Electric vs. Conventional Vehicles:
Environmental Externalities and Urban Spatial Policies

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The spatial interdependence between economic development and environmental degradation creates a lot of concerns and provides a reason for government intervention. Cities, which are the engines of economic development, face a number of challenges, with environmental problems being one of them. Non-point source pollution is a major part of total pollution, since almost 90% of urban air pollution can be attributed to vehicle emissions. In this context, electric vehicles seem to be one of the potential ways that will facilitate the transition towards a more sustainable transport system.

Electric vehicles have a lot of advantages compared to internal combustion engine-based vehicles. They do not produce on-road greenhouse gas emissions and the upstream pollution they produce is considered to be less severe and depends on the electricity source used for battery charging (Mersky et al., 2016; Holdway et al., 2010; Samaras and Meisterling, 2008). However, there are some aspects that prevent their wider use, such the higher price, the limited ranges, the longer refueling times and the fewer public infrastructure refueling opportunities (Zhang et al., 2016; Mersky et al., 2016). This implies that in order to boost the demand for EV and take advantage of the environmental benefits they provide, governments should give some incentives and use policies that will encourage their adoption. Such policies have already increased the number of sales in several European countries, such as Germany, France, Denmark and Norway.

In this paper, we study first- and second-best urban policies that will promote the use
of EVs. More specifically, we study the interior of a city where land is used for residential purposes, while the central business distinct (CBD) is predetermined and located in the middle of the city. Workers commute to the CBD on a daily basis, using their private vehicles, which are either CVs or EVs. Thus, there are two categories of workers: the polluters and the non-polluters. We study the location decisions of both groups as well as the policies that will promote the use of EVs in cities and will lead to environmental benefits and increased welfare.

Pollution externalities have been studied in different urban contexts in a number of studies (e.g. Henderson, 1977; Arnott et al., 2008; Kyriakopoulou and Xepapadeas, 2013, 2017). In these papers, pollution comes from stationary sources - such as the industrial activity - and households tend to avoid polluted areas and prefer to locate in cleaner areas and pay higher land rents. This paper though is closer to few papers that deal with urban pollution that comes from commuting (non-point source pollution). More precisely, Verhoef and Nijkamp (2003) point out the importance of analysing urban air pollution in a spatial framework since aggregate pollution depends on the total amount of commuting in the interior of a city and not on the absolute number of commuters. This implies that changing the location of workers (and not their number) will result in either higher or lower levels of aggregate pollution. In a similar context, Schindler et al. (2017) investigate the effect of urban traffic-induced air pollution on residential choices. Their findings suggest that higher pollution levels reduce the geographical extent and the population of the city.

The aim of the present paper is to extend the standard monocentric model (Alonso, 1964) by assuming the presence of endogenous air pollution coming from commuting. This paper differentiates from the papers mentioned above by assuming the existence of two types of commuters. The “polluters”, who use normal cars, and the “non-polluters”, who
use electric vehicles. We study the decisions of households regarding the purchases of the
cars and also regarding where they will decide to locate in the interior of our city. Policies,
such as fuel taxes on CV users and subsidies for EV, change the size of the city and the
aggregate pollution levels. The location of the EV users compared to the CV users is also
very important since this determines the level of aggregate urban pollution.

In equilibrium, households act myopically, since they do not realise that by changing
their location, they will either increase or decrease aggregate pollution in the whole city.
This environmental externality is only taken fully into account when deriving the optimal
solution. The regulator will maximize the total value of land in the city and will define
two different residential land uses, one that will be occupied by polluters and the second
that will be occupied by non-polluters. At the optimum, long-distance commuters are
expected to rely on electric vehicles, which will be the most beneficial allocation, in terms
of aggregate pollution, for the whole city. Short-distance travellers will still use normal
vehicles, pay fuel taxes which will give some revenues to the government, which in turn
will reallocate that money to the EV users.

References


EC, 2016, Communication from the Commission to the European Parliament, the
Council, the European Economic and Social Committee and the Committee of the regions.


