

Trade Liberalization, Technical Change and Firm Level Restructuring in the South African Automotive Component Sector

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Abstract: This paper examines the interplay between trade liberalization and the processes of learning, technical change and capability development in the South African automotive component sector. Using case studies based on firm level interviews conducted at various points since 1992, it illustrates how the technological capabilities of the industry were shaped by protection, and how this in turn mediated responses to trade liberalization initially via internal restructuring and more recently in the phase of internationalization and growing foreign ownership. In essence, the paper presents a ‘before and after’ picture of firm level responses to liberalization.

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JEL classifications: F14, F23, L52, L62, O33

1. Introduction

The South African automotive industry has become much more integrated into the global industry since 1995 and has been characterized by rapid export expansion and growing foreign ownership. But industry wide changes take place at the level of the firm and the objective of this paper is to investigate the interplay between trade liberalization and the processes of learning, technical change and capability development at the firm level.

While the nature of industrial development under protection may constrain domestic firms’ capacity to restructure production in a more liberalized environment, the accumulation of technological capabilities can also make it possible for firms to adapt quite rapidly and take advantage of new international linkages in the form of export markets and supply opportunities to multinational firms establishing domestic operations. In the liberalization phase, increased foreign control and ownership has frequently been central to the adjustment process. But this in turn has significant implications, both

positive and negative, for the nature of technological development and for upgrading more generally.

Section two examines the character and trajectory of technical change in manufacturing firms in developing countries and, more specifically, in the South African automotive component sector. Apart from different factor costs and much lower technological capacity, developing countries have historically been characterized by differences in industrial structure, smaller markets and relatively higher levels of protection. This had important implications for their capacity to adjust to global competition. Liberalization has a shattering effect on the previously protected industrial structure and this transition from low volume, flexible producer for domestic markets to high volume supplier to international markets is a wrenching one. The impact is so much the greater because of the significantly increased role of foreign firms.

The main section (section three) presents a series of case studies of how component firms developed under protection and how they have responded to changes in the trade regime.¹ Case studies naturally suffer from the usual limitations of this approach in that they do not allow for generalized conclusions.² Nevertheless they are instructive on the complex links between the technological capability of firms, changes in the trade regime and firm level restructuring. The case studies have been conducted at various points in the liberalization process starting in 1992 (Table 1). The same firms and others were then visited at various points up until 2010. It has, therefore, been possible to track their progress over an extended period of rapid change in the automotive industry, giving a ‘before and after’ picture of the interplay between protection, technological learning and liberalization.

Section four draws conclusions from the case studies. Firms had adapted quite efficiently to the previously protected environment in a number of ways. When the liberalization process began, they embarked on major changes. For local firms these changes proved difficult in many cases as investments and production capabilities were singularly inappropriate for the new era of global

Table 1: Dates of Case Study Interviews

Firm	Date of interviews
Alfred Teves (Ate)	1995, 2006
Atlantis Diesel Engines (now Atlantis Foundries)	1992, 1995, 2007, 2010
Behr	2002, 2007
Toyota	1995, 2007, 2010

Source: Author’s survey.

competition. In spite of this, significant learning had taken place and firms had developed considerable technological capability. This has made it possible for them to adapt to a changing environment, by absorbing foreign technology and responding to new export opportunities. However, the limitations of what can be termed ‘internal restructuring’ are also very evident. For many firms, as the industry was opened up to international competition, it became increasingly difficult for them to continue to operate as locally owned entities, reliant on licensed technology. To continue as first tier suppliers, foreign links, including foreign ownership in some cases, became essential in order to source technology and gain access to global networks. Growing foreign ownership in turn has a range of implications for domestic firms and for the industry as a whole.

2. Learning, Technical Change and the Trade Regime

In the late 1980s, the literature on technical change in less developed countries started to shift from a view of technological dependency to one which pointed to the substantial amount of technological activity that goes on in developing countries. This was evident in productivity improvements in protected industries as well as growing exports of sophisticated manufactured products, technology and capital equipment.³ These findings are no longer contentious and the key areas of debate are now the main forms of acquisition of technological capability and how these are affected by factors such as the industrial structure, ownership and the trade regime as well as by more direct policy interventions.

Historically, the trajectory of technical change in developing countries has differed in important ways from that in the developed world (Katz, 1984, 2000). Limited markets and protection meant that plants were frequently small in relation to those in developed countries and economies of scale issues were a key consideration in technical choice. This implied the need to scale down to smaller plant size and diversify product mix requiring in turn simpler, more universal, lower capacity machinery. This frequently led to discontinuous technology and low levels of automation. In products such as vehicles and components where continuous flow is necessary, firms in developing countries could “end up with the worst of all worlds – that is, with a small continuous flow ‘line’ turning out a highly diversified output mix, intended for various, small individual markets” (Katz, 1984: 11).

Katz (1984) also pointed to the weakly developed layers of subcontracting firms, which resulted in higher levels of vertical integration within the firm than would be the case in developed countries. This reduced the level of technological specialization and was also likely to result in the under-utilization of installed capacity.

With these kinds of developments, it was not surprising that the view that industrialization behind tariff barriers was likely to produce un-innovative and inward-looking enterprises became something of a conventional wisdom on the subject, with the automotive industry a frequently cited example. However, work especially in Latin America by Katz and others showed that it would be an oversimplification to cast most firms in protected industries within this category. Many of the firms within protected industries may have been technologically quite dynamic within the parameters in which they operated, with rapid learning taking place and a considerable accumulation of technological capability. However, as a result of the trade regime, industrial structure and factor prices under import substituting industrialization (ISI), much of this effort is mis-directed according to benchmarks of international competitiveness. An example is the vast amount of effort in areas such as logistics, materials flow, machine changeovers and production scheduling that is undertaken in order to deal with the problems of complexity that arise in low volume, multi-product plants, which have characterized the automotive and component industry in developing countries. Firms thus became well-adapted or even 'over-adapted' to the circumstances of captive, protected markets – what Pirela *et al.* (1993) refer to as the 'platypus effect'. The problem, therefore, was not so much a lack of technological effort, but the fact that cost minimization and achieving optimal potential from world scale plant was not the central objective of technological effort. These preliminary observations will be shown to have a clear resonance in the pre-liberalization phase of the South African automotive sector illustrated in section three.

The South African automotive industry, which was highly protected until the early 1990s, has historically depended heavily on imported technology. Although there has been until the late 1990s, a high degree of local ownership, the locally owned vehicle manufacturers and the bulk of locally owned, first tier component producers operated under license from European, Japanese or American firms. This involved royalty costs and also imposed restrictions on exporting, which was a serious constraint for some firms as the domestic market came under pressure and firms were forced to develop export strategies. In spite of these disadvantages, many firms considered licensing to be the most cost effective way to obtain up to date technology.

However, while firms spent relatively little on R&D and were generally highly dependent on foreign licenses, they were by no means totally lacking in technological capacity (Black, 1994). On the product side they possessed the capacity for design even if only in a limited form. On the process side, firms were not only able to fully master the technologies they were working with but also to upgrade them by introducing adaptations. Some important innovations resulted from the experience of high variety, low volume

production, which characterized the South African components industry (Black, 1994). This technological capability is, however, of limited value in the international market place except in the production of certain low volume aftermarket and replacement parts.

2.1 Liberalization, Technological Capability and FDI

Liberalization has a number of important effects at the firm level. In his survey of the experience of Argentina, Brazil and Mexico, Katz (2000) argues that MNCs and large domestic conglomerates were the main beneficiaries. With growing foreign ownership, firms tended to become more specialized and scaled down their local engineering activities, engaging more in final assembly and distribution. Small and medium enterprises also tended to become more involved in final assembly operations with a greater reliance on imported inputs. These conclusions are supported by Rheinhardt and Peres (2000: 1557), also in relation to Latin America, who argue that enterprises linked to international markets were the major gainers and also that “domestic linkages and the development of endogenous technological capabilities have been weakened” in the liberalization process.

Greater openness usually leads to an expansion of international linkages including greater FDI. Whether they establish greenfield sites or take over existing enterprises, foreign firms bring with them new technology and may also establish new supplier networks involving both domestic and foreign firms. Two issues are of direct concern here. The first is the role that foreign links, especially equity links, may play in enabling existing firms to successfully integrate themselves into global networks. The second is the related question of the impact of increasing internationalization and foreign ownership on the capabilities of the domestic industry.

The restructuring of production networks has important implications. In the automotive industry, trends towards ‘global sourcing’ and ‘follower sourcing’ have had a major effect in emerging markets where the trend is towards fewer first tier suppliers and the greater use of foreign owned suppliers. For domestic firms, much will depend on the terms under which they are able to position themselves in these developing networks. They may emerge as favoured first tier suppliers, or be relegated to a more subordinate position as second tier suppliers or even find themselves excluded completely and increasingly dependent on the aftermarket. In trying to optimize their position, domestic suppliers may seek out a foreign partner. Naturally, a key potential asset brought in by a prospective foreign shareholder or owner is the access to markets, which they can provide. This is complemented by their control over technology necessary to supply export markets and to meet the increasingly demanding requirements of domestic vehicle assemblers.

The literature on the impact of FDI on upgrading of domestic firms is mixed. For instance, the inflow of foreign capital may create a more demanding and competitive environment requiring domestic firms to upgrade, but it may also limit the need for indigenous technological adaptation (Lorentzen and Barnes, 2004) which can lead to downgrading both in terms of technological activity and in terms of position in the value chain. But a higher level of absorptive capacity and more robust capabilities within domestic firms and the host economy generally, are likely to lead to more positive spillovers and more developed linkages with the domestic economy (Kokko *et al.*, 1996; Narula and Dunning, 2000; Lall and Narula, 2004).

Humphrey and Salerno (2000) refer to the increasing centralization of design by multinational auto and component firms and the fact that in countries such as Brazil, first tier suppliers are now virtually all foreign owned. Rasiah (2007, 2011) found that foreign automotive component firms in East and Southeast Asia were less R&D intensive than their local counterparts. However, Humphrey and Salerno (2000: 172) also point to the emergence of a 'sun and planets' model in which developing countries have regional design centres linked to the global design headquarters.

Foreign firms appear to exhibit higher levels of productivity and more rapid growth, but again the evidence is not overwhelming (Saggi, 2006; Haddad and Harrison, 1993). In part this depends on how domestic firms are integrated into the global networks of multinationals. Typically, firms which are fully integrated into such global networks operate at larger scale with more advanced technology and attain higher levels of productivity than those which supply protected domestic markets.

A key form of linkage with the domestic economy is through purchases of inputs. There is a considerable international literature which cites the limited linkages of foreign firms in developing countries. Nevertheless, there is considerable evidence that where large scale assembly plants are established by foreign firms, considerable backward linkages do develop. And the level of linkages is not static. In the Mexican automotive industry substantial upgrading occurred, but much of this was with other foreign owned firms rather than with Mexican suppliers (Carrillo, 2004). For Poland, Domanski and Gwosdz (2009) report similar developments with significant upgrading by foreign affiliates of multinational component suppliers. In a study of Volvo truck and bus plants in developing countries, Ivarsson and Alvstam (2005) found that while 'follow source' suppliers had gained a large share of purchases by these assemblers, the technology transfers via domestic firms were very significant. The impact of liberalization and FDI is therefore very much contingent on circumstances.

In the South African case, the first tentative steps to liberalize the sector began under Phase VI of the local content programme in 1989, but much more

significant liberalization took place with the introduction of the Motor Industry Development Programme (MIDP) in 1995. The MIDP made provision for gradually declining tariffs and a system by which automotive exports earn import credits which allow them to offset import duties. It also provided for the abolition of local content requirements.⁴

Firms were therefore encouraged to rapidly develop exports and this meant a substantial reorientation of existing production and the necessity to re-position themselves in the international value chain. For many this was difficult. A number of divisions within the largest domestically owned groups such as Murray and Roberts, Metair and Dorbyl found themselves vacating the first tier and becoming second tier suppliers (Lorentzen and Barnes, 2004).

In the late 1980s, levels of foreign ownership were quite low both among vehicle manufacturers and component producers in South Africa, but this changed with the advent of democracy in South Africa in 1994 and the country's reacceptance back into the international community. The change in trade policy and resulting internationalization of the industry, manifested in growing exports and imports, had major implications for ownership. It became increasingly important for local firms to have links to global networks as a way of facilitating access to international markets. In South Africa, and indeed in other emerging markets, foreign owned assemblers increasingly prefer to source components from joint ventures and wholly owned subsidiaries rather than domestically owned firms. The result for many South African firms has been that they either needed to seek out an international partner or faced the prospect of being confined to the aftermarket (Barnes and Kaplinsky, 2000).⁵

Growing foreign ownership has accelerated technological upgrading but this has taken a particular form (Barnes and Morris, 2004). The main conduits have been through transfers from foreign sources rather than an increase in domestic R&D. Domestic firms, under pressure to upgrade their technological and production capacities, have turned to foreign sources through the establishment of joint ventures, for example. There have been debates as to the impact of this. Earlier work by Barnes and Kaplinsky (2000) took a somewhat pessimistic view about the prospects for domestic suppliers, especially those without foreign connections. Lorentzen and Barnes (2004) and Lorentzen (2005) provide a generally more upbeat assessment of the prospects of domestically owned firms. In a series of case studies of South African component firms, Lorentzen (2005) argues that innovating firms tended to be either domestically owned or owned by 'passive' foreign investors. The latter, by supporting the R&D strategies of local managers, may improve absorptive capacities in domestic subsidiaries as opposed to typical TNCs, where decisions about upgrading or downgrading capabilities in a particular subsidiary will be subordinate to the overall demands of the

worldwide group with possibly very negative implications. There is plenty of evidence that when local firms have come under the control of transnationals, existing R&D establishments are downsized or shut down.⁶ It does not follow, however, that these firms downgrade technologically because the shutting down of formal R&D facilities can be accompanied by the introduction of new specialized product and process technologies which bring host firms closer to the world frontier. With global sourcing, locally owned firms may also stop carrying out adaptations and reduce their R&D capacity. But as we argue in the case study of Alfred Teves below, this technological effort may in fact have been of little value in a more open trading environment.

Perhaps a more useful distinction is the orientation of firms. There is a small group of component suppliers in South Africa which are either locally owned or have South African roots, but which have established themselves as world players. Examples have included Tiger Wheels, Bosal and Plate Glass. These firms are very different in their technological trajectory to first tier suppliers which depend on foreign licenses and may well do R&D, but within much more circumscribed parameters. This latter group are at a substantial disadvantage especially in export markets and as Lorentzen (2005) points out, there may be little incentive for either the licensor or licensee to expand the level of competence of the domestic operation.

There is no doubt that foreign ownership, as opposed to licensing arrangements, has in many cases been critical for vehicle producers to obtain major export contracts, but the question is more complicated for component producers. Prior to the liberalization phase, it is clear that many locally owned firms were heavily constrained in export markets by conditions imposed by foreign licensors (Black, 1994). Since then, many firms have been able to renegotiate the terms of their license agreements. It is nevertheless surprising that data collected by the South African Automotive Benchmarking Club (SAABC, 2006), indicated that the level of export orientation for foreign and locally owned firms was the same, with both types of firms exporting 17 per cent of their output. At least a part of the reason for the surprisingly low orientation towards exports by foreign owned firms is the fact that a number of foreign owned suppliers have established facilities in South Africa with the sole purpose of supplying component subsystems to domestic assemblers.

On the other hand, a striking difference between foreign owned and domestically owned firms was the share of imports as a percentage of output. In the South African component sector, affiliates of multinationals imported 53.7 per cent of their requirements compared to only 29.4 per cent by local firms (SAABC, 2006). The main explanation is that many new foreign component firms are 'systems integrators', supplying entire sub-assemblies to the vehicle manufacturer. This is more of an assembly than a manufacturing activity.⁷ Foreign firms are also clearly less embedded in the domestic

economy although this may also reflect the fact that many of them are fairly new and so have not yet developed local sources of supply (Black, 2009).

3. Case Studies of Firm Level Restructuring

As indicated above, the South African component sector was subject to a long period of protection but since 1989 became increasingly exposed to foreign competition. Coping with increasing competition was particularly challenging because firms had been operating in a fragmented domestic market with associated demand for a wide variety of components in low volumes. Exporting became a key imperative for many firms, partly to replace loss of domestic market share but also to achieve the benefits of specialization through higher volumes. In their endeavour to adjust to a new environment, firms pursued a range of strategies including the introduction of licensed technology, undertaking new investment, incremental adaptations of processes and products, shifting to new products and markets, upgrading the network of suppliers, reducing domestic sourcing and obtaining a foreign equity partner or owner.

These strategies all have implications for the trajectory of technological capability of firms and are illustrated in the case studies which follow. The first case of Atlantis Diesel Engines (now Atlantis Foundries) is a firm which previously had received monopoly protection as a domestically owned, integrated engine producer. It has now become a foreign owned supplier of engine castings and machined components to international markets. The case study of Toyota South Africa (TSA) illustrates the radical transformation of its supplier network over the past decade which has resulted from the incorporation of TSA into the global network of the parent company, Toyota Motor Corporation. Alfred Teves illustrates how firms adapt to the problem of complexity and short production runs. The Behr case study indicates that while foreign ownership brings key advantages it also can have major implications for the type of R&D that occurs in the emerging market location.

3.1 Atlantis Diesel Engines: Reorienting Production from Domestic to Global Markets

In the mid 1990s, Atlantis Diesel Engines (ADE) was a large, state owned engine producer. The parastatal Industrial Development Corporation (IDC) owned 87.5 per cent and Daimler had a 12.5 per cent stake. Together with its affiliated companies, ADE manufactured diesel engines, castings and components. ADE was established as a 'strategic' industry in 1981 as South Africa's political isolation deepened and economic sanctions became a real possibility. In the early stages, the viability of the plant was ensured

by a virtual prohibition on imports. The initial objectives were production capability of a wide range of products to high quality standards with production costs and profitability being lesser considerations.

The plant was designed with an annual capacity of 45,000 engines (two shifts) divided into two engine makes (Perkins and Mercedes Benz) and the capability to produce a wide model range. World scale diesel engine plants produce in excess of 100,000 engines a year of a single make with a smaller model range. High production costs put exports out of reach and the slump in demand in the mid 1980s led to severe under-utilization of capacity. Thus ADE represented an extreme form of the inefficiencies of protection in an industry where economies of scale are important.

Strategic Direction

By the late 1980s, ADE recognized that it had to restructure and when interviews were conducted in 1995, the company was half way through the transformation process from a monopoly engine supplier to component exporter. This process involved, firstly, a major internal focus on costs, which enabled ADE to sharply reduce engine prices in real terms from 1990 to 1995. Secondly, the company sought to define areas of competitive advantage – which in its case were forming and adding value to metal rather than assembling engines. So the objective became one of gradually moving out of engine assembly to become a world class flexible manufacturer of major engine components.

ADE therefore expected to move out of the truck engine assembly business in the future. As a result of falling tariffs, local truck manufacture was giving way to semi-knocked down assembly with much lower levels of local content. The commonization process which required South African truck makers to use ADE engines was being reversed. As its share of the domestic engine market was likely to drop rapidly as protection declined, the future viability of ADE depended on the extent to which it was able to remodel itself as a component exporter of major engine components. Export growth was rapid off a low base.

Technology Licensing and the Acquisition of Production Capability

ADE manufactured engines and components under licence from Mercedes Benz and Perkins and from its inception relied on foreign technology and expertise. ADE regarded licensing to be a far more cost efficient method of getting access to technology in spite of the costs and the restrictions it imposed. The alternative of allowing licensing agreements to lapse and going its own route would have meant the loss of technical support resulting in

the freezing of the level of engine development. According to the financial director “if we (ADE) ever have visions of developing South African designed engines, we should kill them immediately ... it is virtually impossible”.⁸

Expatriates from Mercedes Benz AG were initially responsible for getting the factory running. They were gradually replaced by staff from ADE who received training in Germany. The length of time taken for expatriate staff to be replaced by local ADE management partly reflected the importance attached to particular functions by the licensor. Process technology capabilities were quickly acquired and transferred while the licensor kept greater control over product technology, skills which in any event would take much longer to transfer. In the case of the quality function, the licensor wished to maintain some control.

The acquisition of investment and production capability can be divided into three phases. The first phase involved the licensor advising on the choice of equipment. Partly as a result of this and partly because of demand projections, which proved hopelessly optimistic, they adopted dedicated equipment. Some of the initial technology was fairly dated because the licensor thought this would be appropriate for African conditions. The second phase from the mid-eighties involved all planning being done by ADE with Mercedes Benz ‘looking over their shoulder’. For example in 1985/1986 ADE needed to introduce a new engine block because of local content requirements. They approached Mercedes Benz for advice. According to an ADE manager, “MBAG responded that you use a big transfer line which takes up a whole building and produces one block every 1.8 minutes and our requirement was one block every six hours.” Therefore, ADE did the planning themselves. This involved process innovation in the sense of adapting flexible technology (using a machining centre to perform all operations) to conventional technology. This was a lengthy process, but it eventually worked and the process technology went back to Mercedes in Germany who used it in the production of low volume engines. In the third phase, from 1990, ADE staff were able to carry out all investment decision making themselves and had developed full investment capability. When interviews were conducted in 1995, ADE’s capacity to select technology appropriate to its operating circumstances was highly developed. In line with its strategic direction, it was specializing in certain technologies involved in the manufacture of crankshafts, blocks and cylinder heads as well as forgings and castings.

A similar set of processes took place in the foundry⁹ which was established to supply castings for cylinder blocks and heads and was designed to supply 80-90 per cent of requirements for the planned engine capacity of 50,000 Mercedes Benz and Perkins engines per year. As was the case with the main plant, the major problem has been the under-utilization of plant capacity and the need to raise throughput and simplify product variety.

Initial design was a blend of technology in use for the range of castings to be produced. Total planned output of 12,000 tons/year was very small by international standards as most foundries had a capacity of over 50,000 tons per annum. ADE was also designed to produce an unusually large range of castings (approximately 20). By means of comparison the Mercedes Benz Mannheim plant produced only 14 types of casting and had a capacity of 85,000 tons. The South African plant, therefore, had to be more flexible requiring compromises, for example, in machine selection.

From the mid 1980s, improved rates of capacity utilization were achieved through exports and incremental investment, which enabled the foundry to achieve reasonable economies of scale. In 1990, a new pressure operated pouring furnace was installed which created the opportunity to synergize melting and moulding at the maximum output of the moulding capacity. This investment expanded capacity to 15,000 tons per annum and allowed ADE to service new export contracts to international customers such as Eaton, Ssangyong, MAN and Daewoo. By 1995, 40,000 engine blocks were being exported to Perkins of which 20,000 were machined. As a result of the expansion of export volumes, the plant was working at close to its 12,000 ton capacity by 1995, working three shifts in some areas.

ADE did not do real research themselves, but sought to apply available technologies to specific operations. Formal and informal links with the licensor were important in order to receive exposure to international developments and new technologies. ADE was therefore a follower attempting to catch up rather than establish a lead. However, the company did have expertise in the selection and assessment of equipment and were constantly introducing improvements in process technology some of which incorporated their own innovations. The foundry undertook its own sub-assembly in the core shop and had found ways to integrate core assembly with minimum jointing. Another improvement was the shift away from hotbox methods to coldbox methods of core making. Automation levels were quite low but the signing of large export contracts such as the one with Ssangyong justified further automation such as the introduction of robotic fettling.

The Takeover by DaimlerChrysler¹⁰

By 1995, ADE had shifted from being a monopoly engine producer for the domestic market to being reliant on component exports for most of its revenue. Because of heavy protection in the initial stages, the changes associated with a more open trading environment had been all the more wrenching involving a complete reorientation of the production process, which was initially established to supply a full range of engines at low volume. In 1998, ADE discontinued engine assembly, a step which had long been expected. In spite

of the fact that it had well developed markets for engine components the position of the firm was quite precarious.

In 2000, Atlantis Foundries and some of the machining lines were taken over by DaimlerChrysler and became fully incorporated into the parent company’s Mannheim based truck engine division. Its main business became the casting and machining of engine blocks. Large scale expansion of the foundry followed. At the time of the takeover it was exporting 20,000 tonnes per annum. By 2005/2006 this had increased to 45,000 tonnes, mainly of cylinder blocks, and capacity was being expanded to over 90,000 tonnes with the option of further expansion to 120,000 tonnes.¹¹ The foundry was therefore now producing at world scale although its range is still extensive in terms of the number of types of castings produced. Fifty per cent of turnover was still accounted for by machined components but this was changing as the foundry expanded.

Atlantis Foundries became fully integrated into the Mannheim truck division in a series of steps. The first phase was the installation of new machining capacity to handle high volume exports of machined engine blocks to Perkins. The next phase was to ‘marry up’ AF with DaimlerChrysler’s Mannheim foundry which produced blocks, cylinder heads and other products for Mercedes Benz and DaimlerChrysler subsidiaries. It also supplied into the North American market via DaimlerChrysler’s wholly owned subsidiary, Detroit Diesel, which in turn supplied engines to another subsidiary, Freightliner. Atlantis Foundries was also selected to supply engine blocks to a major new project codenamed ‘the heavy duty engine programme’ which supplies to Fuso in Japan, Mercedes Benz in Germany and Detroit Diesel in the US.

Table 2 illustrates the close integration of Atlantis Foundries with the Mannheim Foundry, which was the development, marketing and distribution centre for the group and produced certain engine components. Atlantis

Table 2: Functional Integration of Atlantis Foundries with the Mannheim Truck Division

	Atlantis Foundries	Mannheim Foundry
	Manufacturing centre	Design, manufacturing and marketing centre
10.8 litre blocks	–	100%
12.8 litre blocks	100%	–
14.8 litre blocks	75%	25%
Cylinder heads	–	100%

Source: Author’s survey.

Foundries was a manufacturing centre with its advantage being a lower cost base. Foreign ownership had conferred a number of advantages for the firm. The Mannheim foundry was able to provide expertise and technology. But most important was the expanded access to global markets. All quoting for exports went through DaimlerChrysler who managed marketing and distribution.

In follow up interviews conducted in 2010,¹² the firm was starting to emerge from the extremely difficult recessionary phase. Heavy exposure to the European and American truck industries had had a devastating impact on sales. In addition, the relatively strong rand and rising electricity prices and supply constraints were a major problem.

The transformation of ADE from a small scale, monopoly engine producer for the domestic market to a large scale exporter of castings and machined components probably involved a degree of change comparable with the restructuring of east European manufacturing operations in the post-socialist era. Employment had fallen to 700 in 2004 but by 2007 was up to 1,100 although it declined again during the recession of 2009.

The case of Atlantis Diesel Engines illustrates that even though the nature of initial investments that took place made it impossible to compete internationally, learning had been rapid and with more appropriate investments, ADE (and then Atlantis Foundries) has been able to build a rapidly growing export business on the basis of its accumulated skills in core capabilities such as the manufacture of engine blocks.

3.2 Toyota – Upgrading the Supply Network

In a producer driven value chain involving the assembly of large numbers of components, the strategy adopted by the assembler is of key importance. In the development of the automotive industry in Japan, vehicle assemblers such as Toyota played a key role in the development of ancillary firms.¹³ Best practice in the automotive industry has increasingly involved assemblers developing closer linkages with component suppliers and providing them with technological assistance as well as devolving responsibility to them.

By the mid 1990s, more cooperative relationships between assemblers and component suppliers had not yet emerged to any significant extent in South Africa except insofar as the industry was small and personal contacts played an important role. Most component producers did not receive significant assistance from assemblers and most firms did not see a more significant trend towards closer cooperation.

Toyota, South Africa's largest motor vehicle assembler had gone further than most others in developing its own supplier network. It was more focused on the local market partly because of its licensing arrangement with Toyota

Motor Corporation in Japan and also because it had developed an extensive supply network, both of in-house components and partly owned supply companies. So while Toyota had been developing global sourcing, it saw its local suppliers as stakeholders and had the objective of raising them to world standards.

In the face of increased price competition which had already led to reduced market share, Toyota had introduced a two pronged strategy aimed at driving down component costs as well as improving quality and delivery. So while domestic suppliers were regarded as stakeholders, they nevertheless had to compete and Toyota was aiming at cost reductions of 2.5-5 per cent per annum. It was also increasing global sourcing from the international Toyota network. It was clear that the prevailing local content levels of 52-55 per cent¹⁴ were unlikely to be maintained at least for the lower volume models. Toyota had reduced the number of suppliers and planned to further reduce these numbers as a result of increased world sourcing following the abolition of local content requirements.

The second prong of Toyota's supply strategy was aimed at upgrading the capacity of its supply network. These interventions took a number of forms. For firms within the Toyota group, TSA was very involved in the negotiation of license agreements to ensure that exactly the right types of technology were secured. Toyota had recently introduced the Toyota Supplier Assessment system, which benchmarked all suppliers according to a detailed set of criteria. The *kanban* system was being extended and a Suppliers Council consisting of top suppliers had been established. A further initiative was the establishment of a Product Engineering Group consisting of *goshi* teams comprising engineers, quality specialists and platform teams who work with suppliers.

In 1995, intensive involvement with suppliers was at an early stage at Toyota and there appeared to be two key constraints to the supplier development process. Firstly, the relatively low volumes and wide range of components required by Toyota and other assemblers militated against achievement of world class productivity standards most glaringly in the case of JIT production. Secondly, Toyota's own progress in terms of work organization was limited at that time so that the company may have been placing demands on suppliers which it had not itself met and had difficulty introducing in South Africa's troubled industrial relations milieu.

The Impact of Foreign Ownership

Toyota's situation had changed very fundamentally by early 2007 when the next set of interviews was conducted.¹⁵ The company had become a subsidiary of Toyota Motor Corporation and was being converted into a global production hub with production volumes set to increase to 220,000 units by 2008. This

Table 3: Changes Affecting Toyota Suppliers from 2002 to 2007

	2002	2007
No. of platforms	7	2
No. of suppliers	160	75
Local content (%)	40-45	40-45
	Old Corolla (2002 model)	New Corolla (2007 model)
% of local components produced by global suppliers (Corolla)	41	82 (45% - global firms – non Japanese 22% - Japanese firms 13% - technical agreements with global company)

Source: Author's survey.

includes two high volume models, the Corolla and international multipurpose vehicle (IMV). Full incorporation into Toyota's global production system and the transition to world scale production had important implications for suppliers as the firm was trying to increase local content and was achieving the volumes which made this possible. A recent poll of suppliers had found that they regarded Toyota as the assembler firm which was most supportive of building the supply network. According to TSA president, Johan van Zyl,

unless you have strong supplier base there is no reason for your existence ... it's in everyone's interest for us to go to our suppliers and help them with quality and logistics, and link them into our system.¹⁶

But at the same time, the number of domestic suppliers was being reduced and by 2007 consisted mainly of global firms.¹⁷ In 2002, Toyota had 7 platforms with 160 local suppliers (Table 3). By early 2007 there were only two primary platforms and 75 suppliers. While local content was hardly changed, the position of suppliers had been transformed with a huge increase in the share of locally produced parts (by value) being sourced from 'global suppliers'.

Toyota's preference was to deal with foreign owned suppliers or joint ventures. From 2002 Toyota SA had spent much effort trying to partner local firms with major foreign suppliers. Even a 25 per cent foreign owned joint venture would effectively be run by the foreign firm and in most cases the foreign partner would increase its stake over time. For this reason, local firms were frequently not supportive of this initiative as they were reluctant to cede control. Many asked Toyota to help them set up a technical agreement but while this route remained a possibility, it was not Toyota's favoured option as licence payments were cost-raising. In dealing with locally owned firms

reluctant to relinquish control, TSA cited itself as an example of a firm which had only been able to survive and expand because the previous owners, the Wessels family, had seen the necessity of Toyota Motor Corporation taking a controlling stake.

In spite of the high volumes being achieved and the fact that Toyota was keen to increase local content, this had not increased and remained at 40-45 per cent for both the Corolla and the IMV¹⁸. The position of local suppliers excluded from this network was extremely precarious. This group consisted of a multitude of smaller firms with capabilities in areas such as tooling and press parts. However, without close links to the design and technology of global suppliers they faced marginalization. Ironically, while the lack of volume has always been a concern in the component industry, these smaller firms found it difficult to cope with the model volumes in excess of 100,000 units per year that Toyota was now achieving.

The second tier of suppliers was also regarded as weak with limited skill levels. Toyota was pessimistic about their prospects. This is one reason that local content remained low. While the new global suppliers were encouraged by Toyota to expand their own local content, these firms were importing sub-components from countries such as China and local firms could not compete.

Supplier development depended on the cycle of new model introductions. Following the launch of the IMV project in 2005, Toyota had identified 17 high risk suppliers and appointed a team of mainly retired technical staff, dubbed 'grey berets', to work with these firms in areas ranging from *kaizen* plans to press loading and human resource development. Toyota also assisted other smaller, domestically and foreign owned suppliers. The larger, foreign owned suppliers received back up from their parent companies but according to Toyota management, many foreign owned firms received little support from the parent company and were quite weak in some respects.

In 2010, Toyota had started planning for new replacement models for the Corolla and IMV which are to be introduced in 2012-2013.¹⁹ The plan was now to increase local content to 60 per cent, which involved two strategies. The first was to bring in new multinational suppliers. Interestingly, Toyota was cooperating with competitor vehicle producers to encourage direct investments by foreign component suppliers. The second prong of the strategy was to encourage more localization of sub-components by first tier suppliers. This strategy was being pursued by encouraging first tier suppliers to develop their own supply networks and also assisting to arrange technical agreements where required. If this eventuates it would represent a reversal of the shift to assembly by first tier producers which took place in the first phase of internationalization.

Toyota's evolving relationship with its suppliers is fairly typical of assembler-supplier relations in the context of globalization. The supplier

base had been consolidated and the level of foreign ownership was much increased. Toyota increasingly dealt with global follow-source firms which had either established operations in South Africa through wholly own firms or joint ventures. Much effort had gone into facilitating these arrangements. Toyota continued to work with local suppliers but the number of these was much reduced. Some domestic firms, which were not part of this new supply chain, have become second tier suppliers to the new global first tier and others have sought out opportunities in the aftermarket. The remainder face very bleak prospects.

3.3 Alfred Teves Brake Systems – Supplying Low Volume Assembly Industry

The scale of production has been one of the central problems facing the South African automotive industry. The cost premium incurred by component makers for producing a wide range of products at low volume is considerable. The case of Alfred Teves illustrates the cost penalties incurred by low volume production and how this has influenced investment patterns and technological effort.

Alfred Teves produces braking systems under licence from Alfred Teves AG, which is now owned by Continental Automotive Systems. Alfred Teves was set up originally for volume production in the early 1980s when the South African market was booming and there was the perception that it would also become a major supply source to Africa. Instead, however, volumes declined and a wider range of vehicles was produced. At the time of the first interviews in 1995, the firm was being further squeezed as it lost its export markets when ITT divested and was struggling to compete because of the high costs resulting from short production runs in the domestic market.

The future of firms such as Ate depended very much on the strategies of local assemblers. The advantages of higher volume production were apparent in the strategy of BMW, which at that stage was planning to source the right hand drive version of the E46 from South Africa. The firm planned to be producing 50,000 *3-Series* vehicles out of South Africa by 2000. This would have had a major impact on the local component sector as BMW wished to source 70 per cent of its components domestically and was encouraging its German component suppliers to take equity stakes in South African licensee firms. The price savings that could be achieved from greater economies of scale were considerable.

These savings could have been achieved by a reduction in fixed costs especially in the amortization of machinery. The key factor would have been reduced machine downtime because of a smaller number of machine changeovers. On the existing line, 380,000 pieces (190,000 car sets) could

be machined per year at 65 per cent machine efficiency. Changeovers also required that before a volume run began the first off sample was tested for quality. Then production could begin at a rate of one piece per minute. In theory at the end of one shift (480 minutes) 480 parts could be produced. This amounted to five months worth of stock for a low volume vehicle such as the BMW 5 series. So for low volume vehicles, the tendency was to invest in flexible CNC equipment (R1 million to R2 million at the time) with a changeover time of 20 minutes. This machinery was highly flexible but very slow for low volumes with a machining time of 14 minutes per piece (Table 4). Dedicated machining lines were designed for speed and comprised a set of eight hydraulically operated fixtures on a rotating table. Eight processes (drilling, milling, etc.) were, therefore, happening simultaneously. With flexible CNC machining equipment each process is separate, accounting for a total of at least eight minutes plus the time for the machine to replace each tool back in the magazine. Machine changeovers on dedicated equipment are a complicated and arduous task involving removal of the machining table, fixture stations and tools and the disconnection of hydraulic clamping devices. These tasks were carried out by artisans. This type of dedicated machinery is not designed for frequent changeovers and foreign technical experts visiting the plant had been amazed that what they considered to be machine rebuilds were carried out on a routine basis. Frequent changeovers can also lead to quality problems.

Low volumes and the proliferation of models in the domestic market were therefore the major obstacles to improved competitiveness. Considerable technological effort went into incremental changes to increase flexibility. To reduce tooling costs for the wide diversity of part numbers produced, a number of innovations had been introduced. For example, broach tools had been divided into segments to make them more versatile. Another large investment was in milling cutters. The numbers of these required had been reduced by putting in special inserts which allow four sides of the cutter instead of two to be used. The presetting of tools on CNC equipment had

Table 4: Flexible Machinery versus Dedicated Automation at ADE, 1995

	Flexible CNC machining line	Dedicated automation
Cost	R1-2m	R10m
Changeover time	20 minutes	6-8 hours
Machining time per piece	14 minutes	1 minute

Source: Author's survey.

reduced downtime in that area due to machine changeovers. On transfer lines, changeover times had been reduced from 16-20 hours to 6-8 hours.

The cost penalties incurred as a result of low volumes and complexity in the domestic market were considerable. What was clear, however, was that firms such as Alfred Teves had developed considerable production capability in operating complex machinery under very unfavourable conditions, in introducing small innovations to increase flexibility and in the capacity to undertake machine rebuilds to stretch the life of capital equipment. In terms of technological capability, firms like this were a match for many low cost producers internationally although on a simple, price comparison they would be regarded as 'uncompetitive'.

Later Developments

At follow up interviews conducted in 2006,²⁰ the firm's position had not changed dramatically. It still operated under licence from Alfred Teves and was reliant primarily on the domestic market. One major new development had been the investment of R17 million in a new plant, opened in 2004, to manufacture friction products for the local and international aftermarket. But this shift to producing for the aftermarket, which now accounted for 33 per cent of sales, reflected the low margins in original equipment (OE) production and in itself was a defensive response to fiercer global competition.

OE volumes had increased to some extent but were still a major constraint and the firm reported that the benefits derived from this had been offset by increased competitive pressures resulting from global sourcing. The main domestic markets were BMW and DaimlerChrysler. In spite of the fact that BMW was building 50,000 three series vehicles per year this model incorporated three different front ends and three different rear ends each with differing brake requirements. Alfred Teves' total 2006 calliper production of 245,000 units was therefore spread across 12 part numbers giving average production per part number of just over 20,000 units. While this had doubled from ten years previously, it was still a very low volume and the company required 50,000 units per part number to be reasonably profitable in OE production. Calliper production was expected to increase substantially, but the addition of eight new part numbers meant that production per part number would hardly increase. Alfred Teves considered that ideal volumes would be 900,000 units per year so the plant remained small in terms of total output with a wide range of parts being produced. Low volume, multi part production together with the fact that the vehicle producers expected Ate to maintain large buffer stocks resulted in inventory levels remaining high at 20 per cent of turnover.

Ate accepted that foreign ownership would yield major advantages but Continental Automotive had decided against buying the South African

operation although it still had an option to do so. This constrained access to the multinational's global network and Continental favoured affiliate suppliers and had established new, low cost capacity in Slovakia, India and China. Its new Welsh plant was focused on low volume, niche products.

Local content in Alfred Teves products had been reduced from 65 per cent to 35 per cent. This was partly as a result of the closing of the foundry in 2004, but other sub-components including brake linings were also now being imported. Employment had fallen from 420 to 230 in 2005 and this latter figure included a staff of 25 in the new friction plant. Over the same period, sales had increased indicating both rapid productivity growth and lower in-house value added per unit of final sales.

Foreign ownership has frequently meant a decline in R&D as domestic firms adopt the precise process and product specifications of the parent firm.²¹ But Ate, a locally owned firm, had also reduced its R&D capacity for these reasons. The relationship with the licensor was good although royalty costs were quite high: 3.5 per cent for new products, 2.5 per cent for locally adapted products and 2 per cent in the aftermarket.

Alfred Teves illustrates two dilemmas facing component firms. In the 1990s, it grappled with the problems of low volumes and multi product production and showed considerable resourcefulness in dealing with this issue. A decade later, although policy had induced a degree of rationalization in vehicle production, volumes remained low. In the more globalized environment of the early 21st century a further potential difficulty was apparent. As a domestically owned firm without proprietary technology, Alfred Teves's options were quite constrained without a foreign partner. The firm reacted by continuing to improve its proficiency in flexible production, by reducing the level of integration within the plant, by importing a greater share of sub-components and by increasingly investing in production for the aftermarket where margins were higher.

3.4 Behr – The Need for a Foreign Partner

For firms wishing to operate as first tier suppliers, a foreign equity link either in the form of a joint venture or foreign ownership has become increasingly important both to provide technology and links to global networks. A growing role for foreign owned firms is characteristic of the automotive industry in many emerging markets and brings certain advantages but also raises question marks over the future of locally owned firms.²² An example is the acquisition of a group of South African based firms by the Stuttgart based Behr Group.²³ Behr is a large German multinational whose major products are vehicle air-conditioning and engine cooling systems. In common with many other German suppliers, the share of production outside of high cost Germany was growing.

As the South African automotive industry has become more internationally integrated, foreign owned vehicle manufacturers have been drawn more closely into the networks of their respective parent companies. This increasingly meant that they wanted selected suppliers to be located in South Africa. The Behr Group faced these pressures from key customers (BMW, Daimler and VW) who were looking to expand vehicle production in South Africa. In particular, the Mercedes C Class export project offered the prospect of large contracts in the form of the air-conditioner, radiator and condenser for this vehicle, which was to be built in volumes of 40,000 per annum in South Africa.

According to the managing director of Behr (SA), the greenfield route was considered to be very demanding in terms of resources and also involved fairly high levels of risk. Maintaining a licensing arrangement was seen as risky because it involved losing control of core technology (Waldburger, 2000).

From the side of the South African operation, it was important to have a global partner. As local management put it “the MIDP was starting to bite” and without a foreign investor the company “could have stagnated into the aftermarket or even died”.²⁴ Behr proved to be an ideal candidate. Not only was it actively looking for an investment in South Africa as a result of pressure from its customers, but the Behr Group already had a well developed relationship with the South African company because of technology developed by the latter, which had been licensed to Behr. Behr purchased 100 per cent of the company in 1999 for an amount of DM50 million.

Performance of the Subsidiary

The basic strategy of the South African subsidiary has been to focus its activities in selected core areas. Turnover doubled in the three years up to 2002 to approximately R620 million. Half of sales were original equipment and the remaining half were to the aftermarket. Direct exports accounted for a third of sales and were nearly all to the aftermarket. While the company did not export significant volumes of original equipment components, it supplied to domestic vehicle assemblers who supply both domestic and export markets. Growth was rapid and the South African subsidiary was highly profitable. Behr (South Africa) had 1,100 employees at four sites in 2002, a number which had increased slightly over the previous few years (up from 1,055 in 2000). Prior to this, the firm had been experiencing ‘jobless growth’ as it restructured in the face of tariff reductions and growing export opportunities. In spite of these changes, the firm remained very labour intensive compared to the overall Behr Group. This was due to lower levels of automation but was also a function of its heavy involvement in production for the aftermarket.

It is clear that this investment was advantageous for the local operation, which faced the prospect of cutting production and increasingly competing on price in the aftermarket. Local management expected that employment would have fallen and the company would have struggled to maintain its technological edge. Since the acquisition, in each business division there had been productivity and efficiency improvements.

As has been typical in the component sector, perhaps the most important contribution of the investor has been to facilitate access to key automotive customers. The Behr Group is one of the largest worldwide suppliers to the three major German automakers (VW, Daimler and BMW) all of which have plants in South Africa, which increasingly act as a base for export. The export drive has necessitated the introduction of new technology on a large scale and the car firms have actively promoted investment and joint ventures by German component suppliers. In the Port Elizabeth air conditioner plant, production has been greatly increased through obtaining the contract to supply the C Class Mercedes. The copper based radiator plant at Silverton, Pretoria which was looking at reducing production because of the transfer of technology to aluminium based radiators has attracted additional business. Production from a recently closed copper based plant in Spain was transferred to Behr (SA).

A few years prior to being acquired by Behr, the South African heat transfer division was spending 4-5 per cent of turnover on R&D. This was significantly higher than most component producers in South Africa and the firm was doing fundamental research and development. The South African operation had even developed innovative production technology, which had been licensed to the Behr Group. This 'composite deposition' process involved a new method of braising aluminium using a specially developed powder. But this innovative capability was not a significant factor in the decision to make the acquisition and by 2000 the situation had changed radically. After the acquisition took place, all R&D activity in South Africa was transferred to Germany or shut down. The South African subsidiary only did development work although its capability for this was expanding partly due to the high cost of assistance from the parent company.²⁵

South African management saw this development as positive for two reasons. Firstly, the South African subsidiary was able to focus to a greater extent on its core activities. Secondly, they now had access to cutting edge R&D. An example of access to this know-how was the huge saving achieved in the course of a short visit from the parent company by a specialist in furnace technology. The Durban plant was set to invest R13 million in a new furnace to increase capacity, but by reorganizing the spacing of parts and the adjustment of heating elements they were able to increase the capacity of the existing furnace with no additional investment.

The South African location offered some important cost advantages. An area where it was particularly competitive was in small batch production. Local management claimed to be able to out-compete the German plants by a significant margin when it came to the low volumes required in the aftermarket. This was because levels of automation were relatively low and the South African subsidiary had high levels of experience and expertise in rapid changeovers and low volume production. Behr has continued to become more integrated into the global activities of the parent company and exports, investment and employment has continued to expand. Along with much of the component sector Behr has moved from being “wide and shallow to narrow and deep.”²⁶ The mode of integration has allowed for an optimal combination of activities which enable the firm to achieve world scale in capital intensive activities while producing efficiently for the low volume domestic assembly industry and also using its expertise in low volume, labour intensive production for the aftermarket.

4. Conclusion

Industrial change takes place at the firm level and examining these changes is helpful in illuminating the processes of technological learning and restructuring in the context of a liberalizing trade regime. We have defined three overlapping stages of firm level responses as the sector moves from protection to a more open trade regime. The first stage is the process of adaptation and development under protection, the ‘platypus effect’. The second, we have termed ‘internal restructuring’. The third involves external restructuring or ‘internationalization,’ and has frequently involved a redefining of relationships (including ownership) *vis-à-vis* foreign firms.

4.1 Adaptation and Development Under Protection – The ‘Platypus Effect’

South Africa’s automotive component industry has historically been inward oriented with low levels of exports. The level of reliance on foreign technology was high and this was mainly secured through licensing and tariff hopping FDI. In the context of the small domestic market, protection led to a low volume, high variety production structure. This was manifested in a wide range of problems, which made the sector uncompetitive. These problems included low rates of machine utilization, high levels of inventory, a weakly-developed supplier network and logistical problems.

We have argued, however, that while most component firms in the early 1990s were heavily reliant on foreign technology and had very limited product development capability, to categorize them as technologically un-

dynamic is an over-simplification. Learning and incremental innovation had been significant and was ongoing. However, much of their technological effort was directed at the problems of low volume, multi-product production rather than simply minimizing costs in a mass production environment. As a result, firms developed forms of expertise which counted for little in the international marketplace. For instance they were flexible, but unit production costs were high.

The fact that firms had therefore accumulated considerable technological capability does not necessarily support the view that the Latin American-style experience of import substituting industrialization provided the basis for industrial learning and later export expansion (Teitel and Thoumi, 1986; Katz, 2000). While substantial learning took place, the costs of restructuring have also been high. It is by no means clear that the industry had to go through this process of 'distorted' development under heavy protection. With hindsight a more rational industry structure could have been established from the start with the judicious use of industrial policy and subsidies. The East Asian experience of combining protection with export support from an early stage is relevant here.

4.2 The Process of Internal Restructuring

Component firms had to make dramatic changes to their mode of operation as a result of liberalization and have shown considerable resourcefulness in doing so. The key to successful adjustment in the South African automotive component sector has been the effectiveness with which firms have been able to adapt accumulated capabilities to a production environment, which requires higher volumes and lower costs for the global market.

The rapid expansion of exports is indicative of a positive supply response. Nevertheless, the process of adjustment has been extremely difficult, requiring not only new skills and technology but frequently new fixed capital and access to new markets. One important constraint has been in the area of fixed investment, particularly where firms had made investments in flexible machinery well suited to the old, protected structure but generally more expensive for high volume production (e.g. Alfred Teves and ADE).

Work organization is an important part of technological upgrading. As a number of studies have attested, there has been a rapid process of catch up over the past decade²⁷ but this alone is insufficient to achieve international competitiveness. The supply base is weak and assemblers have only recently begun to develop more cooperative links with suppliers aimed at upgrading the supply base. The abolition of local content requirements and the ability to rebate import duties has meant that the easiest short term route for assemblers is simply to import. While there are some indications of assemblers increasing

investment in the supply base and encouraging foreign firms to invest in local companies, a more common response as tariffs decline is to source product internationally. On the other hand, assemblers have been keen to promote exports but this has been predominantly from a very small selected group of suppliers.

The pressures to undertake technological effort come from disparate sources. A culture of learning within the organization appears to be an important firm level factor and this is undoubtedly spurred by greater competition as was occurring through tariff reductions. An interesting question was the perceived reluctance to move towards establishing independent technological capability and proprietary technology in product as opposed to process development. Virtually all domestically owned, first tier suppliers operated under licence and the exceptions tended to be in peripheral components. Licensing involves substantial costs in terms of royalties and constrains firms in export markets. But firms producing sophisticated components saw little sense in moving off licence and lacked the capacity and size to catch up to the fast moving technology frontier. Many firms in fact would see the only alternative being to establish a joint venture with a global supplier rather than establishing their own design capability. In fact, firms were remarkably sanguine in their approach to R&D and technological development more generally. In contrast, perhaps, to academic researchers, they do not see R&D as a goal in itself!

4.3 The Limitations of Internal Restructuring: Internationalization and the Role of FDI

Although firms showed considerable ingenuity in responding to the pressures of globalization, one of the most striking observations is the limitations of 'internal restructuring' and the resulting requirement for 'external restructuring' or internationalization. Firms have needed to integrate or re-position themselves within global value chains. Frequently, this has required the introduction of a foreign partner or even the takeover by a foreign firm. Both competitive pressures and the demands of customers have driven this process.

This has, of course, has been very evident in the assembly industry. TSA itself had no choice but to sell a majority stake to Toyota Motor Corporation and become a subsidiary of the Japanese multinational. This hugely expanded its potential and it rapidly became South Africa's leading vehicle exporter. It also had dramatic implications for suppliers who were themselves frequently forced to seek out foreign partners.

ADE clearly needed a foreign partner, so did Behr. They were essential to maintain and expand access to global networks. Without a foreign partner,

Teves faces increasing pressures as a first tier supplier in the domestic market and also in export markets. As a result, Teves is increasingly seeking new opportunities in the aftermarket. An interesting question, which has not been explored here, is whether the weaknesses engendered by import substitution in fact led later to more rapid expansion in foreign ownership than may have otherwise been the case. Any negative implications arising from foreign ownership have to be tempered by the realization that it was absolutely necessary for the survival of many firms.

Foreign owned suppliers themselves make much less use of domestic content. Toyota was, until recently, pessimistic about the capabilities of second tier suppliers and its first tier, global suppliers were using a growing percentage of imported sub-components. Behr has reduced costs by sourcing internationally and local content in its air-conditioner units has been reduced. But growing importation of sub-components was not restricted to foreign owned firms; Ate had also embarked on such a strategy.

Foreign ownership also has implications for R&D in South African based firms. There is less need for ongoing adaptations of products as they become standardized to global designs. Behr, for instance, closed its R&D division. However, foreign ownership brings new technology and easier access to expertise in the high volume, low cost production required for global competitiveness. Direct support for R&D may, therefore, be of little benefit to most firms unless its objectives were clearly specified. A large component producer such as ADE did not even have a formal R&D department even though it has been a rapid learner.

For firms to adjust to a very different trade regime is difficult, time consuming and expensive. It is, therefore, important that the process of trade liberalization takes account of the fact that a significant amount of firm level 'inefficiency' may result from the specific industrial structure and also that the nature of fixed investments mean that adjustment to new market conditions cannot be achieved overnight. South African component suppliers are now more specialized and operate at much higher scale. Levels of foreign ownership are higher and they are more competitive. But the process of restructuring has been a painful one and is by no means complete.

Notes

1. One case study is of supplier development at an assembler firm (Toyota).
2. See Pack (2006) for a discussion of econometric versus case study approaches to technology transfer.
3. See, for example, Katz (1987) and for a review of this early literature see Herbert-Copley (1990).
4. For overviews see Black (2001, 2009).

5. See also the Behr and Toyota case studies in the following section.
6. Lorentzen's (2005) case studies provide some examples. See also the Behr case study in this paper.
7. This conclusion is supported by the Toyota case study cited in this paper.
8. Interview with ADE financial director.
9. This section is based on an interview with J. Davies (foundry senior general manager).
10. This section is based primarily on an interview with John McEwan, managing director of Atlantis Foundries and a plant tour conducted by Tony O'Brien in April 2007.
11. Interviews.
12. Interview with Derik du Plessis, Managing Director, Atlantis Foundries.
13. For an overview of Toyota's relationship with its suppliers at the global level, see Tsuji (2007).
14. This measure is as a percentage of wholesale selling price and therefore includes assembly.
15. The following section draws heavily on interviews conducted in January 2007 with Henry Pretorius (Senior Vice President, PD&P, Toyota SA) and Nigel Ward (General Manager Purchasing, Toyota SA).
16. 'Fortune favours the brave' (*Financial Mail*, "Special Report: The Motor Industry", 15 September 2006).
17. Global supplier in this context refers to a foreign owned or joint venture operating in South Africa or a domestically owned firm with a technical agreement with a global supplier.
18. The definition being used here is of component purchases only and excludes assembly.
19. Interview with Henry Pretorius.
20. Interviews with Peter Hocknell (managing director) and Mike Teasdale (OE director), Ate.
21. See also following Behr case study.
22. See for example, Humphrey and Salerno (2000) for India and Brazil.
23. This section draws primarily on interviews with Ted Waldburger (managing director) and Gavin Simkins (financial director) of Behr SA conducted in 2002.
24. Interviews
25. Interview with Justin Barnes (industry consultant).
26. Interview with Behr SA, managing director Ted Waldburger, May, 2007.
27. See for example Barnes and Morris (2004).

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