Considering the relationship between freight transport and urban form

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Further details of the Green Logistics project can be found at:

http://www.greenlogistics.org

Further details of the Transport for London Freight Unit can be found at:

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1. Introduction

There has been much discussion since the mid-1980s about the relationship between transport and urban form. “Urban form” refers to the strategic and local structure of cities. At a strategic level, urban form characteristics include the location, size and shape of urban development and the type of land use. At a local level, urban form refers to the intensity of land use (i.e. population and employment density) and the layout of urban development (such as transport networks and facilities, and neighbourhood types) (Stead and Marshall, 2001).

The existing research into urban form and passenger transport has investigated the extent to which urban form is influential in determining major characteristics of travel such as the numbers of trips made, journey lengths, and mode choice. Social and economic factors (such as income, family structure, and car ownership) also play an important role in determining these travel characteristics. However, urban transport planners and designers can do little to alter these social and economic factors, but do have the potential to alter urban form, and thereby influence travel patterns, through their policies (Banister, 2005).

However, all of this body of research has concerned itself with passenger transport (i.e. the movement of people). As far as the authors are aware, there has been no consideration to date of the interactions between the various features of urban areas and freight transport operations. This report is intended as an initial investigation into the relationship between road freight transport and urban form.

Section 2 reviews research findings into the relationships between passenger transport and urban form, highlighting the lack of consensus between researchers about whether some of these relationships exist or not.

Section 3 discusses important trends in road freight transport and logistics and the land use associated with these activities. Section 3.1 considers changes in warehousing for urban areas, while section 3.2 addresses trends in urban freight transport vehicle operations. Section 3.3 considers the potential relationships between road freight transport operations and urban form. Section 3.4 outlines a conceptual framework for analysing urban road freight transport.

Section 4 uses data about road freight transport activity by heavy goods vehicles (HGVs – i.e. goods vehicles over 3.5 tonnes gross weight) in urban areas in Britain that has been disaggregated from a UK government survey. This data together with information about the characteristics of urban areas is used in relation to the framework outlined in section 3.1 to investigate the nature of urban freight operations in sixteen selected urban areas. This includes analysis of the efficiency and transport intensity of these operations on journeys to, from and within each urban area. This section contains all the results of the analysis without detailed discussion of these results (which is presented in section 7).

Section 5 analyses data on commercial and industrial land use to understand changes in land use and especially warehousing in the sixteen urban areas over the last ten years. This data is used in conjunction with the road freight activity data analysed in section 4 to estimate the amount of warehousing per tonne of freight lifted in each urban area studied.

Section 6 test scenarios about urban freight operations based on reductions in length of haul, and improvements in vehicle lading factors, vehicle carrying capacities and empty running in order to investigate the potential effect of such changes on the vehicle kilometres performed on journeys to, from and within the sixteen urban areas.

Section 7 provides conclusions about the work presented in the report.
2. Transport and urban form

2.1 Summary of research findings into passenger transport and urban form

There has been much discussion since the mid-1980s about the relationship between transport and urban form in recent years (see for example, Banister, 2005; Breheny, 2001, ECOTEC, 1993; Newman and Kenworthy, 1988; Stead and Marshall, 2001; Taylor and Sloman, 2008). This research has covered a range of different geographical scales and has investigated many different characteristics of urban form. The major focus of much of this work has been to try to determine whether transport growth can be affected by promoting particular forms of urban development – i.e. whether particular designs and layouts of urban areas can help to limit increases in traffic.

This body of research ranges in consideration of urban form from the regional strategic planning level to local planning issues at a neighbourhood level (Stead and Marshall, 2001). The aspects of urban form that have been considered in relation to transport activity levels and patterns include (Stead and Marshall, 2001; Banister, 2005):

- settlement size (in terms of resident population and distance of residence from urban centre)
- intensity of land use and activities
- mixing of land uses
- provision of local facilities (and decentralisation of facilities)
- accessibility to local transport infrastructure/networks
- availability of parking facilities
- road network type
- neighbourhood type

Elements of transport activity that have been considered in relation to the above aspects of urban form in this body of research include: travel distance, journey frequency, mode of travel, travel time and energy consumption (Banister, 2005).

This section provides a summary of these research findings into the relationships between passenger transport and urban form. As will be clear from the summary below there is no consensus between researchers about whether some of these relationships exist or not. Banister (2005) argues that this lack of consensus is due to a general lack of detailed analysis which has been caused by several factors including: deficiencies in the quantity and quality of data available, protagonists’ arguments being affected by the particular types of policy interventions they favour, and incompatible research approaches used. In relation to the latter he notes differences in the geographical unit of analysis (such as region- or city-wide studies compared with neighbourhood studies) as well as different methods and units of analysis for calculating energy consumption.

This summary is based on three publications that contain literature reviews of the variety of research carried out into these relationships over the last twenty years (Banister, 2005; Stead and Marshall, 2001; Taylor and Sloman, 2008).

**Settlement size (in terms of resident population and distance between homes and urban centre)**

The size of the urban settlement can influence the variety of jobs and services that exist as well as the public transport services that can be provided. Therefore in small settlements fewer jobs and transport services can be provided (compared with a larger settlement) and residents have to travel further for work and other purposes. However in the case of very
large cities the distances that residents have to travel to work and other activities can also be relatively long due to the distances between homes and these other locations. This is borne out by National Travel Survey data which shows that travel distance per person is higher in settlements with less than 3,000 residents than in large urban areas (excluding London). However, London residents travel longer distances than those living in the six next largest metropolitan areas in Britain.

Banister (1996) and Barton et al. (1995) have both argued a population of at least 10,000 is required for the settlement to have a diversity of facilities and services.

Various researchers disagree about whether or not the size of the resident population in the urban area impacts on modal choice, travel distance and energy consumption. Banister (2005) provides the following conclusions of different studies:

- There is no correlation between population size and modal choice in US urban areas (Gordon et al., 1989).
- Settlements with populations over 250,000 have lower travel distances per person and a smaller proportion by car (ECOTEC, 1993).
- The most energy efficient settlement in terms of transport is one with a population size of 25,000-100,000 or 250,000 plus (Banister, 1997).

**Intensity of land use and activities (in terms of population density)**

The intensity of land use can be measured in terms of either population density or employment density. There is disagreement among researchers about whether or not higher population densities affect modal choice, travel distance and energy consumption. However, in general there does appear to be a link between population density and these passenger transport factors (i.e. mode, distance, and energy use). Possible reasons for the link between population density and transport include that higher densities i) allow more contact between people without the use of motor vehicles, ii) increase the range of facilities and services that can be supported, iii) reduce average distance between homes, workplaces and other facilities, iv) are better suited to public transport services than car use.

Researchers have reached a wide range of, including opposing, conclusions about the optimum urban form to reduce car travel (ranging from compact cities (i.e. high density) to low density suburban development).

Banister (2005) provides the following conclusions of different studies:

- No clear relationship between the proportion of car journeys and population density in US urban areas (Gordon et al., 1989).
- As population densities increase there is a passenger modal shift towards rail and bus (Banister et al., 1997).
- Compact cities may not reduce transport energy consumption due to greater traffic congestion, also decentralisation may reduce journey lengths (Breheny, 1997 and 2001).
• Density is the most important variable in determining transport energy consumption (Banister et al., 1997).

• As people relocate from large, dense cities to small, less dense towns they travel more by car but the distance travelled may be shorter (Hall, 1998).

**Mixing of land uses**

By mixing land-uses in urban areas it is possible to reduce the distance between residences, workplaces and other locations, and thereby can affect travel patterns in terms of modes used, distances travelled and energy consumed.

Taylor and Sloman (2008) have noted that, "Whether more sustainable travel patterns are generated by placing employment sites amongst residential areas appears to depend on factors such as the type of employment in question and where those residential/employment areas are, relative to access from the public transport network”.

**Provision of local facilities (and decentralisation of facilities)**

The existence of local facilities and services can reduce the journey lengths that residents have to undertake. This can, in turn, affect mode choice and transport energy consumption.

However there is disagreement about the extent to which the provision of local services and facilities influences passenger modal choice, travel distance, and transport energy consumption. Farthing et al. (1997) have argued that local provision does not determine mode choice, instead this is determined by personal and household characteristics. Meanwhile Banister (1996) has stated that a diversity of services and facilities in close proximity to where people live reduces travel distance, and changes modal.

**Distance to local transport infrastructure/networks**

In general distance to local transport facilities (i.e. the nearest bus stop or railway) affects travel patterns, mode choice and energy consumption. Car use tends to increase with increasing distance to the nearest bus stop.

Access to major transport networks such as road and rail networks increases travel speeds and extends the distance that can be travelled in a given period of time, but can lead to greater journey lengths and greater energy consumption.

**Availability of parking facilities**

Parking policies in urban areas affect mode choice, and also affect the journey frequency and journey length per person. Residents with fewer car parking spaces near where they live may make fewer, longer car-based journeys, while those with fewer parking spaces may make more journeys in total, but which are shorter and less car-based. Prices charged for parking will also have a bearing on travel patterns.

Car parking spaces and policies in central urban areas can affect the frequency and mode choice of journeys made to the centre. Taylor and Sloman (2008) have noted that “At a city-wide level, availability of parking in central areas has been shown to have a marked inverse correlation to commuting by public transport”.

4
**Road network type**

Cul-de-sac road networks are a more efficient use of land than grid networks in terms of the amount of useable land (Grammenos and Tasker Browne, 2000). From a passenger transport perspective cul-de-sac layouts also reduce car and motorcycle drivers taking shortcuts through residential areas, and the design can reduce traffic speeds. However, grid networks are better for public transport services, provide greater accessibility and are less dependent on car use (Southworth and Ben-Joseph, 1997).

**Neighbourhood type**

Neighbourhood type refers to attributes of specific local part of a settlement that include: age of the development, style of development, and the street network type (such as grid or loop and cul-de-sac). Some studies have reported higher journey frequencies and a higher proportion of car journeys in suburban neighbourhoods than in "traditional" neighbourhoods (Stead and Marshall, 2001).

**Socio-economic characteristics of urban residents**

There is disagreement about the relative importance of land-use/urban form characteristics and socio-economic characteristics on passenger mode choice, travel distance and energy consumption. Stead (2001) has argued that socio-economic factors are more important than land-use/urban form factors, and that the former explain more than 50% of the variation in the amount of travel by wards, while the latter explain up to one-third of the variation. Key socio-economic factors include: car ownership, socio-economic group and employment.

Ewing and Cervero (2002) have argued that land-use/urban form is more important than socio-economic factors in explaining journey lengths, but that socio-economic factors are more important in explaining journey frequencies and mode choice.

The preferences and attitudes of people are also important (with land-use/urban form and socio-economic factors) in determining travel patterns.

It is commonly argued that travel distance, the proportion of car journeys and energy consumption increases with car ownership. However the importance of car ownership as opposed to land-use/urban form characteristics in determining travel patterns is less clear.

However, Banister (2005) concludes that there are land use and urban form characteristics that influence passenger transport activity, especially in terms of journey length, speed and mode choice, but that there is less influence on the frequency of travel.

**Conclusions**

Banister (2005) has suggested that land-use and urban form influence journey length, speed and mode choice, but has less impact on journey frequency. He has drawn the following conclusions about the relationship between urban form and land use:

- Location of new development, especially housing, should be of a substantial size and located near to or within existing settlements so that total population is at least 25,000 and probably closer to 50,000.

- Journey lengths by car are relatively constant at densities over 15 persons per hectare, but at lower densities increase by up to 35%. As density increases, the relative proportion of journeys by car decreases.
The larger the settlement, the shorter the journeys and the greater the proportion of journeys by public transport. However in the largest cities journey lengths tend to increase due to their complex structures and sizes.

Mixed use development should reduce journey lengths and car use.

Development should be located close to public transport interchanges and corridors so that high levels of accessibility can be provided. But this may also encourage long distance travel, especially commuting.

The availability (and price) of parking is a key determinant of whether a car is used or not.

Car availability and other socio-economic factors determine about 70-80% of variation in travel demand and mode choice. Land-use/urban from factors explain the remaining 20-30% of variation and “provide the main means by which policy interventions can succeed in influencing sustainable development, particularly when combined with actions in the transport sector”.

2.2 Thinking about the relationship between road freight transport and urban form

As previously discussed, despite the wealth of research into the relationships between passenger transport and urban form summarised in the previous section, there has been no comparable research into the interaction between road freight transport and urban form. This section provides a tentative start to such research efforts.

Marshall (2006) has compared the features of passenger transport modes by use of his “modegram” (see Figure 5.1).

The modegram is a powerful conceptual tool for distinguishing between passenger transport modes. However, applying it to freight transport (especially road freight) is far from straightforward. Freight modes other than road (e.g. rail, air, water-based) will be broadly similar to public transport modes shown in the modegram in terms of the coarseness of the networks they operate over, and hence have relatively coarse access density (similar to buses and trains).

However road freight is more difficult to position on the modegram, as in theory all goods vehicles have the potential for fine (door-to-door) access density (regardless of the carrying capacity of the vehicle, whether goods are carried for one or several customers, and whether the journey has a single leg or several legs). Therefore all road freight could be positioned at the top of the modegram (point A) alongside the car.

However, in reality different types of freight operation do tend to exhibit different levels of access density. The operating pattern of freight journeys varies between single leg journeys in which a full load is transported from a single origin to a single destination, and multi-leg journeys which can consist of multiple origins and destinations on a single journey, with parts loads delivered and collected at each stop. A journey with several legs can exhibit equally fine access density as a single leg journey, despite the fact that it visits multiple addresses. Therefore, road freight journeys are far more complicated than passenger journeys.
Figure 5.1: The “modegram”

Notes: “Each mode of movement is plotted according to degree of individualism-collectivism and degree of mechanisation. The values of vehicle occupancy are typical values; in reality each mode would have a range of occupancy values. Note that greener modes tend to be to lower and/or to the right. The consequence of the diagram is that car is a fully comprehensive mode, since it has both range and door-to-door access: Point A represents the apex of automobility, the ability to go one’s own way, anywhere, any time. It includes the car and point-to-point freight movements. On the other hand, collective (transit) modes and human-powered modes – which are least alike – need each other to provide both range and door-to-door access, and therefore must be seen as a complementary system” (Marshall, 2006).


Operating patterns also vary between vehicles that operate on fixed routes and those that have routes that change daily in accordance with demand. For instance, a Royal Mail van making collections from post boxes, or a vehicle delivering newspapers to newsagents’ shops will operate on a fixed route using a relatively coarse network. Meanwhile, at the other extreme a parcel home delivery service will operate on a route that changes daily, and is very fine in terms of making deliveries to different houses each day.

In addition, as discussed in section 2.1, road freight operations vary in terms of journey type and purpose, as well as in terms of the type of goods carried (which is another influence of operating characteristics of the vehicle).

Therefore urban road freight operations and their categorisation can be seen as relatively complex in comparison with passenger transport.
3. Analysing road freight transport in urban areas

This section discusses important trends in road freight transport and logistics and the land use associated with these activities. Section 3.1 considers changes in warehousing for urban areas, while section 3.2 addresses trends in urban freight transport vehicle operations. Section 3.3 considers the potential relationships between road freight transport operations and urban form. Section 3.4 outlines a conceptual framework for analysing urban road freight transport.

3.1 Developments in warehousing in urban areas

The major type of freight transport land use is warehousing (other uses such as vehicle overnight parking space take up far less space). Traditionally, stockholding in supply chains was relatively decentralised with warehouses at various points in the chain – often at the manufacturing site as well as at the receiver’s premises, with other intermediate warehouses between the two. This resulted in many warehouses being located in urban areas, often in the inner city adjacent to industrial areas.

However three major trends have taken place in recent decades that have fundamentally changed the warehousing land use patterns in urban areas in the UK and other western European countries.

First, deindustrialisation has resulted in a major decline in industrial land use (which is a major generator of freight activity) (Hesse, 2008). This has led to a decline in the demand for industry-related warehousing demand in urban areas. Much industrial activity that previously took place in urban areas in western European countries has now been relocated to eastern Europe and Asia where lower labour costs can be exploited. In some cases companies (especially multinationals) have taken these decisions to relocate their facilities, while in the case of smaller indigenous manufacturers they have often gone out of business as a result of competition from producers in these countries. A relocation of the manufacturing process also results in a relocation of the warehousing needs to these other countries, with the imported goods passing through UK ports, with storage either taking place at or near the ports or at regional and national distribution centres outside of urban areas.

Second, increased spatial centralisation of stockholding has resulted in there being fewer warehouses in supply chains. As a result, there has been a shift away from warehousing at both producers’ and receivers’ sites and instead an increase in the use of national and regional distribution centres that serve a far larger geographical area. This centralisation has been made possible by the development of the motorway network, which allows companies to locate extremely large warehouses at strategic points with good accessibility to their hinterlands, and thereby to hold stock at fewer locations in total. By using this approach companies have been able to benefit from the ‘square root law’ of stockholding and economies of scale which results in the need to hold less stock in the supply chain in total (McKinnon, 1989). Although freight transport costs may increase as a result of these locational decisions, these cost increases are more than offset by the cost savings resulting from the centralisation of stock. As McKinnon has noted “the process of centralisation is now at an advanced stage, with many warehousing operations now concentrated at a single location or in premises that have reached their maximum economic size” (McKinnon, 2009). Many of these supply chains operate hub and spoke networks with regional and national warehouses being used in conjunction with local urban depots where goods can be transhipped between vehicles for local delivery.

These regional and national distribution centres have tended over time to become increasingly clustered in particular strategic locations on motorways around areas including London, Birmingham, Bristol, Leeds and Manchester – this is partly due to companies’
locational decision-making regarding accessibility to the road transport network, but also as a result of planning policy that encourages a concentration of such land use.

Third, rapidly rising land prices and increasing traffic congestion in urban areas have forced companies to relocate warehousing to locations with relatively lower prices. This has led to the suburbanisation of warehousing, with urban warehousing being relocated to the edge of the urban area or outside (Hesse, 2008; Dablanc and Rakotonarivo, 2010).

Warehouses are used to perform a range of different roles in relation to goods storage and transportation. These include: the i) storage of goods; ii) the consolidation of loads; iii) break-bulk operations; and iv) the transfer of goods between modes.

Goods may be stored for a number of reasons: it may be simply to provide a buffer point between supply and demand or to cover for seasonal fluctuations. Stockholding can also help to guard against unforeseen circumstances and disruptions within the distribution system.

Consolidation is necessary when goods are collected in relatively small quantities from a number of different locations. By taking these goods to a central point it is possible to combine these goods into bulk loads and thereby improve the efficiency of the secondary stage of the transport operation.

Efficiency in the transport of goods can be achieved by moving the products in bulk loads over the main trunking stage of the distribution system. It is then possible to break the load into smaller consignments at a static facility for the final delivery leg to the customer.

Warehousing can also facilitate the transfer of goods between modes. The use of more than one mode in the distribution of goods is often referred to as combined transport and takes place when the distribution and collection functions are carried out by one mode (such as road) and the main trunking movements are carried out by another mode (such as rail, barge or ship). Combined transport can be attractive when it is beneficial in terms of time or cheaper or faster than single mode operations, but it has also been promoted on environmental grounds when a less environmentally damaging mode is used to perform the long distance movement.

The adoption of just-in-time production and transportation systems in supply chains is resulting in supply being geared more closely to demand and hence goods being held in warehouses for shorter periods of time than in the past. In some operations goods are not stored at the “warehouse” at all, but are simply unloaded from vehicles, sorted by destination and loaded immediately onto other vehicles for onward transport to the customer. This is often referred to as a “cross-docking” facility.

In addition there are other activities that are being carried out in warehouses in order to enhance logistics efficiency in supply chains. This includes inventory monitoring and information collection and analysis, linked to in-store systems - this can increase the visibility of the supply chain, again leading to better availability and service levels, as well as reducing loss of stock. Product quality and quantity checking can be carried out on the arrival of consignments at the warehouse, giving advance notice to the customer of any problems with supplies. Various pre-retailing activities, such as consignment unpacking, preparation of products for display and price labelling, can also be carried out to reduce time and space requirements upon delivery.
3.2 Urban freight transport operating patterns

Section 3.1 considered the role of warehouses in facilitating urban freight services. However, much freight activity in urban areas is concerned with moving goods to market – this includes goods used by consumers and commercial organisations. Since the demise of much industrial production in urban areas in western Europe many of these locations tend to be net importers rather than exporters of freight today (unless they contain international hubs such as seaports and airports through which major flows of goods destined for other locations enter the country). In addition to the demand for finished goods, construction materials are also required for building projects in urban areas and waste removal services from urban commercial and residential sites are also necessary.

As mentioned in section 3.1, some goods moving to and from urban areas pass through warehouses located within the urban area. Over time these urban warehouses have become increasingly suburbanised, relocated from the inner to the outer city. In other cases goods moving to and from the urban areas pass through warehouses situated outside the city (either on the city edge just outside the urban boundaries or a substantial distance from the city).

By considering the location from which goods move to and from on freight journeys with an urban component (i.e. the origin and destination of the journey) it is possible to consider how land use affects journey types and patterns. Freight journeys with an urban component can be sub-divided into several types based on the origin and destination of the journey as follows:

- Journeys to an urban area from elsewhere
- Journeys from an urban area to elsewhere
- Journeys wholly within an urban area
- Journeys that do not start or finish in an urban area but which pass through it (i.e. transit journeys – these have become less common over time due to the construction of bypasses and higher speed alternative routes)

Journeys wholly within an urban area may well comprise a smaller proportion of all freight journeys than is the case for passenger journeys, with many goods either flowing into an urban area for consumption or being transported from an urban area to elsewhere after a stage in the production process.

As well as having differing origins and destinations, these various types of urban freight journey also exhibit varying operational patterns in terms of the structure of the distribution network used in the given supply chain from point of despatch to point of delivery. Figure 3.1 shows the various distribution network structures that exist. Some of these structures involve direct flows from the point of despatch to point of delivery, while others involve intermediate handling. The structures depicted in Figure 3.1 therefore vary in terms of the number of vehicles, modes and transport networks used in the journey. Each journey that a product makes in the physical distribution network can involve a different distribution network structure.
Figure 3.1 Possible distribution network structures for a freight transport journey taking into account vehicles, modes, and transport networks

**Direct flow network (single drop)**
- One vehicle
- One mode
- One transport network

**Consolidation network**
- More than one vehicle
- One or more modes
- One or more transport networks

**Local collection & delivery network**
- More than one vehicle
- One or more modes
- One or more transport networks

**Direct flow network (multi drop)**
- One vehicle
- One mode
- One transport network

**Line network (multi drop)**
- One vehicle
- One mode
- One transport network

**Trunk feeder network**
- More than one vehicle
- One or more modes
- One or more transport networks

**Consolidation network**
- More than one vehicle
- One or more modes
- One or more transport networks

**Local collection & delivery network**
- More than one vehicle
- One or more modes
- One or more transport networks

**Key**
- Despatch point
- Delivery point
- Hub / transhipment point

Figure 3.1 does not reflect the geographical location of the despatch, delivery and hub/transhipment points. In the case of urban freight journeys one or more of these points will be located within an urban area.

As reflected in Figure 3.1, the operating pattern of an individual goods vehicles carrying out urban freight transport (either collections or deliveries) can involve either a multi-leg or single leg journey pattern.

Goods vehicles making deliveries in the urban area can either perform single-leg or multi-leg journeys.

Single-leg journeys (see Figure 3.2) in the urban area involve the vehicle collecting a load and then transporting it and delivering it to its destination (i.e. the entire load is destined for one establishment). The vehicle then collects another load and delivers it and so on. The depot from which the delivery originates could be located either in or outside the urban area.

**Figure 3.2: Single-leg journey**

Multi-leg journeys (see Figure 3.3) involve the vehicle calling at more than one establishment during the delivery round. The vehicle will collect a load and then makes deliveries to several different establishments, (i.e. each establishments receives part of the vehicle's load). Goods vehicle journeys in which the vehicle calls at more than one establishments to deliver
goods are usually referred to as rounds. As with single-leg journeys, the depot from which the delivery originates in the case of a multi-leg round could be located either in or outside the urban area.

**Figure 3.3: Multi-leg delivery journey**

Similarly goods collections can be made by either single or multi-leg journeys. A single leg collection journey will require a vehicle to call at only one establishment to collect its entire load, whereas a multi-leg journey will involve the vehicle in collecting goods from several different establishments on the round.

Whether a goods vehicle performs single- or multi-leg journeys is influenced by a number of factors including:

- The size of each collection/delivery
- The origin and destination
- The time sensitivity of the goods
- The degree of centralisation in the supply chain involved (which affects the opportunity for consolidation goods from different suppliers)
- The size of the goods vehicle to be used

Freight journeys to, from and within urban areas also differ in their operational performance in terms of factors including the lading factor (i.e. how well the vehicle payload is utilised) and the degree of empty running (i.e. the extent to which the vehicle travels empty or not). These performance factors influence the total amount of freight vehicle activity required to deliver a given quantity of goods.

3.3 Potential relationships between road freight transport and urban form

It is important to note that passenger journeys and freight journeys in urban areas are very different in nature. While passenger journeys are decided on (in terms of origin and destination, mode, timing and frequency of travel) by individuals for a multitude of different reasons, freight journeys have a single purpose of transporting goods from one point in the supply chain to another. At each of these points in the supply chain goods are either worked on, stored, or sold. Decisions about the nature of these freight journeys are made by the owners of these goods and the customers they do business with. While passengers can make multiple journeys in a single urban area each day and thousands of journeys per year, this is not the case for goods, which are often delivered into an urban area from outside (as many urban areas are net importers of goods) and then are usually only transported to, at most, one or two additional locations in the urban area before being consumed.
As already discussed, passenger journeys are likely to be influenced by a wide range of urban form factors such as where people live, where they work, the existing transport infrastructure and service provision, land use patterns in the area, density levels, the layout of neighbourhoods and road networks. Meanwhile the majority of goods are transported on journeys either into or out of the urban area rather than from one location to another within the urban area. Although these freight journeys are likely to be influenced to some degree by factors including the size, density and layout of the city these influences are likely to less important than for passenger transport for reasons including: i) fewer modal options exist for freight than for passengers, ii) the demand for freight transport is more inelastic with respect to price than for passenger journeys (and therefore less likely to alter or stop than passenger journeys when prices change), iii) relatively little freight is transported in residential neighbourhoods (and their distinctive development patterns and road layouts). Only home deliveries and waste collections are likely to penetrate these locations, most freight journeys take place to urban locations on the major road network.

This is not to say, however, that freight journeys are unaffected by urban form. Clearly factors such as settlement size, density, industrial land use patterns and the provision of logistics facilities are likely to influence the extent and location of urban freight activity to some extent as well as the operating patterns and types of vehicle used for freight work that takes place within the urban area.

In section 2.1 the relationship between passenger transport and urban form (in terms of travel distance, journey frequency, mode of travel, travel time and energy consumption) was discussed in relation to the following factors:

- settlement size (in terms resident population and area)
- intensity of land use and activities
- mixing of land uses
- provision of local facilities (and decentralisation of facilities)
- access to local transport infrastructure/networks
- availability of parking facilities
- road network type
- neighbourhood type

It is possible to speculate about the potential relationships between road freight transport and these same aspects of urban form, and the impact on transport activity. This is shown in Table 3.1. Two of the aspects of urban form considered for passenger transport are not relevant to freight transport: namely the availability of parking facilities and the accessibility to local transport infrastructure/networks.

The availability of parking facilities is only potentially relevant to goods vehicles being used to provide a service (rather than to collect or deliver goods) and which therefore have to be parked, and are subject to parking (not loading) regulations while the servicing activity is carried out. However goods collection and delivery activity is potentially sensitive to the availability of loading space (loading space can be varied in terms of the amount of space made available and the times at which that space is made available). As the vehicle activity that supports goods collection and delivery is relatively inelastic with respect to price (as in most cases the goods still need to be moved regardless of price) some such activity would continue whatever the availability of loading space – with vehicles stopping illegally to make collections and deliveries and companies having to accept the financial penalties associated with this behaviour. This is what tends to happen in areas of limited loading space/time availability and a high level of loading regulation enforcement (as witnessed in urban areas in the UK with decriminalised parking). Some companies simply choose to contravene the regulations to make deliveries and suffer the financial penalties, however unjust they believe
this to be. However if the loading space/time availability were to be substantially limited and the financial penalties and enforcement activities were substantially increased, there would come a point for all companies at which they would have to reconsider their existing collection and delivery arrangements. Options available would include: using other modes that were made exempt from the loading space regulations (such as possibly on-foot, hand cart, bicycles), making collections and deliveries at other times which were not subject to the regulations, and making larger, and hence fewer, collections and deliveries.

For passenger transport, access to local transport infrastructure/networks refers to the distance people have to travel to the nearest bus stop or railway and the affect this has on travel patterns and mode choice. This is not relevant to freight transport as the overwhelming majority of the goods are transported by goods vehicles rather than other modes, and the existence of rail and water facilities has little if any relationship with the extent of their use for freight transport in urban areas.

In the case of the provision of local transport facilities (such as bus stops and stations) these are not relevant to freight transport, so the provision of local distribution facilities (i.e. warehouses and depots) has been considered instead.

Settlement size is potentially related to freight activity as more populated or geographically larger settlements are likely to contain more freight generating activities, result in more demand for goods from residents and businesses, and have greater potential for internal freight movements between these activities. Very large urban areas are also often multi-centred resulting in the potential for more flows between locations within the same urban area, and hence internal freight vehicle movements.

Intensity of land use (population density and employment density) – as population and employment density rise this has the potential to reduce the inter-drop distance between delivery points on a multi-drop round – which has the effect of reducing the total distance travelled, and hence the energy consumption associated with the activity per delivery. It may also facilitate the delivery of some items by alternative road-based technologies such as by foot or cycle – but this is likely to be restricted to very specific items such as post.

Mixing land uses is also likely to have the potential to reduce the inter-drop distance between delivery points on a multi-drop round (which could thereby reduce the total distance travelled, and hence the energy consumption associated with the activity per delivery).

In terms of the provision of local distribution facilities, an increase in the prevalence of distribution facilities in an urban area is likely to reduce the distance travelled, and hence the travel time and energy consumption. However as facilities increase, journey frequency may also increase as it becomes less expensive for companies to provide frequent collection and delivery services when operated from nearby facilities, and high product throughput is likely to be important to the economic efficiency of the facility. Therefore in this latter case, journey frequency may increase as facilities increase as a result of customer service/business decisions. However, in recent decades there has tended to have been a relocation of distribution facilities in urban areas in the UK as land prices have increased, deindustrialisation has occurred and supply chains have been geographically reconfigured (as discussed in section 3.1). These changes have meant that it is less likely and viable for distribution facilities to be located in urban areas, and instead many have been disposed of and relocated to the edge of or outside the urban area.
Table 3.1: Possible relationships between freight transport activity and urban form

<table>
<thead>
<tr>
<th>Aspect of urban form</th>
<th>Total distance travelled</th>
<th>Journey frequency</th>
<th>Mode of travel</th>
<th>Travel time</th>
<th>Energy consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settlement size (in terms of resident population and area)</td>
<td>Potentially increased as size increases</td>
<td>No effect</td>
<td>Some effect on journeys to and from urban area as larger settlements likely to have more modes available.</td>
<td>Potentially increased as size increases</td>
<td>Potentially increased as size increases</td>
</tr>
<tr>
<td>Intensity of land use and activities (in terms of i) population density and ii) employment density)</td>
<td>Potentially reduced for multi-drop journeys as density increases</td>
<td>No effect</td>
<td>Deliveries by foot or cycle may be more viable as density increases (for limited types of goods)</td>
<td>Potentially reduced for multi-drop journeys as density increases</td>
<td>Potentially reduced for multi-drop journeys as density increases</td>
</tr>
<tr>
<td>Mixing of land uses</td>
<td>Potentially reduced for multi-drop journeys as mixing increases</td>
<td>No effect</td>
<td>No effect</td>
<td>Potentially reduced for multi-drop journeys as mixing increases</td>
<td>Potentially reduced for multi-drop journeys as mixing increases</td>
</tr>
<tr>
<td>Provision of local distribution facilities</td>
<td>Potentially reduced as facilities increase</td>
<td>Potentially increased as facilities increase</td>
<td>No effect</td>
<td>Potentially reduced as facilities increase</td>
<td>Potentially reduced as facilities increase</td>
</tr>
<tr>
<td>Access to local transport infrastructure/networks</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Availability of parking facilities</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Road network type</td>
<td>Potentially increased as connectivity decreases</td>
<td>No effect</td>
<td>No effect</td>
<td>Potentially increased as connectivity decreases</td>
<td>Potentially increased as connectivity decreases</td>
</tr>
<tr>
<td>Neighbourhood type</td>
<td>Unknown</td>
<td>Unknown</td>
<td>No effect</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
Road network type – the connectivity of road network is likely to affect distance travelled by freight. This is especially true for goods vehicles involved in making deliveries to residential addresses, where the greatest variation in the connectivity of roads is likely to occur. Grid layouts are likely to result in less distance travelled than cul-de-sac for goods vehicles making deliveries to residential addresses.

There has been no research into the relationship between neighbourhood type and road freight activity. However, the age or style of an area is unlikely to be related to freight transport patterns or activity levels.

Urban form may also have a bearing on the type of freight transport journeys that take place in terms of: i) journeys within an urban area, and ii) journeys to and from an urban area. A very small settlement is likely to be unable to support a wide range of production, service and logistics facilities and therefore a high proportion of freight transport journeys are likely to originate or end outside the settlement (as both goods and the vehicles that move them have to be transported to the settlement). Larger settlements are likely to be able to support a wider range of production facilities and freight transport services and be multi-centred (i.e. polycentric) and will therefore be likely to generate a greater proportion of internal freight transport journeys. However in the case of very large settlements, the distances that goods have to be transported on internal journeys is likely to be greater than in smaller settlements due to the distances between the locations from which goods need to be moved to and from (including warehouses and similar logistics facilities). Table 3.2 reflects these possible differences in freight journey types and lengths between varying settlement sizes.

Table 3.2: Freight journeys and urban settlement size

<table>
<thead>
<tr>
<th>Settlement Size</th>
<th>Relative importance of freight journeys to/from settlement, and journeys wholly within settlement</th>
<th>Freight journey length for journeys within settlements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small settlements</td>
<td>Likely to have relatively small proportion of journeys that take place wholly within settlement</td>
<td>Likely to be very short</td>
</tr>
<tr>
<td>Medium settlements</td>
<td>Likely to have greater proportion of journeys wholly within settlement</td>
<td>Likely to be greater than in small settlements</td>
</tr>
<tr>
<td>Large settlements</td>
<td>Likely to have greatest proportion of journeys wholly within settlement</td>
<td>Likely to be greater than in medium settlements</td>
</tr>
</tbody>
</table>

3.4 Framework for analysing freight transport

McKinnon (2007) has constructed an analytical framework incorporating all the factors which influence freight traffic volumes. This framework illustrates the links between freight transport and the economic activities that it serves. The framework links the raw materials used in the production of goods with the road freight transport activity used to transport goods to their destinations.

This relationship can be decomposed into a series of key variables each of which converts one output value into another. These variables are explained below.
• Handling factor – each tonne of product is typically handled more than once as it makes it way through the supply chain from point of production to point of sale/consumption. The handling factor determines how the goods produced and imported into the economy are translated into the total tonnes of lifted that require to be lifted by all transport modes.

• Modal split – determines the quantity of goods produced and imported into the economy that are handled by road freight (as opposed to other freight transport modes)

• Length of haul – the average length of links in the supply chain over which goods lifted are transported on road freight journeys. The average length of haul and the handling factor together determine the ‘transport intensity’ of an economy. The tonne-kilometres of road freight activity are a product of the total tonnes lifted by road and average length of haul.

• Load on laden journeys – the quantity of goods carried on a road freight vehicle is one of the two determinants of the vehicle traffic (i.e. vehicle kilometres travelled) required to move these tonne-kilometres (the other being empty running). The average load on laden journeys is in turn determined by the carrying capacity of the vehicle (i.e. how much it is capable of carrying) and the lading factor (i.e. the extent to which the carrying capacity of the vehicle is utilised on laden journeys).

• Empty running – the other determinant of vehicle kilometres travelled (together with the average load on laden journeys) is empty running. This refers to the distance that the vehicle travels empty (i.e. without a load).

Figure 3.4 shows the relationships between these determinants, key variables and outputs.
Measures of the intensity, utilisation and efficiency of road freight transport in relation to the analytical framework are shown in Figure 3.5.

The modal split reflects the proportion of freight lifted carried by the various transport modes.

The ratio of tonne-kilometres to vehicle kilometres reflects the efficiency of road freight transport in relation to the average vehicle carrying capacity, the lading factor on laden journeys and the extent of empty running.

The vehicle kilometres per tonne lifted are dependent on the average length of haul, the average vehicle carrying capacity, the lading factor of goods vehicles on laden journeys, and the extent of empty running. Therefore, vehicle kilometres are the ultimate outcome of the degree of efficiency of goods vehicle operations as well as reflecting the distance over which goods are transported. In addition, vehicle kilometres determine, or are most strongly related to, many of the negative impacts of HGV activity (such as fuel consumption, pollutant emissions, contribution to congestion, number of casualties, noise, vibrations and visual intrusion). The intensity (and the sustainability) of goods vehicle operations can therefore be reflected in the relationship between total goods lifted by goods vehicles and the total vehicle kilometres performed by goods vehicles.
Figure 3.5: Measures of road freight transport intensity, utilisation and efficiency in relation to the framework

3.5 Speculating about the framework in relation to urban freight transport

It is possible to consider the determinants and key variables in the framework in relation to urban freight operations and to speculate on possible differences in these determinants and variables for urban and non-urban journeys. Each is discussed in turn below.

Handling factor – if the number of urban distribution facilities is reduced over time (as has tended to happen in recent decades to avoid the use of expensive land in urban areas) this will reduce the number of times that goods are handled within the urban area. However, if the facility is relocated from the urban area to somewhere outside the urban area this will not change the overall handling factor of the product in its journey along its supply chain, only where these facilities are positioned. Most goods do not typically get moved between many different types of manufacturing, storage and retailing facilities within a single urban area. Instead such movements tend to take place between an urban area and a facility that is located outside the urban area. Examples of transport stages that do occur wholly within urban areas are food retailing and parcel / home delivery services in which goods are often moved from a storage facility on the edge of an urban area to a shop or home. However, even in these cases, only one transport stage in the entire supply chain takes place wholly within the urban area. Therefore handling factors for urban freight journeys tend to be very low and can also be ignored when analysing urban road freight transport.
Modal split – for urban freight the overwhelming majority of goods are moved by road. And unlike passenger transport there are fewer forms of road transport (e.g. bus, walk, bicycle, car, train etc.). For freight transport the vast majority of activity takes place in HGVs, with a far smaller amount (in terms of tonnes lifted) carried out by light goods vehicles (LGVs). There is a small use of cars (mostly for deliveries to homes by home shopping agents and by independent shop keepers), motorcycles (for courier work), on-foot (mainly postmen), and bicycles (by a very small number of cycle delivery companies working in central urban areas). Therefore, unlike passenger transport, in most instances there is little decision to be made about the mode of road freight transport to be used. Modal split can therefore be ignored when considering urban freight transport as the overwhelming majority of freight is transported by road and this is unlikely to change substantially (due to the current modal split and the lack of non-road freight infrastructure - as well as the unavailability of this non-road infrastructure for freight even when it does exist – as it is so heavily used for passenger transport).

Length of haul – given that many freight journeys that start or end in an urban area do not take place wholly within the urban area, the length of the link in the supply chain over which goods are transported into and out of the urban area on these journeys will depend on the location of the point from which the goods are despatched/received outside the urban area. For goods transported to, from and within the urban area the length of haul will be affected by a range of factors such as where the origin and destination are located, the location of intermediate stopping points in the case of multi-drop journeys, the population density, the road infrastructure and its layout, the route choice, and the settlement size. In addition to these urban form factors, the length of haul will also be influenced by organisational and customer service issues decided on by the companies involved such as whether or not the delivery involves a narrow time-window (which will affect the number of deliveries that can be made on a journey and hence reduce the average length of a journey leg), and the frequency of deliveries.

The average load on laden journeys depends on: i) the carrying capacity of the vehicle, and ii) the lading factor. The vehicle carrying capacity is likely to be smaller for journeys wholly within urban areas than journeys that take place entirely outside urban areas (as well as journeys to and from urban areas) as urban areas are typically busy, congested environments and also subject to weight and size restrictions in some locations. In addition journey lengths within urban areas are far shorter than other journey types. These factors tend to result in greater use of smaller, lighter vehicles than for other journeys. Lading factors may also be lower for urban than non-urban journeys as there is greater incentive for operators to ensure high lading factors as journey distance, and hence costs, increases. Multi-leg journeys can also result in lower lading factors than in single drop operations as the load gradually diminishes at each stop rather than being unloaded in its entirety. Many freight journeys in an urban area are multi-leg journeys (multi-leg journeys may well represent a greater proportion of journeys within an urban area than in the case for journeys to and from urban areas or wholly outside urban areas) and this can also contribute to lower lading factors on operations wholly within urban areas.

Empty running - as with, lading factors, there is greater incentive for operators to reduce empty running, and hence non-revenue earning activity, as distance increases. Therefore empty running may be expected to be higher on single drop work wholly within an urban area than for longer distance single drop journeys to and from the urban area. However, many freight journeys in an urban area are multi-leg operations (as discussed above). By definition, multi-leg operations are likely to have lower rates of empty running than single drop operations as at each stop only part of the total load is delivered with the vehicle only becoming empty when all deliveries have been completed. By comparison, on single drop operations the vehicle becomes empty after its one and only delivery.
As discussed in section 3.2 there are different types of urban freight journey based on the geography of the journey. These include:

- Journeys to an urban area from elsewhere
- Journeys from an urban area to elsewhere
- Journeys wholly within an urban area

Table 3.3 reflects possible differences in the key variables for road freight journeys within urban areas compared to all other freight journeys (including those that either start or end in an urban area)

**Table 3.3: Possible differences in key road freight transport variables by journey type**

<table>
<thead>
<tr>
<th></th>
<th>Freight transport journeys within urban areas</th>
<th>National freight transport journeys (including journeys to and from urban areas)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Handling factor</strong></td>
<td>Relatively small proportion of transport stages located wholly within an urban area; and few product supply chains have more than one production/storage point in a single urban area.</td>
<td>Several transport stages likely to be located within the country for most product supply chains</td>
</tr>
<tr>
<td><strong>Modal split</strong></td>
<td>Almost wholly road-based</td>
<td>Road dominant but not to same extent as in urban area</td>
</tr>
<tr>
<td><strong>Average length of haul</strong></td>
<td>Likely to be relatively constant over time as length of haul for journeys within the urban area are constrained by the geographical boundaries of the urban area.</td>
<td>Major changes in length of haul over recent decades as distance between the points in many product supply chains increased.</td>
</tr>
<tr>
<td><strong>Carrying capacity of vehicle</strong></td>
<td>Much use made of smaller, lighter HGVs</td>
<td>Greater use of larger, heavier HGVs</td>
</tr>
<tr>
<td><strong>Lading factor</strong></td>
<td>May be worse in urban areas as shorter distance journeys lead to less concern about lading factor.</td>
<td>Lading factor likely to be greater for longer distance journeys due to greater economic costs.</td>
</tr>
<tr>
<td><strong>Empty running</strong></td>
<td>May be high on journeys within urban areas as shorter distance journeys lead to less concern about empty returns.</td>
<td>Empty running likely to be lower for longer distance journeys due to greater economic costs of long empty return journeys.</td>
</tr>
</tbody>
</table>

### 3.6 Analysis of road freight traffic in urban areas using the framework

Data disaggregated from the Continuing Survey of Road Goods Transport was obtained for urban areas of varying sizes and population densities from the Department for Transport (DfT). The Continuing Survey of Road Goods Transport is a statutory survey of British-registered goods vehicles over 3.5 tonne gross weight (i.e. heavy goods vehicles – HGVs) carrying out domestic operations which is conducted by the DfT. Data was provided by the Road Freight Statistics Team in the DfT for 16 urban areas in Britain (of varying areas, population sizes and population densities) and was disaggregated into three types of
journeys: i) journeys to the urban area from elsewhere, ii) journeys from the urban area to elsewhere, and iii) journeys wholly within the urban area. The following data items were provided:

- loaded vehicle kilometres
- empty vehicle kilometres
- tonnes lifted
- tonne-kilometres
- lading factors

The data provided was for the period 2005-2007. The 16 urban areas for which data was obtained are shown in Table 3.5 together with details of the area and population size of each.

Table 3.5: Profile of the urban areas for which CSRGT freight transport data was obtained

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>Population</th>
<th>Area (sq km)</th>
<th>Population density (pop. / sq km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater London</td>
<td>7,512,000</td>
<td>1,572</td>
<td>4,779</td>
</tr>
<tr>
<td>West Midlands</td>
<td>2,600,000</td>
<td>902</td>
<td>2,884</td>
</tr>
<tr>
<td>Greater Manchester</td>
<td>2,554,000</td>
<td>1,276</td>
<td>2,001</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>2,161,000</td>
<td>2,029</td>
<td>1,065</td>
</tr>
<tr>
<td>Merseyside</td>
<td>1,354,000</td>
<td>645</td>
<td>2,099</td>
</tr>
<tr>
<td>South Yorkshire</td>
<td>1,293,000</td>
<td>1,552</td>
<td>833</td>
</tr>
<tr>
<td>Tyne and Wear</td>
<td>1,088,000</td>
<td>540</td>
<td>2,014</td>
</tr>
<tr>
<td>Glasgow</td>
<td>581,000</td>
<td>175</td>
<td>3,309</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>464,000</td>
<td>264</td>
<td>1,758</td>
</tr>
<tr>
<td>Bristol</td>
<td>411,000</td>
<td>110</td>
<td>3,745</td>
</tr>
<tr>
<td>Cardiff</td>
<td>318,000</td>
<td>140</td>
<td>2,268</td>
</tr>
<tr>
<td>Leicester</td>
<td>290,000</td>
<td>73</td>
<td>3,951</td>
</tr>
<tr>
<td>Brighton &amp; Hove</td>
<td>251,000</td>
<td>83</td>
<td>3,041</td>
</tr>
<tr>
<td>Southampton</td>
<td>229,000</td>
<td>50</td>
<td>4,587</td>
</tr>
<tr>
<td>Milton Keynes</td>
<td>225,000</td>
<td>309</td>
<td>728</td>
</tr>
<tr>
<td>York</td>
<td>192,000</td>
<td>272</td>
<td>705</td>
</tr>
</tbody>
</table>

The urban areas included range in population size from Greater London to York and in geographical area from West Yorkshire to Southampton. Population densities range from 705 people per km² in York to 4,779 people per km² in Greater London. Some metropolitan counties comprising several contiguous urban areas were included in the analysis (such as West Yorkshire, the West Midlands and Merseyside). Cities with historic centres (such as York) and new towns (Milton Keynes) were included due to their varying urban forms and road layouts. Details of the towns and cities included in Greater London and the metropolitan counties included in the analysis are provided in Appendix 1.

Using this data it was possible to analyse and compare the key variables and determinants of road freight transport activity between the 16 urban areas using a spreadsheet model that was developed based on the framework described in section 3.2 and depicted in Figure 3.1.
It is important to make three points about this CSRGT data. First, the data in CSRGT is based on the weight of goods carried by HGVs rather than the volume of goods. Second, only goods vehicles with a gross weight of over 3.5 tonnes (i.e. HGVs) are included in CSRGT. A similar survey of light goods vehicles (LGVs - i.e. goods vehicles up to and including 3.5 tonnes gross) was carried out by the DfT between 2003 and 2005, but not since, so comparable analysis of LGVs has not been possible. DfT data suggests that LGVs were responsible for approximately 7% of tonnes lifted and tonnes-kilometres by all goods vehicles in 2007 (i.e. HGVs and LGVs). LGVs travelled a total of almost 2.5 times more kilometres than HGVs in 2007 (DfT, 2008a). However, only approximately 20-30% of these LGV kilometres are estimated to be associated with goods transport (DfT, 2004; DfT, 2007; DfT, 2010). Third, for journeys to and from the selected urban areas some, and in many cases the majority, of the freight vehicle activity takes place outside the urban area. However for journeys within the urban area, the freight activity takes place within the geographical limits of the urban area (however although these journeys start and end in the urban area in the case of multi-leg journeys with five or more stops the vehicle may travel outside the urban area during the journey in some cases).

It is useful to provide some insight into the quantity of national road freight activity accounted for by journeys to, from and within the 16 urban areas studied. Table 3.6 shows that the journeys studied for the 16 selected urban areas account for just under a half of all goods lifted, tonne-kilometres and vehicle kilometres performed in Britain in the period 2005-7.

Table 3.6: Road freight activity accounted for by journeys to, from and within the 16 selected urban areas (2005-7 annual averages)

<table>
<thead>
<tr>
<th></th>
<th>Freight lifted (million)</th>
<th>Tonne-kms (billion)</th>
<th>Vehicle km (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>1,809</td>
<td>157</td>
<td>22,300</td>
</tr>
<tr>
<td>Selected urban areas</td>
<td>768</td>
<td>74</td>
<td>10,290</td>
</tr>
<tr>
<td>Selected urban areas as % of national activity</td>
<td>42%</td>
<td>47%</td>
<td>46%</td>
</tr>
</tbody>
</table>


It is also possible to reflect the relative importance of journeys within, to and from the 16 urban areas studied with respect to freight lifted, tonne-kilometres and vehicle kilometres (see Table 3.7). This shows that journeys within urban areas account for approximately one third of freight lifted on all the urban journeys, but only 12% of tonne-kilometres and a quarter of vehicle kilometres. This reflects the shorter distances associated with these journeys compared with journeys to and from urban areas.

Table 3.7: Relative importance of each journey type on freight activity in the selected urban areas (2005-7 average)

<table>
<thead>
<tr>
<th>Journey type</th>
<th>Freight lifted (million)</th>
<th>Tonne-kms (billion)</th>
<th>Vehicle km (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within urban area</td>
<td>32%</td>
<td>12%</td>
<td>25%</td>
</tr>
<tr>
<td>To urban area</td>
<td>38%</td>
<td>49%</td>
<td>38%</td>
</tr>
<tr>
<td>From urban area</td>
<td>30%</td>
<td>40%</td>
<td>37%</td>
</tr>
<tr>
<td>All urban journeys</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
4. Results of urban road freight transport analysis

The analysis presented in this section is based on the data obtained from CSRGT (see section 3.4) and is for HGV activity only (i.e. goods vehicles over 3.5 tonnes gross weight) – light goods vehicle activity is not included.

In this section frequent references is made to three types of urban freight journeys: within urban areas, to urban areas and from urban areas. It is important to note that journeys within urban areas are those that take place wholly within the urban area (i.e. both the origin and destination are in the urban area). Journeys to and from the urban area do contain vehicle activity within the urban area (as the collection or delivery point lies within the urban area) but also contain activity outside the urban area.

It should also be noted that it is possible that in the CSRGT data a small number of journeys that are described as within the urban area could actually also involve some travel outside the urban area. This could occur if the origin and destination of the journey are both recorded as being in the same urban area but the vehicle leaves the urban area during part of the journey.

4.1 Goods lifted

Figure 4.1 shows the annual average quantities of good lifted on road freight journeys to, from and within the selected urban areas over the period 2005-2007. As would be expected the largest urban areas generate far higher quantities of tonne lifted by road freight transport than the smaller ones.

Figure 4.1: Road freight lifted on all journeys to, from and within each urban area (2005-2007 annual average)

Table 4.1 shows the total weight of goods lifted on journeys to, from and within each of the urban areas, together with the tonne lifted per capita and per square kilometre. This shows that while more goods (by weight) were lifted in London than in any of the other urban areas,
London was the second lowest on a per capita basis. Bristol and Southampton were the highest in terms of tonnes lifted per capita, which reflects the port traffic that is moved by road in both these locations. In terms of tonnes lifted per square km of urban area, Bristol and Southampton were again the highest, with York and Brighton and Hove the lowest.

**Table 4.1: Road freight lifted on all journeys to, from and within each of the urban areas (2005-2007 annual average)**

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>Tonnes lifted (million)</th>
<th>Tonnes lifted per capita</th>
<th>Tonnes lifted per sq km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater London</td>
<td>144</td>
<td>19</td>
<td>92</td>
</tr>
<tr>
<td>Greater Manchester</td>
<td>106</td>
<td>42</td>
<td>83</td>
</tr>
<tr>
<td>West Midlands</td>
<td>104</td>
<td>40</td>
<td>115</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>99</td>
<td>46</td>
<td>49</td>
</tr>
<tr>
<td>South Yorkshire</td>
<td>66</td>
<td>51</td>
<td>42</td>
</tr>
<tr>
<td>Merseyside</td>
<td>61</td>
<td>45</td>
<td>95</td>
</tr>
<tr>
<td>Tyne and Wear</td>
<td>39</td>
<td>36</td>
<td>72</td>
</tr>
<tr>
<td>Bristol</td>
<td>37</td>
<td>89</td>
<td>333</td>
</tr>
<tr>
<td>Glasgow</td>
<td>23</td>
<td>40</td>
<td>131</td>
</tr>
<tr>
<td>Southampton</td>
<td>20</td>
<td>88</td>
<td>403</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>15</td>
<td>33</td>
<td>58</td>
</tr>
<tr>
<td>Milton Keynes</td>
<td>15</td>
<td>66</td>
<td>48</td>
</tr>
<tr>
<td>Leicester</td>
<td>15</td>
<td>51</td>
<td>201</td>
</tr>
<tr>
<td>Cardiff</td>
<td>13</td>
<td>42</td>
<td>96</td>
</tr>
<tr>
<td>York</td>
<td>7</td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>Brighton &amp; Hove</td>
<td>3</td>
<td>13</td>
<td>40</td>
</tr>
</tbody>
</table>

Figures 4.2 and 4.3 show that, in most cases, the proportion of all road freight lifted on journeys that take place within the urban area is greater in the larger urban areas than the smaller ones. This is likely to be due to two factors: i) larger urban areas typically contain more production and logistics facilities and hence generate more internal journeys than smaller ones, and ii) larger urban areas are likely to have several urban centres between which goods are moved (i.e. they are usually polycentric).
Figure 4.2: Proportion of freight lifted on all journeys to, from and within each urban area (2005-7 average)

Figure 4.3 reflects the importance of journeys within the urban area in relation to total freight lifted on all journeys, with the urban areas ranked in order of importance. This reflects that journeys within the urban area appear to account for a greater proportion of freight lifted on all journeys in larger urban areas than in smaller ones.
Figure 4.3: Proportion of all road freight lifted on journeys within each urban area (2005-2007 average)

Figure 4.2 indicates that many of the urban areas studied are net importers of goods by road with more tonnes flowing in than out. This is especially marked in the case of Edinburgh, Glasgow, Brighton and Hove, York, Milton Keynes and London.

This is highlighted in Figure 4.4 which shows that of all the urban areas only Bristol is a net exporter of goods lifted by road. In Southampton the same quantity of road freight flows in and out by road, while in South Yorkshire, Leicester, and Merseyside the net imbalance is less than 10%. Some of these urban areas generate a net inflow of goods by sea via their ports while others have industries that generate goods flows out of the urban area.
Figure 4.4: Difference in the quantity of freight lifted on journeys to and from urban areas (2005-7 average)

4.2 Average length of haul

Figure 4.5 shows the average length of haul for journeys that take place within the urban area, while Figure 4.6 shows average length of haul for journeys to and from these urban areas.

Figure 4.5: Average length of haul on journeys within each urban area (2005-2007 average)
As expected the length of haul is far greater on journeys to and from the urban areas than on journeys within the urban areas. For journeys within the urban areas, the average length of haul varies from 25 km in Edinburgh to 53 km in Bristol. In the case of Milton Keynes and Bristol (both of which have average lengths of haul that are more than 10 km greater than any of the other urban areas) it is likely that some journeys within the urban area that comprise more than five collections and/or deliveries travel outside the urban area during the journey despite starting and ending inside. This operating pattern of including stops within and outside the urban area on multi-leg journeys that start and end in the urban area is most likely to occur in urban areas with smaller populations such as Milton Keynes and Bristol in which it may prove more difficult for operators to assemble multi-drop journeys wholly within the urban area. In addition Milton Keynes has the lowest population density of all the urban areas studied which potentially results in longer distances between origin and destinations than in urban areas with higher population densities.

The length of haul for journeys to and from the urban areas ranges from 77 km in Edinburgh to 157 km in Southampton. This indicates that there are major differences in the hinterland areas for some of the urban areas. The average length of haul on journeys to and from an urban area are dependent on: i) the location of urban area in relation to other centres, ii) trading links that exist between the urban area and other centres of supply and demand, and iii) the type of economic activity that takes place in the urban area (for instance a port city may have a larger hinterland than other urban areas). Both Bristol and Southampton generate sizeable road freight flows to and from their sea ports which are likely in many cases to have lengthy origins and destinations within the country – this may account for the relatively high average length of haul on journeys to and from the urban area in these two cases. Tyne and Wear is relatively remote from other settlements in the country, which may explain the high average length of haul for journeys to and from it.
4.3 Goods moved

Figure 4.7 shows the average annual quantity of goods moved (i.e. tonne-kilometres performed) on all journeys to, from and within each urban area. The quantity of tonne-kilometres performed is a reflection of the effects of distance over which the goods are moved (i.e. the combination of goods lifted and average length of haul). As would be expected, the largest urban areas (which account for the greatest quantities of tonnes lifted on journeys to, from and within them – see Figure 4.1 and Table 4.1) are associated with the greatest number of tonne-kilometres.

Figure 4.7: Road freight moved on all journeys to, from and within each urban area (2005-2007 annual average)

Figure 4.8 shows the relative importance of tonne-kilometres performed on journeys to, from and within each urban area. As with goods lifted, it indicates that, in most cases, the proportion of tonne-kilometres performed on journeys that take place within the urban area is greater in the larger urban areas than the smaller ones. However, tonne-kilometres on journeys within the urban area account for no more than 14% of total tonne-kilometres on all journeys in any of the urban areas (ranging from 3% in Southampton to 14% in the case of Greater London, Greater Manchester and West Yorkshire). This is due to the influence of journey distance on tonne-kilometres and journeys within the urban area have far shorter distances than those to and from the urban area.

Figure 4.8 reflects that journeys to the urban areas are the most important in terms of tonne-kilometres in all cases. This ranges from 44% of total tonne-kilometres in South Yorkshire to 63% in the case of Edinburgh.
4.4 Average load on laden journeys

Figure 4.9 shows the average vehicle carrying capacity for journeys: i) within, and ii) to and from the 16 urban areas. With the exception of London it can be seen that, in general, lighter vehicles (in terms of their payload weight) are used to transport goods within and to/from smaller urban areas than larger ones. The average vehicle carrying capacity of vehicles used is likely to be related to the type of goods transported and the frequency of transportation. It is possible that vehicles used for journeys to and from London are lighter than for other large urban areas due to London receiving fewer flows of heavy products. This may be related to the economic composition of London compared with other large cities (with the service sector have a relatively more important role compared to heavy industry in London than elsewhere – see section 5.2).

Vehicle carrying capacities can be seen to be far higher in each of the 16 urban areas for journeys to and from the urban area compared with journeys within the urban area. This is likely to be due to several factors including: i) urban areas are typically busy, congested environments in which vehicle manoeuvrability is relatively difficult and in which low average speeds mean that the amount of work a vehicle can do in a given time period is far less than in a non-urban location – this results in a relatively low optimum size of vehicle for many types of operation in urban areas, ii) urban areas can be subject to weight and size restrictions in some locations, iii) the importance of lighter goods and smaller loads within the urban area may be greater than in operations in and out of the urban area (reducing the vehicle size and weight requirements, and iv) the higher costs of journeys to/from urban
areas (given their relative length and hence journey time) resulting in the decision to move larger quantities per journey.

Carrying capacities on journeys within urban areas range from 7.0 tonnes on journeys in York to 12.6 tonnes in Merseyside. For journeys to and from urban areas, carrying capacities range from 17.4 tonnes in Brighton and Hove, and Edinburgh to 22.6 tonnes in Merseyside.

**Figure 4.9: Vehicle carrying capacities on journeys to, from and within each urban area (2005-2007 average)**

![Vehicle carrying capacities graph]

Figure 4.10 shows the vehicle carrying capacity for all journeys to, from and within the urban areas for each of the 16 urban areas together with the national average for all journeys.
Lading factors for journeys within and to/from each of the 16 urban areas are shown in Figures 4.11 and 4.12. Lading factors can be seen to be far higher for journeys to and from urban areas compared to journeys within urban areas. The lading factors on journeys within urban areas vary from 0.27 in Brighton and Hove to 0.46 in Merseyside. Meanwhile, lading factors on journeys to/from urban areas range from 0.51 in Milton Keynes to 0.67 in Edinburgh.

This could be due to several factors including: i) vehicle being more efficiently loaded on journeys to and from urban areas compared to journeys within (as a result of these longer journeys having greater cost penalties for inefficiency than shorter ones), ii) journeys within urban areas may involve goods with lower bulk densities than on journeys to and from the urban area (such as parcels and courier flows) and this is not reflected in the data which is all weight based, and iii) flows within urban areas may be more urgent than those to and from urban areas and therefore provide fewer opportunities for consolidation.
Lading factors also vary considerably between journeys to and from many of the 16 urban areas, with journeys to urban areas typically having a higher average lading factor than journeys from these urban areas (see Table 4.2). In the case of 7 of the 16 urban areas the lading factor on journeys to urban areas was more than 10% higher than on journeys from urban areas (London, Tyne and Wear, Edinburgh, Glasgow, Leicester, Brighton and Hove, and York). In the case of a further 5 urban areas the lading factor on journeys to urban areas
was between 5% and 10% higher than on journeys from urban areas (Greater Manchester, West Yorkshire, West Midlands, Cardiff and Milton Keynes). The reason for lading factors being higher on journeys to urban areas than journeys from urban areas is, in many cases, likely to be due to vehicles being unable to obtain return loads from urban areas that are as heavy as those they delivered and this is likely to be related to many urban areas importing more goods than they export (see section 4.1 and Figure 4.4). The 9 of the 10 urban areas with the greatest differences between lading factors on journeys to urban areas than journeys from urban areas were among the 10 urban areas with the greatest imbalances between goods lifted on journeys to and from the urban areas.

Table 4.2: Lading factors by urban area (2005-7 average)

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>Journeys within</th>
<th>Journeys to</th>
<th>Journeys from</th>
<th>All journeys to, from and within</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater London</td>
<td>0.44</td>
<td>0.62</td>
<td>0.54</td>
<td>0.56</td>
</tr>
<tr>
<td>Greater Manchester</td>
<td>0.40</td>
<td>0.57</td>
<td>0.54</td>
<td>0.53</td>
</tr>
<tr>
<td>Merseyside</td>
<td>0.46</td>
<td>0.64</td>
<td>0.64</td>
<td>0.62</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>0.41</td>
<td>0.61</td>
<td>0.58</td>
<td>0.56</td>
</tr>
<tr>
<td>West Midlands</td>
<td>0.40</td>
<td>0.58</td>
<td>0.53</td>
<td>0.53</td>
</tr>
<tr>
<td>Tyne and Wear</td>
<td>0.43</td>
<td>0.63</td>
<td>0.55</td>
<td>0.56</td>
</tr>
<tr>
<td>South Yorkshire</td>
<td>0.44</td>
<td>0.60</td>
<td>0.62</td>
<td>0.59</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>0.44</td>
<td>0.70</td>
<td>0.54</td>
<td>0.61</td>
</tr>
<tr>
<td>Glasgow</td>
<td>0.37</td>
<td>0.63</td>
<td>0.54</td>
<td>0.57</td>
</tr>
<tr>
<td>Cardiff</td>
<td>0.37</td>
<td>0.65</td>
<td>0.61</td>
<td>0.60</td>
</tr>
<tr>
<td>Bristol</td>
<td>0.39</td>
<td>0.60</td>
<td>0.59</td>
<td>0.56</td>
</tr>
<tr>
<td>Leicester</td>
<td>0.38</td>
<td>0.57</td>
<td>0.49</td>
<td>0.52</td>
</tr>
<tr>
<td>Brighton &amp; Hove</td>
<td>0.27</td>
<td>0.67</td>
<td>0.54</td>
<td>0.59</td>
</tr>
<tr>
<td>Southampton</td>
<td>0.32</td>
<td>0.54</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>Milton Keynes</td>
<td>0.34</td>
<td>0.53</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td>York</td>
<td>0.43</td>
<td>0.66</td>
<td>0.56</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Figure 4.13 shows the combined lading factors for all journeys to, from and within the urban areas for each of the 16 urban areas together with the national average for all journeys.
Figure 4.13: Lading factors on all journeys to, from and within each urban area and nationally (2005-2007 average)

The vehicle carrying capacity and the lading factor determine the average load carried. Figure 4.14 shows the average load (in tonnes) on laden journeys within and to/from the 16 urban areas.

As with vehicle carrying capacities and lading factors, average vehicle loads can be seen to be far higher in each of the 16 urban areas for journeys to/from the urban area compared with journeys within the urban area. As previously explained, this is likely to be due to the types of goods and size of loads involved in these two types of journey, as well as the higher cost penalties involved in low operating efficiencies on longer journeys.

Average vehicle loads on journeys within the urban area range from 2.6 tonnes in Brighton and Hove to 5.8 tonnes in Merseyside. Average loads on journeys to and from the urban areas range from 10.2 tonnes in Milton Keynes to 14.4 tonnes in Merseyside.
Figure 4.14: Average load on laden journeys to, from and within each urban area (2005-2007 average)

Figure 4.15 shows the average load on laden journeys for all journeys to, from and within the urban areas for each of the 16 urban areas together with the national average for all journeys. This shows that across all journey types London has the lowest average load on laden journeys (8.8 tonnes) while Merseyside has the highest (12.7 tonnes).

Figure 4.15: Average load on all laden journeys to, from and within each urban area and nationally (2005-2007 average)
4.5 Empty running

Empty running (i.e. the percentage of total vehicle kilometres travelled during which the vehicle was empty) on journeys within, to and from each of the 16 urban areas are shown in Figures 4.16 and 4.17 respectively. This shows that in most cases empty running on journeys within urban areas is lower than on journeys to and from urban areas. This may be due to the greater importance of multi-leg operations on journeys wholly within the urban area compared with journeys to and from the urban area. By definition, multi-drop operations are likely to have lower rates of empty running than single drop operations as at each stop only part of the total load is delivered with the vehicle only becoming empty when all deliveries have been completed. By comparison, on single drop operations the vehicle becomes empty after its one and only delivery.

However, Table 4.2 shows that in 3 of the 16 urban areas (Greater London, Edinburgh and Glasgow) empty running on journeys to the urban area is lower than for journeys within the urban area.

Figure 4.17 disguises the fact that there are major differences in the proportion of empty running on journeys to urban areas and those from urban areas. The breakdown between empty running on all journey types is provided in Table 4.3 – this shows that in 10 of the 16 urban areas empty running on journeys from the urban area is greater than on journeys to the urban area (and in some cases the difference is substantial (for example London, Edinburgh, Tyne and Wear, Glasgow, Cardiff, and Brighton and Hove). This indicates an imbalance in goods flows in these locations, with operators struggling to identify return loads (see section 4.1 for further discussion of this).

Meanwhile in the case of West Yorkshire, Merseyside, South Yorkshire, Leicester, Greater Manchester, West Midlands and Milton Keynes the rate of empty running is virtually the same on journeys to and from the urban area. As discussed in section 4.1 more than half of these urban areas had only relative small imbalances in the quantity of goods flowing in and out (by weight) which is probably an important factor in the rate of empty running.

**Figure 4.16: Empty running on journeys within the urban areas (2005-7 average)**
Table 4.3: Rates of empty running by urban area (percentages) (2005-7 average)

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>Journeys within</th>
<th>Journeys to</th>
<th>Journeys from</th>
<th>All journeys to, from and within</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater London</td>
<td>22</td>
<td>21</td>
<td>40</td>
<td>28</td>
</tr>
<tr>
<td>Greater Manchester</td>
<td>22</td>
<td>29</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>Merseyside</td>
<td>22</td>
<td>29</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>23</td>
<td>30</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>West Midlands</td>
<td>20</td>
<td>26</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>Tyne and Wear</td>
<td>18</td>
<td>21</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>South Yorkshire</td>
<td>23</td>
<td>32</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>21</td>
<td>20</td>
<td>46</td>
<td>30</td>
</tr>
<tr>
<td>Glasgow</td>
<td>19</td>
<td>15</td>
<td>41</td>
<td>26</td>
</tr>
<tr>
<td>Cardiff</td>
<td>16</td>
<td>25</td>
<td>36</td>
<td>28</td>
</tr>
<tr>
<td>Bristol</td>
<td>20</td>
<td>24</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td>Leicester</td>
<td>16</td>
<td>31</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Brighton &amp; Hove</td>
<td>12</td>
<td>14</td>
<td>52</td>
<td>30</td>
</tr>
<tr>
<td>Southampton</td>
<td>15</td>
<td>19</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td>Milton Keynes</td>
<td>21</td>
<td>28</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>York</td>
<td>18</td>
<td>29</td>
<td>37</td>
<td>30</td>
</tr>
</tbody>
</table>

Figure 4.18 shows the proportion of empty running for all journeys to, from and within each urban area together with the national average rate. This indicates that empty running in most urban areas is not dissimilar to the rate for all journeys nationwide.
Figure 4.18: Empty running on all journeys to, from and within the urban areas (2005-7 average)

Figure 4.19 shows the average load carried on all journeys for each urban area as a proportion of the maximum possible load taking into account both laden and empty journeys. The higher the percentage, the greater the proportion of maximum load weight used on all journeys to, from and within the urban area – indicating a more efficient operation. The range in Figure 4.19 varies from 49% of vehicle carrying capacity (by weight) utilised on journeys to, from and within Milton Keynes to 62% in Merseyside.

Figure 4.19: Average weight of load carried as a proportion of maximum possible load on all journeys (empty and laden) by urban area (2005-7 average)
4.6 Vehicle kilometres

The vehicle carrying capacity, the lading factor and empty running (discussed in sections 4.4 and 4.5) determine how the tonne-kilometres (section 4.3) are transformed into total vehicle kilometres performed on journeys to, from and within each urban area. Figure 4.20 shows the total vehicle kilometre performed on all journeys to, from and within each urban area. As would be expected, those urban areas with the greatest quantity of freight lifted on journeys to, from and within them also generate the greatest vehicle kilometres on journeys transporting these goods (Greater London, West Midlands, Greater Manchester, and West Yorkshire). However the order of importance in terms of vehicle kilometres is not identical to freight lifted for all 16 urban areas, which indicates that the vehicle kilometres generated per tonne lifted is not identical in each (i.e. fewer vehicle kilometres are required per tonne lifted in some urban areas than others – this is addressed in more detail in section 4.7).

Figure 4.20: Vehicle kilometres performed on all journeys to, from and within the urban areas (2005-7 average)

Figure 4.21 shows the relative importance of vehicle kilometres performed on journeys to, from and within each urban area. As with goods lifted and tonne-kilometres, this indicates that, in most cases, the proportion of total vehicle kilometres performed on journeys that take place within the urban area is greater in the larger urban areas than the smaller ones. It also shows that the proportion of total vehicle kilometres performed on journeys within the urban area is far higher than the proportion of tonne-kilometres (see Figure 4.15). This is explained by the fact that the vehicle kilometres reflect the effect of relatively low vehicle carrying capacities and payloads lading factors on the tonne-kilometres shown in Figure 4.7 and 4.8. Therefore differences in these key variables affect the total number of vehicle kilometres performed.
The relative importance of vehicle kilometres within the urban area varies between the urban areas, ranging from 10% in Southampton to 30% in West Yorkshire. Figure 4.21 also reflects that journeys to and from urban areas account for virtually the same proportion of total vehicle kilometres for each urban area, indicating that most goods vehicles return to where they originated from after completing their collection or delivery work.

**Figure 4.21: Proportion of vehicle kilometres on journeys to, from and within each urban area (2005-7 average)**

Table 4.4 shows the absolute vehicle kilometres performed on all journeys to, from and within each urban area as well as the total vehicle kilometres performed per capita and per square kilometre. This indicates that per capita Bristol, Southampton and Milton Keynes produced the greatest number of vehicle kilometres, while Brighton and Hove, London and Edinburgh produced the least. While in terms of geographical area, York, Brighton and Hove and Edinburgh produced the least vehicle kilometres, and Southampton and Bristol produced the most. This is likely to be influenced by the major generators of road freight transport including sea ports and a high density of distribution centres in Southampton, Bristol and Milton Keynes.
Table 4.4: Vehicle km by HGVs on journeys to, from and within each of the urban areas (2005-2007 annual average)

<table>
<thead>
<tr>
<th>Area</th>
<th>Vehicle km (billion)</th>
<th>Vehicle km per capita</th>
<th>Vehicle km per sq km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater London</td>
<td>1.72</td>
<td>63.8</td>
<td>1.1</td>
</tr>
<tr>
<td>West Midlands</td>
<td>1.57</td>
<td>152.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Greater Manchester</td>
<td>1.48</td>
<td>153.0</td>
<td>1.2</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>1.38</td>
<td>176.7</td>
<td>0.7</td>
</tr>
<tr>
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<td>176.6</td>
<td>0.5</td>
</tr>
<tr>
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<td>0.69</td>
<td>141.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Bristol</td>
<td>0.59</td>
<td>370.4</td>
<td>5.3</td>
</tr>
<tr>
<td>Tyne and Wear</td>
<td>0.54</td>
<td>117.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Southampton</td>
<td>0.32</td>
<td>301.6</td>
<td>6.5</td>
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<td>Glasgow</td>
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<td>137.0</td>
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<td>0.8</td>
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<tr>
<td>Edinburgh</td>
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<td>0.5</td>
</tr>
<tr>
<td>York</td>
<td>0.09</td>
<td>136.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Brighton &amp; Hove</td>
<td>0.04</td>
<td>48.3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

4.7 Ratio of tonne-kilometres to vehicle kilometres

As explained in section 3.4, the ratio of tonne-kilometres to vehicle kilometres reflects the efficiency of road freight transport in relation to the average vehicle carrying capacity, the lading factor on laden journeys and the extent of empty running. The higher the number the more efficient the road freight activity.

Figures 4.22 to 4.25 show this calculation (ratio of tonne-kilometres to vehicle kilometres) for journeys within (Figure 4.22), to and from (Figure 4.23), to, from and within separately (Figure 4.24) and all journeys combined (Figure 4.25) for each of the urban areas.

Figures 4.22 and 4.23 indicate that journeys within urban areas are far less efficient in terms of the ratio of tonne-kilometres to vehicle kilometres (ranging from 2.3 in Brighton and Hove to 4.5 in Merseyside) than journeys to and from urban areas (which ranged from 7.2 in the case of Brighton and Hove to 10.2 for Merseyside). Key factors in this difference are the much smaller average vehicle carrying capacities and lower lading factors for journeys within urban areas.
Further analysis has shown that in all but one of the 16 urban areas (South Yorkshire) journeys from urban areas are less efficient than journeys to urban areas in terms of the ratio of tonne-kilometres to vehicle kilometres. This is related to the higher proportion of empty running and lower lading factors on these journeys from urban areas. See Figure 4.24.
Figure 4.24: Ratio of tonne-kilometres : vehicle kilometres on journeys to, from and within each urban area (2005-2007 average)

Figure 4.25 shows that the ratio of tonne-kilometres to vehicle kilometres for all journeys to, from and within the urban area ranged from 6.3 in the case of London to 9.2 in the case of Merseyside. The national average for all journeys (urban and non-urban) was 7.0.

Figure 4.25: Ratio of tonne-kilometres : vehicle kilometres on all journeys to, from and within each urban area (2005-2007 average)
4.8 Average distance travelled per tonne lifted

As explained in section 3.4 the intensity (and sustainability) of goods vehicle operations is reflected in the relationship between total goods lifted by goods vehicles and the total vehicle kilometres performed by these vehicles. The greater the distance travelled per tonne lifted, the greater the intensity of road freight activity. Figures 4.26 to 4.29 show this calculation (the average number of kilometres travelled per tonne lifted) for journeys within (Figure 4.26), to and from combined (Figure 4.27), to, from and within separately (Figure 4.28) and all journeys combined (Figure 4.29) for each of the urban areas.

Figures 4.26 and 4.27 indicate that journeys within urban areas are generally less intensive in terms of vehicle kilometres performed per tonne lifted (ranging from 7.2 vehicle kilometres per tonne lifted in Edinburgh to 17.2 kilometres in Bristol) than journeys to and from urban areas (which ranged from 10.1 kilometres per tonne lifted in the case of Edinburgh to 17.0 kilometres for Southampton). This is due to their far shorter average length of haul, despite the fact that the vehicle operation is far less efficient in terms of average vehicle carrying capacity and lading factors (see section 4.7). Only in 2 of the 16 urban areas (Bristol and Brighton and Hove) were vehicle kilometres per tonne lifted higher on journeys within the urban than on journeys to and from the urban area (compare Figure 4.26 and Figure 4.27).

**Figure 4.26: Average vehicle kilometres travelled per tonne of goods lifted on journeys within each urban area (2005-2007 average)**
Figure 4.27: Average vehicle kilometres travelled per tonne of goods lifted on journeys to and from each urban area (2005-2007 average)

Further analysis has shown that journeys from urban areas are more intensive than journeys to urban areas in terms of the vehicle kilometres performed per tonne lifted (in all 16 urban areas except Bristol). This is related to the higher proportion of empty running and lower lading factors on these journeys (as the average haul of haul and average vehicle carrying capacities are similar for journeys to and from urban areas). This is reflected in Figure 4.28 which shows the results for journeys to, from and within separately for each urban area.

Figure 4.28: Average vehicle kilometres travelled per tonne of goods lifted on journeys to, from and within each urban area (2005-2007 average)
Figure 4.29 shows that the vehicle kilometres per tonne lifted for all journeys to, from and within the urban area ranged from 9.2 in the case of Edinburgh to 16.6 in the case of Milton Keynes. The national average for all journeys (urban and non-urban) was 12.3 vehicle kilometres per tonne lifted.

**Figure 4.29: Average vehicle kilometres travelled per tonne of goods lifted on all journeys to, from and within each urban area (2005-2007 average)**

Figure 4.26 only considers the vehicle kilometres travelled in the urban area by HGVs making journeys that start and end in the urban area. This is obviously not the total HGV traffic in the urban area, which also consists of the distance travelled in the urban area by HGVs on journeys to and from the urban area. However it is not possible to disaggregate the amount of vehicle kilometres travelled in the urban area by HGVs making journeys to and from the urban area in the CSRGT data. Instead the data only provides details of the entire journey distance – it does not divide this into the proportion travelled inside and outside the urban area. Therefore in Figures 4.27 and 4.29 a sizeable proportion of the distance travelled on journeys to and from the urban area will have been performed outside the urban area.

Therefore, if we are interested in the total vehicle kilometres travelled by HGVs inside the urban area per tonne lifted, the CSRGT is unable to provide this data. A method for overcoming this is to use road traffic statistics data, which is collected by manual and automated traffic counts. However before using this data it is necessary to point out that the CSRGT and road traffic counts provide differing estimates of total HGV kilometres. In 2007 road traffic statistics provided an estimate of HGV vehicle kilometres that was 24% higher than that from CSRGT. These differences are due to three factors: i) the road traffic statistics include the distance travelled by foreign-registered HGVs, the road traffic statistics include the distance travelled by all HGVs regardless of tax class, whereas the CSRGT data only includes HGVs with an HGV tax class (approximately 80,000 fewer vehicles), and iii) possible under-reporting of distance travelled by CSRGT respondents (DfT, 2009b).

As part of this research, the Road Traffic Statistics Team in the Department for Transport provided HGV traffic data for all local transport authority areas in 2007 (DfT, 2009c). This comprises town and city authorities, as well as counties – therefore some of the areas are urban while others are mostly rural. From this data it was possible to analyse the 16 urban
areas (including metropolitan counties) that are part of this study. It is important to note that
the Road Traffic Statistics Team was only able to provide estimates of total HGV kilometres
on major roads (i.e. trunk and principal roads) in urban areas. "Trunk" roads consist of most
motorways and many of the long distance “A” roads. This is the national road network and its
management and maintenance lies with the Secretary of State. “Principal” roads comprise all
other major roads which are maintained by local authorities (These are mainly “A” roads).

It was not possible for the DfT to provide estimates of HGV kilometres on minor roads for the
local transport authority areas as count data on minor roads is not sufficiently robust at this
scale. Also, it is important to recognise that some of the distance travelled on trunk roads in
the urban areas studied will reflect through traffic (i.e. HGVs simply passing through an area
on motorways or A roads rather than stopping to collect or deliver goods) and that this
activity is not part of the work done in lifting goods on journeys to, from and within the urban
area. However, it is impossible to isolate this through traffic element of activity on trunk
roads.

Using this road traffic data it is possible to calculate the vehicle kilometres travelled on major
roads within the urban area per tonne of freight lifted (by dividing the HGV traffic data for a
given urban area from the Road Traffic Statistics Team by the CSRGT estimate of tonnes
lifted on journeys to, from and within the urban area). This provides an estimate of the road
freight transport intensity for all freight lifted within the urban area. This is shown in Figure
4.30 – the results range from 0.9 vehicle kilometres on major roads per tonne lifted in
Southampton to 10.1 in South Yorkshire.

**Figure 4.30:** Average vehicle kilometres travelled on major roads in the urban area per
tonne of goods lifted

![Average vehicle kilometres travelled on major roads in the urban area per tonne of goods lifted](image)

**Notes:**
The tonnes lifted data is the 2005-7 annual average from CSRGT, and the vehicle kilometres data on
major roads is from road traffic statistics.
This report has dealt with HGV activity not LGVs. However using the major road traffic data provided by the Road Traffic Statistics Team at the DfT it is possible to reflect the quantity of vehicle kilometres performed by LGVs compared to HGVs in the 16 urban areas. This is shown in Figure 4.31. LGVs account for between 53% and 81% (in Milton Keynes and Brighton and Hove respectively) of total goods vehicle activity on major roads in the urban areas studied 2007. The relative importance of LGVs on minor roads is even greater on but this data is not available by urban area. It is important to bear in mind that not all the work carried out by LGVs is related to goods transport. It has been estimated that goods transport accounts for approximately 20-30% of the total distance travelled by LGVs (DfT, 2004; DfT, 2007, DfT, 2010).

**Figure 4.31: Share of goods vehicle traffic on major roads between HGVs and LGVs by urban area, 2007**

Source: calculated from data in 2009b.
5. Warehousing and other commercial land use patterns

5.1 Trends in warehousing in urban areas

As discussed in section 3.1, three major trends have taken place in recent decades that have fundamentally changed the warehousing land use patterns in urban areas in the UK and other western European countries. These are: i) deindustrialisation, which has been especially marked in urban areas and led to a decline in the demand for industry-related warehousing demand in urban areas, ii) spatial centralisation of stockholding which has increased the use of large, national and regional distribution centres located on the motorway network, and iii) rapidly rising urban land prices which has led to the suburbanisation of warehousing, with urban warehousing being relocated to the edge of the urban area or outside.

Valuation Office Agency data (published by the Department for Communities and Local Government (DCLG) and the Office for National Statistics (ONS) has been analysed for the period from 1998 to 2008 to see whether any of these trends are discernable in the urban areas studied in this report. It is important to note that the data available only provides the warehousing floorspace (i.e. the area) and does not indicate the volume of warehousing (i.e. does not take into account the height of warehouses). There has been a trend towards the construction of higher warehouses to increase the proportion of total warehousing space per unit area but the data is unable to reflect this.

Figure 5.1 shows the change in total warehousing floorspace between 1998 and 2008 for the urban areas and for the whole of England and Wales. Total warehousing floorspace increased over the decade in 12 of the 14 urban areas but at varying rates. Figure 5.1 shows that the growth rate in 8 of the 14 urban areas was lower than the rate in England and Wales as a whole, and that total warehousing actually fell over the decade in Bristol and Southampton. This implies that the majority of growth may have been taking place outside urban areas (such as close to the motorway network). Strong growth in warehousing floorspace was recorded in York, Milton Keynes, South Yorkshire and the West Midlands over the decade. With the exception of York, these urban locations are well situated for motorway access and have been locations of strong growth in national and regional distribution centres.

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1 It has not been possible to analyse warehousing patterns in Edinburgh and Scotland as the Valuation Office Agency data only covers England and Wales.
By analysing changes in warehousing floorspace within the larger urban areas where growth in warehousing floorspace the last decade has been less strong, it is possible to identify some locations within these urban areas that have experienced an increase, while others have seen a decline. Much of the weaker growth and declines in warehousing space have taken place in inner urban and higher density areas while stronger growth has occurred in less central and dense locations. This is likely to reflect relative land values within urban areas.

In Greater Manchester, for example, warehousing floorspace in Manchester fell by 13% between 1998 and 2008, but increased in Wigan by 46%, Thameside by 26% and Trafford by 22% over the period.

In Merseyside, warehousing floorspace in Liverpool fell by 12% between 1998 and 2008, while it rose in Knowsley by 65% and St Helens by 27%.

In West Yorkshire, warehousing floorspace in Leeds rose by only 8% and Bradford fell by 3% between 1998 and 2008, while it rose in Wakefield by 46% and Kirklees by 23%.

In Tyne and Wear, warehousing floorspace in Newcastle fell by 3% over the decade, while it rose in South Tyneside by 23% and in Sunderland by 47%.

By comparison, in the West Midlands, an area that is often considered to be the epicentre of national and regional distribution centres, warehousing floorspace rose strongly over the decade in all the towns and cities that it comprises. It rose by 24% in Birmingham, by 56% in Coventry, by 19% in Solihull, by 14% in Dudley, 27% in Sandwell, 24% in Walsall and 31% in Wolverhampton.
Figure 5.2 shows the change in the total number of warehouses between 1998 and 2008 in the 14 urban areas and in England and Wales as a whole. This shows that the total number of warehouses increased in 7 of the urban areas, and fell in the other 7 urban areas. The increase in the number of warehouses over the decade was greatest in York, Milton Keynes Cardiff and the West Midlands (all increasing by considerably more than England and Wales as a whole), while the reductions were greatest in London, Brighton and Hove, Southampton and Tyne and Wear.

**Figure 5.2: Change in total number of warehouses, 1998-2008 by urban area (percentage)**

Source: Calculated from VOA data in DCLG, 2009 and ONS, 2010.

Figure 5.3 shows the change in the average size of warehouses between 1998 and 2008 in the 14 urban areas and in England and Wales as a whole. This shows that the average size of warehouse has increased in all urban areas over the last decade, but at rates varying from 3% in Southampton to 31% in South Yorkshire. Increasing average warehouse size indicates the logistics trend towards greater centralisation of stockholding in supply chains, with fewer but larger warehouses.

Half of the urban areas have experienced increases in average warehouse size that are greater than the England and Wales average, while the other 7 urban areas have experienced lower growth rates than the national average. These latter urban areas have also all experienced lower growth rates in total warehousing than the national average between 1998 and 2008 (see Figure 5.1).
5.2 Commercial and industrial land use in urban areas

Table 5.1 shows the changes in all commercial and industrial floorspace by land use type in the 14 urban areas between 1998 and 2008. This therefore puts changes in warehousing floorspace in context with changes in floorspace for other commercial and industrial uses.

Table 5.1 reflects the continuation of deindustrialisation in urban areas (and nationally) between 1998 and 2008, with total factory floorspace decreasing in 10 of the 14 urban areas. Industrial production is a major generator of road freight activity and therefore a decline in industrial output in an urban area is likely to lead to a related decline in the extent of road freight transport associated with this activity.

Table 5.1 indicates that retailing floorspace changed at a similar rate to warehousing floorspace in 6 of the 14 urban areas between 1998 and 2008. Meanwhile retailing floorspace either increased at a considerably slower rate than warehousing or fell while warehousing rose in 6 of the 14 urban areas. Only in 2 of the 14 urban areas did retailing floorspace increase far more strongly than warehousing over the period (Milton Keynes and Southampton).

Table 5.1 reflects the land use category growing most strongly over the last decade has been office floorspace. Growth in office floorspace rose considerably more than warehousing floorspace in 8 of the 14 urban areas. However, offices tend to generate far fewer heavy goods vehicle (i.e. goods vehicles over 3.5 tonnes gross weight) movements than retailing and factories, and instead are usually predominantly served by light goods vehicles (i.e. goods vehicles up to and including 3.5 tonnes).
However, it is important to note that floorspace is not the only determinant of the quantity of goods that are delivered to or collected from a retail, factory or office establishment. Another important determinant is the rate of production or turnover of goods (i.e. the rate at which they are produced, consumed or sold) per unit of area. It is likely that the rate of turnover of goods per unit area in retail outlets has been increasing over time due to improvements in product display and a better understanding of consumer demand. Similarly in the case of factories it is likely that the rate of production per unit area has increased with ever-more productive machinery and improved internal factory layouts. These trends in rate of production/turnover of goods per unit area have also been driven by ever-increasing urban land values which make it economically critical to use space as efficiently as possible.

Table 5.1: Change in total commercial and industrial floorspace, 1998-2008 by land use and urban area (percentage)

<table>
<thead>
<tr>
<th></th>
<th>Warehouses</th>
<th>Retail</th>
<th>Offices</th>
<th>Factories</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>4%</td>
<td>5%</td>
<td>18%</td>
<td>-37%</td>
</tr>
<tr>
<td>Greater Manchester</td>
<td>11%</td>
<td>12%</td>
<td>21%</td>
<td>-21%</td>
</tr>
<tr>
<td>Merseyside</td>
<td>6%</td>
<td>5%</td>
<td>29%</td>
<td>-11%</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>14%</td>
<td>-14%</td>
<td>27%</td>
<td>-16%</td>
</tr>
<tr>
<td>West Midlands</td>
<td>27%</td>
<td>9%</td>
<td>21%</td>
<td>-22%</td>
</tr>
<tr>
<td>Tyne and Wear</td>
<td>18%</td>
<td>-15%</td>
<td>44%</td>
<td>5%</td>
</tr>
<tr>
<td>South Yorkshire</td>
<td>36%</td>
<td>4%</td>
<td>40%</td>
<td>9%</td>
</tr>
<tr>
<td>Cardiff</td>
<td>19%</td>
<td>5%</td>
<td>19%</td>
<td>-9%</td>
</tr>
<tr>
<td>Bristol</td>
<td>-3%</td>
<td>1%</td>
<td>8%</td>
<td>-20%</td>
</tr>
<tr>
<td>Leicester</td>
<td>7%</td>
<td>5%</td>
<td>8%</td>
<td>-13%</td>
</tr>
<tr>
<td>Brighton and Hove</td>
<td>5%</td>
<td>7%</td>
<td>17%</td>
<td>-26%</td>
</tr>
<tr>
<td>Southampton</td>
<td>-9%</td>
<td>8%</td>
<td>10%</td>
<td>17%</td>
</tr>
<tr>
<td>Milton Keynes</td>
<td>39%</td>
<td>59%</td>
<td>16%</td>
<td>2%</td>
</tr>
<tr>
<td>York</td>
<td>55%</td>
<td>-6%</td>
<td>47%</td>
<td>-7%</td>
</tr>
<tr>
<td>England and Wales</td>
<td>22%</td>
<td>4%</td>
<td>24%</td>
<td>-8%</td>
</tr>
</tbody>
</table>

Source: Calculated from data in VOA, 2010.

Figure 5.4 shows the proportion of total commercial and industrial floorspace accounted for by warehousing, retail, office, factory and other bulks in 2008 in the 14 urban areas and nationally. This shows that in 10 of the 14 urban areas warehousing accounted for 21-30% of total commercial and industrial floorspace in 2008 (but was 15% in Brighton and Hove, 17% in Southampton, 18% in York, and 43% in Milton Keynes). Retailing accounted for 14-23% of total floorspace in 11 out of 14 urban areas (but was 26% in York, 28% in Southampton and 38% in Brighton and Hove). Offices accounted for 12-25% of total floorspace in 11 out of 14 urban areas (but accounted for 28% in Cardiff, 30% in Brighton and Hove and 40% in London). Factories accounted for 28-43% of total floorspace in 10 out of 14 urban areas (but accounted for 13% in London and Brighton and Hove, 21% in Bristol and 25% in Cardiff). Other bulks accounted for 2-4% of total floorspace in all 14 urban areas.
Figure 5.4: Commercial and industrial floorspace by land use in 2008, by urban area (percentage)

Note: “Other bulks” is a miscellaneous group which consists mainly of halls, social clubs and garden centres.
Source: Calculated from data in VOA, 2010.

Figure 5.5 shows the freight lifted by road on journeys to, from and within each urban area per square metre of commercial and industrial floorspace. This is a measure of the road freight intensity of the commercial and industrial land use in an urban area. The results indicate that 12 of the 14 urban areas generate road freight activity (in terms of tonnes lifted) per square metre of commercial and industrial floorspace that is greater than the England and Wales average.

The results show that London and Brighton and Hove generate the least freight lifted by road per square metre of commercial and industrial floorspace; this is likely to be related to the relatively low proportion of factories and warehousing and the high proportion of office space in these two urban areas (with offices typically generating fewer tonnes lifted by HGV per square metre than factories and warehousing). Meanwhile Southampton and Bristol both generate substantially more freight lifted by road per square metre of commercial and industrial floorspace than the other urban areas. These are both relatively small urban areas in terms of their geographical size and population but both of which have a sea port in both that generates significant freight flows.
Figure 5.5: Freight lifted by road on journeys to, from and within each urban area per square metre of commercial and industrial floorspace

5.3 Current warehousing operations in urban areas

Figure 5.6 shows the average size of warehouse in each of the 14 urban areas and England and Wales as a whole in 2008. This shows that in 12 of the 14 urban areas the average warehouse floorspace is similar to the national average (ranging up to 25% smaller or larger). However in Milton Keynes it is approximately 2.5 times larger than the national average (reflecting the preponderance of national and regional distribution centres located within it), while in Brighton and Hove it is only approximately half the national average.
Estimates have been made of the relative warehousing floorspace in the urban areas studied. These have been calculated in terms of the warehousing floorspace i) per capita, ii) per km$^2$ of urban area, and iii) per tonne lifted by heavy goods vehicles on journeys to, from and within the urban area (using data from CSRGT for goods carried by goods vehicles over 3.5 tonnes gross weight). Obviously in reality the amount of warehousing floorspace in an urban area is dependent on a number factors including: the type and quantity of goods produced and consumed in the urban area, the extent to which the urban area is served by warehousing located outside its boundaries, and the attractiveness of the urban area as a location from which to establish warehouses to serve other areas and regions (based on accessibility to the motorway network, proximity to other regions and the rest of the country, and land values). However, this data is not available and the unit measure proposed provides some insight into the relative warehousing floorspace in each urban area. The results are shown in Table 5.2.

The per capita measure has the weakness that there is not a strong relationship between population size and warehousing floorspace in the case of an urban area that happens to be situated in an ideal location for serving a large region or the entire country (such as Milton Keynes). Similarly size of urban area is unlikely to be strongly related to warehousing floorspace in locations with low population densities (such as York, South Yorkshire) unless there are other reasons for citing warehouses in the area (such as Milton Keynes). Using tonnes lifted by road data for a given urban area assumes that all goods moved by road are transported to and/or from a warehouse which is not necessarily the case. Also the goods lifted by road data does not take account of goods transport by light goods vehicles which is also stored at warehouses, and which may well vary in its relative activity between urban areas.

The warehousing floorspace per tonne of goods lifted by road is probably then most helpful measure for comparing the relative quantity of warehousing in the urban areas studied.
Using this measure suggests that Milton Keynes and Brighton and Hove had by far the most warehousing floorspace relative to the road freight lifted in the area, while Southampton had considerably less than other urban areas. The result for Milton Keynes is related to its importance as a strategic centre for national and regional distribution centres given its proximity to the motorway network and major urban centres (as reflected by the relative importance of warehousing as a land use – see Figure 5.4). In the case of Brighton and Hove the relatively high proportion of warehousing per tonne lifted may well be due to the fact that the urban area comprises a high proportion of office and retail space, and that much of this is likely to be served by light goods vehicles (up to 3.5 tonnes gross weight) and that this road freight activity is not reflected in the HGV activity data used in the calculation.

The relatively high proportion of warehousing per tonne lifted in Southampton may well to be due to the fact that many goods lifted on road freight journeys to, from and with Southampton are likely to have destined for or originating from the sea port (i.e. roll-on roll-off ferries, containers, and bulks that do not require storage in a warehouse) and therefore comparatively less warehousing is required compared to other urban areas.

Table 5.2: Profile of the warehousing by urban areas, 2007/8

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>Total warehousing floorspace (000 m²)</th>
<th>Average size of warehouses (m²)</th>
<th>Warehousing per capita (m² per person)</th>
<th>Warehousing per sq km of land (1000 m² per km²)</th>
<th>Warehousing per tonne lifted by road* (m² per 1000 tonne lifted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>15,648</td>
<td>683</td>
<td>2.1</td>
<td>10.0</td>
<td>262</td>
</tr>
<tr>
<td>Gtr Manchester</td>
<td>10,181</td>
<td>908</td>
<td>4.0</td>
<td>8.0</td>
<td>269</td>
</tr>
<tr>
<td>Merseyside</td>
<td>3,645</td>
<td>832</td>
<td>2.7</td>
<td>5.7</td>
<td>255</td>
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<tr>
<td>West Yorkshire</td>
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</tr>
<tr>
<td>Cardiff</td>
<td>838</td>
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<td>2.6</td>
<td>6.0</td>
<td>250</td>
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<tr>
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<td>Brighton and Hove</td>
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<td>336</td>
<td>1.0</td>
<td>3.0</td>
<td>653</td>
</tr>
<tr>
<td>Southampton</td>
<td>340</td>
<td>567</td>
<td>1.5</td>
<td>6.8</td>
<td>115</td>
</tr>
<tr>
<td>Milton Keynes</td>
<td>1,702</td>
<td>1,915</td>
<td>7.6</td>
<td>5.5</td>
<td>742</td>
</tr>
<tr>
<td>York</td>
<td>359</td>
<td>693</td>
<td>1.9</td>
<td>1.3</td>
<td>281</td>
</tr>
<tr>
<td>England &amp; Wales</td>
<td>158,942</td>
<td>772</td>
<td>3.0</td>
<td>1.1</td>
<td>98</td>
</tr>
</tbody>
</table>

Notes:
* - only taking into account goods lifted by goods vehicles over 3.5 tonnes gross weight on journeys within and from the urban area (as goods lifted on journeys to the urban area will have been loaded at a warehouse outside the urban area). The measure used assumes that all goods move to and/or from a warehouse which will not necessarily be the case in all supply chains.
Warehouse floorspace data is for 2008; goods lifted data is 2005-2007 annual average; population data is for 2006.
Source: Calculated from data in DCLG, 2010; DfT, 2008b; ONS, 2008.
6. Analysing the impact on urban freight activity of potential operational improvements

Section 4 contained the current operational performance of freight journeys to, from and within urban areas (using 2005-2007 data). These results indicated that there are major differences between the operational performances of freight journeys in the 16 urban areas studied.

In this section analysis has been carried out into the potential reduction in vehicle kilometres that would result from improvements in the operational performance of urban freight.

Four of the key determinants of vehicle kilometres have been analysed:

- Average length of haul
- Lading factor
- Vehicle carrying capacity
- Empty running

It is important to note that the reasons for the differences in operational performance with respect to these four factors between the 16 urban areas studied are not well understood. These differences could be due to a range of issues including:

- efficiency of operational management of the vehicle fleet
- location of logistics facilities (i.e. warehouses, cross-docking facilities)
- location of supply and demand points in product supply chains
- economic and social features of the urban area (e.g. type of industrial composition, presence of freight attractors such as seaports, airports)
- size or population density of the urban area
- road layout and network issues (e.g. road width)
- existing regulations (e.g. vehicle weight and time restrictions)
- imbalances in the flows of goods into and out of urban areas
- differences in the bulk densities of goods handled in various locations
- how representative the sample in the CSRGT data is

Therefore the extent to which performance improvements can be achieved are currently uncertain.

However, bearing in mind this lack of understanding of differences in current operational performance in urban areas, scenarios have been developed in which it is assumed that the operational performance of freight journeys is improved with respect to each of these four determinants.

It was felt unrealistic to assume that that all freight performance in each of the urban areas could match the performance of the best urban area. Therefore, instead it was assumed that the performance in the 13 worst performing urban areas could be improved to match the performance of the third best urban area. The spreadsheet model was used to calculate the effects of this performance improvement on the total vehicle kilometres travelled.

Table 6.1 shows the 3 best operational performances from the analysis of the 2005-2007 data for the 16 urban areas studied.
Table 6.1: Three best current operational performances (2005-7 average)

<table>
<thead>
<tr>
<th>Average length of haul (km)</th>
<th>Best</th>
<th>Second best</th>
<th>Third best</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edinburgh – 75</td>
<td>Greater London - 61 km</td>
<td>Brighton and Hove - 80 km</td>
<td></td>
</tr>
<tr>
<td>Lading factor</td>
<td>Merseyside – 0.62</td>
<td>Edinburgh - 0.61</td>
<td>Cardiff/York - 0.60</td>
</tr>
<tr>
<td>Vehicle carrying capacity (tonnes)</td>
<td>Southampton - 21.0</td>
<td>Merseyside - 20.6</td>
<td>South Yorkshire/Milton Keynes - 18.9</td>
</tr>
<tr>
<td>Empty running (%)</td>
<td>Southampton - 21.3</td>
<td>Tyne &amp; Wear - 23.6</td>
<td>West Midlands - 25.2</td>
</tr>
</tbody>
</table>

For the scenario modelling, the best and second performing urban areas were assumed to carry on performing at their current level. The third best operational performance was assumed to be the performance that could be achieved the other 13 urban areas (in which the operational performance currently fell below this level). Therefore the 4th to 16th ranked urban areas were each assumed to achieve the operational performance of the 3rd ranked urban area shown in Table 6.1.

Table 6.2 shows the potential effect on vehicle kilometres performed on journeys to, from and within each urban area if the 4th to 16th ranked urban areas could achieve the best operational performance of the 3rd ranked urban area for each of the four factors considered.

Table 6.2: Change in total vehicle kms on journeys to, from and within each urban area if the operational performance of the 4th to 16th ranked could match the 3rd ranked

<table>
<thead>
<tr>
<th>Average length of haul</th>
<th>Lading factor</th>
<th>Vehicle Carrying capacity</th>
<th>Empty running</th>
<th>All four scenarios combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater London</td>
<td>0%</td>
<td>-7%</td>
<td>-17%</td>
<td>-4%</td>
</tr>
<tr>
<td>Gtr Manchester</td>
<td>-17%</td>
<td>-12%</td>
<td>-7%</td>
<td>-2%</td>
</tr>
<tr>
<td>Merseyside</td>
<td>-23%</td>
<td>0%</td>
<td>0%</td>
<td>-3%</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>-18%</td>
<td>-7%</td>
<td>-9%</td>
<td>-3%</td>
</tr>
<tr>
<td>West Midlands</td>
<td>-23%</td>
<td>-12%</td>
<td>-9%</td>
<td>0%</td>
</tr>
<tr>
<td>Tyne and Wear</td>
<td>-25%</td>
<td>-6%</td>
<td>-6%</td>
<td>0%</td>
</tr>
<tr>
<td>South Yorkshire</td>
<td>-17%</td>
<td>-2%</td>
<td>0%</td>
<td>-5%</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>0%</td>
<td>0%</td>
<td>-19%</td>
<td>-6%</td>
</tr>
<tr>
<td>Glasgow</td>
<td>-23%</td>
<td>-6%</td>
<td>-5%</td>
<td>-1%</td>
</tr>
<tr>
<td>Cardiff</td>
<td>-15%</td>
<td>0%</td>
<td>-9%</td>
<td>-3%</td>
</tr>
<tr>
<td>Bristol</td>
<td>-33%</td>
<td>-6%</td>
<td>-6%</td>
<td>-1%</td>
</tr>
<tr>
<td>Leicester</td>
<td>-22%</td>
<td>-13%</td>
<td>-6%</td>
<td>-3%</td>
</tr>
<tr>
<td>Brighton &amp; Hove</td>
<td>0%</td>
<td>-2%</td>
<td>-16%</td>
<td>-7%</td>
</tr>
<tr>
<td>Southampton</td>
<td>-42%</td>
<td>-13%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Milton Keynes</td>
<td>-30%</td>
<td>-18%</td>
<td>0%</td>
<td>-2%</td>
</tr>
<tr>
<td>York</td>
<td>-10%</td>
<td>0%</td>
<td>-11%</td>
<td>-6%</td>
</tr>
<tr>
<td>All 16 urban areas</td>
<td>-18%</td>
<td>-8%</td>
<td>-8%</td>
<td>-2%</td>
</tr>
</tbody>
</table>

Note: a 0% change is shown for those urban areas that are currently ranked 1st, 2nd or 3rd best performing as it is assumed that they will continue to achieve their current performance.
Figure 6.1 shows the effect on the total vehicle kilometres performed on all journeys to, from and within all of the 16 urban areas if these improvements in operational performance could be achieved.

**Figure 6.1: Comparison of total vehicle kms on journeys to, from and within the 16 urban areas – current situation and scenarios (billion vehicle km and percentage change)**

As indicated by Table 6.2 and Figure 6.1, the results indicate that the average length of haul scenario would lead to the greatest overall reduction in total vehicle kilometres on journeys to, from and within the 16 urban areas. This is due to the fact that the range between the current average length of haul for the 16 urban areas is greater than the range for the other factors modelled (see section 4.2). If the four scenarios are combined this would result in a 32% reduction in vehicle kilometres.

For some individual urban areas it can be seen that the effects of each of the scenarios would be far greater than for others (see Table 6.2). For instance the vehicle kilometres on journeys to, from and within would be reduced by 42% for Southampton in the length of haul scenario, by 18% in Milton Keynes in the lading factor scenario, by 17% in Greater London in the vehicle carrying capacity scenario, and by 7% in Brighton and Hove in the empty running scenario.
7. Conclusions

7.1 Freight transport and urban form

The work presented in this report has attempted to provide insight into the relationship between road freight activity by HGVs and urban form in Britain.

The findings have indicated that some of the urban form factors that are likely to be related to passenger transport are also likely to be related to freight transport while others are not. It appears that settlement size (in terms of population and area) and intensity of land use (population density) are related to freight transport activity, with the proportion of all road freight lifted on journeys that take place within the urban area being greater in the larger urban areas than the smaller ones. This is likely to be due to two factors: i) larger urban areas typically contain more production and logistics facilities and hence generate more internal journeys than smaller ones, and ii) larger urban areas are likely to have several urban centres between which goods are moved (i.e. they are polycentric).

The demand for freight transport is a derived demand and is therefore less prone to changes in times and frequencies as a result of urban features (or even pricing arrangements) than passenger journeys. In addition, goods vehicle collections and deliveries are by far the dominant mode for freight transport in urban areas, whereas passenger transport is subject to a far greater variety of road vehicle types (including cars, buses, motorbikes, bicycles, walking etc.) as well as alternative modes (such as rail and in some cases water). There are therefore major differences in the likelihood of vehicle and modal shift in relation to freight and passenger transport in urban areas.

Urban freight transport journeys exhibit a wide range of patterns including: i) those to, from and within urban areas, as well as ii) single- and multi-drop operations. These freight journeys with an urban component are usually only one part of a wider set of related journeys in the supply chain of a product from its point of production to point of consumption. The total distribution network for products through all their various production, logistics, wholesaling and retailing activities vary enormously in terms of the number of stages, vehicles, modes and transport networks involved.

The analysis carried out suggests that the industrial composition of the urban area plays an important role in determining the extent of goods that are transported into and out of the area, and whether the area is a net importer or exporter. The existence of a major freight generating or transshipment point located within the urban area (such as a large freight-handling sea port) also appears to be important in this respect.

The report has shown that, in general, the proportion of all road freight lifted on journeys that take place within the urban area is greater in the larger urban areas than the smaller ones. This is likely to be due to two factors: i) larger urban areas typically contain more production and logistics facilities and hence generating more internal journeys than smaller ones, and ii) larger urban areas are likely to have several urban centres between which goods are moved (i.e. they are polycentric).

The analysis suggests that the length of haul associated with freight journeys to and from an urban area varies according to the composition of the hinterland and the location of the urban area in relation to other centres that it has trading links with and the economic activity that takes place in the urban area (as some types of freight generating facilities such as seaports have larger hinterlands and greater flows than other types of freight generating land use).
The analysis also shows that, in the case of the majority of urban areas studied, lighter vehicles (in terms of their payload weight) are used to transport goods within and to and from smaller urban areas than larger ones. The average vehicle carrying capacity of vehicles used is likely to be related to the type of goods transported to and from urban areas and the frequency of transportation. Again, this is likely to be related to the economic composition of the urban area and the fact that larger the urban areas have multiple centres which goods are often moved between.

Vehicle carrying capacities have been found to be far higher in each of the 16 urban areas for journeys to and from the urban area compared with journeys within the urban area. This is related to the types of goods transported within the urban area compared to goods transported in and out of the urban area (with the former tending to comprise lighter goods and smaller loads than the latter).

This is likely to be due to several factors including the low speeds and difficult vehicle handling conditions in an urban environment, vehicle weight and size restrictions in some urban locations, the importance of lighter goods and smaller loads in urban areas, and the higher costs of journeys to/from urban areas (given their relative length and hence journey time) resulting in the decision to move larger quantities per journey.

The lading factor of goods vehicles have been shown to be far higher for journeys to and from urban areas compared to journeys within urban areas. This could be due to: i) vehicle being more efficiently loaded on journeys to and from urban areas compared to journeys within urban areas; ii) journeys within urban areas may involve goods with lower bulk densities than on journeys to and from the urban area; and/or iii) flows within urban areas may be more urgent than those to and from urban areas and therefore provide fewer opportunities for consolidation.

Given that vehicle carrying capacities and lading factors are far higher for journeys to and from the urban area compared with journeys within the urban area in each of the 16 urban areas, this results in greater average vehicle loads on journeys to and from urban areas. This is likely to be due to the types of goods and size of loads involved in these two types of journey, as well as the higher cost penalties involved in low operating efficiencies on longer journeys.

The work has also shown that, in the case of most of the urban areas studied, empty running on journeys within urban areas is lower than on journeys to and from urban areas. This may be due to the greater importance of multi-leg operations on journeys within the urban area compared with journeys to and from the urban area. Also, as to be expected given that many of the urban areas are net importers of freight, in the majority of locations studied empty running on journeys from the urban area is greater than on journeys to the urban area.

Analysis of the efficiency of road freight transport (in terms of the ratio of tonne-kilometres to vehicle kilometres) has shown that journeys within urban areas are less efficient in terms of the ratio of tonne-kms to vehicle kms than journeys to and from urban areas. Key factors in this difference are the much smaller average vehicle carrying capacities and lower lading factors for journeys within urban areas.

Journeys to urban areas are generally more efficient than journeys from urban areas due to lower levels of empty running and higher lading factors. These are due to the trade imbalances that exist in most of the urban areas studied, with more goods lifted on journeys to the urban area than from it (i.e. the urban area is a net importer of goods by road).
Analysis of the intensity of goods vehicle operations (reflected in the relationship between total goods lifted by goods vehicles and the total vehicle kilometres performed by these vehicles) has shown that freight journeys from urban areas are the least efficient in terms of vehicle kilometres performed per tonne lifted. Freight journeys to and within each urban area appear to generate a similar number of vehicle kilometres per tonne lifted.

The above findings are summarised in Table 7.1.

The work has also indicated that although the total warehousing floorspace in the urban areas studied did increase between 1998 and 2008 it increased in most of the urban areas studied at a far lower rate than in the whole of England and Wales. This implies that much of the growth in total warehousing floorspace in England and Wales during this period may well have been taking place outside urban areas especially in locations close to the motorway network. The findings also suggest that over the decade weaker growth and even declines in warehousing space have taken place in inner urban and higher density urban areas while stronger growth has occurred in less central and dense urban locations. This is likely to reflect relative land values within urban areas.

The analysis presented reflects the continuation of deindustrialisation in urban areas (and nationally) between 1998 and 2008, with total factory floorspace decreasing in 10 of the 14 urban areas. It also indicates that office floorspace has grown more than any other category of commercial and industrial land use over the last decade in the urban areas studied. However, offices tend to generate far fewer heavy goods vehicle (i.e. goods vehicles over 3.5 tonnes gross weight) movements than retailing and factories, and instead are usually predominantly served by light goods vehicles (i.e. goods vehicles up to and including 3.5 tonnes).

It is important to note that floorspace is not the only determinant of the quantity of goods that are delivered to or collected from a retail, factory or office establishment. Another important determinant is the rate of production or turnover of goods (i.e. the rate at which they are produced, consumed or sold) per unit of area. It is likely that the rate of turnover of goods per unit area in retail outlets has been increasing over time due to improvements in product display and a better understanding of consumer demand. Similarly in the case of factories it is likely that the rate of production per unit area has increased with ever-more productive machinery and improved internal factory layouts. These trends in rate of production/turnover of goods per unit area have also been driven by ever-increasing urban land values which make it economically critical to use space as efficiently as possible.

Estimates have been made of the relative warehousing floorspace in the urban areas studied per tonne lifted by heavy goods vehicles on journeys within and from the urban area.
### Table 7.1: Summary of findings

<table>
<thead>
<tr>
<th>Factor</th>
<th>Differences between journeys within and to/from urban areas</th>
<th>Differences between large and small urban areas</th>
<th>Other factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonnes lifted</td>
<td>Quantity of warehousing within the urban area affects proportion of tonnes lifted on journeys within and to/from urban area.</td>
<td>Greater proportion of total freight lifted on internal journeys in large urban areas.</td>
<td>Commercial and industrial composition of the urban area.</td>
</tr>
<tr>
<td>Average length of haul</td>
<td>Shorter average length of haul on journeys within than to/from urban areas.</td>
<td>No clear relationship between size of urban area and average length of haul on journeys to/from and within.</td>
<td>Composition of product supply chains (including modal split and handling factor).</td>
</tr>
<tr>
<td>Tonne-kilometres</td>
<td>Proportion of tonne-kilometres performed on journeys within the urban area typically greater in larger urban areas (due to proportion of tonnes lifted internally).</td>
<td>In general, lighter vehicles are used to transport goods within and to/from smaller urban areas than larger ones.</td>
<td>Location of the urban area in relation to other centres that it has trading links with. Major freight attractors and gateways located in the urban area (such as seaports and agglomerations of distribution centres).</td>
</tr>
<tr>
<td>Carrying capacity of vehicles</td>
<td>Vehicle carrying capacities for journeys to and from the urban area compared with journeys within the urban area.</td>
<td>In general, lighter vehicles are used to transport goods within and to/from smaller urban areas than larger ones.</td>
<td>Delivery frequency on journeys within urban areas may be greater than on journeys to/from urban areas. Higher operating costs of journeys to urban areas compared to journeys within urban areas may influence lading factors. Given that many urban areas are net importers, achieving good backloads is likely to prove more difficult on journeys from urban areas than on journeys to urban areas.</td>
</tr>
<tr>
<td>Lading factor on laden journeys</td>
<td>Lading factors are higher for journeys to urban areas compared to journeys from urban areas. Journeys within urban areas have the lowest lading factors of all urban journeys.</td>
<td>No clear relationship between size of urban area and lading factors on journeys to/from and within.</td>
<td></td>
</tr>
<tr>
<td>Factor</td>
<td>Differences between journeys within and to/from urban areas</td>
<td>Differences between large and small urban areas</td>
<td>Other factors</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Empty running</td>
<td>In most cases empty running on journeys within urban areas is lower than on journeys to and from urban areas. May be due to a higher proportion of multi-leg journeys within urban areas. Journeys to urban areas have lower empty running than journeys from urban areas in the majority of urban areas studied – probably due to trade imbalances caused by net importation of goods into urban areas.</td>
<td>No clear relationship between the size of urban area and empty running on journeys to/from and within.</td>
<td></td>
</tr>
<tr>
<td>Vehicle kilometres</td>
<td>In most cases, the proportion of total vehicle kilometres performed on journeys that take place within the urban area is greater in the larger urban areas than the smaller ones. The proportion of total vehicle kilometres performed on journeys within the urban area is far higher than the proportion of tonne-kilometres – this is due relatively low vehicle carrying capacities and lading factors.</td>
<td>Larger urban areas (which account for with the greatest quantity of freight lifted on journeys to, from and within them) appear to generate the greatest vehicle kilometres on journeys transporting these goods.</td>
<td>Major generators of road freight transport such as sea ports and high density of distribution centres (such as in Southampton and Milton Keynes) are an important determinant of total vehicle kilometres on journeys to and from the urban area.</td>
</tr>
<tr>
<td>Tonne-kms : vehicle kms</td>
<td>Journeys within urban areas are less efficient in terms of the ratio of tonne-kms to vehicle kms than journeys to and from urban areas. Key factors in this difference are the much smaller average vehicle carrying capacities and lower lading factors for journeys within urban areas. Journeys to urban areas are generally more efficient than journeys from urban areas due to higher levels of empty running and lower lading factors.</td>
<td>No clear relationship between the size of urban area and the ratio of tonne-kms to vehicle kms.</td>
<td></td>
</tr>
<tr>
<td>Vehicle kilometres per tonne lifted</td>
<td>Journeys within urban areas generally less intensive in terms of vehicle kilometres performed per tonne lifted than journeys to and from urban areas. This is due to their far shorter average length of haul, despite the fact that the vehicle operation is far less efficient in terms of average vehicle carrying capacity and lading factors. Journeys from urban areas are more intensive than journeys to urban areas in terms of the vehicle kilometres performed per tonne lifted. This is related to the higher proportion of empty running and lower lading factors on these journeys.</td>
<td>No clear relationship between the size of urban area and the vehicle kms per tonne lifted.</td>
<td></td>
</tr>
</tbody>
</table>
7.2 Operational improvements, policy-making and urban freight transport

Analysis has been carried out into potential reduction in vehicle kilometres that would result from improvements in the operational performance of urban freight. This involved considering the effects of improvement of four of the key determinants of vehicle kilometres: average length of haul, lading factor, vehicle carrying capacity, and empty running.

It was assumed that freight performance in 4th-16th ranked urban areas for each of these determinants could match the performance of the 3rd best urban area. The results indicate that improvements (reductions) in average length of haul would lead to the greatest overall reduction (18%) in total vehicle kilometres on journeys to, from and within the 16 urban areas. This is due to the fact that the range between the current average length of haul for the 16 urban areas is greater than the range for the other factors modelled. Improvements in the other determinants would lead to the following reductions in total vehicle kilometres performed on journeys to, from and within the 16 urban areas: vehicle carrying capacity (8%), lading factor (8%), and empty running (2%). If the four scenarios were combined it is estimated that this would result in a 32% reduction in vehicle kilometres.

However, the extent to which these performance improvements can be achieved are currently uncertain as they are related to a wide range of factors including urban form (size and density of the urban area, and road network), economic composition of the urban areas, current transport regulations in force (e.g. vehicle time and size/weight access and loading restrictions), and company/supply chain decision-making (e.g. efficiency of operational management of vehicle fleet, location of logistics facilities, sourcing and stockholding strategies, the hinterland of various major freight generators, and market areas in product supply chains).

Clearly a reduction in average length of haul could have a major effect on total vehicle kilometres performed by goods vehicles on journeys to, from and within urban areas. This could be achieved if more distribution and production facilities were located in or close to urban areas. However, this is counter to market trends that have been occurring in recent decades, and would therefore be unlikely to happen without major government intervention and would be likely to lead to increases in logistics costs.

Also, simply concentrating more freight activity within urban areas would potentially add to existing urban traffic levels. Therefore, although the total vehicle kilometres performed on journeys to, from and within urban areas may decrease as a result, the absolute and relative level of freight activity within urban areas would be likely to increase. This may prove to be unsustainable for urban areas, as it would potentially result in growing levels of urban traffic congestion. It is necessary to focus on freight activity nationally and regionally as well as just at an urban scale – as what is good at a national or regional scale may be unsustainable at the urban scale and vice versa.

The number and location of distribution facilities in relation to other land uses is also likely to play an important role in the quantity and location of freight activity in and around urban areas (and hence vehicle kilometres generated). However, these facilities are owned and operated privately. Policy makers can however use zoning policies to influence land use patterns. They can also consider the implementation of urban consolidation centres to improve lading factors and vehicle carrying capacities on collection and delivery activity with the urban area. However the number and location of these consolidation centres are likely to have a major influence on the length of haul and empty running within the urban area, which could actually worsen if an unsuitable number of centres or inappropriate locations are selected. Therefore decisions about numbers and locations of such centres are likely to be critical in their impact on vehicle kilometres.
Policymakers can also use fiscal measures such as road pricing and other freight transport-related taxation measures in order to try to influence the geography of supply chain facilities (in terms of the location, number and size of warehouses), company sourcing strategies (i.e. the distance over which goods are transported), and the efficiency with which goods vehicles are used (in terms of lading factors, vehicle carrying capacities and rates of empty running). Influencing these factors through fiscal measures could result in a reduction in total road freight activity both nationally and at an urban level.

The analysis has also shown that the size of an urban area, its population density and its industrial composition are likely to be important factors in the level and pattern of freight activity associated with that area. However, policy makers cannot easily influence these factors through policy-making.

The factors considered in the analysis (average length of haul, lading factor, vehicle carrying capacity, and empty running) are the only means by which goods vehicle kilometres can readily be reduced in urban areas (modal split is also able to achieve this nationally but not at the urban scale as road will continue to dominate). There are many other measures that can be taken by policy makers that can make freight transport more sustainable but which do not alter the total level of vehicle kilometres performed. Examples include: vehicle design, use of alternative fuels, traffic management, speed limits, driver training, drivers' hours regulations, vehicle maintenance checking and enforcement. These measures can influence other issues including the level of fossil fuel use, air pollution, noise pollution, and road safety. It is therefore important for policy makers to be clear about the aspects of urban freight transport they are aiming to influence when considering suitable policy approaches.

7.3 Further research

This work has attempted to provide an initial investigation into the relationship between road freight transport and urban form. The work has included a first attempt to analyse disaggregated CSRGT data for a selection of urban areas in order to gain a more detailed understanding of urban road freight activity levels and patterns.

In carrying out the work it has become clear that continuing to analyse CSRGT data at an urban scale over time would enable the monitoring of trends in the level of urban road freight activity as well as the efficiency and transport intensity of this activity.

It is also worth considering whether CSRGT data can be used to analyse the total number of HGV journeys being made, the average journey length, and the average number of legs per journey on multi-leg journeys in different urban areas. If this analysis is possible this would provide additional insight into the pattern of HGV operations in relation to urban form and could be monitored over time to identify changes in HGV operations.

Further work could also be initiated in order to gain a more detailed understanding of the relationship between trends and patterns in commercial and industrial land use and patterns and levels of urban road freight transport.

The CSRGT data only provides details of road freight activity by HGVs (i.e. goods vehicles over 3.5 tonnes gross weight). Growth in the use of LGVs in urban areas has grown substantially in recent years. This growth in LGV use is related to many factors as LGVs are used for the provision of many services, commuting and personal travel as well as for goods collection and delivery. It is possible that as warehousing has become increasingly suburbanised and even relocated entirely outside the urban area (due to urban land prices, urban deindustrialisation and the centralisation of stockholding) LGVs are being used for a greater proportion of collection and delivery work in urban areas than they were previously. However, there is insufficient data available about LGV use to test this hypothesis. This lack
of LGV data also prevents an analysis of the utilisation and efficiency of LGV use for goods collection and delivery in urban areas and therefore a comparison with the HGV results presented in this report.
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Department for Transport (2009a) Data provided by the Road Freight Statistics Team, DfT.

Department for Transport (2009b) Road Freight Statistics 2008, DfT.

Department for Transport (2009c) Data provided by the Road Traffic Statistics Team, DfT.


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Appendix 1: Towns and cities in Greater London and Metropolitan Counties

Greater London comprises the following 33 London boroughs:

- Barking and Dagenham
- Barnet
- Bexley
- Brent
- Bromley
- Camden
- City of London
- Croydon
- Ealing
- Enfield
- Greenwich
- Hackney
- Hammersmith and Fulham
- Haringey
- Harrow
- Havering
- Hillingdon
- Hounslow
- Islington
- Kensington and Chelsea
- Kingston upon Thames
- Lambeth
- Lewisham
- Merton
- Newham
- Redbridge
- Richmond upon Thames
- Southwark
- Sutton
- Tower Hamlets
- Waltham Forest
- Wandsworth
- Westminster

The metropolitan county of Greater Manchester comprises the following towns and cities:

- Manchester
- Salford
- Stockport
- Tameside
- Trafford
- Bolton
- Bury
- Oldham
- Rochdale
- Wigan
The metropolitan county of Merseyside comprises the following towns and cities:

- Knowsley
- St. Helens
- Liverpool
- Sefton
- Wirral

The metropolitan county of West Yorkshire comprises the following towns and cities:

- Bradford
- Leeds
- Calderdale
- Kirklees
- Wakefield

The metropolitan county of the West Midlands comprises the following towns and cities:

- Birmingham
- Solihull
- Coventry
- Dudley
- Sandwell
- Walsall
- Wolverhampton

The metropolitan county of Tyne and Wear comprises the following towns and cities:

- Gateshead
- Newcastle-upon-Tyne
- North Tyneside
- South Tyneside
- Sunderland

The metropolitan county of South Yorkshire comprises the following towns and cities:

- Barnsley
- Doncaster
- Rotherham
- Sheffield