Quality Management System Standards and Being OEM/ Tier Exporter: Determinants for Indian Auto Component Firms

Neelam Singh*

Abstract: This study explores (i)the OEM/ Tier-level export linkages, and (ii)the industry-specific ISO/TS-16949 certification for automotive component firms in India during 2004-05. The logistic regressions indicate the quality-related variables, including ISO/TS-16949 accredit, being most important for OEM-export participation. Bigger firms are more likely to have this certification, and the OEM/Tier-exporter status. Foreign ownership has generally no significant favourable influences, except a slightly superior performance of non-Japanese affiliates. Pure technical collaboration favours ISO/TS-16949 certification, but not directly the OEM/ Tier export associations. We suggest: financial assistance for ISO/TS-16949 accredit; ensuring credible private ISO-9000 certifiers; and encouraging OEM/ Tier exports, specially for SMEs.

JEL classification: F23, L15, L62.
Key words: OEM/ Tier exports; TNC supply linkages; Quality management system, QMS; ISO/TS 16949 certification; Indian automotive industry; SMEs.

1. Introduction

The literature on the global production networks/ fragmentation/ product mandating by TNCs discusses the factors determining the choice of nations, and the advantages of these TNC linkages for developing nations, e.g. as a source of technical know-how transfer to the supplier firms.[1] Compared to the procurement for local production by TNCs, the association for export purposes generally involves greater technological assistance – formal and informal – and quality improvement. This holds true whether these linkages are formed to meet the performance requirements imposed on TNCs, or are voluntary (UNCTAD 2001 and 2003), as the export markets are more exacting. The industry-specific characteristics influence the type and depth of TNC linkages. Capital and technology-intensive sectors like automobiles and electronics have producer-driven global value chains; and the access to the lead global firms who control key technologies and set parameters, is crucial for the export success. Korea and Taiwan tapped the global production networks by striking OEM contracts with lead companies (Lall et al. 2004: 410).

The automotive industry is tierized[2] with potentially deep backward linkages. For critical/ core auto components the manufacturing is scale-driven; also the technology is complex, proprietary, and requires rapid upgradation. This factor, along with heaviness of assemblies and the rules of origin somewhat constrain the global production sharing or fragmentation. The component design may be vehicle model-specific. There are substantial costs of switching

* Department of Economics, Lady Shri Ram College, Delhi 110024, India. Email: neelamsi@satyam.net.in
The author is grateful to Cristina Chaminade and Jaya Prakash Pradhan for their extremely useful suggestions on an earlier draft of the paper. The usual disclaimer applies.
[1] See e.g. Lall et al.(2004); UNCTAD(2001); www.ids.ac.uk/globalvaluechains/publications.
[2] As part of the supply chain for production of automobiles, Tier-1 automotive component suppliers sell to vehicle assemblers. Tier-2 (3) suppliers cater to Tier-1 (2) suppliers, and so on. The system integrator, Tier 0.5, is a new category globally. The replacement/ after-market for replacement parts, is outside this chain.

suppliers. An automobile is a system product; its performance depends critically on integrative designing of the key components (Nagaoka et al. 2007).[3] Developing design for key components involves interactive learning between the vehicle manufacturer and Tier-1 suppliers; the scope for buyer-supplier interactive learning is less at low ends of the supply chain. There is transfer of some best practices to Tier-1 suppliers; the trickle-down effects on lower Tiers are usually modest/ small (Singh 2007c; Sutton 2004). Thus the 'Tier Level' of TNC linkage influences the likely benefits to the supplier.

Certain developments since the early 1990s have impacted immensely the buyer-supplier relationships in the automotive supply chain. Consequently the requirements for being a Tier-supplier have risen, particularly the importance of large scale of operations and international alliances as enablers. Globally the use of electronic and information technology, telematic applications, and lightweight and 'smart' materials in producing vehicles have been rising. The safety and emission norms have become more stringent. The vehicle markets are not bearing fully the added costs for meeting these norms, and developing new electronic and other features. Hence the cost-cutting is a major concern of OEMs (original equipment manufacturers). The industry has witnessed a tremendous rise in the modularization (OEMs buying assemblies/ sub-assemblies rather than components and parts), tierization, and vendor rationalization – also true of the supply chains in India.[4] With the auto industry-specific quality management system (henceforth QMS) standards, like ISO-TS 16949, coming into force, the global majors have raised the mandatory or compliance requirements of their suppliers. In the emerging economies the vehicle MNEs while entering, have also brought along their several preferred suppliers of components, called the follow-sources. The increasing globalization and multinational control of automotive operations is exposing the indigenous firms, particularly SMEs, to intense competition[5], as in several other industries. The follow/ other MNC sources dominate in the local procurement for production by foreign-owned vehicle assemblers (Humphrey 2003; Ivarsson and Alvstam 2004).

The Indian automotive industry has moved from much protection to fierce competition (Singh 2007c). Many global OEMs have entered the industry since the mid-1990s, as also their preferred and other global suppliers - also setting up international/ regional procurement offices. The local content requirements and the (1997 Auto Policy associated) trade-balancing obligations have been completely abandoned. The quantitative import restrictions were removed in April 2001; also the tariff rates have been lowered. The list of SSI (small scale industry) reserved auto components has shrunk over time, finally scrapped in mid-2006. The components sector is being perceived as a thrust area for exports. Advancing the 1991 and 1997 FDI liberalization, the March 2002 Auto Policy allows 100% automatic foreign ownership. This Policy aims to make India a global hub for automotive components and a regional hub for small

[3] The specificity, inter-dependency and testability of a component affect its sourcing decisions. A non-functional or unsafe to drive vehicle may entail large dismantling expenses for replacing the component.

[4] These tendencies increase the 'distance' between SME component suppliers and vehicle assemblers, which may dent the bargaining power of these suppliers and reduce the technical assistance received by them from their customers (Singh 2007c). For vehicle assemblers which entered India since the mid-1990s, mostly their (follow design &) follow sources and a few other large companies occupy the Tier-1 supplier ranks.

[5] See Chaminade and Vang (2006), Humphrey(2003), Lorentzen (2005), Singh(2007c), Tewari (2005), UNCTAD(2001), and Veloso and Kumar(2002). Further, analysing the absorptive capacity of S. African suppliers, Lorzentzen(2005) argues that with MNC-control, despite the adoption of the possible frontier technology, there are chances of some de-skilling of the local operation; e.g. the process design and product R&D activities may be discontinued subsequent to the foreign ownership. The Indian automotive industry too has some such instances.

cars. In this scenario both the transition challenges and potential rewards from integration into the global supply chains seem high for local firms, including SMEs (Singh 2007b and c).

However, to our knowledge, an empirical analysis of the role of firm-specific factors in being an exporter to OEMs or Tier-level firms (under global value chains) remains largely unexplored so far (for any industry). Again, the exports of auto components at these 'Levels' is being increasingly subjected to the automotive industry-specific QMS requirements; so the firm-level determinants of having these QMS accredits need to be probed empirically. This study, attempting to address these gaps, utilizes data on 466 auto component firms in India for the year 2004-05. We analyze, by way of new econometric evidence, the inter-firm variations in: having the internationally accepted quality management standards (QMS); and being an exporter to OEMs or Tier companies. These issues are significant as the global/ regional outsourcing of components by international vehicle manufacturers and automotive Tier-1 and 2 firms is going up. We examine the influence of international financial and technical alliances, scale of operations and the type of quality management system (QMS) of the firm on its probability of being an OEM exporter or 'OEM/Tier exporter'. The export participation and intensity are analyzed additionally to explore whether the determinants of OEM/Tier exports and of exports in general differ.

Below, Section 2 discusses the institutional support for the auto component sector in India; Appendix 1 evaluates the ACMA/ UNIDO cluster programs. Section 3 describes the QMS standards in the automotive sector. Section 4 deals with the firm-level econometric investigation – the relationships examined; the sample, data and the variables; and the analysis of results (Sections 4.1 to 4.3). Section 5 concludes with a few observations and policy recommendations.

2. Institutional Support and Recent Policies

Though the Indian automotive exports have been growing fast over the last 10 years, India's share is only about 0.3% of global trade - about 0.9% for automotive components (AMP 2006-2016: xiii and 21). During 2005-06 the total automotive exports from India were $4.08 billion, of which $1.8 billion were auto components; the vehicle and auto components production were $28 billion and over $10 billion respectively. The Automotive Mission Plan (AMP) 2006-2016 targets $145 billion total automotive turnover in 2016, and $40-45 billion exports, of which $20-25 billion component exports and $2-2.5 billion outsourcing of engineering services are expected; India has much potential for outsourcing of IT-intensive designing and modeling/ styling services. Meeting these targets requires judicious facilitation by the government and industry associations. This Section discusses mainly the institutional support and policies which affect specially the exports to OEMs/ Tier firms, and the quality and productivity levels.

Quality and Productivity Improvement: As the East Asian experience shows, an innovative way of substantially enhancing the competence of small firms is by 'mentoring' groups of these firms. The UNIDO and the Automotive Component Manufacturers Association (ACMA) initiative in this regard, as Cluster Programs, are discussed in Appendix 1. ACMA has been engaged in upgrading the productivity and quality levels of its members also through the six-sigma training (aimed at reducing rejection rates), quality circles (for total employee involvement), and the ACT-ATOS specialized training programs on Lean Machine Systems, etc. The ITC/ACMA(2004) publication is a commendable effort to make the SMEs understand the nuances of exporting.

For the Indian auto component industry no definite estimates are available for the contribution of SMEs to output and exports.[6] The industry has over 10,000 units, in the tierized format, predominantly SMEs. The Indian auto component industry has numerous family-owned enterprises and first generation entrepreneurs (ACMA 2006). Recently ACMA formed a Young Business Leaders' Forum among the ACMA members. It arranges interaction with the leading automotive CEOs and visits to excelling companies - as an 'awareness and motivating' attempt. ACMA initiated the 'Adoption of Small Companies by Large and Medium Companies' in March 2007, starting with 9 SSI firms and 9 experts from 7 non-SSI firms (ACMA 2007).

For installing any quality management system, QMS, there are initial (preparation, consultation, and certification) and maintenance costs associated with third-party certification. These may be heavy for SMEs. The central/ state governments provide a partial reimbursement for ISO 9000 only. Barring a minor scheme of the Exim Bank, the subsidy/ financial assistance is not available for other QMS standards considered more rigorous for the international automotive industry. For ISO 9000 certification the auto SMEs have been mainly using the services by private local agencies, instead of BIS, a public sector agency (Exim Bank 2000). The charges by private international organizations for the global Standards are often prohibitive for SMEs.

Cluster Development: In recent years some clusters have been identified for development under the Small Industries Development Programme and the Industrial Infrastructure Upgradation Scheme. The National Manufacturing Competitiveness Council is keen to develop the auto components industry and address the problems of SMEs, through emphasis on cluster development. The AMP 2006-2016 recommends the creation of Special Auto Parks and auto component virtual SEZs, and enhancing the transport, communication and export infrastructure facilities as well as streamlining the training/ research institutions in and around the auto hubs.

R&D: The auto component SMEs in India have rather low R&D intensity; the average is under-1%, as against 5% for Germany (Exim Bank 2000); CII-DSIR-IIFT(2004) reports zero R&D by 35% SMEs. The R&D activity is primarily product/ process development – mainly improvements done at the suggestions of the customers; increasingly the big buyers are providing only the product and test specifications. The R&D financing is a major concern. In the absence of an assured off-take and long-term supply relationship, the SMEs are hesitant to commit their own limited funds (Exim Bank 2000). SMEs also complain about inadequate market development assistance. Clubbing together of small and medium enterprises under the Micro, Small and Medium Enterprises Development (MSMED) Act, 2006 is expected to encourage technology upgradation and FDI in the SME sector.

McKinsey & Company (2006) find that in India and China the large auto component suppliers have improved their performance over 2002-04 in terms of the rejection rates and productivity. However, the strategic importance of innovation is much lower than that of operational excellence. Many of these suppliers are at an inflexion point. Both nations have a vast and fast growing pool of engineers to develop and design complete integrated systems. Currently, their system developer space is dominated by subsidiaries/ JVs of global tier-1 suppliers with significantly higher cost structures than of local suppliers (p. 26). However, to reduce their own costs the OEMs are increasingly turning to the local suppliers for systems.

[6] For estimating the total industry production, ACMA has been adding another 30% to the total production by firms listed in ACMA Buyer's Guide (ACMA, *Facts and Figures: Automotive Industry of India*, various issues).

The scheme of 150% deduction of R&D expenses from taxable income, operational since July 2004, has been extended till March 2012. Since April 2005 there has been an excise duty exemption for products designed and developed locally by Indian-owned firms and patented in India, USA, Japan or any country in the European Union. Since April 2006 the government has allowed the auto component manufacturers to import vehicles without homologation, for R&D purpose. In 2005 the government sanctioned the National Automotive Testing and R&D Infrastructure Project, NATRIP, as a major initiative to enhance and upgrade this infrastructure. By harnessing the Indian strengths in automotive engineering, IT and electronics, this project is expected to encourage the automotive exports, including OEM/ Tier exports and outsourcing of design & engineering services, and to crowd-in private investment in R&D/ innovation.

Agreements on Technical Regulations (GTRs): Notably non-uniform regulations and approval procedures in different countries, for vehicles sold there, require expensive design modifications, additional tests and duplicating approvals for the global trade of vehicles and their components (WP.29 sources). This acts as a non-tariff barrier, particularly so for small (independent) enterprises and firms operating without any foreign collaboration. Currently India like most other developing nations and USA are not signatories to the UN-ECE 1958 Agreement. The 1958 Agreement deals with the adoption of uniform (harmonized) technical regulations for vehicles and components, bearing on the vehicle safety, fuel efficiency and emissions; it imposes reciprocity for Regulations adopted by a contracting party. India is viewing the pros and cons of signing it. India became a member of the 1998 Global Technical Regulations (GTR) Agreement in April 2006 (AMP 2006-2016: 40), after being an observer for three years. This Agreement aims at the development of GTRs through participation by a large number of nations; a member country may adopt any established GTR for domestic regulation and/or for approval for import of vehicles and components. Such participation may provide exposure to frontier technologies.[7]

Testing and Homologation Facilities: Low cost, easily accessible and credible testing facilities are particularly important for exports. Even for domestic sale of certain crucial components prior testing at the Automotive Research Association of India (ARAI) is compulsory (Exim Bank 2000). At present the (shared) testing facilities in India are inadequate and geographically concentrated in the Western region (Singh 2007b). Some developing nations like China and Thailand have extensive testing facilities. Our informal discussions with SMEs strongly point to the need for upgraded centralized testing facilities. The NATRIP project should be completed at the earliest. At the same time the local testing centres should not be ignored, and some minimum testing and other technical facilities must be ensured in the vicinity of even smaller auto clusters.

A related issue is the facilities for homologation, i.e. road-worthiness certificate. Till recently, for vehicles and automotive components, India had no certification agency which is globally accepted. The exporters have to send the products abroad for testing, usually with a specified agency in the customer's country. This involves considerable time and money especially for repeated tests in iterative product development processes. Now NATRIP has signed a Memorandum of Understanding with Vehicle Certification Agency of U.K. (VCA) for the issue of certificates in India by the VCA after the testing at NATRIP Centres.

[7] Among India's main low cost competitors in international trade of auto components, China too has signed the 1998 Agreement, not the 1958 Agreement; Thailand has signed only the 1958 Agreement; Republic of Korea, Malaysia and South Africa have signed both the Agreements (as on 13 March 2007; WP.29 sources).

Recent Auto Policies in China and India: A Brief Comparison - In the automotive sector China is a close competitor to India in terms of exports and as FDI destination. Imports of standard auto components by India from China are expected to rise, also with the Indian firms undertaking FDI in China (ACMA and SIAM 2003).[8] Therefore we briefly mention the recent Chinese automotive policies. The 2004 Chinese Automotive Policy aims to encourage the systems development ability of auto component producers (ACMA 2005). Those supplying several independent OEMs or entering global purchasing system would be supported in terms of technology upgradation, transformation, financing and organization. Vehicle manufacturers would be encouraged to source key automotive components domestically and these imports would be discouraged (the custom regulations were changed accordingly w.e.f. April 2005; the Chinese AutoParts Case is under a WTO-dispute). Again, new projects for vehicles or engines must meet certain minimum investment and R&D facility requirements; for JV proposals, also a contract for technology transfer and cooperation from foreign partner must be appended. These stipulations would indirectly develop the Chinese auto component industry. The JV (minimum 50% local equity) requirement is still applicable, except for 100% export-oriented units in EPZs (*China Daily*, 1 June 2004). The 2004 Policy permits, subject to the JV condition, the consolidation of firms through merger.

At present, under the Auto Policy 2002 India does not have any such (explicit) policies. The Auto Policy 1997 imposed the localization and trade-balancing requirements which were instrumental to quality and technology upgradation in the component sector (Singh 2007a and b); for foreign subsidiaries, there was also a minimum FDI investment amount condition.[9] Again, China has an Innovation Fund for Small 'technology-based' firms, and an SME information network on regulations, policies, emerging technologies, demand trends etc. (Exim Bank 2005). Thus the Chinese policies seem more focused on developing the local firms, specially SMEs and the global supply linkages. In India the AMP 2006-2016 promises government encouragement to establishment of Development Centres for SMEs; recommends setting up of a national level Automotive Institute for training and an Auto Design Centre; and creation of Technology Modernization Fund, with special emphasis on SMEs. The appropriate operative measures should be taken soon.

3. Quality Management System (QMS) Standards

A Quality Management System (QMS) standard is a definitive list of features and characteristics to be present through documented policies, manuals and procedures (Dale 2003). The aim is systematic quality assurance and control. These are not methods of control, only broad principles like leadership, employee involvement, process approach, system approach to management, continual improvement, factual approach to decision-making, and customer satisfaction. Assessment of QMS may be done by an independent (third) party for certification, called

[8] Looking at India's auto components trade with China, imports from China have risen from Rs. 47 crores during 2002-03 to Rs. 578 crores for 2005-06 (Rs. 760 crores for April06 to Jan.07); the export figures for the corresponding periods are Rs. 69, 157 and 39 crores only (*Business Line*, July 21, 2007: 1; based on DGCI&S and ACMA sources). For certain components for commercial vehicles, the Chinese prices are lower by 30-35%.

[9] The abolition of the minimum investment condition under the 2002 Auto Policy has been criticized by the Society of Indian Automobile Manufacturers (SIAM), arguing that it would discourage the domestic value-addition. The local content and trade-balancing requirements are not permissible under the WTO-TRIMs Agreement.

accredit, or by the customer (2nd party), specially for elements not covered in the QMS accredit. The registration is usually for three years.

Quality maintenance and improvement is a regular continuous process. However, a third-party QMS certification facilitates, or may be mandatory for supplies to certain customers or even bidding for them. A QMS accredit reduces the number of and time taken for audits and assessments by prospective buyers (Exim Bank 2000: 63). Having a QMS improves the internal operating efficiency, and reduces errors, rejections & customer complaints, and waste. These may be through better production processes and accounting procedures, changes in equipment & tooling, use of different raw materials, improved plant outlay, etc. Acquiring QMS accredits and applying other quality control measures also impact the productivity and production flexibility.[10] The lack of mutual recognition of the certifying bodies between countries is restrictive at times (Dale 2003).

Types of QMS in Automotive Sector - The efficiency of vehicle production and running is closely linked to that of the supply base. Vehicle manufacturers insist upon high standards of QMS from their component and sub-assemblies suppliers, and therefore, the Tier-1 and 2 suppliers too in turn down the supply chain. Box 1 mentions the different types of quality management system (QMS) accredits acquired by automotive firms (plants).

There have been some major changes in the QMS standards since 2000 (ITC/ACMA 2004). With the revision of the ISO 9000 standard in Dec. 2000, the 1994 series was to be withdrawn (becoming invalid) after 3 years. The revised standard is more in-depth, encourages process-approach, and reduces the documentation requirement. The ISO 9001:2000, which lists the QMS requirements, improves upon ISO 9000:1994 (and ISO 9001:1994) - all part of the ISO 9000 family.

Some international standards incorporate the respective country/ region-specific added requirements into the ISO 9001:1994 (see Box 1). Of these, QS-9000 – containing harmonized requirements of the Big Three, namely DaimlerChrysler, Ford, and General Motors – has been globally the most accepted standard earlier, also by Japanese and Korean OEMs. E-mark/ e-mark is a European standard (covering also E. Europe) for vehicles, sub-assemblies and auto components (Internet Sources). Absence of Agreements on Mutual Recognition of Standards has acted as a non-tariff trade barrier.

ISO/TS 16949, meant specifically for the automotive industry, is an ISO technical specification, aligned with the existing American, German, French and Italian standards mentioned in Box 1. However, it does not replace those standards. ISO/TS 16949:2002 was prepared by the International Automotive Task Force (IATF), represented by an international group of vehicle manufacturers, and Automotive Associations from Japan, USA, Germany, France and Italy. ISO/TS 16949:2002, called TS-2 (or TS2), has been integrated with ISO 9001:2000; it adds certain specific requirements for the automobile industry, and for the automotive supply chain. It can eliminate the need for multiple certifications, thus recognized as globally harmonized QMS standard.

TS-2 specifies the quality system requirements for the design and development, production, installation, and servicing of automotive-related products; in addition there are customer-specific requirements by the subscribing individual vehicle manufacturers. TS-2 can apply to vehicle manufacturing plants and sites producing auto modules, and components (any

[10] See Bhawani(2006) and Ivarsson and Alvstam(2004) for evidence for auto component firms in India. Besides QMS accredit for plants/ sites, there are also quality certifications for products.

Tier), including heat treating, welding, painting, plating or other finishing services. Apparently, manufacturers of parts for only the aftermarket are excluded from the ISO/TS 16949:2002 applicability (source: UL ISO-TS 16949.htm). Any Tier can apply if it has a direct (existing or proved potential) customer requiring compliance or registration to TS-2 (www.ts16949.com).

Box 1: Quality Management System (QMS) Standards in Automotive Sector

QMS Type	Customer Acceptability	Remarks
ISO 9000	Optional; at the discretion of customer	▪ A family/ series; of these, now ISO 9001:2000 specifies the requirements (revision of ISO 9001:1994 & 9000:1994). ▪ ISO 9001:2000 is a minimum condition for any supplier to an ISO-TS 16949:2002 customer.
QS-9000 (American); VDA 6.1 (German); EAQF (French); AVSQ (Italian); 'E/e' Mark (European)	o Country/ region specific, as indicated; those requirements are added to ISO 9000. o In practice, QS-9000 quite widely accepted.	o These standards are essentially based on ISO 9001: 1994; the latter revised since. o QS-9000 registrations were extended till 14th Dec. 2006, to expire later.
ISO-TS 16949	▪ Global; harmonized standard specifically for the automotive sector. ▪ Since 2004 major OEMs have been increasingly imposing ISO-TS 16949: 2002 accredit as mandatory for their suppliers, or are asking for compliance with it.	▪ ISO-TS 16949: 2002, also called TS-2, incorporates ISO 9001:2000. (The 1999 version was based on ISO 9001:1994). ▪ TS-2 was aligned with QS-9000, VDA 6.1, EAQF and AVSQ standards. ▪ Adds automotive sector requirements. ▪ Individual customer-specific requirements may also be listed.

Sources: ITC/ACMA (2004); IAOB, ISO, and BSI India sources; www.ts16949.com; www.tuv-sud.in.

With the ISO/TS 16949:2002, i.e. TS-2, coming into force in late 2003, the ISO/TS 16949:1999 registrants were required to upgrade by 14th Dec. 2004. The IATF extended the QS-9000 registrations till 14th Dec. 2006, for expiry then (internet sources). Since 2004 most of the OEMs which participated in the TS-2 formulation, have announced TS-2 as an essential requirement of their Tier-1 suppliers[11]; some others require compliance with TS-2 or

[11] DaimlerChrysler, Renault and PSA-Peugeot Citroen announced the deadline as July 1, 2004; some others announced 2005 or 2006 dates, till 14 Dec. 2006 as effective date by Ford and General Motors; Visteon, a Tier-1 supplier, announced the date July 1, 2005 for its suppliers (source: UL ISO-TS 16949.htm).

acknowledge it during 2nd party audits. The global Tier-1 suppliers may now spread this tendency to the 2nd and 3rd Tier sub-contractors to bring greater consistency in the supply chain. The year 2004-05 of our empirical study is part of this period of 'transition to TS-2' in the automotive world.

Thus at present the choice at the time of a new QMS registration or QMS renewal is essentially between ISO 9001:2000 and ISO-TS 16949:2002. The future belongs to the latter, specially for auto component producers aiming at international business in a big way. At present, an ISO 9001:2000 is a minimum requirement for any auto component plant supplying to an ISO-TS 16949:2002 customer, even domestically. However, for QMS certification the cost considerations can be paramount for SMEs.

Quality Management in Indian Auto Component Industry: The foreign exchange neutrality (export obligation) and localization requirements imposed under the 1997 Auto Policy contributed substantially to improving the quality of components produced in India, reduced the customer-rejection rates and led to skill upgradation (see e.g. Chaturvedi 2003; Okada 2004; Singh 2007b). In recent years the major contributing factors include the rising vehicle exports and greater quality consciousness among domestic buyers of vehicles. A primary survey by Singh(2007b: 270) reveals that since the 1991 liberalization the automotive firms have responded by way of the maximum emphasis on improving quality standards; on a scale of 0 to 3 (none to most important), for component firms this average scale is 2.85.[12]

Out of 466 firms covered in this study, 237 and 139 firms have ISO 9000 and QS 9000/ E-Mark quality accredits. It is remarkable that 244 of these 466 firms have ISO/TS 16949 certification (257 out of total 512 firms listed in ACMA, Buyer's Guide 2006). Comparing this information with earlier years' Buyer's Guide, and Exim Bank(2000: 65) indicates: a remarkable increase in the number of ISO/TS 16949 accredited firms; and the industry (ACMA members) significantly moving towards the globally accepted standards among OEMs and Tier-level buyers. Many firms have multiple quality accredits; the new additional plants by existing firms are usually set up with more advanced standards. Twelve firms have also received the Deming and/or other prestigious international awards. However, the SME segment in the industry is far behind. A survey of auto component SMEs in the Northern NCR region during July-August 2004 finds 43% of the firms to be non-(QMS) certified, while 13% firms had ISO/TS 16949 certification; now the emphasis is on ISO/TS 16949 standard for Tier-1 suppliers, and ensuring some QMS certification of the lower Tier suppliers (Rani 2004).

4. Firm-level Analysis

4.1 The Relationships Examined

At present over 60% of auto component exports from India are to America and Europe, considered as high accepted quality level destinations (ACMA sources).[13] Foreign OEMs or Tier companies may require the supplier to have an internationally accepted QMS standard, like the

[12] It is 2.00 for seeking new technology tie-ups and 1.85 for increasing the R&D efforts. The author's recent discussions with some SMEs executives corroborate these tendencies. The major changes have come after 1997.
[13] Developed countries have generally more stringent regulations, and higher quality consciousness of consumers and product recall liabilities pertaining to the sale of automobiles (the final automotive product).

buyer country's standard. We attempt to explain the acquisition (holding) of accredit for the globally harmonized standard, ISO/TS 16949; alternatively we explain the determinants of having certification for this standard and/or certain important country or region-specific standards (QClevel3 and QClevelG). Later we also estimate the impact of type of QMS standard on the exports by the firm and on the probability of exporting to OEMs or Tier companies.

In the highly competitive export markets the OEM or Tier buyers are relatively more quality and technology conscious customers.[14] They may also transmit best practices and provide advice relating to exports logistics. Both for domestic and overseas sales, having direct links with OEMs or Tier-1 automotive firms is said to be conducive to quality and technology upgradation, and product improvement.[15] This study focuses on the determinants of the vendor-association with international OEM or global Tier firms for export of components/ parts/ assemblies/ sub-assemblies. We analyze the 'Level of Exports', i.e. whether the firm is an exporter to OEMs or to 'OEMs and/or Tier firms' (XerOE and XerOT), or not. We additionally examine the export participation in general, i.e. even as aftermarket exporter, as well as the export intensity among exporters (XPosi and Xint).

For the binary (1-0) variables to be explained we obtain the logistic regression estimates[16]; the coefficient estimates and, in view of the heteroscedasticity, the robust z-values are presented. The main hypotheses tested are discussed under the specification of individual equations. Some remarks pertaining to the potential role of explanatory variables common to a number of equations are made below.

The Role of Firm-specific Variables: The explanatory variables employed here are the firm size (SalesL), several aspects of foreign collaboration, age of the firm (Age), location-specific factors, etc.; for the size and age variables the quadratic term is added to capture the non-linearlity, if any. For the exports analysis we consider additionally the role of QMS standards. We explore the effects of having separate in-charges for quality, R&D, or HRD (Qinch, RDinch and HRDinch)- reflecting the emphasis on theses activities. The data on R&D inputs or output are not available to us.

For estimating the foreign collaboration effects, minority (>= 10 to <50%) and majority (>=50%) foreign equity (FE) firms are compared by employing the Low_FED and High_FED variables. Alternatively we attempt to capture any differential effect of foreign ownership on

---

[14] Though the exports to OEMs or Tier firms are usually mega orders, the Indian-owned firms or JVs have concerns of getting orders with 'wafer thin margins', given the cost-cutting pressures on automobile MNEs, and intense competition among auto component suppliers from low cost countries; the customer/ product diversification by supplier firms might improve the bargaining power (Singh 2007b: 263). In general, exclusive linkages with large buyers – domestic or foreign - can lead to unfair terms and conditions for suppliers (UNCTAD 2001).

[15] For the present sample, among firms selling domestically, only a small number of them do not supply to a domestic OEM. However, with a few exceptions, they supply at least to a domestic Tier-1 firm.

The auto parts and component sector is an agglomeration of industries, varying in labour, skill and technology intensities; again some firms are diversified outside automotive components. In India there is significant components manufacturing by the associated firms of local and foreign OEMs, and the auto component Groups exist. Most of the broad product-categories have large market shares by 3-5 players (or Groups).

[16] A linear probability model states $P(Y=1 \mid X_i) = \beta' X_i$ but the predicted probability can lie beyond the 0-1 range. This limitation can be overcome by modeling the probability as a function $G(\beta' X_i)$. A logistic cumulative distribution function is used here. The ratio of P(Y=1) to P(Y=0), called odds ratio, is $\exp(\beta' X_i)$; the β coefficients are in log-odds ratio units. The Psuedo-R^2 is 1 minus (the ratio of unrestricted to restricted log likelihood).

Since OEM, Tier and aftermarket exporter are not mutually exclusive categories, we do not employ the multinomial logit technique; the same is true for the QMS accredits.

SMEs (FCD, FCD_SME). The effect of pure technical and financial-cum-technical collaboration is examined through separate variables PTCDum and FTCDum, as the latter has also elements of foreign financial collaboration.

The corporate practices and internationalization strategies vary across the FDI home (source) countries. European OEMs e.g. follow a more open competition policy for new vehicle contracts compared to Japanese OEMs under *Kieretsu* system (Humphrey 2003). ACMA and SIAM(2003) refers to the 1983-1993 period as the 'Japanisation Phase' for the Indian automotive industry (1985-1991 for the components segment) – characterized by subtle encouragement to FDI by Japanese MNEs vs. other MNEs. For examining the MNE nationality-related patterns, with Japan as the base group, we employ the Germany, USA, and OthNat dummies. The number of foreign affiliates having these nationalities is 38, 18, 16 and 18; of these, 10, 8, 7 and 6 respectively have majority foreign ownership.

Sometimes it is alleged that the singly-owned or partnership firms may not be as professionally run as companies. This sample has 48 non-companies, all locally-owned. Accordingly we employ the variable Othd (non-company) dummy. SMEs in general are not adequately aware of the intellectual property rules. Some SMEs may not even register their trademarks. Trademark plays a role similar to brandname in the case of a final product. We explore the effect of having a trademark on the export performance.

The industry-specific locations offer among others the advantages of proximity of markets for final and intermediate products. In India, certain towns/ cities have clustering of automotive production; these auto hubs operate as satellite clusters, i.e. the periphery, along with the core. Our sample data indicate geographical concentration of firms in Gurgaon and Faridabad in the North, Chennai and Bangalore/Hosur in the South, and Pune in the West, labelled here as ClusNG, ClusNF, ClusSC, ClusSBH and ClusWP.[17]

The remaining firms are mostly located in an industrial area/ zone, and the rest (67), are called 'isolated' firms (Isol). The (non-cluster) industrial area firms are categorized into North, South, and East/West regions. Taking the East/ West region industrial area firms as the base group, we employ the other-region industrial area dummies along with cluster dummies and Isol variables. The various regions and clusters differ in terms of the product specialization, proximity of OEMs, FDI level and entry timing, the vicinity of shared (government) testing and certification facilities, etc. The (non-auto cluster) industrial areas usually house firms having similar and related industrial activities, and offer certain shared resources and facilities. However, the advantages of an 'auto hub location' are expected to be relatively more intense, specially for OEM/ Tier level automotive exports. The Isol_SME variable is added to capture the differential effect of isolation on SMEs. We may add that out of 23 isolated SMEs in the sample, only one is foreign-owned.

We have not come across any econometric study of the determinants of type of QMS certification or export 'levels', i.e. being exporter to OEMs or Tier firms. Based on a 2002-03 cross-section survey of over 100 auto component firms in India, Parhi(2005) examines the adoption of advanced manufacturing techniques. The logistic regressions indicate a consistently positive impact of being a supplier to foreign OEMs. Parhi also finds positive effects of size (or R&D) dummy, participation in trade fairs, age, skill, joint training (HRD) participation, and Gurgaon cluster location. However, she does not consider the role of technology import or FDI; the local-foreign ownership composition of the sample is not mentioned.

[17] In this sample there are only 17 firms in the East region, of which 9 are in Jamdeshpur.

Quality Certification Levels (Eq. QClevel3 and QClevelG)

Since 93% of the firms have acquired one or more quality management system (QMS) accredits, we analyze only the type/ level of QMS certification. In the light of earlier discussion (Section 3), we call the presence of ISO/TS 16949 accredit as QClevel3 (dummy). QClevel2 is, in the absence of ISO/TS 16949 certification, having foreign country or region-related certification, QS-9000 and/or E-mark – the widely accepted standards during the period of the analysis. QClevel1 is having only the ISO 9000 accredit (from private bodies, or from BIS, called Bis-Mark certification).[18] QClevelG (=QClevel3 + QClevel2) is having the globally accepted standards ISO/TS 16949 and/or QS-9000/ E-Mark.

We examine the factors affecting the likelihood of adopting QClevel3 and QClevelG. In our sample the non-Japanese foreign affiliates have a very high proportion of adoption of 'non-ISO 9000 standards' (QClevelG); most of them have been following their own home country/ region-specific standard, and are gradually switching to the ISO/TS 16949 standard. Therefore, the inter-firm analysis of QClevelG is limited to the sub-sample of Japanese and locally-owned firms (N=414). QClevel3 (i.e. ISO/TS 16949) is examined for the entire sample (N=466). For QClevel3 we explore the role of several aspects of foreign financial collaboration; for QClevelG only the (Japanese) foreign ownership dummy is included. Other explanatory variables considered are the same for the two equations.

We expect a positive effect of the firm size, as smaller firms may find it more difficult to meet the organizational requirements and the expenses involved in third-party certification for non-ISO 9000 standards. Again, the investment in quality-related equipment has economies of scale (Bhaduri and Ray 2004). Firms having an R&D or HRD incharge are expected to have a higher propensity to adopt high quality standards. Information asymmetries between the isolated and other firms may not be significant as regards the acquisition of QMS accredits, specially in the case of large firms.

A priori, the effect of age is difficult to predict. Some firms gradually switch from ISO 9000 to more rigorous QMS standards (or establish new plants with advanced standards). However, younger firms may be more inclined to use advanced techniques and machinery (Bhaduri and Ray 2004; Parhi 2005). Further the rising export opportunities, also to automotive MNEs, and the liberalization of foreign investment and technology regulations are likely to have influenced the choice of QMS standard adopted by firms set up in recent years. The sample has 56, 81, 140 and 189 firms respectively in four age-wise phases, namely recent (1998 onwards), early liberalization period (1992-97), Maruti phase (1982-91), and pre-Maruti phase (till 1981).

Firms entering into a foreign collaboration may be encouraged or asked by the collaborator to upgrade their QMS standard. UNCTAD(2001) provides evidence on such assistance by OEMs, limited though, in automotive and other industries; see also Ivarsson and Alvstam(2004). Since the major US and German vehicle manufacturers actively participated in formulating and revising the ISO/TS 16949 standard, among foreign affiliates we expect the US and German firms to be relatively more inclined to hold this certification.

[18] Some firms in the sample have VDA 6.1, EAQF or AVSQ accredits, however, along with ISO/TS 16949, QS-9000 or E-mark certification. Out of 32 firms without any QMS accredit, 5 firms have foreign financial collaboration and another 2 firms have pure technical collaboration; 17 firms are exporters, 12 of these at OEM/ Tier level. Some of these firms are subsidiaries of another firm operating in India (thus the possibility of indirect exports), or are producers of castings, for which the QMS requirements may be less stringent or lax.

The foreign collaborator may discriminate against mandatory JVs/ low FE affiliates in matters of employment of cutting-edge technology and technical training to workers (e.g. UNCTAD 2003: 27). The difference may be significant between the JVs oriented towards host country markets and export-oriented wholly/majority foreign-owned enterprises (Moran 2003: 8). Yet, Korea has managed the technology acquisition well with only licensing and minority foreign ownership/ JVs till 1987. However, about 60-70% of Korean exports till 1980s were via OE manufacturing contracts for foreign TNCs, " --- through which important flows of production methods, quality control practices, and management procedures were channelled back to local suppliers" (UNCTAD 2003: 27-28). Again, in general, the local partners of JVs may be keen on local absorption and diffusion of whatever technology is transferred to the enterprise for production, and on increasing their exports (Singh 2001 and 2007a). Hence we expect the minority and majority foreign-owned firms to have similar propensities to adopt the globally accepted QMS standards.

Exports Analysis

Exports Participation (Eq. XPosi): For auto component exports, a consistent good quality, meeting delivery requirements and price competitiveness are the most critical operative factors (ACMA-McKinsey Report 2005; Singh 2007b). Given the fixed costs of exports, a larger firm is more likely to export. Having a trademark may facilitate being an exporter. In general, firms graduate from being exclusively domestic seller to partly an exporter. Thus older firms are likely to have a higher probability of being an exporter. However, the rising export opportunities or certain export promotion policies can lead to the emergence of exclusively or primarily export-oriented new (young) firms. The impact of any foreign collaboration on exports is potentially favourable; however, the export restrictions, formal or otherwise, may work to the contrary, even though the cases of complete restriction seem rare (Singh 2007b). Having R&D and HRD incharges can contribute to the firm's ability to export. The role of quality-related variables is discussed later.

A firm located in a major auto cluster town or in an Industrial Development Estate/ Area may enjoy agglomeration economies; clusters provide common facilities and labour training, which are important to SMEs (e.g. Exim bank 2005; Singh 2007c). Thus the effect of isolation on export participation is likely to be adverse, especially for SMEs, particularly as regards the OEM/ Tier exports. We expect negative coefficients on Isol and Isol_SME variables.

Export 'Levels' (Eq. XerOE, XerOT): From a position of primarily aftermarket (i.e. replacement market) exporter barely a decade ago, India has turned into a major sourcing hub for global OEMs and Tier 1 or 2 firms. Availability of skilled labour, engineering & IT services at competitive rates, and metal resources, high quality standards, and adaptation of technology are the major reasons (Chaturvedi 2003; Singh 2007c). Besides, the Indian vehicle industry is performing well domestically too. The first global launch and the Indian launch of new vehicle models being introduced by foreign OEMs operating in India are getting closer, now almost simultaneous. This raises the likelihood of the component suppliers in India (local and foreign-owned) being involved with these new vehicle models at an early stage, and later becoming the preferred regional/ global suppliers of components for these models.

Much export growth in the future will be situated in or around MNEs and global value chains; the returns are increasingly shifting to areas like design and product development, and

the links with higher value-added face less vulnerability (UNCTAD 2005: 3 and 11). In the automotive sector the 'Level' of exports of components is associated with the extent of supplier involvement in vehicle design and product development, and the value-added by the firm. The exports in decreasing 'Level' order are to OEMs, Tier-1, Tier-2, lower Tiers and to the aftermarket. The direct exports to OEMs usually consist mainly of high-end critical components, often requiring joint development. Exports to OEMs/ Tier-1 firms put the enterprise on a steeper learning curve of quality and export logistic parameters, probably ahead of that from interaction with only domestic OEMs/ Tier-1 units. We analyse the determinants of being an exporter to OEMs (XerOE). Also the 'OEM and/or Tier level exporter' status (XerOT) is examined.

Exports to OEMs or Tier companies, specially the former, are likely to demand superior technology (engineering capabilities) and more rigorous quality requirements – e.g. plant and product certification, sometimes customer-specific. Lead-time (final order to delivery) and on-time delivery logistic capabilities are also considered. Again global OEMs these days want to share the finished product warranties with their suppliers; the product recall liabilities act as a deterrent for small suppliers. SMEs find it hard to navigate through the rules of origin under plethora of RTAs and FTAs. Bigger firms may enter into overseas marketing alliances for exports, directly favouring OEM/ Tier-level exports. SMEs suffer from lack of exposure to foreign OEMs and Tier firms. They have insufficient funds for global marketing and doubts persist regarding their delivery capabilities (Singh 2007b). Hence relatively big firms are more likely to establish direct supply contacts with foreign OEMs or Tier firms.

A priori, the effect of age is uncertain. The OEM/ Tier level supply linkages once made, are likely to be long-term; on the other hand, some new firms have been set up in the post (1991)-liberalization period employing sophisticated machinery and technology to cater mainly to OEM or Tier exports. The suppliers of auto components tend to modify or develop products according to the customer specifications, though it may often happen as informal R&D. The supplier's innovative capacity is particularly critical for OEM/ Tier-1 export linkages. OEMs have been partly shifting the R&D and designing costs, and responsibility to their Tier-1 suppliers or system integrators (Humphrey 2003; Veloso and Kumar 2002). In the absence of data on R&D expenses, we consider the effect of having an R&D incharge, and expect it to exert a positive influence on exports, especially on XerOE.

The quality-related factors – namely having a Quality Incharge or a high level of QMS certification (Qinch; QClevel3, Qclevel2) – are expected to promote exports, and the 'Level' of exports.[19] In practice, much depends upon the technology intensity of exports and the role of cost competitiveness, as well as the use of informal mechanisms to ensure minimum quality requirements. In the case of ISO 9000 accredit, the buyer's (importer's) perception of the creditworthiness of the local certifying agency is relevant too. During the year of this empirical analysis (2004-05), the ISO/TS 16949 and QS 9000/ E-mark standards have been widely accepted globally. So their effects on high export 'Levels' may be similar. The Deming/ JIPM/ JQM awards indicate excellence in quality and delivery, and act like brand equity. Though the award cases are few, we additionally consider the impact of award dummy, AwardDum.[20] In the

[19] Based on an inter-industry sample, Das and Bandyopadhyay(2003) find that during 1989-1997 the firms having ISO 9000 certification, or those belonging to top business groups (reputation factor) were more likely to export.

[20] In our sample there are 12 firms having Deming/ JIPM/ JQM award(s), with a total of 14 awards. All these are Large firms belonging to Southern automotive Industrial Groups. Of these firms, 1 firm has a pure technical collaboration and 9 firms have financial collaboration (4 Japanese, 4 USA, none German and 1 other foreign nationality; 2 US affiliates have high, i.e. majority FE(%), and the rest 7 affiliates have low FE).

light of the earlier discussion we expect the favourable effects of the quality-related variables to be the maximum for the participation in OEM exports, followed by that in OEM/ Tier-level exports, and then any ('Level') export participation.

The effect of a technical or financial foreign collaboration on exports depends on the extent of technology transfer – broadly, including quality management and organizational practices – export restrictions, and whether the collaborating MNE decides to use India as an outsourcing hub. In the literature pertaining to the likely consequences of joint venture (or low FE %) condition imposed by host countries on foreign investors (see e.g. UNCTAD 2003), one strand of arguments is that allowing majority FE promotes the technology transfer and exports. In that case, for an automotive component firm the exports to the collaborator and its major OEM customers worldwide would also be favourably affected. We examine this possibility indirectly through the minority and majority foreign ownership effects on XerOE and XerOT. We additionally explore the effect of (ongoing) foreign technical collaborations – pure technical and financial-cum-technical agreements as separate variables.

Export Intensity and Exports-Log (Eq. Xint, ExportsL): For examining the determinants of export intensity and the value of exports in log terms[21], we exclude non-exporters (151 units), and marginal exporters (19 units), namely those having exports below $0.025 million.[22] The export intensity in this sub-sample of exporters ranges from almost zero to 100%.

The main relationships examined here pertain to the effects of firm size, foreign collaboration, R&D and quality-related variables and isolation factor. The discussion above alludes to the effect on export propensity as well. We may add here that while a bigger size and foreign collaboration relax the constraints to exports, this may not necessarily lead to a greater export-orientation in terms of the ratio to sales. Some relatively small firms may operate as 100% or primarily export-oriented units. Singh(2001) argues that local partners in minority foreign venture may find the exports as integral to the firm growth; she finds an inferior performance of majority foreign-owned affiliates in terms of increasing the export intensity over time.

In the absence of a more suitable measure, we employ the average sales per employee as an indicator of labour productivity, LabPrody. Since this ratio also depends upon the capital intensity of operations while the bulk of auto component exports from India have been of labour-intensive items, the sign of LabPrody is difficult to predict. A few large firms in the Indian automotive component industry have undertaken outward foreign direct investment (OFDI) in the recent years. This is expected to promote their exports of components and parts, as foreign establishments facilitate the supply of modules and sub-assemblies to the host country OEMs and Tier-1 firms, adopting just-in-time delivery and joint development strategies (Singh 2007b).[23] However, the data constraints have prevented us from examining the effect of OFDI.

[21] The top 10 exporters of auto components from India during 2001-02, as listed by Sutton(2004), included 6 MNC-JV and MNC firms (like the follow-source companies Visteon and Delphi), while the 4 domestic companies belonged to 'automotive Industrial Groups'.

[22] It is approx. Rs. 1.12 m. at the 2004-05 average Rs.-$ exchange rate of 44.95 (the 2003-04 average was 45.92).

[23] Pradhan(2007) provides supporting evidence on the trade (exports)-promoting effect of OFDI for the Indian manufacturing firms, also separately for the Indian Transport Equipment sector firms. He also finds favourable effects of R&D intensity and labour productivity (value-added per employee) on the export intensity. Bhaduri and Ray(2004) find a positive combined effect of the firm sales and R&D stock/ efficiency on its total exports.

4.2 The Sample, Data and Variables

The Data and the Sample: The firm-level data for this study have been collected primarily from the ACMA's publication "Buyer's Guide (or Source India)" for recent years, covering the ACMA members and also some non-member firms. We supplemented these data by the company and internet sources to fill the occasional gaps for some variables.[24] The disaggregate value figures are not available for exports to OEMs, Tier firms and the aftermarket.Though having a large variation in firm size, these ACMA data pertain mainly to (a part of) the top layers of the auto component and parts industry. This study uses firm-level data for the year 2004-05. For a small number of firms only the 2003-04 or else 2002-03 data were available; we adjusted their sales and exports figures, applying the 'growth rate of production ($ values)' of the Indian auto component industry. We excluded firms for which none of the three years data were available, as well as those not reporting the number of employees. This leaves us with a sample of 466 observations (out of 512 firms listed by ACMA). Box 2 defines the variables; these are dichotomous (1-0) variables, unless indicated otherwise.
Box 2: Variables ---- here

Select Averages by Size and Foreign Ownership: We first compare some important (simple) average values by size categories, i.e. for Small (upto 100 employees), Medium, and Large (>200 employees) firms, as reported in Table 1. The difference between QC and QClevelG shows having only ISO 9000 certification. The proportions of firms having a QMS certification and the Quality, HRD, R&D Incharge are higher for bigger firms. Such size-related differences are quite sharp for more rigorous QMS certifications, say QClevel3 (ISO/TS 16949), as well as for being an exporter to OEMs or to OEMs/ Tier firms (XerOE and XerOT). The export participation is relatively low for Small firms. However, the average export intensity among exporters (Xint divided by XPosi) - being 38.005, 26.054 and 19.353% for Small, Medium and Large firms - is higher for smaller firms.

There is a noticeable difference across the size categories in the average propensity to enter into a foreign financial or technical collaboration, the average being the lowest for Small firms. The CII-DSIR-IIFT(2004) survey also finds the absence of such linkages for most of the SMEs. We find the difference between SMEs and Large firms to be quite sharp for pure technical collaborations (the dummy and the number, i.e. PTCDum and PTC_No), and for minority foreign ownership alliances, while the proportion of High (i.e. majority) FE cases is not much dissimilar. This reflects lower bargaining power of SMEs, particularly for concluding international alliances without majority foreign ownership (Exim Bank 2000). Many SMEs have reservations against majority foreign alliances; even in the case of JVs, they fear being edged out later (conversations with the author), or the foreign partner pulling out.

[24] Two remarks are in order. First, a few Tier-level exporters have clubbed the categories 'exports to vehicle manufacturers' and 'exports to Tier companies' while listing the firms they export to, or just mentioned those names under the first category. For the 'OEM exporter' and 'Tier-level exporter' classifications, in order to cross-check (for correction) we referred to the 'List of Automobile Manufacturers' in different countries obtained from Wikipedia website and also to the 'Buyer's Guide' for earlier years. Second, some firms do not report any exports but mention being an aftermarket or OEM/ Tier exporter. Those exports may be negligible or might have started by the time of sending the filled Performa to ACMA. We treat them as non-exporters for the period of the analysis.

Table 1 also shows that compared to locally-owned firms, on an average, a higher proportion of foreign-owned firms have a globally-accepted QMS certification, and are OEM (or upto Tier level) exporter. They have higher export participation but much lower export intensity – overall and among exporters. Most of these differences may be size-associated. The tendency to conclude pure technical collaborations and the average number of such agreements (PTCDum and PTC_No) is found to be greater among foreign-owned firms. Compared to majority foreign-owned affiliates in the sample, minority foreign-owned units have lower average export intensity. However, a larger percentage of minority foreign-owned firms have an 'OEM exporter' and 'OEM/ Tier exporter' status (XerOE and XerOT). They also have a greater tendency to have (formal) foreign technical collaborations (TCDum and TC_No).

The Exports and Export 'Levels': The total exports and sales of the sample firms are $1217 million and $10340 million (including, if any, products other than auto components). This compares well with the total auto component exports and production figures for India during 2004-05, being $1.4 billion and $8.7 billion respectively (ACMA sources); the total OEM/ Tier exports values are not available. ACMA believes that during 2005-06 only about 30% of exports of auto components from India were to the aftermarket. This being a tierized industry, the industry gross sales exceed the production value.

In this sample out of 315 exporters, there are 196 OEM/Tier level exporters (102 firms are OEM exporters); 55.05% of the total exports are by firms exporting to OEMs (i.e. XerOE), and 76.83% of the total exports are by OEM/ Tier level exporters (XerOT). However, given the composition of the sample, these percentages are expected to be higher than the industry average. Even in this sample among the OEM-level exporters, those exporting only to OEMs export merely 5.18% of the sample exports; among OEM/ Tier level exporters, those exporting only to OEMs and/or Tier companies export 48.52% of the sample exports. The rest of these exporters export at the lower Level(s) as well. The average export intensity is 15.93% for the entire sample, and 23.57% among exporters. This proportion is similar among OEM exporters, OEM/Tier exporters and only aftermarket exporters, being 23.20, 25.08 and 21.08% respectively.

4.3 Analysis of Results

We now analyse the results of the multivariate analysis (Tables 2-4). All the estimated equations are significant at 0.0001 level. As a test for the multicollinearity we calculated the mean variance inflation factor (VIF) for the explanatory variables employed.[25] As the mean VIF values are much below 10, the multicollinearity is not severe for these equations. The results for the binary variables (Tables 2-3) are analyzed keeping in mind that the OEM-level exporters are a sub-set of OEM/ Tier level exporters, which are part of 'any level exporters' set (variables XerOE, XerOT and XPosi). The same holds true of QClevel3, QClevelG and QC variables, i.e. having ISO/TS 16949, any globally widely accepted QMS, and any QMS certification. Variables having highly insignificant coefficients have been dropped from the preferred equations. Among the location dummies, the set of industrial area dummies and Isol variables are insignificant for all

[25] Excluding the quadratic term, if any (SalesL2 and Age2), the mean VIF varies from 1.1 to 1.5 for different equations. With the quadratic term included, it is somewhat higher.

the reported equations. Thus a negative significant coefficient of Isol_SME variable implies an adverse impact of isolation only for SMEs.

Quality Management System Certification

Table 2 reports the estimates of QClevel3 and QClevelG Eqs. These equations explain respectively the likelihood of having certification for the globally harmonized automotive industry-specific standard ISO/TS 16949, and for the globally widely accepted any QMS standard in the automotive industry. A bigger size favours holding these accredits. For both these QMS variables there is a considerable and highly significant effect of the firm size (SalesL). In the QClevelG equation the effect of firm size seems to taper off, yet it is positive throughout the sample size range (-4.348 to 6.271 SalesL).

For the ISO/TS 16949 standard, i.e. QClevel3, on the whole, a foreign financial collaboration, even with a majority foreign ownership, does not lead to a higher propensity to hold this accredit. A high vs. low FE(%) seems immaterial in this regard. Among foreign-owned firms, the German affiliates and to some extent the American affiliates have a higher tendency to hold the ISO/TS 16949 certification, as compared to the Japanese and other foreign nationality affiliates. The OthNat variable was highly insignificant. The effect of 'non-German non-American foreign ownership' (FCD coefficient) seems slightly negative for Large (non-SME) firms, while being slightly positive for SMEs (FCD and FCD_SME coefficients added). Thus on the whole SMEs seem to benefit from a financial collaboration, as it prompts them to a greater adoption of ISO/TS 16949 standard. As said above (Section 4.1), the non-Japanese foreign affiliates have a very high incidence of adopting some globally widely accepted QMS standard (QClevelG). Excluding these affiliates, the (Japanese) foreign ownership variable, FCD, does not affect the QClevelG.

A noteworthy finding is that an (ongoing) pure technical collaboration, PTCDum, strongly induces the holding of accredits for internationally accepted QMS standards. Comparing its coefficient in QClevel3 and QClevelG equations (i.e. computing the coefficient difference), the favourable effect seems limited to the ISO/TS 16949 certification only. This is understandable at a time of transit of the global automotive world to this QMS standard.

The age of the firm (Age) does not have a systematic influence on QClevelG; for QClevel3 there is a mild effect, initially positive and later negative after about 20 years. Firms other than companies (Othd) are slightly behind others in terms of having a non-ISO 9000 accredit (QClevelG); the effect on ISO/TS 16949 certification alone is quite insignificant. Having an R&D incharge (RDinch) has a rather small and weak favourable effect on QClevelG; the coefficient is positive for QClevel3 equations too but even less significant. The location variables (results not tabulated) indicate a higher probability of ISO/TS 16949 accredit for the Chennai, Bangalore/ Hosur, and Gurgaon cluster firms. The effect of isolation for SMEs is negative but generally small and insignificant.

Exports Analysis

Table 3 reports the estimates of equations explaining export participation at the OEM level, OEM/ Tier level, and any level (XerOE, XerOT and Xposi). It must be added that the XerOE and XerOT equations refer only to the OEM/ Tier exporter status (1-0 variable), and not to the value

or intensity of exports at these 'Levels'. Table 4 presents the estimates of export intensity and exports-log among exporters (excluding marginal exporters). We discuss these results together.

As expected, a large scale of operations seems important for high 'Levels' of export participation. The effect of firm size is consistently positive – insignificant for XPosi, significant at 5% level for XerOT, and highly significant for XerOE. Even the magnitude of SalesL coefficient follows this order of importance. However, a bigger size of the firm leads to a strong and considerable adverse effect on the export intensity. This is also evident from the ExportsL Eq. as the total exports elasticity w.r.t. sales is below unity (≈ 0.7, the SalesL coefficient).

Like the size of operations, the quality-related variables are not significant in XPosi equations, while are consistently larger and/or more significant for OEM exporter status than for being an OEM/ Tier level exporter. It underlines the importance of quality factor for the TNC supply linkages, specially with OEMs. Compared to QClevel1 (having only ISO 9000 accredit), having QClevel3 or QClevel2 increases the probability of being OEM or OEM/ Tier level exporter.[26] Similar coefficients of QClevel3 and QClevel2 variables reflect the close substitutability between the automotive industry harmonized QMS standard ISO/TS 16949 and the other widely accepted standards QS 9000 or E-mark during the period of the analysis (year 2004-05).

As explained in Section 3, now onwards the choice is between the ISO/TS 16949 and ISO 9000 standard. Our results indicate that an upgradation from ISO 9000 to ISO/TS 16949 certification would be instrumental in promoting the OEM/ Tier level export linkages, especially in being an OEM exporter. Among exporters, having an ISO/TS 16949 certification also leads to larger volume of exports (ExportsL Eq., Table 4); firms having QS 9000 or E-mark without the ISO/TS 16949 accredit are more domestic-oriented, judged by their lower export intensity, a weak tendency. The aftermarket exports, being relatively less challenging, may be equally possible with ISO 9000 certification or sometimes even without any QMS certification; this may explain the lack of significance of quality related variables in the XPosi equation. Having a Quality-Incharge increases the likelihood of being an OEM exporter; the effects on other exports-related variables are positive but non-significant. Being a Deming/ JIPM/ JQM award winner (AwardDum) increases significantly only the likelihood of being an OEM exporter; this effect is, however, sizeable.

Our micro-level study does not support the presumption that FDI promotes TNC supply linkages. Considering the coefficients of all financial collaboration variables together (including the foreign nationality dummies and FTCDum), overall the partial effect of foreign ownership on the exports-related variables is negligible. Having a financial-cum-technical collaboration (FTCDum) by a foreign affiliate slightly lowers the probability of its being an OEM/ Tier exporter. The (FCD, FCD_SME) coefficients are not significant for exports-related equations.

These results strongly reject the argument that a high FE ratio would encourage exports, including being an exporter at OEM or Tier level. Looking at the (Low_FED, High_FED) coefficients, it seems that compared to minority foreign ownership, a majority foreign ownership promotes neither the export participation at any level, nor higher export intensity among exporters. In fact, as regards the OEM/ Tier export linkages (XerOT Eq.), the high FE firms seem to have a somewhat inferior performance, while overall the minority foreign ownership has a slight positive influence; the Low_FED coefficient is highly insignificant here.

[26] The variable QC_None (no QMS accredit) has been dropped from the preferred XerOE equations; here this coefficient, though positive, is smaller and almost invariably insignificant; see a footnote discussion on QC_None cases in Section 4.1. For the XerOT Eq. we employ alternatively QClevel1 in lieu of the (QClevel3, QClevel2) set.

There are some foreign nationality associated differences. Compared to the Japanese affiliates, German and other nationality (OthNat) affiliates seem to have a higher probability of exporting at OEM level, and thus at OEM/Tier level. The US affiliates have a similar, but weak, tendency for OEM/Tier exports only. Even for the export participation in general and the exports volume, the non-Japanese affiliates have slightly better performance, *albeit* weak tendencies.

Pure technical collaboration (PTCDum) does not favour establishing the OEM or Tier level export linkages. However, we must point to the possible indirect effect through the greater probability of having an ISO/TS 16949 accredit. A pure technical collaboration has a rather weak and small favourable effect on the export participation in general (XPosi). A strong negative effect of PTCDum on the export intensity and the exports-volume of exporters, implying greater domestic-orientation, may be reflective of the partial export restrictions.

Older firms seem to have a higher propensity for export participation (XPosi). For XerOE and XerOT linkages, the effect of age becomes negative after about 30 years. The variable age has no systematic effect on Xint and ExportsL. Non-corporate firms have similar export participation as the corporations. Given the QMS standards, the former have surprisingly a greater tendency to establish OEM export linkage, and have higher overall export intensity among exporters. Having a trademark seems to facilitate being an exporter, or even a Tier-level exporter; it does not significantly raise the likelihood of being an OEM exporter or the export intensity of operations. Emphasis on HRD increases the probability of export participation, apparently at the aftermarket level only. Having an R&D incharge contributes only mildly to the likelihood of being an OEM/ Tier level exporter (statistically weak effect); else, this variable seems unimportant in determining exports, even the XerOE status; due to data limitations we could not estimate the impact of R&D intensity. The variable LabPrody, i.e. average sales per employee, has a negative effect on the export intensity and volume. This may reflect the current overall comparative advantage of India in relatively labour-intensive/ lower value-added auto components.

A noteworthy finding is that ceteris paribus, being 'isolated' renders an SME far less likely to be an exporter. The disadvantage of isolation for SMEs is evident very strongly for being an OEM/ Tier level exporter. This is understandable, as isolated SMEs lack access to several joint facilities, critical for OEM/ Tier exports. The Isol_SME coefficient is not significant in XerOE Eq. Comparing this coefficient in XerOT and XPosi Eqs., it appears that the export participation in the aftermarket though is not adversely affected for isolated SMEs. The export intensity among exporters appears to be less for isolated SMEs. The disadvantages of isolation will be more visible in near future with the shared facilities being added and improved upon in and around auto clusters under the focused hub/ cluster approach of the government policies.

As said above, the regional variations among non-cluster industrial area firms are not significant. The cluster dummies (results not tabulated) indicate that the Chennai cluster out-performs other locations in terms of the firm being an OEM/ Tier exporter, and the exports-volume (log), though not for the probability of OEM-exports. The Faridabad cluster has lower export intensity among exporters, as well as lower export participation at OEM and Tier levels, particularly at OEM level. For other clusters the effects are mixed/ insignificant for different exports variables. The Pune cluster location in the West leads to a slightly lower export intensity while a slightly superior performance in terms of being an OEM-exporter; the latter tendency may be probably due to better availability of testing & homologation facilities and exports-related infrastructure in the vicinity. The Faridabad auto cluster needs attention for rejuvenation, also in the light of increasing import competition from Chinese standardized auto components.

5. Conclusions and Policy Implications

We find that as expected, the quality-related variables are most significant for OEM level export participation. For direct exports to vehicle assemblers (OEMs), having the globally harmonized auto-industry specific quality management system (QMS) standard ISO/TS 16949 counts a lot. A similar tendency is found for exports to OEMs/ Tier companies (the combined OEM and/or Tier exporter status). The ISO/TS 16949 and QS-9000/ E-mark - the other standards which have been globally widely accepted till the recent past - seem to have worked significantly better than the ISO 9000 standard for TNC linkages. In future the ISO/TS 16949 certification is likely to be even more important to have a 'visible' international presence through OEM/ Tier exports, and promote automotive exports at these Levels in relative terms.

At present (for year 2004-05) the export participation does not depend on having the globally harmonized standard ISO/TS 16949 accredit, or on having a quality incharge. However, the global aftermarket is becoming fiercely competitive, with many automotive TNCs intensifying their sales efforts in this segment. In near future, though having an ISO/TS 16949 certification would not be a requirement for being an aftermarket exporter, acquiring this accredit, say for exports to automotive chains, would promote the firm's aftermarket exports as well. High Tier supplier-exporters to automotive TNCs, would have to impose minimum ISO 9000 standard for their own Tier-purchases. Also the domestic vehicle market in India is becoming quality-conscious. Even the replacement market share will shrink for low capability auto component firms (Chaturvedi 2003). The empirical analysis in this study points to much lower likelihood of the holding of ISO/TS 16949 certification by smaller firms.

Hence it is imperative to re-structure the financial assistance and other schemes of institutional support for quality (QMS) certification and upgradation by industrial firms - at present limited to the acquisition of ISO 9000 quality accredits. Some special schemes need to be evolved to cover also the industry-specific standards like ISO/TS 16949. We suggest that for the automotive sector this should be done urgently under the Technology Modernization Fund, which the AMP 2006-2016 has recommended for creation. In the light of our results, facilitating pure technical collaboration and in the case of SMEs, probably even financial collaboration are other possible means of encouraging an upgradation of QMS standards; however, these collaborations do not promote directly the chances of being an OEM/ Tier exporter, or the exports volume or intensity.

The markets for quality certification process are notoriously imperfect (Humphrey and Memedovic 2003); SMEs find it hard to assess their needs and the service providers. Most of the automotive SMEs cannot afford the ISO/TS 16949 certification, and for many of them an ISO 9000 certification may well suffice. The (customer-perceived) reliability of the ISO 9000 certifying private local agencies must be ensured across-the-board. This would reduce the excessive monitoring of auto component suppliers by the buyers. Given the rising importance of the intellectual property issues (ITC/ACMA 2004), some info-cum-legal assistance cell relating to foreign trade, would support exports by SMEs. We find that having a trademark improves the likelihood of export participation, and of being at least a Tier-level exporter; firms should be prompted to acquire trademark.

Our results indicate that even with similar QMS standards (certification), compared to bigger firms, smaller firms are less likely to export to OEMs or Tier firms. Given the high transaction costs of marketing and product testing for such exports, there should be some

promotional/ incentive scheme for OEM/ Tier exports, at least for SMEs (as also felt by them; see Singh 2007b). More important, it would be especially desirable to review the market development assistance schemes, and evolve better financing options for R&D and technology improvement and for export marketing. Adequate training and re-training of employees of SMEs need concerted efforts at various levels. There are a noticeably large number of isolated firms in the Indian auto component industry. We find that being isolated hits particularly the SMEs. It lessens their export participation at 'OEM/ Tier' level, and their likelihood of being an exporter; among exporters, the isolated SMEs seem to have lower export intensity. The State governments should facilitate/ encourage the transfer of isolated SMEs to areas of more intense automotive manufacturing activity.

Ceteris paribus, the locally-owned firms do not significantly lag behind the foreign affiliates in holding ISO/TS 16949 certification; minority and majority foreign-owned firms behave similarly in this regard. Compared to the Japanese affiliates, the non-Japanese foreign firms are more likely to hold accredit for ISO/TS 16949 and/or other internationally widely accepted QMS standards during the study period; the German affiliates have also a significantly higher propensity to hold the ISO/TS 16949 accredit. The Japanese affiliates are not ahead of indigenous firms in these regards. Contrary to the general belief, ceteris paribus, overall, the foreign ownership of a firm, even majority foreign ownership, does not exert a significant positive influence on having an OEM or OEM/ Tier level export linkage; also it has no significant favourable effect on the export participation in general, or among exporters, on the export intensity. A pure technical collaboration does not significantly enhance the probability of export participation at OEM or even OEM/Tier level; it significantly lowers the export intensity among exporters, probably due to export restraints by the collaborator.

Large size and high quality standards, and not the foreign ownership, seem to be the key determinants of TNC export linkages, specially at OEM level. We must add that for being the OEM or Tier level exporter, we consider only the status (as 1-0 variable), and are unable to examine these export values. Again, the presence of foreign affiliates in an industry can generate perceptible demonstration effects and informational externalities in the top and high-middle layer of the locally-owned segment. Our sample covers a large fraction of this layer. Notwithstanding these comments, strengthening the competence of indigenous firms, as suggested above, would enable them to develop OEM/ Tier level export linkages founded more on innovative strengths, and on sustained and fair basis. For pure technical agreements, the firms should explore more vigorously having the buy-back clauses.

List of Abbreviations

ACMA	Automotive Component Manufacturers Association
AMP 2006-2016	Automotive Mission Plan 2006-2016
FE	Foreign Equity (%)
IATF	International Automotive Task Force
NATRIP	National Automotive Testing and R&D Infrastructure Project
OEM	Original Equipment Manufacturer
QMS	Quality Management System
SSI	Small Scale Industry

Appendix 1: Cluster Programs for Auto Component SMEs in India

The UNIDO Partnership program was launched for the Indian automotive component industry in Nov. 1998 in partnership with the Government and ACMA. The aim of the UNIDO(-ACMA) Cluster program is to enhance the performance of 2nd/ 3rd Tier SME producers to be globally competitive. Considering the need for similar assistance to Medium & Large companies (≥ Rs.50 crore annual sales turnover firms), ACMA has been operating also another cluster program through its Division, the ACMA Centre for Technology, ACT.[27] There is a close interaction among counsellors/ Experts for the UNIDO and ACT Cluster programs, both operated region-wise.

These cluster programs seek to transform companies into Lean Manufacturing organizations through a training module on Best Practices customized for use by SMEs, and provide shop-floor interventions and on-site guidance. These are excellent platforms for sharing experiences by the participant firms. The industry experts are relatively few and expensive (Assaf 2003: 394). Therefore, independent SMEs without any foreign collaboration, or even those having technical agreements and/or minority foreign stake but not obtaining continuous technical assistance from the collaborator, may find this program cost-effective and informative.

The UNIDO cluster program for automotive SMEs started modestly with 20 companies in the Western region and focused on non-capital changes and 'good-house keeping' practices. It was extended to other regions since its Phase II; the ACMA-ACT cluster program has been operating region-wise since its inception. The training module has been evolving with the learning experience of the counsellors and the organizations involved, and with periodic training of the counsellors. The Sundaram Clayton Group has been deeply associated with these programs, as they have shared their own best practices - partly acquired through import of technology and locally adapted. The Program module is broken into several sub-modules for implementation, e.g. 5-S (Sort-Straighten-Sweep-Standardize-Self-discipline), 3-M, etc. The duration of a cluster program is 24-30 months.

Participation in these counselling clusters is against payment; for the UNIDO clusters the three major Partners – UNIDO, Government of India and ACMA - bear part of the expenses. Again there is requirement of being ISO certified. These expenses apart, there are short-run costs associated with the organizational changes required under the program, attending review meetings, and hosting in turn the review meetings and plant visits for the cluster participants. Therefore a high degree of initial motivation is required.

For this study, after making a special request, the author attended the Northern region Review Meetings of both the ACT and UNIDO Clusters Phase III held in April 2006, and had also informal discussions with the participants and counsellors/ experts; these provided many insights. The counsellors examined minutely the different operations at the host company factory - appreciating the improvements and pointing out any slackness. The non-host company participants suggested modifications, and mentioned 'carry home' good points. There was also a short visit to a 'model' company, employing good practices, like an earlier cluster participant. These factory visits create better awareness and demonstration effects.

The data on key performance indicators pertaining to the quality, cost and delivery are presented by the member firms at the periodic review meetings, and compared against the

[27] The ACT cluster program works in strategic alliance with the Confederation of Indian Industries, CII. The CII has also conducted separately a few clusters for automotive SMEs, e.g. TPM clusters for suppliers of a few vehicle assemblers and Tier-1 firms (for Bajaj, TVS, Maruti, Sona Koyo and Pricol), and Gurgaon Cluster (CII sources).

baseline survey. These indicators are defects ppm, labour and overall productivity, inventory turnover, delivery schedule achievement, space utilization, etc. According to the counsellors, a substantial difference is noticed within a year, or even within a few months. The benefits are also in terms of the reduction of energy use, wastage, absenteeism, lead-time for production and preparation time for customer visits, and by way of better capability to meet rush orders. The participating firms feel that this program enhances their awareness of the best practices, quality standards, and potential demands of foreign markets, and is instrumental to a dramatic change in mindset and to a culture of continuous improvement. The dynamics of group activity and sharing of experiences contributes to the improvement in competitiveness.

The total number of participant companies so far under the UNIDO-ACMA and ACT Cluster Program Phases 1-3 are more than 150: (20, 40 and 48) for UNIDO and (14, 17 and 16) for ACT Clusters.[28] Even though these clusters have so far covered only a small minority of auto component SMEs in India, the long-term benefits are far-reaching. This set of participant firms, by applying the best locally-suitable practices, can provide in near future a strong middle layer to the Indian auto component industry. There would also be some 'knowledge' diffusion to their lower Tier-suppliers and the parts & materials suppliers of those firms, as significant spillovers; the cluster participants' own related establishments and new future plants would gain as well.

The supplier development programs in some countries have involved TNCs (UNCTAD 2001). However, the OEMs and Tier-1 automotive companies operating in India have only limited direct association until recently – at least - with the UNIDO and ACT cluster programs for SMEs.[29] Nor have these programs in India involved much the local engineering and other training institutes in this pursuit, though this participation has been improving. Both these types of linkages and integration, envisaged at the beginning of the program, are crucial for regular updating of the training modules for industrial application. The Chennai Cluster (Southern Region) has been somewhat of an exception in these regards. Similar efforts need to be made for other regions. Further, we believe that the creation or adoption of automotive training institutes by vehicle manufacturers, as suggested by the AMP 2006-2016, would benefit the industry immensely; the re-training of SMEs employees should be made an integral part of the scheme.

[28] Source: *ACT now*, ACT, ACMA, Delhi, April 2007; the information for UNIDO Clusters Phase I-II is from Assaf(2003).

[29] FIAT and FORD provided inputs on project designing for UNIDO Clusters Phase I and II respectively.

References

ACMA(2005), '*China's Auto Component Industry Profile: Market Entry Strategies for Indian Companies*', Automotive Component Manufacturers Association, New Delhi; a report prepared by Economic and Commercial Section, Embassy of India, Beijing.

ACMA(2006), 'Annual Report 2005-06', ACMA, Delhi.

ACMA(2007), *Auto News*, Feb.-March.

ACMA-Mckinsey Report(2005), '*Vision 2015 for the Indian Automotive Components Industry*', Mckinsey and Co. and ACMA, New Delhi, March.

ACMA and SIAM(2003), '*Competitiveness of the Indian Automobile Industry*', a study commissioned by ACMA and SIAM, prepared by ICRA Advisory Services, Delhi, Feb.

AMP 2006-2016 (2006), '*Automotive Mission Plan 2006-2016: A Mission for Development of Indian Automotive Industry*', Ministry of Heavy Industries & Public Enterprises, Government of India, Dec.

Assaf, G.(2003), 'Integrating Supply Chains Through UNIDO's Partnership Programme', *Productivity* 44(3): 392-95, October-December.

Bhaduri, S. and A. Ray(2004), 'Exporting through Technological Capability: Econometric Evidence from India's Pharmaceutical and Electrical/Electronics Firms', *Oxford Development Studies* 32(1): 87-100, March.

Bhawani, T.A.(2006), '*Globalisation & Indian Small Scale Industries: Technology and Competitiveness*', Ane Books, India, N. Delhi.

Chaminade, Cristina and J. Vang(2006), 'Upgrading in Asian clusters: Rethinking the importance of interactive-learning', mimeo; forthcoming, *Science, Technology and Society*.

Chaturvedi, S.(2003), 'Indian Automotive Industry: Challenges and Prospects', *Productivity* 44(3): 345-57, October-December.

CII-DSIR-IIFT(2004), '*Technology Financing in SMEs towards Global Competitiveness: A Survey Report on Auto-Component SMEs*', CII, DSIR and IIFT, New Delhi.

Dale, B.(ed.)(2003), '*Managing Quality*', Blackwell, U.K., 4th ed.

Das, S.K. and A. Bandyopadhyay(2003), 'Quality Signals and Export Performance: A Micro-Level Study, 1989-97', *Economic and Political Weekly* 38(39): 4135-43, Sept. 27.

Exim Bank(2000), '*Institutional Support to SMEs: A Study of Select Sectors*', Export-Import Bank of India, Mumbai, Occasional Paper #76, March.

Exim Bank(2005), '*Export Performance of Small and Medium Scale Enterprises in India*', Export-Import Bank of India, Mumbai, Working Paper #13, October.

Humphrey, J.(2003), 'Globalization and Supply Chain Networks: The Auto Industry in Brazil and India', *Global Networks* 3(2): 121-41, April.

Humphrey, J. and O. Memedovic(2003), '*The Global Automotive Industry Value Chain: What prospects for Upgrading by Developing Countries*', UNIDO, Vienna, Sectoral Studies Series.

ITC/ACMA(2004), '*Exporting Automotive Components: An Answer Book for Small and Medium-Sized Enterprises*', Trade Secrets Series, ITC, UNCTAD/WTO, Geneva and ACMA, Delhi.

Ivarsson, I. and C. Alvstam(2004), 'International Technology Transfer through Local Business Linkages: The Case of Volvo Trucks and their Domestic Suppliers in India', *Oxford Development Studies* 32(2): 241-60, June.

Lall, S., Albaladejo, M. and J. Zhang(2004), 'Mapping Fragmentation: Electronics and Automobiles in East Asia and Latin America', *Oxford Development Studies* 32(3): 407-32, Sept.

Lorentzen, J.(2005), 'The Absorptive Capacities of South African Automotive Component Suppliers', *World Development* 33(7): 1153-82, July.

McKinsey & Company(2006), '*Towards a New Global Order for Automotive Suppliers: Findings from the China and India Supplier Survey*', McKinsey & Company, Mumbai, Aug.

Moran, T.(2003), 'FDI and development: what is the role of international rules and regulations?', *Transnational Corporations* 12(2): 1-44, August.

Nagaoka, S., Takeishi, A. and Y. Noro(2007), '*Determinants of Firm Boundaries: Empirical Analysis of the Japanese Auto Industry from 1984 to 2002*', NBER Working Paper # 13063, April.

Okada, A.(2004), 'Skills Development and Interfirm Learning Linkages under Globalization: Lessons from the Indian Automobile Industry', *World Development* 32(7): 1265-88, July.

Parhi, Mamata(2005), '*Diffusion of New Technology in Indian Auto Component Industry: An Examination of the Determinants of Adoption*', UNU-INTECH Discussion Paper # 2005-8, Nov.

Pradhan, J.(2007), '*How do Indian Multinationals Affect Exports from Home Country?*', Institute for Studies in Industrial Development, Delhi, Working Paper No. 2007/07, April.

Rani, Uma(2004), 'Technology and Skill Transfer in Auto Component Firms of the National Capital Region', *The Indian Journal of Labour Economics* 47(4): 1067-82.

Singh, Neelam(2001), 'Trade Intensities over a Liberalization Phase: The Influence of Firm Size, Foreign Ownership, and Technological Inputs in Indian Pharmaceuticals', In Guha, A., Krishna, K.L. and A. Lahiri (eds.), '*Trade and Industry: Essays by NIPFP-Ford Foundation Fellows*', Vikas, Delhi, pp. 27-64.

Singh, Neelam(2007a), 'The Investment Issue: Revive or TRIM the Performance Requirements?', In Thakur, A. and N. Sharma (eds.), '*WTO and India'*, Deep & Deep Publications Pvt. Ltd., N. Delhi, pp. 632-52.

Singh, Neelam(2007b), 'Automotive Industry', In, Kumar, Nagesh and K.J. Joseph (eds.), '*International Competitiveness & Knowledge-based Industries in India'*, OUP, Delhi, pp. 233-79.

Singh, Neelam(2007c), 'Globalisation and Auto Component SMEs in India', a paper presented at the seminar '*Globalisation and the Millennium Development Goals*', organized by CITD (SIS), JNU and London School of Economics, Delhi, Jan. 19-20, 2006; revised version in the Seminar Volume, 2007, *forthcoming*, Allied, Delhi.

Sutton, John(2004), '*The Auto-component Supply Chain in China and India – A Benchmarking Study*', Feb., mimeo.

Tewari, Meenu(2005), 'Foreign Direct Investment and the Transformation of Tamil Nadu's Automotive Supply Base', In Faure, Y.A., Kennedy L. and P. Labazée (eds.), '*Local Production Systems and Global Markets in Emerging Economies: Brazil, India, Mexico*', IRD/Karthala, Paris.

UNCTAD(2001), '*World Investment Report 2001: Promoting Linkages*', UN, Geneva.

UNCTAD(2003), '*Foreign Direct Investment and Performance Requirements: New Evidence from Selected Countries*', U.N., New York and Geneva.

UNCTAD(2005), '*Linkages, Value Chains and Outward Investment: Internationalization Patterns of Developing Countries' SMEs*', U.N., Geneva, TD/B/COM.3/69, January 4.

Veloso, F. and R. Kumar(2002), '*The Automotive Supply Chain: Global Trends and Asian Perspectives*', ERD Working Paper Series No. 3, Asian Development Bank, Philippines, Jan.

Box 2: Variables

Age: Age in years in 2005 since commencement of production (truncated to 50 years; a few cases)
AwardDum: Award dummy (1-0); having Deming/ JIPM/ JQM Award(s).
LabPrody: Labour Productivity; sales ($ thousands) per employee
OthD: Non-Company Dummy (0 for public/ private limited company)
SalesL: Sales ($million) $\log_e$
SME[0]: Small or Medium Enterprise (<= 200 employees). *Small* firm is upto 100 employees.
TM: Having Trademark

Quality Management System (QMS) Certification Variables

QClevel1: Having only ISO 9000 (or BIS-mark) certification
QClevel2: Having a country/ region specific (QS-9000/ E-mark) certification (w/o ISO/TS 16949)
QClevel3: Having ISO/TS 16949 certification
QClevelG: Having certification for a globally accepted QMS standard (= QClevel2 + QClevel3)
QC: Any QMS certification (= QClevel1 + QClevel2 + QClevel3)
QC_None: Absence of QMS certification (= 1 – QC)

Exports-related Variables

ExportsL: Exports ($thousands) $\log_e$
XerOE: Being exporter to OEMs
XerOT: Being exporter to OEMs or Tier firms
Xint: Export Intensity(%); ratio of exports to sales
XPosi: Exports positive, i.e. export participation (dummy).

Foreign Collaboration Variables

FCD: Financial collaboration dummy
FCD_SME: SME having financial collaboration (= FCD * SME)
FTCDum: Financial-cum-technical collaboration dummy
High_FED, Low_FED: High (>= 50%) and Low (10 to <50%) total foreign equity dummies
Germany, Japan, USA, OthNat: Dummies for nationality of (major) financial collaborator
OthNat: other nationality of foreign collaborator (= FCD - Germany – Japan – USA)
NonJapan: Non-Japanese foreign affiliate (= Germany + USA + OthNat)
PTCDum: Pure technical collaboration dummy
PTC_No: Pure technical collaborations (No.)
TCDum: Technical collaboration dummy (= FTCDum + PTCDum)
TC_No: Technical collaborations (No.)

Location (of Main Plant) Variables

ClusNF, ClusNG, ClusSBH, ClusSC, ClusWP: Located in (region-) auto cluster town [0]of North-Faridabad, North-Gurgaon, South-Bangalore/Hosur, South-Chennai, and West-Pune.
IndArea_N, IndArea_S, IndArea_EW: Dummies for (non-cluster) industrial development area/ estate firms in the North, South, and East/West regions
Isol: Isolated; located neither in a major auto cluster town (listed above) nor in any industrial area
Isol_SME: Isolated SME (= Isol * SME)

Incharge Variables

HRDinch, Qinch, RDinch: Having HRD, Quality, R&D Incharge (dummies)

Table 1: Select Averages by Firm Size and Foreign Ownership

Variable↓	Size				All	Ownership			
	Small	Medium	SME	Large		Local	Foreign	<50% FE	>=50% FE
Sales	4.194	5.516	4.786	35.390	**22.190**	16.976	43.973	48.279	35.779
QC	0.865	0.911	0.886	0.966	**0.931**	0.928	0.944	0.932	0.968
QClevelG	0.369	0.578	0.463	0.849	**0.682**	0.628	0.911	0.915	0.903
QClevel3	0.270	0.389	0.323	0.675	**0.524**	0.476	0.722	0.695	0.774
Qinch	0.505	0.622	0.557	0.675	**0.624**	0.598	0.733	0.712	0.774
HRDinch	0.306	0.422	0.358	0.551	**0.468**	0.436	0.600	0.610	0.581
RDinch	0.288	0.467	0.368	0.479	**0.431**	0.394	0.589	0.627	0.516
XPosi	0.432	0.722	0.562	0.762	**0.676**	0.654	0.767	0.797	0.710
XerOT	0.207	0.389	0.289	0.521	**0.421**	0.394	0.533	0.610	0.387
XerOE	0.072	0.144	0.104	0.306	**0.219**	0.189	0.344	0.390	0.258
Xint	16.418	18.811	17.490	14.747	**15.930**	16.888	11.927	11.029	13.636
FCD	0.108	0.144	0.124	0.245	**0.193**	0	1	1	1
Low_FED	0.063	0.067	0.065	0.174	**0.127**	0	0.656	1	0
High_FED	0.045	0.078	0.060	0.072	**0.067**	0	0.344	0	1
PTCDum	0.045	0.133	0.085	0.253	**0.180**	0.154	0.289	0.322	0.226
FTCDum	0.063	0.078	0.070	0.140	**0.109**	0	0.567	0.661	0.387
TCDum	0.108	0.200	0.149	0.340	**0.258**	0.154	0.689	0.763	0.548
PTC_No	0.054	0.144	0.095	0.479	**0.313**	0.242	0.611	0.712	0.419
TC_No	0.117	0.233	0.169	0.638	**0.436**	0.242	1.244	1.424	0.903
N	111	90	201	265	**466**	376	90	59	31

Table 2: Logistic Regression Estimates of Quality Management System (QMS) Certification: QClevel3 and QClevelG Eqs.

Explanatory Var.↓	QClevel3		QClevelG	
	Eq. 1	**Eq. 2**	**Eq. 1**	**Eq. 2**
SalesL	0.676***	0.622***	0.825***	0.826***
	(6.98)	(6.86)	(4.65)	(4.66)
SalesL2			-0.0508	-0.0533
			(1.19)	(1.25)
Age	0.064*	0.056		
	(1.85)	(1.64)		
Age2	-0.0015**	-0.0013**		
	(2.20)	(2.02)		
OthD			-0.587	-0.580
			(1.58)	(1.56)
RDinch			0.286	0.278
			(1.16)	(1.12)
FCD	-0.707*			0.182
	(1.68)			(0.32)
FCD_SME	1.545**			
	(2.42)			
Low_FED		-0.434		
		(0.94)		
High_FED		0.341		
		(0.60)		
Germany	1.500**	1.522**		
	(2.12)	(2.11)		
USA	0.714	0.772		
	(0.98)	(1.04)		
PTCDum	1.158***	1.122***	1.186***	1.188***
	(3.79)	(3.62)	(2.76)	(2.77)
	Cluster Dummies included			
Constant	-2.188***	-2.004***	-0.758***	-0.756***
	(4.72)	(4.50)	(3.27)	(3.26)
Psuedo R^2	0.201	0.193	0.206	0.206
Firms	All		Locally or Japanese Owned	
N	466	466	414	414

Notes: Parentheses contain robust Z-values. *, ** and *** indicate 10, 5 and 1% level of significance.

Table 3: Logistic Regression Estimates of Export Participation 'Levels': XerOE, XerOT, and XPosi Eqs. N=466

Explan.Var.↓	XerOE Eq.		XerOT Eq.		XPosi Eq.	
SalesL	0.424***	0.425***	0.188**	0.184**	0.116	0.127
	(3.92)	(3.91)	(2.06)	(2.06)	(1.26)	(1.35)
Age	0.064	0.066	0.079**	0.087**	0.040***	0.039***
	(1.26)	(1.28)	(2.05)	(2.28)	(4.08)	(4.01)
Age2	-0.0010	-0.0011	-0.0013*	-0.0014**		
	(1.14)	(1.16)	(1.81)	(2.06)		
OthD	1.041**	1.061**				
	(2.17)	(2.19)				
TM	0.379	0.369	0.460**	0.518**	0.966***	0.944***
	(1.34)	(1.30)	(1.96)	(2.20)	(4.18)	(4.06)
HRDinch					0.630***	0.483*
					(2.77)	(1.73)
RDinch		0.139	0.270	0.282		0.265
		(0.41)	(1.24)	(1.29)		(0.93)
Qinch	0.697**	0.607				
	(2.38)	(1.63)				
AwardDum	1.658**	1.652**				
	(2.23)	(2.21)				
QClevel3	1.332***	1.331***	0.911***			
	(3.25)	(3.25)	(3.15)			
QClevel2	1.234***	1.242***	0.935***			
	(2.59)	(2.62)	(2.69)			
QClevel1				-1.172***		
				(3.94)		
Low_FED	-0.495	-0.520			0.090	0.022
	(1.13)	(1.17)			(0.018)	(0.004)
High_FED	-1.016	-1.018	-1.327***	-1.284***	-0.327	-0.390
	(1.51)	(1.51)	(2.66)	(2.60)	(0.51)	(0.59)
Germany	1.166*	1.181*	1.266***	1.268***		
	(1.81)	(1.85)	(2.59)	(2.61)		
USA			1.436*	1.451**		
			(1.93)	(1.96)		
OthNat	1.882***	1.901***	1.775***	1.731***		
	(2.89)	(2.92)	(2.69)	(2.69)		
NonJapan					0.705	0.740
					(1.20)	(1.25)
FTCDum			-0.617	-0.698*		
			(1.55)	(1.83)		
PTCDum					0.385	0.362
					(1.18)	(1.11)
	Cluster Dummies included					
Isol_SME			-2.379**	-2.459**	-1.680***	-1.644***
			(2.36)	(2.43)	(2.93)	(2.83)
Constant	-4.889***	-4.912***	-2.621***	-1.814***	-1.148***	-1.175***
	(6.56)	(6.51)	(5.04)	(3.77)	(4.33)	(4.34)
Psuedo R^2	0.197	0.197	0.170	0.179	0.158	0.158

Notes: Parentheses contain robust Z-values. *, ** and *** indicate 10, 5 and 1% level of significance.

Table 4: Regressions of Export Intensity (Xint) and Exports-log (ExportsL)

N=296

Explanatory Variable ↓	**Xint Eq.**		**ExportsL Eq.**	
SalesL	-5.423***	-5.134***	0.700***	0.724***
	(4.75)	(4.37)	(10.76)	(10.45)
OthD	12.810*	12.513*	0.483**	0.509**
	(1.92)	(1.86)	(1.97)	(2.07)
LabPrody	-0.052***	-0.058***	-0.005***	-0.006***
	(2.61)	(2.87)	(3.55)	(3.64)
Qinch	3.491		0.259	0.261
	(1.08)		(1.51)	(1.49)
QClevel3			0.380**	0.357*
			(2.07)	(1.90)
QClevel2	-7.046*	-6.687*		
	(1.90)	(1.76)		
Low_FED		-4.199		-0.360
		(0.91)		(0.84)
High_FED		-1.361		-0.384
		(0.24)		(0.80)
NonJapan		2.177		0.486
		(0.45)		(1.15)
PTCDum	-9.448***	-9.084***	-0.670***	-0.670***
	(2.96)	(2.77)	(3.27)	(3.18)
Clusters Dummies included				
Isol_SME	-9.417	-9.823		
	(1.64)	(1.59)		
Constant	40.559***	42.680***	5.373***	5.341***
	(8.37)	(10.23)	(26.82)	(26.15)
R^2	0.222	0.221	0.367	0.371

Notes: Parentheses contain robust t-values. *, ** and *** indicate 10, 5 and 1% level of significance.