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Economic, social, energy and environmental assessment of inter-municipality commuting: The case of Portugal

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HIGHLIGHTS

- This paper provides an insight into the magnitude of opportunity costs of commuting.
- Input–output modeling is valuable to assess changes in final consumption patterns.
- About 25% of household's fuel consumption is due to inter-municipality commuting.
- Inter-municipality commuting has net negative effects on GDP, GVA and employment.
- The main opportunity costs come from metropolitan and long distance commuting.

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ABSTRACT

Commuting is one of the main contributors to the high energy consumption patterns in modern economies. The need to reduce the energy spent in commuting has attracted the attention of academics and policy makers. The main goal of this research is to improve knowledge of the economic, social, energy and environmental opportunity costs of inter-municipality commuting and to support policy-oriented strategies that explicitly take them into account. For this, we use hypothetical assumptions based on the baseline scenario that Portuguese households do not travel between municipalities for commuting purposes coupled with the expected changes in private final consumption. Accordingly, the direct, indirect and induced opportunity costs of inter-municipality commuting are assessed using an input–output model. The significance of the estimated virtual net benefits of commuting is analyzed according to their macroeconomic (GVA, taxes, international imports and employment), energy (primary energy consumption) and environmental (CO_2 emissions) dimensions. The results obtained empirically indicate that inter-municipality commuting has significant opportunity costs in the GVA and GDP as well as in primary energy consumption and CO_2 emissions. The results also indicate that commuters in metropolitan regions and long-distance commuters are responsible for a major share of these opportunity costs.

1. Introduction

The urban population has grown consistently throughout the last century, worldwide. Large metropolitan areas have expanded in terms of population and dimension. Naturally, these processes did not occur homogeneously. Over recent decades, the population in the suburbs of most European and American cities has tended to increase while the population living in Central Business Districts has generally shrunk. Portugal was no exception. Census data shows that between 1980 and 2011 Lisbon and Porto municipalities lost 33% and 27% of their population, respectively. But the population of Greater Lisbon and Greater Porto metropolitan areas has increased by more than 14% and 15%, respectively (INE, 2012). This phenomenon is often referred to as urban sprawl and is associated with an increasing need to travel further between home and workplace. This increase in commuting was sustained by economic conditions that enabled people to buy fuel at relatively low prices. Such conditions have favored increases in the consumption of primary energy and consequently in CO_2 emissions.

Analyzing the Portuguese consumption of Refined petroleum products in 2007, we can see that 21.5% is due to household consumption, 23.2% is for exportation and the rest is consumed as intermediate goods for industrial production. Additionally, 7.5% of total household income is spent on buying and repairing cars and

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1.4% on road and rail passenger transportation services (INE, 2011). Consumption of these products affects the consumption of natural resources and the generation of pollutants as well as the corresponding levels of gross domestic product (GDP), gross value added (GVA), employment, imports and tax collection. In the Portuguese economy (and other European economies), these goods are mainly imported or require a large amount of imported inputs in their production processes, thereby contributing to the negative impacts on the balance of payments and to reducing the multiplier effects in the economy.

This research contributes to improving knowledge on the economic, social, energy and environmental opportunity costs of inter-municipality commuting[1]. These aspects of commuting are addressed by analyzing different scenarios. The first scenario addresses the likely impacts of ceasing metropolitan versus non-metropolitan commuting. In this case, attention is focused on the trips made by commuters within the two major Portuguese metropolitan areas: Lisbon and Porto. The second scenario distinguishes between the energy and economic impacts of short and long distance commuting. The definition of short and long commute is related to the estimation of average trip-distance per commuter. Finally, to evaluate the overall opportunity costs of commuting, a very extreme scenario takes the reference assumption that all the inter-municipality commuting in Portugal ceases, i.e. that people work in the same municipality in which they live or, alternatively, for our modeling purposes, any commuting to other municipalities does not involve fossil energy or other commuting expenditure. Accordingly, the opportunity costs of commuting can be estimated as the differences between the current situation (2007, our base year) and the suggested scenarios. It is important to note that in the scenarios in which no inter-municipality commuting is assumed, the consumption of Portuguese households in terms of cars, fuel and other products is reduced and, conversely, their spending on other products unrelated to commuting is increased. We assessed the economic, social, energy and environmental effects of commuting, by applying an input–output (I/O) model with a supply and use table (SUT) format at basic prices and domestic flows, extended with an energy-environment satellite account. The results consider different energy and environmental indicators (oil, natural gas, coal consumption and CO_2 emissions) as well as economic and social ones (GDP, GVA, imports, VAT, other taxes on products and employment).

This modeling approach provides important insights for policy makers, in particular by contributing to a better understanding of where commuting policies can be more effective and which categories of commuting have higher opportunity costs. Several strategies regarding the demand and supply of transportation, the price and taxes paid by car owners and by fuel consumers, and even differentiated urban taxes can be proposed to induce a reduction in the vehicle miles traveled and in the number of commuters within a metropolitan area.

The next section contains a concise literature review, highlighting the leading attempts to address the impacts of commuting on the economy, environment and energy consumption. The instruments that can be used to achieve more sustainable commuting patterns are also discussed since this would make a significant contribution to cutting energy consumption and thus to reducing the commuting footprint. Section 3 presents the methodology, i.e. the procedures to estimate fuel consumption associated with inter-municipality commuting scenarios, the approach to assessing the impact on the other products in the economy and, finally, a brief description of the I/O model adopted and the derivation of the energy-environment satellite account. Section 4 gives the results obtained and suggests opportunities to explore the policy significance of the energy, environmental, economic and social opportunity costs associated with inter-municipality commuting.

2. Literature review

In recent years, people have become increasingly aware of critical issues such as energy consumption and greenhouse gas (GHG) emissions. Accordingly, numerous contributions have focused their attention on the issue of passenger transportation, stressing its responsibility for 20% of the world primary energy use and in 13% of energy-related CO_2 emissions (IEA, 2006; Zhao et al., 2011). Regarding the Portuguese case, it is worth mentioning that in 2010 the transportation sector's total share of final energy consumption was 40.6%, while this sector's direct 'responsibility' for GHG emissions reached a share of 26.8% (EUROSTAT, 2013). These figures, especially regarding passenger transportation, have to a large extent been related to urban forms and city density, i.e., as the constraints on traveling greater distances have been relaxed, cities have expanded and become less dense. This led to a fast increase in car ownership and use (Glaeser and Kahn, 2001; Zhao et al., 2011). For example, Camagni et al. (2002), in a study on the Milan metropolitan area, confirmed that higher energy consumption and environmental impacts are associated with lower density, sprawling development and urbanization. Modarres (2013) confirms the importance of urban density in determining commuting patterns and therefore on related energy consumption. These studies, and others focusing more on energy consumption or its environmental consequences (Naess et al., 1995; Naess, 2010) had come to similar conclusions regarding the effects of extensive car use, the modal split and energy consumption. Fu et al. (2012) estimated the energy savings per commuter in Ireland, resulting from the increase in home working. Banister et al. (1997) and Muñiz and Galindo (2005) highlight that energy consumption is also related to travel distance, transport mode choice and journey frequency. Overall, these authors argue that policies to restrain commuting should have top priority in terms of energy and emissions reduction.

To promote the modal split within a metropolitan area, transportation demand management (TDM) policies are being applied with the aim of influencing people's travel behavior in such a way that alternative mobility options are presented and/or congestion is reduced (Meyer, 1997). Meyer (1999) explores 3 different sets of strategies: (a) alternative transportation choices; (b) (dis)incentives to reduce traveling, and (c) satisfaction of the trip's purpose by other, non-transportation means. Murray (2001) argues that one critical challenge for urban planners and decision-makers is to identify effective strategies for dealing with resistance to travel by public transport. Some of the instruments used include reducing the price of public transit (Dorsey, 2005), subsidizing public transport in order to increase feasibility (Tisato, 1998) and improving the information available to users and/or on the network coverage (Litman, 2011). In many cities, parking fees are also being charged, mainly to rebalance the modal split between private car and alternative public transit systems (D'Acierno et al., 2006; Barata et al., 2011). Congestion tolls to enter the central business district, restrictions on the issuance of car license plates by a period of time, and the circulation of vehicles depending on the license plates are also good examples of additional TDM instruments that have been considered by metropolitan area

[1] It should be taken into account that inter-municipality commuting is only a share, expected to be significant, of overall commuting. Our option to focus on this type of commuting also took into account the absence of data on intra-municipality commuting, i.e. Portuguese Census data only identify the origin and destiny of commuters when they travel between municipalities.