



Eight municipal driverless bus demonstrations

Research agenda

User's ride satisfaction drivers

Behavioral intention

- Ride without personnel
- Ride alone
- Substitute regular bus

Driverless bus main concern

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Why Should We Regulate the Driverless Urban Bus Market?



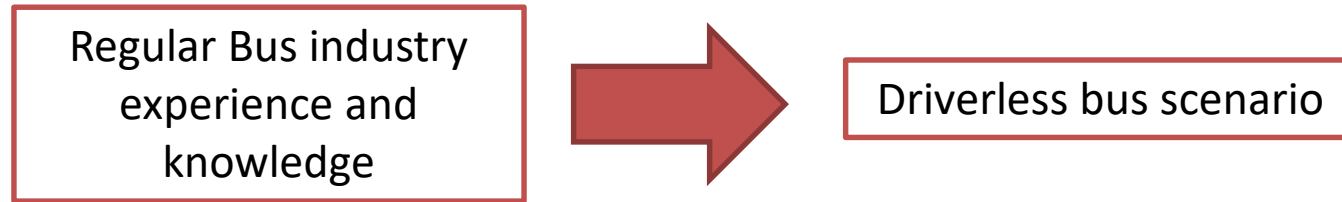
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Outline → Driverless bus Thredbo journey



- Should we intervene? Market failures
- Deregulation, privatization and competition
- Driverless bus contracts
- Should we subsidize it?
- Driverless bus main concerns
- Tentative recommendations - Conclusions

Market failures

The first fundamental theorem of welfare economics states that markets lead to social optimum and no government intervention is required under some assumptions

When these assumptions are not reached → market failures

In the transport market, governments intervene to rectify such market failures (Docherty et al., 2018).

Market failures

- ❑ Free market and competition
 - Market power vs. prohibiting



Market failures

❑ Free market and competition

- Market power vs. prohibiting

❑ Externalities

▪ Congestion

-  Vehicles-mile travelled (ITF, 2016)
-  Congestión in initial & mature stages (Hensher, 2018)
- SAVs would satisfy unmet and induce demand (Truong et al., 2017)

▪ Environmental impacts (emissions)

- Energy-efficient driving thanks to traffic homogenization (Fagnant and Kockelman, 2015)
- EV debate

▪ Accidents (Fagnant and Kockelman, 2015)

- 10% market penetration → 50% accidents less
- 90% market penetration → 90% accidents less

But more accidents during the transition

Privatization, regulation and competition

- ☐ Privatization (Outsourcing or private provision)
 - ☐ Arguments in favor
 - ☐ Innovation
 - ☐ Incentives to increase patronage
 - ☐ Access capital markets
 - ☐ Arguments against
 - ☐ Regulatory capture

Privatization, regulation and competition

- ❑ (De)Regulation
 - ❑ Deregulating and implementing on-the-road bus competition can lead to too much service at too high fares with too low quality of service (Preston, 2005).

	Local bus outside London (deregulation)	Local Bus London (privatization and competitive tendering)
Demand	-35%	+ 25%
Fares	+ 40%	+ 8%
Service	+ 25%	+39%
Costs	-43%	- 43%
Subsidy	-33%	-18%

Source: Preston, 2005

Privatization, regulation and competition

☐ Competition

- ☐ Competitive tendering reduced service regular bus costs by 10-50% (Wallis and Hensher, 2007),
- ☐ But there are some rigidities to diminish them over time
- ☐ Driverless bus scenario: When a sectorial structural changes occur, e.g. driverless bus, Total Factor Productivity (TFP) grows due to technological progress. Since this technological progress will be more intense in the initial years of implementation, competition can help uphold these cost savings and ensure better service due to TFP growth.

Driverless bus contracts

❑ Contract characteristics

Regular bus: contract length 5 + 2 years (Wong and Hensher, 2018). The lower the entrance barriers (bus and depots owned by the regulator), the shorter the contract should be

Driverless bus initial contracts purpose is to acquire experience, so shorter contracts are preferable (between one and three years). Likewise, possibility of dividing the contract between two geographical areas

❑ Bidders

- Driverless bus providers have the technology, while regular bus providers have area knowledge and a prior relation with the regulator → possible joint-ventures (initially)
- In a driverless bus scenario, bus manufacturers have incentives to vertically integrate both stages jointly with regular bus operators due to their knowledge and previous relationship with the regulator.

Driverless bus contracts

❑ Initial stages

- Step by step reforms (avoid Transantiago experience)
- Avoid high interaction zones
- Tramway infrastructure, bridges, bus lanes or feeding stations in zones of low demand.
- Route based level rather than large area-served

▪ Next stages

- Introduce area-served level
- ...

Driverless bus contracts

❑ Awarding procedure

- Initial stage
 - PTA non previous experience on driverless bus → NOT TENDER
 - Contract innovation, openness and dialogue → NEGOTIATED contracts.
 - Regular bus provider
 - New operator or joint venture
- Development stage
 - If previous experience → tend to move to Competitive Tendering

Driverless bus contracts

❑ Risk scheme

Regular bus preferred contracts: gross and gross with incentives

Driverless bus:

Production risk: Operator!

Revenue risk: incentives to increase patronage

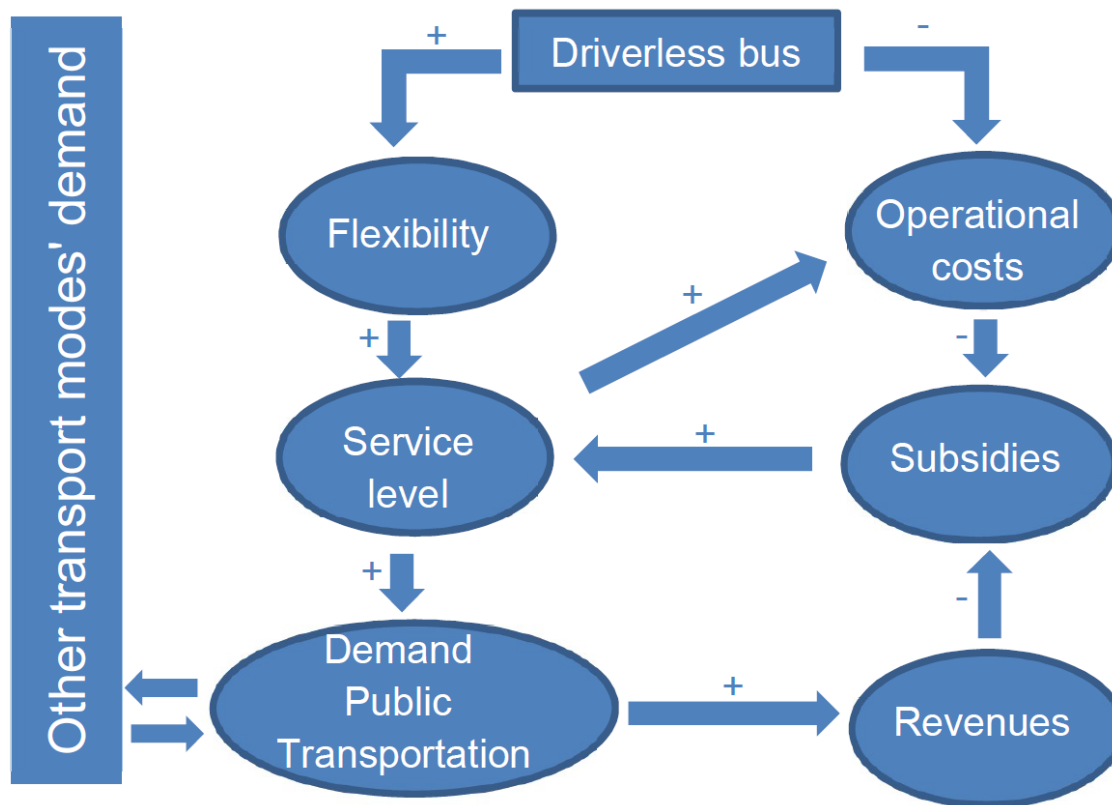
	Revenue risk	
	Shared	Operator
Production risk (operator)	Gross cost contract with patronage incentive	Net cost contract
	Net cost contract with shared revenue risk	Super-incentive contract

Source: Stanley and van de Velde (2008)

Should we subsidize it?

In regular public transportation, we subsidize as a second best tool

Effects related to driverless bus introduction



Source: Adapted from Ortúzar and Willumsen (2011) by Bahamonde-Birket *et al.* (2018)

Driverless bus main concerns

- ❑ PTA: Not enough experience (US city planners, Freemark et al., 2019)
 - Optimism on technology: safety, congestion, costs and environment
 - Main problem: local opposition from citizens
 - In more dense and rich municipalities → they should regulate it

- ❑ Users / citizens

- Satisfaction: Concerns about riding on driverless buses are strongly associated with the willingness to use the service (Dong et al., 2019).

The greater a passenger's concerns with vehicle operational **safety**, support for disabled riders, and access to information, the less willing she/he will be to ride a driverless bus.

Passenger perceptions on traffic safety were on a driverless bus than on a regular one (Salonen, 2018).
- Disatisfaction:

slow speeds explains why SAVs not see as a good substitute for traditional buses (Nordhoff et al., 2018)

Driverless bus users main concerns

- Driverless bus trials were conducted in eight Catalan municipalities
- Survey to thousand passengers to determine their main concerns about boarding a driverless bus.
- September and October 2018.
- Main problem: self-selection on users
- Main concerns from previous literature (Dong et al., 2019)
 - External safety
 - Internal security
 - Assistance from personnel
 - Disabled people

Driverless bus users main concerns

Main concerns	Proportion	Std. Err.	Bus user	Females	Age > 65	High income
External security (accidents)	26,93	1,361	29,12	28,39	24,44	31,98
Internal security	20,62	1,242	22,93	21,61	12,22	17,57
Low level of assistance due to non-personnel	9,42	0,896	8,47	9,1	11,11	8,55
Riders with reduced mobility	25,80	1,343	23,14	27,5	35,55	25,23
Non problems	16,01	1,125	15,08	11,96	14,14	15,77
NR/DK	1,22	0,338	1,24	1,42	2,22	0,90

Driverless bus users main concerns – Performance measure

Advances in technology can overcome problems of in-vehicle safety, low levels of assistance and the barriers faced by those with low levels of mobility.

The main challenge for the industry today is to ensure higher levels of safety in interactions with street elements.

PTAs should design contracts in which driverless bus rewards are not only linked to patronage levels, but also to performance as measured by a range of other indicators. When selecting service providers, PTAs should therefore take performance into consideration on contract management phase not only in the operational phase but also in relation to the concerns identified by passengers.

- Around a third of this score should be awarded to how the provider addresses external safety,
- Another third to addressing riders' mobility problems,
- Quarter to in-vehicle safety
- Tenth to customer services

Driverless bus operational framework implementation

	Regular bus service	Driverless bus	
		Initial stage	Development stage
Awarding procedure	CT / NPBC	NPBC	CT
Area served	Area-based	Route-based/Area-based	Area-based
Contract length (years)	5+2	1-3	3+2
Bus owner	PTA	Operator	Operator/PTA
Depot owner	PTA	PTA	PTA
Production risk	Operator	Operator	Operator
Revenue risk	PTA	Shared / patronage incentives	Shared / Operator

**Thank you for your attention
and
Suggestions more than welcome!**

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