The New Global Linkages and Innovation in Production Networks: a Comparison of Polish and Turkish Autocomponents Clusters

Guldem Ozatagan
Department of Geography,
School of Social and Cultural Studies,
University of Sussex,
Brighton, UK
G.Saral@sussex.ac.uk

Economic Geography Research Group

Working Paper Series No. 03.07

THE NEW GLOBAL LINKAGES AND INNOVATION IN PRODUCTION NETWORKS: A COMPARISON OF POLISH AND TURKISH AUTO-COMPONENTS CLUSTERS

Paper presented at the RGS/IBG Economic Geography Annual Symposium, 6-8 June 2007, Brighton, UK

Guldem Ozatagan
Department of Geography, School of Social and Cultural Studies, University of Sussex, Brighton, UK, G.Saral@sussex.ac.uk

Abstract

In recent decades, many industries have gone through a process of significant restructuring where peripheral locations are becoming increasingly important as nodes in this process of creating global production networks. They are transforming themselves and building new linkages to the newly emerging global production networks. This paper aims to investigate these new linkages peripheral locations are building to integrate themselves to the emerging production networks and analyse the performance of the networks they have built. To pursue these objectives, we draw on primary data gathered through structured interviews with firms in Turkish and Polish auto-components clusters. The data is employed to compare the two clusters regarding the linkages they have built in global production networks, the nature of these linkages, and the innovativeness of the two clusters. Results from quantitative analysis show that the two clusters which have built different types of linkages in global networks of auto-production are equally innovative but the difference lies in their innovative behaviour. Based on the findings we discuss the possible explanations and argue that the two clusters are taking advantage of the different dynamics characterising their industrial histories, the reorganisation of the industry and the linkages they have built.

I. INTRODUCTION

In recent decades, the processes of technological innovation and economic globalisation created important changes in many industries. This process created a wave of research in economic geography which studied the reorganisation process industrial systems have gone through. Different strands of research directed attention to different aspects of this process. Among these, an initial wave of research studied the global commodity/value chain in which firms operate. Global commodity chains are defined as 'sets of inter-organisational networks clustered around one commodity or product, linking households, enterprises and states to one another in the world-economy.' (Gereffi, 1994:2 cited in Palpacuer and Parisotto, 2003). The literature on commodity chains showed how fragmented and globally dispersed production activities are functionally integrated and coordinated in the absence of vertical integration (hierarchies). This research showed the growing significance of lead firms in global value chains-mainly global buyers- in coordinating globally dispersed production and distribution systems with control over intangible activities such as product design and development, marketing and logistics (Gereffi, 1994; Gereffi, 1999; Dolan et al., 1999 retail; Dolan and Humphrey, 2000 retail). Evidence mainly comes from buyer-driven chains like horticulture and retail, with limited evidence on producer-driven chains (examples mainly come from the automotive industry: Humphrey, 2003b; Humphrey and Memedovic, 2003).

One other strand of research directed attention to another important aspect of this restructuring process, which is that peripheral locations becoming increasingly important actors. Linking the initial wave of research on commodity/value chains and the research on industrial districts/clusters this research identified that they are transforming themselves and building new linkages in the newly emerging production networks, and studied the ways in which they are integrated in global networks of production and the impact of this on the ways in which they upgrade (Humphrey and Schmitz, 2002; 2004; Schmitz and Knorringa, 1999 footwear chain; Bazan et al., 2004 Sinos Valley, Brazil; Memedovic, 2004; Pietrobelli and Rabellotti, 2004; Schmitz, 1999 footwear Sinos Valley; Schmitz, 2004). Evidence based on comparative and historical analysis based on interview data with small samples.

A third strand of research on the other hand directs attention to the networks of firms and focused on understanding the complex sets of inter-firm linkages/production networks and how these are organised around a flagship firm at the global scale. (Sturgeon, 2001 cited in Palpacuer and Parisotto; Coe et al., 2004; Sturgeon, 2003; Berger et al., 2001; Henderson et al., 2002). Evidence from complex assembly industries such as electronics and automotive is used to understand how power is distributed in these networks and value is created, enhanced and captured. Empirical work mainly points to the emergence of modular production networks where the exchange of codified information links the functionally specialised value chain nodes of tacit knowledge (Sturgeon, 2003).

One important aspect of the three lines of research is that they focus on the nature of the linkages in global networks of production and argue that the different ways in which these linkages are coordinated importantly affects the transfer of knowledge and has significant impacts on innovation. This evidence tend to be based on interviews and case studies with small samples and provided limited quantitative evidence to adequately deal with cross-country differences nor with an evaluation of the different linkages and their impact on innovation as a whole (an exception is Pietrobelli and Saliola, 2006).

This paper adopts elements of these three strands of research in its investigation of the linkages peripheral nodes have built in global production networks and its impact on their innovativeness. But the paper is distinctive in its focus on cross-country analysis and its use of quantitative techniques. Drawing upon a case study of two auto-components clusters in Turkey and Poland, the paper is able to identify different types of linkages that firms operating in these clusters have established in global auto-production networks, examine in detail the nature of these relationships and analyse how this impacts upon firms' innovativeness. In this analysis, we are mainly concerned with two issues: (1) compare the two clusters regarding (a) the linkages they built in global auto-production networks and the nature of these linkages (b) the degree of their innovativeness and (c) their innovative behaviour (2) study the link between the type of linkage the two clusters built and their innovativeness (how the degree of innovativeness and the innovative behaviour differs by the nature of the linkage two clusters established in global production networks).

The rest of the paper is organised as follows. The paper starts with a review of the theoretical approaches to understand the new global linkages and their impact on innovation. In Part III the paper details the research questions and methodology and offers a descriptive comparison of the two cases studied. Part IV. deals with the results emerging from the quantitative analysis of the association between different types of inter-firm linkages in global production networks and firms' innovativeness. Finally, in the conclusions, the paper discusses the theoretical and empirical implications of the findings and makes further remarks.

II. UNDERSTANDING THE NEW GLOBAL LINKAGES AND INNOVATION: SOME THEORETICAL CONSIDERATIONS

One important aspect of the global value chain and global production networks literatures is their recognition networks as a form of organising and coordinating the globally dispersed production activities. Doing so, they placed networks between *vertically integrated corporations (hierarchies)* and *arm's-length market relations* and aimed to understand the new global linkages observed in production networks and their nature. The literature is full of empirical evidence from different chains and different localities which are characterised by different linkages with different nature. In the first section of this part, we will summarise the different types of linkages identified in the literature. In the second section we will turn to the implications for innovation.

II. 1. The new global linkages in production networks

The initial work of Gereffi where he identified the power of leader firms in buyer-driven chains provided the grounds for proving the existence of power in global value chains. Developing this idea that linkages established in global value chains are not homogenous, Humphrey and Schmitz (2000, 2002) distinguished between **network relationships** and **quasi-hierarchical relationships.** This distinction is grounded on the argument that in some networks the doubts of the lead firm about the *competence of its supplier* leads to a situation where the lead firm dominates its supplier by *specifying product characteristics* and *how products are to be produced* (Schmitz, 2004). Accordingly, while in networks relationships are characterised by shared/complementary competences between the interacting firms and the relationship is based on the equal exchange of information; in quasi-hierarchical chains the relationship is uneven, which is characterised by the dominance of the leader firm *by specifying product characteristics and how they are to be produced.* Support to this idea comes mainly from buyer-driven chains in developing country clusters. Schmitz's (1999) research on footwear manufacture in Brazil shows how the producers were dependent on a few large customers for their sales and also on their design capabilities for the shoes they produce (quasi-hierarchy).

A rather different classification comes mainly from global production networks literature, mainly based on research in producer-driven chains in Gereffi's terms. Berger et al. (2001) identify three types of production networks, namely captive, relational, and turn-key production networks. **Captive production networks** are networks where tiers of suppliers are coordinated by dominant lead firms. Here, suppliers are dependent on a small number of key customer firms and most of the time formed through equity investments of lead firms in their suppliers over time in order to dominate them financially. In this description Berger et al.'s captive production networks correspond to Humphrey and Schmitz's quasi-hierarchical chains. Rather different, however, is their view of **relational networks**, which are built through long-term relationships between firms through social and spatial proximity. In this sense, relational networks correspond to the idea of networks in the industrial district/cluster literatures. Finally, in **turn-key production networks** lead firms ask and provide technical and financial assistance to their suppliers to adopt specific production technologies and quality systems. The difference from captive networks is that in turn-key networks' a merchant character is achieved through the diversity of customers. The focus of such networks is on cost-cutting, price-based supplier relationships and competitive switching of partners.

In a different manner, Sturgeon (2002) and Sturgeon and Lee (2001) differentiate between three types of suppliers based on *the degree of standardisation of products* for electronics and contract manufacturing. The **commodity supplier** provides standard products through arm's length market relationships; the **captive supplier** makes non-standard products using machinery dedicated to buyer's needs; the **turn-key supplier** produces customized products for buyers and uses flexible machinery to pool capacity for different customers. In fact, Sturgeon (2002) and Sturgeon and Lee (2001) classifications rest on *the nature of information exchanged between the interacting firms* and *the degree of asset specificity in production equipment* (Gereffi et al., 2005).

Later Sturgeon (2000, 2002, 2003) introduced **modular production networks** as an emergent type of network observed in the US electronics and automotive industry. In his view modular networks are thinly relational, looser networks because of the *extensive codification* and *deepened capabilities of the suppliers*. Modular networks are more open in character in that the interdependence between firms is reduced by the extensive use of ICT as well as product and quality standards, which altogether enable the transfer of codified knowledge between the interacting firms, and hence reduce the necessity for tacit linkages across the inter-firm link. With the introduction of modular networks as another type, Sturgeon's (2000, 2002) classification encompasses three types; namely captive/authority networks, relational networks, and virtual/modular networks[1].

As can be seen the literature provided a variety of linkages/networks with emphasis on different variables. In some cases same names are given different explanations (as in the case of 'relational' networks/chains), in others networks with similar characteristics are given different names (as in the case of turn-key and modular networks). In the following sections, we will try to develop a typology to study the different linkages in global production networks. But before doing that we shall turn to the relationship between networking and innovation.

II. 2. The relationship between networking and innovation: the impact of power asymmetries on firms' innovative behaviour

The literature-mainly the global value chain literature- goes further from identifying the different linkages in global value chains and considers the different ways in which firms within global value chains can upgrade. GVC defines upgrading as innovating to increase value added by entering higher stages of the value chain (Giuliani et al., 2004 cited in Pietrobelli and Saliola, 2006; Morrison and Rabellotti, 2006). There are three different ways to upgrade; by entering higher unit value market niches, by entering new sectors (sectoral upgrading), or by undertaking new functions other than production (functional upgrading). Upgrading implies growing up the value ladder, moving away from activities in which competition is of the 'low road' type and entry barriers are low.

Empirical work shows how inter-firm relations in global production networks foster upgrading activities. They stress on the specific types of linkages in global production networks in fostering different types of firms' upgrading activities. The main argument is that

[1] In Berger et al.'s (2000) and Sturgeon's categorisations relational networks is narrower and corresponds to social relationships based on trust and reputation, observed in Italian industrial districts and overseas Chinese in East Asia. However, Humphrey and Schmitz's conceptualisation of relational networks is broader, characterised not by the 'social' component but by the equality or the mutual dependency between the partners in the network. In this paper we take on the latter view.

knowledge transfers and upgrading activities are constrained by the governance structures in the value chain in which actors are embedded in (Morrisson and Rabellotti, 2006).

Emphasis is mainly put on quasi-hierarchical chains, which are said to rapid product and process upgrading while they are usually hindered from functional and sectoral upgrading (Humphrey and Schmitz, 2002; Schmitz, 2004). The reasons for these results are that local firms are forced by their buyers to differentiate products and are provided with technical assistance and best practice management and production (Florida, 1995 cited in Cumbers, 2000; Kaplinsky, 1995; Posthuma, 1995) as well as mechanisms facilitating adherence to common procedures, rules and standards (Schmitz, 2004; Schmitz and Nadvi, 1999; Nadvi, 1999; Nadvi and Kazmi, 2001). However, these local firms are dependent on their buyers in terms of core competences like design, marketing and branding and are discouraged to develop them. These ideas are supported by research in developing country clusters (Schmitz and Knorringa, 2000 cited in Humphrey and Schmitz, 2002; Schmitz and Knorringa (2001) cited in Morrisson and Rabellotti, 2006; Bazan et al., 2004 cited in Morrisson and Rabellotti, 2006) where large, global buyers define design, marketing and branding as their core competence and do not want to share these competences with others in the value chain. They conclude that *power relations may inhibit upgrading and limit knowledge flows* within the chain.

Humphrey and Schmitz (2000, 2002) distinguish between different types of chain governance and investigate its link between different types of upgrading. Using evidence from Sinos Valley, Brazil, they argue that producers in quasi-hierarchical chains made progress in process upgrading, whereas functional upgrading (design, branding, and marketing) is limited. On the other hand, market-based relationships provide space for functional upgrading but with a cost (early transmission of market requirements is necessary, they usually cannot get information about market requirements nor assistance to meet these requirements but product and process upgrading is slow (not fostered by buyers). Compared to these types of chains, the GVC favour networks, where complementary/shared competences between the interacting firms allow equal exchange of information and provide different upgrading opportunities.

The global production networks literature is less explicit about the implications for upgrading of the different types of production networks. But they implicitly favour modular production networks in that increased codification with extensive use of ICT and standards in these networks reduce the dependency of interacting firms and hence allow flexibility, which in turn contributes to their performance.

III. THE NEW GLOBAL LINKAGES AND INNOVATION IN PRODUCTION NETWORKS: Evidence from the Turkish and Polish auto-components clusters

III.1. Research questions and methodology

In light of the discussions in the literature, this paper will address the following questions:

1. what different types of linkages are peripheral locations building in global networks of auto-production?
2. to what extent are these peripheral industrial clusters different regarding their innovativeness?
2a. are peripheral locations building different linkages different in terms of the degree of their innovativeness?

2b. are they different regarding their innovative behaviour?

To provide answers to these questions we applied a case study approach in the two auto-components clusters, namely Bursa in Turkey and Upper Silesia in Poland. With the help of the case study of these two different clusters we hope to understand the different ways in which the two auto-components clusters located at the periphery of automotive production are integrated in global auto-production networks and the possible implications for their trajectories. The two cases studied represent two peripheral areas with different industrial histories while they are similar regarding the development of the components industry primarily via the development of the production network of Fiat.

The existence of Fiat in Poland dates back to 1975 when the first licence agreement was signed by the FSM and the assembly plant of FSM-Fiat was established. Relations with Fiat had been problematic until 1992 when Fiat acquired the Polish car company FSM. After that time, Fiat's started to look for suppliers in 1995 for the growing production of the Fiat plant in Tychy and an assembly plant of Opel (GM) was established in Gliwice in 1995, which altogether have attracted a number of global component manufacturers and made Upper Silesia take the largest share of the new capital (Domanski et al., 2005). This process later attracted other foreign component suppliers and also led to the development of local Polish companies as suppliers of Fiat and Opel.

The components industry has a much longer history in Bursa, the start of which dates back to the 1960s as an assembly industry. This niche of the components industry developed when three car manufacturing companies (Karsan under the licence of Peugeot in 1966, Tofas under the licence of Fiat in 1971 and Oyak-Renault under the licence of Renault in 1971) also made investments in component suppliers. The protectionist import substitution policies of the time contributed much to the development of the local Turkish component companies and with the export oriented policies of the 1980s started the integration of local companies to the world auto production network as component exporters.

III.2. Data

The data presented here was collected in December 2005-December 2006 using structured face-to-face interviews in Bursa and telephone interviews in Upper Silesia. The list of firms operating in the auto-components industry is provided by the Chamber of Industry and Commerce and by the Undersecretariat of the Prime Ministry for Foreign Trade for Bursa, Turkey (2005) and by the Central statistical Office and Polish Information and Foreign Investment Agency (2006) for Upper Silesia. The original database included information on the name, location, telephone number and addresses of 406 firms in Bursa and 138 in Upper Silesia. Of these firms 38 of them were inaccessible in Bursa and 35 in Upper Silesia either because of wrong contact information or because the firm started to operate in another sector. Out of the 368 accessible firms in Bursa, 103 of them provided consistent and usable information leading to a response rate of more than 25%. Of the 103 accessible firms in Upper Silesia we could approach 31 but we obtained only 19 usable interviews, resulting in 18% response rate (Table 1).

Table 1: Survey results by country

	Bursa, Turkey	**Upper Silesia, Poland**

	Number of firms	%	Number of firms	%
Firms interviewed	103	27.99	19	18.12
Firms which provided inconsistent/missing information	3	0.81	12	11.65
Firms which refused	24	6.52	72	69.90
Firms not contacted	238	64.67		
Total	368		103	

*Includes firms which could not be accessed because of wrong telephone number or because they started to operate in a different sector.

III.3. Empirical Assessment of Inter-firm relations and Innovation in Peripheral Auto-Components Clusters

III.3.1. Inter-firm relations

Building the typology of inter-firm relations

Taking into account the theoretical arguments developed by the GSC/GPN literature, 3 dimensions of the nature of inter-firm dimensions are identified. These three dimensions are:
1. client specification of product characteristics and standards: Identified on the basis of the following questions:
- the extent to which the business partner specifies product characteristics.
- the extent to which the business partner contributes to the improvement of quality and technical standards

2. client engagement in product and process development, technology improvement, and training: Identified on the basis of the following questions:
- the extent to which business partner is involved in product and process development
- the extent to which business partner is involved in improving technology
- the extent to which business partner is involved in training
3. supplier capability in design and product and process development. Identified on the basis of the following questions:

-the degree of local firm's involvement in the definition of product characteristics: the extent to which the firm offers suggestions to improve original design and specifications; to suggest modifications and improvements in product features
-the degree of local firm's involvement in research and development activities: the extent to which the local firm develops new products; develop new production processes; develop new designs of moulds, equipments, etc.)

Firms are expected to attribute a degree to each of these variables ranging between 'no involvement', 'to some extent' and 'to a large extent'. Each degree of involvement is given a value of 1. The value for each dimension is defined as the sum of the values attributed to each variable under the relevant dimension, divided by the maximum possible amount for each of the three dimensions.

Cutting across these three dimensions, firms with a coefficient between 1 and 0.67 are classified as 'high' and those with a coefficient less than 0.67 are classified as 'low'. Firms are classified on the basis of their 'high' and 'low' positions on each of these dimensions and

these three dimensions are combined to develop a typology of inter-firm relations that might be observed.

A synthesised typology of inter-firm relations

The high and low values in these three dimensions are combined to yield six types of inter-firm relations, reflecting the earlier discussion of asymmetric power relations in networks[2]. Table 3 summarises the resulting types of inter-firm relations.

Type 1 is typical of vertically integrated firms, which are characterised by ***hierarchical*** relationships where the subsidiary rests on the tacit knowledge diffused from the headquarter in the form of technology and R&D. The need to effectively manage inputs and outputs and control resources by the headquarter abandons the subsidiary to develop capabilities in design and research and development.

Type 2 is typical of ***market-based*** relationships where price-based information flows between the supplier and the customer. It is characterised by high involvement of clients in specifying product characteristics and standards, but low involvement in technology and R&D related activities. In this type of relations the local firm's capability in product and R&D related activities is high.

Type 3 defines ***relational*** networks, where client specification of product characteristics and standards is low but tacit knowledge is exchanged between the supplier and the customer. In that respect, the local firm and its client both take active part in technology and R&D related activities. Compared with hierarchical relations, the fragmented organisational structure associated with relational networks allows the flexibility to meet the requirements of small batch production, short lead times, fast delivery, and quick market entry and exit (Sturgeon, 2002).

Table 3 Classification of the inter-firm relations/typology of inter-firm relations:

Type of relationship	***Client specification of product characteristics and standards/*** *transfer of codified knowledge from the client*	***Client engagement in complex transactions/*** *transfer of tacit knowledge from the client*	***Supplier engagement in complex transactions/*** *supplier capability on complex transactions*
Hierarchy	Low	High	Low
Market	High	Low	High
Relational	Low	High	High
Modular	High	High	High
Captive	High	High	Low
Exclusion/ locked in	High	Low	Low
Unlikely	Low	Low	High
Unlikely	Low	Low	Low

[2] The resulting types of relationships correspond to the different types of networks specified in the literature, which are recently synthesized by Gereffi et al. (2005). Although Gereffi et al.'s (2005) emphasis is on different variables, still they are related with the ones used in our research.

Type 4 is typical of ***modular*** relationships where suppliers make products to customer specifications using their capabilities in technology, design and product and process development. In modular networks, the thickness of inter-firm relations and the mutual dependency between the interacting firms are reduced by codified applications. This also allows the lead firms to reduce the risks and costs of setting up production facilities of their own and reconfiguring the geography of their production operations on a global basis. Compared with market relations, the information that flows between the interacting firms is of higher value, which extends beyond the simple price-based information but still the focus on cost-cutting and price-based supplier relationships is maintained. In that respect, modular networks provide low costs, rapid technological diffusion, flexible relationships and geographical flexibility (Sturgeon, 2002).

Type 5 appears when the customer provides the supplier with the necessary specifications and standards required to make complex products. In this way, the customer maintains a high degree of monitoring and control of the supplier. The supplier's dependence on the customer in tacit activities like design, technology and research and development prevents it to develop capabilities in these activities, which makes the relationship ***quasi-hierarchical/captive***. Customer's investment in the development of the supplier capabilities results in technological upgrading in the supply base as well as increased efficiency created by increased quality, low cost, quick delivery, and flexibility.

Type 6 is characterised by high involvement of the customer in specifying product characteristics and standards but low engagement in tacit activities. The low capability of the suppliers in design, technology as well as product and process development makes it likely for the supplier to be excluded from the relationship. Sturgeon and Lester (2004 cited in Gereffi et al., 2005) argue that increasing requirements for suppliers makes exclusion more likely to occur. Gereffi et al. (2005) underline that this case is important as it opens up a discussion for the problems faced by developing country suppliers and their upgrading opportunities.

The remaining two categories are unlikely according to the predefined typology. Hence firms which show this type of relationships in our sample are eliminated from further analysis with the assumption that the interview was not healthy.

Patterns of inter-firm relations in Turkish and Polish auto-component clusters

Table 4 shows the distribution of firms in Turkey and Poland by the type of inter-firm relations they established in global networks of auto-production. It seems that firms in Bursa become integrated in global auto-production networks dominantly through establishing modular (45.83% of firms), while firms in the Polish sample are dominantly integrated through hierarchical type of relations (47.06). While 17.65% of firms in the Polish sample established modular and captive relationships each, firms which show market type of relations are not represented in the Polish sample. The percentage of firms with captive and market relations as the next extensive type of relations observed in the Turkish sample are 14.58% and 11.45% respectively.

Table 4. Inter-firm relations in Bursa and Upper Silesia

			Type of inter-firm relation						Total
			modular	market	captive	relational	exclusion	hierarchy	
City	Bursa	Count	44	11	14	10	9	8	96
		% within city	**45.83%**	11.45%	14.58%	10.42%	9.37%	8.33%	100.0%
	Upper Silesia	Count	3		3	2	1	8	17
		% within city	17.65%		17.65%	11.76%	5.88%	**47.06%**	100.0%
Total		Count	47	11	17	12	10	16	113
		% within city	41.59%	9.73%	15.04%	10.62%	8.85%	14.16%	100.0%

III.3.2. Innovativeness of firms in Turkish and Polish auto-components clusters

Measuring innovation
With regards to innovation, we follow the systemic view deriving from innovation systems literature. Our view of innovation is broad which covers both the activities performed (not only the development of new products, processes and designs but also the improvement of existing ones as well as marketing and branding activities), and changes in technology, organisational, and work systems.

a. Improvement of production process:
- Increasing production speed
- Cost price reduction
- Improving delivery speed
- Improving product quality

b. Product and process development
- Develop new products
- Develop new processes
- Modification of existing products and processes
- Develop new designs (moulds, equipment, etc)

c. Marketing and branding

The sum of 'usually' and 'always' answers are divided by the number of these variables for each innovation activity.

d. Innovation in work systems:
- Documentation of procedures
- Use of batch trays
- Use of statistical process cards
- Use of travel cards

Collection and analysis of cell performance data
Stock control and traceability

The sum of all 'to a great extent answers' are divided by the number of these variables.

e. Innovation in technology systems:

The sum of all 'yes' answers to the question which asks whether the firms have invested in a number of IT hardware and software to the number of these variables.

f. Innovation in HRM systems/organisational system/implementation of advanced management techniques:

Team working
Suggestion schemes
Workplace rotation
Delegation of responsibility
Performance award systems
Personal development schemes

The sum of 'to a large extent' answers are divided by the number of these variables.

From here, we derived two variables to measure the firm innovativeness. First, the *degree of innovativeness* is calculated by the sum of each individual coefficient regarding the six types of innovation activity. The resulting degree of innovativeness is recoded into four categories as low, medium, medium-high and high. Then, due to the low frequencies of the first two categories they are recoded into one category as low. The resulting categories of the degree of innovativeness are 'low' (0-2.99), 'medium' (3-3.99), and 'high' (4-5.99).

Second, distinct groups of firms' *innovative behaviour* are identified using cluster analysis of the above described variables by Ward method. Since cluster analysis is a descriptive than an analytical tool, this is accompanied by a discriminant analysis to profile the resulting 3 clusters and identify the sets of variables that form the discriminant functions, which provide statistically significant differences between the resulting clusters.

Table 5. Results of cluster analysis: distinct groups of innovative behaviour

Types of innovative behaviour	Frequency	Percent	Valid Percent	Cumulative Percent
Process innovation oriented	47	41.6	41.6	41.6
Non innovative	16	14.2	14.2	55.8
Design and marketing oriented	50	44.2	44.2	100.0
Total	113	100.0	100.0	

Figure 1

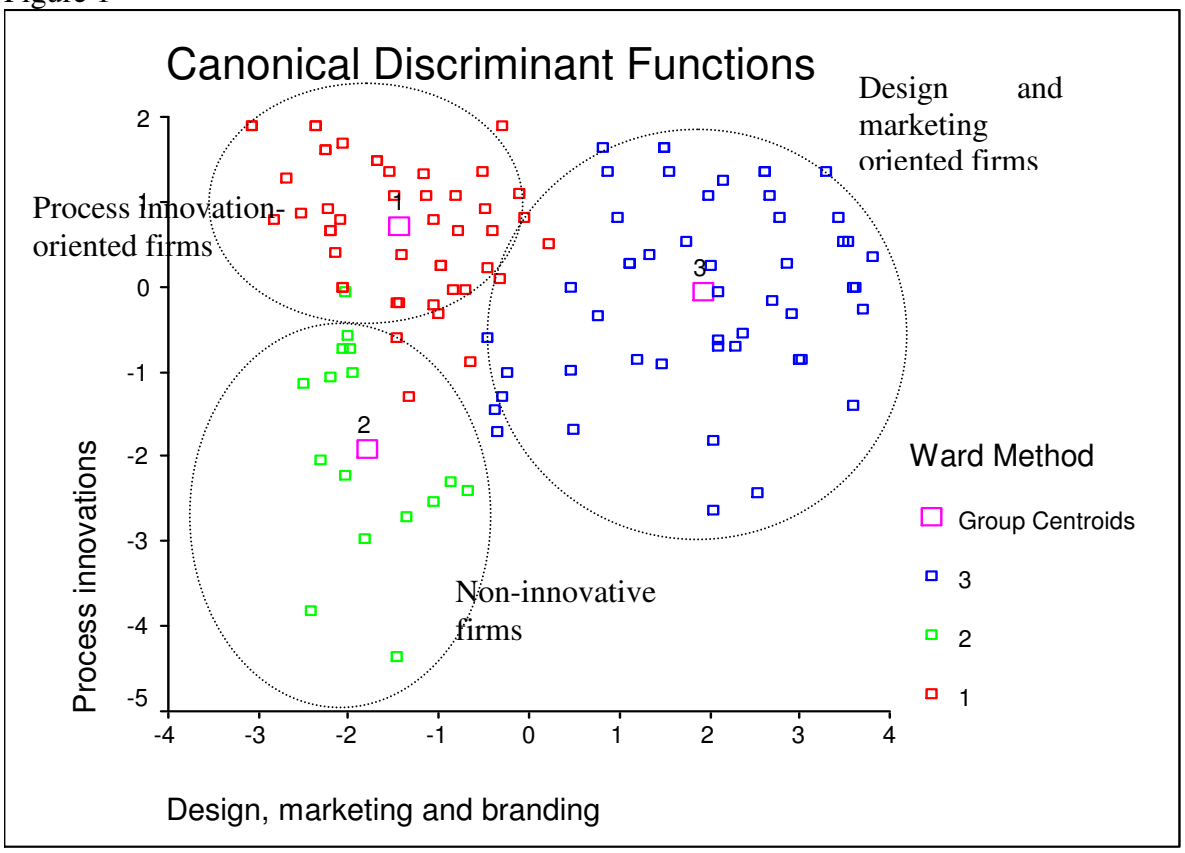

Table 5 shows the distribution of firms among the resulting three clusters. Results of discriminant analysis indicate that 92.9% of firms are correctly classified[3]. Interpreting the standardised coefficients (Table 8) and the functions for cluster centroids (Table 9) together with Figure 1, we see the resulting three types of firms clustered on the basis of their innovative behaviour. The innovative behaviour of firms in the first group, which represent 41.6% of the sample, is oriented to process innovations, while they have negative values in design, marketing and branding activities. What differ the firms in the second group (14.2% of the sample) from the other groups of firms is the negative values they have both in process innovations and in design, marketing and branding. This situation makes these firms non-innovative. Finally, the innovative behaviour of the third group of firms (44.2% of the sample) is oriented towards design, marketing and branding, with negative or close to zero values in process innovation.

Degree of innovativeness of firms in Turkish and Polish clusters

Table 12 shows the distribution of firms in Turkish and Polish clusters by the degree of their innovativeness. Almost 40% of firms in Bursa are highly innovative, while in Upper Silesia this figure is 31.6%. The percentage of firms with medium degrees of innovation in Bursa and Upper Silesia is almost equal (37.9% and 36.8% respectively); while there are more firms with low degrees of innovativeness in Upper Silesia (31.6%) than in Bursa (22.3%). Despite

[3] The univariate ANOVA shows for each variable except for 'improvements in production process' that the similarity of group means is significant (Table 6). Discriminant analysis generated two functions which are effective predictors of group membership, which account for more than 98% of the variation in the discriminant functions (Table 7).

these slight differences, however, the two auto-components clusters do not seem to be strikingly different from each other regarding the degree of their innovativeness.

Table 12. Innovativeness of firms in Bursa and Upper Silesia

			Degree of innovativeness			Total
			low	medium	high	
City	Bursa	Count	23	39	41	103
		% within city	22.3%	**37.9%**	**39.8%**	100.0%
	Upper Silesia	Count	6	7	6	19
		% within city	**31.6%**	**36.8%**	**31.6%**	100.0%
Total		Count	29	46	47	122
		% within city	23.8%	37.7%	38.5%	100.0%

Innovative behaviour of Turkish and Polish auto-components clusters

Table 13 summarises the distribution of firms in the two clusters on the basis of the three types of innovative behaviour that we observed in our sample. Although we could not find striking differences in the innovativeness of the two clusters, there are differences in the innovative behaviour of the two clusters. While almost equal percentages of firms in Bursa are process innovations oriented and design and marketing oriented (44.8% and 43.8% respectively), in Poland firms with process oriented innovative behaviour is half the design and marketing oriented firms (23.5% and 47.1% respectively). In design and marketing oriented innovative behaviour, Bursa and Upper Silesia seem to be comparable while process innovations oriented firms in Bursa (44.8%) are more than those in Upper Silesia (23.5%). Another striking difference between Bursa and Upper Silesia is regarding non-innovative behaviour. While 29.4% of firms in Upper Silesia are non-innovative, the share of non-innovative firms in Bursa is only 11.5%.

Table 13. Innovative behaviour of firms in Bursa and Upper Silesia

			Ward Method			Total
			Process innovations oriented firms	Non-innovative firms	Design and marketing oriented firms	
City	Bursa	Count	43	11	42	96
		% within city	**44.8%**	11.5%	**43.8%**	100.0%
	Upper Silesia	Count	4	5	8	17
		% within city	23.5%	**29.4%**	**47.1%**	100.0%
Total		Count	47	16	50	113
		% within city	41.6%	14.2%	44.2%	100.0%

III.3.3. Synthesising the findings: Comparison of Bursa and Upper Silesia as peripheral nodes integrated in Global Networks of Auto-production

Table 18 Comparison of Bursa and Upper Silesia

	DOMINANT TYPE OF INTER-FIRM RELATION	DEGREE OF INNOVATION	INNOVATIVE BEHAVIOUR
BURSA	MODULAR (46%) CAPTIVE (15%) MARKET (11%) RELATIONAL (10%)	MEDIUM AND HIGH (78%) LOW (22%)	DESIGN, MARKETING AND BRANDING (44%) PROCESS INNOVATIONS (45%) NON-INNOVATIVE (11%)
UPPER SILESIA	HIERARCHY (47%) MODULAR (18%) CAPTIVE (18%)	MEDIUM AND HIGH (69%) LOW (32%)	DESIGN, MARKETING AND BRANDING (47%) PROCESS INNOVATIONS (23%) NON-INNOVATIVE (30%)

Based on the findings it appears that Bursa and Upper Silesia represent two peripheral nodes with different industrial histories, which are integrated in global networks of automotive production in different ways. Despite the fact that Bursa and Upper Silesia are slightly different regarding their degree of innovativeness, overall being innovative seems to be a characterising feature of the two peripheral nodes. Significant differences, however, arise with regards to their innovative behaviour, which shows that the two nodes achieve similar performances in different ways. First, the significance of design, marketing and branding oriented innovations are more or less similar in the two nodes (with Upper Silesia being slightly more innovative). Second, it seems that firms in Bursa are taking advantage of a variety of innovation activities (not only design, marketing and branding but also process oriented innovations); while for firms in Upper Silesia process oriented innovations are not equally important. May we explain these differences with the type of inter-firm linkage the two nodes have built in global production networks? The following part deals with this question and asks if the different types of inter-firm relations associated with firms' innovativeness?

IV. ASSOCIATING INTER-FIRM LINKAGE AND INNOVATION

In order to test the significance of the typology of inter-firm linkages in explaining the innovativeness of firms, we apply ANOVA. We also carried out a post hoc test (LSD) to detect the particular pairs of relation types that differ significantly relative to the type of relationships with the highest values. In this section we will first comment briefly on the results on the association between the type of inter-firm relation and firms' innovativeness. Then, we provide possible interpretations for these associations.

Table 14. Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
total innovation	1.927	5	107	.096
innovation in technology systems	5.807	5	107	.000
marketing and branding	.494	5	107	.780
design, product and process development	.334	5	107	.891
innovation in work systems	5.576	5	107	.000
innovation in organisational systems	.594	5	107	.705
improvements in production process	13.526	5	107	.000

Table 15. Robust Tests of Equality of Means

		Statistic	df1	df2	Sig.
total innovation	Brown-Forsythe	5.441	5	46.670	.001
innovation in technology systems	Brown-Forsythe	3.101	5	31.634	.022
marketing and branding	Brown-Forsythe	2.918	5	67.740	.019
design, product and process development	Brown-Forsythe	8.065	5	76.503	.000
innovation in work systems	Brown-Forsythe	2.150	5	36.708	.081
innovation in organisational systems	Brown-Forsythe	2.216	5	76.273	.061
improvements in production process	Brown-Forsythe	.	.	.	.

a Asymptotically F distributed.
b Robust tests of equality of means cannot be performed for improvements in production process because at least one group has 0 variance.

Our analysis did not provide significant results for the homogeneity of variances test for three variables of innovativeness, namely marketing and branding, design, product and process development, and innovation in organisational systems. Since for these variables cell variances came out to be unequal, we rested our interpretations on the figures from Browns-Forsythe test as a substitute. The analysis did not provide results for improvements in production process because at least one of the groups appeared to have zero variance.

The results from ANOVA (Table 16) indicate that the type of inter-firm relations firms have established global networks of production does make a difference in firms' innovativeness (both overall innovativeness and different types of innovative behaviour, except for innovation in organisational systems). The results also show that firms' innovativeness in organisational systems does not vary by the type of inter-firm relationship they have established.

Table 16. ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
overall innovativeness	Between Groups	23.446	5	4.689	6.129	.000
	Within Groups	81.859	107	.765		
	Total	105.305	112			
innovation in technology systems	Between Groups	.954	5	.191	3.714	.004
	Within Groups	5.497	107	.051		
	Total	6.451	112			
marketing and branding	Between Groups	2.048	5	.410	2.905	.017
	Within Groups	15.089	107	.141		
	Total	17.137	112			
design, product and process development	Between Groups	3.573	5	.715	7.423	.000
	Within Groups	10.300	107	.096		
	Total	13.873	112			
innovation in work systems	Between Groups	1.209	5	.242	2.757	.022
	Within Groups	9.387	107	.088		
	Total	10.596	112			
innovation in organisational systems	Between Groups	1.392	5	.278	2.016	.082
	Within Groups	14.778	107	.138		
	Total	16.171	112			
improvements in production process	Between Groups	.312	5	.062	3.440	.006
	Within Groups	1.939	107	.018		
	Total	2.251	112			

Table 17: Types of inter-firm relations and innovativeness

Type of innovation/Type of inter-firm relation*	**I. MODULAR**	**II. MARKET**	**III. CAPTIVE**	**IV. RELATIONAL**	**V. EXCLUSION**	**VI. HIERARCHY**	**ANOVA test (Sig.)**	**Post-hoc test****
Overall innovativeness	**4.1980**	**3.5015**	**3.4189**	**3.8403**	2.6895	**3.6542**	0.000	**I>II,III,IV,VI** **I,II,III,IV,VI>V**
Innovation in technology systems	**0.8576**	0.7483	0.7466	**0.9167**	0.5692	**0.8462**	0.004	**I,IV,VI>V** **IV>III**
Marketing and branding	**0.5106**	**0.4545**	0.3529	0.2500	0.2500	0.1563	0.017	**I>IV,V,VI** **II>VI**
Design, product and process development	**0.6915**	0.3636	0.3382	0.4167	0.1750	**0.4375**	0.000	**I>II,III,IV,V,VI** **VI>V**
Innovation in work systems	**1.1277**	0.9351	0.9664	**1.1667**	0.8286	1.0268	0.022	**I,IV>V**
Innovation in organisational systems	0.7305	0.6061	0.7647	**1.0139**	0.6000	0.8229	0.082	**IV>I,II,V**
Improvements in production process	**0.9681**	**1.0000**	**0.9265**	**0.9792**	0.8000	**0.9063**	0.006	**I,II,III,IV>V**

*Mean value per type of inter-firm relation

**The test identified pairs which differed significantly. Here, we provided the results of significant pairs relative to the type of inter-firm relation with the highest value

In order to understand which differences are most important and contribute most to the significant F-ratios for these differences, Table 17 summarises results from post hoc test (LSD). The test compares the means of all possible pairs of the types of inter-firm relations and shows which combinations of means contribute most to the significant F-ratio.

The table shows the results for the differences for firms' overall innovativeness. It seems that firms with modular relations are significantly more innovative than firms with all other types of inter-firm relations. Despite this fact, however, the innovativeness of firms with modular, market, captive, relational and hierarchical relations does not seem to be strikingly different that the mean differences are not significantly different between each other. Overall, they are different only from firms with exclusion type of relations with their high mean values of innovativeness. A similar conclusion may be drawn for improvements in production process, where firms with all other types of relations are significantly different from firms with exclusion type of relations, with equally higher means.

Firms with *modular* type of inter-firm relations are significantly more innovative than firms with all other types of inter-firm relations. Moreover, regarding their innovative behaviour, they are more innovative in almost all types of innovation activity (except for organisational systems. This is evident in their high values not only in process related innovations but also in design, product and process development as well as marketing and branding. Despite these innovations, however, these firms do not show high levels of innovation in their organisational systems, which appeared not to differ significantly among the type of inter-firm relation) than firms with all other types of relations.

In contrast, firms which are faced with *exclusion* seem to be associated with patterns of limited innovative activity: they are typically different from firms with other types of inter-firm relations with their fairly low mean values for indicators of overall innovativeness and various types of innovative activity. Firms with *market-based relations* seem to be different from firms with other types of relations (except for firms with modular relations) with higher values in marketing and branding. Firms with *captive relations* are significantly more innovative than only firms with exclusion relations with a relatively higher mean in overall innovativeness.

Firms with *relational* type of inter-firm relations rank the second regarding mean levels of overall innovation and are the most innovative in technology systems, work systems and organisational systems. Despite these significantly higher levels of process-based innovations, however, they do not appear to generate the relatively high levels of innovative activity (especially in design, product and process development, marketing and branding) expected by the literature from them. Firms with *hierarchical relations* on the other hand rank the second regarding innovativeness in design, product and process development and are significantly different from firms with exclusion type of relations in this sense and also in technology systems and regarding improvements in production process.

Synthesising and interpreting the findings

Table 18 synthesises our results on the interaction between the type of inter-firm relation and innovation. Overall, types of inter-firm relations with different nature seem to be associated with different degrees and types of innovative behaviour. Differing nature of inter-firm relations seems to affect the degree and the type of innovative activity that firms undertake. It seems that the nature of the relationship that firms have established with global networks of

production matters more than simply the existence of their linkages with global networks of production. Differential power relations exist between the actors in the network and this power shapes the abilities of actors to create.

Table 18 Type of inter-firm relation, degree of innovation, and innovative behaviour: a synthesis

TYPE OF RELATIONSHIP	NATURE OF THE RELATIONSHIP	DEGREE OF INNOVATION	INNOVATIVE BEHAVIOUR
Exclusion	Locked in the standardised information from the business partner	Low	**Non-innovative**
Market	Flow of price-based information	High	**Cost-cutting and quality increase** Marketing and branding
Captive	Dependence on the business partner on both tacit and codified transactions Low capability in complex activities Resistance to knowledge outside the established network	High	**Cost-cutting and quality increase**
Hierarchy	Tacit transactions from the corporate group	High	**Cost-cutting and quality increase** Technology Design, product and process development
Relational	Mutual dependency	High	**Cost-cutting and quality increase** Technology Work Organisational
Modular	Reduced mutual dependency	High	**Innovative** Except organisational

Innovation is a must for firms to build linkages and maintain and improve the established linkages in global networks of production:
Being innovative is a characterising feature of being integrated in global production networks. As the comparison of exclusion type of relations and all other types of relations show, firms are continuously in danger of being locked in the linkage they established, with the result being to be excluded from the global production network. This is a two-faced sword. While being locked in the linkage prevents being innovative, being non-innovative prevents keeping the established linkages or building new linkages. In this sense, being innovative is a must for firms to build linkages in GPNs and maintain and improve the established ones.

Pervasiveness of innovation oriented to cost-cutting and quality increase:
Innovative behaviour oriented to cost-cutting and quality increase is widespread among the different types of inter-firm relations. This is in fact very much related with the dynamics of the restructuring of auto-supply chain. First of all, the rising quality and safety requirements and technology orientation of every new model in the automotive sector requires the suppliers to improve their production process and technology so as to produce the components required for the new model. Secondly, customers are increasingly demanding suppliers with the capability to improve productivity continuously in order to *secure price cuts* while at the same time *raising quality standards*. One way customers achieve this is to compare suppliers

against each other and foster rivalry among them. This pressure forces suppliers to make improvements and innovations in the production process that will help them increase quality and easily solve problems, while at the same time saving costs. Such innovation activities are like marketing tools to ensure that they get selected for or keep existing contracts or relations. This pressure is so strong that it causes a hidden struggle between the suppliers and customers on getting the profits from these innovations. This struggle reveals itself in the situation where the innovations are not reported to the customers. This way, which may be viewed as a mechanism for the supplier of designating its independence, helps the supplier to keep the profits from reduced costs out of its innovative activities.

The type of inter-firm relation makes a difference in the type of innovation undertaken:

Although there are only slight differences in the overall innovativeness of firms, the type of inter-firm relation makes a difference in the type of innovation activity undertaken by firms. In other words, although firms with different types of inter-firm relations are not significantly different in their overall innovativeness, the ways in which they achieve this much degree of innovativeness is different.

The differences are evident first between captive relations and market relations. While the innovative behaviour of the former does not extend beyond process improvements, the latter is more innovative in marketing and branding. This finding is in line with Humphrey and Schmitz's (2000) argument that market-based relationships provide more space for functional upgrading when compared to quasi-hierarchical relations.

Second, there are differences between the innovative behaviours of firms with relational and firms with hierarchical types of relations. In fact, results from quantitative analysis imply interesting results for firms in relational networks, which are more innovative in technology, work and organisational systems. The implicit discussions in the literature on relational networks do not provide clear implications on the expected innovative behaviour of firms in such relationships. The GVC research expects relational interactions to lead to innovative behaviour the output of which is higher value added. The network theory and its territorial extensions, however, suggest that the mutual dependency in relational networks may lead to situations like lock-in. Our findings are closer to this latter view. The interacting firms in relational networks undertake complementary activities based on a division of labour between the network partners. Our interviews with firms suggest that relational networks are characterised by complementary specialisation where the provision of product development, design, innovation by the global partner, while the local supplier is responsible for the production process. The innovation activities are oriented to cost reduction so as to create trust with the network partner. This leads to a situation in which the local firm is locked-in a situation where it does not undertake other innovative activities in order not to obscure its partner.

In a different manner, innovation activities of vertically integrated firms are oriented towards technology systems, as well as design, product and process development to sustain the subsidiary's competitiveness in the local, national or export markets. Obviously, an exploration of the innovative behaviour of MNC subsidiaries is a broad topic, which may be the focus of another paper but there are possible explanations of our findings. First, the subsidiaries that are part of our analysis were the subsidiaries of global suppliers. The innovative behaviour that we observed here may be related with the changing role of global suppliers in the context of a global reconfiguration of automotive production, where global

component suppliers are increasingly becoming responsible for module and component innovations. Second, in their empirical study on Argentina, Bell and Marin (2006) for example focus on possible explanations of the differences in MNC subsidiaries' innovative behaviour within a particular industry. Bell and Marin (2006) argue that one factor that affects the innovative behaviour of MNC subsidiaries may be the subsidiary's strategic significance for the corporate group to link it to the host country market or to link the production in the host country to the global market.

Third, firms with modular type of interaction undertake a variety of innovation activities. It seems that the reduced mutual dependency in this kind of relations prevents the lock-in that may appear out of the division of labour between the interacting parties, and allows the firms to undertake a wide range of innovative activities. However, it appears that the innovative behaviour to adapt to the changing conditions is not extended to their organisational systems.

CONCLUSION AND FURTHER REMARKS

The case study of Bursa and Upper Silesia as nodes located at the periphery of auto-production showed the different ways in which two different nodes are integrated in global networks of auto-production. While Bursa is dominantly integrated through network relations characterised by modularity, the integration of Upper Silesia occurred via MNCs. It also seems that the two nodes are taking advantage of different dynamics characterising the reorganisation of production and the types of relations they have established.

What might the possible explanations for these differences be? Might this result be related to the different ways in which the two nodes are integrated in global production networks?

The innovativeness of Upper Silesia which is integrated via subsidiaries of multinational corporations by building hierarchical relations may be related with the *changing role of global suppliers* in the context of a global reconfiguration of automotive production, where global component suppliers are increasingly becoming responsible for module and component innovations. On the other hand, there may be other factors in effect. One of them is the global corporate strategies of auto-makers. In their empirical study on Argentina, Bell and Marin (2006) for example focus on possible explanations of the differences in MNC subsidiaries' innovative behaviour within a particular industry. Bell and Marin (2006) argue that one factor that affects the innovative behaviour of MNC subsidiaries may be the subsidiary's strategic significance for the corporate group to link it to the host country market or to link the production in the host country to the global market. When we think that Poland is chosen as the manufacturing site of car production for the European market, this appears as an important factor. It seems that Upper Silesia is taking advantage of the restructuring in the auto-supply chain as well as the company strategies of the corporate groups. Finally, our empirical analysis of the relationship between the type of linkage and innovation showed that the nature of the linkage established in global production networks makes a difference in innovative behaviour. The findings show that tacit knowledge flowing from the corporate group, which characterises hierarchical relations, contributes to the innovative behaviour of such linkages with the result being innovation oriented to design, marketing and branding.

The situation for Bursa, which is integrated through modular inter-firm relations, is rather different and more difficult to explain. Having a longer history in the production of auto components than Upper Silesia, it is probable that local firms had the most desirable characteristics before they established their relations with global firms in auto-production

networks. On the other hand, as our empirical findings indicate, it is equally likely that firms in Bursa are taking advantage of the reduced mutual dependency characterising modular types of inter-firm relations, which prevents the lock-in that may appear out of the long-time interaction between partners. It may be this reduced mutual dependency that may allow firms in Bursa to adapt to the changing conditions.

Results from a previous study (Ozatagan, 2007), which showed that firms' innovative behaviour differs by the type of inter-firm relations they have established in global networks of production, supports such a relation. In this research we found that firms with modular types of inter-firm relations are different from firms with other types of relations in the sense that they are the most innovative in a variety of innovation activities ranging between process innovations to design, marketing and branding. Firms integrated through hierarchical relations as subsidiaries of MNCs, on the other hand are different from firms with other types of relations (except for firms with modular relations) with relatively higher innovativeness in design, marketing and branding.

This paper showed how the two peripheral nodes have become part of the emerging innovative global production networks in different ways. Each path has its own pros and cons and the trajectory of the two nodes will depend on which one will dominate. But there are a number of issues which need to be emphasised. First, the types of networks and their impact on the competitive power of firms may be associated with the dynamics of the components produced. **Morrison and Rabellotti (2006) call for considering the knowledge characteristics such as complexity and tacitness characterising different industries which has an effect on the balance of power**. In similar vein, the complexity of the part produced may have an impact on the nature of the relationship. Second, how the existing linkages will evolve and how the two nodes will adapt their capabilities to the new conditions caused by the reorganisation of the global supply chain are important issues which will have an impact on the trajectories of the two nodes. As recently recognised by the GSC/GPN literatures (Humphrey and Schmitz, 2002 cited in Pietrobelli and Saliola, 2006; Gereffi et al., 2005), firms often operate in different chains and in that respect they are part of different types of networks (different types of networks co-exist with each other). In that respect, competences and capabilities learned in one chain may be applied to other chains. Conversely, capabilities not required by one chain may cause the firm to forget those capabilities and prevent it from being part of other chains.

APPENDIX

Discriminant analysis

Table 6. Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
innovation in technology systems	.786	14.978	2	110	.000
innovation in work systems	.633	31.883	2	110	.000
innovation in organisational systems	.728	20.529	2	110	.000
marketing and branding	.389	86.408	2	110	.000
design, product and process development	.533	48.175	2	110	.000
improvements in production process	.960	2.266	2	110	.109

Table 7. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	3.053	80.1	80.1	.868
2	.758	19.9	100.0	.657

a First 2 canonical discriminant functions were used in the analysis.

Table 8. Standardized Canonical Discriminant Function Coefficients

	Function	
	1 Design, marketing, branding	2 Process innovations
innovation in technology systems	-.046	.004
innovation in work systems	-.004	.723
innovation in organisational systems	-.118	.536
marketing and branding	.886	-.133
design, product and process development	.721	.005
improvements in production process	-.182	.105

Table 9. Functions at Group Centroids

Ward Method	Function	
	1 Design, marketing, branding	2 Process innovations
1	-1.441	.721
2	-1.801	-1.915
3	1.931	-6.532E-02

Unstandardized canonical discriminant functions evaluated at group means

Classification function coefficients (Table 10) profiles the three clusters on the variables. What appears from the table is that all the three clusters value high in process improvements. On the other hand, cluster 1 and 3 are comparable in innovation technology systems and work systems, although cluster 1 is more favourable than cluster 3. What discriminates most between cluster 1 and 3 is that the former is not innovative in marketing and branding nor in design, product and process development. Compared to cluster 1, cluster 2 is less likely for innovation in work systems and organisational systems. What discriminates between cluster 2 and 3 is the latter's positive association with marketing and branding as well as design, product and process development. Moreover, it is also more favourable than cluster 2 on innovation in work systems and organisational systems.

Table 10. Classification Function Coefficients

	Ward Method		
	1	2	3
innovation in technology systems	5.452	5.478	4.710
innovation in work systems	13.336	5.622	10.971
innovation in organisational systems	4.670	.482	2.169
marketing and branding	-6.064	-5.929	6.505
design, product and process development	-1.974	-3.029	7.379
improvements in production process	46.338	44.834	41.375
(Constant)	-34.528	-23.569	-34.867

Fisher's linear discriminant functions

Table 11 shows the correlations of each predictor variable with the discriminant function. The structure matrix reveals that marketing and branding, and design, product and process development are variables that provide the greatest discrimination between the clusters for the first discriminating function)(these variables add most to the discrimination between cluster 1 and 2 from cluster and 3, while for the second function these variables are innovation in work systems, in technology systems and in organisational systems (these variables add most to the discrimination between cluster 1 from clusters 2 and 3).

Table 11. Structure Matrix

	Function	
	1	2
marketing and branding	.717	.067
design, product and process development	.532	.120
innovation in work systems	.114	.844
innovation in organisational systems	.005	.702
innovation in technology systems	.100	.565
improvements in production process	.071	.185

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions Variables ordered by absolute size of correlation within function.

* Largest absolute correlation between each variable and any discriminant function

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