Indirect effects of transport infrastructure: a land rent approach

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Measuring the direct impact of transport infrastructure on aggregate welfare is relatively simple. The indirect (wider) effects due to agglomeration externalities, changes in location behaviour and land use are more difficult to establish. This paper develops a computable general equilibrium model to value a wide range of indirect effects of concrete investment projects using their impact on local land rents. Land rents are an excellent measure for the indirect effects from local public goods, as all these benefits capitalize in land rents.

Our model lets workers decide on their home and job location, on their mode of transport (modal split), and on the amount of land they want to use for living at their home location. On the production side, our model allows for agglomeration economies. A higher density raises productivity. By this set up, our model allows to value a range of effects of transport infrastructure. Consider an investment that reduces travel time for the train connection between two locations. Above the valuation of the direct effect of reduced travel time for current users, the model allows the valuation of (i) modal shift for commuters currently using other modes of transport; (ii) switching jobs for people currently working elsewhere; (iii) switching the place of living to a location of which the available infrastructure is better adjusted to the personal needs. Since the supply of homes at each location is largely fixed, if somebody wants to move into a location that has greater accessibility, then somebody else has to move out. The land rent acts as an equilibrium device for supply and demand at a location: the attractiveness of the location will go up due to its greater accessibility, its attractiveness will go down due to the increase in land rent. The former effect will dominate for people who use the infrastructure frequently, the latter will dominate for the infrequent users. This spatial segregation tends to raise social efficiency; we are able to value this selection effect.

Next to the mentioned effects, the model includes two other indirect effects. First, the changes in land rents discussed before induce changes in land use. Higher land rents induce people to substitute away from land services to other types of consumption. This tends to raise social efficiency, because lower land use increases the density, which allows more people to benefit from the proximity of scarce infrastructure. Finally, changes in job location choices by consumers affect agglomeration benefits at various locations. Locations with declining employment loose, those with increasing employment gain. Since agglomeration effects are externalities, there is no mechanism that induces people to shift locations to make optimal use of these benefits. We are able to calculate the net value of this effect.

We estimate the model for the Netherlands around 2004. We use a detailed regional classification in some 3000 Zip codes.

We apply the model to a policy experiment. The city of Amsterdam is located just South of a major canal, connecting the Amsterdam harbour to the sea. The main connection between Amsterdam and the area North of the canal is 5 highway tunnels and 2 train tunnels. Since many people commute from the North to jobs in Amsterdam and neighbouring community of Haarlemmermeer (the location of Schiphol airport), this connection is of vital interest to the Dutch economy. As a policy experiment, we consider the effect of closing down both train tunnels. Obviously, this would lead to
a massive shift in the modal split on this trajectory, from the train (which goes to zero by construction) towards the car. However, we also see a shift in work and job locations.

All this leads to a change in land rents. Land rents North of the canal go down substantially, in particular those close to a railway station. Land rents South of the canal go up a bit, in particular close to Amsterdam. Agglomeration benefits go down, as fewer people find it worthwhile to commute from the North to the high-paying job locations in Amsterdam the South of the canal. By and large, closing the railway tunnels reduces welfare by about 0.2 to 0.3 % of GDP. For comparison, as an alternative experiment we close down a small railway track through a sparsely populated area in the middle of the country. Welfare effects on this trajectory are much smaller.

This paper contributes to a number of strands of literature. The first one consists of studies that use a general equilibrium framework to value local public goods through their effects on land rents, such as Rosen (1974), Arnott and MacKinnon (1977), and Roback (1982). Most relevant for our research is the study by Haughwout (2002) who develops a spatial general equilibrium framework with transport infrastructure modeled as a regional amenity. In his paper the total value of the regional infrastructure yields benefits for consumers and firms located in the same region. This approach makes it possible to calculate the average effect of an extra dollar transport infrastructure investment in a specific region. However, it does not allow to calculate the effects of concrete investments in specific modes (such as a new railway line, a new highway, road pricing etc.), nor to compare the cost-effectiveness of these investments. By contrast, our methodology allows to evaluate and compare the effects of specific infrastructural improvements in various transportation modes.

The second strand of literature examines empirically the effects on the price of local real estate of infrastructure investments such as new highways (Klaiber and Smith, 2010), new railways (Bowes and Ihlandfeldt, 2001; Gibbons and Macchin, 2005 and the references therein). These studies cannot disentangle easily the direct effect of better infrastructure for current users from the indirect effects due to changes in modal shift, in home and job location choices, and in local productivity due to agglomeration effects. Baum-Snow and Kahn (2000) address changes in the modal shift. Ahlfeldt (2011) develops a gravity model to measure the effect of accessibility.

Finally, our paper is related to the recent and growing literature that investigates how transport infrastructure influences the distribution of economic activities across space. The theory of land use by Alonso (1964) predicts that faster commuting times pushes up the demand for space in suburbs relative to central cities. Baum-Snow (2007, 2010) finds indeed empirically that highway construction accounts for a large share of decentralization of population and of jobs in USA in the second part of the 20th century. Duranton and Turner (2012) develop and estimate a growth model explaining the joint evolution of highways and employment in American cities. Complementary to this literature, we suggest a methodology that allows to calculate the welfare effects of the changes in the location of economic activities that are induced by transport infrastructure.

References


