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Conclusions of Round Table 137

"Transport, Urban Form and Economic Growth"

INTRODUCTION

Round Table 137 was the first Round Table to be held in a non-European country. It was hosted by the Institute of Transportation Studies of the University of California at Berkeley. The Round Table was chaired by Marty Wachs (RAND, Los Angeles). Background papers were provided by David Banister (University of Oxford), Elisabeth Deakin, (UC Berkeley), Gilles Duranton (University of Toronto) and Matthew Kahn (Tufts University).

Transport technology and the associated transport costs have always been among the dominant determinants of urban location and form. In the first half of the 19th century, most cities were tied to waterways, developing around harbours and by rivers and canals. Towards the end of that century, railways competed with inland waterways, and urban growth and form became determined by investments in rail terminals and by their scale economies providing advantages of proximity.

The high cost of intra-urban transport by horse and wagon favoured the creation of single manufacturing districts, located near harbours or railheads, with residential areas surrounding them. Before the advent of horse-drawn and electric street-cars, personal transport was mainly carried out by foot and horse-drawn carriage, implying a strong need to live close to the city centre.

With street-car transport, residential areas spread out around stations or street-car lines. The urban structure changed to a compact production core surrounded by residential areas, which were determined by mass transport facilities.

Only by the middle of the 20th century did the private car start to compete successfully with mass transit -- despite transit fares remaining flat in nominal terms (Barrett, 1983) -- by providing speed, privacy and convenience and being facilitated by the expansion and upgrading of public roads.

The concentration of production at the city centre was undermined by the declining cost of inter-city trucking, a development that was particularly helped by the construction and expansion of highway systems.

Similar developments arose in the USA and Europe but were slower and less pronounced on the latter continent. A major reason for these differences lies in the durability of urban capital stock in general and urban transport infrastructure in particular. This lasting impact of urban infrastructure was coupled with a slower pace of urbanisation due to: (i) a less rapid transition from an agrarian to an industrialised society in some European countries, and (ii) to the fact that European cities are much older, with historically established city centres containing a greater mixture of dwellings and businesses at the core. However, in Europe as in the US there has been a massive process of suburbanisation, which has given rise to substantial controversy as to whether or not its social cost outweighs its benefits.

Along with the evaluation of the changes in urban size and form, there are contrasting views on how urban transport policy should accommodate, contain or otherwise guide the processes of suburbanisation.

Those who are concerned about the surface growth of city areas or the decrease in population densities associate these trends with a long list of negative effects, making them difficult to evaluate. The perceived costs stem from the loss of open space, decaying historical urban structures, urban air and water

pollution, traffic congestion, the loss of a sense of community, patchwork housing developments on what was once agricultural land, the separation of residential and work locations, greater public investment requirements due to spreading urban developments and, last but not least, an increasing reliance on private car use (Nechyba and Walsh, 2004).

At least part of the negative list seems to have appeared by accident or mistake, and not through attempts to reap private benefits. Strong transport policy conclusions have been drawn from negative views of the current trends of suburbanisation. The UK Urban Task Force, for example, recommended that 65% of all public expenditure for transport should be spent on projects that benefit pedestrians, cyclists and public transport users (Urban Task Force, 1999). Where urban form is concerned, it is recommended that: "*Towns and cities should be well designed to be more compact and connected, support a range of diverse uses within a sustainable urban environment which is well integrated with public transport and adaptable to change*." It is not unusual that measures to change the attitudes of transport system users are postulated: "*The renaissance will require a change of culture – through education, debate, information and participation. It is about skills, beliefs and values, not just policies* (Ibid., p. 3)."

For the US, some analysts saw an endogenous return to a lifestyle associated with dense urban developments, the advent of a "new urbanism".

Recently, some economics literature has emerged postulating a more detailed and quantitative assessment of the costs and benefits of urban sprawl, or of the costs and benefits of changing the trends in urban development, *inter alia*, by transport policy measures. The argument emphasizes the identification and quantification of the benefits of the trends towards suburbanisation, and provides a critical review of the claim that, while individuals perceive private benefits from the ongoing changes in urban structure, the social costs outweigh those benefits (Kahn, 2006; Glaeser and Kahn, 2004). Moreover, increasing efforts are being devoted to a research programme designed to determine the importance of urban form (and the system of cities) for the overall competitiveness of national economies and for long-run economic growth rates (Henderson, 2005). Productivity effects result from changing urban structures, such that a maximum of agglomeration economies materialise. These can result from exploiting increasing returns to scale in the provision of public facilities and public services as well as from increasing returns from manufacturing production. The close connection between urban and national economic development was recognised by Lucas (1988) and inspired by the development of endogenous growth models. To the extent that endogenous growth is based on knowledge spillovers and sharing between researchers and producers, and given the importance of face-to-face communication and the requirement of close spatial proximity, much of the interaction and knowledge sharing must occur at the level of individual cities.

The objective of the Round Table was to discuss these recent developments in the perspective of informing transport policies.

There is no unique way to measure urban sprawl. How it is measured is strongly influenced by whether a monocentric urban structure is perceived to be the norm or not. Close to the monocentric view of urban structure is the measure of the share of employment within a certain radius of the Central Business District (CBD) (Glaeser and Kahn, 2004).

A more comprehensive measure has been proposed by Ewing, Pendall and Chen (2005). To construct an index of urban compactness, they combine:

- residential density;
- neighbourhood mix of homes, jobs and services;
- strength of activity centres and downtowns; and
- accessibility of the street network.

This index is a more general measure of sprawl, in that it can capture the polycentric character of metropolitan areas. Based on this index, Kahn (forthcoming) presented indicators of "benefits of sprawl" for four classes of compactness for urban areas (high sprawl, sprawl, low sprawl, very low sprawl).

A first difference in consumption patterns and associated benefits concerns home ownership propensities and land consumption. Controlling for other factors which influence consumption, home ownership rates are 8.5 per cent higher in the most sprawled cities relative to the most compact city type. In compact cities, residential lots are about 40 per cent smaller than those of the median household living in a sprawled city. This does not show by how much households value such gains, as households which live in compact urban areas might have different preferences for house sizes compared to those who live in low-density settlements. However, a more compact city would lead to higher land rents, with a negative impact on the real incomes of all inhabitants.

The Round Table discussed the distributional effects of sprawl, or the distributional effects of containing sprawl by appropriate transport or other smart growth policies (e.g. Quigley and Raphael, 2005). Incumbent homeowners benefit from the increase in land rents which could result from higher intra-urban transport costs, as long as the locations of jobs and services remain fixed.

Low-income groups, with limited opportunities for wealth accumulation, tend to suffer from higher land rents. For the US, when comparing the minority/majority housing consumption differential in compact cities, it has been found that minorities who live in sprawled cities catch up in some housing consumption dimensions to majority households (Kahn, 2001, forthcoming).

COMMUTING

Much of the concern about urban sprawl has to do with an expected or observed increase in private car use and the associated increase in air pollution. This is based on the assumption that in compact cities people are likely to live closer to their downtown jobs, and that more people use public transit. It is also based on the expectation that sprawl increases congestion, leading to low private car commuting speeds, with high time losses and high costs in terms of value of time lost. As shown in two of the background papers (Kahn forthcoming, Banister forthcoming), these hypotheses cannot be confirmed in general. For the US, it was found that compared to workers in compact cities, workers in sprawled cities indeed commute over longer distances (1.8 miles further each way) but that their commute times are shorter (4.3 minutes on average), as they travel at higher speeds. The effect of this commuting pattern on air pollution is, *a priori*, ambiguous as longer distances mean more pollution for a given speed, and a higher speed may imply lower emissions per unit of distance.

A closer look at the commuting patterns in the US reveals that it may be misleading to discuss sprawl and the associated commuting patterns on the basis of the general presumption of a sprawling, monocentric structure (Anas, Arnott and Small, 1998).

A combination of the information provided by the US Neighborhood Change Database and the information on distances from the Central Business District provided by the census tracts, revealed that the share of commuters with a short commute declines over the distance 0 to 10 miles from the CBD. From the 11th mile from the CBD, the share of commuters with a short commute stops declining. An increasing share of workers with residences distant from the CBD stop commuting to the Central District. This might reflect the fact that with an expanding city size, initially through households relocating from inner city areas to outskirts, after some time, jobs follow the households, manifesting in the increasing importance of polycentric changes of urban form.

This suggestion is strongly confirmed with a closer look at US and European cases relating urban transport, and in particular commuting patterns, to settlement size, population density, the job-housing balance and mixed-use development, as well as accessibility and neighbourhood design. These four characteristics of urban areas are seen as the central control instruments of urban planners (Banister, forthcoming). The UK National Travel Survey, for example, revealed a clear correlation between settlement size and a decrease in travel distances. Looking at individual metropolitan areas, London turned out to be a special case in that commuting distances did not stop increasing when the distance of residential location from city centre increased beyond a certain threshold. For Birmingham and Manchester, the threshold distances were seven and five kilometres, respectively.

Both settlement density and the ratio of jobs to workers in a (sub-)urban region seem to have little effect on travel behaviour in general, and commuting behaviour in particular. The design of transport networks seems to have strong effects on travel patterns. The accessibility of public transit stops plays a major role in containing private car use.

Urban street design can have ambiguous effects as an instrument to reduce the demand for sprawl: while a "loops and cul-de-sac" design increases the amount of usable land, and thereby could increase density relative to a grid network (Grammenos and Tasker Brown, n.d.), the latter seems to have the advantage of increasing walking and cycling in cities (Boarnet and Crane, 1999b; Marshall, 2005).

PRODUCTIVITY AND GROWTH EFFECTS OF URBAN SPRAWL

Despite a vast literature on agglomeration effects and associated concepts of "optimal city size" as balancing economies and diseconomies, the discussion of the pros and cons of an expansion of urban areas had only little reference to this normative concept of urban form. (As an example, see Prudhomme and Lee, 1999.) One reason why economic activity agglomerates into cities is the provision of indivisible local public goods whose use is associated with transport costs. More importantly, agglomeration is due to the external benefits of production and consumption activities of firms and households. These drivers of agglomeration are, at the same time, the determinants for long-run growth rates of national economies. Consequently, urban size and urban form might strongly influence the aggregate, national growth process. Moreover, with urban form being the result of the endogenous location decisions of firms and households, the pattern of urbanisation determines the efficiency of the growth process (Black and Henderson, 1999a). This section reflects the arguments that have been raised on the link between urban form and productivity in the Round Table discussions.

External scale economies, i.e. the positive effects of the production of one firm or industry on the production of another firm or industry (Romer, 1986), or knowledge spillovers which increase the returns

of private investment in education, training and research (Lucas, 1988), drive long-run increases in productivity. Early work to explain how such spillovers affected urban form simply assumed a spatial decay of the positive external effects (Fujita and Ogawa, 1982). Only recently has there been progress in providing microfoundations for such a decay (see the review in Duranton and Puga, 2004).

- A first source of city size advantages derives from the fact that the higher the level of local production, the higher will be the number of locally supplied intermediate goods. The greater the variety of intermediate goods, the greater will be the productivity of the industries using those goods. Modeling of this mechanism in the urban context assumes that increasing the congestion costs of workers commuting to the Central Business District will ultimately exhaust the benefits resulting from a greater variety of inputs (Abdel-Rahman and Fujita, 1990).

- Secondly, in an argument going back to Adam Smith (1776), the increase in the number of workers in one firm, due to an increased scale of production, allows the workers to specialise on a narrower set of tasks. The resulting productivity increase is due to workers' "learning-by-doing" effects. Moreover, the switching between tasks in production is associated with fixed switching costs, which are saved in the case of a greater specialisation. And finally, a greater specialisation on a small set of tasks allows for more technical change, as simpler tasks can be mechanised more easily (Duranton, 1998; Becker and Henderson, 2000a; Becker and Murphy, 1992). A reduction of transport costs by reducing congestion costs in transport or increasing the supply of public transport, potentially widens the market per firm and allows for a greater specialisation of the work force.

- A third positive productivity effect might result from the fact that lower urban transport costs improve the working of the labour market. A positive productivity effect is brought about by the fact that an increase in the number of firms and households trying to find a superior working relation, enhances the expected quality of a match (Helsley and Strange, 1990) and the likelihood of finding such a match (Mortensen and Pissarides, 1999; Berliant *et al.*, 2000b). The pool of interacting firms and households is limited by commuting costs or, in the longer term, by relocation costs.

- A dynamic productivity effect is expected from cities providing opportunities to enhance production-relevant knowledge. Hypotheses on the positive effects of low transport costs on the creation and dissemination of technical and organisational knowledge are based on the perception that learning is not only an individual activity but involves interaction with others, much of which is of a face-to-face nature. Cities, by bringing together large numbers of people, should therefore facilitate the production and use of technical and organisational knowledge. The smaller the intra-urban transport costs, the greater is the potential number of interacting parties.

- Knowledge diffusion is mainly considered to occur via a knowledge transfer from skilled workers to lower skilled and young workers. One mechanism, as in Jovanovic and Rob (1989), is that low-skilled workers increase their skill level by successful face-to-face interaction with skilled workers. The number of contacts between the skilled and unskilled increases with city size (Glaeser, 1999). The smaller the urban transport costs, the higher would be the number and quality of the interactions between the skilled and unskilled labour forces.

- City growth has been considered to be based on the dissemination of all workers' knowledge rather than on the transmission of knowledge from skilled to less skilled workers. The learning abilities of individual workers depend on the level of knowledge already achieved and the aggregate stock of knowledge that is available in the city. The latter provides dynamic external benefits to the workers (Lucas, 1988; Eaton and Eckstein, 1997). At least for the US, there is

strong empirical evidence that the presence of educated populations in cities drives their further growth (Simon and Nardinelli, 2002; Glaeser and Saiz, 2004).

The arguments on the advantages of city size might suggest that the accommodation of an increasing city size by transport policy leads to the productivity and growth effects mentioned above. Such a conclusion is, however, in contrast to some analysis that sees population densities rather than city size as the main determinant of dynamic efficiency in production. Ciccone and Hall (1996) argue the importance of population density for productivity in a more general context, based on an empirical study. Lucas and Rossi-Hansberg (2002) also emphasize density as a driver of productivity. These arguments suggest that sprawl, a reduction of urban density, could indeed reduce agglomeration economies and therefore negatively impact on aggregate productivity. What makes the tension between the arguments asserting the importance of size and density difficult to resolve is the fact that the latter depend on the choice of the geographic area of study. Glaeser and Kahn (2004), for example, conclude that aggregate density at the metropolitan area level matters in explaining variations in per-capita income across cities, but the degree to which jobs are centralised in a Central Business District seems to be irrelevant.

Firms which are able to split management, R&D and production locations, increasingly site non-management occupations at the edge of major cities (Rossi-Hansberg, Sarte and Owens, 2005). These firms are likely to gain greatly from extensions of the city size area.

What complicates the relationship between productivity, growth and urban form further is the fact that the monocentric urban form increasingly gives way to polycentric structures. In addition, and parallel to this development, "centres" change their socio-economic function over time. As was discussed by the Round Table and argued in one of the background papers, the process of land development shares some similarities with slash-and-burn agriculture (Duranton, forthcoming). For commercial developments, economic change (sectoral decline, new technologies, etc.) typically involves leaving a vacant or under-utilised, developed site behind. Changes of urban form and structure involve some element of "creative destruction". Because real developments are highly durable, the creative destruction of production activities and firms implies a movement or re-use of company buildings and possibly a partial or complete desertion of land. The US Environmental Protection Agency, using a restrictive definition and focusing on commercial sites, estimates that there are about 450 000 brownfield sites in the US. British authorities estimate that there are 660 square kilometres of brownfield sites in England alone. Only a small part of the brownfield sites is redeveloped.

City governments or developers have to choose whether to redevelop a brownfield site or initiate new developments on a greenfield site. They face a trade-off between redeveloping a brownfield site, which may allow a better use of existing infrastructure but is maybe associated with high demolition and clean-up costs, and a greenfield development that requires new public infrastructure. From a commercial point of view, a relocation to a greenfield site may look advantageous because the costs for the required infrastructure are not, or not fully, charged to the local users, while firms often have to bear the full redevelopment costs. This allocation problem sometimes extends to communal land use and transport policy decisions, when fiscal redistribution implies that part of the infrastructure costs are borne by non-local taxpayers.

THE SOCIAL COSTS OF URBAN SPRAWL

Parallel to the progress of research on the economic benefits of the current changes in urban form, there is a continuing discussion about the social costs. The debate proceeds on distinct levels. A first level concerns the basic discussion of what should be the foundation of urban and transport policy objectives. More concretely, it tries to find an answer to the question whether individual benefits or some aggregate of individual benefits should be the only or dominant determinant of policy objectives. Often implicitly, the debate seems to evolve around the question of whether governments should supply "meritoric" goods, i.e. goods that have a social value distinct from and beyond the individual perception of their benefits. More generally, such normative arguments are related to an organic understanding of the state (Popper, 2003; Wilson, 1942). The Round Table discussion focussed on the quantitative dimension and the consequences of the social costs of sprawl. This mainly concerns the loss of farm and forest land, the consequences of urban sprawl for the transport system, and the effects of the changes of both land use and the transport system on the environment and public health (Deakin, forthcoming).

The loss of farm- and forestland

US Census data provide the opportunity to quantitatively assess the loss of open space in the form of farmland and forests due to the extension of urban space. In overall terms, the loss does not seem to be dramatic: Over the period 1974 to 2002, the total number of farmland acres in the US declined by about 8 per cent, according to the Census of 2004. Not all of the decrease was due to expanding cities but to changes in agricultural technologies, changing international competitiveness and restrictions on the provision of agricultural subsidies for some farm products. The US Department of Agriculture estimates the average annual decline to be 0.25 per cent over the 1960-2002 period.

What potentially amounts to a more substantial effect for the agricultural sector is the fact that prime farmland has been converted at two to four times the rate of less productive farm land. The loss of prime farmland is considered to be due to the competition between agrarian and urban interests in land use (USDA, 1999). The loss of forests due to urban developments is in some areas greater than forestland preserved to protect the habitat for a variety of flora and fauna, including endangered and threatened species (US Department of Agriculture, Forest Service, 2006).

These problematic trends have been mitigated to some extent by new markets in land development rights (Kahn, forthcoming): Throughout the US, municipalities are purchasing open space around their borders to guarantee that the land is not developed. The city of Boulder, Colorado has, for example, earmarked a 0.73 per cent sales tax to fund the purchase of open space around city borders to avoid it being developed. Whether and how such initiatives occur depends on the political influence of groups with an interest in new land developments and those who prefer greenbelts surrounding cities. Richer communities and jurisdictions with more home-owners seem to be more likely to initiate greenbelt initiatives (Kotchen and Powers, 2006).

Immediate costs of urban sprawl for the transport system

About 90 per cent of all person-trips in the US are made by automobile, and trucks account for more than 90 per cent of all shipments. From 1970 to 2000 the number of vehicle miles travelled has doubled

and truck travel has tripled. The increasing road transport intensity, due to road transport demand growth being greater than population growth, is associated with the expectation that the public transport infrastructure cost per head is increasing. The demand for physical infrastructure is also expected to increase with the rising number of vehicle miles travelled. this is due to the relative decline of public transport use and walking as a consequence of urban sprawl.

The reduced commuting times in sprawled urban areas reported above are sometimes expected to be of a transitory nature, giving way to congestion with increasing congestion costs when scattered suburbanisation is followed by subsequent infill and development. The relatively high commuting speeds are then no longer sustainable (Cervero, 1986; Landis and Reilly, 2003).

Low-density development, and the emergence of a polycentric urban structure, make it difficult and costly to provide bus, light rail or metro services. The increased private car use required by these urban forms is sometimes held to lead to greater resource demands for transport than a transport system with a higher share of public transport and a different settlement pattern.

Environmental costs of the transport consequences of urban sprawl

There is no disagreement that changes in urban form, which reduce the compactness of cities and lower the settlement density, increase the vehicle-miles travelled by individual households and reduce the share of public transport usage. Both effects contribute to current changes of urban form being associated with higher environmental costs for transport. Greenhouse gas emissions from transport are a function of fuel use. In the US, transport is currently responsible for 32 per cent of total carbon emissions. Moreover, its emissions from transport increase by 1 to 2 per cent annually.

Air pollution more generally remains a public health concern. To some extent, this is due to inadequate responses to more restrictive air quality regulations. The full health consequences of air toxins and fine particles have not always led to the required technical standards for transport equipment.

The relationship between urban form and emissions is complicated by the fact that emissions are not a simple product of speed. Stop-and-go traffic, which might result from congestion in compact cities, is more polluting than steady-flow traffic. On the other hand, very high speeds, which might be associated with sprawl and metropolitan highways, also produce very high emission levels.

While not necessarily providing an argument against the environmental concerns relating to low-density settlements, vehicle emissions regulation has been able to offset increased vehicle mileage due to changing settlement patterns. The Los Angeles Basin, for example, suffers from the highest levels of air pollution in the US, mainly caused by vehicle emissions. The area is, at the same time, a prime example of low-density, car-dependent urban development (Giuliano and Small, 1991). But ambient ozone, a leading indicator of smog, declined by 55% between 1980 and 2002, from 0.21 to 0.095 parts per million on average for the country's nine monitoring stations. This decline occurred despite an increase in population of 29 per cent in the same period of time and a 70 per cent increase in total automobile mileage (Kahn, forthcoming). Due to developments in vehicle technology, population growth in low-density areas was not necessarily associated with higher air pollution. Kahn found a negative correlation between country population growth and increased ambient air pollution for California over the years 1997-2002.

Current research shows that relationships between urban form, infrastructure design and travel behaviour are still not fully understood. Much of the research into the relationship between the transport sector and urban form has focussed on physical effects. It is even more demanding to identify the valuations of external costs and benefits of different urban forms. Only a full evaluation of external effects

would allow to draw final conclusions on whether current changes of urban form provide net benefits and how these should be maximised by transport policy action.

CONCLUSION

The Round Table discussed recent research that throws light on the benefits derived and costs incurred through changes of urban form. The development of city sizes and structures is driven by the design of the transport system, and/or confronts transport policy with demands to accommodate or contain ongoing changes of land use.

On the benefit side, the discussion identified two main benefits to be drawn from current trends towards suburbanisation, which amount to an increase in city size, and a decreasing housing and population density in urban areas:

- The decline in housing density has clearly increased the number of vehicle miles travelled. However, beyond a certain threshold distance from traditional city centres, commuting times decrease. While passenger transport became more infrastructure-intensive, travel, and in particular commuting times, decreased. Higher infrastructure investment has led to time savings, owing to reduced congestion. The effect of these changes on fuel consumption is ambiguous: less congestion might lead to lower fuel consumption if higher speeds remain within an intermediate range.

- Households living in low-density settlements, with relatively small land rents, have higher rates of home-ownership and consume more residential land. This has particularly benefited low-income households.

Agglomeration economies are central to the argument that an increase of city size increases the productivity of goods and services. Decreasing transport costs are considered to be instrumental for the spatial extension of the mechanisms leading to agglomeration economies:

- An increase in city size might increase the availability of specialised inputs. This in turn increases the productivity of final goods production.

- An increasing city size driven by lower transport costs might allow a greater specialisation of the work force, leading to productivity effects associated with “learning-by-doing”.

- Lower passenger travel costs within metropolitan areas may increase the performance of the labour market. A more highly mobile workforce is expected to increase the probability and quality matches between employers and workers.

Dynamic agglomeration economies have recently received particular attention. The larger the cities, and the easier the interaction between skilled and unskilled workers or knowledge-producing agents, the higher is the rate of knowledge diffusion, and the higher will be the rate of knowledge production. Both determine the long-run growth of urban as well as national economies. To the extent that the ease of interaction between individuals who transmit or jointly produce knowledge depends on density, urban

sprawl might negatively affect growth. This is strongly influenced by firms deciding to separate management, R&D and production locations. The more companies can split production from research and management, the more they will benefit from increasing city sizes.

Intensive research efforts have led to a great awareness of the costs of urban sprawl. Many effects are, however, context specific. A major part of the research focuses on the physical consequences of urban design and the design of transport systems.

- A first social cost of the current trend toward urban development is seen in the loss of farm- and forestland. While the annual percentage decline of farmland is rather small, some concern exists about the loss being concentrated on prime farmland.

- The immediate, transport-related costs are considered to be high, and to be due to the fact that infrastructure costs are not internalised by users of the transport system. A similar argument is made for congestion costs. The reduction of time losses due to congestion is expected to be a temporary phenomenon, which will disappear with the filling in of vacant land.

- Environmental costs and air pollution, which are due to the augmentation of vehicle-kilometres and the decline of public transit patronage, remain major concerns of critics of increasing city size. This criticism is maintained, despite the strong emission reductions that have been observed in metropolitan areas over the last decade. Rapid developments in car technology, often induced by more restrictive regulations, have led to a reduction of emissions despite the increase in vehicle miles travelled associated with urban sprawl.

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