

Global Production Networks: Realizing the Potential

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Abstract

Understanding and conceptualising the complexities of the contemporary global economy is a challenging but vitally important task. In this article we critically evaluate the potential of one interpretive framework – the Global Production Networks (GPN) perspective – for analysing the global economy and its impacts on territorial development. After situating the approach in relation to other cognate chain/network approaches, the article proceeds to review and evaluate a number of underdeveloped areas that need to be understood and incorporated more fully if the framework is to deliver on its early potential. The article concludes with a consideration of the key research issues facing work in this area.

Keywords: Global Production Networks, economic globalisation, territorial development, critical review

JEL classifications: F00, F23, L14, L22, L23

1. Introduction: Networks and chains - metaphors and meanings

Unravelling the complexities of the global economy, with its fundamental geographical unevenness and huge inequalities, poses immense conceptual and empirical difficulties. Any approach that goes beyond the merely superficial must be able to incorporate the complex actions and interactions of a variety of institutions and interest groups – economic, political, social, cultural – which operate at multi-scalar levels and territorialities and through dynamic and asymmetrical power relationships to produce specific geographical outcomes: the *material* world in which people struggle to make their lives. At the same time, it has to be recognized that such material economic processes are themselves part of the 'lifeworld', the 'identities, discourses, work cultures and the social and cultural embedding of economic activity', the subject of what Sayer terms a critical cultural political economy (Sayer 2001: 688. See also Hudson, this issue).

Despite differences in terminology, as well as in focus, between different researchersⁱⁱ, there is a growing consensus around the idea that one of the most useful keys to understanding the complexity of the global economy – especially its geographical complexity – is the concept of the *network*. This is not to imply that networks are, in any way, new but rather that they reflect the fundamental *structural* and *relational* nature of how production, distribution and consumption of goods and services are – indeed always have been – organized. Although they have undoubtedly become far more complex organizationally, as well as far more extensive geographically, production networks are a *generic* form of economic organization. They are not some hybrid form existing in the void between markets and hierarchies, as some continue to argue (see, for example, Thompson 2003).

Production networks are inherently dynamic; they are always, by definition, in a process of flux - in the process of *becoming* - both

organizationally and geographically. The *spatio-temporality* of production networks, therefore, is highly variable and contingent. As Hudson (2004: 462) points out, '[...] economic processes must be conceptualized in terms of a complex circuitry with a multiplicity of linkages and feedback loops rather than just "simple" circuits or, even worse, linear flows'. Some networks are long-lived, others are more ephemeral; some are geographically extensive, others are more geographically localized. None remain completely unchanged for very long. Adjustments, some large, some small, are continuously being made in response to both internal and external circumstances. Analysing these issues, therefore, requires a heuristic framework that is time- and space-sensitive. We argue here that the *Global Production Network* (GPN) concept constitutes such a heuristic framework.

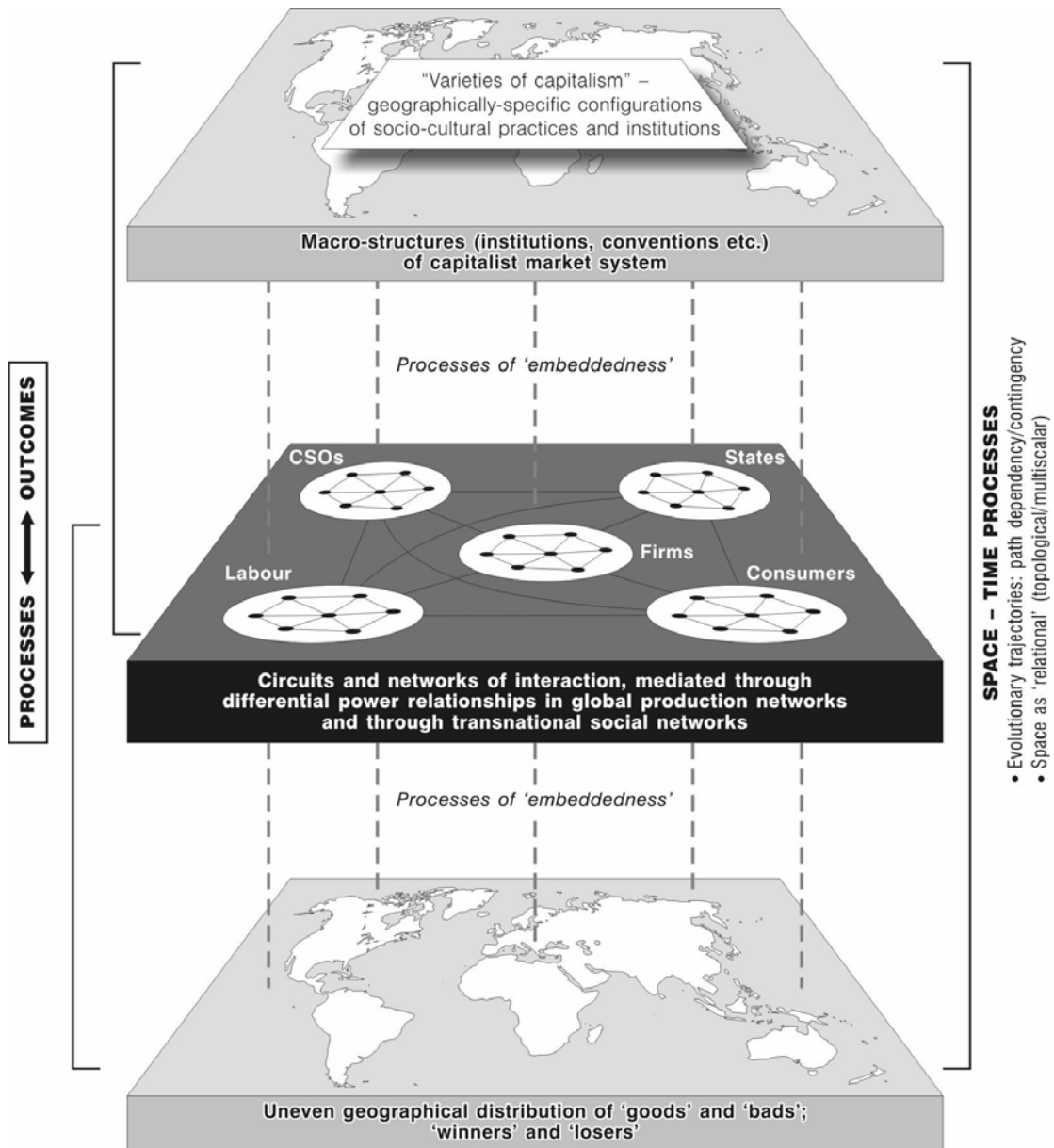
The GPN approach is a broad relational framework, which attempts to go beyond the very valuable but, in practice, more restricted, Global Commodity Chain (GCC) and Global Value Chain (GVC) formulations. Although the core of all three conceptualizations is similar – the nexus of interconnected functions, operations and transactions through which a specific product or service is produced, distributed and consumed – there are two crucial differences, in practice, between GCCs/GVCs on the one hand and GPNs on the other. First, GCCs/GVCs are essentially linear structures, whereas GPNs strive to go beyond such linearity to incorporate all kinds of network configuration. Second, GCCs/GVCs focus narrowly on the governance of inter-firm transactions while GPNs attempt to encompass all relevant sets of actors and relationships.

Figure 1 provides a broad heuristic framework that attempts to capture some of the complex processes and inter-relationships shaping and reshaping the global economy. GPN analysis focuses upon the inter-related actions of the sets of actors shown in the central section of Figure 1 which are, themselves, embedded in the broader structures and

institutions of the global economy shown in the upper part of Figure 1, the whole being mutually constitutive but also highly contingent in time and space. It is, of course, a crude and simplistic representation of a highly complex and dynamic situation. In particular, it is difficult to avoid the impression of top-down, nested relationships whereas, in fact, what are involved are dynamically inter-connected and simultaneous processes, heavily laden within asymmetries of power. It is, fundamentally, a deeply *relational* view of the world (see Dicken 2004, Yeung 2005). Indeed, Urry (2003: 122, emphasis added) goes so far as to claim that there is 'no "structure" and no "agency", no "macro" and no "micro" levels...This is because each presumes that there are entities with separate and distinct essences that are then brought into external juxtaposition with its other...my argument...is one that rests upon a *profound relationality*.'

GPNs are, as Levy (2007: xx) argues, 'simultaneously economic and political phenomena...[they]...resemble contested organizational fields in which actors struggle over the construction of economic relationships, governance structures, institutional rules and norms, and discursive frames...GPNs thus exist within the "transnational space" that is constituted and structured by transnational elites, institutions, and ideologies'. GPNs are also, of course, 'social' and 'cultural' phenomena. GPN configurations and characteristics are shaped by and, in turn, shape the geographically differentiated social, political and cultural circumstances in which they exist as well as the material technicalities of the specific transformational processes which lie at the core of a particular GPN.

Figure 1: A heuristic framework for analysing the global economy



Source: adapted from Dicken 2004, Figure 2.

So far, however, as Levy (2007:xx) also rightly observes, despite its 'lofty ambitions, most of the studies spawned by the GPN framework to date are, in practice, very similar to those generated using GCC analysis...the GCC/GPN framework appears to be converging with more conventional approaches to competitiveness and losing touch with its more critical origins.' In the light of this justifiable criticism, the aims of this

paper are to reflect upon some of the 'underdeveloped' aspects of the GPN framework which, in our view, need to be pushed forward analytically in order better to understand the complexity of contemporary economic globalization and its impacts on territorial development.

2. The 'core' of a GPN: transforming 'inputs' into 'outputs'

As noted earlier, a production network is, at its core, the nexus of interconnected functions, operations and transactions through which a specific product or service is produced, distributed and consumed. A *global* production network is one whose interconnected nodes and links extend spatially across national boundaries and, in so doing, integrates parts of disparate national and sub-national territories.ⁱⁱⁱ

In a production network, whose 'purpose' is to create value through the transformation of material and non-material inputs into demanded goods and services, there is inevitably an element of *linearity* or *verticality* in the structure of its nodes and links. It is perfectly understandable, therefore, that much attention has been devoted to *chain* structures (as in the value chain and commodity chain literature). This captures the process of *sequential transformation* from inputs, through stages of transformation to outputs and through to distribution and final consumption, a sequence in which each stage adds value to the process of production of goods or services.^{iv} It is the set of processes that is conventionally involved in supply chain analysis.

However, focusing only on the linear/vertical dimension of a production network is undoubtedly a problem (Henderson, Dicken, Hess, Coe and Yeung 2002; Smith, Rainnie, Dunford, Hardy, Hudson and Sadler 2002). In reality, each stage of a production chain is embedded in much wider sets of non-linear/horizontal relationships. Such multi-dimensionality must be incorporated in any analysis of production networks without, at the same time, losing sight of the 'directed' nature of the processes

involved. In this regard, Lazzarini, Chaddad and Cook (2000: 7) have put forward the concept of the *netchain*: 'a set of networks comprised of horizontal ties between firms within a particular industry or group, which are sequentially arranged based on vertical ties between firms in different layers...Netchain analysis explicitly differentiates between horizontal (transactions in the same layer) and vertical ties (transactions between layers), mapping how agents in each layer are related to each other and to agents in other layers.'

Although it seems unnecessary to add further terminological complexity to an already confused field, the ideas contained in the netchain concept are useful because they make us more aware of the multi-dimensional nature of production networks. The overall structure of a production network, therefore, can be thought of in terms of a series of intricate intersections between vertical and horizontal networks of varying degrees of size (length, width) and complexity (see Lambert and Cooper 2000: 71-72). In some production networks, the vertical length of the sequential process (the production chain itself) may be very short and consist of only a small number of layers. In others, the chain may be very long. Equally, the horizontal width of each layer may be broad or narrow, depending on the number of actors involved.

Adopting an explicitly networked approach brings several specific advantages. First, it allows us to identify a wide range of non-firm actors as *constituent* parts of the overall production system. We will develop this argument in much more detail in Section 3 of the paper. Second, it helps us to see beyond the linear progression of the product or service in question to reveal the complex circulations of capital, knowledge and people that underlie the production of all goods and services, and the various service firms of different kinds that are involved in those circulatory processes. Third, a multi-dimensional network perspective brings into view the connections and synergies between processes of value creation in different production networks (see Weller, 2007).

Such an approach also emphasizes the complex nature of the *interdependencies* that exist within production networks. Thompson's (1967) typology of intra-organizational interdependencies – sequential, pooled, reciprocal – merits further attention in this broader, inter-firm context. Such interdependencies, of course, have to be 'ordered by formal or informal agreements on the division of labour between the actors' (Andersen and Christensen 2004:3). This takes us on to issues of co-ordination and control within production networks, that is, to questions of *network governance* and of *power relationships*.

In the global commodity chain and global value chain literature, the issue of governance has received by far the most attention, often to the neglect of other attributes. Gereffi, Humphrey and Sturgeon (2005), in their reformulated GVC framework, propose a five-fold typology of governance relationships: market, modular, relational, captive, and hierarchy (see also Sturgeon et al, this issue). This typology is closely related to transactions cost economics and based upon three criteria: complexity of transactions, ability to codify transactions, and capabilities in the supply base. This expanded governance framework is, without doubt, a major improvement on Gereffi's dichotomous categories of buyer-driven and producer-driven chains. Not least, it demonstrates a more nuanced understanding of power relationships, although only one set of relationships – between firms and suppliers – is considered. However, despite its greater breadth and depth it remains, as do all typologies, a set of ideal-types based upon quite a narrow (deliberately so) view of production networks. What is more, like Thompson (2003) this typology reifies and essentialises the market and the hierarchy as distinct, non-networked forms of governance where the distribution of power seems to be clear. However, the specific configurations and asymmetries of power within GPNs are infinitely more complex, contingent, and variable over time. For example, the power relationships between firms and their suppliers are rarely as simple as the conventional

wisdom tends to suggest whereby the large automatically dominate and exploit the small. Size does not always matter.

As in all bargaining situations, the relative power of actors within a network depends, in large part, on the extent to which each possesses assets sought by the other party and the extent to which access to such assets can be controlled. The scarcer the asset the greater the bargaining power it conveys and vice versa. In a GPN, therefore, the firms in the weakest position are those producing what are in effect commodities that are easily replaced. But this is not necessarily a static situation. Firms may be able to upgrade their assets and competencies. In addition, the *position* a firm develops within a GPN may well, in itself, confer significant bargaining power, especially when one bears in mind that firms tend to belong to more than one production network at the same time. Andersen and Christensen (2005) identify five types of supplier which, they argue, may act as important 'connective nodes' in global production networks, while Hobday, Davies and Principe (2005) focus upon the processes of system integration involving complex networks of firms. This leads us to a consideration of two gaps in virtually all studies of global production networks and value chains.

2.1 Circulation processes are fundamental

The first gap relates to the *circulation processes* through which the nodes in the network are actually connected in a functional and physical sense. For reasons that remain something of a mystery, social scientists – including, remarkably, economic geographers (although for notable exceptions see Aoyama et al. 2006; Aoyama and Ratick 2007; Bowen and Leinbach 2006; van Egeraat and Jacobsen 2005; Dicken 2003b, 2007, Hall et al. 2006; Hesse and Rodrigue 2004, 2006; Leinbach and Bowen 2004) – seem to assume that, with the development of the time-space shrinking technologies of transportation and communication, the problem of actually moving materials, components and finished products has been solved. In fact, with the vastly increased complexity

and geographical extensiveness of production networks, and the need to coordinate and integrate extraordinarily intricate operations as rapidly and efficiently as possible, the *logistics* problem is absolutely central. We need to understand it. And yet it is virtually ignored outside the specialist technical world of supply chain management. It is especially paradoxical that until recently transportation geographers – at least those writing in English – have largely neglected this key area.

But it is not only academics who underestimate the importance of logistics. A German automobile manufacturer made the following observation (Dicken 2003a: 23-4): 'logistics costs are the most hidden and underestimated costs in production. Under globalization, of course, they gain importance. As a rule of thumb, if you look at the value-added of a car, about one-third of it is attributed to logistics costs...And for that the customer doesn't pay a single deutschmark. So we are well advised to reduce these costs. If I see the eagerness with which we try to save a minute of production time here and there, and how much we have neglected the issue of logistics costs, then there is a wide area' (Interview with German automobile assembler, 2001).

At the core of the need to develop efficient circulation services within GPNs is the fact that 'time- and quality-based competition depends on eliminating waste in the form of time, effort, defective units, and inventory in manufacturing-distribution systems...Time- and quality-based competition requires firms to practise such logistical strategies as just-in-time management, lean logistics, vendor-managed inventory, direct delivery, and outsourcing of logistics services so that they become more flexible and fast, to better satisfy customer requirements' (Min and Keebler 2001: 265). As a result of such pressures, a highly sophisticated set of logistics service providers has emerged, some developing out of traditional transportation companies (rail, road, shipping, airlines), some from wholesalers and trading companies, while others are entirely new

forms of logistics organizations. Such providers are 'tiered' in a similar manner to conventional suppliers (see Schary and Skjott-Larsen 2001).

2.2 What goes in *inside* the firm matters a lot

The second gap in the GPN/GVC literature concerns the treatment of the *firm*. Although the firm is clearly – and explicitly – the central actor in all analyses it is, invariably, treated as a *black box*. In the GVC/GPN literature, firms tend to be dichotomized very simplistically into 'lead' firms (what Ernst (2005; Ernst and Kim 2002) terms 'flagship' firms) and supplier firms. The usual analytical focus is the lead firm, although this need not be the case. Indeed, one advantage of adopting a GPN approach is that it is possible to shift the focal point of analysis to different positions in the network. This, in turn, facilitates our understanding of the differentiated network positionality of firms and, therefore, of their potential local impacts. However, it is important to bear in mind that virtually all firms 'belong' to more than one – in some cases several – production networks. Of course, by definition, it is the 'lead' firm that plays the dominant role in a GPN. It is, in effect, 'a firm that has the power to coordinate and control operations in more than one country, even if it does not own them' (Dicken 2007: 16).

In fact, virtually all of the attention in the GPN/GVC literature focuses upon inter-firm relationships to the almost total neglect of *intra-firm* relationships and of the ways in which the internal structures and relationships inside firms play a critical role in how GPNs operate and have their impact (Dicken and Malmberg 2001). However, there is a definitional problem involved here. Within a network framework, it makes sense to conceive of the firm as a relational network embedded in wider networks of social actors and institutions and defined by 'ownership, hierarchical control, centralized power, managerial discretion, social bonds of membership loyalty and shared purpose, and formal, legal contractual relationships' (Badaracco 1991: 293. See also Blois 2006). In this view, the boundaries of the firm are 'fuzzy.' On the other hand, a firm

is a clearly defined legal entity with distinct boundaries. As Markusen (1999: 878) argues, from this perspective the boundaries of a firm are 'not at all fuzzy – they are written down in asset, cost, and revenue statements that owners and managers...scrutinize very carefully...as organizations and institutions, firms are clearly bounded.'

In fact, both definitions are 'true'. Firms are networks embedded within networks, with varying degrees of imbrication and interconnection. At their core, however, is a set of formally organized rules and conventions that are institutionalized and regulated both internally and externally. There is abundant empirical evidence that the boundaries between internalization and externalization of functions are in a continuous state of flux, involving a complex reconfiguring of organizational boundaries, including the proliferation of various forms of inter-firm collaboration. However, it is a mistake to see this as an inevitably one-way, or irreversible, process.

At least as important as this 'boundary' issue is the nature of the power relationships *within* firms. Even in the archetypical hierarchical firm, whose governance structures are essentially top-down, it is not invariably the case that each individual part simply responds passively to decisions from on high. Different subsidiaries, for example, may compete against each other for investment (Birkinshaw 1996; Phelps and Fuller 2000). In reality, intra-firm relationships are highly contested, a reflection of the particular internal governance system, including formal and informal power structures and relationships and competing versions of corporate cultures (Schoenberger 1997; O'Neill and Gibson-Graham 1999). 'Firms are themselves systems of power with constituent groups (e.g. of engineers, managers, workers, R & D staff) challenging each others' power...[and]...in which different kinds of interests within the firm try to pursue their own...strategies (Cawson et al 1990: 8, 27). As we shall see later, these internal power relationships also have a strong *territorial* dimension.

Opening up the 'black box' of the firm in this way has important advantages. It allows us 'to explore the complex ways in which corporations produce multiple, dynamic and contested rationalities in response to similar economic imperatives and competitive pressures' (Dawley, 2007: 68). In this way, the tendency for GVC/GPN analyses to assume that firms occupying similar positions in production networks will respond in a similar fashion can be avoided. Relatedly, it helps explain how dynamic firms with 'strategic intent' can alter the *status quo* in global production networks through exploiting 'the fragility of the power relationships and [upgrading] into higher value-added activities despite discouragements that are imposed by the networked relationships' (Tokatli and Kizilgun 2004: 222)

3. Spatial asymmetries: 'Non-firm' actors in GPNs

In focusing on the internal complexities of production networks it is all too easy to overlook the fundamental fact that such networks do not exist in a vacuum. Unfortunately, far too much of the production network literature pays little more than lip service to the institutional and geographical environments within which networks not only operate but also within which they are formed and shaped. All production networks exist within a diversity of multi-scalar structures within the global economy, constituting a *relational topology*, to use Amin's (2002) terminology (see also Hess 2006). 'The variety of institutions leads to complex spatialities of governance and regulation. These combine the diverse spaces and spatial scales (national, supranational and subnational) of state organizations and institutions within civil society. Systems of governance and regulation are now more multiscalar...but *national states retain a critical role* within them' (Hudson 2004: 453. Emphasis added). Every element in a global production network – every firm, every function – is, quite literally, *grounded* in specific locations. Such grounding is both material (the fixed assets of production), and also

less tangible (localized social relationships and distinctive institutions and cultural practices).

Hence, the precise nature and articulation of global production networks are deeply influenced by the concrete socio-political, institutional and cultural 'places' within which they are embedded, produced and reproduced. The relationships between firms and territories are exceedingly complex (see Dicken and Malmberg 2001). There are strong processes of path-dependency – though not determinacy – involved in these mutually constitutive processes of embeddedness (Hess 2004): what have been described as processes of 'placing' firms and 'firming' places (Dicken 2000, 2003c). As the geographical extensiveness and complexity of GPNs increases, the nature of this embeddedness also becomes far more complex.

On the one hand, the nature of the places within which the parts of GPNs are situated influences how these component firms or establishments behave and perform within the overall network subject, of course, to the prevailing power relationships in the network. As Schoenberger (1999: 211) observes, 'different "places" within the firm, organizationally and geographically, develop their own identities, ways of doing things and ways of thinking over time, the reason being that they live in different places and must confront and respond to the particularities of these places across a whole range of practices and issues.'

Such place-related situatedness has important implications for the bargaining and negotiating processes that occur within firms as decisions are made to invest, to re-invest, or to dis-invest in specific locations. Indeed, there is evidence that the particular territorial embeddedness of individual firm units/subsidiaries may play a significant role in that unit's ability to create or maintain a specific intra-firm role. A unit's level of competence determines the strength of its influence within its firm network. Such competence 'is driven (at least partly) by

environmental factors derived from the dynamics of the location in which it is situated. The competencies of a corporate unit are created over extended periods as a firm interacts with its surrounding environment' (Dicken and Malmberg 2001: 356; see also Birkinshaw 1996).

One of the major problems in coordinating GPNs, therefore, is that, by definition, they are made up of actors from a wide variety of national (and local) environments. In the case of a dominant firm within a GPN, the country of origin remains an important influence on how it operates both across the network as a whole and in those specific locations where its operations are situated (Dicken 2000, 2003c; Mikler 2007), a dynamic we term *societal embeddedness* (Hess, 2004). On the other hand, the nature of the production networks themselves, in which the individual firms or establishments are connected, has a profound influence on their prospects and that of the communities in which they are located. Humphrey and Schmitz (2002), for example, make this point in discussing the prospects of industrial upgrading of enterprises in localized industrial clusters (see also Schmitz 2004). More broadly in a regional development context, Coe, Hess, Yeung, Dicken and Henderson (2004) explore the complex ways in which global production networks and regional development interact through what is termed a 'strategic coupling process'.

In the GVC framework, the focus is deliberately confined to firms and their transactional relationships within the value chain. GVC researchers recognize that other actors may be involved but they tend not to be included in the analysis and – crucially – are mostly viewed as external forces. Although there may be some justification for this in terms of its theoretical simplicity and practical application, in the broader theoretical context it has to be regarded as a weakness. The major difference between a GPN and GVC approach, therefore, is that the

former aims to be more inclusive than the latter, even though this poses considerable practical problems.

As noted earlier in reference to Figure 1, GPNs are very much more than economic phenomena: they are also fundamentally social, cultural, and political systems (see Levy 2007), which is why a critical cultural political economy of GPNs is needed. Although the material economic processes of production, distribution and consumption are at the core of a GPN, these processes are not simply driven by 'firms'. Indeed, the whole question of the operation and governance of GPNs involves, in various degrees and in contingent circumstances, some or all of the other actors shown in the central section of Figure 1. These need to be incorporated into GPN analyses in a serious way. Each of the major non-economic actors – states, civil society organizations, labour, and consumers – have very different spatialities from those of firms/GPNs. There are, in other words, marked *spatial asymmetries* involved between what Mattsson (2007) terms the polycentric spatiality of GPNs and the essentially mono-territoriality of states and other actors. This translates into complex bargaining processes in which, contrary to much conventional wisdom, there is no unambiguous and totally predictable outcome.

3.1 States and multi-scalar regulatory systems

All global production networks are embedded within *multi-scalar regulatory systems*. International regulatory bodies, such as the WTO - part of the 'confusion' of institutions that makes up the incoherent architecture of global governance - are immensely significant in influencing the geography of global production networks. One needs only look at the influence of the Multi-Fibre Arrangement (MFA) in the clothing and textiles industries to be aware of this (the abolition of the MFA at the beginning of 2005 is having a massive influence on global production networks in these industries). Such international regulatory structures are widely recognized, if not sufficiently well integrated into GPN research. Less widely recognized is the role of International

institutions establishing technical standards (like the ISO 9000, the international quality management standard, or the ISO 14000 international environmental standard) (Braithwaite and Drahos 2000; Messner 2004, Ponte and Gibbon 2005; Nadvi this issue). In some cases these make the operation of global networks more feasible through their introduction of codifiable standards. In other cases, they create problems of conformity to an international standard in specific places.

3.1.1 International standards

In the context of GPN analysis, four aspects of standards are especially important. First, standards apply to different aspects and/or parts of a value chain or global production network (for example labour conditions or environmental protection). Second, the standards implemented may take different, stronger or weaker forms, e.g. enforceable rules or less binding codes of conduct. Third, while some types of standards may be sector specific, others may be generic, but vary in different geographical and institutional contexts. Fourth, standards are produced by a variety of public and private actors, thus reinforcing complex governance structures in GPNs.^v

The world of standards has a considerable impact on governance structures in production networks. The implementation of environmental and social standards is often based on cooperation between the parties involved, whereas the development of technological standards in many cases is based on rivalry between competing firms struggling for market control. The system known as 'Wintelism' – based on the dominance of Intel as supplier for computer processors and Microsoft Windows as market-dominating computer operating system (a de-facto standard) – is a case in point here. Once the standards have been developed and established, it very much depends on the certification processes and regulatory implications to determine the dominant form of governance.

These processes are all innately geographical. This can be seen on at least three levels. First, it is important to recognize the multiple scales

at which global standards are *negotiated*. Many of the private and public actors – firms, NGOs, consumer groups, trade unions etc. – are distinct at the local, regional, national, and international level. This suggests new institutional arrangements that link across geographical scales. Second, we can think about the various territories or networks *covered* by the jurisdiction of different forms of standards (e.g. a scheme applying to products sold by UK retailers in their home market). Third, we can think about the *impacts* of standards initiatives, which may be felt at geographically disparate points of production networks by ‘distant others’ (and not always in the ‘progressive’ manner intended: see for example, Friedberg, 2004; Mutersbaugh, 2005).

3.1.2 The continuing centrality of nation-states as key actors

Among the multiplicity of regulatory institutions, and allowing for the proliferation of international and sub-national bodies, the *nation-state* remains a key actor in GPNs. *All* the elements in global production networks are regulated within some kind of political structure whose basic unit is the national state. International institutions exist only because they are sanctioned by national states; sub-national institutions are commonly subservient to the national level, although, of course, the situation is more complex in federal political systems. Despite the widely predicted demise of the nation-state, the number of states has grown markedly, particularly since 1989. At the same time, the propensity for states to enter into preferential trading agreements (PTAs) with other states, both geographically proximate and geographically separate, has accelerated dramatically (Dicken 2007:187-188).

As a result, firms and states are continuously engaged in intricately choreographed negotiating and bargaining processes, including what are often termed ‘locational tournaments’ over investment projects (see Dicken 1990; Dicken and Tickell 1992; Dawley 2007). On the one hand, firms attempt to take advantage of national differences in regulatory regimes (such as taxation or performance requirements, like local

content). On the other hand, states strive to minimize such 'regulatory arbitrage' and to entice mobile investment through competitive bidding against other states. The situation is especially complex because while states are essentially territorially fixed and clearly bounded geographically, a TNC's 'territory' is more fluid and flexible. Global production networks slice through national boundaries (although not necessarily as smoothly as some would claim). In the process parts of different national spaces become incorporated into GPNs (and vice versa).

Although it is often argued that states have suffered a major secular diminution of power *vis-à-vis* firms and, especially, global production networks (see, for example, Petkova 2006), the actual situation is far more complex and contingent (Stopford and Strange 1991). Under certain specific conditions, the state *can* exert a material influence and can ensure that there are positive national and local benefits. To achieve this, however, the state not only has to have the *theoretical* capacity to control access to assets within its territory but also the power *actually* to determine such access. In other words, 'strong' states can be highly effective in the power struggle over investments.

The contrasting situations in the automobile industries of China and of Eastern Europe illustrate this point very well (Liu and Dicken 2006). There is little doubt that the form – and the geography – of automobile production networks in China would have been quite different had the firms had unhindered access and freedom optimally to organize their global production networks. But the Chinese government has exerted virtually complete control over such entry and has adopted a policy of limited access for foreign firms, including the form that their involvement can take. Here, therefore, we have the obverse of the usual situation. Whereas, in many cases, TNCs are able to play off one country against another to achieve the best deal, in the Chinese case it is the state

whose unique bargaining position has enabled it to play off one TNC against another.

In the countries of Eastern Europe, on the other hand, there has been a much more fundamental political – as well as economic – transition towards a more neo-liberal position. The transitional states of Eastern Europe overwhelmingly adopted neo-liberal market policies, which considerably reduced their individual bargaining power. But, as Bartlett and Seleny (1998: 320) have argued, the situation is made far more complex by these states' increasing integration into the EU political system which, they suggest, has, at least partially, shifted the balance of bargaining power between automobile TNCs and states.

However, the increasing *political* integration of the Eastern European states into the European Union, with its particular regulations on the concessions and incentives that can be granted to TNCs, has enabled those states to retrieve some of their bargaining power. But, as Bartlett and Seleny emphasise, this was only possible because, in effect, the EU acted as a 'strong state'. Left alone, the post-communist Eastern European countries would have been relatively powerless. As it is, their degrees of bargaining freedom should not be over-exaggerated. As experience throughout Europe shows, the intensity of competition between states for mobile investment – especially in industries like automobiles – places them in a far weaker position than China. There are far more substitutable locations within Europe for potential investors to retain considerable bargaining strength. In the Chinese case, that does not apply.

3.1.3 The increasing salience of macro-regional economic arrangements

This empirical example raises the issue of the increasing significance of *macro-regional economic arrangements* for the organization of GPNs. As noted earlier, there has been a spectacular proliferation of preferential trading arrangements, some of which are

between geographically co-terminous states. The creation of such structures significantly changes the economic (and political) surface on which GPNs – and the TNCs driving them - operate. On the one hand, they provide additional incentives for GPNs to be organized regionally (in addition to the benefits of geographical proximity) and there is abundant evidence of regionally-organized GPNs in many industries (see Dicken 2007 Part III; Morrison and Roth 1992; Muller 2004; Sturgeon et al, this issue).

But to what extent does the desire for TNCs to enhance their GPNs itself contribute towards the creation of regional economic groupings, rather than merely responding to the opportunities for restructuring provided by them? Yoshimatsu (2002: 128-129) argues that such pressures do exist: 'Firms are likely to support the formation of a regional trade arrangement if the formation would enable them to enjoy benefits from preferential access to the regional market where they are heavily dependent, or to procure intermediate parts and components from countries in the region with reduced tariffs. In contrast, firms tend to oppose a regional trade arrangement if they have plants manufacturing products with a high degree of national integration and in markets protected against international competition.'

Hence, the relationship between the regional development of global production networks and regional political integration is both contingent and dynamic. Where regional political integration occurs and develops then it will tend to attract inward foreign investment and, in certain circumstances, the further development of regional production networks. Conversely, pressures exerted by TNCs on states for greater integration of regional economic spaces may, in some cases, help to speed up the process of political integration. The actual configuration and geographical scale of regional political integration will also influence the subsequent development of global production networks within a region. The nature and degree of intra-regional

differentiation – economic, social, cultural, political – will also have a significant influence on the ways in which global production networks develop.

3.2 Labour, consumers, civil society organizations

The production network literature is especially silent on the other major actors: labour, consumers and civil society organizations. Yet each of these plays a fundamentally important role in how GPNs work.

3.2.1 Labour

Rather like the circulation/logistics processes discussed earlier, labour is, most commonly, simply assumed to be an intrinsic part of the production process (labour as commodity). As Smith et al (2002: 47) argue, 'insofar as "workers" are present in this literature, they appear as passive victims as capital seeks cheap labour...this lacuna is surprising given the existence of a great quantity of research on the dynamics and contradictions of the labour process within firms examined in the commodity chain literature in sectors such as clothing, autos and retailing' (see also Knorringa and Pegler 2006).

Arguably, a major reason for this lack of a serious engagement with the role of labour in production networks is related to a point made earlier: the tendency to view the firm as a black box. Consequently, 'little, if any, attention is given to the organization of work and employment at the intra-firm level, clearly limiting an assessment of a place's location within a commodity chain...labour process dynamics strongly influence wealth creation and work conditions within any one node and across a chain...organized labour can have an important influence upon locational decisions within and between countries, thereby determining in part the geography of activities within a value chain' (Smith et al 2002: 47).

Given that a fundamental characteristic of labour is that it is 'idiosyncratic and place-bound' (Storper and Walker 1989: 155), there is a

clear spatial asymmetry between place-bound labour and polycentric GPNs. This close tie between labour and place provides a major basis of its differentiation (related to place-specific histories, cultures, social stratification, gender-relations, education systems, and so on). Within and between places, labour is highly segmented: by skill, by gender, by age, by ethnicity. Although labour migration, both within and between countries, is immense, overall labour is far less mobile than capital. This reinforces its place-based differentiation and also its place-bound problems.

A major need, therefore, is to link work on GPNs more explicitly with work within 'labour geographies' (see Castree et al 2004; Cumbers et al, this issue; Herod 1997, 2001; Peck 1996; Wills 2001a,b). What this work has in common is a desire to open up analytical space for the agency of workers, and worker groups, to shape the geographies of capitalism. In Herod's (1997: 3) view, what is needed is a shift from thinking about *geographies of labour* – i.e. how workers are distributed through space and how they are affected by the vagaries of the global economy – to a notion of *labour geographies* that enables us to conceptualise labour 'not merely in terms of "factors" of location or the exchange value of "abstract labour" but to treat working class people as sentient social beings who both intentionally and unintentionally produce economic geographies through their actions'. In other words, we need to recognise that workers have the agency to strive to improve their relative position and, at the same time, to contribute towards re-shaping economic geographies.

Figure 2: Potential spatial strategies of labour.

		<i>Targets of solidarity</i>	
		LOCAL NEEDS	NON-LOCAL NEEDS
Scale of action	LOCAL	e.g. defensive, place-based campaigns and coalitions	e.g. consumer boycotts targeting labour practices elsewhere
	TRANSLOCAL	e.g. workers supporting their families through labour migration	e.g. global union campaigns for rights, standards and wages

Source: Lier, 2007, Figure 2.

The agency potential of workers is innately geographical. By intersecting the scale of action (local or translocal) with the targets of action (local or non-local), we can produce four ideal types of labour’s spatial strategies (see Figure 2). These strategies can cover both production and consumption politics and can encompass resistance within the workplace, acting in a locality both alone and in coalitions, working across different places, and proactive migration. While the link to the migration literature has been made only sporadically by labour geographers (e.g. Castree *et al.*, 2004), recent work has tended to focus on either worker ‘upscaling’ initiatives – e.g. Herod’s (2001) study of GM workers’ ability to cause widespread disruption in Just-In-Time production systems – or more place-based ‘community unionism’ initiatives that see workers collaborating with a wide range of other community groups – e.g. Will’s (2001a) work on the Battersea and Wandsworth Trades Union Council (BWTUC).

The labour geographies literature is not without its problems: it tends to be driven by case studies of successful actions; it tends to focus primarily on unions and union strategies, manufacturing sectors and

developed world examples; and the notion of 'agency' is oddly rather under-developed and thinly conceptualised. Equally, we should not be overly sanguine about the potential for labour to upscale and effectively to challenge the forces of globalization. We need to keep the 'degrees of freedom' of labour within a globalizing economy in perspective. As Rutherford and Holmes (2007: 196) argue, 'the emphasis placed on labour's agency by some labour geographers needs to be tempered by considering the continued significance of macro-processes' (see also Lambert and Gillan 2007). The fundamental spatial asymmetries between labour and capital – based upon the relative fixity of labour and the greater mobility of capital – are a key limiting condition. The fact that, globally, the level of labour force unionization has continued to decline, though unevenly, and that the share of income going to labour has also continued to decline whilst, at the same time, the effective global labour supply quadrupled between 1980 and 2005, with 50 per cent of that increase occurring in East Asia (IMF 2007: chapter 5) is a major issue.

The labour geography literature tends to focus on those employees within global production networks whose position offers them the potential to exert effective pressure on their employers; it is difficult to 'jump scales' without pre-existing local/national organisational structures; and labour internationalism is not necessarily progressive, if it impacts deleteriously on workers elsewhere (Lier 2007). Nonetheless, there is a potentially analytically and politically rich line of enquiry that can, in certain contexts at least, serve to reveal the active and constituent role of workers within the value dynamics of global production networks.

3.2.2 Consumers

One of the criticisms levelled at the chain/network approach is that it is overwhelmingly *productionist*: that it ignores *consumption*.^{vi} In one sense, that is true. As Pelulessy and Van Kempen (2005: 362) argue,

'At present, consumer preferences are not well-integrated in global commodity chain analysis. In most GCC studies the consumer only plays a marginal role – if any – and his or her preferences tend to linger in the background ... Firms comprise the main unit of analysis in GCC studies and, consequently, the distributions of wealth along chains are outcomes of inter-firm competition. This renders the incorporation of the consumer as a full-fledged chain actor problematic'. Indeed, the conventional depiction of a production chain is as a uni-directional sequence whereas, in fact, the transformational/transactional sequence is intrinsically two-way, in which the demands and specifications of customers flow in the opposite direction and help to shape the processes at each stage in the sequence. This tends to be under-emphasized.

However, it is really *final consumption* that has been neglected in much chain research; in every other respect, 'consumption' is an inherent part of the process, as is clear in the virtually universal focus on the governance of supplier-customer transactions. This point is often overlooked by consumerist critics of GPNs. Nevertheless, it is clear that we do need to find ways of integrating the role of consumption more fully into GPN analysis (Jackson 2002). We also need to avoid 'treating retail and consumption as simple, unproblematic starting points from which to embark on a more worthy examination of exploitation in the productive sphere' (Hughes 2000: 177). One challenge is to extend our understanding of production networks to incorporate key consumption spaces and, in particular in the case of final demand goods, the home (Leslie and Reimer, 1999).

Finding answers to these challenges is far from easy. In the case of agri-food products, Pelupessy and Van Kempen suggest using ideas from Lancaster's (1966) product characteristics approach – in which products are seen as end use services for needs satisfaction – to explore how producers who supply mainly nutritional characteristics may lose out to

producers who add higher-order characteristics to the same food products.

Other areas of work in the literature are also suggestive. First, there is now a well-established body of work looking at the context-specific meanings attached to goods and services in different times, places and phases of commodity circulation (e.g. Cook and Crang, 1996; Jackson, 2002). These kinds of 'thick' ethnographic accounts can also reveal the importance of different kinds of knowledge relating to commodities, and how these circulate through the production system in a non-linear and non-deterministic fashion. In line with Leslie and Reimer (1999), however, our sense is that these studies perhaps reveal less about the power and value relations inherent to such systems, and their impacts.

Second, there may also be ways of reconnecting production and consumption that recognise the dual role of workers, i.e. as both producers and consumers. An indicative example would be the work of Raghuram (2004) on South Asian women entrepreneurs in the garment industry and their role in designing new products and initiating new networks. More broadly, the argument is that the kinds of 'product biographies' mentioned above need to be combined with 'personal biographies' of key actors in production networks that explore the intricate connections between production, innovation and consumption.

A third line of enquiry would explore the impacts of new technologies, and in the particular the Internet and related forms of social 'software', that are greatly enhancing the thickness and richness of knowledge flows between 'producers' and 'consumers' to the extent that the two acts of production and consumption blend into each other and become analytically indistinguishable in a process of 'co-development' (Grabher 2007). These changes are leading to hybrid communities that bring together experts and laypeople and are altering the usually perceived balance of power between users and producers.

A fourth potential approach concerns the application of consumer politics and initiatives, a development intimately bound up with the growth of various kinds of civil society organizations, a topic to which we now turn.

3.2.3 Organizing resistances: civil society organizations

Insofar as both labour and consumers are often (though not always) relatively powerless compared with the TNCs which dominate GPNs, they need to organize to be effective. The problem is that such organization needs to be *trans*-national. Within the past 25 years, there has been phenomenal growth in the number of civil society organizations (CSOs), many of which are either by origin or by development, transnational in their scope (see, for example, Glasius, Kaldor and Anheier 2002; Kaldor 2003; Yanacopulos 2005). Equally, the diversity of CSOs is immense, as Kaldor (2003) demonstrates, ranging from the pre-1970 'old' social movements through the 'new' social movements of the 1970s/1980s, the NGOs and the transnational civic networks of the late 1980s and 1990s, the 'new' nationalist movements of the 1990s and the 'new' anti-capitalist movements of the late 1990s and 2000s.

Although the influence of CSOs varies enormously, there is no doubt that, as important actors in the global system, they have to be taken into account in GPN analyses. In some GPNs, of course, notably agro-food industries, natural resources, energy, clothing and textiles, they are extremely prominent and have a significant influence on corporate behaviour. More broadly, as Beck (2005: 238) argues, 'the advocatory movements of global civil society are the originators, advocates and judges of global values and norms. The way they create and hone this everyday, local and global awareness of values is by sparking public outrage and generating global public indignation over spectacular norm violations. They do this by focusing on individual cases.' Pressures from CSOs undoubtedly exert a considerable influence on firms to

engage in more socially responsible behaviour. Although there may well be some altruistic cases, the current trend towards explicit corporate social responsibility policies among TNCs (see Dicken 2007; Gereffi, Garcia-Johnson and Sasser 2001; Hughes et al, this issue; van Tulder with van der Zwart 2006) is largely the result of such pressures.

3.3 Networks of cooperation *and* conflict

GPNs are, to use Levy's (2007) terminology, *contested fields*. They are made up not only of firms but also of a diversity of actors and institutions, each of which has its own agendas. The extent to which such agendas can be realised clearly depends on the relative power configuration in specific situations. We have already commented on this. But there is a further dimension that needs emphasis. Not only are power relationships between GPN actors not structurally determined but also they are not unidirectional. Each of the major sets of actors in the global economy is involved in *both* cooperation and collaboration on the one hand *and* in conflict and competition on the other (Dicken 2004: 13). Such apparently paradoxical behaviour should warn us against assuming that relationships between certain actors are always of one kind: for example, that those between TNCs, or between TNCs and states, or between TNCs and labour are always *either* conflictual *or* competitive. Or, conversely, that the relationships between groups of workers or labour organizations are always cooperative (in the name of class solidarity). This is not the case: these various actor-networks are imbued with an ever-changing mixture of both kinds of relationship.

So, for example, TNCs in the same industry are fierce competitors but also, invariably, enmeshed in a complex web of collaborative relationships. Intriguingly, many of these alliances are between competing firms. States compete in cut-throat fashion with other states to entice internationally-mobile investment by TNCs or to find ways to keep out certain types of imports whilst, at the same time, increasingly engaging in preferential trading arrangements. Labour unions in one

country engage in competition with labour unions in other countries in the scramble for new, or to protect existing, jobs whilst, at the same time, unions strive to create international alliances with unions in other countries, especially those involved in the geographically-dispersed operations of major TNCs. They also increasingly attempt to negotiate international framework agreements with TNCs as part of a strategy of ensuring workers' rights (Cumbers et al, this issue). CSOs, likewise, are not immune from these conflicting actions. In the context of the anti-globalization protests, for example, CSOs have developed collaborations across national boundaries but, at the same time, the goals and values of individual CSOs are not always compatible, to say the least.

The anthropologist Anna Tsing uses the metaphor of 'friction' to capture the contested, shifting and uncertain nature of the various relationships that constitute production networks. In her words, 'friction reminds us that heterogeneous and unequal encounters can lead to new arrangements of culture and power' (2005: 5). This notion, derived from ethnographic research in the rainforests of Indonesia, is further relevant to the arguments of this paper and special issue in two ways. First, by focusing on forestry, Tsing draws attention to the particularly volatile attributes of production networks concerned with the extraction of natural resources (see Bridge, this issue). Second, Tsing (2005: 51) describes how 'global capitalism is made in the friction in these chains as divergent cultural economies are linked, often awkwardly': we return to issues of the *cultural* political economy of global production networks now.

4. Moving forward: some key research issues

A GPN framework has enormous potential to help us to understand the dynamic organizational and geographical complexities of the global economy. In particular, it offers the following major advantages (Dicken 2004: 15; Henderson, Dicken, Hess, Coe and Yeung

2002). First, it has the capability of being *inclusive of all the major actors*, not just 'producers'. Second, it is totally *flexible in terms of geographical scale*. Third, it recognises that the precise nature and articulation of GPNs are fundamentally influenced by the concrete socio-spatial contexts in which they are embedded. Fourth, it forces us to distinguish between such *territorial embeddedness* and *network embeddedness* (connections between network members regardless of country of origin or location in specific places). Fifth, it facilitates a more *nuanced articulation of power relationships* than has tended to be the case in chain-type analysis. In this regard, it enables us not only to analyse corporate power but also institutional power (states at different levels, as well as the 'global' institutions) and collective power (e.g. CSOs, labour unions). Sixth, it enables us to identify the points within the network where *value* is created (and for whom), where it is captured (which may not be in the same place), and how such value might be enhanced (e.g. in terms of upgrading). Seventh, and relatedly, it raises the possibility of identifying potential *points of intervention or resistance* within the network by, for example, CSOs (as in the case of consumer boycott movements, ethical trading initiatives, and the like).

However, we are some way from realizing such potential. As we have seen, there are still some ontological and epistemological differences between the GCC literature, the work on value chains and production networks and the literature on economic globalisation in general (see also Hess and Yeung 2006). More specifically, for GPN research to be productive we need a conceptualisation that operates at the interface of structure and agency, flows and territories, culture and economy to overcome such unhelpful and ultimately artificial dualisms. Rather than essentialising the economic and the cultural, the market and (atomistic) action, we call for an integrative perspective that combines the insights from political economy and cultural economy approaches (see Hudson 2005; Hudson, this issue) to describe and

explain the complexities and emergent properties of GPNs. This perspective is based on the recent conceptualisations of a (critical) cultural political economy or CPE (Jessop and Sum 2006); Jessop and Oosterlynck 2007; Sayer 2001; Sum and Jessop 2008).

Such a CPE approach to the study of global production networks offers several advantages in dealing with the above mentioned ontological and epistemological challenges. First, it enables us to acknowledge both structure and agency as important in shaping GPN. For instance, drawing on the work of social theorist Jürgen Habermas, Sayer (2001) demonstrates how economic organisations like firms (and the GPNs they are involved in) exist in both the system-world of structural imperatives – capitalist modes of production, markets etc. - and the life-world of everyday agency and practice. In contrast to Habermas, however, no dominance of the system-world over the life-world is assumed, they are rather seen as mutually constitutive, a view that has been expressed earlier in Anthony Giddens' structuration theory (Giddens 1984).

Second, systems are always culturally embedded in the life-world, hence the need to take both the material properties of GPNs and their socio-cultural construction into account. As Jessop and Oosterlynck (2007: 3) put it: 'For CPE, technical and economic objects are always socially constructed, historically specific, more or less socially embedded in – or disembedded from – broader networks of social relations and institutional ensembles, more or less embodied and "embrained" in individual actors [...]. At the same time, in stressing the materiality of social relations and their emergent properties, CPE aims to avoid the temptations of pure social constructivism [...].' Third, by combining critical semiotic analysis with an evolutionary and institutional approach to political economy, CPE not only stresses the importance of the semiotic and the extra-semiotic, the discursive as well as the material properties, but also applies a strategic-relational approach (Jessop 2001)

that can be usefully linked to GPN research and its emphasis on the relational and networked nature of territories and flows in the global economy.

Although the conceptualization of GPNs undoubtedly needs further refinement it is in the *empirical* sphere that most needs to be done if the concept is to be more than an interesting abstraction. We need carefully designed and constructed but essentially *grounded* research into the entire structure of GPNs. This implies that a 'lone researcher' approach will not get us very far. The very nature of GPNs – their organizational complexity, their multi-actor composition, their spatial extent and geographical diversity – necessitates multi-national team research. This is, of course, far easier said than done, both from a funding perspective but also because of the inherent problems of building and organizing multi-national research projects.

Not only will multi-national teams be required, but also combinations of expertise in quantitative/extensive and qualitative/intensive research in order to combine an appreciation both of the prevalence of particular structural dynamics and the ability of individual actors to exert their agency and alter the prevailing *modus operandi* of the GPN (or part of it at least). In some instances, mobilising the notion of cultural political economy will necessitate using the tools of discourse and semiotic analysis to reveal the discursive and rhetorical strategies that are at work within GPNs (Jessop and Oosterlynck 2007).

Other issues may be raised as we move beyond the relatively 'parsimonious' theoretical/empirical approach of GVC research with its tight focus on the governance of inter-firm relations: what are the boundaries of a GPN? What is the best entry point for studying a GPN? Do we inevitably focus on a 'lead' firm or should we be taking a polycentric approach? Our view is that the entry point does not matter, and where the boundaries are of a GPN is a moot point. In concentrated industries, where power is wielded by a small number of

firms, it may make sense to work outwards from those focal firms. In other instances, it may be equally, if not more, valid to start with a focus on small suppliers, or workers, or consumers, or government agencies and so on. This will depend on the specific focus of the research and the precise research questions that are being tackled.

The analytical power of a GPN approach is clear, however. Whatever the starting point for empirical research – whether it be a firm or non-firm actor, at the heart of a clearly defined production network or at the junction of different network systems – adopting a broad-based relational approach allows the researcher to ‘follow-the-network’ outwards from that starting point to reveal the complex interconnections and interdependencies between the wide variety of social actors that constitute GPNs and influence the processes of value creation, enhancement and capture therein. The length and direction of the journey taken by a particular researcher will depend on, among other things, their interests, resources, competencies, positionality and collaborative linkages. However, to constrain one’s worldview to a subset of these interactions from the outset seems to us to limit the explanatory power of our analyses.

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ⁱⁱ Three sets of terminology have become especially prominent. The term *global commodity chain* (GCC) was popularized by Gereffi in a large number of publications since 1994 (see, for example, Gereffi and Korzeniewicz 1994; Gereffi 2005). This has subsequently been superseded in the collaborative work of Gereffi, Humphrey, Sturgeon and others by the term *global value chain* (GVC): see Gereffi and Kaplinsky (2001) Gereffi, Humphrey and Sturgeon(2005). The GVC is a direct link with Porter's (1986) value-added chain which, in turn, derived from an old-established concept in industrial economics. The third approach is the *global production network* (GPN), a term developed independently by Ernst (see Ernst and Kim 2002) and by what Bathelt (2006) calls the 'Manchester School' of economic geographers (see Coe, Hess, Yeung, Dicken and Henderson 2004; Coe and Hess 2005; Coe and Lee 2006; Dicken 1994, 2003a, 2004, 2007; Dicken, Kelly, Olds and Yeung 2001; Dicken and Malmberg 2001; Henderson, Dicken, Hess, Coe and Yeung 2002; Hess and Coe 2006; Hess and Yeung 2006; Johns 2006; Wrigley, Coe and Currah 2005).

ⁱⁱⁱ Strictly speaking the term *transnational* production network is more accurate. However, current usage suggests that it is better to retain the term '*global*'.

^{iv} Of course, the question of who 'captures' that value is a key developmental issue (see Henderson, Dicken, Hess, Coe and Yeung 2002: 448-450).

^v The telecommunications industry provides a good illustration of these processes (Hess and Coe 2006).

^{vi} See, for example, Leslie and Reimer (1999).