Industrial Clusters and Production Networks in Southeast Asia: A Global Production Networks Approach

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Acknowledgement
I would like to thank Dr. Ikuo Kuroiwa for inviting me to contribute to this project. The NUS Academic Research Fund (R-109-000-050-112) supports the research project underpinning this paper. I am grateful to my research collaborators, Jang-sup Shin and Yong-Sook Lee, for their significant intellectual inputs, and to Angela Leung for her excellent research assistance. Comments from both editors on an earlier draft are very helpful. I am solely responsible for the content of this paper.

11 February 2008
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1. Introduction

Economic development at the regional scale is becoming an increasingly complex phenomenon to be analyzed satisfactorily. On the one hand, the accelerated globalization of economic activity has apparently rendered the region as the most significant site of competition across the global economy. Many pundits have argued for a while that macro-regions such as North America, Western Europe, and Northeast and Southeast Asia are becoming important “Triad” (Ohmae, 1995) and “motors” (Scott, 1996; 1998) of the global economy. On the other hand, we are not yet entirely sure of the various mechanisms and processes that connect economic actors in different regions, whether these are macro-regions or regions in specific national territories. One helpful analytical approach burgeoning in urban and regional studies is to think of the global economy as comprising of different territorial regions increasingly interconnected and interdependent through the variegated transnational operations of business firms that resemble a form of networks. For the past one decade, different conceptual terms have been developed to describe the formation and dynamics of such global networks (see Gereffi, 2005; Hess and Yeung, 2006) – global commodity chains (GCCs), global value chains (GVCs), and global production networks (GPNs). In this chapter, I will examine how global production networks in different industries serve as the critical link that increasingly influences the economic fate and trajectories of development in specific regions and countries.

More specifically, even though different global production networks are spanning the global economy and drawing different regions closer together in a new
form of international division of labour, we continue to observe spatial differentiation in
the location of different firms and their production networks. In Southeast Asia, there is
a clear regional division of labour in the form of fragmentation of production networks
and specialization of different countries in diverse value-chain activities (Yeung, 2001;
see also Arndt and Kierzkowski, 2001; Cheng and Kierzkowski, 2001; other chapters in
this volume). Intra-industry trade in intermediate goods, particularly in the material and
machinery industries, has also increased dramatically during the past 15 years (see
Chapter 9 in this volume). For over two decades, American and Japanese transnational
corporations (TNCs) have played a highly significant role in the spatial organization of
regional production networks in Southeast Asia (Henderson, 1989; Doner, 1991; Hatch
and Yamamura, 1996; Hatch, 2000; McKendrick et al., 2000; Yusuf et al., 2004). More
recently, Taiwanese TNCs have transferred some of their tightly integrated production
networks to Southeast Asia (Chen, 1998; Chen and Ku, 2004). This reconfiguration of
global production networks points to one crucial analytical question – why Southeast
Asia? This is an important question, as its answers will illuminate the processes of
economic development and regional transformation in Southeast Asia.

To explain why some sub-national regions in Southeast Asia are well placed
within the global configuration of production networks, we have to zoom into their local
and territorial specificity. In particular, we need to examine how certain industrial
clusters have emerged in high growth regions in specific Southeast Asian countries.
These range from the electronics clusters in Penang and Johor (Malaysia), Greater
Bangkok Area (Thailand), and Singapore to the automobile cluster in Bangkok and
Rayong (Thailand) and the chemical and biomedical clusters in Singapore. In theoretical
terms, there is indeed an intricate link between global production networks and
industrial clusters. We can therefore think of global production networks as a
globalized/decentralized phenomenon and industrial clusters as a localized/concentrated
constellation of different configurations of global production networks. The former
operates on a global scale and is constantly searching for better production locations,
whereas the latter is developed to “bring down” and “localize” this highly globalized
production activity. For global production networks to work and prosper, there must be
good “network economies” to be reaped from spatially differentiated production
arrangements. For industrial clusters to emerge and sustain, both local and non-local
links are highly important. Local links refer to localized assets in specific territories
such as institutions, labour, and capital formation. Non-local links point to flows of
knowledge, people, and capital exogenous to these industrial clusters. They are critical
to the formation of industrial clusters insofar as they bring in new markets and
technologies.

To pursue my mostly conceptual analysis in this chapter, I examine in the next
section the complex dynamics of global production networks and attempt to connect
these dynamics to the evolving regional division of labour in Southeast Asia. In the
third section of this chapter, I offer a typology of three different industrial clusters and
apply them to specific regions in Southeast Asia. I then locate sector-specific dynamics
of global production networks in these industrial clusters and discuss the role of
different cluster economies in their formation and transformation. In the concluding
section, I develop some general implications for government policy and development
strategies. Throughout the chapter, I will draw upon existing empirical studies to
illustrate my arguments (see also other chapters in this volume). In some instances, I
will support my analysis with original empirical evidence gathered from a recently completed research project.²

2. Global production networks and regional integration in Southeast Asia

Dynamics of global production networks

To explain the development of industrial clusters in Southeast Asia, we first need to ground our analysis in a robust theoretical framework. A convenient conceptual point of entry is the global production network, which involves both business firms and national economies in organizationally complex and geographically extensive ways.

Production networks – the nexus of interconnected functions and operations through which goods and services are produced, distributed and consumed – have become both organizationally more complex and also increasingly global in their geographic extent. Such networks not only integrate firms (and parts of firms) into structures which blur traditional organizational boundaries – through the development of diverse forms of equity and non-equity relationships – but also integrate national economies (or parts of such economies) in ways which have enormous implications for their well-being. At the same time, the precise nature and articulation of firm-centred production networks are deeply influenced by the concrete socio-political contexts within which they are embedded (Henderson et al., 2002: 445-46).

Coe et al. (2004:471-73) define global production networks as the globally organized nexus of interconnected functions and operations by firms and non-firm institutions through which goods and services are produced and distributed. As shown in Figure 1, such networks not only integrate firms (and parts of firms) into structures which blur
traditional organizational boundaries through the development of diverse forms of equity and non-equity relationships, but also integrate regional and national economies in ways that have enormous implications for their developmental outcomes. At the same time, the precise nature and articulation of firm-centred production networks are deeply influenced by the concrete socio-political contexts within which they are embedded. The process is especially complex because while the latter are essentially territorially specific (primarily, though not exclusively, at the level of the nation state and/or the region), the production networks themselves are not. Global production networks “cut through” national and regional boundaries in highly differentiated ways, influenced in part by regulatory and non-regulatory barriers and local socio-cultural conditions, to create structures that are “discontinuously territorial” (see also Dicken et al., 2001; Dicken and Malmberg, 2001; Henderson et al., 2002).

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Figure 1 here

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As shown in Table 1, the state and its development agencies are institutions that are strongly embedded locally in specific regions. This institutional dimension of regional development has been well theorized in the new regionalism literature (e.g. MacLeod, 2001; Hudson, 2006). Suffice it to say that the increasing devolution of political and economic authority from the nation state to local and regional institutions has led not only to the rise of growth coalitions within specific regions, but also to a higher degree of uneven regional development. The latter phenomenon occurs primarily because different regions have very different configurations of state institutions that in turn shape how these regions are articulated into global production networks (see the
The situation power and role of the state (and labour) and its manifestations in local and regional institutions has very important implications for understanding the distributional aspects of regional development. In regions that have strongly embedded local labour markets and local labour control regimes, lead firms in global production networks can better exploit economies of scale through technology- or expertise-specific production systems (e.g. in biotechnology or cultural industries). In regions with more flexible labour markets, economies of scope might be better achieved through the co-presence of a variety of different industries that reap the benefits of what Storper (1997) terms “untraded interdependencies”. The role of state institutions is important here through their regulation of labour and its organizations. In some regions, state institutions may work with labour organizations and labour market intermediaries to increase the skill levels of labour and the flexibility of local labour markets (Jones, 1999; Peck, 2000; Christopherson, 2002; Benner, 2003). In other regions, the adversarial and confrontational relationship between the state and labour may significantly reduce the region’s attractiveness to lead firms in global production networks (Kelly, 2002).

Before we move on to unravel the complexity behind the strategic considerations of lead firms in global production networks, it is useful to consider one category of non-local actors that impact significantly on local and regional development: financial capital institutions. While global production networks may not directly encapsulate financial capital in their network configuration, it is useful to distinguish three types of
financial capital in relation to their differential territorial embeddedness: local venture capital, national banking institutions, and globally decentralized financial networks (see Table 1). From the perspective of global production networks, venture capital tends to be highly localized primarily because talents and expertise are often embodied in people within a particular region that are known to venture capitalists through interpersonal networks of relationships. Venture capital is important to regional development both in terms of its financing of high risk ventures that are more likely to be at the cutting edge of technological development and in terms of its financing of supporting industries that supply to global production networks. The nature and organization of local venture capital, however, is embedded within national banking systems.

In some countries, venture capital is much less active because of the close relationships between banks and industries (e.g. Germany and Japan). Firms tend to borrow from banks rather than financed by venture capital. Regional developmental trajectories are therefore highly dependent on the direction and influence of national banking institutions (see Pauly and Reich, 1997; Shleifer and Vishny, 1997; La Porta et al., 1999; Dore, 2000; Franks et al., 2003). In other countries (e.g. the US and the UK), banking institutions play much less significant roles vis-à-vis globally decentralized financial networks that are mediated through global financial centres (e.g. New York and London). Regional development in these countries is much less dependent on the presence of national banking institutions and more on the articulation of those regions into global financial networks. In other words, firms in these countries tend to finance their production activity through capital markets, such as stock exchanges, private equity investment, venture capital, and so on. For example, the availability of investment and equity funds has been critical to the continuous growth and development
of Silicon Valley. Unlike national banking systems, such equity funds emerge from a variety of financial networks that are decentralized in terms of their origin and composition (e.g. US pension funds vs. Taiwanese private capital). The uneven access to these local (e.g. venture capital) and non-local (e.g. private equity) forms of financial capital can both enhance the strategic importance of some regional economies to global production networks and diminish others. These different forms of capital also embody different territorial logics, with venture capital being mostly local in its orientation, and decentralized financial networks more global in nature (see Clark et al., 2002; Clark and Wójcik, 2003). Locations well plugged into both local and non-local forms of capital are much more attractive to serve as a coordination centre for different global production networks, thereby enabling much higher value-added activity (e.g. strategic planning and corporate finance) to be created and captured in these locations.

How then does a global production network look like? Typically in Figure 1, a global production network is coordinated and controlled by a globally significant transnational corporation – known as lead firm in this chapter, and involves a vast network of their overseas affiliates, strategic partners, key customers, and non-firm institutions (see also Coe et al., 2004; Hess and Yeung, 2006; Yeung, 2007). Take the computer industry as an example. A brand name company such as Dell or Hewlett Packard is likely to be a global lead firm, coordinating its own R&D and manufacturing affiliates worldwide and its less than a dozen strategic partners such as electronic manufacturing service (EMS) providers and integrated design manufacturers (IDMs). It also has to coordinate marketing activities with its key customers worldwide and to deal with non-firm institutions such as labour organizations and civil society organizations in different host countries. This diversity of firms and institutions in different countries
explains why a global production network is organizationally complex and geographically extensive. It also points to a diversity of modes through which any particular global production network is governed (see Gereffi et al., 2005).

**GPN dynamics and regional integration in Southeast Asia**

One important aspect of contemporary global production networks in many industries is their *changing organizational dynamics*. Since the early 1990s, global lead firms in different global production networks and sectors have moved towards a business model of increasing specialization in value chain activities described in Figure 2. This trend has been much further accelerated since the late 1990s, particularly in the electronics, automobile, and clothing sectors (Gereffi et al., 2005; Pickles, 2006; Scott, 2006; Dicken, 2007). What this value chain specialization entails is a more strategically focused role played by global lead firms in the upstream (research and development) and downstream (marketing, distribution, and post-sale services) segments of the value chain, leaving much of the manufacturing portion of the value chain to its international strategic partners and supply chain managers. This “organizational fix” in global production networks refers to how global lead firms reorganize and reconfigure their value activities in order to extract greater value from specialization in core competencies and to increase market competitiveness of their products manufactured by strategic partners (see more in Yeung, 2007). In certain industries, this organizational fix may entail spatial relocation of productive facilities. In other instances, the fix can come from international outsourcing to manufacturing partners from developing economies (e.g. Southeast Asia) who are more attuned to local cost structures and changing policy conditions.

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There are many reasons accounting for this trend towards value chain specialization and the vertical disintegration of global production networks (see also Borrus et al., 2000; Cheng and Kierzkowski, 2001; Gereffi, 2005; Dicken, 2007). The validity of these reasons may also vary depending on the sectors and sub-sectors chosen for analysis. However, two critical factors are generally applicable. First, *time-to-market* becomes one of the most important competitive pressures that force global lead firms to reconsider their roles in global production networks. As product life cycles become increasingly shorter due to disruptive technological change and market preferences, *time-to-market* has emerged as a critical success factor in global competition (Stalk, 1988; Stalk and Hout, 1990; Schoenberger, 1994; 1997). Global lead firms are finding it increasingly hard to excel in every aspect of the value chain and therefore prefer to specialize in segments of the value chain that they possess the greatest core competencies. These segments usually encompass research and development, product design, manufacturing of core products, marketing, distribution, and, in some cases, post-sale services.

Second, as global competition intensifies and product life cycles become shorter, global lead firms are much more concerned with *cost drivers*, particularly production costs. With greater maturity in manufacturing technologies and lower profit margins from manufacturing products, production can now be outsourced to specialized manufacturers that enjoy both scale and scope economies and therefore significant cost advantages. Over time, these specialized manufacturers grow into massive scale and become transnational corporations in their own right. This outsourcing possibility also
enables global lead firms to concentrate on their core competencies and strategic new businesses and to mitigate investment risks associated with market demand fluctuations.

This increasing specialization in value chain activities by global lead firms in the global production networks of many key sectors in today’s global economy have two significant implications for our understanding of changing regional divisions of labour in Southeast Asia. First, as “latecomers” in global competition, Asian firms benefit from this increasing demand for strategic partners and supply chain management from global lead firms that are mostly based in advanced industrialized economies in North America, Western Europe, and Japan. As I have demonstrated elsewhere (Yeung, 2007), these Asian firms have relentlessly pursued certain competitive strategies that give rise to their favourable cost advantages and production capabilities (see also Hobday, 1995a; Shin, 1996; Li, 2003; Poon and MacPherson, 2005; Poon et al., 2006; Hsu et al., 2007). Together with their global lead firm “customers”, these Asian firms have begun to organize their production activities on a regional basis in Southeast Asia, thereby contributing to a nascent form of regional division of labour. Capitalizing on their greater knowledge of local factors of production in Southeast Asia, these Asian firms serve as a critical value-chain partner and intermediary that connects high growth regions in Southeast Asia and lead firms in global production networks (see examples below).

Second, the trend towards increasing specialization in value chain activities in global production networks also points to the opening up of new market avenues and opportunities for technological upgrading. This is an important implication because such possibility for industrial upgrading was not apparent during the earlier decades (1960s-1980s) with the emergence of the new international division of labour (Fröbel et
Much of international production taking place during these earlier decades was low value labour-intensive assembly work. Global production networks of lead firms then, particularly those from the US, were much more vertically integrated, involving very few external firms and institutions (see Henderson, 1986; Henderson and Scott, 1987; Scott, 1987). Since the 1990s, however, the increasing upstream and downstream specialization by global lead firms have opened up certain market segments for Asian firms, particularly in low- and medium-value mass products that are not seen as core competencies or products to these global lead firms. Meanwhile, increasing specialization in value chain activities requires greater technological inputs and sophistication and complementary competencies, resulting in greater opportunities for strategic partners in Asia to upgrade their technologies. This process of technological upgrading occurs because global lead firms can benefit from the concurrent research and development and co-evolution of product/process technologies in their strategic partners. This process of co-development also expedites the time-to-market of new products, thereby presenting a “win-win” solution for global lead firms and their strategic partners.

The global electronics industry represents a useful case study of how Southeast Asian countries can benefit from the changing organization of global production networks in the industry and growing home base advantages. Compared to another industry in which Asian firms excel – clothing industry, electronics is also an industry that has significantly market development potential and possibility for technological upgrading. As one of the first truly global industries, electronics covers a wide range of sectors, from semiconductors to consumer electronics (see Dicken, 2007). One of the most significant developments in the global electronics industry since the 1960s has
been the *globalization of production* from dominant centres in North America and Western Europe to Northeast and Southeast Asia (Scott, 1987; Henderson, 1989; Angel, 1994; Dicken, 2007). During this complex and overlapping process of globalizing production networks in the electronics industry, particularly in the personal computer and semiconductor sectors, different windows of opportunities have emerged for budding Southeast Asian manufacturers. At the early stage during the 1960s and the 1970s, few Southeast Asian manufacturers were plugged into these global production networks that remained fairly vertically integrated. Leading American, Europe, and later Japanese manufacturers established production facilities in several Southeast Asian countries (e.g. first Singapore and later Malaysia and Thailand) in order to take advantage of their cheaper labour and infrastructure costs. The manufacturing capabilities of local firms were relatively weak and thus most of these local firms served as low-end component suppliers to global electronics lead firms. As original equipment manufacturer (OEM) suppliers, these Southeast Asian firms were mere followers of the production demand controlled by their lead firm customers.

By the 1980s, some of these existing Southeast Asian firms had accumulated sufficient production know-how to take on more complex subcontracting work from established global lead firms. Meanwhile, a new generation of engineers and production managers employed in major electronics transnational corporations such as HP, National Semiconductor, Motorola, and IBM became entrepreneurs in their own right and established manufacturing facilities to partake in the rapidly growing outsourcing markets (e.g. Singapore’s Venture Corp and WBL). Some Southeast Asian engineers and senior managers in the US were also returning to their home economies to set up
their own businesses – a process recently described by Saxenian (2006) as “brain circulation”.

As the global electronics industry became increasingly competitive by the late 1980s, particularly in the personal computer, semiconductor, and consumer electronics sectors, time-to-market and cost efficiency emerged as prime considerations of brand name global lead firms. In order to focus on developing new technologies and to shorten their product development cycles, many global lead firms began to consolidate their global production networks, leading to the outsourcing of a significant portion of their manufactured products in the forms of specialized components and integrated modules. This changing organization of global production networks from vertical integration to greater fragmentation of production created an extremely important and favourable context for the emergence of domestic electronics firms in Singapore, Malaysia, and Thailand (Hobday, 1995b; 2001; Mathews and Cho, 1998; Borrus et al., 2000; Yeung, 2007). This fragmentation of value chain activities in the personal computer and semiconductor industry in Southeast Asia, enhanced by technological innovations and, sometimes, spatial proximity, results in the rise of a number of specialized component suppliers, manufacturing service providers, and modular manufacturers.

By the late 1990s, the world of electronics industry experienced another “revolution” with the emergence of contracting manufacturing as the key platform to achieve cost efficiency through economies of scale and supply chain management (Sturgeon, 2002; 2003). In this mode of industrial organization, lead firms in global production networks engage large globalized contract manufacturers as their strategic partners to take care of their manufacturing activities, while they specialize in the higher return premium product markets and higher value-added activities such as research and
development, production development, marketing, and sometimes, distribution. Most of the world’s leading brand name computer companies outsource a large proportion of their notebook and desktop computers, peripherals, and accessories to contract manufacturers in Northeast and Southeast Asia. This reorganization of global production networks continue to benefit Southeast Asian firms that are well plugged into the production networks of large contract manufacturers and system integrators. Meanwhile, electronics manufacturers in Southeast Asia are quick to capitalize on their established market positions and production know-how to emerge as manufacturing partners in the global electronics industry. Interestingly, this emergence takes place in specific industrial clusters located in high growth regions in certain Southeast Asian countries (e.g. Penang and Johor in Malaysia, Greater Bangkok Region in Thailand, and Singapore). The spatial clustering of electronics production networks in Southeast Asia is clearly not a random phenomenon. It occurs primarily due to the changing organization of global production networks described above and location-specific factors associated with costs, government policies, and market conditions in these Southeast Asian countries (see below).

3. Industrial clusters in Southeast Asia

While economic integration in Southeast Asia can be mediated organizationally through global production networks, I argue that this integration must take place in specific territories, commonly known as industrial clusters. Before I explain the intricate relationships between these industrial clusters and global production networks, it is important to understand more fully the theoretical foundation of clusters and their spatial dynamics. Academic and policy studies of clusters since the 1990s, however, have become a kind of cottage industry in itself. There is no shortage of conceptual
models of cluster development. Neither is there a lack of comprehensive and yet critical reviews of cluster studies (e.g. Malmberg and Maskell, 2002; Martin and Sunley, 2003; Benneworth and Henry, 2004; Asheim et al., 2006; Cooke et al., 2007). Perry (2005: 10), for example, summarizes this critical view on cluster studies very well: “The growing identification of clusters does not of itself indicate universal trends are affecting the organization and location of business activity. Neither does the existence of a cluster indicate that a particular set of advantages are being gained by its participants”.

In this section, I briefly outline several influential models of cluster development before we delineate different types of cluster economies in the context of Southeast Asia. While Michael Porter’s (1998) model of cluster development is certainly the most influential one in the policy circle, I have chosen not to rehash it here for the same reasons that Martin and Sunley (2003) have proposed – its vagueness, ambiguity, and one-size-fits-all approach to understanding clusters and their territorial development. Equally, I will not delve into the original formulation of the underlying idea of clusters in the writings of Alfred Marshall and others on the spatial concentration of specialized industries and the role of such external economies as the availability of skilled labor, the development of supporting trade, and the industrial and production specialization of firms. While these Marshallian ideas remain relevant to today’s cluster development, there are new dimensions of cluster development that remain underestimated in the existing literature, particularly external linkages and joint action (see Schmitz, 1999; 2004; Schmitz and Nadvi, 1999; Bathelt et al., 2004; Perry, 2005; Yeung et al., 2006).

Moreover, the spatial, institutional, and discursive contexts of cluster development are profoundly different in today’s global economy compared with those
prevailing in Marshall’s day. The spatial scales and forms of clusters are increasingly
differentiated and enlarged in contemporary contexts (see Phelps, 2004; Perry, 2005;
Asheim et al., 2006). Local and regional institutional capacity in many regions has been
increasingly strengthened in recent years, partly due to a widespread process of
rescaling and devolution of governance, particularly at the economic level (e.g. Penang
in Malaysia and Singapore). Concomitantly, the discursive context in this quest for local
and regional development in association with growing and developing institutional
structures at the local scale has been overwhelmingly pro-growth and pro-business. In
other words, the development of a cluster in a local setting, whether imaginary or real, is
inevitably going to attract a great deal of policy and public interests. Clusters are
virtually seen as an unquestionable solution to local and regional development
problems.

Three ideal-typical models of industrial clusters

How then do we know whether clusters are indeed good or bad? In this respect,
we do need conceptual models to guide our understanding of the nature and dynamics of
cluster development. Gordon and McCann (2000) offer a relatively clear and precise
review of three major ideal-typical models of industrial clusters:

(1) the classic model of pure agglomeration;

(2) the industrial complex model and

(3) the social network model.

These three ideal-type cluster models are summarized in Table 2 (see also Yeung et al.,
2006: 523-25). In the first model, industrial clusters are developed through the natural
agglomeration of economic activities, so that firms in similar and different industries
can enjoy external economies from their embeddedness in these clusters. However, such
firms may not have traded interdependencies with other firms in the cluster. The agglomeration economies in these industrial clusters originate from the development of a local pool of specialized labor (reduction in search costs), the increased local provision of non-traded inputs specific to an industry (realization of economies of scale), and the maximum flow of information and ideas (spillover of product and market knowledge). The basic assumption of this model of agglomeration economies is that the local cluster is essentially an “open system”. Any firm may enter and exit the cluster, provided that it is “willing to pay a market rent level which reflects the net value of spatial externalities (as well as other inherent locational advantages)” (Gordon and McCann, 2000: 518). This approach to cluster development is most commonly found in neoclassical industrial and urban economics (e.g. Fujita and Thisse, 1996; Ellison and Glaeser, 1999; Fujita et al., 1999). In this literature, spillover in clusters particularly through technological innovation can create a favourable condition of increasing returns to scale.

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Industrial clusters can also develop through deliberate construction of industrial complexes that minimize transaction costs in inter-firm trade through spatial concentration and proximity. In this model, cluster-based firms are able to enjoy lower transport and logistics costs and lower uncertainties in transactions through mutual interactions facilitated by physical proximity (see Table 2). The raison d’être of this type of industrial cluster is that firms must engage with each other through traded interdependencies. Gordon and McCann (2000: 519) note that “where there are strategic
interactions among the locational decisions of a few firms, and/or where viability depends on co-location, concerted planning of these decisions by the firms concerned (and long-term production/contracting arrangements) is necessary, with or without state encouragement”. These clusters are particularly common in the oil refining, chemicals, pharmaceuticals, and automobile industries throughout the world (see Cumbers, 2000; Wang and Yeung, 2000; Yeung, 2006; Dicken, 2007). They are effective only if spatial proximity enhances inter-firm transactions along particular production chains via the formalization of just-in-time production and supply chain management practices (e.g. the Toyota City; see Womack et al., 1990; Fujita and Hill, 1995).

There is thus a great deal of industrial concentration and specialization of firm activities in this type of cluster than is found in the model of pure agglomeration economies. There is also much less scope for untraded interdependencies than in the first model. Nevertheless, most empirical studies of this model of industrial complexes tend to focus excessively on inter-firm transactional dynamics within clusters and overlook the possible connections and linkages that these cluster firms might have with other firms outside these industrial complexes – a significant shortcoming partially addressed by the third model on social networks. This omission is not surprising given that most studies of industrial complexes take inter-firm transactions, measured quantitatively in input-output models, as their main unit of empirical analysis.

The third model of cluster formation identified by Gordon and McCann (2000) refers to the important role of local networks of inter-personal relationships, trust and institutionalized practices in facilitating the coming together of firms in particular localities (see also Karlsson et al., 2005). Strong social networks, institutionalized through cooperative practices, can enable tacit knowledge to develop and be transferred
among firms in clusters that, in turn, further contributes to technological innovations and knowledge development (see Table 2). Firms embedded in such social networks are conceived as being highly localized in their innovative and production activities. As such, the role of external economies in these untraded interdependencies is akin to the Marshallian notion of “atmosphere”. These agglomeration economies emanate from such tangible assets as common services and ancillary facilities to such relational assets as cooperative spirit, local “buzz”, social codebooks and conventions (see also Storper, 1995; 1997; Bathelt et al., 2004; Maskell and Lorenzen, 2004; Morosini, 2004; Tallman et al., 2004).

Most empirical studies of cluster formation in this genre tend to focus on cluster-specific external economies of spatial proximity in relation to promoting learning, innovation, and knowledge transfer among different, and often unrelated, firms. Two problems emerge from this model of cluster development. First, positive benefits derived from firms’ embeddedness in localized social networks are a form of external economies not too different from those identified in the first model of industrial agglomeration. Second, the excessive focus on localized social networks tends to ignore the articulation of these firms in regional and global production networks that operate well beyond the local scale. In fact, many innovative firms in local clusters are as strongly embedded in non-local networks of knowledge communities and corporate organizations as they are locally embedded (see Bunnell and Coe, 2001; MacKinnon et al., 2002; Wolfe and Gertler, 2004). Malmberg (2003: 155) perceptively reflects on this “local” departure in most writings on clusters:

Here, the role of large global firms tends to cause unease. The ‘true’ actors of such milieus are locally owned small and medium-sized firms, while globally
oriented transnational corporations (TNCs) one way or another are seen as alien to the idea of a dynamic local milieu. This is most explicitly expressed in some of the work on industrial districts, but the same model of thought is implicitly expressed in much work on regional clusters.

Recent work on industrial clusters in developing countries has incorporated the global value chain approach to explain cluster development and governance issues (see Bair and Gereffi, 2001; Gibbon, 2001; Humphrey and Schmitz, 2002; Schmitz, 2004; Gereffi et al., 2005). Through comparative and detailed case studies, this emerging literature has convincingly shown the critical role of external linkages and joint action in determining the upgrading possibilities of different industrial clusters in developing countries.

**Industrial clusters and global production networks in Southeast Asia**

How then do industrial clusters in Southeast Asia emerge in the context of changing organization of global production networks in such industrial sectors as electronics, automobile, and chemical and biomedical? To locate sector-specific global production networks in these industrial clusters, we need to bring in global lead firms and other relevant actors and show how selected industrial clusters grow hand-in-hand with the activity of these lead firms. In this sub-section, I will apply some of the conceptual apparatuses developed earlier to several industrial clusters in Southeast Asia. Cluster economies such as scale economies and agglomeration economies (such as cost savings from physical proximity) will also be discussed.

In the global electronics industry, local firms in Singapore are able to tap into the strong presence of global lead firms in electronics clusters. In the hard disk drive (HDD) industry, for example, local suppliers such as MMI have developed technological know-how and market expertise through accumulated experience in
supplying to global lead firms such as Seagate, Conner Peripherals (later merged with Seagate in 1996), Western Digital, and Maxtor (acquired by Seagate in May 2006). The presence of these global lead firms in Singapore’s HDD cluster has contributed to the emergence of Singapore as the world’s largest producer during the 1990s (see McKendrick et al., 2000). Singapore’s strong competitive advantage in physical infrastructure and transport and communications further strengthens its central position in the global HDD production networks. Its strength in supply chain and logistics management encompasses a wide range of services such as warehousing, inventory management, packaging, and shipping (see Bowen and Leinbach, 2006 and Chapter 4 in this volume). Most global players in third-party logistics such as DHL, Exel, and GeoLogistics have established their distribution centres in Singapore in order to serve the entire Southeast Asia or even the Asia Pacific region.

By 2000, Singapore still maintained a 35% share of the world’s hard disk drives market by volume (Chan, 2002). As illustrated in Figure 3, Singapore continues to play a very important role in Seagate’s global production network. As the world’s market leader in HDD, Seagate has chosen to locate its Operational Headquarters in Singapore (so is Flextronics, the world’s Top-3 EMS provider). MMI Holdings, a world’s leading precision component supplier from Singapore and a strategic partner of Seagate, enjoys proximity to Seagate’s operational headquarter in Singapore and a long-standing partnership since its inception as an OEM supplier to Seagate in 1989. As a Singaporean company, MMI has developed very strong capability and competitiveness in manufacturing die cast base plates for Seagate disk drives. In 2005, Seagate still accounted for some 60% of MMI’s revenue. Being close to the Seagate’s Operational Headquarters where R&D activities are located is very important in its role as a strategic
partner supplying die cast plates. MMI’s engineers are able to participate in Seagate’s HDD product development right at the beginning of the product life cycle and this is critical to MMI’s successful business partnership with Seagate (Interview with Group Managing Director, Singapore, 22 June 2006).

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Figure 3 here

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Spatial proximity is thus translated into lower information costs and greater co-development of product knowledge. Another good example is Singapore’s Venture Corp. While it is significantly smaller than Flextronics – a US-origin manufacturer headquartered in Singapore, in operating revenue, it is one of the most profitable EMS providers. In 2005, Venture’s operating revenue was US$1.95 billion, compared to Flextronics’ US$15.3 billion (http://www.flextronics.com, accessed on 23 June 2006). Still, Venture is able to corner a large share of computer peripherals market such as HP’s printers, Iomega’s storage devices, and Agilent Technology’s networking devices. The fact that its Chairman and CEO and most top executives were formerly senior employees of Hewlett Packard does make a huge difference in developing a strong partnership relationship with HP’s operational headquarters in Singapore, particularly its printer division that serves as a global mandate centre. Venture’s EMS capability is underpinned by its “seamless transition” from R&D to manufacturing and its strong design capability since inception in 1989. This “seamless transition” is a critical competitive advantage in the EMS business as global lead firm customers always require very strong product design support, manufacturing capability, and delivery efficiency (Interview with Chairman and CEO, Singapore, 19 May 2006).
Moreover, these cluster economies are extended beyond the territorial boundaries of Singapore to incorporate different geographical locations in nearby countries in Southeast Asia. Global lead firms and local partners in Singapore’s HDD industry benefit from their access to low cost hinterlands in Southeast Asia. Singaporean firms (e.g. MMI) and some Taiwanese firms (e.g. Delta Electronics) can tap into specific electronics clusters such as the HDD industry in Thailand and the personal computer industry in Penang, Malaysia. Most Southeast Asian countries are also low cost production locations that sustain the price competitiveness of these electronics manufacturers. For example, Penang has gained a strong foothold in the development of integrated manufacturing of computer and semiconductor products (see Table 3). It now hosts over 10 semiconductor firms. In 2000, electronics accounted for over 80% of Malaysia’s total manufactured exports (Rasiah, 2006: 127; see also Ernst, 2004; Chapter 7 in this volume). After over three decades of active promotion of the industry at the federal and state level, Penang is now well articulated into the electronics global production networks, primarily through such global lead firms as Intel, Dell, AMD, Hewlett Packard, National Semiconductor, and Seagate (including the former Maxtor and Conner Peripherals), and their different tiers of foreign and domestic suppliers (e.g. Read-Rite, Komag, MMI, and Eng Teknologi). To Fields (2006: 135), for example, Dell “relies on the intermediary of the 3PL [third-party logistics] in the procurement channel to perform a critical step in moving parts form locations of supply to locations of assembly”. It has drastically cut its number of days’ supply of inventory from 32 days in 1994 to 8 days in 1998 and 3 days in 2002. With DHL’s strong presence in Penang (see Figure 4), Dell is able to articulate its regional production network, through DHL’s strong networks, its key suppliers such as Intel, Jabil Circuit,
Seagate, and SCI in Penang and Seagate in Singapore. Dell also uses other 3PLs such as BAX, Menlo Logistics, Ryder, and Eagle Global Logistics.

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Table 3 and Figure 4 here

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Apart from evolving inter-firm networks in the electronics industry, the Penang Development Corporation (PDC) also plays a critical role in the development of the cluster by developing and maintaining an excellent air hub at Penang with strong links to Singapore, Taipei, and Tokyo, and introducing IT into the supply chains of local firms. This airfreight capability is particularly important in lightweight electronics modular components such as hard disk drives (HDD). Together with Singapore and Thailand, Penang is an integral part of the Southeast Asian “golden triangle” that accounts for a massive majority of the global hard disk drive production. It now serves as a “ramp-up” centre for these global lead firms to prepare new products for mass production in other lower cost locations in Southeast Asia or China (Bowen and Leinbach, 2006: 155). Going back to the example of Singapore’s MMI Holdings, it has four manufacturing facilities in Malaysia – one in Penang and three in Johor – that form an integral part of its evolving regional production networks. Its Malaysian factories produce high volume precision components and medium volume mechanical assembly.

In Thailand’s Greater Bangkok region that includes Rayong and Samutprakarn provinces along the eastern seaboard (see Table 3), global lead firms in HDD and automobile industries have found favourable production platforms for their regional and global markets (see also Krongkaew and Krongkaew, 2006). The Thai regions have successfully plugged into the demand by global lead firms for low cost and reliable
production platforms. In the HDD industry, we can find major manufacturing facilities in the same Thai regions, operated by the world’s leading HDD firms such as Seagate, Maxtor (part of Seagate after the acquisition in May 2006), Western Digital, Hitachi-IBM, and Fujitsu. Thailand is only second to Singapore in terms of global HDD outputs. In the HDD industry, McKendrick et al. (2000: 8) note that “[t]he ongoing fit between the operational requirements of American HDD firms and the region’s abilities underscores the dynamic character of competitive advantage”. The Thai regions are also intimately woven into the complex regional production networks of these global lead firms and their major suppliers based in Singapore (McKendrick et al., 2000; Wong, 2001). MMI Holdings, for example, has one plant in Navanakorn, Thailand, that is engaged in high volume precision components and medium volume mechanical assembly.

In the automobile industry, the Greater Bangkok region and the eastern seaboard comprising Rayong and Chonburi have now become Southeast Asia’s leading production centre, featuring some two dozen automobile assemblers (global lead firms) and their 700 plus first-tier suppliers (Coe et al., 2004: 479; see also Lecler, 2002; Doner et al., 2004; Takayasu and Mori, 2004; Hassler, 2006). In 2003, the automobile industry exported 230,000 units of its total production of 760,000 cars. By 2005, the export number increased to 440,715 (see Chapter 8 in this volume). It is now the second largest export industry after electronics and electrical products. In this automobile manufacturing cluster, both assemblers and different tiers of suppliers – whether foreign or Thai-owned – benefit from a wide range of internal economies such as lower transport and logistics costs and greater certainty in inter-firm transactions. Time-to-market is also substantially reduced as just-in-time production flexibility can be
achieved through spatial proximity of assemblers and suppliers. Just like the case of Penang and Singapore, the Thai government’s supportive industrial and economic policies have played a highly significant role in the formation and development of such automobile manufacturing cluster. From the development of sector-specific industrial estates to its leadership role in regional economic cooperation initiatives and the strategic absence of a national car project like Proton in Malaysia and Kia-Timor in Indonesia, the Thai government has been actively involved in plugging the Bangkok-Rayong region into the global production networks of lead firms in the automobile industry.

The above kind of industrial complex-related cluster economies is also evident in Singapore’s petrochemical cluster located on Jurong Island (Wang and Yeung, 2000). During the last three decades, Singapore has distinguished itself as a regional centre for trade in petroleum, petrochemicals, and chemicals. While Singapore’s geographical advantages have provided the basis for the country to secure a role as a regional producer, supportive state policies have just been as important in creating a conducive business environment for the transnational operations of international oil, petrochemical, and chemical companies. Given today’s highly competitive environment, however, the provision of incentives by local, regional, and national authorities will not automatically attract foreign investments. The fact that many of the world’s leading chemical companies have chosen Singapore as their strategic hub in the Asia-Pacific region points to the competitive position attained by the city-state in embedding these foreign investments.

Under the Manufacturing 2000 (M2000) umbrella, the Chemical 2000 (C2000) study was completed with specific recommendations to enhance the chemical cluster.
C2000 aims to reinforce Singapore’s position as a strategic manufacturing centre of chemicals in the Asia-Pacific region (Economic Development Board, 1995). More importantly, the implementation of the C2000 programme reaffirms the role of the government in developing the cluster. Committed to nurturing Singapore as a regional chemical hub, the government has invested S$7.2 billion to build a chemical island complex that will rival the world’s best. This infrastructural project involves combining seven southern offshore islands of Singapore into a single landmass, known as the Jurong Island Chemical Complex. As related and interdependent activities, diverse petrochemical investments by global lead firms such as Exxon-Mobil and Sumitomo Chemicals have contributed to the cluster development strategy by adding strength to a highly integrated industry structure. In 2005, the combined output of chemicals and petrochemicals accounted for 31.2% of total output in Singapore’s manufacturing sector – a close rival to the 36.5% held by the predominant electronics sector (Ministry of Trade and Industry, 2006: 179).4

4. Conclusion and policy implications

This chapter has analyzed the complex interaction between global production networks and industrial clusters. Through the cross-border activities of lead firms and their strategic partners, industrial clusters in selective Southeast Asian high growth regions are plugged into dynamic global production networks. In the cases of Thailand’s automobile industry and Singapore’s petrochemical industry, the industrial complex model of cluster formation seems to be applicable, as both clusters benefit enormously from agglomeration economies arising from lower transport costs and greater logistical flexibility through spatial proximity. There is thus a relatively high level of local content in material inputs (see Chapter 9 in this volume). The experience of the HDD industry
in Southeast Asia, however, shows that HDD industrial clusters do not emerge as pure agglomeration in a Marshallian sense. Instead, they are intentional creation in the context of supportive government policies (e.g. free trade regimes), institutional structures (e.g. pro-FDI business environment), and cost conditions (e.g. lower labour and land costs). Moreover, the industrial clusters in Penang, Greater Bangkok Region, and Singapore do not resemble characteristics of the industrial complex model described in Table 2. The key impetus to their formation and transformation originates from external actors such as lead firms and their strategic partners in global production networks. While lower transport and logistics costs are observed in these clusters, these agglomeration economies are not sufficient in explaining cluster formation. In the HDD industry, these three production sites collectively form a tightly integrated regional production network, spearheaded by such lead firms as Seagate and Western Digital, that transcends individual production location. In other words, each cluster enjoys network economies through its participation in the value chain of the entire industry itself. These network economies are not necessarily based on inter-personal relationships described in the social network model.

In conclusion, we need a new conceptual model to explain such industrial clusters that simultaneously enjoy agglomeration economies derived from spatial concentration and proximity of producers in these clusters and benefit from their strategic importance in globally decentralized production networks comprising different clusters. In other words, we can think of global production networks as organizational clusters that produce footprints in different locations. In each of these locations, there are territorially based clusters constituted through overlapping footprints of similar global production networks. We might therefore call this “global production network
model” of industrial clusters, for the reason that there are both local and non-local links in each of these clusters. Those local links are related to such agglomeration economies as the existence of a local pool of cheap or specialized labour, the provision of non-traded inputs through infrastructure, subsidies or grants, and access to local markets. However, these local links are insufficient in explaining the formation and evolutionary growth of such clusters. We need to understand their position in global production networks that are mediated through non-local links such as firm-specific organization of value-chain activity. In such a global production network model, industrial clusters emerge to fulfill specific and yet complementary functions in particular value chains. Such functional links are external to individual clusters and often ignored in the existing literature on industrial clusters.

What policy lessons can we learn from the above analysis? I think three general lessons clearly stand out. First, we can learn a great deal about strategic policy options from a global production network perspective. Regional authorities and government agencies should not be paying excessive policy attention to building regional capability without carefully (re)assessing and understanding the kind of global production networks into which the region can have a good chance of fitting and articulating. This means an in-depth assessment of the position of a region within certain sector-specific global production networks. There is, of course, no easy policy solution and universal panacea, as pointed out by the critics of the cluster literature (Martin and Sunley, 2003). Regions can become locked-into the strategic interests of global lead firms and face a serious policy dilemma when the latter disembed and exit from these regions (Phelps et al., 1998; Phelps and Waley, 2004; see also Martin and Sunley, 2006).
Second, while regions are not necessarily the scale at which competition takes place, regions do certainly experience the outcomes of this competition. This is where policy instruments might be deployed to mitigate the potential negative regional impact of intense competition within and between different global production networks. Again, such policy initiatives should be situated within a comprehensive understanding of the relationships and positions of a region in certain highly competitive global production networks. This greater sensitivity and sensibility in regional policy making, in Stiglitz’s (2001: 523) words, requires decisions makers “to resist accepting without question the current mantras of the global marketplace of ideas”. It does not make much sense, for example, to implement policies that promote a region as a production platform for lead firms in global production networks, if the region already has some presence of local firms and technological competence (e.g. Penang). Regional policies will likely to be more effective if they are designed to help these local firms to achieve enduring strategic partnership with lead firms in global production networks (e.g. Singapore and Taiwan). In other developing regions (e.g. the Greater Bangkok Area), the policy challenge is much more complicated as local firms remain relatively weak in their organizational and technological capabilities. And yet these regions face tremendous pressure from cost-based competition. Whatever the chosen development trajectory and policy regime, one important lesson is that they are unlikely to be effective and sustainable without a full appreciation of the trans-local dynamics in which the region and its clusters are located. This is the key contribution of thinking of industrial clusters as necessarily situated in the competitive dynamics of global production networks.

Third, national governments can develop specific policies facilitating the grounding of global production networks in developing industrial clusters. Free trade
agreements and pro-growth industrial policies at the national and Southeast Asian regional levels can make a significant difference to lowering the production costs and increasing access to markets and sourcing choices (see also Chapter 5 in this volume). For example, special economic zones can foster the formation of industrial clusters that seek lower production costs through spatial proximity of different value-chain partners. These zones can also enable those purpose-specific clusters that resemble the industrial complex model. At the broader regional scale, industrial clusters can be fostered through bilateral or trilateral free trade agreements. While the Singapore-Johor-Riau growth triangle has been in place since the late 1980s, its developmental trajectory has been enhanced by the May 2003 US-Singapore Free Trade Agreement (USSFTA). In the electronics sector, for example, Liew’s (2005) study shows that both Johor and Batam are more integrated into the global production networks orchestrated by Singapore-based local and foreign firms exporting to the US. The USSFTA has created a new window of opportunity for the three neighbouring localities to form a mega industrial cluster such that labour cost-sensitive production of parts and components is located in Johor or Batam, whereas substantial transformations in value chain activity are performed in Singapore (e.g. R&D, design, and logistics). In this trade-based arrangement specific to the US as the final market, the three locations can benefit from their spatial proximity and established relationships in co-organizing production networks.

On the other hand, certain policy instruments that used to work in extracting benefits from foreign investment may no longer work in light of today’s sophisticated global production networks. Local content requirement, for example, will clearly dampen the chance of a locality or region to be even considered by lead firms in global
production networks. Instead, greater technological capability and production know-how among local firms are much more desirable features that can enhance the locational attractiveness of an emerging industrial cluster. These competitive attributes of local clusters are no easy policy outcomes. But in the context of highly dynamic global production networks, they are perhaps one of the more reliable and sustainable routes to regional development.

Notes

1 In Fukunari Kimura’s terms (see Chapter 2 in this volume), production fragmentation and industrial agglomeration can go hand in hand at the aggregate industry level. However, the two phenomenon are not necessarily two sides of the same coin, as they can happen independently of each other. For example, industrial agglomeration existed in the 19th century, long before technological and organizational innovations have enabled production to be fragmented and spatially dispersed.

2 This is a major transnational research project in which personal interviews with top executives of leading Asian firms were conducted in the four Newly Industrialized Economies (NIEs). We interviewed a total of 72 leading Asian firms between June 2004 and November 2006: 20 Hong Kong firms, 13 South Korean firms, 24 Taiwanese firms, and 15 Singaporean firms. Many of them have operations in one or more Southeast Asian countries. These firms were selected on the basis of their 2003/2004 operating revenues or turnover captured in the OSIRIS database published by Bureau van Dijk Electronic Publishing, a comprehensive database containing detail financial information on publicly listed companies worldwide. We selected the top 50 firms from each of the four NIEs and approached them for personal interviews with their top executives. Among the 72 leading Asian firms interviewed, 16 were in the top-10 and 29 were in
the top-20 by operating revenues in their respective economies. Twelve of them were ranked in UNCTAD’s (2005) Top 50 TNCs from developing economies. Some 37 of the interviewees were CEOs/Presidents or Managing Directors, whereas another 32 were Executive Directors, General Managers, or (Senior/Executive) Vice Presidents. In some cases (e.g. Samsung Electronics), personal interviews with several top executives were conducted. Apart from these corporate interviews, we also conducted 18 personal interviews with top officials in respective governments ministries and business associations. In all corporate and institutional interviews lasting between one to two hours, we took an open-ended approach and used only brief interview aides. Extensively background information from all available public sources was consulted to form the basis of customized qualitative questions during each interview. All except one interview were taped and transcribed.

3 The availability of such venture capital is also highly important to the development of Singapore’s biomedical sciences sector (see Chapter 6 in this volume).

4 See also Chapter 6 in this volume for the development of Singapore’s biomedical sciences sector.
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**TABLE 1. Local and Non-Local Dimensions of Regional Development**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Local Manifestations</th>
<th>Non-Local Forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms</td>
<td>• indigenous SMEs</td>
<td>• global corporations</td>
</tr>
<tr>
<td></td>
<td>• industrial clusters</td>
<td>• entrepreneurial subsidiaries</td>
</tr>
<tr>
<td></td>
<td>• intra-regional markets</td>
<td>• distant global markets</td>
</tr>
<tr>
<td></td>
<td>• venture capitalists</td>
<td>• decentralized business and financial networks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• global production networks</td>
</tr>
<tr>
<td>Labour</td>
<td>• skilled and unskilled workers</td>
<td>• skilled experts and technologists</td>
</tr>
<tr>
<td></td>
<td>• permanent migrants</td>
<td>• transient migrants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• transnational business elites</td>
</tr>
<tr>
<td>Technology</td>
<td>• spillover effects</td>
<td>• global standards and practices</td>
</tr>
<tr>
<td></td>
<td>• tacit knowledge</td>
<td>• intra-firm R&amp;D activities</td>
</tr>
<tr>
<td></td>
<td>• infrastructure and assets</td>
<td>• technological licensing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• strategic alliances</td>
</tr>
<tr>
<td>Institutions</td>
<td>• conventions and norms</td>
<td>• labour and trade unions</td>
</tr>
<tr>
<td></td>
<td>• growth coalitions</td>
<td>• business associations</td>
</tr>
<tr>
<td></td>
<td>• local authorities</td>
<td>• national agencies and authorities</td>
</tr>
<tr>
<td></td>
<td>• development agencies</td>
<td>• inter-institutional alliances</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• supranational and international organizations</td>
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</tbody>
</table>

Source: Coe et al. (2004: Table 1).
### TABLE 2. Three Models of Industrial Clusters and External Economies

<table>
<thead>
<tr>
<th>Model of clusters</th>
<th>Intellectual traditions</th>
<th>External economies accrued to firms in clusters</th>
<th>Territorial sources</th>
</tr>
</thead>
</table>
| Pure agglomeration economies model | Neoclassical economics after Alfred Marshall | 1. A local pool of specialized labour (lower search costs)  
2. Local provision of non-traded inputs (economies of scale)  
3. Maximum flow of information and ideas (product and market knowledge) | Within clusters |
| Industrial complex model | Location theory after Alfred Weber | 1. Lower transport and logistics costs  
2. Greater certainty in transactions | Within clusters |
| Social network model | Embeddedness in new economic sociology | 1. Localized trust and interpersonal relationships (relational assets)  
2. Institutionalized practices, e.g. conventions and norms (institutional thickness) | Within clusters |

Source: Adapted from text in Gordon and McCann (2000).
Table 3. Economic statistics on growth regions in Malaysia and Thailand
(Population in 10,000 persons, employment in thousands, and value in billions in local currencies)

<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>2613</td>
<td>19705</td>
<td>1489</td>
<td>-3.7</td>
</tr>
<tr>
<td>Penang</td>
<td>147</td>
<td>1645</td>
<td>297</td>
<td>5</td>
<td>-7.9</td>
</tr>
<tr>
<td>Johor</td>
<td>135</td>
<td>3660</td>
<td>196</td>
<td>4.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Selangor</td>
<td>474</td>
<td>3469</td>
<td>393</td>
<td>8.8</td>
<td>1</td>
</tr>
</tbody>
</table>

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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>6420</td>
<td>6577</td>
<td>2312</td>
</tr>
<tr>
<td>Bangkok and vicinities</td>
<td>1114</td>
<td>2899</td>
<td>1104</td>
<td>24.3</td>
</tr>
<tr>
<td>Eastern region</td>
<td>434</td>
<td>998</td>
<td>528</td>
<td>59.9</td>
</tr>
</tbody>
</table>

FIGURE 1. Global production networks – A stylized example

Source: Henderson et al. (2002: Figure 2).
Figure 2. Changing industrial organization and global production networks and their impact on knowledge diffusion

Source: Ernst (2005: Figure 1, p.11).
Figure 3. The role of Singapore in Seagate’s hard disk drive production network

Worldwide locations: an example of Seagate Technology and its suppliers

Component fabrication activities
1. Media manufacture
   - Japan (e.g., Konag)
   - Malaysia (e.g., Konag)
   - Thailand
   - Singapore
2. Wafers, Heads and Semiconductors
   - Japan (e.g., Read-Rite)
   - Northern Ireland (e.g., Read-Rite)
   - USA (e.g., Read-Rite)

Subassembly activities
- China
- Indonesia
- Malaysia
- Philippines
- Singapore
- Thailand (e.g., Read-Rite)

Final assembly activities
- China
- Malaysia
- Singapore

Source: Adapted from Gourevitch et al. (2000: Figures 1 and 3).
Figure 4. DHL’s global connectivity in the electronics production networks

Source: Bowen and Leinbach (2006: Figure 4).