How do knowledge spillovers shape the activity of public transport operators?

Transportation contributes to around 25% of CO2 emissions and 14% of annual overall emissions on the world scale (Gao et al., 2020). Shifting private car users to public transit is a widely recognized strategy contributing to sustainable road transport systems. For the public decision maker, an important challenge is then to identify the relevant tools that help promoting the use of public transit. One key solution is to subsidize the activity that produces positive externalities, and to impose taxes on the one that produces negative externalities. Subsidizing public transit also guarantees that the rule of universal service obligations (everybody should be allowed to travel at a low cost) is implemented.

While subsidies allow public authorities to reach efficient economic outcomes, they also have the negative effect of being costly to society as the State needs an administration to raise taxes. Researchers usually agree on the fact that 1 Euro of subsidy costs society around 1.3 euro in developed countries (Kleven and Kreiner, 2006 ; Sun et al., 2016). Hence, being able to reduce subsidies while keeping the quality of the service unaffected is an important issue. In other words, is it possible to reduce the costs of the transport operators given the objectives set by each local authority in charge of the organization of the service? One potential solution lies in the exploitation of the knowledge spillovers that may arise in transport operations. Knowledge spillovers are usually seen as a process in which firms obtain new knowledge from external sources. They are key ingredients of firms' productivity and economic growth (Grossman and Helpman, 1991).

In the public transit activity, the innovation process of the operator is related to a series of actions and decisions that may help reducing costs:

First, it is related to the action of managers who spend time and energy in improving the location of transport vehicles within the network, finding cheaper suppliers, bargaining better procurement contracts, subcontracting non-essential activities, monitoring employees, or solving potential labor conflicts. It also entails the development of changes in environmental friendly energy standards and propulsion systems, or trip information to travelers, the design of timetable and frequency, or pricing and marketing strategies.

Second, the industrial organization of the activity is particular in the sense that most transport operators belong to larger industrial groups, such as Keolis, Veolia Transport, or Transdev. As a result, it is expected that actions related to cost-reducing activities taken in a specific urban network do generate a positive externality on the operating costs of the remaining operators of the group who operate other networks. The knowledge generated in a given location can be processed by the group's headquarters and later be transmitted and used in another network operated by the group. For instance, the results of process R&D obtained in one location can spill-over to another operator through the group's headquarters. The latter operator would therefore benefit from (part of) this R&D without investing as much effort as it would have to if it were independent. Similarly, the effort incurred to find a cheaper supplier in one network may reduce the need to look for a cheaper supplier in another city. The bargaining of the contract signed by the local operator and the local authority may also be easier if the operator belongs to a group with relevant experience in other networks. In that sense, an operator belonging to a group will benefit from positive externalities coming from the effort exerted by all the remaining operators of the group. To be able to exploit incoming spillovers, operators need to work on their absorptive capacity. The latter defines the ability of the operator to identify the value of new information and assimilate it, which requires from the operator specific skills in understanding a message or a language, or scientific or technological capabilities.

The production of Innovation is very often a decentralized activity

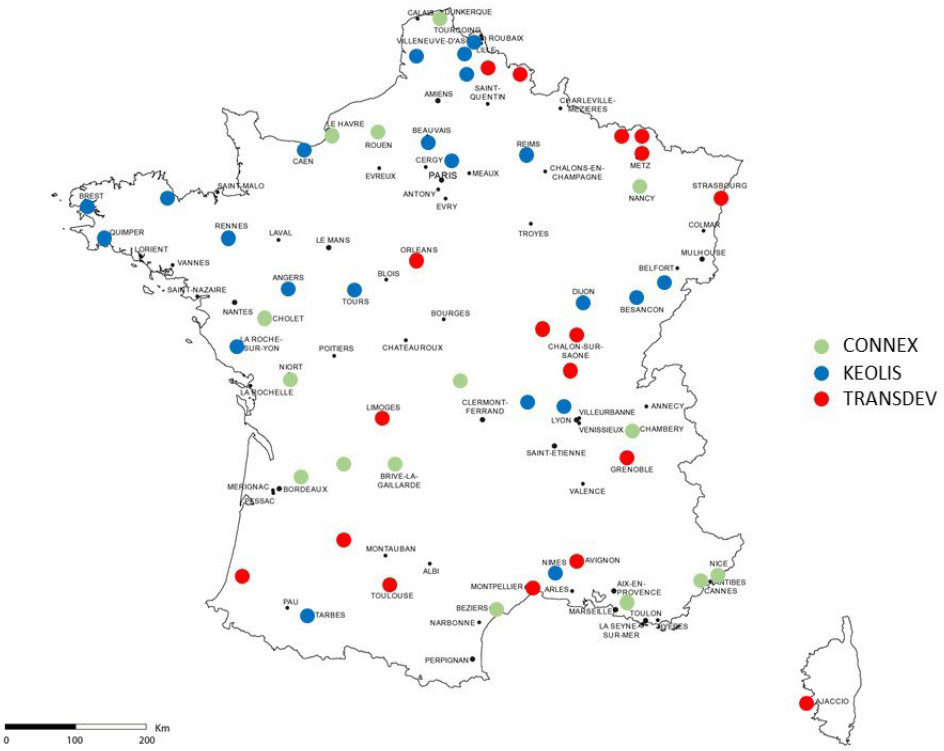
Although innovation in public transport is carried out by operators, it is very often triggered locally by the public authority in charge of regulating the service. For instance, the use of contactless travel cards by consumers started in the 1990s thanks to the introduction of a new smart card technology and originated in the cities of Nice and Amiens (Ampélas, 2001). The city of Lyon was a leader in the experimentation of the dynamic bus lane with an innovation that allows a lane to be reserved in the event of a traffic jam. The city of Dijon improved drastically a system that allows the operator to control the traffic lights of the urban network directly in order to prioritize public transport. More recently, contactless payments, which allow the consumer to buy a ticket without the need for a desk selling got promoted in Grenoble.

In a recent published paper with Luis Aguiar, we propose to focus on the issue of the identification of spillovers in the particular case of the French urban transport industry. The exercise consists in building and estimating an economic model that accounts for the fact that R&D expenditures and absorptive capacity are directly related and allow the production of knowledge spillovers. In each given city, the operator is one of the three large industrial groups present in France, namely Keolis, Connex (Veolia Transport from 2005) and Transdev, or it can be an independent local entity. In both cases, the operations are run by a local manager who decides upon the effort level to be exerted to reduce the operating costs of the local transportation activity. The operator maximizes its own profit and determines the optimal effort level. The latter is affected by all the other effort activities exerted by the other operators of the same group.

The results suggest that the flow of knowledge spillovers across the members of the same group are significant and increase with the size of the group, and they allow transport operators to obtain significant cost reductions. Moreover, networks that present larger differences in characteristics (such as the size of the network or the share of engineers in the total labor force) relative to their group benefit to a larger extent from the efforts provided in the other networks from their group. Thus, while a minimum degree of overlap of knowledge across operators is necessary for internal communication, there are also benefits to diversity of knowledge and organizational structures across networks. This goes in line with Simon (1985) which emphasizes that diverse knowledge experiences elicit the sort of learning and problem solving that yields innovation. It is key for the industrial groups in charge of transportation services in France to develop an active network of external relationships in order to strengthen each local managers' awareness of others' expertise. As a result, the group's absorptive capacity is increased.

The geographical distance between two networks could also influence the ability of each operator to exploit incoming spillovers. In other words, the diffusion of spillovers could be facilitated among the closest urban networks of the same group as a shorter distance facilitates face-to-face communication and on the spot feedback. As suggested by *Figure 1*, urban networks of the same group might be clustered in the same geographical area. This is the case for instance of Hénin-Carvin, Lens, and Lille, which are located less than forty kilometers apart from each other in the north of France, and all of them belong to Keolis. The model considers a closeness centrality index which provides information on the geographical position of an operator within the set of all operators that belong to the same group (Bloch et al., 2019). The results suggest that the effect of distance is nil. Hence, the absorptive capacity of transport operators is mostly built upon diversity of knowledge and experience but does not require operators to be in close geographical positions to each other.

Figure 1: Urban networks



The paper also proposes a counterfactual exercise which aims at appraising the total cost reduction effect of adding extra operators to a group. A short version of the exercise is shown in *Table 1 to 3* below. Being in a group of at least two operators yields a higher cost reduction compared to a situation where all operators remain independent. As expected, costs reductions increase with the number of participants in each group and can be quite important. Take the case of Keolis for instance: Switching from one to two participants allows each group member to reduce their costs by 1.62% each; at the same time, switching from one to five participants allows a 6.09% cost reduction for each of them. Over our period of observation, Connex, Keolis, and Transdev run services in 15, 22, and 19 networks respectively. Increasing the current number of networks by one unit would allow them to decrease their cost by 3.44, 1.32, and 2.84% respectively. In general,Connex enjoys higher cost reductions because its absorptive capacity is estimated to be larger compared to the other two operators.

Table 1: % change in total costs -- Connex

	... to *n* + *p* operators				
Going from *n* operators...		2	3	4	5
	1	-4.51	-8.58	-12.28	-15.65
	2	-	-4.40	-8.39	-12.03
	3	-	-	-4.30	-8.22
	4	-	-	-	-4.21

Table 2: % change in total costs -- Keolis

	... to *n* + *p* operators				
Going from *n* operators...		2	3	4	5
	1	-1.62	-3.17	-4.66	-6.09
	2	-	-1.60	-3.14	-4.62
	3	-	-	-1.59	-3.11
	4	-	-	-	-1.57

Table 3: % change in total costs -- Transdev

	... to *n* + *p* operators				
Going from *n* operators...		2	3	4	5
	1	-3.77	-7.29	-10.58	-13.66
	2	-	-3.71	-7.18	-10.42
	3	-	-	-3.66	-7.08
	4	-	-	-	-3.60

From a social point of view, and based on these results, it is relevant to guarantee a significant market power to transport groups in order to allow them to be present in several networks. As structural differences across operators/networks is an important driver of absorptive capacity, these groups should be incentivized to take control of networks with different characteristics, which implies that geographical clusters of networks operated by the same group should be avoided as much as possible. In practice, a simple recommendation would then be to foster ex ante competition through tenders in areas where geographical clusters are observed. If a more concentrated industry is not acceptable, another solution could consist in facilitating information flows between the local operators, whether or not they belong to the same group, through an industry-level research joint venture. More in general, whether a more concentrated industry guarantees sufficient efficiency gains that offset the loss of competition remains to be tested. Gagnepain and Martimort (2016) indicates that, in the case of the merger between Veolia Transport and Transdev, the loss in competition would have been outweighed by a minimum of 18% efficiency gains. The results obtained in our research suggest that this statistic is a realistic target.

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