# Experience of Hungarian Firms in the Heavy Engineering and Automotive Industries

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**Abstract**

*Global networks shape international manufacturing and trade. The main question which our paper deals with is how Hungarian companies can improve their positions within these global value chains. The production and export parts of the automotive and heavy engineering industry sectors are dominated by foreign multinational corporations. Therefore, these sectors were chosen as examples. Research is based on interviews that explore local manufacturing subsidiaries' production processes and functional upgrading experience. Our findings show that there are differences among the firms regarding the extent of the upgrading. This depends, on the one hand, on the owner's global strategy, as well as on the type of final product being turned out. On the other hand local capabilities are of vital importance among the factors that influence the volume of intangible transfers. Furthermore, our interviews have suggested that upgrading is not a mono-directional process: previously gained mandates can also be lost. Economic policy should support the business development and entrepreneurial learning, as well as providing adequate conditions for suppliers and subsidiaries of leading multinational enterprises.*

**Keywords:** Global Value Chains, Hungary, multinational companies

## Introduction and Methodology[8]

Today, global production networks are widespread. Their activities form a new phase of globalisation characterised by fragmented production, transfer of technology and decreasing transport costs (Kaplinsky, 2013). The Central European countries have been actively participating in the chains of multinational firms since the 1990's. The benefits accruing from this

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participation varies across the sectors and their firms. In this paper we analyse the experience of Hungarian companies in the heavy engineering and automotive industries.

Since around 2000, intra-industry trade turnover data reveal a strong expansion between the Visegrad (V4) countries and their main trading partners (Germany, Austria) in the automotive and heavy engineering industries. This suggests an increase in cross-border activity by global value chains (GVCs).[9] The role of foreign enterprise in both industries is dominant; such companies often operating for over two decades in Hungary. While in the automotive industry large foreign corporations play a decisive role; in the heavy engineering sector the picture varies. This gives us an opportunity to analyse the large, medium and small foreign-owned subsidiaries. Upgrading is strongly related to both industries, thus providing ideal terrain for its analysis.

The inclusion of Hungarian firms in the global value chains is a fact. The question is how these companies can improve their position. We are trying to assess the process of upgrading and the role of the given supplier firms, as well as mother companies in this process. Therefore, we asked questions relevant to product, process and functional upgrading during personal interviews, which were carried out at the respondent companies.

Our methodological approach is to apply company case studies. Personal interviews can reveal factors accumulated during the upgrading process (such as the transfer of tacit knowledge), which are hard to measure. Sample firms in the sector of heavy engineering were selected with the aim of demonstrating the heterogeneity of successful development trajectories even within one single area of industry. Affiliates of large corporations in the automotive industry offered good samples for detecting differences behind the similarities. Being an established company was an important selection criterion, since upgrading is based partly on demonstrated subsidiary capabilities. We have included small, medium and large corporations in our sample, in order to identify possible correlations between size and upgrading. Interviews were based on open-ended questions that focused on the histories, drivers and outcomes of upgrading.

The structure of the paper is as follows: First a literature review is provided, then we introduce the participating companies, as well as reviewing the product, process and the experience gained through their functional upgrading. Finally, we discuss our findings and propose some managerial and policy implications.

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[9] WIOD table data for the years 2000 and 2011 show a significant increase in the exports and imports of each individual V4 country, especially towards Germany, but for their intra-industry trade relations as well.

## 1. Literature Review

As we already know, during recent decades, international trade and manufacturing has become controlled by global value chains. There is a large and growing body of literature on the activities, measurement and upgrading of the global value chains. We focus now on the last mentioned.

Participants in the global production network are constantly developing their activities. Suppliers to global value chains are often multinational companies themselves. Thus, GVCs are mostly not controlled by one single leader; the direction itself can be fragmented. One affiliate of a multinational can have several roles within its function (Sass-Szalavetz, 2014). It can have higher (global) and lower level tasks within one segment.

We analyse upgrading by applying the widely used and accepted definition of upgrading, which is a move from a lower value-added activity towards a higher value-added one (Barrientos et al., 2010, Milberg-Winkler, 2011).

Economic upgrading was organised into *four main types* by Humphrey-Schmitz (2002) and this typology is usually applied since then (in addition to economic upgrading „social upgrading" also exists[10]). According to these authors upgrading of a firm may be:

1. product upgrading: moving into more sophisticated product lines (which can be defined in terms of increased unit values);
2. process upgrading: transforming inputs into outputs more efficiently by reorganising the production system, or by the introduction of superior technology;
3. functional upgrading: acquiring new functions in the chain (or abandoning existing functions) to increase the overall skill content of activities;
4. intersectoral upgrading: using the knowledge acquired in particular chain functions to move into different sectors (often called 'inter-chain' upgrading taking place in one strand of a value chain, also).

Certainly, these groups overlap or derive from each other. Therefore, it is sometimes difficult to distinguish product and process upgrading, especially

[10] Social upgrading is not discussed in this paper. It means improvements in working conditions and rights. It includes such measurable standards as health, safety, working hours, and enabling rights, like non-discrimination and freedom of association (Barrientos et al., 2011). As some authors claim, economic upgrading can lead to social upgrading, but not necessarily (Barrientos et al., 2010, 2011, Bernhardt – Milberg, 2011, Bernhardt, 2013, Goger, et al., 2014). Several factors affect the interaction of economic and social upgrading, like the type of work, status of workers (Barrientos et al., 2010). There are cases when economic upgrading in a GVC can lead even to social downgrading, labour exploitation, and a manufacturing shift to lower-wage areas.

where the introduction of new processes generates new categories of products. Apart from that, the manufacturing process can also be improved by matching safety, technical or environmental standards that may lead to products with better qualities. However, these are not necessarily of higher-value to the producer (Ponte-Ewert, 2009). Economies of scale can also increase profits in value chains, but not only from process upgrading, but also via aggregating orders to increase the volume of sales. This can actually lead to product 'downgrading' (lower value products sold in larger amounts; see Gibbon – Ponte, 2005).

Regarding the manufacturing sector, the largest number of articles have concentrated on functional upgrading [which can be voluntary, but in most cases the mother company expects that its affiliate fulfils a greater quantity of more complex tasks]. Functional upgrading can be realised in three main ways: *widening* of functions (several other functions have been joined to the production process itself; the extent of diversification depends on the company size and age), *deepening* of a given function, by increasing its complexity, or *widening* the *scope* of a given function (an affiliate can itself become regionally or globally competent and responsible).

It is important to stress that upgrading of affiliates often takes place together with the changing and development of the whole production chain. As external conditions change, mother companies react and modify value chains, develop certain parts, as well as reorganising and diversifying them. Innovation activity is continuous. From the participant firm's aspect upgrading is crucial for survival.

More recent contributions have highlighted the links between different forms of GVC *governance,* as well as the possibilities for upgrading, particularly functional upgrading. Governance is a top-down process starting from the leading firms, while upgrading is bottom-up concept, designed to improve initial positions (Lee–Gereffi, 2015). According to the first typology from decades ago, governance can be producer-driven or buyer-driven (Gereffi–Korzeniewicz, 1994). As GVCs became more and more widespread, the increasing complexity of production networks made it necessary to create a more refined typology. Thus five types of governance were defined (Gereffi, et al. 2005): market, modular, relational, captive, and hierarchical. Each governance type can exert different effects upon the upgrading of a supplier firm.

*Market* governance involves simple transactions with no formal cooperation between participants and the cost of switching to new partners is low. The organisation of the chain presents low barriers to upgrading, though it may not be easy without the support of lead-firms (technical, financial support, market

information, etc.). In the case of *modular* governance, suppliers make products or provide services to a customer's specifications. Here the product is more complex, but sufficiently modular in design. *Relational* governance types involve complex interactions between the lead-firm and supplier. The buyer and supplier develop intertwined relationships involving tacit knowledge exchange and knowledge spill-overs (Cattaneo et al., 2013). *Captive* governance is characterised by a high degree of monitoring and control by the lead-firm, with small firms dependent on those larger buyers for trade. In captive relationships, significant product and process upgrading by local suppliers takes place. At the same time, functional upgrading is either discouraged, or limited to some functions (Schmitz, 2006). *Hierarchical* governance is characterized by vertical integration and managerial control within a set of lead firms that develop and manufacture products in-house. This usually occurs when product specifications cannot be codified, products are complex, or highly competent suppliers cannot be found (Cattaneo et al., 2013). Hierarchical structures provide regular employment, guarantee quality and build producer capacity.

The economic literature on global value chains contains some articles concerning certain sectors where upgrading and GVC participation of the firms in the Central-European region are analysed. Here we have included those that deal with Hungary.

Upgrading in the electronic sector, with regard to Hungary and Romania, is the subject of the article by Plank–Staritz (2013). As low-cost export production platforms, CEE firms were integrated into the global electronic production networks with support by domestic government policies. Later these countries were also hit by outsourcing to Asian, and other, countries, where costs were lower. Often the transnational corporations brought foreign suppliers to their host countries, and this had an effect on domestic suppliers. Sass–Szalavetz (2014), found successful R&D based upgraders among Hungarian subsidiaries, as well as stressing the importance of proactive behaviour, the local business climate and highly skilled employees.

Concerning the upgrading process in the automotive industry in the CEE countries, Pavlínek and his co-authors (2009), analysed long-term structural changes in exports. They revealed that the structure of Hungarian exports between 1996 and 2006 moved to high value added products. Based on company research, he added that the characteristics of production have an influence on the prospects for industrial upgrading. When the product is designed locally, more added value is created in the host country (2009, p. 54.). At the end of the 2000's the picture in the Hungarian automotive sector is rather heterogeneous: there were companies with medium to high local content (e.g., Magyar Suzuki),

and companies with very low local content (e.g., Audi Hungaria Motor). This draws our attention to the heterogeneity of the upgrading process. Jürgens and Krzywdzinski (2010) highlighted the fact that updating in the narrow sense does not necessarily mean updating in the broader sense. Based on case studies and surveys, the upgrading of the organization of work and the transfer of best practices (e.g., working time flexibility) into the CEE countries, were realized as part of the standardisation of the production process (Krzywdzinski 2008).

Concerning the transfer of research and development r to affiliates, Winter (2010) draws attention to the constraints placed on such transfers; namely that R&D is a core competence, which remains located in the MNC's' home countries. Smahó (2012) also confirmed this while focusing on the knowledge-transfer system of the automotive industry in six Central and Eastern European countries, as well as in Austria and Germany. She pointed out that FDI has led to a modernisation of processes in the automotive industry. However, R&D activities cover only applied research. Basic research remains at the home headquarters of the MNCs.

## 2. Case Study Findings of three Hungarian Subsidiaries in the Heavy Engineering Sector

In this part we analyse the findings of interviews carried out with the CEOs of three multinational companies' Hungarian subsidiaries in the heavy engineering sector. Our interviews' aim was to reveal details about product, process and functional upgrading.

We have included a small company (TIPA Vezérléstechnikai Kft), as well as a medium-sized (IGM Robotrendszerek Kft) and large company (Grundfos Magyarország Gyártó Kft.) in the sample. Two of them are export-oriented with export shares above 95%. One company is integrated in global value chains through selling the majority of its products (70 % of total sales) to the local subsidiary of a large global company.

The sample companies, their ownership and governance structures are to some extent heterogeneous. IGM and Grundfos are both vertically integrated into their MNC's' organisation, i.e., they are subject to explicit coordination in a hierarchical form of governance. TIPA enjoys high levels of autonomy in all functions (see later), and its transactions can be characterised by relational governance, especially in the case of its dominant buyer.

Two companies are integrated into the multinational organisations of a rapidly globalising IGM, as well as a global Grundfos company, respectively. TIPA has a domestic (minority: 30%) owner, which partly explains the relatively

higher autonomy of its local management. Another factor that influenced the development trajectory and the autonomy of TIPA is that its current foreign owners are two Austrian private equity firms.[11] Table 1 summarises the main data of the companies in our sample.

**Table 5: Data of the surveyed heavy engineering companies (2014)**

| | *TIPA* | *IGM* | *Grundfos* |
|---|---|---|---|
| ***Owner's nationality*** | Austrian (70%) Hungarian (30%) | Austrian | Danish |
| ***Number of subsidiaries of the MNC*** | 3 (*) | 24 | 80 + companies in 55 countries |
| ***Products*** | production equipment (automotive), customised machines and industrial electronic equipment | welding robot systems | pumps (and components thereof) for diverse applications (industrial, construction, utilities, agriculture etc.) |
| ***Foundation*** | 1995 / 2006 (2) | 1990 / 2000(4) | 2000 |
| ***Number of employees*** | 47 | 166 (1) | 2,200 (1) |
| ***Sales 2013 (€ million)*** | 4.6 (3) | 19.7 | 428.4 |
| ***Share of exports (%)*** | 15 | 99.5 | 97 |

Note: (1) at the time of the interview
(2) predecessor established in 1995; since 2006 the company is in its current form (ownership, activity portfolio etc.)
(3) 2014
(4) entered through privatisation, major development through greenfield expansion
(*) portfolio companies in a diverse range of industries
Source: Interview data and income statements for sales

## 2.1 Product Upgrading

The interviewed managers were unanimous in reporting a substantial qualitative and quantitative expansion of the product mix during the past

[11] As is evident from the management literature, there are large differences between private equity firm owners and vertically integrated MNC's in terms of governance arrangements; i.e. between the degree of autonomy granted by private equity firms to portfolio companies, and the patterns by which MNC headquarters coordinate their subsidiaries (Barber–Goold, 2007; Klein et al., 2012).

decade. While the evolution of the product mix was the outcome of TIPA's local management's, own strategic initiative; in the cases of IGM and Grundfos, expansion was the result of the owners' relocation decisions.

Specialised initially in the manufacturing of control units to be integrated in industrial production equipment, TIPA decided to upgrade and to also include the complex task of manufacturing its own self-designed production equipment into its product mix. Upgrading in this case required, first of all, business development capabilities: the ability to persuade customers that the small Hungarian factory is a reliable supplier of production equipment, complete assembly lines, and of newly designed, customised solutions.[12]

Conversely, the expansion and the upgrading of the product mix at IGM and Grundfos were driven by the mother companies' relocation decisions. Production at Grundfos expanded rapidly with the relocation of additional products from the investor's home country, as well as from its other facilities. Product upgrading took a qualitative turn when the MNC owner's newly developed products were also located to the Hungarian facility. At the time of the interview, two thirds of the MNC owner's newly developed products were being manufactured in Hungary.

IGM has a "textbook-type" product upgrading history. The initial entry mode of its owner was through privatisation of the Győr facility of a socialist state-owned enterprise. Mechanical metal processing activity was transferred to the privatised facility in 1990. Positive experience motivated the owner to engage in greenfield expansion in the Győr Business Park for the assembly of complex welding robots, followed by the transfer of the production of control systems. Currently the subsidiary is in the process of substantial product upgrading with the partial relocation of the MNC owner's most up-to-date (electron beam) technology from its German subsidiary. Expansion (in both IGM and Grundfos) was continuous, and of such a large extent that it required not only the enlargement of the initial facility, but also the construction of new production facilities (Grundfos has already four production facilities in Hungary; IGM recently completed the construction of its third facility). As a result of consecutive (re)location turns, Hungary has become the largest European manufacturing location for both IGM and Grundfos.

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[12] Interestingly, the crisis contributed to the fulfilment of TIPA's upgrading objectives. During the crisis years automotive companies (the main customers of 'A') would opt for improving the efficiency and the reliability of their production equipment instead of investing in new machinery. Demand increased for TIPA's solutions such as camera control systems (automatic optical inspection and handling solutions), and dedicated retrofit solutions of existing production systems.

Decisions on the expansion of production, and on the location of newly developed products, were in several cases the outcomes of intra-MNC competition:[13] the result of already demonstrated subsidiary capabilities. However, once the decision on the expansion of the Hungarian location was taken, and investment was made (i.e. production technology was deployed to the newly established manufacturing facility), it became self-evident that the production of specific newly developed products will be located to Hungary. In short, the deployment of the new production technology created a path dependent trajectory for further product upgrading.

### 2.2 Evolution of the Production Process

As has been already stated in the previous section, product and process upgrading are strongly interrelated. The improvement of process efficiency started with the effective absorption and mastering of the transferred technology. The considerable subsidiary capabilities have proven to be a precondition for further product upgrading.

A conspicuously common thread running through our interviews was that the surveyed companies co-evolved with their mother companies. Subsidiaries kept pace with the technological development of the production and testing of equipment related to their core activities: irrespective of size, they purchased (several times during the surveyed period) new production equipment which was state of the art. They invested in enterprise resource planning solutions, where the manufacturing modules contribute to production scheduling, material requirements planning, engineering data management and the like: in short to process optimisation.

We found strong positive relationships between size and commitment to adopt formal process development techniques, such as lean practices[14].

TIPA has not invested in the introduction of formal process improvement techniques. Nevertheless, its products perfectly comply with the non-negligible formal requirements of Audi, its main customer, even without these practices.[15]

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[13] In the case of Grundfos, for example, competing locations included partner subsidiaries in Romania, Slovakia, Serbia, and Bulgaria.

[14] As highlighted in the operations management literature, the combination of advanced manufacturing technologies and lean practices may result in synergistic effects on operational performance (see review by Khanchanapong et al., 2014). Lean practices have a positive impact on multiple dimensions of operational performance: product quality, lead time, flexibility and costs.

[15] Notice that in TIPA's case, the lack of formal process management techniques can be explained by the fact that TIPA outsources a large volume of manufacturing tasks to

TIPA's experts keep monitoring the technological development that takes place in their industry (e.g. in control technique), and transfer information about the newest innovations to their core employees through targeted seminars.

IGM, the medium-sized company, employs highly skilled engineers for development tasks, as well as a group of quality control managers. A major process development objective at IGM was the reduction of the time requirement for manufacturing customised, special purpose machinery. The reduction of the lead time required a comprehensive review of the processes, and the optimisation of both the core and support processes (e.g. logistics). Consequently, the time requirement for the full assembly of an industrial welding robot was reduced to 3–4 months (previously, full assembly took 5–8 months).

Process development is even more formalised at Grundfos. Formalisation is manifested in the systematic introduction of up-to-date quality control & quality improvement techniques, which at the same time, ensure the continuous enhancement of process efficiency. Investment in the work environment (health and safety) also contributed, albeit indirectly, to process efficiency improvement. Moreover, Grundfos has adopted advanced approaches to measuring business excellence. Production (quality, sustainability) and productivity improvement, in short: the improvement of *the company's own* (company-specific) *production system* is driven ahead, not by individual projects (i.e. by implementing from time to time the latest production concepts); it constitutes one of the objectives of *lasting strategic programmes*.

In 1996, the Danish headquarters launched an overarching performance management programme using the manufacturing PROBE; a best practice benchmarking solution. PROBE implementation starts with a review of the operational and management practices which are benchmarked with the help of a database of more than 7,000 companies in 40 countries. The method helps to identify inefficiencies and proposes solutions for improvement. In the second half of the 2000's new group-level reviews started, and that time, the Hungarian subsidiary was already audited as well.

In 2008, Grundfos started a systematic business excellence development programme (EFQM Excellence) in order to try to improve on all aspects identified by the PROBE benchmarking tool. The outcome was a non-negligible

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processing (turning, forging) workshops in the region. TIPA specialises rather in the know-how of the design of customised special purpose machinery, and in the final assembly, deployment and installation thereof.

productivity improvement. This programme has also opened up a variety of functional upgrading opportunities.

Another channel of process upgrading was related to Grundfos's environmental programme, which transcends the 'simple' implementation of the ISO 14001 Environment Management System (implemented in 2004). In an effort to reduce $CO^2$ emissions, the Hungarian subsidiary invested heavily in solutions that improve sustainability, reduce emissions and enhance energy efficiency[16]. A positive side-effect of this was additional process upgrading: investments made in order to achieve sustainability objectives turned out to have a considerable impact on process upgrading as well.

### 2.3 Functional Upgrading

The expansion of production has, to some extent, automatically triggered functional upgrading at the surveyed companies. Support activities such as HR, accounting, administrative and clerical work, factory maintenance, quality control, etc. were immediately delegated to the local level.

The involvement of the Hungarian management in the procurement and deployment of new production machinery was already a function of the subsidiary's great capabilities at Grundfos. Hence, it can be considered as a primary example of functional upgrading. The development of this function was a long and gradual process at Grundfos, since the first milestones in the expansion of local production were marked by the relocation and the local deployment of the foreign investors' own production machinery from Denmark. Later on, the further expansion of local production already necessitated the purchase of new production machinery. The subsidiary's proven capabilities contributed to the increased involvement of the local process engineers and procurement officers in the selection and procurement of the new production machinery. However, although the local experts at Grundfos participated in the selection of the new equipment, the assembly lines were first delivered to the headquarters' premises, installed and tested (pilot production runs were carried out) by the engineers and the technicians of the headquarters, before being transferred to Hungary. Later again, following several successful upscaling

[16] In 2008, the strategy of 'no increase in $CO^2$emission' was announced by the headquarters. Although the Hungarian subsidiary has increased its production volume by more than 50 % since 2008, its $CO^2$ emissions have declined in absolute terms. This was achieved through investment in factory buildings, e.g. heating and lighting; adoption of green solutions (deployment of solar panels, and heat pumps etc.); substitution of old production equipment for new, energy efficient machinery; systematic analysis of energy consumption and waste and dedicated improvement steps.

operations, the Hungarian engineers were entrusted already with the design, procurement and deployment of the technological equipment, without the involvement of their Danish colleagues. This kind of functional upgrading was facilitated by another functional upgrading achievement: by the introduction of the process development function. Local engineers were given responsibility for designing the layout of the assembly lines, as well as for optimising the manufacturing processes of the new products.

This gradual development (functional upgrading in breadth and depth[17]) was not characteristic for TIPA. Upon its establishment, the CEO of the local subsidiary was entrusted with the building up of the firm. Ever since, he has been responsible for finding and hiring experts in all the necessary business functions, including procurement, finance, HR, logistics, training, engineering, R&D, business development and sales. Consequently, TIPA resembles a family managed, autonomous, domestic-owned company rather than a subsidiary integrated through hierarchical governance arrangements in a multinational company's organisation. This can be explained by the fact that the owners of TIPA are private equity investors. The upgrading trajectory of TIPA required rather entrepreneurial learning (e.g. Wang–Chugh, 2014). Integration in global value chains was a similarly strong driving force of TIPA's performance: many of its new business partners have been acquired, directly or indirectly, through its major business partner: through Audi's Hungarian subsidiary.

IGM is an in-between case from the point of view of autonomy. There is a clear division of labour between the Hungarian subsidiary and the Austrian owner: the latter is responsible for sales, logistics and also for general engineering and strategic R&D issues. The Hungarian subsidiary assumes responsibility for operational procurement tasks (strategic procurement decision making powers are retained by headquarters), and for all the operational support activities that are related to the local core activity (except for logistics and sales). Local responsibility is accompanied by a relatively high degree of autonomy in a number of (auxiliary) functions.[18]

The current division of labour is the outcome of substantial functional upgrading by the Hungarian subsidiary: in terms of transferring new products, transfer/purchase of the necessary production equipment, and the transfer of new business functions. As for the latter, over time the Hungarian subsidiary

[17] Functional upgrading in breadth refers to the increase in the number of business functions a given company is responsible for. Functional upgrading in depth denotes the increase in the complexity and knowledge-intensity of a given business function (Szalavetz, 2012)

[18] The degree of autonomy was fairly high already in the very beginning – note that the Austrian owner's first investment (privatisation of an existing facility) took place in 1990!

has gradually taken up several business functions, including engineering; the design of the internal robot base (welding cables, control lines, etc.); IT: programming of the industrial robots; and various support functions, including procurement, controlling, process and product development.

R&D is carried out jointly with the Austrian owner's engineers and the product developers. The increased role of the Hungarian subsidiary in MNC-level R&D activities is reflected by the increased share of the highly qualified Hungarian engineers in the workforce. The Austrian engineers decide on the division of the R&D tasks with their Hungarian counterparts: they provide their Hungarian colleagues with the technical specifications of the robots to be designed and manufactured.

The three most recent examples of functional upgrading at IGM was the take-up of joint responsibility for the programming of the robot systems; the hiring of a sales specialist (he/she is responsible for the Hungarian customers and reports directly to Head Office), as well as the further development of the electron beam technology, which is in the process of being partly relocated from Germany to Hungary.

Grundfos has followed an even longer functional upgrading trajectory, assuming responsibility for product development and testing; for the development of the software embedded in the production machinery; for selected procurement tasks and for the localisation of procurement (i.e., for finding domestic or CEE suppliers instead of the traditional advanced economy suppliers). As the Hungarian subsidiary had become the largest European manufacturing facility, the Danish headquarters decided to locate distribution and logistics to Hungary as well. Hungarian customer service was organised from the local distribution centre, where not only the locally manufactured products were stored, but also the full product mix of the MNC owner. Over time the local distribution centre became responsible for other CEE economies too.

In 2007 a training centre was inaugurated at the 'headquarters premises' of the Hungarian subsidiary. Grundfos organises courses for, among others, architectural engineers that provide deep insight into the ways Grundfos's products can be used in buildings, about environmental friendly solutions that apply Grundfos's products, etc. The e-Academy site operated by Grundfos serves a similar purpose.

Functional upgrading took a new turn with the location of a shared services centre (specialised in finances and IT) to Hungary. Though similar to local sales

and after sales activities, it is performed by a separate legal entity.[19] From the point of view of the Hungarian location, this decision can still be considered to be functional upgrading.

As mentioned earlier, the EFQM Excellence Programme opened up a variety of opportunities for functional upgrading in depth. As for workforce management, the absorption and local implementation of the mother company's corporate culture required a fair sized development of the related functions, often in a formalised and standardised manner. Workforce management, for example, is being improved through the implementation of the Occupational Health and Safety Management System (OHSAS 18001 certificate), which requires the implementation (and the documentation thereof) of all the required procedures. Needless to emphasise here, that the transfer of the corporate culture,[20] and the development of the HR function, involved substantial intangible investment, addressing for example workforce development, and the improvement of employee commitment.

Another function that was even more systematically developed at Grundfos was supplier development. The localisation of supplies required the development of supplier screening and system audit skills.[21]In the Hungarian case it also necessitated support to suppliers in order to help them meet the requirements. In 2011, the Hungarian subsidiary developed a supplier excellence programme. In addition to auditing suppliers' business processes; transport quality; cultural, ethical, and environmental requirements; as well as monitoring performance; this multi-year programme included the transfer of best practice solutions; design of customised development programmes (jointly with suppliers); consultation, coaching and evaluation of the results. The outcome of the programme (that, again, necessitated substantial intangible investment by Grundfos) was a spectacular increase in the share of local suppliers: currently (in 2013) the share of locally procured input is 27 %.

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[19] Grundfos has three subsidiaries in Hungary. Our interview was made with the CEO of the manufacturing subsidiary (four factories, a distribution centre, a training centre and the 'headquarters' responsible for support functions). Another subsidiary is responsible for sales, targeting the Hungarian market, and maintenance and repair services. Finally, the third subsidiary is the shared services centre specialised in group-level financial transactions and IT-services.

[20] The Hungarian subsidiary is relatively autonomous in designing and implementing its corporate social responsibility (CSR) policy. It finances various local community (social, environmental and educational) projects. As a result of deliberate corporate policy, 5 % of Grundfos's employees are handicapped or workers with other disabilities.

[21] System audit refers to auditing existing and potential suppliers' performance including quality, social and environmental dimensions.

Grundfos is, however, also an example of functional 'downgrading', i.e. of the loss of previous mandates. Due to headquarters' decision on organisational renewal and the concentration of specific business functions in shared services centres (SSC); the first loss of mandate concerned finance and accounting. This function was transferred to the newly established SSC that provides services for all companies in the group. Later IT-related tasks were also transferred to this SSC, which involved a reduction in the number of IT employees and a partial loss of Grundfos's IT-related mandate.

The most recent decision on organisational restructuring involved the concentration of the procurement tasks in one centralised organisational unit. This entailed the partial loss of Grundfos's mandate in procurement (irrespective of the recognised successful local management of this business process). Similar global consolidation is expected in distribution and in the organisation of internal transactions.

## 3. Case studies on Automotive Companies

Our sample companies are remarkable players in the Hungarian economy (i.e., in terms of volume of investment, value added, employment, export), and due to their continuous investments they are also good examples of the upgrading process. This group of automotive companies includes final assemblers, as well as main parts manufacturers.

One company is directly owned by the parent company (Mercedes-Benz Manufacturing Hungary Kft.), the other is a subsidiary of a Group's company (Audi Hungaria Motor Kft.), and the third belongs to a European affiliate of a global company (Opel Szentgotthárd Autóipari Kft.).

**Table 6: Data of the surveyed automotive companies (2014)**

| | *Opel Szentgotthárd* | *Audi Hungaria* | *Mercedes-Benz Hungary Kft.* |
|---|---|---|---|
| ***Owner's nationality*** | U.S. | German | German |
| ***Number of subsidiaries in the MNC*** | 10 (Opel AG) | 16 (Audi Group) | 26 (Daimler AG) |
| ***Activity*** | production and sales of internal combustion engines; production of cylinders; production and repair of transmissions; production of engine components/parts | final assembly of passenger vehicles; production of internal combustion engines; tool making | final assembly of passenger vehicles |
| ***Foundation*** | 1990 | 1993 | 2008 |
| ***Number of employees (2014)*** | 813 | 10,954 | 3,428 |
| ***Sales 2014 (€ million)*** | 150 | 7,420 | 2,815 |
| ***Share of exports (%)*** | 96.00 | 99.98 | 99.68 |

Source: Interview data and income statements for sales

### 3.1 Product Upgrading

*Opel Szentgotthárd* and *Audi Hungaria* were brownfield investments in the early 1990's, while *Mercedes-Benz Hungary* is a classic greenfield investment from the late 2000's. The evolution of product mix is substantial in the case of all subsidiaries since their establishment.

Regarding *Opel Szentgotthárd*, engine production and final assembly of cars started at the beginning of 1992. Thanks to consecutive investments from the beginning, the product portfolio has been expanding. Even so, there were some turning points in the history of the Hungarian affiliate when new production started, some activities ceased, and when the position of the Szentgotthárd plant in the global value chain changed (both upwards and downwards). Shortly after

GM acquired full ownership in 1995[22], it announced new investments and the doubling of the capacity of the engine plant. In the following years the manufacturing of some other components (cylinders) started. The final assembly of passenger vehicles ceased at the plant and production was relocated to Poland and China.

In 2000 the production of Allison transmissions began. 2003 saw the commencement of the production of all own-use cylinders. Between 2000 and 2005 the company was owned 50-50 by Fiat and GM respectively. The corporate network (Pavlínek et al. 2009) and the position of the Hungarian affiliate have played a key role regarding product upgrading. While in joint ownership with the Italian automaker, Fiat, the reputation and the position of the Hungarian plant in the company's global value chain declined.[23] Production stagnated; furthermore, in this period significant stock piled up at the factory. Cooperation ended in 2005 and the Hungarian factory was returned to GM as part of GM Powertrain Europe, which is responsible for manufacturing engines and transmissions.

Since the establishment of the *Opel Szentgotthárd* plant, the General Motors Company has invested more than 700 million euro in the development of production technology (i.e., evolution of the production process). The construction of the Flex-plant in 2012 made fast and flexible product changeovers possible. The favourable Hungarian business environment has played an important role in this investment. The introduction of flexible working hours into labour law has increased the competitive advantage of the Szentgotthárd plant. At the same time, the old engine factory also produced the former "FAM1" engines, which are exported to China. In 2014, with an investment of 60 million euro, production capacity of the Flex-plant grew by 60 percent; i.e., up to 650 thousand engines per year. Together with the production of the "FAM1" engines, the Szentgotthárd plant may become the biggest engine factory in Opel AG.

Both the growth of the production and the dynamic expansion of the product assortment are relevant at *Audi Hungaria*. Regarding upgrading process, due to the positive experience (i.e., high profitability and quality of the Hungarian subsidiary) gained over the past decade, the parent company Audi AG has been continuously financing the development of the production plant

[22] The company was established in 1990 by the General Motors Corporation (GM) as a joint venture, the minority stake (25%) was owned by the Hungarian company, Rába.

[23] http://www.autoipari-klaszter.hu/2009/04/28/szentgotthard-sem-orulne-a-fiat-es-az-opel-autoipari-fuziojanak/

with a record high investment of 7.4 billion euro. The establishment of *Audi Hungaria* was based on relocating the engine production plant from Ingolstadt (Germany) to Győr. Today, besides the production of small-series engines for Lamborghini in Italy, *Audi Hungaria* is the only engine producer within the Audi Group.

The main profile of *Audi Hungaria* is engine production; it started with 1.8-litre four-cylinder five-valve engines. In the following period new technologies and products were introduced in the Győr factory. Use of existing capacities, as well as increasing capacities in Győr was dependent on global market conditions. The production highly depends on global markets because within the GVC, the *Audi Hungaria* plant is a worldwide supplier and exchange partner. The tool making department was established in 2005. Its main task is to supply all production plants belonging to the Volkswagen Group. In 2011 the tool making part was further developed. It is a major asset and technological development, employing more than 580 people. They are engaged in tool making in Győr in various shift models.[24]

The position of the Hungarian factory within passenger car production has been improving from the very beginning. The Audi TT is produced exclusively in Győr, and over the past 7–8 years the final assembly of several new models[25] has begun. Since the beginning there has been upgrading in technology of the production of passenger vehicles as well. In 2013 the production of the Audi A3 sedan started in the new factory building. This investment is proof of progress in production, as this is the first vehicle completely produced in Győr.

*Mercedes-Benz Hungary* was founded in 2008 as a subsidiary of the German Daimler AG. The main activities are final assembly and production of parts. There is also a tool making department that can make important corrections to existing tools in cooperation with Daimler AG plants in Sindelfingen and Bremen in Germany. In addition to these two sites, parts are also delivered to Rastatt in Germany, and to Valmet Automotive in Finland. Car production started in 2012. The current strategy of Daimler AG is to increase the compact class within the total production portfolio in order to be dominant by 2020–2025.[26] Therefore the Hungarian plant is a new production place for the future portfolio.

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[24] https://audi.hu/en/profil/termekek/szerszamgyar/

[25] TT Sport Coupé, TT Roadster, A3 cabriolet, RS 3 Sportback

[26] http://www.portfolio.hu/vallalatok/magyar_mercedes-vezer_az_elektromos_hajtase_a_jovo.1.214633.html?utm_source=index_main&utm_medium=portfolio_box&utm_campaign=portfoliobox

The task of *Mercedes-Benz Hungary* in the global value chain of Daimler is not only final assembly: the production plant cooperates with the affiliate in Rastatt in Germany and the independent manufacturer Valmet Automotive in Finland (Daimler AG 2013).

Most of the upgrading activity of *Mercedes-Benz Hungary* is focused on the development and expansion of final assembly capacities. Thanks to the favourable Hungarian conditions now pertaining (politics and local factors of production), the production management has decided to expand existing capacities. Mercedes CLA Class is produced exclusively in Hungary, but further expansion of demand, and the possible option of producing it in Mexico may change this situation.[27] Competition among the global production plants is rather strong.

Corporate issues are the main driving force behind product upgrading. Mergers, or inter-industrial cooperation (in the case of *Opel Szentgotthárd*), determine the potential of development. Further, competition, and in some cases cooperation, among production places influences the evolution of the production mix. In the case of *Audi Hungaria,* competition factors like cost pressure also continuously play an important role in specifying the local product mix. Intra-firm competition plays an important role in all companies measured. In the case of *Mercedes-Benz Hungary,* the short term development prospects of the newly established factory are obvious. Tax holidays, state/EU investment incentives (grants), training contributions and the liberalization of labour law[28] (using flexible working hours) also play an important role in investment and development decisions. However, *Mercedes-Benz Hungary* was not fully satisfied with the level of vocational training in Hungary. Therefore, the company started a training program for both prospective and current employees.

### 3.2 Evolution of the Production Process (Production Process Upgrading)

*Opel Szentgotthárd* introduced a SAP system in 1996 to provide support for globalization among factories, offering interoperability. The factory's Environmental Management System obtained the ISO 14001 certificate in 1997, and the QS/ISO 9000 certification for Quality Management Standards in 1998. In 2014, when production started in the new Flex-plant, new types of machines were installed and new methods of organizing work were introduced to increase

[27] http://hvg.hu/gazdasag/20131008_Amerikaban_is_meno_a_kecskemeti_Mercedes

[28] http://m.portfolio.hu/vallalatok/szentgotthardi_csillagok_szazmilliardokat_hozott_az_onfelaldozas.201482.html

the effectiveness of production. One of these new features, for example, is to increase the number of tasks carried out by machines.

Thanks to the investment made in 2014, Opel Szentgotthárd achieved energy savings by developing certain parts of the processing machine lines serving the central cooling and lubricating systems. Modernization of the machines installed in 1996 with a new computer controlling system means that the factory can save energy and reduce errors during production.

*Audi Hungaria* uses the SAP system and also the ISO 9000 system, and in 2000 introduced lean production. The factory has had its own environmental management system since 1999, and obtained ISO 50001 in 2011. The main driving forces in the evolution of the production process are the takeover of standardized production processes, using local ideas to increase affectivity. Last but not least, local decisions based on the strategy set by the Audi AG are another driver in the process. Since 2013 Audi Hungaria has been a fully-fledged company, and so the elaboration of local strategy is the responsibility (elaborating and implementation) of the Hungarian affiliate.

The production development process is also helped by the exchange program in the Group. Engineers from Győr visit worldwide production places to exchange experiences. Audi Hungaria also hosts engineers from other factories. Process upgrading also focuses on increasing energy efficiency. Projects on reducing waste generated during production and using renewable energies are completed, or are in progress.

SAP and ISO 9001 monitoring and quality assurance is applied by *Mercedes-Benz Hungary.* In 2011, before starting production, the factory obtained the ISO 140001 environment al certification. During production the factory uses the best available technology (BAT). Thanks to continuous monitoring, the factory is committed to reducing emissions. All models fulfil the ISO 14062 regulations (eco-friendly product design). Following the environmental protection goals of Daimler AG, a low CO2 emission program was started in the Kecskemét factory. The main target is to reduce the CO2 emission by 20 percent by 2020. Up to now the optimization of transport activities was realized by giving up road transport and using rail transport from 2013. As a result, the factory has reduced its carbon footprint.

### 3.3 Functional Upgrading

Production support activities like maintenance, controlling and production management functions, product introduction, as well as human resources; are usually delivered at local level. The expansion of local responsibilities, and the

carrying out of new functions within the value chain are confirmed by the interviews and corresponding company reports.

The subsidiary position of *Opel Szentgotthárd* has been changing.[29] As mentioned earlier, the development of the product-mix of *Opel Szentgotthárd* is continuous. Parallel with the expansion of production (variety and volume as well), support functions have been developed. In 2001 logistical infrastructure was developed. Other supporting functions like industrial engineering responsibilities, were also expanded. Monitoring and developing the production processes is one of the tasks delegated to local engineers. In addition, quality management and environmental management were expanded, by the application of IT solutions in the last period.

*Audi Hungaria* has been undergoing functional upgrading. In a period of ten years the company became the central engine supplier of the Audi Group. The most important steps were the creation and expansion of R&D facilities and the tool factory. However, the R&D activities in Hungary are mostly applied research as has been already mentioned Smahó (2012). The core competences are located in the home country/parent company (Winter 2010). Even so, these activities are important for the creation of higher added value in Hungary, and also for strengthening international cooperation and moving the position of the Hungarian subsidiary within Audi AG forward. In 2001 the Department of Internal Combustion Engines started. Regarding R&D, in addition to series-produced engines, test engines have been built in Győr since 2010. As mentioned earlier in the literature review, the complexity of the production has been increasing within the GVC from the beginning. In 2011 *Audi Hungaria* expanded its development activities with the Complete Vehicle Development department, which has responsibility for testing vehicles close to production. Developments are also utilized in higher education by supporting the practice-oriented educational concept at the Technical Faculty of the Széchenyi István University in Győr.

Since 2011 *Audi Hungaria* has been taking part in dual vocational training. Cooperating with Győr's vocational schools, in the framework of dual education, 100 students complete their practical studies at Audi annually (HITA 2012). In 2011, after a history of cooperation, and as a step into a new phase, a new department called the Audi Hungaria Internal Combustion Engines Department was opened at István Széchenyi University in Győr. Its research

[29] In 1997 the trade department of Opel Hungary in Budapest was given regional functions. The newly created organization became independent under the name Opel Southeast Europe Ltd. Its responsibilities include organizing sales-related tasks for Hungary and several Central and Eastern European countries as well.

profile is the design and development of internal combustion engines, along with the development of alternative automotive drive systems and automotive industrial technologies.[30]

The inter-firm tasks of *Mercedes-Benz Hungary* have been expanding from the beginning. The tool making department cooperates with German plants; parts are delivered to the German plants and to those of the Finnish partner. Because of the importance of the product segment and increasing demand for models, cooperation has been deepening since 2012. In the area of functional upgrading, *Mercedes-Benz Hungary* is very proactive. In 2009 *Mercedes-Benz Hungary* made the strategic decision to introduce dual vocational training in the factory. In 2011 Mercedes-Benz Hungary signed an agreement with the Faculty of Mechanical Engineering and Automation (GAMF) of the College of Kecskemét to cooperate in dual education. Additionally, an exchange program was started which enables students from all the plants around the world to visit the factory in Kecskemét. There is close cooperation between the German and Hungarian factory sites not only for students, but for engineers from the R&D departments as well.

### 3.4 Changing Subsidiary Position and Embeddedness

Examples of product assortment expansion have been mentioned above. This leads to the allocation of certain functions to local subsidiaries and changing the position of the affiliate within the global value chain. New functions increase embeddedness, providing the affiliate as well as the local suppliers with more functions. Functional upgrading, i.e., cooperation with local organizations and educational institutions, also increases embeddedness.

*Opel Szenttgothárd* started final assembly of cars in 1992. Due to the optimisation of production within the global value chain, and improved market and production conditions, the owner considered developing final car assembly capabilities in Poland and China, and to cease assembly operations in Hungary altogether. In other cases, relocation was favourable for the Hungarian affiliate. As a result of the former crisis, GM reorganized its global value chain, and with it optimized European production. In Bochum (Germany), employees and IG Metall did not agree to the bailout program, and GM management decided to close the factory by the end of 2014. Contrary to this, as a result of good relations between employers and employees due to additional investments, Szentgotthárd will become the primary engine producer of Opel AG in the medium-term. Expansion of engine production from 2012 saw some functions being outsourced

[30] http://tmk.sze.hu/department-of-audi-hungaria-internal-combustion-engines

to suppliers. As such the factory has approximately 400 subcontractors and employees working in the field of engine production.

Continuous development has led to even more functions being delegated to *Audi Hungaria*. The Győr plant became the leading engine producer within the Audi Group, serving other Volkswagen factories as well. The company's global position was improved in 2013 when complete car production started, making *Audi Hungaria* a fully-fledged company.

We attempted to classify the three companies based on the type of governance introduced by Gereffi and his co-authors (2005). They defined governance models based on three factors: the complexity of information exchange; the codifiability (adoption of technical standards) of knowledge; and the capabilities resident in the supply-base. As the author concluded, the type of governance depends on the technological characteristics of the product, i.e., the complexity of production.

Sturgeon and his co-authors (2008) highlighted the complexity of the investigation of governance as global integration continues to drive the complexity of the analytical problem upward. Schmitt and Van Biesebroeck in a current piece of research[31] are investigating the governance in the automotive supply chain using empirical analysis. They separate profit, value added and research and development linkages. They find that in the case of the profit and the value added activities, the relations show *modular* type while in the case of R&D the relations are *captive*. Using this approach in terms of value added, Opel and Audi have modular and Mercedes-Benz has hierarchical governance. Concerning R&D, the governance of Opel is captive, while those of Audi and of Mercedes-Benz are relational and hierarchical, respectively. Differences can originate the position of the subsidiaries within the MNCs, and also the type/complexity of the final products.

## 4. Policy implications

Our study, which is based on the cases of heavy engineering and automotive firms, has some implications for managers. It seems that the three best ways for local subsidiaries striving to gain access to additional resources and engage in further upgrading are as follows:

[31] "Relationship governance in the automotive supply chain" http://www.rug.nl/research/ggdc/activities/workshops/eframe/slides/session2_vanbiesebroeck.pdf based on a work in progress: Schmitt, A. - Van Biesebroeck, J. Relationship governance in the automotive supply industry - an integrative approach. University of Leuven, Faculty of Economics and Business.

1) Excel in absorbing the mother companies' transfers and continuously demonstrate local capabilities;
2) Be aware that the various upgrading channels (product, process and functional) are interrelated: try to identify the interrelated aspects of past specific upgrading results and 'push' to achieve new opportunities in the given fields;
3) Lay particular emphasis on intangible transfers: try to gain additional intangible investments in a variety of conventional (footnote 10), and unconventional, fields by taking initiatives and gaining the attention of headquarters (Bouquet–Birkinshaw, 2008). This latter recommendation led us to the policy implications of our findings.

First of all, the surveyed cases have demonstrated the importance of plugging into global value chains, which need to be supported by all possible means (including support to both inward and outward FDI, and the promotion of MNC subsidiaries' backward linkages –Antalóczy et al., 2011).

Secondly, TIPA's case demonstrated the importance of business development and entrepreneurial learning. This finding highlights the often neglected difference between upgrading by subsidiaries integrated in the global value chains as part of their MNC owner's organisation, and industrial upgrading (see e.g. Kawakami–Sturgeon, 2011). This latter requires the promotion of entrepreneurship or, in broader terms, the development of the national system of entrepreneurship (Ács et al., 2014) that needs to *complement* the FDI-based modernisation trajectory Hungary has been following.

Thirdly, and finally, as the case of Grundfos has demonstrated, large local subsidiaries of blue chip, global companies have a special role in driving growth and industrial upgrading in Hungary. As Bouquet and Birkinshaw (2008) have demonstrated, weight is a strong explanatory factor of headquarters' attention and commitment: these flagship subsidiaries have greater-than-average upgrading perspectives (see also: Birkinshaw et al., 2007). (Notice that IGM is equally in a special position in terms of weight, being the largest production site in Europe).

Consequently, policy should treat these companies with special care, for example, initiate regular regional and national level consultations with the representatives of these companies, in order to ensure that the framework conditions of their operation becomes, and remains, optimal.

## Conclusion

This paper discussed the experience of three machinery suppliers and three automotive OEMs. Industrial upgrading, global learning and transfer of general production principles can be observed in all of the automotive companies. The upgrading process appears mostly through changing the position/role of the subsidiaries within the firms' global value chain. There are differences among the firms in terms of the scale of the upgrading. It not only depends on the owner's global strategy, but also on the type of final products.

That *Mercedes-Benz Hungary* is a final assembler closely cooperating with two other production plants, therefore using global solutions as well as implementing new methods and technologies is beyond question. Technological and organizational upgrading means using and implementing Daimler AG's global solutions during the whole production process (from procurement to sales). *Audi Hungaria* has become a strategic subsidiary, not only in the case of the internal combustion engines (gasoline and diesel), and R&D activities, but in the final assembly, as well as the exclusive complete production of certain classes. The upgrading process is continuous, using not only the innovations of the MNC's global solutions but also the know-how of local employees. *Audi Hungaria* is the textbook example of global learning and transfer. *Opel Szentgotthárd* – after an optimisation/rationalisation process – maintained its engine production and expanded its portfolio with the production of transmissions. The negative effects of global trends were most conspicuous here. The impetus of the upgrading process is precisely reflected in the changes (relocations) within the global company. After the inauguration of the Flex-plant it became able to increase and change its engine production more flexibly to keep in step with changing market conditions. This was a great upgrading leap forward, raising the affiliate in the company's hierarchy.

An overarching finding of our interviews was that plugging into global value chains accelerates the development of local subsidiaries: in a continuous *technological, organisational and management learning* process they *co-evolve with their MNC owners*. Owners provide the necessary means for subsidiary learning and upgrading, in the form of tangible and intangible investments, and through providing markets for the subsidiaries' products. In terms of product upgrading, the surveyed subsidiaries depend on their mother companies: products developed in the central and/or regional research departments are transferred to the premises of the Hungarian production facilities. Nevertheless, some of the surveyed companies host R&D and testing facilities, hence they contribute to a smaller or larger extent to overall R&D activities.

'Entrepreneurial' subsidiaries (Birkinshaw, 1997, 1998) compete (internally) for additional resources and upgrading opportunities, by successfully absorbing the transferred resources, demonstrating their capabilities and taking initiatives on their own.

Another finding was that there is a strong, positive relationship between size and intangible investments: large and powerful global MNCs are more inclined to invest both in 'conventional' knowledge-based assets[32] and in intangible assets the returns from which is ambiguous[33] (such as corporate culture, CSR, supplier development programmes). This finding is important given that a large and increasing number of studies contend that intangible investments have substantial spillover effects; and contribute to productivity increase (as intangible assets are complementary to tangible assets, such as up-to-date production machinery – Corrado et al., 2014; Goodridge et al., 2012; Khanchanapong et al., 2014).

Furthermore, our interviews suggested that upgrading is not a one directional process: external factors, such as changes in the business environment and/or in parent companies' strategic decisions may result in the partial loss of previously gained mandates. For example, globalisation tendencies often force large MNCs to centralise selected functions and improve thereby the efficiency of support activities. Consequently, the loss of certain areas of competence is in most cases independent of the local companies' performance.

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[32] Traditional intangible assets include innovative property (R&D and design-specific intellectual property rights, and technological competencies); organisational assets (embodied in firm-specific human capital, organisational practices, reputation, brand equity and business network) and computerised information (firm-specific information solutions and databases) – Corrado et al., 2005; Görzig–Gornig, 2013; OECD, 2013.

[33] Or, at least, return on investment in these intangible assets seems more elusive than the return on traditional intangible investments.

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