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Transport poverty and fuel poverty in the UK: From analogy to comparison

Giulio Mattioli [a,b,*], Karen Lucas [a], Greg Marsden [a]

[a] *Institute for Transport Studies, University of Leeds, LS2 9JT, Leeds, UK*
[b] *Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK*

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ABSTRACT

The notion of 'fuel poverty', referring to affordable warmth, underpins established research and policy agendas in the UK and has been extremely influential worldwide. In this context, British researchers, official policymaking bodies and NGOs have put forward the notion of 'transport poverty', building on an implicit analogy between (recognised) fuel poverty and (neglected) transport affordability issues. However, the conceptual similarities and differences between 'fuel' and 'transport' poverty remain largely unaddressed in the UK. This paper systematically compares and contrasts the two concepts, examining critically the assumption of a simple equivalence between them. We illustrate similarities and differences under four headings: (i) negative consequences of lack of warmth and lack of access; (ii) drivers of fuel and transport poverty; (iii) definition and measurement; (iv) policy interventions. Our review suggests that there are important conceptual and practical differences between transport and domestic energy consumption, with crucial consequences for how affordability problems amongst households are to be conceptualised and addressed. In a context where transport and energy exhibit two parallel policy worlds, the analysis in the paper and these conclusions reinforce how and why these differences matter. As we embark on an ever closer union between our domestic energy and transport energy systems the importance of these contradictions will become increasingly evident and problematic. This work contributes to the long-term debate about how best to manage these issues in a radical energy transition that properly pays attention to issues of equity and affordability.

1. Introduction

Domestic and transport energy consumption have traditionally belonged to distinct academic and policy silos. Recent developments, however, suggest the need for convergence. The UK is committed to reducing greenhouse gas emissions by 80% by 2050, and reductions have to be achieved across all sectors (HMG, 2010). This includes both transport and domestic energy uses, which together account for most of household emissions (Preston et al., 2013). Strongly connected to this agenda is the need for technological decarbonisation of the private car fleet with a shift to electric vehicles powered through charging from the grid or hydrogen generated from 'green' electricity (OLEV, 2013).

Affordability in both the domestic and the transport sector is a critically important issue, which has high political salience (Lyons and Chatterjee, 2002; Preston et al., 2013; RACF, 2012). However, the approaches to conceptualising energy need and affordability are currently quite different within these two sectors. With an ever closer coupling of domestic energy and energy for mobility these conceptual gaps will become difficult to defend, and this paper, therefore, seeks to explore and propose ways to close that gap.

A reflection on energy affordability is also particularly salient now because, whilst the status quo of affordability is unevenly distributed (Preston et al., 2013), a transition to a new lower carbon system for domestic energy and mobility could imply quite radical shifts in prices (Stern, 2006; Weber and Matthews, 2008) and access to alternatives (Mullen and Marsden, 2016). This has generated an initial literature which raises concern for the vulnerability of different (and especially low-income) social groups to the current energy transition (Bickerstaff et al., 2013; Dodson, 2013; Jouffe and Massot, 2013; Lucas and Pangbourne, 2014), as well as for the accessibility and affordability of energy services across both sectors (Bouzarovski and Petrova, 2015; UN-Habitat, 2013).

This paper begins by situating the debate about energy affordability in the British context, where substantial research traditions exist in both domestic and transport energy consumption. The UK has long established the notion of 'fuel poverty' (Boardman, 1991, 2010; DEFRA, 2001; Hills, 2012), which refers to the affordability of domestic energy and most notably heating. This notion underpins established research and policy

* Corresponding author. Present address: Room 104, Institute for Transport Studies, University of Leeds, 34-40 University Road, LS2 9JU, Leeds, UK.
E-mail addresses: g.mattioli@leeds.ac.uk, giulio.mattioli@gmail.com (G. Mattioli).

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agendas in the UK, and it influences how these issues are now being framed in an increasing number of countries (e.g. Bafoil et al., 2014; Bouzarovski and Petrova, 2015; Heindl, 2015; ONPE, 2014).

Similarly, the worldwide influence of the UK 'transport and social exclusion' research tradition within transport poverty policy in the UK cannot be understated (Cass et al., 2003; DfT, 2006; Hine and Mitchell, 2003; Lucas, 2004, 2012; SDC, 2011; SEU, 2003). However, this research has focused largely on low mobility individuals and carless households, while transport affordability, the costs of motoring, and vulnerability to fuel price increases have received less attention than in other countries (Mattioli, 2015).

In this context, British researchers and NGOs have put forward the notion of 'transport poverty', building on an implicit analogy between (recognised) fuel poverty and (neglected) transport affordability issues. However, the justification for this analogy, and its implications for how transport affordability should be defined, measured and tackled have rarely been discussed.

This paper aims to fill this gap, by *critically comparing and contrasting* the notions of fuel poverty and transport poverty. In doing so, it questions the assumption of a simple equivalence between the two problems, illustrating how transport consumption is conceptually different from domestic energy and heating consumption in a number of key respects. To the best of our knowledge, this is the first English-language publication to offer a thorough critical discussion of the two problems in a comparative perspective.

The article is structured as follows. Section 2 focuses on domestic energy affordability. After an overview of debates in the UK (2.1), the notion of fuel poverty is discussed under four headings: consequences (2.2), drivers (2.3), measurement (2.4) and policies (2.5). Section 3 focuses on transport affordability, starting with a discussion of the fuel poverty - transport poverty analogy in British debates (3.1), followed by a comparison of the two problems, which is structured under the same four headings (3.2–3.5). In Section 4, we conduct a critical assessment of similarities and differences, and outline directions for future research and discuss policy implications.

2. Domestic energy affordability and 'fuel poverty'

2.1. The fuel poverty debate in the UK

Brenda Boardman's book "*Fuel poverty: from cold homes to affordable warmth*" (1991) provided a first and well-known definition of fuel poverty as being "unable to obtain an adequate level of energy services, particularly warmth, for 10 per cent of (household) income" (1991, p.207). The first *UK Fuel Poverty Strategy* (DEFRA, 2001) adopted Boardman's 'ten per cent ratio' definition (TPR in the following) and committed the government to the 'eradication' of fuel poverty by 2016, publishing data and reports annually (e.g. DECC, 2016; FPAG, 2014; DECC, 2009).

Following growing criticism of this definition (Liddell et al., 2012; Moore, 2012), in 2010 the government commissioned an independent review (Hills, 2011, 2012). The outcome was the 'Low-Income-High-Costs' (LIHC) indicator, which was adopted as the new official definition of fuel poverty in England. LIHC defines fuel poor households as those who (i) have "required fuel costs that are above the median level" and (ii) "were they to spend that amount they would be left with a residual income below the official poverty line" (Hills, 2012, p. 9). In 2014, 10.6% of English households (2.38 million) were fuel poor (DECC, 2016).

An important characteristic of the British debate is the ambiguity about which domestic energy uses are considered. While all energy uses within the home are considered in the official indicators, policy and public discourse typically focus on heating only (Simcock and Walker, 2015; Simcock et al., 2016). For simplicity, in this article we refer to fuel poverty as a space heating issue only.

2.2. Health and social consequences

The negative physical health consequences of living in cold and damp conditions have been emphasised (Boardman, 2010; Hills, 2011; Liddell and Morris, 2010; Ormandy and Ezratty, 2012; Simcock et al., 2016), and this magnifies the political salience of fuel poverty in the UK. Living at cold temperatures has been linked to the incidence of cardiovascular events, respiratory problems, rheumatisms and infections (WHO, 1987), and to increased rates of mortality during winters ('excess winter deaths') (Boardman, 2010; Hills, 2011; Liddell et al., 2016). In 2014/2015 "an estimated 43,900 excess winter deaths occurred in England and Wales", 83% of which among people aged 75 and over (ONS, 2015; unpaginated).

Beyond health impacts, fuel poor households face a choice between enduring cold temperatures, incurring debt, and cutting expenditure in other areas (Anderson et al., 2012; Gibbons and Singler, 2008; Hills, 2011, p.86–87), such as food consumption (Beatty et al., 2014).

2.3. Drivers of fuel poverty

In mainstream fuel poverty research, lack of warmth is seen to arise from three factors (Boardman, 2010; Hills, 2011): income, energy prices and energy efficiency.

Fluctuations of *energy prices* over time have been reflected in estimates of the extent and depth of fuel poverty (DECC, 2016). Recent increases in domestic energy prices reflect changes in global energy markets, but also the cost of environmental obligations put by the government on energy suppliers, which are recouped through higher energy prices (Hills, 2011; Preston et al., 2013). The *thermal efficiency* of homes is a second key driver, with fuel poverty rates higher for households in dwellings that are larger, older, poorly insulated and/or not connected to the gas grid (DECC, 2016). At a given moment in time, fuel poverty correlates strongly with *low-income* (Boardman, 2010, p.31–32): in 2014, fuel poverty rates were highest (40%) among the lowest income quintile group (DECC, 2016, p.53).

Research has highlighted two types of 'mismatches' between the drivers of fuel poverty, i.e. situations where they could (or should) offset each other, but they do not (similar mismatches can be observed in the case of transport poverty, as we shall see in Section 3.3):

1. a mismatch *between income and energy efficiency*. Boardman argues that as "the lower the income of the household, the more energy efficient the property has to be to ensure that they are not in fuel poverty (…), the poorest people should have the most energy-efficient homes" (2010, p.35–36). In Britain, lower income households are more likely to live in smaller properties, in flats and in modern or recently renovated social housing, all factors that tend to result in higher thermal efficiency (Hills, 2011, p. 41–42). On the other hand, they are more likely to use expensive fuels and less likely to be able to make capital investments on energy efficiency improvements, and this can leave them "locked-in to high energy costs" (Hills, 2011, p. 39). Overall, the Hills review found no significant differences in thermal efficiency between income groups, after controlling for tenure (2011, p.42)
2. a mismatch *between income and fuel prices*: low income households generally pay higher tariffs, as a result of payment method (higher prevalence of prepayment meters), marginal cost pricing (whereby smaller consumers pay proportionally more) and inability or unwillingness to "shop around for the best deals" (Boardman, 2010, p.81–97; Hills, 2011, p.44–50). Overall, while Boardman argues that the poorest households should have access to the cheapest options (2010, p. 89) the opposite seems to be the case.

2.4. Measurement

There are four key components to the official definitions of fuel poverty adopted in the UK (Boardman, 2010, p.22–24; Hills, 2011, p.7; Walker et al., 2015 - see Table 2 in Section 3.4), which are important to bear in mind for when we later discuss the measurement of transport poverty.

First, the unit of analysis is the household, reflecting the reasonable assumption that household members share income and house space, and therefore will be affected to the same extent by cold temperatures and/or by the negative consequences of spending disproportionate amounts on domestic energy.

Second, both official indicators of fuel poverty for England are based on *modelled* estimates of *required* (rather than *actual*) spending on domestic energy services. This means that "households whose actual expenditure is low because they cannot afford enough fuel to be warm are not wrongly considered not to be in fuel poverty (while) households who have high expenditure while wasting energy are not considered to be fuel poor" (Hills, 2012, p. 30).

The modelling of 'required spending' on space heating consists of four steps (for details see Table 2 below, Simcock and Walker, 2015): (i) specification of a temperature standard; (ii) application of one of four 'heating regimes' (i.e. number of hours and portion of the house that need to be heated); (iii) estimation of required energy consumption; (iv) estimation of required expenditure.

A third key component of the measurement is the calculation of the threshold of affordability: having to spend more than the critical value is the, or one of the criteria for being defined as fuel poor. In TPR, the threshold is defined based on cost burden, i.e. the ratio between spending and income (10%). This originally corresponded to twice the median cost burden actually observed in the British population and to the average expenditure ratio among the lowest 30% of the income distribution in 1988 (Liddell et al., 2012). The LIHC indicator is based on a threshold of required domestic energy costs, i.e. not normalised based on income. Here the critical value is not fixed, but corresponds to the median required costs estimated based on the annual sample, equivalised to reflect the different energy needs of different types of households.

A fourth component of the measurement, the definition of a critical threshold of income, only applies to LIHC. With the new LIHC indicator, non-poor households are excluded a priori from fuel poverty, unless high required domestic energy costs bring their residual income below the official poverty line (Hills, 2012). Under Boardman's previous TPR indicator all households having to spend more than 10% on domestic energy were considered fuel poor, regardless of income.

2.5. Policy responses

Fuel poverty policies are generally categorised based on the three drivers. Table 3 (in Section 3.5) presents examples of UK policy schemes (past or present) fully or partially aimed at fuel poverty alleviation, alongside a discussion of similar measures for transport poverty.

1. *Income* policies consist of government transfers to households to help them pay domestic energy costs. In England, a large share of the expenditure on fuel poverty mitigation is accounted for by these measures (Hills, 2012, p.115; Boardman, 2010, p.154; HMG, 2015, p.35). The fact that Winter Fuel Payments are made to all households with an elderly member, regardless of other factors such as income (Table 3), has drawn criticism as this is seen as a poorly targeted and inefficient measure to mitigate fuel poverty (Boardman, 2010; Hills, 2012; Preston et al., 2013).
2. *Price* policies. In the UK the degree of government control on energy tariffs is limited due to market liberalisation and privatisation. However the government regulator has the power to impose obligations on the energy suppliers, and since 2011 these are required to provide rebates to low-income or vulnerable households.
3. *Energy efficiency*. Grants are provided to low-income households that need support to undertake capital expenditure for heating efficiency improvements. There is some overlap with climate policy here, with some schemes aiming at improving the thermal efficiency of the housing stock across the board, but including components that target specifically low-income households and deprived areas (Table 3).

Having discussed the key components of the definition, measurement and policy responses to domestic fuel poverty, we now turn our attention to the issue of transport poverty.

3. Transport affordability and 'transport poverty'

3.1. The fuel poverty – transport poverty analogy in the British debate

While the concept of fuel poverty has a well-established set of definitions, binding policy targets and monitoring processes, there is a relative lack of academic and policy interest for questions related to transport poverty in the UK. So far in this article the term 'transport poverty' has been used in a generic way. It is crucial, however, to ensure a clear and consistent use of terms in this area. In the international academic literature, the term is used in two essentially different ways. In a broader understanding, it is used to refer to all kinds of inequalities related to transport and access (e.g. Lucas et al., 2016b;Martens, 2013; Velaga et al., 2012), i.e. as *poverty of transport*. In this meaning, the term is used alongside other notions such as 'transport-related social exclusion' (e.g. Preston and Rajé, 2007; SEU, 2003), 'transport disadvantage' (Currie, 2011; Hine and Mitchell, 2003), etc. In a more specific meaning, 'transport poverty' is used to refer to the affordability of transport costs (e.g. Gleeson and Randolph, 2002). In this understanding, it is used alongside other notions such as 'transport affordability' (e.g. Litman, 2015; Lucas et al., 2016b), 'forced car ownership' (e.g. Curl et al., in press; Currie and Senbergs, 2007) and 'car-related economic stress' (Mattioli and Colleoni, 2016; Mattioli et al., 2016b). From here on in this paper, we will use 'transport poverty' to refer to the former, broader problem, and 'transport affordability' to refer to the latter, more specific issue (for a fuller discussion of terminology in this area see Lucas et al., 2016b).

In developed countries, research on transport affordability has focused mostly on households who need to spend a disproportionate amount of money on car-based mobility in order to access essential services and opportunities. This reflects the fact that motoring accounts for around 80% of all household spending on transport in OECD countries (Kauppila, 2011, p.6), and the assumption that car ownership and use can be a necessity in car-dependent societies. In the UK, there have been few attempts to quantify the prevalence of transport affordability problems in the population. These have typically been based on an analogy with fuel poverty, but have produced very different findings, as illustrated in Table 1. On the policy side, the Environmental Audit Committee of the House of Commons' inquiry into "Transport and the accessibility to public services" asked stakeholders whether "a measure of the transport accessibility of key public services, in a similar manner as 'fuel poverty', (would) be useful for policy-making (and if so, how should it be defined?)", finding "some support" for the idea (EAC, 2013, p. 9–10).

Overall, then, the British debate on transport affordability has been dominated by an *analogy* with the dominant fuel poverty agenda, in which the substantial equivalence between the two issues has been largely implied and taken for granted. As a result, a critical discussion of the similarities and differences between domestic energy affordability and transport affordability has not been undertaken in the UK yet. Internationally, however (and notably in a French-speaking context), a number of studies have *explicitly* compared the two issues, both theoretically (Jaboeuf et al., 2016; Jouffe and Massot, 2013; ONPE, 2014; Saujot, 2012) and empirically (Berry et al., 2016; Cochez et al., 2015; Desjardins and Mettetal, 2012; Mayer et al., 2014; Ortar, in press; Verry et al., 2017), mostly concluding that there are important conceptual differences between them. In the following sections, we build on these contributions and offer a discussion of transport affordability as seen through the lens of British fuel poverty research and policy. This is useful in light of the international influence that the 'fuel poverty' notion has had to date.

Table 1
Studies quantifying the prevalence of transport affordability problems in the UK.

Source	Definition	Findings	Fuel poverty indicator of reference
RACF (2012)	*Transport poverty* as when "more than ten percent of (household) expenditure goes on transport (both personal and public)"	"21 million households in transport poverty. An estimated four fifths of the UK's 26 million households"	Boardman's TPR indicator (Boardman, 1991)
Sustrans (2012)	Composite *'risk of transport poverty* index, based on three variables: 1. households that would need to spend 10% or more of their income on car running costs 2. people living more than one mile from nearest bus or station 3. number of essential services that would take more than 1 h to access by walking, cycling and public transport	"Nearly 1.5 million people are at high risk of suffering from 'transport poverty'. Half of all local authorities in England have at least one high risk area"	
Lovelace and Philips (2014)	*Commuter fuel poverty* as the proportion of people spending more than 10% of their income on work travel	For three selected areas in York, the proportion of commuter fuel poor is respectively 3.3% (central area) 1.7% (suburb) and 5.9% (outskirts)	
Mattioli et al. (2016b)	Household in *car-related economic stress* if: 1. equivalised income after housing and running motor vehicles costs is below 60% of the median 2. the percentage of income spent on running motor vehicles is more than twice the sample median (i.e. 9.5%)	An estimated 9.4% of households in the UK (corresponding to roughly 2.5 million households) were in car-related economic stress in 2012.	Hills' LIHC indicator (Hills, 2012)

3.2. Social consequences

The less obvious causal chain between lack of affordable transport and its negative social consequences might explain the relative lack of policy interest in the problem of transport affordability, especially if compared to the political salience of fuel poverty and its clear negative health consequences.

Transport is a derived demand, i.e. a certain amount of mobility is generally required to access services and opportunities, as well as to engage in social activities and networks. Hence transport and access problems have been suggested to be contributory factors to a wide range of poor life outcomes (SEU, 2003) including unemployment (Blumenberg and Manville, 2004; Cebollada, 2009; Cervero et al., 2002; Dobbs, 2007; Lucas, 2004; Lucas and Nicholson, 2003; Smart and Klein, 2015), reduced participation in education and training (Currie, 2007; Kenyon, 2011; Owen et al., 2012), poor diets (Wrigley, 2002), reduced health services usage (Mackett and Thoreau, 2015; Neutens, 2015; Páez et al., 2010), as well as exclusion from a wider range of social activities and social networks (Cass et al., 2003; Farber and Páez, 2009, 2011; Mollenkopf et al., 1997; Scheiner, 2006; Schwanen et al., 2015).

In each of these areas, however, transport is generally only one factor among many others in explaining the observed and associated social inequalities. Furthermore, while there is quantitative evidence to demonstrate the relationships between transport disadvantage, reduced social inclusion, social capital and well-being (Currie, 2011), these are less likely to draw public and political attention than reported figures for excess winter deaths.

As with fuel poverty, limiting spending on transport is not the only short-term option for households struggling to afford transport costs, as they can curtail spending in other areas (BBSR, 2009) and/or incur debt (Walks, in press). There is evidence to suggest that transport and motoring costs are given high priority by households, who prefer to cut other costs first (Deutsch et al., 2015; Ferdous et al., 2010; Froud et al., 2002; Gicheva et al., 2007; Taylor et al., 2009). Notably, empirical studies on energy-related economic stress suggest that households are more likely to maintain their travel patterns and reduce domestic energy consumption than the other way round (Jouffe and Massot, 2013; Desjardins and Mettetal, 2012), suggesting a possible causal link from transport affordability to fuel poverty. The prioritization of transport costs is often explained by the fact that travel is a precondition for employment and income generation for households.

3.3. Drivers of transport affordability

The broad issue of *transport poverty* has a wide range of drivers, including non-economic factors such as disability, age, gender, ethnicity, household type, and cognitive and psychological factors, etc. (Lucas et al., 2016b). If the focus is on the more specific issue of transport affordability, however, it makes sense to assume that the drivers are the same as those of fuel poverty: income, prices and energy efficiency. These are critically discussed below.

3.3.1. Income

Most research on transport affordability in developed countries has focused on motoring among low income groups. In detail, two distinct manifestations of affordability problems in relation to car ownership and use have been brought to light. First, low-income households are more likely not to be able to afford car ownership (Mattioli, 2013a; Lucas et al., 2016a). The lack of car ownership is often associated with reduced accessibility to key service facilities and everyday activities, most notably in car dependent areas where modal alternatives are few (e.g. Cervero et al., 2002; Lucas, 2004; Mattioli, 2014; Smart and Klein, 2015). This can result in reduced overall travel as a result of 'suppressed travel demand' (Duvarci and Mizokami, 2009). To adopt the terminology of fuel poverty research, many low-income household *underspend* on travel, as a result of being unable to afford the *capital expenditure* on car ownership, which would enable them to travel more and satisfy their accessibility needs.

The second manifestation is that of households who own and use cars despite limited income, and therefore have to trade-off transport costs against spending in other essential areas, resulting in 'forced car ownership' and 'car-related economic stress'. Mattioliet al. (2016b) show that around 9% of UK households have low income, high motoring costs, and low capacity to reduce fuel demand in response to higher prices, which leaves them in a situation of vulnerability.

In both cases, the *recursive relationship between transport expenditure and income generation* adds a further layer of complexity. Individuals can be unemployed (or in lower-paying jobs) because they are unable to afford car ownership and/or commuting costs (Belton-Chevallier et al., in press). At the same time, some households are willing to spend large amounts on commuting travel, curtailing other expenses, as the alternative is an even lower standard of living as a result of reduced income (Fol, 2009; Froud et al., 2002; Lucas, 2011). Indeed, empirical studies have found that commuting costs can be very large as compared to household income (Smart and Klein, 2015) and that employed households are overrepresented among those spending disproportionate amounts on transport (Jouffe and Massot, 2013; Mattioli et al., 2016a,b; Nicolas et al., 2012; Verry et al., 2017). This recursive relationship has no clear equivalent in fuel poverty.

3.3.2. Prices

Historically the affordability of all transport modes has increased in real terms in most countries (Schäfer et al., 2009). However, as a result of the massive increase in travelled distances and the associated shift towards car travel (which is more expensive on a per kilometre basis) the share of transport on total household spending has remained relatively constant over time *at the aggregate level* (Kauppila, 2011; Schäfer et al., 2009), although it varies greatly across different social groups.

Lower-income households generally spend a smaller share of their transport budget on vehicle purchase, and more on running motor vehicles and public transport fares (Demoli, 2015; Kauppila, 2011; Titheridge et al., 2014). Fig. 1 depicts the evolution of transport costs in the UK between 1996 and 2015, showing that while vehicle prices have significantly declined, other components (running costs of private vehicles and public transport) have increased or remained stable over time. Arguably, these trends are not beneficial to transport affordability, as the components of transport costs that are most significant for low-income households have increased since 2003. Internationally, high oil and motor fuel prices between the early-2000s and 2014 have resulted in a surge of studies on transport affordability (e.g. BBSR, 2009; Dodson and Sipe, 2007; Ferdous et al., 2010; Gertz et al., 2015; Lovelace and Philips, 2014; Motte-Baumvol et al., 2010; Nicolas et al., 2012).

3.3.3. Energy efficiency

As with fuel poverty and heating, in this paper we adopt a broad definition of energy efficiency as the total amount of transport-related energy required to satisfy a given set of accessibility needs (in terms of activity participation). In this perspective, energy efficiency consists of three components. First, the *required travel distances* to activity destinations and the *practicability of energy-efficient modes*, two factors which are strongly influenced by urban form, land use and the characteristics of the built environment. A third factor is the *energy efficiency of motor vehicles*. These components are discussed in turn below.

There is a large body of evidence on the relationships between land use, the built environment and travel behaviour (Ewing and Cervero, 2010), showing that low density, distance from city centres and mono-functional land use patterns are associated with increased car travel. Empirical studies have shown that higher-density urban areas have lower transport-related energy consumption and carbon emissions (Kennedy et al., 2009; Liddle, 2013; Newman and Kenworthy, 1999; Rickwood et al., 2008), because distances between residences and activity destinations are shorter, and this makes more energy-efficient modes like walking, cycling and public transport more practicable, reducing car dependence. This relationship holds at a lower geographical level: in England there is a negative relationship between degree of urbanity and household energy usage from motor vehicles (Chatterton et al., 2016), as well as with motor running costs (Chatterton et al., in press), at the small area level. Other studies confirm the inverse relationship between degree of urbanisation and total transport spending (Kauppila, 2011; Titheridge et al., 2014).

This highlights the importance of the residential location choices of households. These are driven by a wider range of factors than just transport costs (Scheiner, in press), including notably housing costs (Coulombel, in press; Gertz et al., 2015; Li et al., in press), but also other factors such as e.g. proximity to social networks, lifestyle choices, etc. (Belton-Chevallier et al., in press; Mullen and Marsden, in press; Ortar, in press). Also, from the perspective of households, improving transport energy efficiency through residential relocation is a more difficult and disruptive choice than improving home heating efficiency through

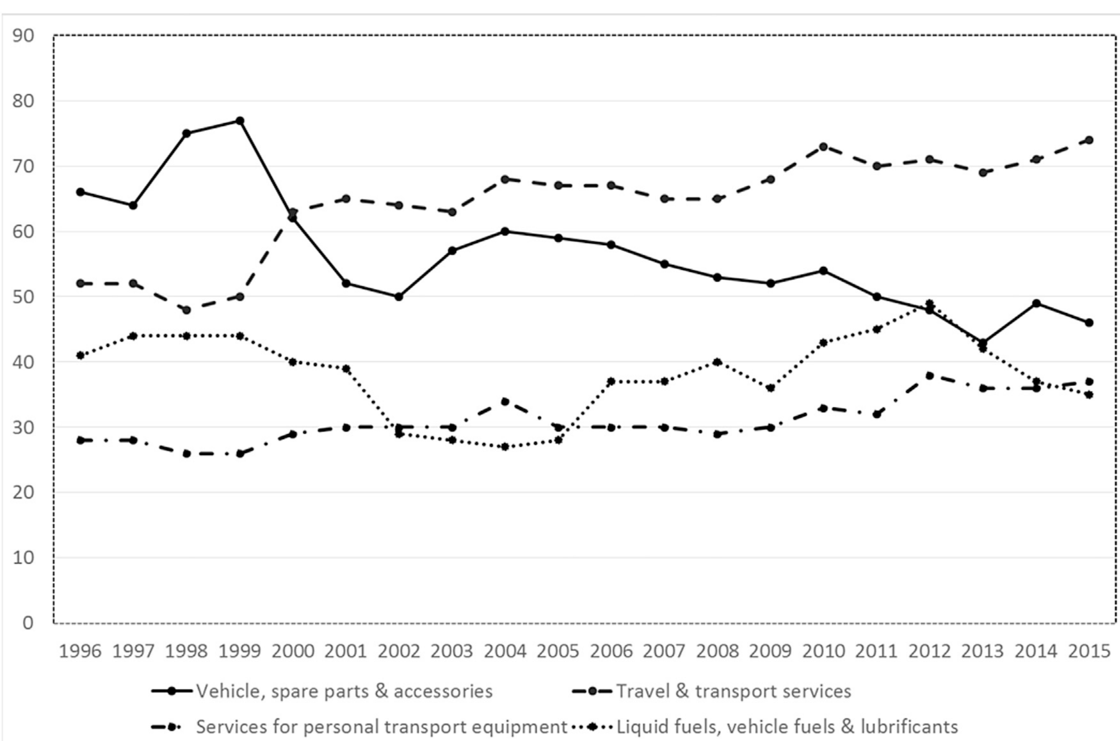

Fig. 1. Transport-related components of the Consumer Price Index for the UK, 1996–2015. Source: Office for National Statistics.

housing renovation (Desjardins and Mettetal, 2012). Overall, this suggests that the lock-in into low energy efficiency may be stronger for transport affordability than for fuel poverty.

A third component of transport energy efficiency is vehicle efficiency. While the energy efficiency of the housing stock increases almost by definition over time (Boardman, 2010, p.130; DECC, 2016, p.19), this is not the case for transport energy efficiency as we have defined it here. Historical trends towards suburbanisation have meant relative population gains for the areas with the highest transport-energy consumption (Breheny, 1995). At the same time, technological improvements in vehicle fuel efficiency have historically been offset by other factors (larger and more powerful vehicles, declining occupancy rates) (Schäfer et al., 2009), although this may change in the future.

3.3.4. Mismatches

As with fuel poverty, there are possible 'mismatches' between the drivers of transport affordability listed above. We discuss two examples of mismatches between income and energy efficiency here:

1. Urban research demonstrates the existence of a variety of 'urban socio-spatial configurations', i.e. patterns in the distribution of income groups across city-regions (Kesteloot, 2005). To put it simply, in some urban areas the rich tend to live in the urban core, and the poor in peripheral areas, while in others the opposite pattern is observed. Since generally central areas are characterised by better levels of accessibility and lower car dependence, these configurations have opposite effects on transport affordability problems (Mattioli and Colleoni, 2016), i.e. they may compound them, as in Australian cities (Dodson and Sipe, 2007), or alleviate them, as in Christchurch, New Zealand (Rendall et al., 2014). This suggests the need for a context-sensitive analysis of the relationships between transport affordability and urban socio-spatial configurations
2. A second mismatch concerns socioeconomic lags and gradients in access to energy- and cost-efficient vehicle technology. If low-income households owned the most fuel-efficient vehicles, this would help with transport affordability. However, high upfront costs of new and technologically superior vehicles, including electric vehicles (Tran et al., 2012), might mean that low income households run less energy efficient vehicles, compounding transport affordability problems. Here the parallel with fuel poverty is accurate, as in both domains high initial capital expenditure is a condition for benefiting from low running costs. Australian studies (Li et al., 2013, 2015) have found lower vehicle efficiency in areas of lower socio-economic status, due to more frequent ownership of old and large engine vehicles.

3.4. Measurement

The adoption of metrics developed in fuel poverty for use in the transport domain is tempting, but it is not without its challenges, because of the conceptual differences between fuel poverty and transport affordability. In Table 2, we identify four key components to the official English indicators of fuel poverty (as discussed in Section 2.4), along with factors of complexity and proposed solutions for developing a similar metric for transport. Elsewhere (Mattioli et al., 2016b) we present the results of an empirical study where a metric has been developed according to the solutions proposed in Table 2.

A first factor of complexity is that, while fuel poverty is clearly a household attribute, transport and accessibility problems reside with individuals rather than the whole household - i.e. one member of a household may experience it whilst another member of the same household does not. Therefore, while income is better treated as a household attribute, transport needs should be assessed at the individual level, and this complicates the definition of a metric of transport affordability. We propose that, while transport affordability should be quantitatively assessed at the household level, complementary approaches (possibly involving qualitative methods) should be developed to investigate within-household variation.

A second and key characteristic of English fuel poverty metrics is that they are based on a modelled assessment of *required* domestic energy use, i.e. of households' heating *needs*. As previous research has pointed out (Berry et al., 2016; Jouffe and Massot, 2013; Mayer et al., 2014; ONPE, 2014; Stokes and Lucas, 2011; Titheridge et al., 2014) the adoption of this approach for transport affordability runs into extremely serious obstacles. A modelling of required transport spending would require the definition of normative standards of out-of-home activity participation, allowing for sufficient variation between different types of individuals.

While fuel poverty modelling allows for just four different heating regimes, the highly individualised nature of accessibility needs results in much greater, and potentially overwhelming, complexity. For example, older people would need to access different services, and with a different

Table 2
Key components of official fuel poverty metrics in England, factors of complexity for transport affordability and proposed solutions.

Key component	Fuel poverty metrics	Transport affordability	
		Factors of complexity	Proposed solution
Unit of analysis	Households: household members share both income and house space.	Transport needs are attributes of the individual, i.e. vary among household members, while income is better treated as a household attribute.	Transport affordability metrics should be based at household level. Complementary approaches need to be developed to assess within-household variation.
Modelling of required energy use and related expenditure	Four steps: (i) temperature standards based on WHO (1987) guidance (21 °C in living rooms and 18 °C in bedrooms); (ii) four heating regimes based on activity status of adults and under-occupancy (i.e. whether house size is too large as compared to household size); (iii) required energy consumption estimated based on actual thermal efficiency of dwelling, heating system, boiler, etc.; (iv) required expenditure estimated based on prices It allows to include 'underspending' (and exclude 'overspending') households.	Overwhelming complexity of defining activity participation standards given their highly individualised and context-specific nature. Each required trip would need to be assigned destination, travel distance and mode, based on an assessment of geographical context, individual abilities and time availability.	Transport affordability metrics should be based on *actual* (rather than modelled) expenditure. Other approaches can be used to assess under-spending and suppressed travel demand.
Affordability threshold	TPR: 10% as twice the actual median cost burden of domestic energy in the UK in 1988 LIHC: median required costs of domestic energy estimated for that year, equivalised based on ad-hoc factors	10% or other thresholds originally estimated based on domestic energy costs data are not suited for use in transport.	Any threshold of transport affordability should be derived by data on *transport* spending.
Income threshold	TPR: absent, but regressive distribution of domestic energy costs ensures that most non-poor households are excluded anyway. LIHC: 60% of median residual income (after housing and required domestic energy costs)	Unlike domestic energy costs, transport costs are not necessarily regressively distributed, therefore a simple cost burden threshold will not ensure that well-off households are excluded.	An income threshold is necessary for an indicator of transport affordability. LIHC approach should be preferred to TPR.

frequency, than commuting parents, etc. (Solomon and Titheridge, 2009). Also, the required activity sets would be different for different household members. Moreover, while fuel poverty measures are based on expert knowledge on healthy temperature ranges (WHO, 1987), there is no comparable knowledge on standards of out-of-home activity participation, with greater scope for disagreement on what ought to be included.

Given these complexities, we argue that it is not currently advisable to develop metrics of transport affordability based on the modelling of *required* transport spending. The definition of ‘accessibility benchmarks’ for different types of household remains an interesting area of research (Solomon and Titheridge, 2009), and further studies into normative mobility standards could contribute to the development of better transport affordability metrics in the future (Jaboeuf et al., 2016; Jouffe and Massot, 2013; ONPE, 2014; Titheridge et al., 2014). We argue, however, that the drawbacks of employing wrong models of required travel (in terms e.g. of misleading policy recommendations) currently outweigh the benefits.

We therefore suggest that it is preferable to adopt affordability metrics based on *actual* transport expenditure. Adopting this approach, Mattioli et al. (2016b) find for example that 9.4% of UK households spend more than 9.5% of their income on costs related to running motor vehicles, while having residual income below the poverty line. The main drawback of this approach is that it does not allow the identification of ‘under-spending’ households, who spend less than they ought to because they curtail travel to essential activities. Arguably, however, this is not such a limitation, since other approaches exist to quantify the prevalence of reduced mobility and suppressed travel demand (see e.g. Duvarci and Mizokami, 2009; Falavigna and Hernandez, 2016; Lucas et al., 2016a). Transport affordability metrics based on actual expenditure can complement these insights with an assessment of households spending an excessive amount of money on travel, i.e. possibly curtailing spending in other parts of the budget. Another possible limitation of this approach is that it does not exclude ‘overspending’ households, i.e. those spending more than they ‘need’ on transport. However, this issue can be mitigated by building an income threshold into the indicator, as discussed below.

The third and essential component of English fuel poverty metrics is an affordability threshold. TRP and LIHC both derive this threshold by the average (required or actual) level of spending on *domestic energy* (see Section 2.4). It is clearly inappropriate to adopt the exact same thresholds for transport (e.g. the 10% cost burden threshold – see Table 1), particularly given the fact that on average households spend more on transport than on domestic energy. A more sensible approach is to base the threshold on figures of spending for *transport*. For example, Nicolas et al. (2012) propose a threshold at 18% of income spent on transport, corresponding to twice the median of actual expenditure in France. A similar approach has been adopted by further studies (e.g. Berry et al., 2016; Mattioli et al., 2016b; Mayer et al., 2014).

Finally, while the LIHC fuel poverty indicator includes an income threshold, TRP does not. However, in practice this does not lead to major differences as domestic energy spending is regressively distributed (Boardman, 2010, p.22–24). This is not the case for transport: in a review of ‘stylised facts about household spending on transport’ in OECD countries, Kauppila (2011) finds that the cost burden of transport increases as income increases, i.e. richer households spend proportionately more of their wealth on transport, mainly as a result of greater car ownership and use. This suggests that the TPR indicator is potentially misleading when applied to transport spending, as it may lead to include mid-to-high income households with sufficient residual income, who may be ‘overspending’ on travel for reasons including e.g. preference for distant activity destinations. We argue therefore that the LIHC approach is better suited for use in transport, as it excludes such households. While it is possible that some households below the poverty line spend more on travel than they need to, it is reasonable to assume that overspending is not so common among households whose resources are very limited.

3.5. Policy responses

As with fuel poverty, we categorise policies to tackle transport affordability based on the three drivers (Table 3). Our focus in this section is mainly on the UK context, although for illustrative purposes we also refer to examples of policies in other developed countries.

Table 3
Examples of policies to tackle fuel poverty and transport affordability in the UK [policies not implemented in the UK in square brackets].

	Fuel poverty	Transport affordability
Income policies	Taxpayer-funded cash transfers made to qualifying households to help them pay domestic energy bills (but with no requirement that they are actually spent on it): • *Cold Weather Payments* (1994-present): made when temperatures are predicted to be below 0°C, to individuals receiving certain means-tested benefits • *Winter Fuel Payments* (1997-present): made every winter to all households with a member aged 60 or over	[Public transport: demand-side subsidies such as transport vouchers and direct transfers using the welfare system] Financial aids to car ownership and use: e.g. low-interest loans to subsidize vehicle acquisition, subsidised driving lessons, repair and maintenance grants, and social benefits to cover the cost of car trips. [Income tax deductions for commuting]
Price policies	Requirements on energy suppliers to provide bill rebates to low-income and/or vulnerable households: • *Warm Home Discount* (2011-present): targeted to low-income pensioners and other vulnerable households (specific eligibility criteria defined by energy suppliers)	Reduced or discounted fares for vulnerable groups, concessionary travel passes: • *English National Concessionary Bus Travel Scheme* (2000-present): free off-peak bus travel for English residents having attained the state pension age
Energy efficiency policies	Taxpayer-funded interventions for heating efficiency improvements: • *Warm Front Scheme* (2001–2013): grants targeted at low-income households living in dwellings with poor thermal energy efficiency, mostly in the private housing sector • *Decent Homes Standard* (2000-present): efficiency improvements in social housing Statutory obligations placed on energy suppliers to deliver efficiency measures (e.g. insulation, boiler replacement, district heating) to households: • *Community Energy Saving Programme* (CESP) (2009–2012): grants for energy saving measures, targeted at low-income areas • *Energy Company Obligation* (ECO) (2013-present) – grants for measures resulting in heating savings. It includes: 1. *Affordable Warmth Obligation*: targeted at private tenants claiming certain income-related benefits 2. *Carbon Savings Communities Obligation*: targeted at low-income areas	Densification and ‘compact city’ policies: • *Planning Policy Guidance Note 3 on housing* (2000–2010): set targets for building on previously-developed land and housing densities (DETR, 2000) Improvement of public transport services: • Subsidised services targeted at low-income areas, *Statutory Quality Partnerships*, *Quality Contracts*, community transport services [Encourage inner-urban residential location choice: • web tools to increase awareness of high transport costs in suburban and peri-urban areas • ‘location efficient mortgages’] Incentives to the purchase of ultra-low emission vehicles: • *Plug-in Car Grant* (2011-present): provides 35% off the cost of an eligible vehicle (up to a maximum of £5000)

With regard to *income* policies, demand-side subsidies such as transport vouchers and direct transfers using the welfare system have been implemented to improve the affordability of public transport in a number of countries (Serebrisky et al., 2009). On the other hand, given the high degree of car dependence in many developed countries, it is often argued that financial aid should be provided to the poor to help them operate and get access to private cars (e.g. Smart and Klein, 2015). In France, the UK and the US, such measures have been implemented locally as part of welfare-to-work programmes but have not been adopted on a large scale, for reasons related to cost to the public purse, the conflict with environmental policy goals and the risk of encouraging car ownership among households who are not able to afford the associated running costs (Fol et al., 2007).

A discussion of *price* policies brings to the fore hidden or little discussed realities regarding the different taxation treatment of domestic energy and energy for mobility, with the latter being generally much more highly taxed through the petrol pump (Chatterton et al., in press). In countries such as the UK where the domestic energy market is deregulated, this arguably gives the government a greater degree of control over motor fuel prices as compared to domestic fuel. In the UK, this has been reflected in public debates about the appropriate level of taxation of motor fuels (Lyons and Chatterjee, 2002), which are often linked to concerns about transport affordability (Gray et al., 2001). For example, the Royal Automobile Club Foundation (RACF, 2012) has argued that the rate of fuel duty should be lowered in order to alleviate ‘transport poverty’.

Internationally, public transport is an area where the affordability of fares is often ensured through supply-side price subsidies (Serebrisky et al., 2009). In most of the UK, early deregulation of local public transport in the 1980s has resulted in very large reductions in the level of public subsidies and in a parallel increase in fares (Preston and Almutairi, 2013), clearly limiting the scope for pricing policies. However, concessionary fares are offered to groups such as the disabled and older people, and funded through general taxation (Titheridge et al., 2014). The *English National Concessionary Bus Travel Scheme* offers free bus travel to seniors, and was introduced specifically to address affordability problems among them. It has been criticised for being very expensive and poorly targeted, as it is not restricted to low-income households, as well as for diverting resources from more effective investments (Shaw and Docherty, 2014; Titheridge et al., 2014).

With regard to *energy efficiency*, improving the viability of energy- and cost-efficient transport modes, such as walking, cycling and public transport, can relieve low-income households from ‘forced car ownership’, ‘car-related economic stress’ and expensive reliance on taxis. For instance, increasing public transport services in deprived areas can bring huge cost savings to individuals who use them (Lucas et al., 2009). Arguably, in order to tackle affordability problems, new public transport services need to be specifically targeted towards low-income areas and individuals, as it cannot be assumed that they will automatically benefit from such initiatives. In the UK deregulated public transport market, this is possible to an extent with subsidised services and agreements between operators and local authorities (Table 3), although there are serious limits to what has been achieved in this area to date (Preston and Almutairi, 2013).

Densification and ‘compact city’ policies (OECD, 2012) reduce car dependence and need to travel long distances, thus reducing the household expenditure required to satisfy travel needs and increasing resilience to fuel price increases (BBSR, 2009; Dodson, 2013; Gertz et al., 2015; Litman, 2015; Nicolas et al., 2012; Scheiner, in press). However, living in high density areas may be associated with worse local environmental conditions (Melia et al., 2011) and higher housing costs (Downs, 2004), and in many developed countries households' location preferences remain strongly oriented towards low-density living (Evans and Unsworth, 2012). As a result, improving the transport-related energy efficiency of the urban fabric through densification is more politically controversial than retrofitting the housing stock is in the case of fuel poverty. For example, in the UK many of the spatial planning policies introduced by the Labour governments to encourage higher density development were rolled back after the change of government in 2010, while retrofitting investments are still part of the current Conservative Government's fuel poverty policy package (Table 3).

In many countries, initiatives have emerged to increase households' awareness of the transport cost consequences of residential location choices, through e.g. the development of online calculators and ‘housing and transport’ affordability indices (e.g. Allard et al., 2014; Litman, 2015). These aim to counter the phenomenon whereby households are attracted to car dependent areas by low housing costs, but underestimate the corresponding increase in transport costs once they are settled in these areas (Coulombel, in press). Mortgage policies such as *location efficient mortgages* have also been developed to take into account the better repayment capacity of those buying properties in accessible areas with lower transport costs, although not in the UK (Chatman and Voorhoeve, 2010). In both cases, the goal is to encourage inner-urban residential location choices and reduce household transport costs.

Incentives to the purchase of low-carbon vehicles may improve transport affordability through reducing running costs, although they generally aim primarily at carbon reduction (e.g. HMG, 2011; OLEV, 2013). However, these vehicles currently remain out of the reach of the majority of low-income customers, due to high upfront prices even after grants are deducted. Therefore, there is a risk that these incentive policies may worsen the mismatch between income and vehicle energy efficiency, thereby deepening inequalities in terms of transport affordability (Mullen and Marsden, 2016). In UK fuel poverty policy, some government grants for heating improvements are targeted specifically at low-income households, even though social gradients in the diffusion of low-carbon micro-generation technologies are a point of concern.

Only a few studies have considered the synergies and the trade-offs between climate change and transport poverty policies (Lucas and Pangbourne, 2014; Mattioli, 2013b; SDC, 2011). They conclude that both cost and income policies result in trade-offs, as reducing (or helping with) the cost of travel tends to result in greater emissions, while increasing costs risks pricing out the poor from access to essential opportunities. Only energy efficiency policies, such as reducing the need to travel through densification or improving the viability of alternative modes, are regarded as a win-win for both climate change mitigation and transport affordability. A very similar policy tension between social and environmental goals is highlighted in fuel poverty research (Boardman, 2010; Preston et al., 2013; Ürge-Vorsatz and Herrero, 2012).

4. Critical assessment, further research directions, and policy recommendations

This paper started with the observation that there has been an uncritical transfer of concepts and indicators from fuel poverty into the transport field in the UK. Our comparative discussion of fuel poverty and transport affordability highlights a number of similarities and differences, which have not been clearly identified and discussed in the literature to date. In this section, we critically discuss the most important insights emerging from the comparison. These are summarised in Table 4, along with related guidelines for policy and future research.

The transfer of concepts from one field to another always comes with opportunities and risks. Where similarities between fuel poverty and transport affordability exist (first column in Table 4), developing parallels and transferring concepts can be instructive. For example, our review demonstrates that the ‘triad framework’ of fuel poverty drivers (income, prices, and energy efficiency) can deliver useful insights when applied to transport affordability and related policy making.

In this paper, we have put forward the notion of ‘mismatches’ to highlight situations where the misalignment between income, prices and energy efficiency compounds energy affordability issues. We argue that the concept provides a useful lens to look at transport affordability. From a research perspective, it draws attention to important questions such as:

Table 4
Summary and critical assessment of similarities and differences between fuel poverty and transport affordability.

	Similarities: parallel is warranted/ instructive	Differences: parallel can be misleading	Directions for future research	Policy recommendations
Negative consequences	spillover effects of high domestic/ transport energy costs into other expenditure areas (energy and non-energy-related) and debt	less obvious causal chain between lack of affordable transport and (multiple) negative consequences	empirical research on the overlaps between the two issues and how households trade-off between domestic and transport energy expenditure (particularly in times of increasing prices)	avoid 'siloed' policy making when devising measures for energy affordability. Consider the combined financial burdens and trade-offs placed on households by domestic and transport energy costs
Drivers	'three drivers' framework (income, prices, energy efficiency) and notion of 'mismatches' between drivers	unique recursive relationship between transport expenditure and income generation	research into mismatches between patterns of income, price and energy efficiency and their relevance for transport affordability	
Measurement		multiple differences between the problems (see Table 2) mean that fuel poverty indicators cannot be transferred 'as is' to transport	transport affordability indicators: – should be based on actual rather than modelled expenditure – should not be modelled on TPR – LIHC approach is a better blueprint (although adaptation is necessary)	adopt carefully-designed transport affordability indicators as part of broader set of transport poverty metrics
Policy response	similar tension between social (affordability) and environmental goals: only energy efficiency policies are 'win-win' (in UK) similar targeting of income/ price policies on older people, regardless of need	stronger lock-in into low-energy efficiency for transport (in UK) some fuel poverty alleviation measures are deliberately aimed at offsetting 'mismatches' between income, prices and energy efficiency – not the case for transport		consider targeting e.g. electric vehicle subsidies to low-income households (in UK) avoid indiscriminately targeting transport and domestic energy affordability policies to older people

do low-income households live in the most car dependent (and hence least energy-efficient) areas? Do they tend to own older, larger and less fuel-efficient vehicles? From a policy perspective, our review shows that such mismatches are implicitly or explicitly taken into account in fuel poverty policies, e.g. through the targeting of housing retrofit to low-income areas. They have however received less attention within transport policy.

Notably, we argue that the transport affordability implications of lags and gradients in the diffusion of energy- and cost-efficient vehicle technology deserve more policy and research attention, given the emphasis currently placed on the electrification of the vehicle fleet. There is a need to avoid a future in which electric vehicles are adopted by the middle and upper classes, while low-income households rely on internal combustion engine vehicles which are cheaper to buy, but more expensive to run (and more highly taxed). At the same time, the rise of electric vehicles may blur the distinction between domestic and transport energy consumption, while creating interesting interactions between the two. Here again, there is potential for mismatches, as higher-income households in detached housing may be more likely to take advantage of home 'solar plus storage' packages, with resulting lower electricity costs. Similar considerations apply to the vehicle-to-grid concept (Sovacool and Hirsh, 2009).

Another similarity between the fuel poverty and transport poverty literatures is that both identify synergies and trade-offs between *social* policies to improve affordability and *environmental* policies to reduce carbon emissions, and argue that synergies can only be achieved if energy efficiency policies are given priority. On the other hand, however, our discussion suggests that improving energy efficiency in the transport sector is more challenging, as it involves reducing the car dependence of urban and transport systems, something which is more long-term, resource intensive and politically controversial than even large-scale retrofitting of the housing stock. Also, currently the most cost- and energy-efficient transport modes (walking, cycling and public transport) are not necessarily those providing the best levels of access to services and opportunities – a situation that has no parallel in heating. This complicates the task of reconciling social and environmental goals in transport policy.

One area where the analogy can be particularly misleading is the development of empirical indicators. As discussed at length in Section 3.4, there are a number of important differences between the two problems, which make a direct transfer of indicators inappropriate. Notably, studies that have uncritically adopted the TPR metric to measure transport affordability in the UK have produced inconsistent (and sometimes implausible) results, with rates of incidence varying between 3% and 80% (see Table 1). This is problematic not just from a scientific perspective, but from a policy perspective as well. This paper puts forward specific guidelines for future research looking to adapt fuel poverty indicators for use in the transport sector (summarised in Table 2), arguing notably that the LIHC approach is a better blueprint for such efforts.

More broadly, it must be stressed again that 'transport affordability' problems are only a subset of a broader set of 'transport poverty' issues. In practice, this means that, while fuel poverty policy typically relies on a single metric to assess the extent of 'lack of warmth' in homes, it is unreasonable to expect the same for transport, as there is a wider range of non-economic factors that may result in 'lack of access'. Therefore, any fuel-poverty-inspired metric of transport affordability would need to sit alongside a variety of different concepts and multi-layered measurement approaches in helping us to grasp the multiple facets of transport poverty (see Berry et al., 2016; Lucas et al., 2016b).

A further direction for future research emerging from our review is investigating to what extent fuel poverty and transport affordability problems affect the same types of households or areas. Initial empirical evidence from France suggests that there is only limited overlap (Cochez et al., 2015; Jouffe and Massot, 2013; Verry et al., 2017), but it is an open question whether this applies to other countries such as the UK. Clearly, establishing a sound methodology to assess transport affordability is a crucial precondition for carrying out this kind of empirical research.

There is also a need to better understand how households react to increases in domestic and transport energy costs, notably with regard to the dynamic trade-offs between the two. The findings reviewed in this paper (and elsewhere in this special issue) suggest that, given the recursive relationship between transport expenditure and income generation, households tend to prioritise commuting costs over other expenses, including heating, although the evidence is not yet robust. A number of studies in the field of energy economics have modelled the cross elasticity of domestic- and transport-energy demand (e.g. Baker et al., 1989; Labandeira et al., 2006), although typically they do not have an explicit focus on affordability. This leaves ample scope for empirical studies to bring together and integrate these approaches.

More broadly, we argue there is need for a joined-up approach to energy affordability, in contrast to the current situation where domestic and transport-related energy affordability belong to distinct academic and policy silos. The evidence suggests that households make important trade-offs across all of their expenditure areas, and spillover effects exist. From a fuel poverty perspective, it seems unreasonable to maintain a set of policies to subsidize those that are the worst off whilst simultaneously allowing them to spend disproportionate amounts of income on travel. From a transport affordability perspective, a unisectoral approach limits us to looking at travel behaviour responses to price changes, while the most serious negative outcomes might be elsewhere.

Finally our review highlights a striking parallel between fuel poverty and transport affordability policies in the UK: currently, significant public resources are invested in ensuring that older people, regardless of income, receive free public transport and 'winter fuel payments', whilst others in similar or greater need receive no help. This is arguably a key obstacle to the effective alleviation of affordability problems, and the case for better targeting is compelling. Overall, it appears that domestic energy and transport affordability policies are currently being (mis) aligned to indirectly improve the financial welfare of the elderly, possibly reflecting a 'moral status' attached to old age, or their importance as a key electoral constituency.

5. Conclusion

In a context where transport and energy exhibit two parallel policy worlds, our critical review has highlighted lessons that can be learned from a systematic comparison, as well as the need for a more joined-up approach to energy affordability. At the same time, our analysis also highlights critical differences between the two sectors and how and why these matter. Notably, metrics come with a set of assumptions and their own (policy) history, and in working across sectors it is necessary to have a critical eye to where they have come from and why differences matter. As we embark on an ever closer union between our domestic energy and transport energy systems the importance of these contradictions will become increasingly evident and problematic. This work contributes to the long-term debate about how best to manage these issues in a radical energy transition that properly pays attention to issues of equity and affordability.

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