)^2}{8c} \tag{12}$$

The joint profit of non-integrated firms is the sum of surpluses, i.e.,

$$\pi_{NI}^* = \frac{3(P_m - A)^2}{8c} \tag{13}$$

It is interesting to note that both profits are dependent on the market price of final good.

If they are vertically integrated, the producer decides the optimum production given the final good price, similar to (6).

$$\max_{q_i} \pi_I = P_m q_i - A q_i - \frac{c}{2} q_i^2 \tag{14}$$

Solving (14), we get

$$q_I^* = \frac{(P_m - A)^2}{c} \tag{15}$$

$$\pi_I^* = \frac{(P_m - A)^2}{2c} \tag{16}$$

Comparing (13) and (16), we can write

$$\pi_I^* - \pi_{NI}^* = \frac{(P_m - A)^2}{8c} > 0$$

Hence, profit for integrated firm is higher than non-integration in case no integrating cost. Because, amount of supply is higher than the non-integration, i.e., $q_I = 2q_i$. So, π_I^* is the 'first best solution'.

Now if there is a cost for integration, say,

$z \in (\lambda, \alpha : \lambda > 1, \alpha > 0)$

There is z, $z = z^* = \frac{(P_m - A)^2}{8c}$ and if $z < z^*$, integration is preferable and integrating firm goes for maximum possible surplus, π_I^*, which is the 'first best solution'.

In other words, if $z < z^*$, $\pi_I^* > \pi_{NI}^*$

And if $z > z^*, \pi_I^* < \pi_{NI}^*$ and both firms earn π_m^* and π_i^* respectively. This is 'second best solution'.

Lemma II: If λ and α belongs to z, such that $z = \{(\lambda, s) : \lambda \geq 1, 0 \leq \alpha \leq 1\}$, and if $\alpha \to 0$ and $\lambda > 1$, then $\pi_I^*(\lambda) < \pi_m^*$, i.e., non-integration dominates.

One could understand that integration and non-integration has costs to the firm. For quality output within the firm, it incurs a cost, 'governance cost' ($\lambda > 1$). On the other hand, firms face a cost for hold-up problem arising out of 'incompleteness of contract' between specific buyer-supplier relationship ($\alpha > 0$). As long as these 'governance cost' are unrelated to specificity of input, integration dominates market transaction at high level of specificity and low level of governance cost, and the market transactions dominate integration at low level input specificity and high level of governance cost.

If the specialized input is of high quality, final good production generates sales revenues equal to R(q_i), where q_i refers to the amount of high quality intermediate input

used in the production. If the input is of low quality, sale revenues are zero. The buyer has two options for obtaining intermediate inputs. It can either manufacture then in-house at a marginal cost of $\lambda > 1$ or obtain from suppliers. For better quality, q_i, the governance cost, λ , would be higher. Then, the net profit for integrating firm is

$$\max_{q_i} \pi(\lambda) = R(q_i) - \lambda c(q_i) \tag{17}$$

Now the profit maximize conditions is

$$R'(q_i) = \lambda c'(q_i)$$

Note that, the larger λ i.e., larger governance costs, the lower q_i.

Moreover, using envelope theorem, from (17)

$$\frac{d\pi(\lambda)}{d\lambda} = -c(q_i) < 0 \tag{18}$$

Hence, net profit under integrating firm is decreasing in λ .

Now, substituting (1) into (17), q_i can be derived as

$$\text{or } q_i^{\lambda} = \frac{P_m - \lambda A}{\lambda c} \tag{19}$$

Note that higher be the λ, lower be the q_i^{λ}. As $\lambda \to 1$, $q_i^{\lambda} \to q_I^*$, (15) and (19) are identical, i.e., first best output. It means that output under integrating firm is same to the firm under no cost as $\lambda \to 1$.

Substituting (19) and (2) into (17), we get

$$\pi^*(\lambda) = \frac{(P_m - \lambda A)^2}{2\lambda c} \tag{20}$$

Now, $\pi_\lambda = \pi_\lambda(P_m, \lambda)$ where, $\pi_\lambda^{P_m} > 0$ and $\pi_\lambda^{\lambda} < 0$.

Note that, as $\lambda \to 1$, (16) and (20) tends to be identical, i.e., $\pi^*(\lambda) \to \pi_I^*$, which is 'first best solution'. However, if $\lambda > 1$, there is a threshold λ^*, for which $\pi^*(\lambda^*) = \pi_m^*$, firm prefers to integrate until second best solution reaches. In other words, if $\lambda > \lambda^*$, then $\pi^*(\lambda^*) < \pi_m^*$ and non-integration dominates

Lemma III: If λ and α belongs to z, such that $z = \{(\lambda, s) : \lambda \geq 1, 0 \leq \alpha \leq 1\}$, and if $\lambda \to 1$ and $\alpha > 0$, then $\pi_m^* > \pi(\alpha)$, i.e., integration dominates

Economic actors are 'self-interest seeking with guile' (Williamson, 1985). The fact that agents are opportunistic is a necessary condition for incompleteness of contracts to lead to inefficiencies. If agents could credibly pledge at the outset to execute the contract efficiently, then although the contract would have gaps, renegotiation would always occur in joint profit maximizing manner. Since certain assets are relationship specific, in the sense that the value of these assets is high inside a particular relationship than outside of it. It implies that parties cannot costlessly switch to alternative trading partners and are particularly locked in a bilateral relationship. In this situation, agents incur certain costs for asset specificity.

Let the intermediate input is specialized and specific to the final good producer. If the contractual relationship between input supplier and final producer breaks down, the supplier would have access to a technology for converting that input into a final output, but in that case sales revenue would be

$$(1-\alpha)R(q_i) < R(q_i)\ ,\ \alpha > 0$$

The higher is α, the higher the degree of specificity in the model. The contract is incomplete, because they are unable to write an ex-ante enforceable contract specifying the purchase of a specialized intermediate input of a particular quality for a certain price. In addition, the parties cannot sign contracts contingent on the volume of sales revenue obtained when the final good is sold. Self-interested input supplier always goes for low quality, and charges additional margin for better quality supply. If input supplier realize that the final producer receives additional revenue, $\frac{\alpha}{2}R(q_i)$ due to his input specificity, the supplier solve the maximum profit keeping at least half of additional revenue before the bargaining. The supplier solve net profit as

$$\pi_i(\alpha) = p_i q_i - c(q_i) - \frac{\alpha}{2}R(q_i) \qquad (21)$$

Since supplier believe that the additional revenue is derived his input specificity, then (21) can be rewritten as

$$\max_{q_i} \pi_i(\alpha) = (1-\frac{\alpha}{2}) p_i q_i - c(q_i) \qquad (22)$$

In two-stage game, at first supplier solves q_i given P_m and then buyer solves p_i given q_i. Finally, we get

$$p_i(\alpha) = \frac{(1-\frac{\alpha}{2})P_m + A}{2(1-\frac{\alpha}{2})} \tag{23}$$

and $$q_i(\alpha) = \frac{(1-\frac{\alpha}{2})P_m - A}{2c} \tag{24}$$

Substituting (23) and (24) into (22), we get

$$\pi_i(\alpha) = \frac{((1-\frac{\alpha}{2})P_m - A)^2}{8c} \tag{25}$$

The surplus of buyer can be derived as

$$\pi_m(\alpha) = \frac{((1-\frac{\alpha}{2})P_m - A)^2}{4c(1-\frac{\alpha}{2})} \tag{26}$$

Note that if $\alpha \to 0$, then all p_i, q_i, π_i and π_m tend to be identical as under no cost non-integration situation, i.e., 'second best solution'. Due to input specificity, upstream firm supply less output, i.e., as $\alpha > 0$, $q_i(\alpha) < q_i^*$

In other words, as $\alpha \to 0$, then $q_i(\alpha) \to q_i^*$, and consequently $p_i(\alpha) \to p_i^*, \pi_i(\alpha) \to \pi_i^*, \pi_m(\alpha) \to \pi_m^*$.

Note that, $\pi_m = \pi_m(p_m, \alpha)$ where, $\pi_m^{P_m} > 0$ and $\pi_m^{\alpha} < 0$.

If $\alpha > 0, \pi_m(\alpha) < \pi_m^*$, integration dominates.

Now if $\alpha > 0$ and $\lambda > 1$, then there should a threshold α^*, for which $\pi_m(\alpha^*) = \pi_m(\lambda^*)$.

Given λ^*, if $\pi_m(\alpha) < \pi_m(\lambda^*)$, then integration still dominates

Proposition I: If λ and α belongs to z, such that $z = \{(\lambda, s) : \lambda \geq 1, 0 \leq \alpha \leq 1\}$, and if $\alpha \to 0$ and $\lambda > 1$, then tariff reduction increases the incentive to non-integrate. Then the threshold limit is $\tilde{\lambda}$, where $\tilde{\lambda} < \lambda^*$ for which $\pi(\tilde{\lambda}) < \pi(\lambda^*)$.

In our case, one upstream firm cannot set his price for monopsony. Input specificity in the monopolistic competitive market is very law and $\alpha \to 0$. In that context, vertical integration and non-integration largely depends on the intensity of λ. Depending on λ, monopsonist decides how much to be manufactured in-house and how much to be subcontracted to the tied supplier and his threshold limit is π_m^* (i.e., second best solution).

Given a tariff rate, the downstream firm set market price (P_m) for the final product which is marginally higher than the actual price (P_m^0), i.e., $(P_m > P_m^0)$. So when the tariff rate has been reduced as a policy of trade reform, market price tends to be actual price. Let t be the tariff rate to the value addition of the final product. Then, the monopsonist's profit function is

$$\pi_m = P_m Q_m - p_i q_i \qquad (27)$$

Where $P_m = (1+t)P_m^0$

If $t > 0, P_m > P_m^0$

As $t \to 0, P_m \to P_m^0$

As P_m falls, both 'first best profit' limit for integration and 'second best profit' limit for non-integration diminish. But, as P_m falls, $\pi(\lambda^*)$ diminish faster than π_m, if λ^* is sufficiently large (i.e., approaches to 1.5 and more). So, the firm should readjust λ cutting down some in-house production. Since, given λ^*, integrating firm will be less profitable, it cuts down certain in-house production to equate new 'second best profit' limit for integration. In this situation, the firm decides to integrate up $\tilde{\lambda}$, where $\lambda < \tilde{\lambda} < \lambda^*$.

Proposition II: If $\alpha \to 0$, $\lambda > 1$ ***and*** $x_i > 0$ ***(i) upstream innovation is directly related to input price, and (ii) input price is further directly related to final goods price***

Let us assume that buyer faces high transaction cost in the form of bureaucratic and governance cost, but cost for input specificity is negligible, and purchases input from upstream market at the price determined by the bargaining power of the buyer-seller.

Here we introduce the innovation effort of upstream firm into the system. Given an input price, the firm solves equilibrium innovation effort and sells the intermediate goods as an independent seller. In the first stage the downstream monoposonist and upstream supplier act simultaneously. In particular, the monopsonist sets input price, p_i, and upstream firm determines the innovation cost, x_i. In this situation, monopsonomist does not offer any price higher than competitive one, and does not consider effect of upstream innovation own surplus. In second stage, the upstream firm determines the profit maximizing output quantities. Using standard backward induction method eventually, the market could be solved by two stage game. With the cost of innovation effort, the *i*-th upstream profit function can be written as

$$\pi_i = p_i q_i - (A - x_i)q_i - \frac{c}{2}q_i^2 - \frac{\gamma}{2}x_i^2 \qquad \forall_i, i = 1,.....,n \qquad (28)$$

Given the level of innovation efforts, x_i, and the price, p_i, the equilibrium output quantities with be solved from (28),

$$q_i = \frac{p_i - A + x_i}{c}, \qquad \forall_i, i = 1,.....,n \qquad (29)$$

It is noticeable that the equilibrium production at the upstream market not only positively depends on the price of the intermediate goods but also the level of innovation efforts, i.e., $q_i = q_i(p_i, x_i)$, $q_i^{p_i} > 0, q_i^{x_i} > 0$.

Now, the equilibrium price is determined by the monopsony solving the monopsonist profit.

$$\pi_m = (P_m - p_i)q_i \qquad \forall_i, i = 1,.....,n \qquad (30)$$

Given x_i and P_m, one can solve p_i

$$p_i^*(x_i) = \frac{1}{2}(P_m + A - x_i), \ \forall_i, i = 1,.....,n \qquad (31)$$

$p_i = p_i(P_m), \quad p_i^{P_m} > 0$

The equation (31) suggests the input price (p_i) depends on monopsonost's final price (P_m) and the cost parameter (*A*). Now, given the input price, *i*-th supplier derives the optimum innovation efforts solving (28).

$$x_i = \frac{p_i - A}{c\gamma - 1} \qquad \forall_i, i = 1,.....,n \tag{32}$$

The equilibrium innovation effort depends on the price of the intermediate goods, if $c\gamma > 1$ (we assume this restriction throughout this paper). Note that innovation effort of upstream firm is positively related to input price, i.e., $x_i = x_i(p_i), x_i^{p_i} > 0$. Now, substituting (32) into (31), we can solve the optimum innovation effort, i.e.

$$x_i^* = \frac{P_m - A}{2c\gamma - 1} \tag{33}$$

Since, the innovation effort of upstream firm demands on input price, and further input price depends on final price received by the monoposonist. Hence, x_i monotonically depends on P_m. Substituting (33) into (32) and then into (29), optimum output supply by the upstream firm can be solved, i.e.,

$$q_i^* = \frac{\gamma(P_m - A)}{(2c\gamma - 1)} \tag{34}$$

Figure 1 clearly described the equilibrium condition of buyer and seller. Due to innovation effort of upstream firm input market equilibrium shifts from F' to F and optimum supply is higher compared the case of no innovation effort.

Proposition II1 (Independent and Competitive Situation): Under competitive and independent situation, (i) tariff cut leads to reduction of upstream innovation efforts, and (ii) it further reduces profits of both buyer and supplier.

If both buyer and seller act independently, as an impact of tariff buyer receives lower final price by the amount of tariff reduction, and having monopsony power over the upstream market the buyer essentially reduces the upstream prices to shift down the burden of tariff cut. The monoposonist exploit its market power by reducing input purchases and lowering the input price respectively. Equation (31) suggests that the monopsonist reduces input price at least 50% of the price fall of final goods. If the price of final goods fallen from P_m to P_m^0, the equilibrium input price is p_i^0, where $p_i^0 < p_i^*$. The decline of supplier price pushes down the innovation effort. Let x_i^0 is the equilibrium innovation effort after tariff cut,

$$\bar{x}_i^0 = \frac{P_m^o - A}{2c\gamma - 1} \tag{35}$$

Comparing (33) and (35), we get $x_i^0 < x_i^*$. The optimum input supply is

$$\bar{q}_i^0 = \frac{\gamma(P_m - A)}{(2c\gamma - 1)} \tag{36}$$

Where $\bar{q}_i^0 < q_i^*$. Essentially the surplus of both buyer and seller diminish due to fall of price and quantity sale respectively during post tariff cut period. Moreover, both surpluses further fall due to reduction of innovation effort. Substituting (36), (25) and (31) into (28), we get the surplus of the upstream firm, i.e.,

$$\bar{\pi}_i^0 = \frac{\gamma\left(P_m^0 - A\right)^2 (c\gamma - 1)}{2(2c\gamma - 1)^2} \tag{37}$$

Similarly, substituting (36) and (31) into (30), we get the surplus of buyer, i.e.,

$$\bar{\pi}_m^0 = \frac{2c\gamma\left(P_m^0 - A\right)^2}{(2c\gamma - 1)^2} \tag{38}$$

Proposition IV (Price Commitment Situation): Commitment for higher input price, i.e., $p_i^C > p_i^0$***, it leads to (i) higher innovation efforts of upstream firm, i.e.,*** $\bar{x}_i^C > \bar{x}_i^0$***, and (ii) higher profit for both buyer and supplier i.e.,*** $\bar{\pi}_i^C > \bar{\pi}_i^0$ ***and*** $\bar{\pi}_m^C > \bar{\pi}_m^0$***, compared to independent and competitive case.***

In the previous case, monopsonist does not consider the feedback effect of squeezing upstream innovation on own profit exercising power over upstream price setting at its marginal cost (perfect competitive price). Looking at the squeezing profit, even a power buyer realize and may be willing to set higher input price for the sake of higher innovation effort of supplier. Since monopsonist is also price taker, he cannot influence the final price after tariff cut. Now, if the monopsonist commits higher price than competitive case, the innovation decisions of upstream firm rises.

The whole process could be solved by three stages game. In first stage, buyer announces higher input price, p_i^C (where, $p_i^C > p_i^0$) in anticipation for higher optimal upstream innovation effort. In second stage, suppler solves the innovation efforts as given by (31). Finally upstream firm solves the amount of quantity to be supplied optimally as

given by (29). Substituting optimal innovation effort, given by (31), into (29), we solve supplier's output.

$$q_i^C(p_i) = \frac{\gamma(p_i - A)}{c\gamma - 1} \tag{39}$$

Given q_i^C, the buyer solve the optimal price to be set for supplier.

$$\pi_m = (P_m - p_i)q_i^C \tag{40}$$

Substituting (39) into (40) and differentiating with respect to p_i, we get

$$p_i^C = \frac{1}{2}(P_m^0 + A) \tag{41}$$

Comparing (31) and (41), one can see the higher price paid to supplier under commitment, which do not account for marginal cost of supplier innovation effort, $p_i^C > p_i^0$. Receiving higher price, the quantity supply is higher than the previous one. Substituting (41) into (40), we get

$$\bar{q}_i^C = \frac{\gamma(P_m^0 - A)}{2(c\gamma - 1)} \tag{42}$$

Comparing (36) and (42), $\bar{q}_i^C > \bar{q}_i^0$

The higher input price raises the incentive for the innovation of supplier. We can solve optimal innovation effort by substituting (41) into (33):

$$\bar{x}_i^C = \frac{P_m^0 - A}{2(c\gamma - 1)} \tag{43}$$

Comparing (33) and (42), one could see that $\bar{x}_i^C > \bar{x}_i^0$.

Combining higher input price and higher innovation effort result to the higher surplus of upstream firm. Substituting (43), (42) and (39) into (28), we get

$$\bar{\pi}_i^C = \frac{\gamma(P_m^0 - A)^2}{8(c\gamma - 1)} \tag{44}$$

Comparing (37) and (44), we find that $\bar{\pi}_i^C > \bar{\pi}_i^0$.

Most important for monopsonist is to compare his surplus before and after price commitment to the upstream firm. Substituting (41) and (42) into (40), we get

$$\bar{\pi}_m^P = \frac{\gamma(P_m^0 - A)^2}{4(c\gamma - 1)} \tag{45}$$

Comparing profits between two situations, (38) and (45), we get that $\bar{\pi}_m^P > \bar{\pi}_m^0$. While monopsonist commit higher input price, he faces two counteracting force on the surplus. Higher input price reduces the downstream surplus, while it raises surplus influencing upstream innovation effort. The resultant surplus is higher compared to no price commitment case.

Proposition V (Tied Situation): If monopsonist ties up to assist upstream innovation effort, it invariably leads to (i) net increase of innovation efforts of upstream firm, i.e., $\bar{x}_i^S > \bar{x}_i^C$***, and (ii) higher profit for both buyer and supplier i.e.,*** $\bar{\pi}_i^S > \bar{\pi}_i^C$ ***and*** $\bar{\pi}_m^S > \bar{\pi}_m^C$***, compared to price commitment case.***

The input commitment affects innovation efforts only indirectly via higher supplier profits and, moreover, an upstream firm ignores the positive effects its innovation has on monopsonist's profit. Therefore, the effects of such a commitment may mainly increase supplier profits, rather than increase in innovation efforts. As a result, the buyer may prefer a more direct way to increase upstream innovation by tying up to the supplier's innovation effort. An upstream firm lacks proper information and knowledge of quality upgration to cater wider market, and lacks ample capital to procure better raw materials. If buyer helps innovation effort directly providing design of products and advancing better raw materials, the upstream can get rid off financial constraint and raise innovation effort effectively. The suppler should have incurred a cost for acquiring proper knowledge of the design of the products (e.g., training for skill upgradation) and procuring better raw materials (e.g., interest cost for working capital loan). Eventually, helping the upstream innovation the buyer actually shares the innovation cost of upstream firm for his own sake. In this case, instead of guaranteeing higher price monopsony incur a share of upstream innovation cost, s_i, directly or indirectly. Then, the cost of supplier's innovation effort would be

$$F(x_i) = (1 - s_i)F(x_i) + s_i F(x_i) \qquad (46)$$

The first part of the cost is incurred by upstream firm and remaining part is taken care by monopsony supplier. The effective innovation cost is incurred by supplier,

$$F(x_i) = (1-s_i)\frac{\gamma}{2}x_i^2 \tag{47}$$

The Nash equilibrium could be solved by three stage game. In first stage the buyer solves s_i , and in second stage simultaneously monopsonist sets input price and upstream firm decides innovation cost. Finally, the supplier determines the output supply.

So, the upstream firm solves output as follows,

$$\max_{q_i} \pi_i = p_i q_i - (A - x_i)q_i - \frac{c}{2}q_i^2 - (1-s_i)\frac{\gamma}{2}x_i^2 \tag{48}$$

The upstream firm solves output as given by (29) and then input price is determined from (31). In order to analyse the supplier's innovation levels, x_i is solved for (48) a given s_i and we get

$$x_i(s_i) = \frac{p_i - A}{(1-s_i)c\gamma - 1} \tag{49}$$

Substituting p_i for (49) into (31), we get

$$x_i(s_i) = \frac{P_m - A}{2(1-s)c\gamma - 1} \tag{50}$$

Now, equilibrium input price, p_i^S , can be derived by substituting (50) into (31), and we get

$$p_i^S = \frac{\{(1-s)c\gamma - 1\}P_m + (1-s)c\gamma A}{2(1-s)c\gamma - 1} \tag{51}$$

Finally, equilibrium upstream output is derived by substituting (50) and (51) into (29), we get

$$q_i^S = \frac{(1-s)\gamma(P_m^0 - A)}{2(1-s)c\gamma - 1} \tag{52}$$

In the first stage, the monopsonist decides about the extent of support to upstream innovation, s_i , and the profit function of monopsonist is as follows:

$$\pi_m = P_m^0 q_i^S - p_i^S q_i^S - s\frac{\gamma}{2}(x_i^S)^2 \tag{53}$$

Substituting (50), (51) and (52) into (53), and then differentiating with respect to s_i and solving first order condition, we get

$$\bar{s} = \frac{2c\gamma + 1}{6c\gamma} \tag{54}$$

The optimal investment share on upstream innovation effort decreases with the higher value of both c and γ, since $c\gamma > \frac{1}{1-\bar{s}}$, $0 < s < 1$. One can easily see that $\bar{s} \to \frac{1}{3}$, if $c\gamma \to \infty$ and $\bar{s} \to \frac{3}{7}$, if $c\gamma \to \frac{1}{1-s}$. In other words, the optimum share lies between 33 to 43 percent of total innovation investment of upstream firm. Note that if innovation cost is too high (high value of γ), buyer reduce the share of support. Similarly if the cost curve of upstream firm is very steep (high value of γ), buyer does not get much benefit from cost reducing effect of innovation effort and reduces the share of support. Substituting (54) into (50) to obtain optimum innovation investment, we get

$$\bar{x}_i^S = \frac{3(P_m - A)}{4(c\gamma - 1)} \tag{55}$$

Comparing (55) with (43), we get, $\bar{x}_i^S > \bar{x}_i^C$, i.e., innovation investment under tied situation is higher than the price commitment situation. Essentially this implies that $\bar{x}_i^S > \bar{x}_i^C > \bar{x}_i^0$

Substituting (54) into (51) and (52), we determine the equilibrium price and output respectively,

$$\bar{p}_i^S = \frac{(4c\gamma - 1)(P_m + A) - 6P_m}{8(c\gamma - 1)} \tag{56}$$

$$\bar{q}_i^S = \frac{(4c\gamma - 1)(P_m^0 - A)}{8c(c\gamma - 1)} \tag{57}$$

Now the equilibrium surplus of upstream is derived by substituting (54), (55), (56) and (57) into (48), we get

$$\bar{\pi}_i^S = \frac{(4c\gamma - 1)^2 (P_m^0 - A)^2}{64c(c\gamma - 1)^2} \tag{58}$$

Comparing (44) and (58), we get $\bar{\pi}_i^S > \bar{\pi}_i^C$. This result implies that $\bar{\pi}_i^S > \bar{\pi}_i^C > \bar{\pi}_i^0$. The upstream firm particularly derives additional surplus for greater cost reduction effect of higher innovation investment under tied situation.

Similarly, the monopsonist buyer determines the surplus by substituting (54), (56) and (57) into (53), we get

$$\bar{\pi}_m^S = \frac{(8c\gamma+1)(P_m^0 - A)^2}{32c(c\gamma-1)} \tag{59}$$

Comparing (45) and (59), we get $\bar{\pi}_m^S > \bar{\pi}_m^C$. This result implies that $\bar{\pi}_m^S > \bar{\pi}_m^C > \bar{\pi}_m^0$. In tied situation, monopsonist derives higher surplus due to greater cost reduction effect of higher innovation investment. While tying up to the assistance to upstream innovation monopsonist overcomes the dilemma of loosing marginal surplus through committing higher input price in earlier case. By directing taking part of innovation cost, monopsonist motivates a stronger increase of upstream innovation and eliminates the counteracting forces from high input price. In other words, monopsonist yield higher surplus from effective cost reduction through tying up to the upstream innovation effort compared to price commitment. As a result, both upstream and downstream firms prefers to tie up assisting upstream innovation effort for higher surplus during post reform period

4. Conclusion:

Recent ongoing literature focuses that technological development and globalization are transforming the internal organization of the firm. The present study attempts to contribute in this line of research by giving an explanation for ongoing transformation of process, fragmentation of formal production structure and tying up to the informal sector through vertical contracts to reap upstream innovation benefits as an impact of trade reform in developing economy, particularly in India. The reasons for expansion of informal contract and nature contracts during post trade reform period in these economies are still under researched except a few attempts recently. We empirically observe the increasing trend of vertical contracts for the expansion of informal sector. We observe three important features of vertical contracts, viz., (i) high present of subcontracting activities by informal producer at small scale for master enterprise or traders just as principal-agent relationship, (2) increasing tendency of vertical contracts through fragmentation of production process during post reform period, and (3) tying up to upstream innovation effort by the downstream firm assisting design of the products and procuring key raw materials.

In small open economy framework, firms are price taker. We argue that incentives of vertical separation increase during post reform in order to adjust the present of integration cost for monitoring the quality output inside the integrating firm. Once the vertical firms are separated, having the monopsonist power, the buyer shifts the burden of tariff cut to the small scale upstream firm, who are in perfect competitive market. By squeezing the upstream input price, buyer effectively reduces the upstream innovation effort. Once, the monopsony buyer realizes his margin squeezing due to reduction of upstream innovation effort, he has two options to raise innovation efforts, viz., either commitment of higher input price or tying up to upstream firm directing assisting their innovation sharing a part of cost of it. Both these options lead to higher surpluses of both buyer and sellers. However, we find that tying up to the innovation effort yields better result. Under high price commitment to upstream, monopsony buyer faces two counteracting forces to his surplus, one force reduces the margin for higher price paid to the supplier, and another force pushes the margin my motivating higher upstream innovation effort. However, the buyer is not sure about extent of effective innovation receiving higher price. In tied situation, monopsonist buyer directly takes part of the upstream innovation effort and ensures higher benefits for both parties.

Figure 1: Buyer and seller Equilibrium Condition

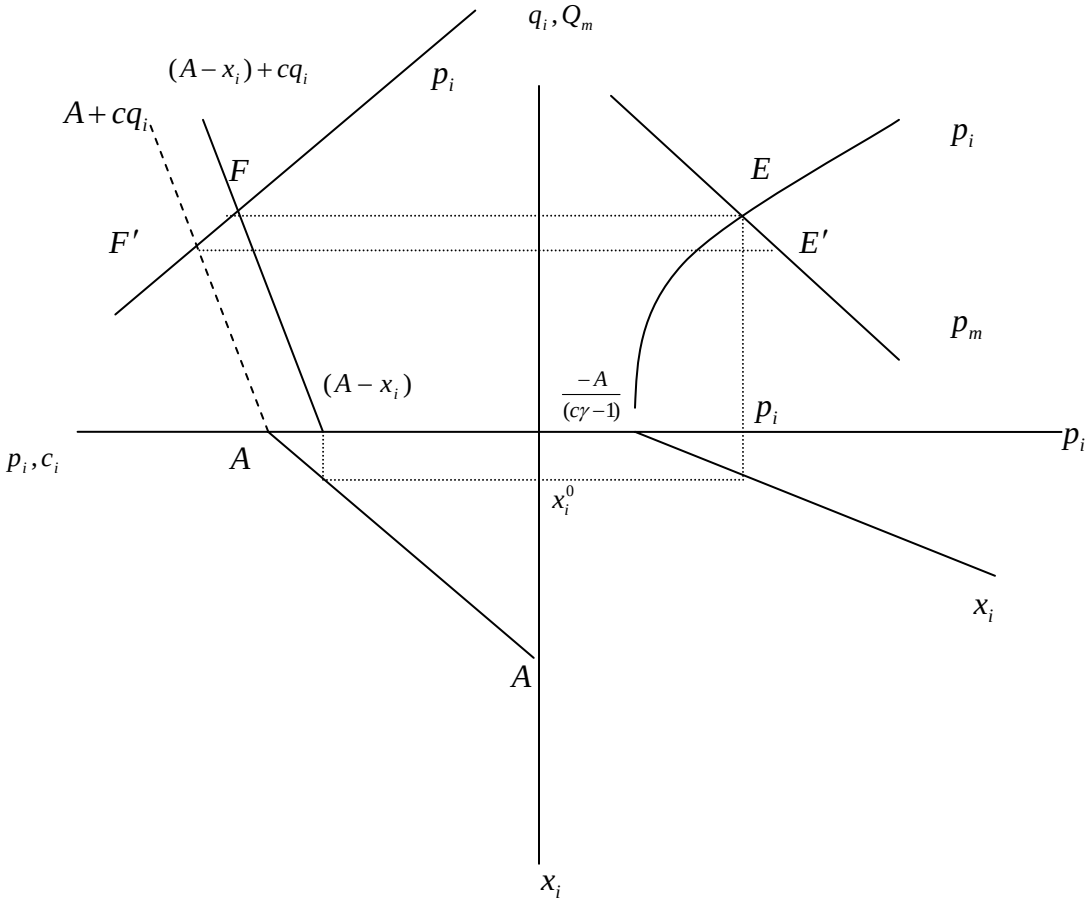

Table 1

Percentage of unorganized enterprises by types of contracts in major states of India, 2000-01

State/UT	Percentage of working on contract	Enterprise working on contract (%)			
		Solely for master enterprise/contractor	Mainly on contractor	Mainly/solely for customer	All
Andra Pradesh	20.4	76.5	13.1	10.2	100
Bihar	11.5	74.7	11.9	13.3	100
Gujrat	24.9	68.7	21.2	9.8	100
Haryana	6.5	37	23.7	37.6	100
Himachal Pradesh	6.3	38.8	22.5	29.8	100
Jammu & Kashmir	47.8	94.2	3.5	2.2	100
Karnataka	36.9	97.3	1.2	1.2	100
Kerala	25.2	68.5	15.7	15.8	100
Madhya Pradesh	41.1	70.5	4.5	24.8	100
Maharastra	21.8	53.8	26.2	18.7	100
Orrissa	4.8	53.9	20.6	25.5	100
Punjab	24.9	85.3	6.5	8	100
Rajasthan	12.9	67.1	12.2	18.2	100
Tamil Nadu	42.1	92.1	4.9	2.9	100
Tripura	4.7	30.6	19.3	10.8	100
Uttar Pradesh	29.7	81.4	6.9	9.3	100
West Bengal	57.1	82.2	6.5	11.2	100
Delhi	59.4	67.4	19.3	11.9	100
All India	30.7	79.6	8.9	10.8	100

Source: 56th NSS Report No. 478

Table 2

Percentage distribution of unorganized manufacturing working on contract separately (i) by source of equipment, (ii) by supply of raw materials and (iii) specification of design, by major states of India, 2000-01

State/UT	Source of equipment (%)			Source of raw materials (%)			Whether design specified by master/contractor	
	Self procured	Supplied by master enterprise/ Contractor	Both	Self procured	Supplied by master enterprise/ contractor	Both	Yes	No
Andra Pradesh	84.2	14.2	1.5	8.2	89.1	2.7	97.8	2.2
Bihar	89.5	9.1	1.4	8.1	86.6	5.3	87	13
Gujrat	85.7	13.5	0.8	4	88.5	7.5	87.9	12.1
Haryana	83.8	13.3	2.9	14.9	54.2	31	93.6	6.4
Himachal Pradesh	75.2	21.4	3.4	6.8	89.5	3.8	88.3	11.7
Jammu & Kashmir	81.6	18.4	0	2.4	97.3	0.3	83.1	16.9
Karnataka	97.6	2.4	0	1.4	97.7	0.9	98.7	1.3
Kerala	94.3	5.3	0.4	16.3	75.1	8.6	89.9	10.1
Madhya Pradesh	85.6	11.9	2.5	6.1	83.4	10.5	97.8	2.2
Maharastra	88.5	10.5	1	9.1	75.9	15	88.7	11.3
Orrissa	88.3	10.1	1.6	11.3	83.6	5.2	94.9	5.1
Punjab	75.9	23.3	0.8	8.4	86.3	5.2	95.8	4.2
Rajasthan	82.2	15.5	2.3	9.2	72.8	18	84.8	15.2
Tamil Nadu	92.2	7.6	0.2	3.5	91.4	5.1	98.7	1.3
Tripura	68.7	24.6	6.6	64	33.4	2.6	57.4	42.6
Uttar pradesh	89.4	7.1	3.5	6.9	88	5.1	90.7	9.3
West bengal	91.4	3.1	5.5	3.1	91.4	5.5	11.3	88.7
Delhi	94.8	4.6	0.5	8.9	67.4	23.7	94.4	5.6
All India	90	7.3	2.6	5.4	88.2	6.4	93	7

Source: 56th NSS Report No. 478

Table 3a: Percentage share of manufacturing enterprises by problems faced by them

Common problems faced				
	OAME	NDME	DME	ALL
No specific problem	26.5	20.1	16.9	26.0
Non-availability of electricity	14.0	9.7	8.8	13.6
Power cut	11.4	31.3	32.7	12.9
Shortage of capital	49.6	54.5	52.7	50.0
Non-availability of Raw materials	18.1	12.4	17.2	17.8
Marketing of the product	21.0	20.8	31.2	21.2
Other problem	33.5	36.9	45.1	33.9
Other than common problem				
Lack of Infrastructure facility	8.0	5.5	3.3	7.7
Local problem	20.6	12.9	10.1	19.9
Harassment	4.7	0.5	1.5	4.4
Competition from larger unit	22.2	31.5	27.8	22.9
Non-availability of labour	0.6	3.1	10.9	1.1
Labour problems	2.0	5.4	14.4	2.5
Fuel not available or very costly	4.8	0.7	6.3	4.6
Non-recovery of service charges/ credit	17.5	20.0	8.2	17.4
Others	18.9	20.2	17.3	18.9

Source: Same as Table 1

OAME: Own account manufacturing enterprises (no hired labour); NDME: Non-directory manufacturing enterprises (maximum 5 hired workers) and DME: Directory manufacturing enterprise (employ more than 5 hired workers)

Table 3b: Percentage of manufacturing enterprises receiving assistance by type of assistance received

Types of assistance	Unorganized sector (2000-01)			
	OAME	NDME	DME	All
1. loan	2.1	10.0	19.8	2.9
2. subsidy	0.6	1.4	2.6	0.6
3. machinery/equipment	0.1	0.8	0.5	1.0
4. training	0.3	0.4	2.3	0.4
5. marketing	0.4	0.4	2.0	0.5
6. procurement of raw materials	0.4	0.6	2.0	0.4
7. others	0.2	0.3	1.6	0.3
8. Not receiving any assistance	96.0	87.9	77.8	95.2

Source: NSS 56th Round, 2000-01

Table 4: Organizational Change of rural industries during 10 years after economic liberalization (1991-2001)

Organization	1991	2001
1. Independent	158 (44.38)	149 (41.85)
2. Tied	75 (21.07)	162 (45.51)
3. Cooperative	123 (34.56)	45 (12.64)
Total	356 (100)	356 (100)

Source: Field Survey

Note: Parentheses indicate the percentage

Table 5
Technological deffusion of sample manufacturing during 1991-2001

Industry	Old Machine and tools	Modern Machine and tools
Handloom	Ordinary Loom	Purni, Rid, Pit loom, Big Drum
Brassware	Hammer & accessories	Press Machine, electricity
Clay works	Mud Structure	Cement or plaster of parish Structure
Hornware	Sirish paper, Furnaces	Electric Wheel, Generator
Conchshell	Sil, Dara, Batali, file, Bhamara	Cutting machine, Grinder machine
Lac works	Handmade rope	Ship machine

Source: Field Survey

Table 6
Product innovation of sample manufacring during 1991-2001

Industry	Traditional Items	Modern Items
Handloom	Napnkin, bed sheet, sharee, handcarchip	Exclusive *sharee* (*Baluchari, Tasar*), swab, duster, exportable items
Brassware	Glass, jug, plate	Decorative structure like god and goddess, medal and households items of region specific
Clay	Ordinary doll	Structure of fruits, animal, god & goddess etc.
Hornware	Comb, pen	Weasel, decorative and designed household product, flower, fish, animals, body of watch, spectacle frame
Conchshell	Bangle, Sankha, finger ring	Ring, watch by shell structure, decorative structure
Lac	Rope made *chapra*	Machine made *chapra*, plate, bottom, comb etc.

Source Field Survey

Table 7: Tariff Structure of India (%)

Tariff rate	1990-91	1993-94	1995-96	1996-97	1997-98	1999-00	2000-01
Average unweighted (whole economy)	125	71	41	39	35		
Average weighted (whole economy)	87	47	25	22	20		
Consumer goods	153	86	36	33	25		
Intermediate goods	77	42	22	19	18		
Capital goods	97	50	29	29	24		
Maximum traffic rate	355	85	50	52	45	40	35

Source: Pradhan and Amarendra (2006)

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Appendix

Proof of Lemma I:

In backward induction game, at first, upstream firm derive the quantity of supply at give input price.

$$\max_{q_i} \pi_i = p_i q_i - A q_i - \frac{c}{2} q_i^2$$

First order condition for maximization, $\frac{\partial \pi_i}{\partial q_i} = p_i - A - c q_i = 0$

Second order condition, $\frac{\partial^2 \pi_i}{\partial q_i^2} = -c < 0$

Now the equilibrium input price is determined by the buyer, by solving the monopsonist profit, given P_m. $\max_{p_i} \pi_m = (P_m - p_i) q_i$

First order condition for maximization, $\frac{\partial \pi_m}{\partial q_m} = p_m + A - 2 p_i = 0$

Second order condition, $\frac{\partial^2 \pi_m}{\partial q_m^2} = -2 < 0$

Profit for vertically integrated firm, $\max_{q_i} \pi_I = P_m q_i - A q_i - \frac{c}{2} q_i^2$

First and second order condition are similar to derivation of optimum quantity by upstream firm.

Proof of Lemma II:

Profit of integrated firm with λ can be written as $\pi(\lambda) = p_m q_i - \lambda(A q_i + \frac{c}{2} q_i^{\,2})$

First order condition, $\frac{\partial \pi(\lambda)}{\partial q_i} = P_m - \lambda(A + c q_i) = 0$, or $q_i = \frac{P_m - \lambda A}{\lambda c}$

Substituting q_i into $\pi(\lambda)$, we get $\pi(\lambda) = \frac{(P_m - \lambda A)^2}{2\lambda c}$

Differentiating $\pi(\lambda)$ with respect to λ, $\frac{\partial \pi(\lambda)}{\partial \lambda} = -\frac{(P_m + \lambda A)(P_m - \lambda A)}{2c\lambda^2} < 0$

Second order condition, $\frac{\partial^2 \pi(\lambda)}{\partial q_i^2} = -\lambda c < 0$

Proof of Lemma III:

Profit of buyer with α can be written as, $\max_{q_i} \pi_i(\alpha) = p_i q_i - c(q_i) - \frac{\alpha}{2} R(q_i)$

This can be rewritten as, $\max_{q_i} \pi_i(\alpha) = (1 - \frac{\alpha}{2}) p_i q_i - c(q_i)$

Differentiating with respect to q_i, we get first order condition

$\frac{\partial \pi_i(\alpha)}{\partial q_i} = (1 - \frac{\alpha}{2}) p_i - A - c q_i = 0$, or, $q_i = \frac{(1 - \frac{\alpha}{2}) p_i - A}{c}$

Second order condition will be as follows: $\frac{\partial^2 \pi_i(\alpha)}{\partial q_i^2} = -c < 0$

Now, profit function of the buyer would be as $\max_{p_i} \pi_m(\alpha) = (P_m - p_i) q_i$

and $q_i = \frac{(1 - \frac{\alpha}{2}) P_m - A}{2c}$

First order condition for maximization, $\frac{\partial \pi_m(\alpha)}{\partial p_i} = \left(1 - \frac{\alpha}{2}\right) P_m + A - 2\left(1 - \frac{\alpha}{2}\right) p_i = 0$

or, $p_i = \frac{(1 - \frac{\alpha}{2}) P_m + A}{2(1 - \frac{\alpha}{2})}$

Second order condition, $\frac{\partial \pi_m(\alpha)}{\partial p_i} = -2\left(1 - \frac{\alpha}{2}\right) < 0$

Then, $\pi_i(\alpha) = \frac{((1 - \frac{\alpha}{2}) P_m - A)^2}{8c}$ and $\pi_m(\alpha) = \frac{((1 - \frac{\alpha}{2}) P_m - A)^2}{4c(1 - \frac{\alpha}{2})}$

$$\frac{\partial \pi_m(\alpha)}{\partial \alpha} = -\frac{\left(\left(1-\frac{\alpha}{2}\right)P_m - A\right)\left(\left(1-\frac{\alpha}{2}\right)P_m + A\right)}{8c\left(1-\frac{\alpha}{2}\right)} < 0$$

Proof of Proposition I:

Let t be the tariff rate to the value addition of the final product. Then, the profit function is, $\pi_m = (1+t)P_m^0 Q_m - p_i q_i$, Or, $\pi_m = P_m Q_m - p_i q_i$, Where $P_m = (1+t)P_m^0$

If $t > 0, P_m > P_m^0$, the equilibrium input price is $p_i^0 = \frac{1}{2}(P_m^0 + A)$

As P_m falls, $\frac{\partial \pi(\lambda)}{\partial P_m} = \frac{(P_m - \lambda A)}{\lambda c} > 0$ and $\frac{\partial \pi_m^*}{\partial P_m} = \frac{(P_m - A)}{2c} > 0$

If λ is sufficiently large (appro. 1.5), $\pi(\lambda^*)$ falls faster than π_m^*.

Proof of Proposition II:

Using standard backward induction method, the market could be solved by two stage game, in case upstream innovation. With the cost of innovation effort, the *i*-th upstream profit function can be written as $\max_{q_i} \pi_i = p_i q_i - (A - x_i)q_i - \frac{c}{2}q_i^2 - \frac{\gamma}{2}x_i^2$

First order condition for maximization, $\frac{\partial \pi_i}{\partial q_i} = p_i - A - x_i - cq_i$, or , $q_i = \frac{p_i - A + x_i}{c}$

Second order condition, $\frac{\partial^2 \pi_i}{\partial q_i^2} = -c < 0$

Now, the equilibrium price is determined by the monopsony solving the monopsonist profit, $\max_{p_i} \pi_m = (P_m - p_i)q_i$

First order condition, $\frac{\partial \pi_m}{\partial q_m} = p_m + A - x_i - 2p_i = 0$, or, $p_i^*(x_i) = \frac{1}{2}(P_m + A - x_i)$

Second order condition, $\frac{\partial^2 \pi_m}{\partial q_i^2} = -2 < 0$

Upstream firm also maximizes x_i, $\max_{x_i} \pi_i = p_i q_i - (A - x_i)q_i - \frac{c}{2}q_i^2 - \frac{\gamma}{2}x_i^2$

then first order condition can be written as: $\frac{\partial \pi_i}{\partial x_i} = q_i - \gamma x_i = 0$, where, $x_i = \frac{p_i - A}{c\gamma - 1}$

Second order condition, $\frac{\partial^2 \pi_i}{\partial x_i^2} = -\gamma < 0$

Proof of Proposition III:

Differentiating p_i, x_i, π_i, π_m with respect to p_m, we get

$$\frac{\partial p_i}{\partial P_m} = \frac{1}{2} > 0, \quad \frac{\partial x_i}{\partial p_i} = \frac{1}{c\gamma - 1} > 0, \quad \frac{\partial \pi_i}{\partial P_m} = \frac{\gamma(P_m - A)(c\gamma - 1)}{(2c\gamma - 1)^2} > 0, \quad \frac{\partial \pi_m}{\partial P_m} = \frac{4c\gamma(P_m - A)}{(2c\gamma - 1)^2} > 0$$

Proof of proposition IV:

$$\frac{\bar{x}_i^C}{\bar{x}_i^0} = \frac{\frac{P_m^0 - A}{2(c\gamma - 1)}}{\frac{P_m^0 - A}{(2c\gamma - 1)}} = \frac{(2c\gamma - 1)}{2(c\gamma - 1)}, \text{ or, } \frac{\bar{x}_i^C}{\bar{x}_i^0} = 1 + \frac{1}{2(c\gamma - 1)} > 1 \qquad (\text{since } c\gamma > 0)$$

Or, $\bar{x}_i^C > \bar{x}_i^0$, QED.

If $\bar{\pi}_m^C > \bar{\pi}_m^0$,

$$\frac{\gamma(P_m^0 - A)^2}{4(c\gamma - 1)} > \frac{c\gamma^2(P_m^0 - A)^2}{(2c\gamma - 1)^2}, \text{ or, } \frac{1}{4(c\gamma - 1)} > \frac{c\gamma}{(2c\gamma - 1)^2}, \text{ or, } (2c\gamma - 1)^2 > 4c\gamma(c\gamma - 1)$$

or, $(2c\gamma - 1)^2 > 4c\gamma(c\gamma - 1)$, or, $\frac{(4(c\gamma)^2 - 4c\gamma) + 1}{4c\gamma(c\gamma - 1)} > 1$

Hence, $\frac{\bar{\pi}_m^C}{\bar{\pi}_m^0} = 1 + \frac{1}{4c\gamma(c\gamma - 1)} > 1$, or, Or, $\bar{\pi}_m^C > \bar{\pi}_m^0$ (QED)

$$\frac{\bar{\pi}_i^C}{\bar{\pi}_i^0} = \frac{\frac{\gamma(P_m^0 - A)}{8(c\gamma - 1)}}{\frac{(P_m^0 - A)^2(c\gamma - 1)}{2(2c\gamma - 1)^2}} = \frac{(2c\gamma - 1)^2}{4(c\gamma - 1)^2}$$

$$\frac{\bar{\pi}_i^C}{\bar{\pi}_i^0} = \frac{4(c\gamma)^2 - 4c\gamma + 1}{4(c\gamma)^2 - 8c\gamma + 4} = 1 + \frac{4c\gamma - 3}{4(c\gamma - 1)^2} = 2 + \frac{1}{(c\gamma - 1)} > 1 \qquad (\text{since } c\gamma > 1)$$

Or, $\bar{\pi}_i^C > \bar{\pi}_i^0$ QED

$$\frac{\bar{q}_i^C}{\bar{q}_i^0} = \frac{\frac{\gamma(P_m^0 - A)}{2(c\gamma - 1)}}{\frac{\gamma(P_m^0 - A)^2}{(2c\gamma - 1)}} = \frac{(2c\gamma - 1)}{2(c\gamma - 1)} = 1 + \frac{1}{2(c\gamma - 1)} > 1 \qquad \text{(since } c\gamma > 1\text{)}$$

Proof of Proposition V:

If monopsony incurs a share of upstream innovation cost, s_i, directly or indirectly, the cost of supplier's innovation effort would be, $F(x_i) = (1 - s_i)F(x_i) + s_i F(x_i)$ The effective innovation cost is incurred by supplier, $F(x_i) = (1 - s_i)\frac{\gamma}{2}x_i^2$. The game follows three stage. In first stage the buyer solves s_i , and in second stage simultaneously buyer sets p_i and upstream firm decides x_i. Finally, the supplier determines q_i. So, the upstream firm solves output as follows, $\max_{q_i} \pi_i = p_i q_i - (A - x_i)q_i - \frac{c}{2}q_i^2 - (1 - s_i)\frac{\gamma}{2}x_i^2$

First order and second order condition for maximization with respect to q_i as earlier. But, First order condition for maximization with respect to x_i,

$\frac{\partial \pi_i}{\partial x_i} = q_i - (1 - s_i)\gamma x_i$, or, $x_i(s_i) = \frac{p_i - A}{(1 - s_i)c\gamma - 1}$

Second order condition, $\frac{\partial^2 \pi_i}{\partial x_i^2} = -(1 - s_i)\gamma < 0$

In the first stage, the monopsonist solves s_i, and the profit function of monopsonist is as follows: $\pi_m = P_m^0 q_i^S - p_i^S q_i^S - s\frac{\gamma}{2}(x_i^S)^2$, Substituting value of p_i^s, q_i^s, x_i^s, and simplifying we get the first order condition as follows $\frac{\partial \pi_m}{\partial s_i} = 2c\gamma + 1 - 6c\gamma s_i = 0$ **, or,** $\bar{s} = \frac{2c\gamma + 1}{6c\gamma}$

The second order condition, $\frac{\partial \pi_m}{\partial s_i} = -6c\gamma < 0$

Dividing $\bar{x}_i^s$ by $\bar{x}_i^C$, we get, $\frac{\bar{x}_i^S}{\bar{x}_i^C} = \frac{3}{2}$, then this implies, $\bar{x}_i^S > \bar{x}_i^C$ or, $\bar{x}_i^S > \bar{x}_i^C > \bar{x}_i^0$

$$\frac{\bar{\pi}_i^S}{\bar{\pi}_i^C} = \frac{\frac{(4c\gamma-1)^2(P_m^0-A)^2}{64c(c\gamma-1)^2}}{\frac{\gamma(P_m^0-A)^2}{8(c\gamma-1)}} = \frac{(4c\gamma-1)^2}{8c\gamma(c\gamma-1)} = \frac{16c^2\gamma^2-8c\gamma+1}{8c^2\gamma^2-8c\gamma} = \frac{8c^2\gamma^2+c\gamma+1}{c\gamma} > 1$$

Hence, $\bar{\pi}_i^S > \bar{\pi}_i^C$ or $\bar{\pi}_i^S > \bar{\pi}_i^C > \bar{\pi}_i^0$

$$\frac{\bar{\pi}_m^S}{\bar{\pi}_m^C} = \frac{\frac{(8c\gamma+1)(P_m^0-A)^2}{32c(c\gamma-1)}}{\frac{\gamma(P_m^0-A)^2}{4(c\gamma-1)}} = \frac{8c\gamma+1}{8c\gamma} > 1$$

Hence, $\bar{\pi}_m^S > \bar{\pi}_m^C$ or $\bar{\pi}_m^S > \bar{\pi}_m^C > \bar{\pi}_m^0$