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Decoupling transport from economic growth: Extending the debate to include environmental and social externalities

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ABSTRACT

The concept of decoupling embraces both immaterialisation and dematerialisation, by referring to the general delinking of environmental harm from economic production. This paper extends the theoretical debate and methodology on decoupling in transport to cover environmental (e.g. carbon) and social (e.g. fatalities) issues as well as the economic dimensions (e.g. income growth and transport activities). The typology developed here details the concepts of absolute and relative decoupling in a strong and weak version. This typology is then applied to explore the potential and the reality of transport decoupling in 15 major countries over the period since 1990, when concerns over the global environment and social issues have become a central part of the sustainable development agenda, through the measurement of changes in all three of the elements of sustainable development (economic, environmental and social). Two key transport externalities, carbon dioxide emissions and traffic fatalities, are studied, as these represent examples of environmental and social costs associated with increased levels of mobility. These 15 key countries included both developed and developing countries, and they together account for the majority of the global economy, carbon emissions and a substantial proportion of transport fatalities. The results show that decarbonisation of the transport sector has proved more difficult to achieve in the 15 countries over the 22 years than the reduction in the levels of transport-related fatalities. Nevertheless, there is progress being made. Decoupling has taken place in both developed and developing countries, though the experiences vary in terms of timing (earlier vs more recent), consistency (stable vs variable), form (absolute vs relative) and magnitude (strong vs weak). Recoupling effects are limited. Transport has proved to be the most difficult sector to make more sustainable, as it is growing so fast and as it is necessary to support economies and lifestyles. Yet through combining measures of economic (e.g. income), environmental (e.g. carbon) and social (e.g. fatalities) wellbeing, it has been possible to identify positive trends in decoupling transport at the national level, as measured through relative decoupling. The much harder objective of an absolute decoupling is only just beginning to take place, but this must be seen as the primary objective in moving towards sustainability in the transport sector.

1. Introduction

This paper extends the decoupling debate in the literature to examine the general relationship between transport, economic growth and environmental and social externalities. Two key transport externalities, carbon dioxide emissions and traffic fatalities, are studied as illustrative examples because they represent major and quantifiable forms of environmental and social costs associated with increased levels of mobility. Transport provides an interesting focus for this study because transport activities tend to increase as the economy grows, not only because of more economic activities but also because of more cultural, political, social, and other forms of human interactions. For example, based on a panel data from 1963 to 1999 for 88 countries, Kopits and Cropper (2005: 169) have remarked that most death rates decline as countries develop, but deaths due to traffic crashes are "a notable exception". Motorization (growth in vehicle usage) has tended to be strongly and positively correlated with economic growth in all countries, particularly those in a rapid state of development (Kutzbach, 2009). In addition, industrialization, particularly export-oriented industrialization, leads to the rapid growth of goods vehicles and in the distances travelled. These trends, in turn, greatly increase not just the total road traffic volume but also the mix of traffic and risk profiles of different road users (Paulozzi et al., 2007). The associated increases in energy consumption, CO_2 emissions, traffic crashes and other negative transport externalities (notably land consumption, local air pollution, noise, barrier effects,

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intrusion on outdoor recreation areas, and loss of cultural heritage) can lead to environmental degradation and a lower quality of life.

In recent decades, the scale and speed of the increase of transport externalities in many developing countries are unprecedented. In China, the total vehicle fleet (including automobiles and motorcycles) rose from 0.4 million in 1970, 2.0 million in 1980, 9.7 million in 1990, 53.8 million in 2000 to 154.2 million in 2008 (Loo et al., 2011). In 2013, there were 22 million new automobiles sold in China, making it the largest global market (China Association of Automobile Manufacturers, 2014). Using the distance-based method, the average CO_2 emissions in China from passenger transport alone have risen 23.8 times from 14 million tons (Mt) in 1980 to 333 Mt in 2009 (Loo and Li, 2012). Since 2008, China has become the largest CO_2 emitter (EIA, 2015). Similarly, road safety problems in developing countries are serious. In China alone, the number of 30-day adjusted number of road traffic fatalities increased from 49,243 in 1990 to 93,853 in 2000 before reducing to 58,539 in 2013 (National Bureau of Statistics of China, 2013). Yet, the huge and rapid increase in these negative transport externalities over the past few decades have also been associated with rapid economic growth. In China, its Gross National Income at purchasing power parity in current International dollars (GNI_{PPP}) has risen by about 14 times from 1095 billion in 1990 to 16,084 billion in 2013 (World Bank, 2015). The key question here is about what can be done in developing countries to minimize negative transport externalities, as their governments strive to develop the national economies and to improve the quality of life of people. It is not acceptable to policy-makers in any developing country (as defined and updated by the UN, 2015) to cut negative transport externalities through reducing economic growth. Putting the blame on developing countries for causing huge increases in world total CO_2 emissions, traffic fatalities and other negative transport externalities is problematic from two perspectives. Firstly, many developed countries have undergone a similar path of rapidly worsening environment and road safety problems, as they have developed historically (Kopits and Cropper, 2005; Paulozzi et al., 2007). Secondly, despite the huge increase of CO_2 emission in developing countries, the CO_2 emission per capita is still generally much lower than in many developed countries. In 2010, the CO_2 emission per capita in China (6.2 metric tons per capita) was still lower than the UK (7.9 metric tons per capita) and the USA (17.6 metric tons per capita) (World Bank, 2015). Whether the situation will dramatically change or even reverse in the future depends on the commitments and measures adopted in developed countries to combat CO_2 emissions, and the levels of increase in CO_2 emissions expected in developing countries.

In his seminal work, Haight (1985) summarizes eight aspects that have improved our theoretical understanding of road safety. At the top of his list was "abandoning the language of cause and blame". In particular, taxonomies based on the concept of "identifying the culprits" fail to recognize the complexity of the problem and can lead to a mistaken focus on countermeasures targeted at one agent (e.g. drivers) of the system only. In this paper we do the same and look for new solutions through the development of a general typology for the understanding of the links between transport, economic growth and a selection of externalities. We aim to identify situations where there is good practice in achieving the sustainability goal of raising economic growth with a minimum negative impact on the environment and society. Section 2 places this research within the broader literature of decoupling between transport and economic growth, including the environmental and social impacts. To this end, transport-related CO_2 emissions and road fatalities are taken as major and measurable examples to extend the framework to cover the impact of the wider transport externalities on society. Section 3 describes the data and methods used to provide an overview of the existing situation, and it describes trends and demonstrates the workings of the typology. Section 4 highlights the key findings from the application of the typology, and it identifies successful decoupling experiences, in both developed and developing countries over the recent past. Section 5 concludes this paper.

2. Literature review and the decoupling typology

The concept of decoupling transport from economic growth has become popular, as growth in the economy is seen as desirable but it should not be contingent on similar growth in the use of carbon based transport. Immaterialisation describes the decoupling of both material production and consumption from economic production (Tapio, 2002). At the national level, aggregate economic production can be measured by Gross Domestic Product (GDP) or GNI_{PPP}. It is also referred as national income or simply income in this paper, which is different from the concept of individual or household income at the disaggregate level. Immaterialisation can be measured by using indicators such as energy intensity (total primary energy supply/GDP) or transport intensity (transport volume/GDP). In other words, all measurements (including income) are made at the aggregate national level. The same phenomenon has also been labelled as qualitative economic growth, amaterialisation (Heinonen et al., 2005), post-industrialism (Bell, 1974) and ecological structural change.

Dematerialisation refers to the decoupling of the specified environmental harm from material production (Ausubel, 1995; de Bruyn, 2002). The same phenomenon has also been called increasing eco-efficiency. It may consist of technical development (Simon, 1980) and/or shifts within the sector observed, for example fuel switching or changes in the traffic modal split (Kaivo-oja and Luukkanen, 2002). Dematerialisation can be measured, by changes in the carbon intensity of energy production (total CO_2 emissions / TPES) or by changes in the carbon intensity of transport (transport CO_2 emissions / transport volume).

The concept of decoupling embraces both immaterialisation and dematerialisation, by referring to the general delinking of environmental harm from economic production (de Bruyn, 2002; de Bruyn et al., 1998a,b; Vehmas et al., 2003). Decarbonisation is seen as an example of decoupling in terms of CO_2 emissions, measured by changes in the total carbon intensity of the economy (CO_2/GDP) (Nakicenovic, 1996) or by changes in the sectoral carbon intensity of the economy (transport CO_2/GDP). Alternatively, Ausubel (1995) has used the concept of decarbonisation as an example of dematerialisation. This is the context within which this paper has been framed, and it is now appropriate to define the actual formulations used here.

As noted above, decoupling is the key concept that we use in this study. It is closely associated with the income elasticity of negative transport externalities (e_i), which is given by the equation:

$$e_i = \frac{\Delta nte_i}{\Delta y} \quad (1)$$

where nte_i is the amount of negative transport externality i, y is income or the value of aggregate economic production, and Δ is percentage change. The relationship between income and transport externality i at a given time can be given by the equation of:

$$c_i = \frac{nte_i}{y} \quad (2)$$

where c_i is the intensity of negative transport externality i per income. Whenever c_i increases, a higher level of negative externality or harm (whether environmental or social) is created for each dollar of income generated. Hence, it is undesirable from the perspective of decoupling transport negative externality from economic growth.

This conceptual framing will be used as a basis for the transport (sectoral) decoupling framework. Although there are many different relationships that can be used (some 8 feasible options in total), our interest is in the four basic forms of decoupling and coupling. Relative decoupling occurs when both income (y) and the negative externality (nte_i) change in the same direction but with a lower c_i. In the literature, the discussion has focused on situations where both indicators keep