Decoupling freight transport from GDP – conditions for a 'regime shift'

Paper to be presented at the 2006 Berlin Conference on the Human Dimensions of Global Environmental Change, Berlin, 17-18 November 2006

Markku Lehtonen
Ph.D., Research Fellow
Sussex Energy Group
SPRU – Science and Technology Policy Research
The Freeman Centre, University of Sussex
Brighton BN1 9QE
United Kingdom
Tel: +44 (0)1273 872787
fax: +44 (0)1273 685865
e-mail: M.Lehtonen@sussex.ac.uk.

Abstract

Until recently, the volume of road freight transport has been expected to follow the growth of GDP and any policy aimed at curbing freight demand has been thought deleterious to economic development. However, recent studies indicate a 'relative decoupling' in some European countries, including the UK. These figures may be misleading, since they fail to take into account the increasing proportion of foreign haulers in the UK, and the increasing volume of imports in many industrial sectors. Moreover, a far more drastic system change – a transformation of the oil-dependent 'socio-technical regime' – will be needed to achieve the UK government's goal of 60% reduction in CO_2-emissions by 2050.

This paper first presents key trends in the UK road freight in the past two decades, looking specifically at a number of 'key ratios' that explain the observed growth in road freight activity. It then sets these trends into a context, by analysing the evolution of the UK road freight system as a 'socio-technical regime' and the potential of stimulating a regime transformation that would be needed to reduce the environmental burden from road freight transport. The changes in the trends measuring road freight sector's environmental performance may be a sign of changes in the 'transition context', with the potential of bringing about a genuine regime shift. To identify the governance measures with the potential of breaking the institutional inertia a better understanding is needed of the respective roles of key actors, and their situation along the different dimensions of power.

Table of contents

1 Introduction

Energy use and carbon emissions are growing faster in road freight transport than almost any other sector. While structural change in many OECD economies has stabilised the weight of goods generated (tonnes), the volume of goods moved by road (tonne kilometres) and the volume of road freight traffic (vehicle kilometres) continue to grow rapidly. For example, over the period 1990-2000, heavy goods vehicle kilometres increased by 18%. The European Commission (EC 2006) predicts that the increase in the volume of freight activity will continue to drive CO2 emissions upwards, despite the expected efficiency improvements in terms of tonne-kilometres per unit of GDP and energy use per tonne-km.

Econometric evidence suggests that freight activity (measured in tonne kilometres) is closely correlated with GDP (Bennathan et al. 1992). This linkage between GDP and freight transport growth has for long been taken as a given, and freight transport is still seen as an essential driver of economic growth (e.g. DETR 1999). Yet, 'decoupling' of the growth of environmental pressures from economic growth has in recent years been adopted as a key objective of environmental policies and a means to achieve sustainability (e.g. OECD 2001, 13-16; EC 2001), and the potential for decoupling has been recognised (e.g. SACTRA 1999). Recent research has suggested that the strong coupling between GDP growth and freight demand may be weakening, especially in the 'peripheral' EU countries, including the UK (e.g. Tapio 2005; McKinnon 2006).

In the view of the commitment of the UK government to cutting GHG emissions by at least 60% by 2050 – and in view of the recent research results suggesting that 80-90% reductions would be needed to avoid serious damage from climate change – mere decoupling will not be enough, but far more radical changes will be needed in what can be described as a large technological system (e.g. Hughes 1983) or 'socio-technical regime' (e.g. Smith et al. 2005) of road freight transport, composed of a complex, but relatively stable set of institutions, rules, policies, technologies and infrastructures, together with the networks of actors – a regime whose fundamental function is to ensure that goods are being moved around in society as efficiently as possible. From a systems perspective, combating dangerous climate change will require significant changes in this very regime, rather than mere piecemeal improvements in the functioning of the system. It also requires disentangling the complex web of factors related to trade, production, distribution and retail that drive freight demand. The governance challenge – bringing about a transition towards sustainability – then becomes one of not only identifying the causal linkages between the driving forces, logistics dynamics, and environmental burdens, but also identifying the main actors within the regime so as to better understanding of what types of governance might be effective in the prevailing 'transition context'.

This paper starts by looking at the evidence for decoupling in the UK road freight transport sector, and examining the reasons why the apparent decoupling might be at least partly a 'statistical illusion'. It then continues by examining closer some of the main trends in the sector, presenting preliminary results of work carried out by the Sussex Energy Group on factors behind the growth of road freight transport in the UK over the past 15-20 years. It focuses on a number of 'key ratios' that define the

environmental burden caused by road freight transport. These trends are then placed in a broader context, looking at the changes in the freight transport regime, the general driving forces or 'selection pressures' behind those changes, and the capabilities of regime members and other actors influencing the regime to bring about transitions towards sustainability. Lessons for governance and ideas for further analysis are then presented.

2 Decoupling of GDP and road freight transport: a statistical illusion?

Recent research has explored the historical evidence for decoupling, as well as estimating its future potential (Pastowski 1997; SACTRA 1999; Banister and Stead 2002; Gilbert and Nadeau 2002; OECD 2003a; Tapio 2005; Verny 2005). Perhaps the most significant contribution has been from the European-wide 'REDEFINE' project, which examined freight transport trends in five European countries between 1985 and 1995 (NEI 1999a; 1999b). REDEFINE concluded that rather than a decoupling, there had a been a 'recoupling' of the growth of freight transport and GDP in all but one of the case study countries (Sweden) and that these trends were likely to continue.

In contrast with these predictions, recent research has suggested that 'weak' decoupling may have already begun at least in some countries, such as Japan and the U.S. (OECD 2003a), with tonne-km in the U.S. increasing slower than GDP since 1960 (Banister and Stead 2002). In his study focused on Europe, Tapio (2005) found signs of decoupling in the 1990s in Finland, Ireland, Luxembourg[1], Sweden and the UK. His analysis suggested that freight transport in the UK has moved from 'expansive negative decoupling'[2] in the 1970s, through a period of 'expansive coupling'[3] in the 1980s, to 'weak decoupling'[4] in the 1990s. (Tapio 2005). McKinnon (2006) found similar evidence, suggesting that 'peripheral' countries in Europe may have benefited from being sheltered from the increasing freight transport in the more centrally located countries. He also points out, however, that about a third of the decoupling seems to be due to the increased penetration of the British road freight market by foreign hauliers. Since the source of data commonly used for estimating UK freight transport volumes, the Continuing Survey of Road Goods Transport (CSRGT), only accounts for activity by vehicles registered in Great Britain, any increase in foreign hauliers on UK roads would go unnoticed.[5] Previous research (NEI 1999) had excluded activity of foreign-registered vehicles in the UK, partly because of lack of reliable data, but also because this activity was considered negligible. Indeed, the REDEFINE research project estimated that the total export of road freight would represent less than 1% of tonnes lifted and 5% of tonne-kms in the UK (NEI

[1] Tapio (2005) notes, however, that the figures for Luxembourg may be distorted because of consumers from the neighbouring countries, attracted by the low fuel prices, coming to fill their tanks in Luxembourg.

[2] Increase in both GDP and transport volume, but transport growing faster (elasticity of transport volume in relation to GDP growth > 1.2).

[3] GDP and transport volume grow at a similar speed (elasticity of transport volume in relation to GDP growth between 0.8 and 1.2).

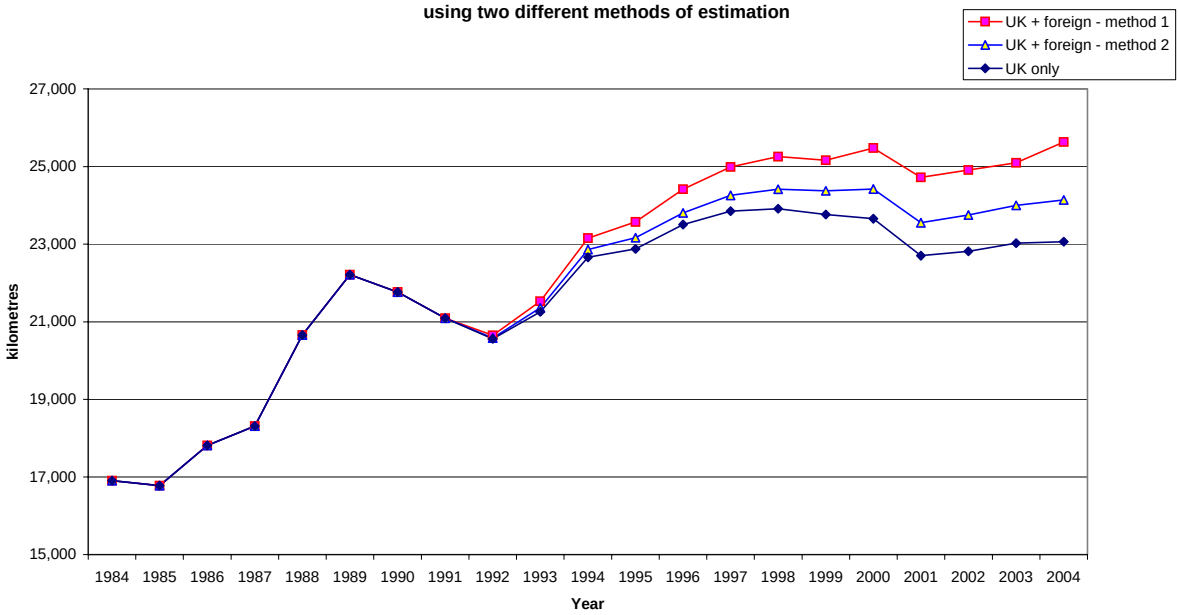
[4] Both GDP and transport volume increase, but GDP at a greater speed (elasticity of transport volume in relation to GDP growth is between 0 and 0.8).

[5] The relevant types of foreign-registered vehicle activity excluded from the CSRGT are cabotage (domestic movement of freight by foreign-registered vehicles) and UK legs of international transport carried by foreign-registered vehicles (international dispatch and international receipt).

1999b, 35). Preliminary results from our research confirm the findings of McKinnon (2006), suggesting that the growing penetration of foreign-registered vehicles in the UK market, together with increasing manufacturing imports, have grown to an extent that excluding them from the analysis would give misleading results.

To include freight activity by foreign vehicles in our analysis, we complemented CSRGT data by three additional sources of data, namely the Roll-on Roll-off (RoRo) inquiry, International Road Haulage Survey (IRHS), and Eurostat statistics. Since the international road haulage data only covers Great Britain, the data was complemented by information on tonnes lifted for Northern Ireland.[6] Figure 1 presents the results for total vehicle-kilometres, first using data covering only UK-registered vehicles (CSRGT), including estimated vehicle-kms for Northern Ireland, and two estimates using different methods for arriving at a vehicle-km figure for the whole of the UK (for a more detailed description of the methods used, see Sorrell et al. (2006). The data gives support to McKinnon's conclusions about the increasing importance of foreign-registered vehicles and questions the durability of the decoupling trend. While the growth of freight volumes did indeed come to a halt around 1998-2000, taking into account the penetration of foreign-registered vehicles suggests that freight volumes have been increasing again since 2001.

Figure 1. Total vehicle-kilometres for UK-registered vehicles only and for UK and foreign-registered vehicles, using two different methods of estimation



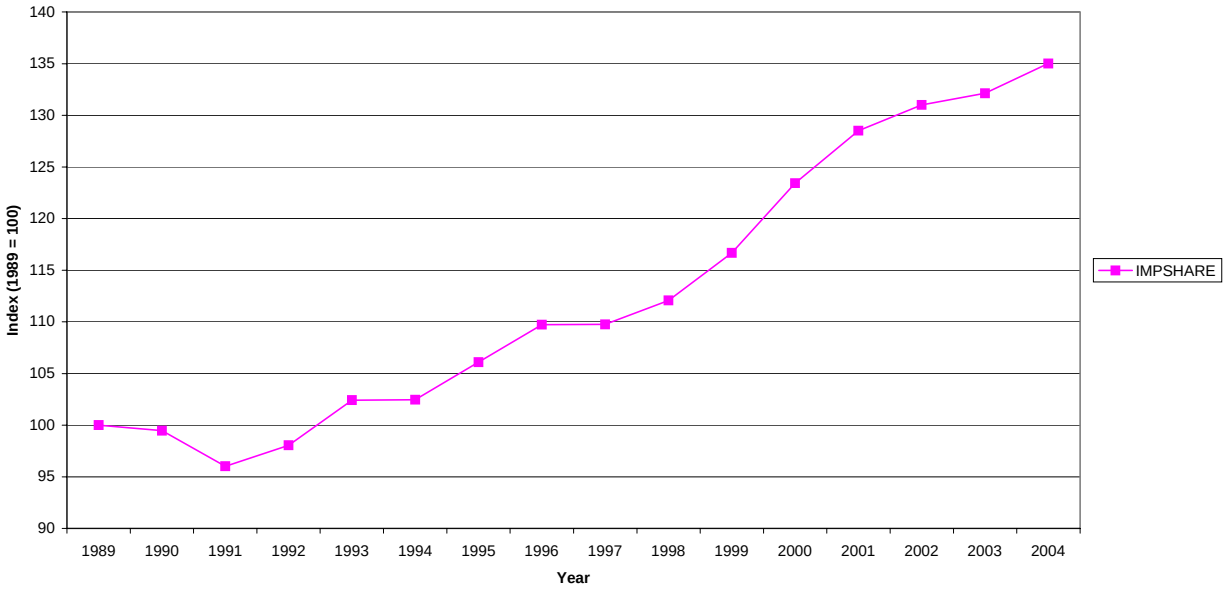
Weak decoupling is still occurring, i.e. GDP is growing faster than freight volumes, but significantly less than the exclusive reliance on national statistics would suggest, as one can see in figure 2, which shows the GDP/VKM ratios calculated using the three different methods (the steeper the upward slope of the curve, the stronger the decoupling).

[6] Obtained from the region's environmental authorities

Figure 2. Decoupling: ratio GDP/vehicle-km

Another reason to be cautious when interpreting the decoupling trend is the "erosion of production activity to other countries", which essentially means that an increasing proportion of goods consumed in the UK originates from overseas, and majority of the freight transport required during the production of these imported goods is removed from UK roads (McKinnon 2006). Figure 2 shows the share of imports as share of the value of total manufacturing output in 1989-2004. The rise of imports has been particularly strong since 1997.

Figure 3. Share of imports in total manufacturing output



3 Freight traffic growth decomposed: 'key ratios'

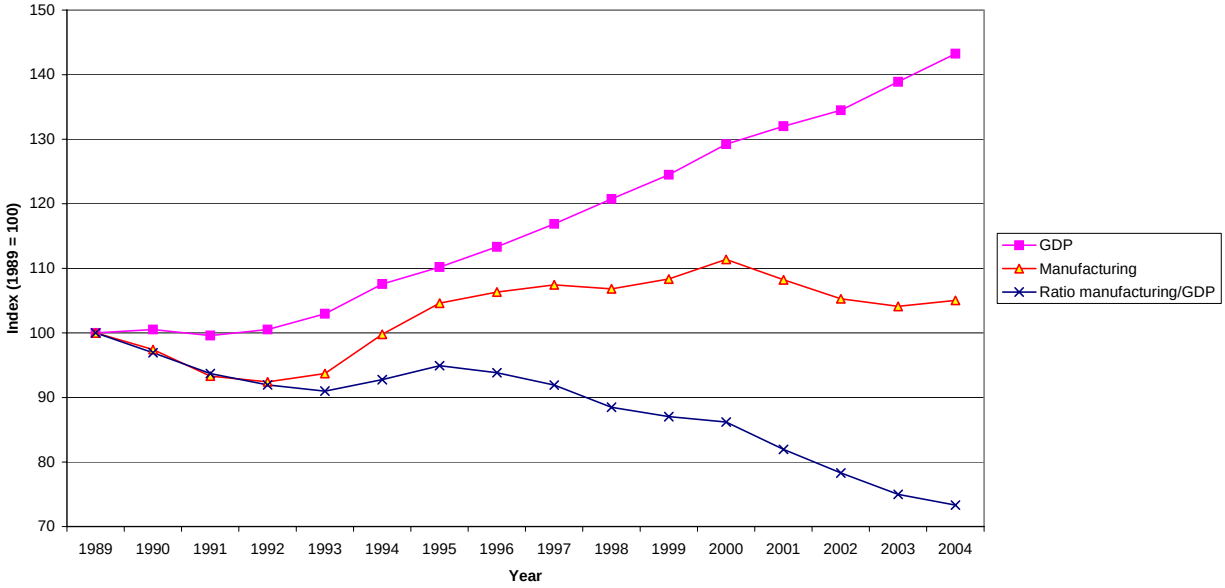
To provide a deeper understanding of the determinants of road freight activity, it is helpful to decompose aggregate trends into the product of a number of different variables. Trends in these individual variables may contribute to either increasing or decreasing overall freight activity. For example, improvements in the average load factor of freight vehicles may help to reduce freight traffic, while increasing length of haul may act to increase it. Decomposition analysis expresses trends in aggregate quantities as the product of a number of different variables. Thanks in part to the work of Lee Schipper and colleagues (Schipper and Meyers 1992), decomposition analysis has become a standard tool within energy economics but has only been applied to freight transport at a relatively aggregate level (Schipper et al. 1997; Greening et al. 1999; Tapio 2005; Steenhof et al. 2006). However, freight transport researchers have developed very similar but less formal techniques using the notion of 'key ratios' (NEI 1999a; Kveiborg and Fosgerau 2005; McKinnon 2006). The Sussex Energy Group seeks to bring these two approaches together by conducting a formal decomposition analysis of energy use for UK road freight analysing changes in 13 individual 'key ratios' and quantify their relative contribution to freight energy use over the period from 1989 to 2004. In many cases, these key ratios are disaggregated by commodity group and vehicle type. The analysis is confined to energy use and CO_2 emissions from heavy goods vehicles (>3.5 tonnes). Heavy goods vehicles (HGVs) are dominant mode in UK freight transport accounting for approximately 80% of goods lifted and 95% of goods moved by road.

The decomposition analysis is still work in progress, and therefore the following presents only preliminary trends at the aggregate level, without trying to quantify the relative contribution of each variable to freight energy use. We shall focus on seven key factors, namely the production output (and GDP), handling factor, modal split, average length of haul, empty running, average load factor, and fuel efficiency.

3.1 GDP and manufacturing output

While GDP is by far the most commonly used measure of economic well-being and the most often used variable to measure decoupling, it is the growth of goods output – not GDP per se – that drives growth in road freight demand. Despite structural changes leading towards a 'service economy', growth of the volume of production still continues as a key driver of freight demand (e.g. Kveiborg and Fosgerau 2005). Manufacturing accounts for a declining proportion of total GDP in the UK. Excluding the recession years, this share has declined constantly, by about 27% between 1989 and 2004, and the value of manufacturing has declined in absolute terms since 2000 (figure 4).

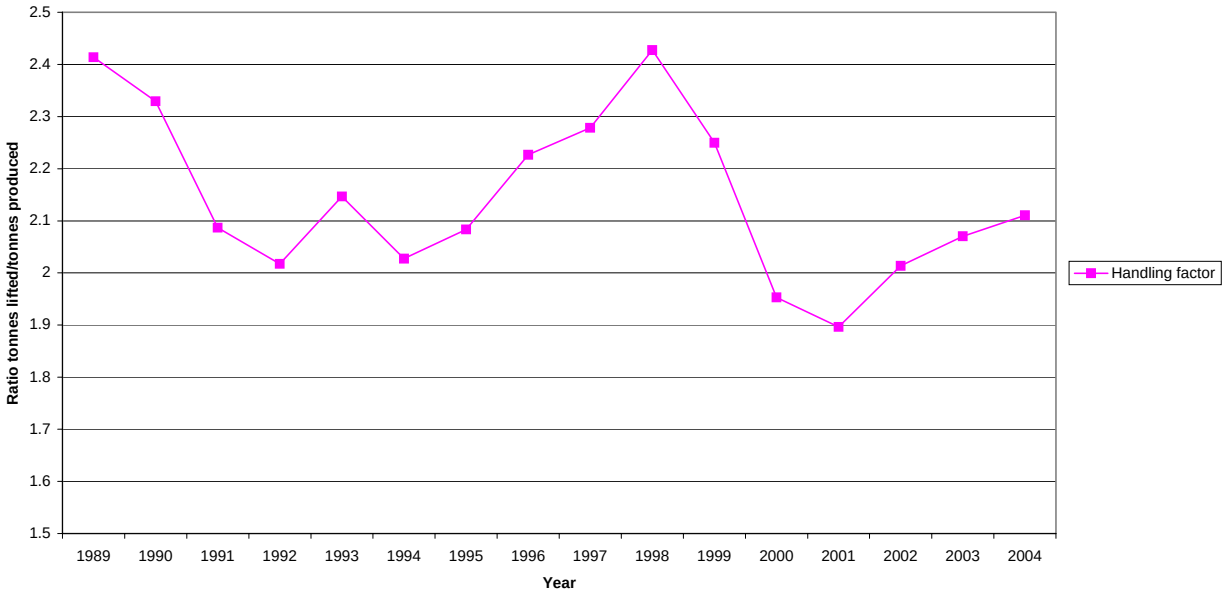
Figure 4. GDP, value of manufacturing and share of manufacturing in GDP



3.2 Handling factor

The average handling factor for freight is obtained by dividing the weight of goods lifted by the total weight of manufacturing production. It essentially measures the average number of links in a commodity chain. Figure 5 shows handling factor for the entire freight sector, including not only road, but also rail, water, and pipeline. While no clear trend can be detected, the peak value in 1998 and the subsequent decline suggest that changes are taking place in the freight system. Recent slight increase in handling factor may suggest that the efficiency gains to be gained through the centralisation of production and warehousing are reaching their limits. It may also reflect changes in the product mix, as the average handling factor varies from one type of goods to the other.

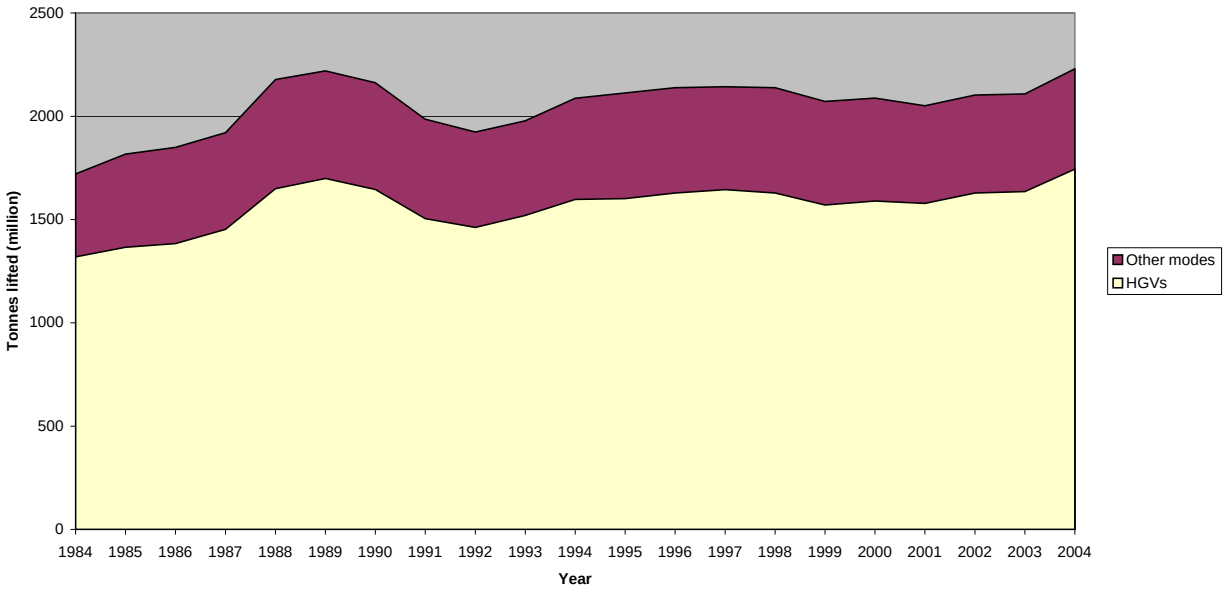
Figure 5. Average handling factor for the freight sector



3.3 Modal split

Modal split has not changed significantly over the past 20 years, as the major shift to road freight had largely been completed by the early 1980s. The share of rail declined, however, while that of water and pipeline increased. There was about a 30% increase in tonnes lifted over the period, with road freight transport increasing slightly quicker than the total. The HGVs accounted for 76.5% of total tonnes lifted in 1984 and 78% twenty years later.

Figure 6. Modal split: share of HGVs in total tonnes lifted



3.4 Length of haul

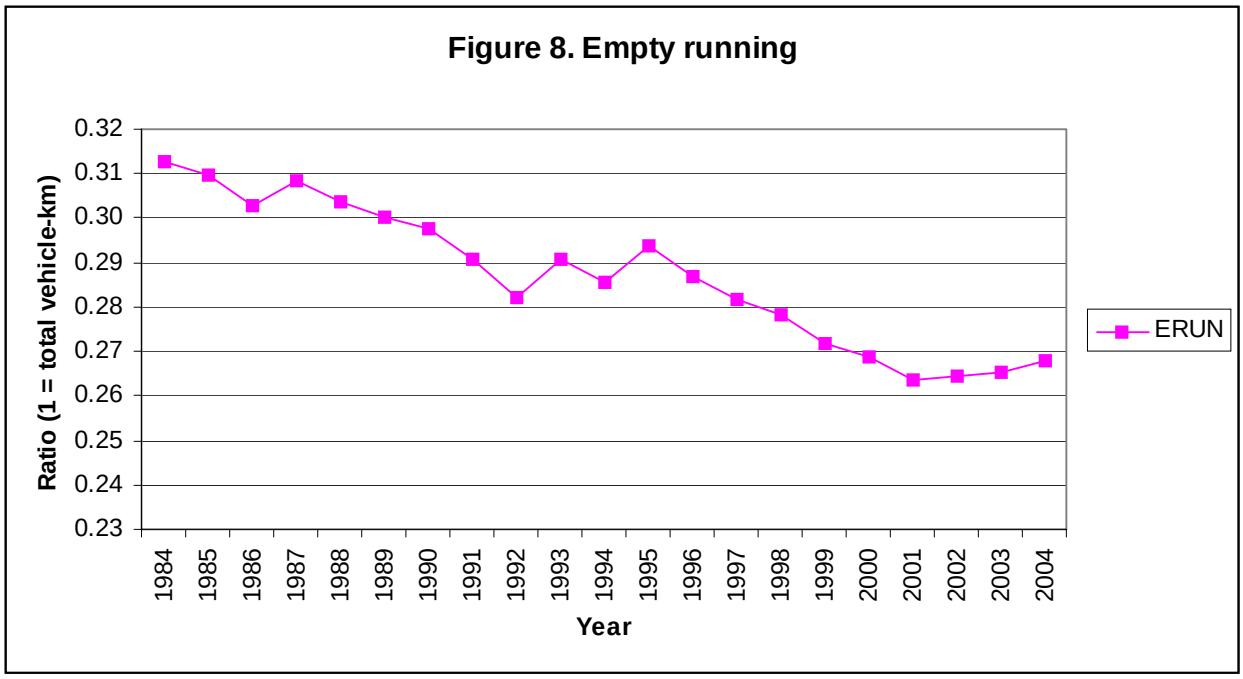
Increasing average length of haul, defined as the ratio between tonne-kilometres and tonnes lifted by road, was suggested as the single most important factor contributing to the increase in road freight transport during the 1980s and the 1990s (e.g. NEI 1999a). This ratio increased by 30% in 1984-1999, yet began to decline thereafter. One reason for this might be that the European integration led to especially some food imports from non-European countries to be substituted by imports from UK's European neighbours. Another possible explanation is that there is hardly more room for companies to extend further the area in which they source their supplies. However, the recent EU enlargement may turn the trend again, by making cheaper imports from Eastern and Central Europe more attractive.

The length of haul varies from one commodity group to another, and between different vehicle categories. Notable was the rapid increase in the average length of haul in the category of rigid vehicles 17-25 tonnes of gross vehicle weight since the late 1990s, and the concomitant steep decline in the length of haul in the smaller 7.5 – 17 tonne rigid vehicles.

Figure 7. Average length of haul for road freight

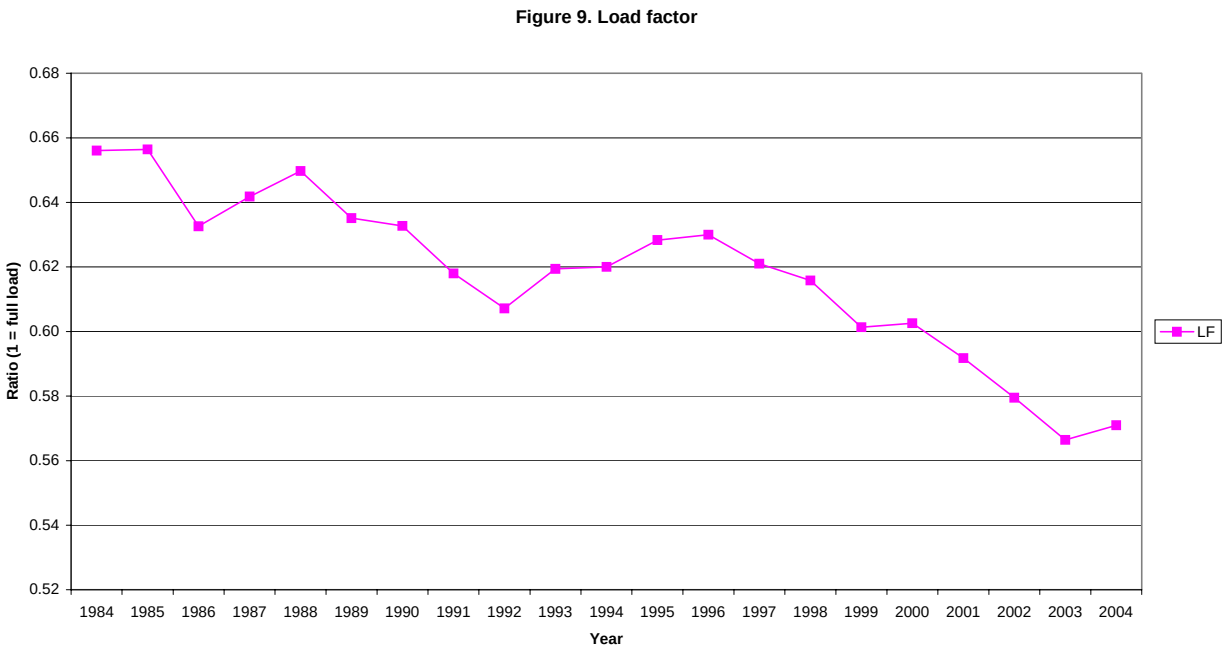
3.5 Empty running

Empty running is measured as the ratio between loaded and total vehicle-kilometres. This measure does not take into account to what extent the vehicles are fully loaded, but counts any degree of loading as a 'loaded run'. Empty runs declined constantly until 2001, but started then to increase, especially in the category of rigid vehicles.



3.6 Load factor

Load factor is another indicator of the efficiency of fleet capacity utilisation, as it measures the degree to which trucks, when loaded, are loaded to their full capacity.[7] The average load factor was about 14 % lower in 2004 than two decades earlier (figure 9).



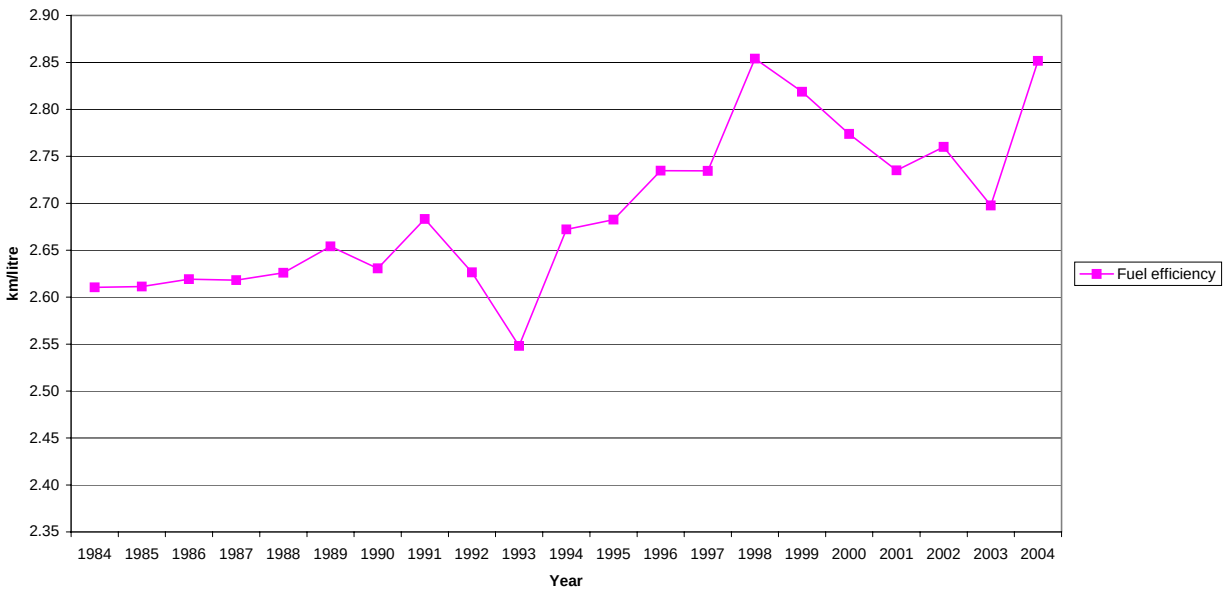
[7] Calculated as tonne-km divided by the product of loaded vehicle-km and the average carrying capacity of the truck fleet weighted by loaded distance driven.

The two measures – empty running and load factor – are related to the extent that rationalisation of logistics systems and increased 'return loading' tend to reduce empty running, but may at the same time make it more difficult to load trucks to their full capacity. The adoption of just-in-time delivery systems, increase in packaging, and the increase in the value density of goods likewise tend to lower load factors, as truck volume rather than weight increasingly becomes the limiting factor.

3.7 Fuel efficiency

Finally, as a lot of the transport policy has focused on improving fuel efficiency and vehicle technology as means of reducing emissions from road freight transport. In heavy goods vehicles, the progress has been relatively modest over the past 20 years, all improvements having been done in the larger, articulated vehicles. The average fuel efficiency seems even to have declined between 1998-2003 by about 5%.

Figure 10. Fuel efficiency of the fleet



While the contribution of the different factors to the growth in road freight still remains to be quantified through the decomposition analysis, our preliminary findings confirm those from earlier studies: the increase in the average length of haul, deterioration in the load factors, and the simultaneous reduction of empty running were among the main consequences of rationalisation and integration of logistics structures in the 1980s and until the late 1990s. The reversal of these trends of empty running and average length of haul, as well the possible increase in handling factor that seems to have begun around 1997-2000 suggests that the long-standing driving forces shaping logistics may have changed an/or that the rationalisation of logistics systems may be reaching a saturation point. These changes indicate that decoupling of freight volumes from economic growth has begun, even though a significant proportion of the decoupling merely reflects the increasing penetration of foreign hauliers in the UK market on the one hand, and strongly increasing exports on the other. Road has maintained its absolute dominance in the freight market, as the share

of road freight, measured in tonnes lifted, has remained practically unchanged over the past 20 years.

4 The UK freight transport as a socio-technical regime

To understand the drivers behind the trends in the UK road freight transport, and to help design appropriate governance measures, a useful approach is to look at the country's freight sector as a 'socio-technical regime'. Such socio-technical regimes can be defined as "relatively stable configurations of institutions, techniques and artefacts, as well as rules, practices and networks that determine the normal development and use of technologies" (Rip and Kemp 1998; Smith et al. 2005). Such a regime therefore includes a series of complex, nested real world phenomena, embodying natural and artificial physical elements, as well as social, economic, cultural and cognitive attributes (Rip and Kemp 1998; Geels 2002a, 2002b; Smith et al. 2005). A socio-technical regime can be for instance a different type of agricultural production – 'modern' or organic – or an electricity-generating regime. A regime typically hosts several, nested, subordinate regimes.

In the case of freight transport, one can talk about the global freight regime within which the UK regime is nested. Furthermore, the UK freight regime can be seen as a sum of different sub-regimes built around the transportation of specific groups of commodities, for instance. Another way is to look at the different competing regimes within the freight transport system: road, rail, sea, and air freight regimes compete with each other, while at times being complementary, especially in the context of the current strong emphasis on intermodal[8] transport (e.g. DETR 1999; Woodburn 2006). Furthermore, to some extent freight competes with passenger transport, and might not receive the same level of representation within transport administrations (Woodburn 2006, 301). A modern freight regime, in turn, is intimately linked and interacting with, for example, global and national fuel regimes. In short, defining what constitutes a socio-technical regime can be tricky (e.g. Berkhout et al. 2004; Eames and McDowall 2006). The approach here is to base the definition on the social function of a regime: we are talking about the socio-technical regime whose main function is to transport goods around in the UK.

4.1 Selection pressures and adaptive capabilities

Changes in socio-technical regimes can be perceived as a function of 'selection pressures' bearing on the regime, and the coordination of resources available, inside and outside the regime, to adapt to these pressures (Smith et al. 2005).

The *selection pressures* can be directed at specific regimes (such as the anti-nuclear movement) or they can be more general changes, emanating from the socio-cultural 'landscape' (Geels 2004), such as the ebb and flow of environmental attitudes in society, demographic shifts, and the rise of consumer culture or neoliberal model of

[8] Intermodal freight refers to the "conveyance of goods in unitised loads, where the unit itself is transferred between modes, thus avoiding the direct handling of goods at the point of modal transfer" (Woodburn 2006, 299).

globalisation. The pressures can also be more tangible economic pressures from other, competing, regimes, our may emanate from below, from 'technological niches'. (e.g. Geels 2004; Smith et al. 2005). The numerous pressures acting on any given regime often push in different direction. A crucial question for governance is therefore the extent to which the pressures are oriented coherently to a specific direction as opposed to acting incoherently and sometimes conflicting with each other (Smith et al. 2005).

The *adaptive capacities* of the regime members in responding to the selection pressures, in turn, are determined by the ability of the regime members to fulfil the functions that contribute to the reproduction of technological systems. Such functions include (Smith et al. 2005; Bergek et al. 2006):

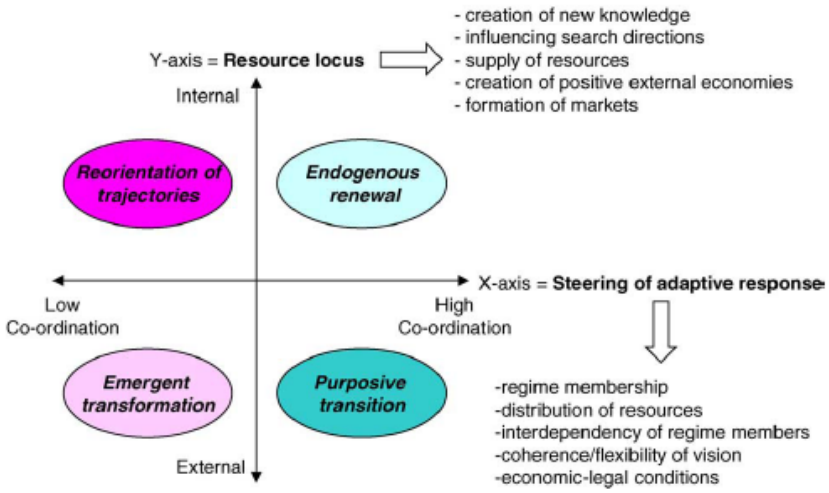
- *creation of new knowledge*: learning, the breadth and depth of the (technical) knowledge base of the regime; and the diffusion of this knowledge within the system (Bergek et al. 2006);
- *influence over the direction of search processes* leading towards a socio-technical change: incentives and/or pressures for the organisations to join the regime; the influence of different actors on the direction of search *within* the regime, in terms of different competing technologies, applications, markets, business models etc.
- *entrepreneurial activities and experimentation* to deal with the uncertainties involved in regime transformation: the 'entrepreneurs' may be new entrants that have the vision of business opportunities in new markets or incumbent companies who diversify their business strategy to take advantage of new developments;
- *supply of human, financial and other resources*
- *creation of positive external economies*, e.g. positive 'spill-over effects' in terms of knowledge development (e.g. R&D), reduction of uncertainty with respect to technologies/applications/markets and strengthened legitimacy;
- *formation of markets* for the new technologies and products: a new regime must be able to create markets for its 'products'; from 'nursing markets', through 'bridging markets' to mass markets;
- *legitimisation* through conscious actions by various organisations and individuals (e.g. through advocacy coalitions), eventually helping the new regime to overcome its "liability of newness" (Zimmerman and Zeitz 2002).

Four transition contexts can be constructed by identifying the regime adaptation processes along two dimensions:

1. the degree to which the adaptive responses to the selection pressures are articulated towards a given direction or goal, i.e. whether the transition is intended or unintended; the former situation is usually characterised by the existence of a shared guiding vision among core regime members, whereas conflicting ideas and competing visions tend to lead to uncoordinated selection pressures (e.g. Eames and McDowall 2006); and
2. the extent to which resources required for transformation come from inside or outside of the regime.

These distinctions result in four different transition contexts, as defined in figure 11.

Figure 11. Transition contexts (Smith et al. 2005, 1499).



'Endogenous renewal' corresponds to a situation in which regime members undertake conscious, coordinated efforts to in response to selection pressures. The response is coordinated, and conducted within the regime. In *'reorientation of trajectories'*, selection pressures prompt action by regime members, yet these actions are uncoordinated and highly unpredictable. *'Emergent transformation'*, in turn, entails a situation whereby resources for adjusting to pressures come from outside the regime – for instance from scientific activity or small firms outside the regime – and the responses are uncoordinated and unpredictable. Finally, *'purposive transition'* comes closest to what has become known as 'transition management' (e.g. Kemp and Rotmans 2004): actors outside the regime bring about transformation into a desired and clearly defined direction.

4.2 Agency and power

The final element of the framework is that focusing on agency, power and conflict – which are at the heart of institutional change processes. Power is, of course, a slippery concept and our ambition in this paper is not to provide an exhaustive review of the various meanings and interpretations of the term. What is important for our purposes, is to recognise the 'multiple faces' of power: argues that a lot of the discussion on power centres around the idea of power in terms of possession, sovereignty and control – something to be possessed, held or lost – to the exclusion of a view of power as a set of relations, a perspective in which power is exercised rather than possessed (Flyvbjerg 2001, 131-132). In particular, the symbolic or ideological dimensions of power often tend to be neglected. The power to define the terms of appraising which type and direction of transition is to be deemed desirable plays a central role in shaping institutional change. Smith et al. (2005) suggest regime membership (core vs. 'peripheral' members), distribution of resources (tangible economic resources, ability to control material artefacts, influence over the production and definition of what is deemed as salient knowledge; legitimacy, credibility and authority), and 'guiding visions' (e.g. the degree of coherence between the actors' mental frameworks, implicit

theories, expectations, discourses, and representations of problems and solutions) (e.g. Hajer 1995; Weber 2003) as the key foci of power analysis and the attempt to determine actors' capability of effecting change. Another possibility would be to analyse actors' – whether they are regime members or 'outsiders' – 'problem pictures', 'repertoires' (van der Meer 1999), and frameworks of thought in a context of unequal positions along the different dimensions of power. Galtung (1971) distinguishes actors' resource power (rank), their role in both concrete and symbolic exchange (division of labour), and location in the networks of exchange relations. The three dimensions of power are often interrelated, strength along one type of power strengthening one's position along the two other dimensions (at the simplest level, money, or possibility to exercise physical force, make it easier to acquire a central position in the networks).

Table 1. Elements of agency and power in regime transformation (adapted from Smith et al. 2005).

Membership of socio-technical regimes

- Core members vs. more peripheral members

Distribution and interdependency of resources

- Economic resources
- Ability to control material artefacts, or the production of salient knowledge (research and marketing)
- Legitimacy, credibility and other sources of recognised authority

Visions and expectations

- Mental models
- Beliefs
- Discourses

5 UK road freight transport regime since the 1980s until the late 1990s: liberalisation and 'flow society'

What follows is a very tentative sketch, based on a literature survey, of the transitions that occurred in the UK road freight transport regime over the past couple of decades, seen from the perspective of theories of socio-technical transitions described above. The objective of this exercise is, first, to help identify and understand the drivers behind the trends identified above in sections 2 and 3, and second, analyse the potential of different governance measures to orient a regime transition along a more sustainable pathway. This framework will be complemented and its correspondence with reality tested in further research, involving in particular interviews with key stakeholders and 'regime members' so as to carry out a more thorough 'power analysis' along the lines suggested above.

5.1 Selection pressures

The UK road freight transport regime evolved in the post-War context of easily accessible cheap oil, fuelled by the economic growth and emergence of a consumer society. As a socio-technical regime, it encompasses the material infrastructures (highways, terminals, vehicles); increasingly globalised markets for products; networks among the goods producers, wholesalers, carriers, and retailers; as well as a political and regulatory system largely designed to facilitate fluid flow of goods in economy and regulate the system so as to minimise its adverse impacts. At the heart of the system is the function of 'physical distribution', defined as "the range of activities involved in the movement of goods from point of production to final point of sale" (McKinnon 1988, 133). The robustness of the regime is further backed by the deeply rooted belief in the crucial role of freight transport in ensuring continuous economic growth on the one hand, and gradual changes in consumer expectations and habits on the other, whereby it has access to an unprecedented range of ever cheaper and higher quality goods has become to be perceived as a part of 'normal' or 'ordinary' lifestyle (Shove 2004).

This regime has undergone major transformations over the past couple of decades or so, triggered by a number of selection pressures. At the 'landscape' level, the most tangible pressures stem from globalisation and liberalisation. Economic trends (recession of the early 1990s), liberalisation of markets – EU Single Market in 1993 show in freight transport trends (for similar trends in Canada, see Steenhof et al. 2006). Sharpening competition, stimulated by liberalisation and ultimately further backed by the tight monetary policies by the central banks (McKinnon 2002), together with improvements in transport technologies, have led to compression of time and space and the creation of a 'flow society', in which products and information move continuously between firms (Hansen 2005). Freight transport growth is not only a product of globalisation, but is more efficient freight connections have helped make globalisation possible (OECD 2003b). These trends particularly favoured road freight transport, which, by virtue of its flexibility, was better capable than rail transport to exploit the new opportunities. These trends together with technological development led to a decline in the real cost of road freight, whereas the railway market continues to be plagued by a number of rigidities, starting from such seemingly minor details as the non-recognition of train drivers' diplomas across countries (ECMT 2003, 21). Despite liberalisation, government regulation continued to play a role in creating selection pressures mainly by increasing costs, but also by stimulating change in the organisation of logistics: waste and recycling regulations increased transport costs and reduced empty running (but reduced load factors), limits to drivers' working hours likewise increased costs, while fuel and vehicle taxation (e.g. 'fuel duty escalator') stimulated greater efficiency and improved rail freight's competitiveness.

5.2 Regime response to selection pressures

The internationalisation of production during the 1980s and 1990s resulted in an increasing focus on supply management and the logistic chain, while firms had previously concentrated on issues of marketing and distribution. The increasing volumes of freight flow of not only raw materials and final goods, but especially intermediate goods and components between producers, have greatly increased the

complexity of supply chain, increasing the need for better coordination of logistics. (Pedersen 2001.) Freight transport became to be perceived no longer as a mere 'derived demand', a 'residual' of other processes, but instead as a part of an integrated demand for logistics, composed of two key functions: physical distribution and materials management (Hesse and Rodrigue 2004). Among the key consequences are the increase in third-party services (outsourcing of transport and logistics services), the establishment of European and regional distribution centres, the integration of services and the tailoring them to individual user needs; and the move towards more corporate management approach among service providers. Yet, the emergence of true pan-European 'mega-carriers' has been slow to realise. (Peters et al. 1998.) The increasing transport costs and government's waste and recycling legislation gave rise to a totally new sub-sector, 'reverse logistics' (Rodrigue et al. 2001).

In brief, the key changes in logistics systems in most industrialised countries have been characterised by three developments. Transport *distances* have increased, as firms have extended their sourcing and marketing areas and concentrated their production and warehousing facilities to fewer locations. The supply chains have become longer and more complex. The *speed* of goods movements has increased, made possible by technological development – including IT – and sometimes by provision of infrastructure (e.g. Hansen 2005), which has increased customers' demand for faster and timelier deliveries. Faced by competitive pressures, firms have attempted to exploit economies of scale by minimising their inventories. This has meant much more *frequent deliveries*, within systems of just-in-time and 'quick replenishment', creating continuous flows of goods to and from companies. It has also *narrowed the time-windows* in which goods need to be delivered, thereby posing new challenges to the planning and coordination of distribution. Technological developments, economic pressures, and the improvement of transport infrastructure have together shaped customers' expectations concerning quality of service, prompting companies to adopt more customer-oriented production strategies, and further reinforcing the trend towards a 'flow society'. (Defra 2005; Hansen 2005.) Consumption habits have changed in favour of consumption of more processed, manufactured goods.

5.3 Actors in the regime and the 'transition context'

Understanding the dynamics of UK freight transport system and identifying the possible bottlenecks or levers of change requires a closer look at the key actors in the field. This paper provides only a first superficial glance at the actors that seem to be the most important in shaping the UK road freight regime. Further research would have to dig deeper in the dynamics between the actors, as well as their resources and positions in the networks of power, to better understand the possibilities of different types of governance.

The changes that took place in the freight sector during the 1980s and 1990s can be best characterised as lying somewhere between *'emergent transformation'* and *'re-orientation of trajectories'*. The resources for responding to the selection pressures came partly from the inside, notably the retailers and wholesalers who reorganised their logistics systems, but a number of key resources were brought in from the outside. In particular, the development of information and communication

technologies was a fundamental prerequisite for the development of logistics planning and the rise of just-in-time delivery systems 'quick replenishment' solutions. The government's role in steering the operation of the system weakened with the deregulation of the market, yet it still continues to play a major role in providing infrastructure and through land use planning, for example. Government should not, nevertheless, be considered as a monolith: the Department for Transport can still be considered a key player within the regime, whereas the Department for the Environment, Food and Rural Affairs (Defra) operates from the outside. The Treasury and the Central Banks are, in turn, powerful players outside the regime, influencing through fiscal and monetary policies the selection pressures and adaptive capabilities.

The increasing logistics integration led to the creation of large retail chains, freight forwarders, ocean shipping companies and large conglomerates having multiple production and distribution units. These firms are able to control the conditions of delivery that must be fulfilled by service providers, thereby exercising significant 'supply chain power'. The uneven distribution of power stems primarily from specific supplier-customer relationships, and depends on the firm's position within the chain, related to its organisational or technological know-how, market demand, or factors such as the size of the firm. (Hesse and Rodrigue 2004.) Especially in the food sector, the influence of retailers over the supply chain has increased considerably, the shopkeepers having very limited influence either on the range or the source of products on sale in their shops (Defra 2005).

The transition in the road freight regime during the 1980s and 1990s took place without clear coordination and shared 'guiding vision'. The liberalisation 'ethos' provided the backdrop for the transformations in the logistics systems, yet one can hardly speak of a consciously designed and coordinated response in which the regime members would have acted in concert towards a predefined system. Rather, the regime coevolved under the influence of the selection pressures, and developments in technology. Improvements in product quality, shortening of lead-times, and more customer-oriented production strategies shaped habits and expectations of customers, who began to take for granted the quality and speed of service that a few years earlier would have been considered as luxury. Through 'cumulative causation', the system had gathered a degree of inertia and momentum[9] difficult to break.

Table 2 below lists, for the period of liberalisation, since mid 1980s until the late 1990s, the key selection pressures bearing upon the regime. Table 3 presents, for the sake of illustration, a summary of the selection pressures, regime changes, and causal links between logistics systems and some of the 'key ratios' affecting transport volumes. Table 4 is a tentative list of the regime members and actors affecting the regime.

[9] Hughes (1994), in his account of the development of large technological systems, notes that as a technological system matures, grows and becomes consolidated, it gains *momentum*, stemming from a mass of technical and organisational components, their direction or goals, and their rate of growth. Mature systems have inertia that likewise stems from the concurring interests that inventors, engineers, scientists, managers, owners, investors, financiers, civil servants, and politicians have in the growth and durability of the system.

Table 2. Selection pressures in the freight transport regime in the 1980s and 1990

General (economic) landscape

Liberalisation and deregulation
Reduction of international trade barriers
Tight fiscal policies
Establishment of the EU Single Market
Move towards a 'service economy'
Declining sea, air, and road transport costs
Increasing land prices in city centres
Congestion
Intensification of agriculture

Regulation

Liberalisation and privatisation of road freight markets
Lack of liberalisation and other 'rigidities' in rail markets
Land use planning (favouring the spreading of urban structures)
Limits to drivers' working hours
Increase in maximum allowable gross vehicle weight

Knowledge production

Transport growth forecasts predicting GDP and freight growth to be decoupled (DfT 1985; see McKinnon 2006, 5)

Consumer demand and habits

Growth in disposable income
'Flow economy' creates expectations for quicker and timelier deliveries
Demand for higher-quality goods
'Exotic', out-of-season products become part of 'normality'
Growth of shopping by car

Technology

Improvements in freight technology make transport faster and cheaper
Improved vehicle fuel efficiency reduces costs and emissions
Development of ICT to improve logistics planning, routeing and scheduling

Infrastructure

Highway construction
Provision of terminal capacity

Ideas

Liberalisation and market-focused 'ethos'
Trans-European rail and road networks

Alternative visions

Niche experiments

Table 3. Selection pressures, regime responses and impacts on the 'key ratios' in the UK road freight transport regime

Selection pressures	**General changes in the regime**	**Changes in logistics structures**	**Impact on the 'key ratios'**			
			Handling factor	Average length of haul	Load factor	Empty running
General (economic) landscape	Growth in imports		↓			
	Growth in production output					
Regulation	Concentration of retailing					
Knowledge production	Greater processing and packaging (esp. food)	Spatial concentration of production		↑	↑	
Consumer demand and habits	Greater product differentiation (Voordijk 1999)	Spatial concentration of inventory		↑		
Technology	Flexible production technologies (Voordijk 1999)	Development of local break-bulk operations	↑	↓		
Infrastructure	Change in product composition towards higher-value goods (value density)	Creation of hub-satellite networks	↑	↓		
Ideas	Growth in emphasis on customer satisfaction and customer-driven product design	Insertion of more production stages	↑			
Alternative visions	'Hubbing' strategies of deep-sea container shipping lines and air freight operators	Vertical disintegration of production	↑			
Niche experiments	'Containerisation'	Increase in single sourcing			↑	
		Wider sourcing of supplies		↑		
		Increase in retailers' control over supply chain		↑	↑	
		Concentration of international trade on hub ports		↑		
		Adoption of JIT/quick response replenishment			↓	
		Growth of 'nominated day' deliveries			↑	

		Modal shift towards road	↑			
		Outsourcing of logistics / transport			↑	
		Increase in average vehicle size			↑	
		Changes in handling systems and packaging			↓	
		Use of computerised vehicle routing / scheduling			↓	↓
		Increase in return loading				↓

Table 4. Actors and stakeholders in the UK road freight transport regime

Core members

- Manufacturers
    - Multinational
    - Large national
- Carriers (enterprises engaged in the business of transporting goods)
- Freight forwarders (enterprises that provide services to facilitate the transport of shipments)
- Retailers
    - Multinational
    - Large national
- Wholesalers
- Large industrial farmers
- Oil industry
- Department for Transport & transport planners
- EU Ministers of Transport

Marginal/peripheral members

- Manufacturing and retailing SMEs
- Consumers
- Shop managers
- Food producing farmers
- EU Ministers of Energy
- EU DG Transport

Actors outside of the regime

- Biofuel producers
- Defra
- Treasury
- Central Bank of England
- EU Ministers of the Environment
- EU DG Environment
- ECMT

6 New selection pressures since the late 1990s: towards decoupling and 'sustainable distribution'?

While many of the selection pressures in operation since the 1980s still act upon the regime, a number of the less tangible pressures have become stronger since the late 1990s. Most relevant for our purposes, the harmful unintended impacts of road freight transport have become increasingly acute and widely recognised. Increasing concern for climate change, and other environmental concerns are not, however, the only changes, but worsening congestion, increasing labour and insurance costs (partly caused by terrorist threats) and rising oil prices threaten the functioning of the system itself and increase the costs of road haulage (McKinnon 2006). The critique against globalisation, the wave of left-wing governments, and the recent episodes showing the darker sides of unfettered free-market liberalism (e.g. the Enron scandal, mass layoffs, stock option scandals, etc.) have prepared public opinion for more interventionist policies. The concerns have been translated into policies such as fuel taxes, zoning regulations limiting the construction of out-of-town supermarkets, stricter vehicle emission standards, support to rail and intermodal transport (e.g. Haywood 1999; Steenhof et al 2006; Woodburn 2006) and development of indicators measuring freight sector's environmental performance. The privatisation of British Rail in the mid-1990s improved rail freight's competitiveness (Haywood 1999, 267), as did efficiency-enhancing technological improvements (e.g. Haywood 1999; Steenhof et al. 2006, 373). Technological developments, such as the increasing use of easy-to-load containers, have helped to make intermodal freight transport a viable option (Pedersen 2001; Steenhof et al. 2006, 373).

On the other hand, the pressures working to maintain the current regime are still strong. The recent and ongoing EU enlargement, as well as the future trans-European highway networks, is likely to result in further widening of the market areas and sourcing of supplies, thereby increasing road freight activity. And, last but not least, the extraordinary increase in manufactured goods imports from Asia, notably China (e.g. Steenhof et al. 2006, 373), testifies to the continuing pressures acting in the direction of further centralisation, international competition, and widening of market areas and sourcing of supplies.

Table 5 presents a tentative list of the changing selection pressures acting upon the regime since the late 1990s.

Table 5. Changes to the selection pressures in the freight transport regime from the late 1990s to present

General (economic) landscape

EU enlargement
Increasing transport costs
Higher oil prices
Aggravating congestion

Regulation

Land use planning (e.g. limitations to construction of out-of-town supermarkets)
Waste recycling obligations
Prohibition of dumping of demolition waste
Limits to drivers' working hours
Fuel taxes
Vehicle emission standards

Knowledge production

Transport growth forecasts predict continuing growth of transport volumes
Indicators of transport's environmental performance

Consumer demand and habits

Technology

Improvements in freight technology make transport faster and cheaper
Improved vehicle fuel efficiency reduces costs and emissions
Development of ICT to improve logistics planning, routeing and scheduling

Infrastructure

Ideas

Concerns for terrorism
'Europe of the regions'
Slight weakening of the liberalisation and market-focused 'ethos' (fuelled by e.g. Enron scandals)
Globalisation critique
EU legitimacy crisis
Increasing concern for climate change
'Decoupling' becomes an accepted policy objective
Trans-European rail and road networks
'Sustainable mobility'
Emphasis on voluntary schemes

Alternative visions

Dematerialisation
'Food miles' and 'local food'
Biofuel revolution
'Customised mobility'

Niche experiments

E-commerce
Direct delivery services (B2C systems)
'City logistics'
Creation of small-scale local delivery networks

Experiments within the regime

Company social and environmental responsibility schemes
Indicators of sustainability (benchmarking)

6.1 Regime adaptation and inertia

The emerging new selection pressures have been far from sufficient to stimulate a regime transformation, and reverse the trend of worsening environmental problems. The main impetus for change seems at present to reside at present at the level of ideas and alternative visions on the one hand, and various 'niche' experiments on the other. While the prevailing liberalisation 'ethos' is far from being overthrown, it is at least being complemented by a number of alternative views, starting from the relatively close-to-mainstream 'sustainable mobility' and 'sustainable distribution' (refs from UK), through 'dematerialisation', 'food miles' and 'local foods' (Defra 2005), to the idea of 'customised mobility' (Kemp and Rotmans 2004), and 'intermodality', emphasising the complementarity of different transport modes and private and public transport. In terms of regime transformations, if the distinctions between the road, rail, sea, and air transport have never been clear-cut, within the present context they are becoming increasingly blurred: intermodality and customised mobility represent attempts to seek synergies between different freight transport modes, thereby fundamentally transforming the regimes. The idea of 'decoupling' has gained legitimacy and constitutes at the international level a 'guiding vision' for more sustainable transport policies. The ideas of regionalisation of freight transport systems are likewise being promoted by some researchers and NGOs (e.g. Rodrigue et al. 2001; Garnett 2003). E-commerce can be seen as a niche experiment that rapidly spread within and transformed the regime, while door-to-door delivery systems, and attempts to improve efficiency of logistics systems through 'city logistics' (Weber 2003), or experiments with small-scale local delivery networks are niches with growth potential.

The 'momentum' that the road freight regime has gained over the entire post-War period is, however, difficult to break, in view of the numerous sources of inertia. The 'sunk costs' in the form of infrastructure investments works against rapid changes: for instance, increasing transport costs may not have a significant impact on logistics decisions, because of the low elasticity of demand in this sector, implying that very high price increases would be necessary to turn the growth trend.[10]. Interestingly from the perspective of regime change, hypothesised increases in transport costs tend to lead to adaptations mainly in the area of transport operations, without greater potential to fundamentally affect the logistics structures (Runhaar and van der Heijden 2005). Decisions on business location are seldom influenced by the current transportation costs, and the level of taxation should be very high to deflect the structural long-term trend towards greater road freight transport demand (e.g. Runhaar and van der Heijden 2005). Transport being today a part of an integrated logistics system means that a lot of the transport costs are hidden in aggregated payments to suppliers and subcontractors, companies trying to minimize the sum of external and internal

[10] Ahman (2004) refers to studies carried out by the Swedish Institute for Transport and Communications Analysis (SIKA 2003), which estimates an elasticity of demand of -0.8 for passenger transport and –0.2 for all other transport, including freight. This implies that passenger travel would be considerably easier to influence through price changes than freight transport, where an increase of 1% in fuel prices would thus result in a decrease in freight fuel use by mere 0.2%. Bleijenberg (1996; cited by Rodrigue et al. 2001) estimates the price elasticity in logistics industry to be around -0.1 %. Modelling exercises have indicated that even for products with a relatively low value density, transport costs would have to rise by over 100 % (equivalent to a six-fold increase in fuel taxes) to make a move to a more decentralised logistic structure economically beneficial. (McKinnon 1998, 105-106.)

transport, storage and transaction costs (Pedersen 2001, 86). Transport costs and congestion problems therefore are increasingly a part of strategic and operational decision-making, which is much more influenced by the desire to maintain a competitive level of customer service than minimising transport costs. (McKinnon 1998, 106; Runhaar and van der Heijden 2005.)

Furthermore, while congestion was estimated to cause fuel wastage corresponding to 18% of total transport fuel consumption in Germany (OECD 2003b), van Schijndel and Dinwoodie (2000) concluded that even in the highly congested Netherlands, costs of congestion are not yet sufficient to trigger a voluntary shift by companies from road to multimodal transport. McKinnon (1999b) reached similar conclusions noting that congestion caused only minor disruption to warehousing operations of seven distribution centres in FMCG sector in the UK. Especially the large companies are able to respond to increasing congestion problems through better planning, night driving and the use of IT in planning and communicating with drivers.

However, cost has not completely lost significance in shaping company decisions. In the long term, such changes might have a greater impact, as companies would adjust their location decisions to the new price structures. Furthermore, intra- and inter-sectoral differences in responsiveness to price signals can be significant, reflecting differences in product value density, geographical location and competitive position. Especially sectors producing and distributing bulky, low-value goods have transport cost to sales ratios significantly higher than average. (McKinnon and Woodburn 1996; McKinnon 1998, 104-105; Pedersen 2001, 86.) While transport expenditure represents only a few per cent of sales revenue of an average company (European Logistics Association 1999), it accounts for a much larger proportion of the net value-added and can have significant importance on profit margins (McKinnon et al. 2002, xiv). Furthermore, rising transport costs may induce changes in the long term, and are likely to improve vehicle fuel efficiency (Goodwin et al. 2004; EEA 2006).

Shifting freight from road to other modes, notably rail and water, is being promoted by the British government, mainly for environmental reasons (Woodburn 2006).[11] Partly for reasons related to geography and concentration of production activity in the south of the country, the scope for increasing the share of rail and intermodal freight is deemed modest in the UK (e.g. Woodburn 2006, 300). After decades of underinvestment, very sizable financial resources would be needed to improve rail and water transport infrastructures, especially intermodal terminals and local freight depots (Fowkes et al. 1991; NEI 1999a; HOC 2006, 54; Woodburn 2006, 300). Some improvements have been done; in particular the opening of the Channel Tunnel improved possibilities for intermodal transport (Haywood 1999; McKinnon et al. 2002, xix).

These observations illustrate the combined effects of economic, political and ideational factors as sources of institutional inertia: reducing tonne-kilometres would have a detrimental effect on the economy, and therefore would be unlikely to gather sufficient political support. Restructuring the economy towards a more decentralised

[11] Modal shift is not a panacea, however, as it may in some cases actually increase the environmental burden. Building new rail infrastructure to promote rail transport may, for instance, boost the transport volume of rail without decreasing road transport volumes, thus resulting in higher total emissions (EEA 2006, 20).

structure would be "a very clumsy and costly way of reducing the demand for freight transport", and command-and-control measures such as 'zoning'[12] that was applied in War-time Britain are unlikely to succeed, given that the deregulation of the sector has only recently been finalised (McKinnon's 1989, 242-243; OECD 2003b). Consumption habits do not change overnight, either, further contributing to inertia.

Finally, while laudable as such, the attempts by companies to improve the efficiency of their logistics systems so as to alleviate environmental impacts may reinforce the dominating regime, thus effectively blocking more innovative 'niches' from developing and preventing regime transformation. While Holman (1996) saw the increasing uptake of company environmental management systems as a sign that environment has already become a tool for firms to acquire a competitive edge, Rodrigue et al. (2001), point at the contradiction between environmental objectives and the key factors affecting logistics companies' decisions such as costs, speed, reliability, warehousing and e-commerce. The great emphasis on logistics efficiency, e.g. through more 'intelligent' pricing and greater use of IT, may simply serve the reproduction of the existing regime, especially if coupled with the 'plan and provide' infrastructure policy (e.g. Gleave 2006). There was plenty of reason for scepticism concerning companies' 'greening of logistics' operations in the early 1990s, as these were often very narrowly focused, mainly concerned with recycling and waste management, and overlooked significant issues such as pollution, congestion, and resource depletion (Murphy et al. 1994; Rodrigue et al. 2001). Logistics industry managers in the US were in the 1990s strongly opposed to any kind of government regulation to improve the environmental performance of the sector (Rodrigue et al. 2001). A more fundamental change in management culture and a reordering of strategic priorities would be needed (McKinnon 1998, 107). The increasing concern for climate change may have prepared ground for a more fundamental change.

6.2 Actors and their power resources: shifts in the adaptive capabilities?

In the mid-1990s, it was considered unlikely that the influence of large players in the supply chain would weaken. On the contrary, Nijkamp et al. (1997) foresaw that the further integration at the European level would lead to an increasingly pan-European logistics network, consisting of a small number of companies. Likewise, the increasing trade flows tend to strengthen the role of multinational shipping companies and airlines that control international connections (Pedersen 2001, 86). However, the new selection pressures have increased the legitimacy of the actors at the margins – or outside – the regime, by lending credibility to alternative transport solutions. Large manufacturing and retailing companies are in key positions to influence the system, yet they have far too heterogeneous interests and objectives to allow themselves to unite around a shared vision concerning the desired direction of a regime transition. Transport companies have a limited role in decision-making, as most of the key decisions are taken elsewhere (Leonardi and Baumgartner 2004), at the level of strategic decisions on the location of production and warehousing facilities.

[12] A system whereby retailers and wholesalers were allowed to draw supplies only from producers within their specific geographic zone.

While government may have lost a lot of its capacity to directly influence the regime (e.g. Runhaar and van der Heijden 2005), it may have gained legitimacy in that government intervention in favour of more sustainable solutions is today perhaps considered more justified than twenty years ago (e.g. Rodrigue et al. 2001). Physical planning can play a role, on the local level through zoning policies and building permits (Hesse and Rodrigue 2004), and possibly by promoting more regionalised supply chains. However, competition between local communities in attracting new firms, and the changes of customer-supplier relationships over time may render the success of such policies uncertain (Runhaar and van der Heijden 2005). The absence of a clear 'guiding vision' and the weakness of the forces pushing for sustainability are reflected in the British government's somewhat changeable policy concerning rail freight over the past decade, as a period of support from 1997 to 2001, was followed by a partial retreat. The ambitious targets for the growth of rail freight announced in 1998 (DETR 1998) and confirmed in the Ten Year Plan (DETR 2000) seem to have been silently dropped as the emphasis has shifted to efficiency and affordability. The concessions made to the road freight industry (e.g. withdrawal of the fuel duty escalator and reduced excise duties for certain lorry categories), operational and technical difficulties in railways in early 2000s, and the removal of several freight-specific support measures have further reduced the potential for modal shift. (Woodburn 2006, 300-301.)

If the actors acting in favour of a regime shift have today somewhat greater resources to influence the system and make it move towards a more sustainable direction, do they also have the skill and ability to coordinate their actions towards a shared goal? The obstacles on the way towards shared goals and visions are still considerable, beginning with the dispersed nature of the key groups, and their widely varying interests and visions of what a 'sustainable distribution system' should look like. For example, within the present system of centralised production and warehousing facilities, seemingly irrational supply chains involving transporting intermediate goods back and forth between the locations of production and retail may in fact be more efficient than local supply and distribution within the same system. However, things might look different if the location of production and warehousing were not taken as given, but something to be optimised to arrive at a more localised and energy-efficient logistics system. Should we therefore aim at a more regional approach to logistics (Rodrigue et al. 2001; Garnett 2003; Vanek and Morlok 2000),[13] or recognise the efficiency gains of a centralised system as well as the political and structural obstacles associated with attempts to force a shift to more decentralised structures (e.g. McKinnon 1989, 242-243; OECD 2003b)? The latter approach would be in line with the current emphasis – both in the UK and North America – on technical solutions to transport problems (e.g. DTI 2006; Gleave 2006). Certainly it is easier to arrive at a consensus around technological development and incentives to R&D capable of producing win-win situations and positive external economies than around the objective of more fundamental structural changes in the system. Yet the crucial questions are who has the power to determine the direction of technological

[13] Rodrigue et al. (2001), along the lines of Garnett (2003), argue in favour of government intervention to bring about a more regional approach to logistics, notably the reduction in the number of trips (i.e. handling factor), notwithstanding the growing importance of international haulage. Vanek and Morlok (2000) identify significant potential for reducing energy use in road freight transport through the geographical and temporal rearrangement of the product flows that would eliminate the longest hauls and relocate production closer to consumption centres. Trends towards greater length of haul in high-value density commodity groups could be offset by spatial redistribution in other groups.

development and investments, and whether the technological progress is harnessed towards a regime change, or serves instead to strengthen the incumbent regime.

Disagreement over 'visions' also hampers the efforts to provide information that would link consumer choices to the sustainability of the freight transport system. If one does not know what a sustainable freight transport system would look like, how is one to measure progress towards that goal? The problem is aggravated by the fact that while the environmental impacts of passenger transport are relatively easy to understand, the sheer complexity of the freight transport system makes the freight system more difficult for a consumer to grasp, let alone see in which way an individual could influence freight transport decisions. That passenger transport generally receives far more attention among researchers working on transport and the environment does not help the situation either.

Ways of 'rendering the transport problem visible' (Ahman 2004) would be company environmental reporting, which would reveal the transport-intensity of the product, and the application of the 'food miles' approach (Defra 2005; Runhaar and van der Heijden 2005). The UK government suggests two measures – freight intensity and lorry traffic intensity of GDP – to assess the 'sustainability of distribution' (DETR 1999), whereas a host of alternative measures have been suggested, both at the level of the economy (e.g. Vanek 2000; Stead 2001; Léonardi and Baumgartner 2004; Tapio et al. 2007), and companies (e.g. Potter et al. 2002). The indicator debates are intimately linked with the discussion on decoupling, the fundamental question being 'what should be decoupled from what?' McKinnon (OECD 2003b) argues that tonne-km would be difficult to decouple, because of the economic problems it would create, and advocates instead focusing on the ratios GDP/vehicle-km and vehicle-km/CO2 emissions, more sensitive to policy intervention. Likewise, Tapio et al. (2007) concentrate on what they call 'delinking', i.e. decoupling environmental damage from economic production, suggesting 'decarbonisation' CO_2/GDP as the relevant measure for transport.

Decisions upon the appropriate indicators and evaluation criteria are essential for the follow-up of transport policy targets, which has been identified as a weakness in the British transport policy (Gleave 2006). Developing rigorous measures to assess and monitor the impact of government transport policies on the achievement of climate objectives, and the follow-up of e.g. rail freight growth targets would necessary for a better integration and coordination of transport, land use planning and environmental policies. They would also be a way to harness the 'landscape' changes to the service of sustainability, by exploiting the concerns for sustainability, and the current emphasis on 'evidence-based policy', results-based management and accountability.

A related disagreement concerns the targets for emission reduction across sectors. Newbery (2005) argues that the cost of carbon abatement in the transport sector is much higher than in other sectors, and that applying a uniform emission reduction target for all sectors would therefore be economically inefficient. A possible solution could be to extend emissions trading schemes to include the transport sector, thereby allowing road users to finance emission reduction in other sectors (Vanek 2000).

Applying the terms of Smith et al. (2005), these information-based measures are crucial both in shaping and reorienting the selection pressures – by serving

knowledge-production and orientating the search processes – and strengthening the adaptive capabilities by helping build consensus around common, shared visions, and stimulating informed public debate about the possible, desirable solutions. Most fundamentally, however, the debates over indicators, targets, assessments and sharing of responsibilities bring to the fore the questions concerning power and agency: who has the power to define what goals and objectives are worth striving for, on which knowledge basis, and based on which legitimacy? These questions are at the core of the various consensus-building, backcasting and scenario-based methods used for stimulating the search for shared visions, promote innovative solutions, and arrive at common policy agendas for sustainable transport (e.g. Dreborg 1996; Robinson 2003; Jespersen and Drewes Nielsen 2005).

7 Conclusions

The preliminary analysis of the recent transitions in the UK road freight transport system above indicates that many of the dominant drivers are still in operation. The growth of production volume, liberalisation and deregulation of the formerly highly regulated freight sector, complexification of supply chains and extension of both the supply and market areas, decline of the relative cost of road freight transport, greater sophistication of product design, and increasing adherence to a just-in-time delivery regime – all of these factors still continue to drive greater road transport demand. The apparent start of 'decoupling' between GDP and road freight growth has been partly, but only partly, fuelled by greater internationalisation, and may indicate that the changing 'selection pressures' – greater concern for sustainability and increasing transport costs in particular – may signal the potential for a regime transition towards sustainability. If transport sector is to bear anything near to its share of 60% reduction in greenhouse gas emissions, far greater changes will be needed than piecemeal efficiency improvements in logistics operations.

In order to identify potential 'levers of change' and the potentially appropriate governance measures, a clearer view will be needed of the prevailing 'transition context'. First of all, a clearer picture will be needed of the differences between commodity groups and supply chains, because of the wide variations between the nature of for instance bulk and high-value density products. In particular, a better picture will be needed of the key actors and how the resources and power are distributed across the stakeholders. Further analysis could usefully apply the approach of Smith et al. (2005) for analysing the regime adaptive capabilities. Likewise, far better understanding will be needed on the desired direction of change: what would a sustainable freight transport system look like? To what extent should the prevailing centralised production and distribution systems be decentralised or regionalised? How to harness technological innovation to serve regime transformation, rather than the reproduction of the existing regime? These questions will be explored in future research by the Sussex Energy Group.

References

Ahman, M., 2004, A Closer Look at Road Freight Transport and Economic Growth in Sweden: Are There Any Opportunities for Decoupling?, Naturvardsverket, Report 5370, Stockholm, pp. 43.

EC, 2001, A sustainable Europe for a better world: a European Union strategy for sustainable development. Communication of the European Commission [COM(2001)264], Commission of the European Communities, Luxembourg.

EC, 2006, European Energy and Transport: Trends to 2030 - update 2005, European Communities, Luxembourg, pp. 146.

Bennathan, E., Fraser, J., and Thompson, L. S., 1992, What determines demand for freight transport, Policy Research Working Papers, Transport, Infrastructure and Urban Development Department, The World Bank.

DETR, 1999, Sustainable Distribution: A Strategy, Department of the Environment, Transport and the Regions, London.

OECD, 2001, Policies to Enhance Sustainable Development, OECD, Paris.

OECD, 2003a, Analysis of the Links Between Transport and Economic Growth, OECD Working Party on National Environmental Policy, Working Group on Transport, Project on Decoupling Transport Impacts and Economic Growth, ENV/EPOC/WPNEP/T(2003)4/FINAL, Paris, pp. 94.

OECD, 2003b, EPOC High-Level Special Session on Decoupling Environmental Pressures of the Transport Sector in the Context of Unsustainable Production and Consumption Patterns; abstracts of the presentations, OECD, Paris, pp. 12.

SACTRA, 1999, Transport and the Economy: Report of the Standing Advisory Committee on Trunk Road Appraisal, UK Government, London.

Tapio, P., 2005, Towards a theory of decoupling: degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001, *Transport Policy* **12**(2)**:**137-151.

McKinnon, A., 2006, The Decoupling of Road Freight Transport and Economic Growth Trends in the UK: An Exploratory Analysis, Logistics Research Centre, Heriot-Watt University, Edinburgh.

McKinnon, A. C., 1998, Logistical Restructuring, Freight Traffic Growth and the Environment, in: *Transport Policy and the Environment* (D. Banister, ed.), Spon Press, London, pp. 97-109.

McKinnon, A., Stirling, I., and Kirkhope, J.

Hughes, T. P., 1983, Networks of Power: Electrification in Western Society, 1880-1930, The Johns Hopkins University Press, Baltimore and London, pp. 474.

Hughes, T. P., 1994, Technological Momentum, in: *Does Technology Drive History? The Dilemma of Technological Determinism* (M. R. Smith, and L. Marx, eds.), MIT Press, Cambridge, MA and London, pp. 101-113.

Smith, A., Stirling, A., and Berkhout, F., 2005, The governance of sustainable socio-technical transitions, *Research Policy* **34**(10)**:**1491-1510.

Pastowski, A., 1997, Decoupling Economic Development and Freight for Reducing its Negative Impacts, in: *Wuppertal Papers 79*, Wuppertal Institut für Klima, Umwelt, Energie, Wuppertal.

Banister, D., and Stead, D., 2002, Reducing Transport Intensity, *EJTIR* **2**(3/4)**:**161-178.

Gilbert, R., and Nadeau, K., 2002, Decoupling economic growth and transport

demand: a requirement for sustainability, *Paper presented at the conference 'Transportation and Economic Development 2001' organised by the Transportation Research Board of the U.S. National Research Council, Portland, Oregon, May 5-7, 2002.*

Verny, J., 2005, The Problem of Decoupling Between Freight Transport and Economic Growth, *Paper presented at the 8th NECTAR conference, Las Palmas, G.C., 2-4 June 2005*.

NEI, 1999a, REDEFINE: Final Report, Rotterdam.

NEI, 1999b, REDEFINE: Deliverables, WP1.

Schipper, L., and Meyers, S., 1992, Energy efficiency and human activity: past trends, future prospects, Cambridge University Press, Cambridge.

Schipper, L., Scholl, L., and Price, L., 1997, Energy use and carbon emissions from freight in 10 industrialized countries: An analysis of trends from 1973 to 1992, *Transportation Research Part D: Transport and Environment* **2**(1)**:**57-76.

Greening, L. A., Ting, M., and Davis, W. B., 1999, Decomposition of aggregate carbon intensity for freight: trends from 10 OECD countries for the period 1971-1993, *Energy Economics* **21**(4)**:**331-361.

Steenhof, P., Woudsma, C., and Sparling, E., 2006, Greenhouse gas emissions and the surface transport of freight in Canada, *Transportation Research Part D: Transport and Environment* **11**(5)**:**369-376.

Kveiborg, O., and Fosgerau, M., 2005, Decomposing the decoupling of freight traffic growth and economic growth, Danish Transport Research Institute.

Rip, A., and Kemp, R., 1998, Technological change, in: *Human Choices and Climate Change* (S. Rayner, and E. Malone, eds.), Battelle, Columbus, Ohio.

Geels, F. W., 2002a, Understanding the Dynamics of Technological Transitions, Twente University Press, Enschede.

Geels, F. W., 2002b, Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, *Research Policy* **31**(8-9)**:**1257-1274.

Geels, F. W., 2004, From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory, *Research Policy* **33**(6-7)**:**897-920.

Gleave, S. D., 2006, Driving up Carbon Dioxide Emissions from Road Transport: An Analysis of Current Government Projections, London.

Goodwin, P., Dargay, J., and Hanly, M., 2004, Elasticities of road traffic and fuel consumption with respect to price and income: a review, *Transport Reviews* **24**(3)**:**275–292.

Berkhout, F., Smith, A., and Stirling, A., 2004, Socio-technical regimes and transition contexts, in: *System Innovation and the Transition to Sustainability* (B. Elzen, F. W. Geels, and K. Green, eds.), Edward Elgar, Cheltenham, UK and Northampton, USA, pp. 48-75.

Woodburn, A. G., 2006, The non-bulk market for rail freight in Great Britain, *Journal of Transport Geography* **14**(4)**:**299-308.

Bergek, A., Hekkert, M., and Jacobsson, S., 2006, Functions in innovation systems: a framework for analysing energy system dynamics. Paper presented at the research workshop on 'Innovation in energy systems: Learning from economic, institutional and management approaches', Oxford, 22-24 March, 2006.

Eames, M., and McDowall, W., 2006, Systems innovation and the transition to a sustainable hydrogen economy: a multi-level perspective. Paper for the SPRU

40th Anniversary Conference, September 2006.
Flyvbjerg, B., 2001, Making Social Science Matter: Why social inquiry fails and how it can succeed again, Cambridge University Press, Cambridge, pp. 204.
Hajer, M., 1995, The Politics of Environmental Discourse, Clarendon Press, Oxford.
Weber, M. K., 2003, Transforming Large Socio-technical Systems towards Sustainability: On the Role of Users and Future Visions for the Uptake of City Logistics and Combined Heat and Power Generation, *Innovation* **16**(2)**:**155-175.
Van der Meer, F.-B., 1999, Evaluation and the Social Construction of Impacts, *Evaluation* **5**(4)**:**387-406.
Galtung, J., 1971, A Structural Theory of Imperialism, *Journal of Peace Research* **8**(2)**:**81-117.
Shove, E., 2004, Sustainability, system innovation and the laundry, in: *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy* (B. Elzen, F. W. Geels, and K. Green, eds.), Edward Elgar, Cheltenham, UK and Northampton, USA, pp. 76-94.
Hansen, L. G., 2005, Impacts of Infrastructure Investment on Logistics and Transport - Examples from the Fixed Links of the Great Belt and Oresund in Denmark, in: *Social Perspectives on Mobility* (T. U. Thomsen, L. Drewes Nielsen, and H. Gudmundsson, eds.), Ashgate, Aldershot, UK and Burlington, VT, USA, pp. 67-88.
ECMT, 2003, Trends in the Transport Sector 1970-2001, European Conference of Ministers of Transport, Paris, pp. 65.
Hesse, M., and Rodrigue, J.-P., 2004, The transport geography of logistics and freight distribution, *Journal of Transport Geography* **12**(3)**:**171-184.
Rodrigue, J.-P., Slack, B., and Comtois, C., 2001, Green Logistics (The Paradoxes of), in: *The Handbook of Logistics and Supply-Chain Management* (A. M. Brewer, K. J. Button, and D. A. Hensher, eds.), Pergamon/Elsevier, London.
Peters, M. J., Lieb, R. C., and Randall, H. L., 1998, The use of third-party logistics services by European industry, *Transport Logistics* **1**(3)**:**167-179.
Defra, 2005, The validity of food miles as an indicator of sustainable development, UK Department for Environment, Food and Rural Affairs (DEFRA), London.
Voordijk, H., 1999, Logistical Restructuring of Supply Chains of Building Materials and Road Freight Traffic Growth, *International Journal of Logistics: Research and Applications* **2**(3)**:**285-304.
Haywood, R., 1999, Land development implications of the British rail freight renaissance, *Journal of Transport Geography* **7**(4)**:**263-275.
Pedersen, P. O., 2001, Freight transport under globalisation and its impact on Africa, *Journal of Transport Geography* **9**(2)**:**85-99.
Kemp, R., and Rotmans, J., 2004, Managing the transition to sustainable mobility, in: *System Innovation and the Transition to Sustainability* (B. Elzen, F. W. Geels, and K. Green, eds.), Edward Elgar, Cheltenham, UK and Northampton, MA, USA, pp. 137-167.
Garnett, T., 2003, Wise Moves: Exploring the relationship between food, transport and CO_2, Transport 2000 Trust, London, pp. 112.
Runhaar, H., and Heijden, R. v. d., 2005, Public policy intervention in freight transport costs: effects on printed media logistics in the Netherlands, *Transport Policy* **12**(1)**:**35-46.
Van Schijndel, W.-J., and Dinwoodie, J., 2000, Congestion and Multimodal Transport: A Survey of Cargo Transport Operators in the Netherlands,

Transport Policy **7**(4)**:**231-241.

McKinnon, A., and Woodburn, A., 1996, Logistical Restructuring and Freight Traffic Growth: An Empirical Assessment, *Transportation* **23**(2)**:**141-161.

McKinnon, A., Button, K., and Nijkamp, P., 2002, Transport Logistics, in: *Classics in Transport Analysis*, Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

EEA, 2006, Transport and environment: facing a dilemma

TERM 2005: indicators tracking transport and environment in the European Union, in: *EEA Report 3/2006*, European Environment Agency, Copenhagen.

Fowkes, A. S., Nash, C. A., and Tweddle, G., 1991, Investigating the Market for Inter-modal Freight Technologies, *Transportation Reseach A: General* **25**(4)**:**161-172.

HOC, 2006, Reducing Carbon Emissions from Transport: Ninth Report of Session 2005–06, Volume 1, House of Commons, Environmental Audit Committee, London.

Murphy, P. R., Poist, R. F., and Braunschwieg, C. D., 1994, Management of environmental issues in logistics: Current status and future potential, *Transportation Journal* **34**(1)**:**48.

Nijkamp, P., Reggiani, A., and Bolis, S., 1997, European freight transport and the environment: empirical applications and scenarios, *Transportation Research Part D: Transport and Environment* **2**(4)**:**233-244.

Leonardi, J., and Baumgartner, M., 2004, CO2 efficiency in road freight transportation: Status quo, measures and potential, *Transportation Research Part D: Transport and Environment* **9**(6)**:**451-464.

DETR, 1998, A New Deal for Transport: Better for Everyone - Integrated Transport White Paper, Department of the Environment, Transport and the Regions, London.

DETR, 2000, Transport 2010: The 10-Year Plan - , London (T. a. t. R. Department of Environment, ed.), Department of Environment, Transport and the Regions, London.

Vanek, F. M., 2000, Sustainably Distributed? An environmental critique of the UK Government's White Paper on Distribution, *World Transport Policy & Practice* **6**(2)**:**5-12.

Vanek, F. M., and Morlok, E., 2000, Improving the energy efficiency of freight in the United States through a commodity-based analysis: justification and implementation, *Transportation Research Part D: Transport and Environment* **5**(1)**:**11-29.