Information Technologies and Travel

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ENGLISH SUMMARY

Over the last century travel has become faster, safer, more energy efficient, more reliable and comfortable, but above all – much cheaper. These improvements were often caused by a general progress in science and engineering. Recent developments in information technologies follow suit as, for example, modern satellite navigation devices allow car drivers to follow complex routes in an efficient and stress-free manner. One might reasonably expect that technological progress will continue in the future as well. This thesis contributes to a better understanding of the economic implications of such progress and supports informed policy-making in a pursuit of a better organization of modern transportation.

An increase in both population size and household's prosperity has kept both the number and the length of trips on a rise in the past. As a result, transportation expenditures continue to be an important part of household budgets, and governments routinely fuel substantial public funds into transport infrastructure. Nevertheless, and despite the last century's progress, transportation still faces problems that are sometimes remarkably similar to the ones from hundred years ago. Environmental nuisances due to peculiarities of the animal-drawn transport have turned into concerns over air and noise pollution. Congestion has increased over the last decades and traffic safety remains an issue. Privatization of transport facilities, and regulation of private transport firms frequently ignite fierce public debate, as the outcomes of such policies are not always easy to anticipate, and typically benefit some and harm others. While engineers, urban planners and, among others, economists have contributed to an improved efficiency of transportation, the persistence of yet unresolved issues indicates the need for innovative ways to approach them.

This dissertation examines, from an economic viewpoint, a number of intriguing transport policy measures that became viable due to the recent development of information technologies which broadly include Internet, wireless communications and powerful computing devices. The choice of policies analyzed in this thesis is in part guided by the aspiration to fill certain gaps in the research agenda that previous literature has indicated. Whether and

under what conditions these technology-driven measures lead to socially desirable changes in travel behavior of individuals is the key question that four research chapters of this thesis try to address.

Chapter 2 studies the effects of teleworking on commuting costs under traffic congestion. Teleworking is broadly defined as an out-of-office work arrangement where an employee can perform some of the job tasks from home. Unlike the majority of the existing studies that analyze the economic effects of whole-day teleworking, this chapter focuses on the travel impacts of - empirically relevant - part-day teleworking. This means that an employee might work from home for a few hours in the morning to avoid peak period congestion. The possibility to work from home due to the teleworking-enabling technology, such as Internet and computers, affects utility an individual might derive from spending additional time at home, which in turn affects her decision when to depart from home to a workplace.

It turns out that an individual who is equipped with teleworking-enabling technology tends to postpone the commute, and to depart from home later than she would otherwise do. While it is beneficial for the teleworker, it might also be welfare improving for unequipped drivers who face weaker congestion. However, the larger the number of drivers who telework and postpone their commute in the same manner, the more the congestion peak period shifts to a later time period. Social benefits from a dispersion of preferences may then decrease when the number of teleworkers increases. This result shows that, in absence of optimal congestion pricing, there is an optimal level of technology penetration above which teleworking technology, even if it is free-of-charge, might be socially detrimental. Due to this, private monopolistic supply of the technology, albeit restrictive, might yield a higher social welfare than perfectly competitive supply.

This result highlights that second-best solutions to transport problems should be applied with certain caution, as they may produce unanticipated effects. In general, road congestion arises when too many people at the same place and at the same time want to pass through a road with limited capacity. One way to resolve congestion problems is to spread the incoming flow of vehicles, either over space or over time. Part-day teleworking induces drivers to reconsider their departure time decisions and avoid peak period travel by traveling later. However, if too many people decide to behave the same way, the queues may become longer in a different time period. While current levels

of teleworking might not be high enough for this problem to become pressing, an efficient policy should account for this effect in the future when endorsing teleworking in the hope to fight congestion.

Chapter 3 analyses the longer run economic interactions between commuting, including the scheduling of commuter trips, and urban development. This chapter attempts to create, for the first time, an economic model in which both scheduling and location choices of individuals influence each other. The new model considers a city with a single central business centre in a city centre and residential areas around it. A traffic bottleneck is located at the entrance of the central business district. Importantly, the commuters' departure times from home, residential locations, and lot sizes, are all determined within a model.

The results show that the elimination of queuing time under optimal road pricing induces individuals to spend more time at home and therefore to have larger houses, thus causing urban sprawl in the long run. To reach such conclusion, the model in chapter 3 considers how the amount of time that drivers spend at home and in the car changes due to the introduction of congestion pricing. Because drivers would no longer spend time waiting in the car, the amount of time spent at home increases. An important assumption that the model introduces is that, if everything else is constant, the larger the house one lives in, the more benefit one derives from spending additional time in it. Thus, when a driver spends more time at home in the morning, he or she has a stronger demand for a larger house. While this effect might be relatively small at an individual level, over the long term for the entire city it might be noticeable. This is opposite to the typical results of urban models in which congestion is fixed to a constant level throughout the day, as such models usually predict that cities become denser with road pricing. Despite this, the result is in another sense in line with previous studies that show that improved urban transportation, such as availability of larger roads or cheaper transportation modes, causes urban sprawl as well.

Traffic congestion is a predominantly urban problem, especially the one of a recurrent nature that often happens during morning and evening commute hours. It has been known from earlier work that transportation costs affect urban structure, and this fact has been reconfirmed in this thesis. Importantly, a more realistic consideration of congestion by accounting for its dynamic nature, shows that improvements of transportation by imposing first-best road pricing

may increase city size and welfare, like the construction of larger transport capacity or the provision of cheaper transport modes would. This might give another reason for urban transport authorities to support congestion pricing as a policy tool to tackle congestion.

Chapter 4 considers welfare effects of traffic information provided to drivers. While both private and public firms might inform drivers about traffic conditions, it is not clear to what extent these arrangements are socially beneficial in a market where a separate firm manages a road network. This chapter uses a simple microeconomic model with elastic travel demand and stochastic travel cost to derive an endogenous demand for traffic information. Profit-maximizing pricing strategies of the information provider and road operator depend on each other as both road toll and price of traffic information affect the number of drivers making a trip, and thus the market size that can generate profit.

It appears that the distortive welfare effect of monopolistic information provision is relatively small. The main pricing strategy of the information provider is to appropriate the (constant) consumer surplus of drivers who travel even when the travel costs are high. The monopolistic mark-up redistributes surplus from the consumers to the information monopolist, but does not crowd many drivers out of the market. The results show that a cooperating road operator and traffic information provider offer a lower joint price compared to the case where these companies operate separately, because their profits are interrelated. The mechanism behind this is closely related to the regular argument in models of double marginalization, albeit that now both firms sell directly to consumers and the two goods are not strictly complementary: one could travel without having the information. There appears little reason to prevent private road operators from offering information on traffic conditions on their roads.

Travel-complementary information technologies, such as traffic information to drivers, seem to be a popular way of achieving transportation improvements. The results of this thesis suggest that the private provision of traffic information is a feasible and relatively efficient way of achieving social benefits from such technologies, as abuse of monopolistic market power does not lead to large forgone economic activities as is usually the case in monopolistic markets. Traffic information firms should be encouraged to

provide their services even if they cooperate with road operators, private or public.

Chapter 5 returns to the topic of teleworking and examines its spatial consequences empirically. Despite strong policy support for teleworking, economists raise concerns that if commuting becomes less expensive due to teleworking, an employee might change the residential location to a (cheaper) place further away from the workplace. Additional kilometers traveled, although less frequently, could potentially offset the positive effects of teleworking on, for example, congestion and air pollution. This chapter checks whether within professions where many people telework, average commuting distance is affected by the technology. The identification strategy of chapter 5 tests this assertion while taking care of the reverse causality problem, by applying a difference-in-differences method in combination with propensity score matching. Cross-sectional Dutch labor force survey data from 1996, when technology was barely present, and 2010, when Internet was pervasive, provides a way to estimate the long-run casual effect of the adoption of teleworking practices on the length of commuting distances.

The results indicate that average commuting distances have increased over time by 2 km for professions where substantial share of employees telework. The same increase took place over time in the professions where no one teleworks. This implies that the adoption of teleworking technologies does not affect average commuting distances. The results also suggest that there is a divergent effect of technology on teleworkers and non-teleworkers within teleworking professions. While teleworkers would still have a longer commute, on average it is counterweighted by the reduction of commuting distances for non-teleworkers, as compared to non-teleworkers in non-teleworking professions. This puzzle warrants an explanation which appears difficult to pinpoint. From a policy point of view, the results of chapter 5 suggest that policy makers might feel more comfortable with the promotion of teleworking as a suitable tool to fight negative travel externalities than what would be warranted if such effects would have been found.

As long as technological progress continues, there will always be a need for analysis of its economic implications for informed policy making. And only by carefully applying the whole spectrum of the available policy tools, both traditional, like taxation and road construction, and innovative, like

teleworking and traffic information, efficient transportation of the XXI century can be achieved.