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– the energy crisis, the impact on the transition –

Research on the Effect of Policy Implementation in Test Demonstration Zones on the Commercial Operation of Autonomous Driving ——Verification Based on DID Model

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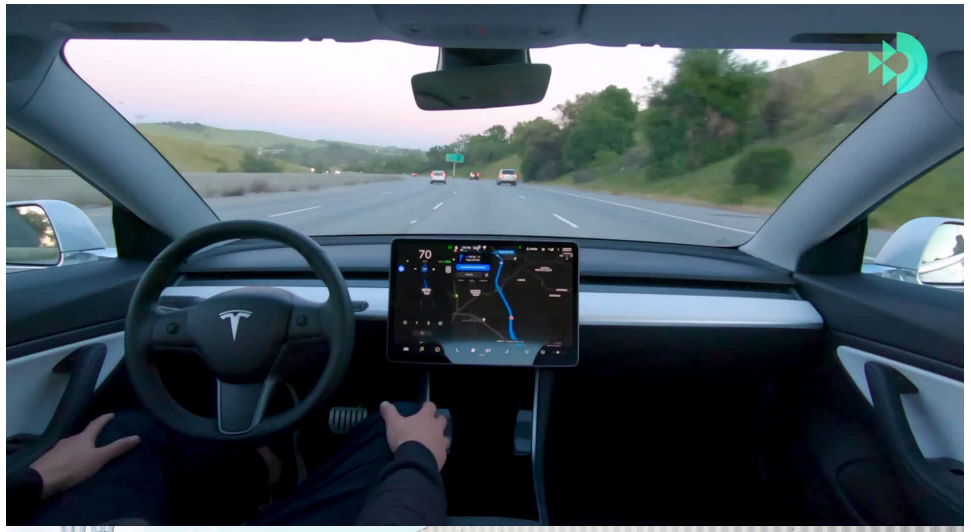
01 Introduction

Autonomous driving refers to the organic combination of the Internet of Vehicles and intelligent vehicles. It is a new generation of vehicles equipped with advanced on-board sensors, controllers, actuators and other devices, and integrated with modern communication and network technology to achieve intelligent information exchange and sharing between **vehicles and X (vehicles, roads, people, clouds, etc.**). It has complex environmental awareness, intelligent decision-making, collaborative control and other functions, which can achieve safe, efficient, comfortable, energy-saving driving, and ultimately replace human operation.

Reduce the occurrence of traffic accidents
Improve safety and efficiency of driving
Reduce environmental pollution
Reduce traffic congestion



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The six levels of autonomous driving

Driver only	Driver assistance	Partial automation	Conditional automation	High automation	Full automation

01 Introduction

Policies and regulations related to autonomous driving around the world

China

National level

- 2016 《Intelligent Connected Vehicle Technology Roadmap》
- 2017 《Internet of Vehicles Guidelines for Industrial System Construction》
- 2018 《Plan for the Development of the Internet of Vehicles Industry》
- 2020 《Innovative Development Strategy for New Energy Vehicles》
- 2021 《Opinions on Strengthening the Access Management of Intelligent Connected Vehicle Manufacturing Enterprises and Products 》
- 2023 《Notice on Launching Pilot Projects for Intelligent Connected Vehicles Access and Road Traffic》

Local level

Beijing

- 2020 《Implementation Rules for Road Testing Management of AVs》
- 2021 《Implementation Rules for Unmanned Road-Testing Management》
- 2022 《Implementation Rules for Unmanned Road Testing and Demonstration Application Management》
- 2023 《Guiding Opinions on the Pilot Work of High Precision Maps for Intelligent Connected Vehicles (Trial)》

Shanghai

- 2019 《Management Measures for Road Testing and Demonstration Application of Intelligent Connected Vehicles (Trial)》
- 2021 《Implementation Measures for Testing and Demonstration of ICVs》
- 2023 《Several policies to promote the development of ICVs in the Shanghai Pilot Free Trade Zone》

Shenzhen

- 2020 《Several Measures to Support the Development of ICVs》
- 2021 《Implementation Rules for Road Testing and Demonstration Application Management of ICVs》
- 2022 《Regulations on the Management of ICVs in Shenzhen 》

America

- 2016 《Federal autonomous vehicle Policy: Accelerating Road Safety Change》
- 2017 《Auto drive system 2.0: Safety Vision》
- 2018 《Prepare for the future traffic: autonomous vehicle 3.0》
- 2020 《Ensure the leading position of the United States in autonomous vehicle technology: autonomous vehicle 4.0》
- 2020 《Outline legislation on autonomous vehicle》
- 2021 《Autonomous vehicle Comprehensive Plan》
- 2022 《Regulations on Passenger Protection of Autonomous Vehicles》

Germany

- 2017 《Amendment to the Road Traffic Law》
- 2017 《Code of Ethics for Automated and Connected Vehicle Traffic》
- 2018 《Ethical and moral standards for autonomous driving technology》
- 2018 《The Road to Automated Mobility: The EU's Future Mobility Strategy》
- 2019 《EU Guidelines for Exemption Process of Autonomous Vehicle License》
- 2021 《Autonomous Driving Law》， Revise 《Road Traffic Law》 《Compulsory Motor Vehicle Insurance Law》

Britain

- 2017 《The Road to Unmanned Driving: Test Practice Criteria for autonomous vehicle》
- 2018 《Automatic and Electric Vehicle Act》
- 2019 《UK Connected and Automated Mobility Roadmap 2030》
- 2022 《Interconnection and automated travel 2025: benefits of releasing autonomous vehicle in the UK》
- 2024 《Autonomous vehicle Act》

Japan

- 2014 《ITS Concept and Route Map for Officials and Citizens》
- 2016 《Road Test Guide for autonomous vehicle》
- 2017 《Measures for Road Test License of Remote auto drive system》
- 2018 《Safety Technical Guide for autonomous vehicle》
- 2019 Revision of 《Road Transport Vehicle Law》 and 《Road Traffic Law》
- 2022 Amendment to 《Road Traffic Law》

01 Introduction

Virtual simulation testing

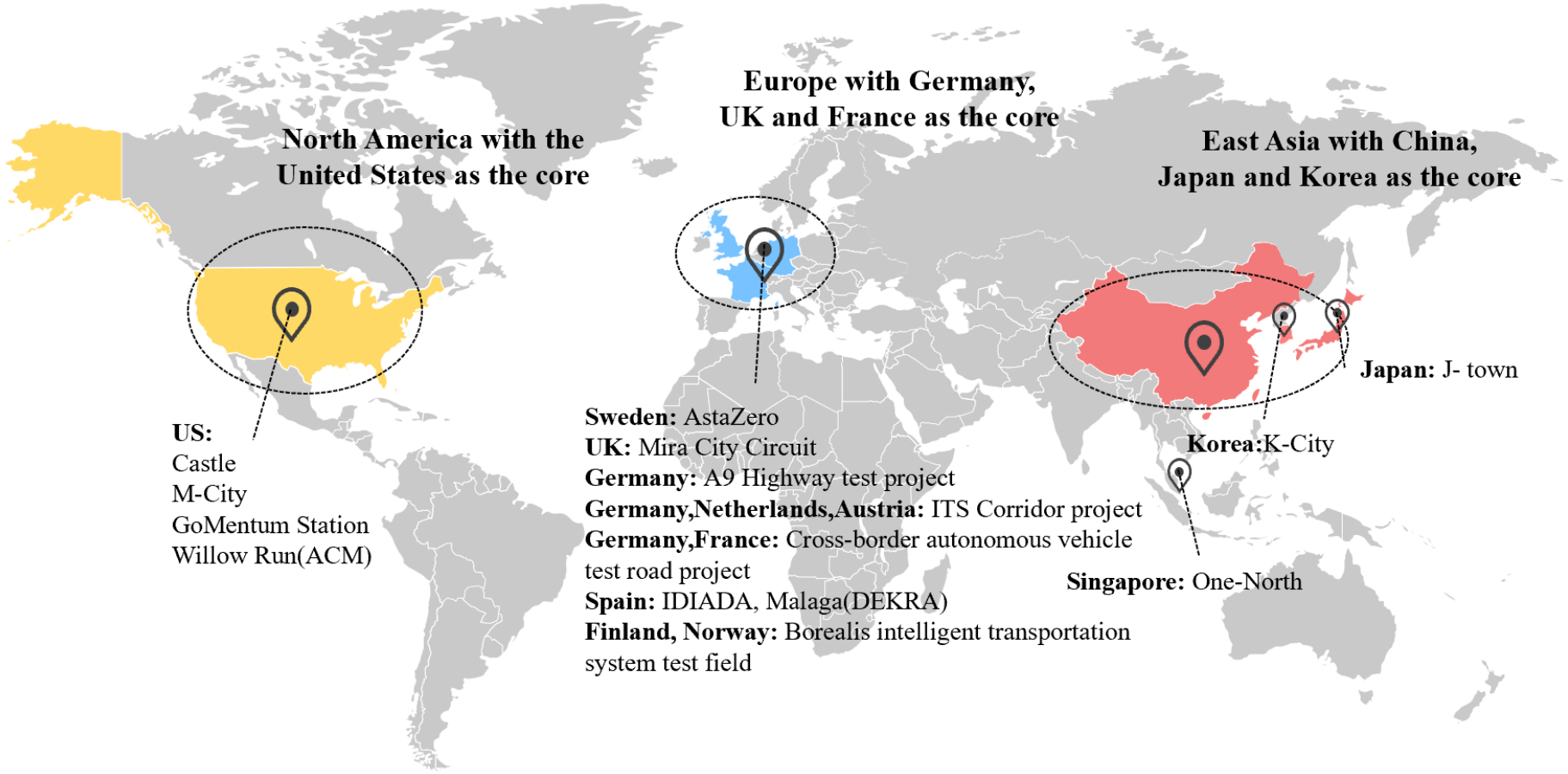
Closed road testing

Open road testing

Regional trial operation

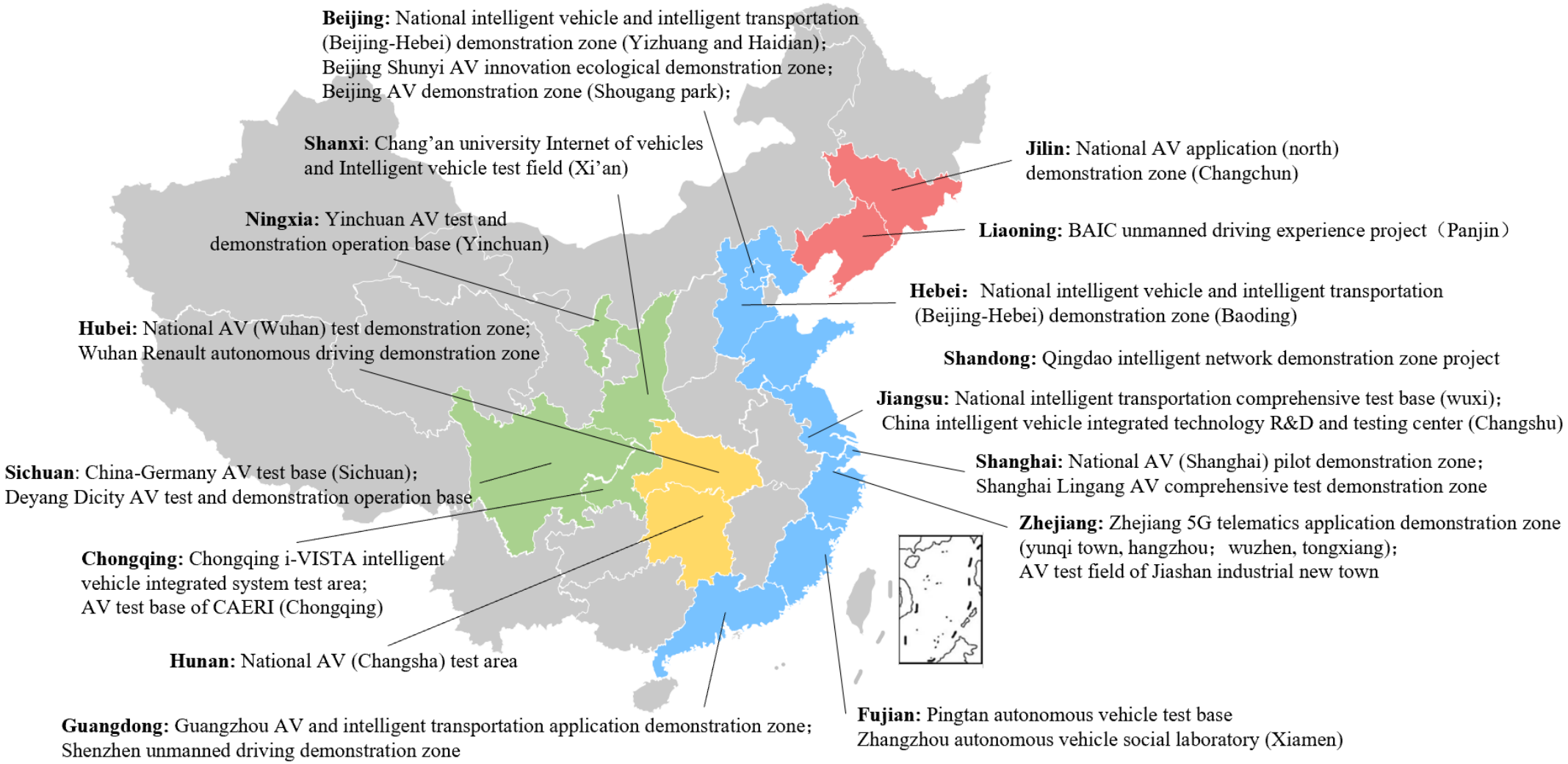
Commercial operation

Global layout of autonomous driving test site



01 Introduction

Distribution of Autonomous Driving Test Demonstration Zones and Pilot Cities in China



01 Background

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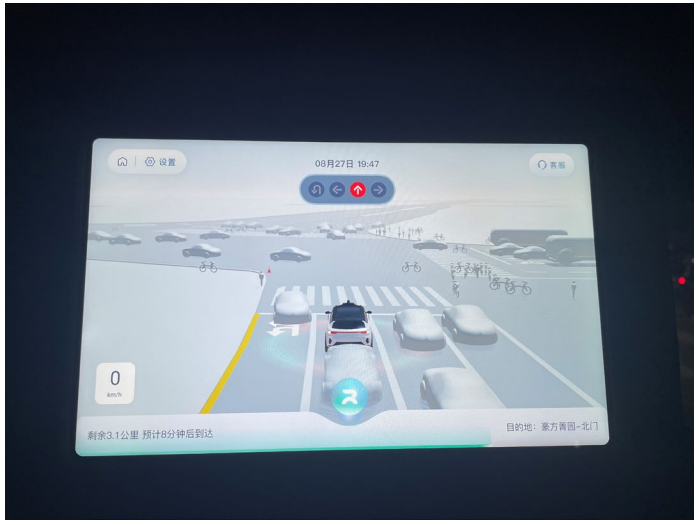
Apol ny Pilot



01 Introduction

Concern for users

- The reliability of autonomous driving technology
- Data and network security issues
- Personal privacy issues
- Ethical and moral issues

Literature Review

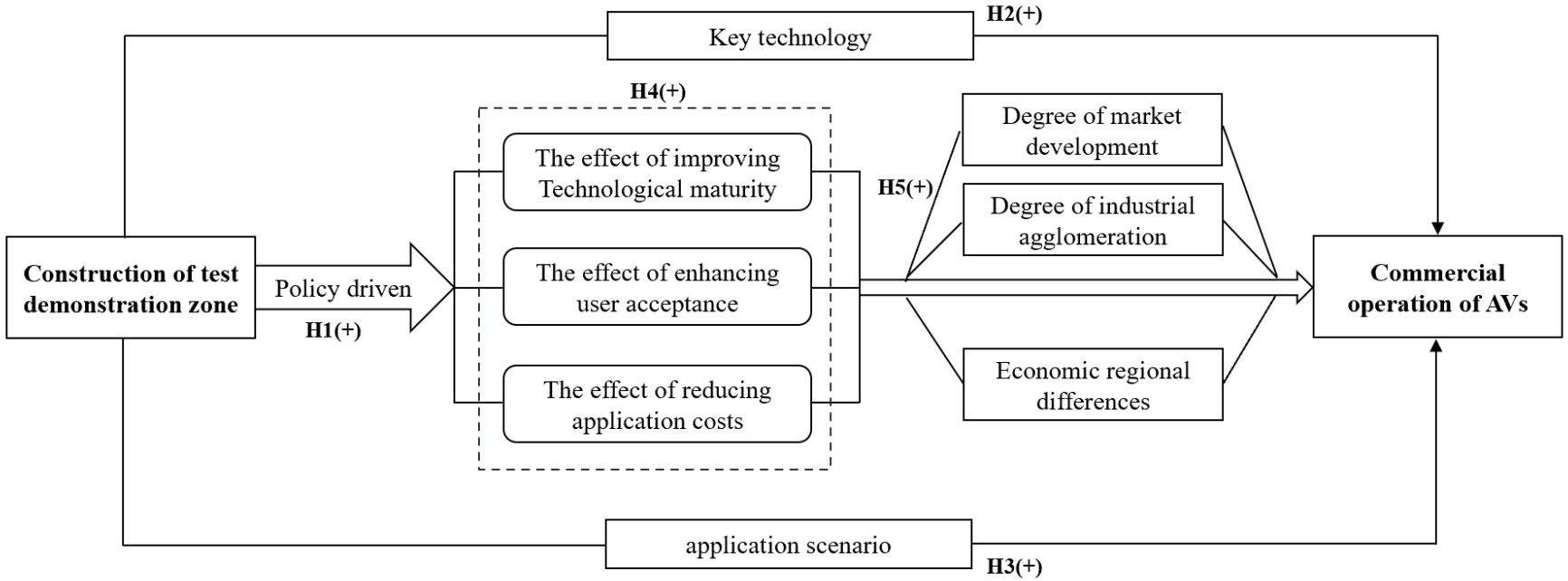
- Testing technology and testing scenarios
- Construction and operation of the test demonstration zone
- Policies and regulations for road testing
- Autonomous driving virtual testing platform
- Public awareness and acceptance of autonomous driving
- Accident liability determination and insurance issues

DID model

- **How does the construction of the test demonstration zone promote commercial operation?**
- **What mechanism does it work through?**
- **Is there heterogeneity in the effectiveness of the action?**
- **Will it have an impact on other regions?**

02 Methodology

Theoretical framework of the research



- **H1:** The construction of test demonstration zones can positively promote the commercial operation of AVs
- **H2:** The mediation effect of key technology
- **H3:** The mediation effect of test scenario
- **H4:** By improving technological maturity, enhancing user acceptance, reducing application costs(Mechanism test)
- **H5:** Degree of market development; Degree of industrial agglomeration; Economic regional differences (Heterogeneity effect)

02 Methodology

Multi-temporal double difference model : $$CO_{it} = \alpha_0 + \alpha_1 DID_{it} + \alpha_2 X_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (1)$$

(CO_{it} is the explanatory variable, representing the commercial operation of AVs;
DID_{it} is the core explanatory variable, representing the construction of test demonstration zone, and consists of *time*×*treat*;
Time is a dummy variable for the time of policy implementation, *time*=1 means before the year of policy implementation, otherwise it is 0;
Treat is a dummy variable for the target of policy implementation, *treat*=1 means the city becomes a test demonstration zone (experimental group), otherwise it is 0 (control group);
X_{it} represents all control variables, λ_i is the fixed effect of the city, μ_t is the fixed effect of the time, ε_{it} is the random disturbance term.)

Mediating effects of key technology : $$CO_{it} = \alpha_0 + \alpha_1 DID_{it} + \alpha_2 KT_{it} + \alpha_3 DID\text{-}KT_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (2)$$

Mediating effects of test scenario : $$CO_{it} = \alpha_0 + \alpha_1 DID_{it} + \alpha_2 TS_{it} + \alpha_3 DID\text{-}TS_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (3)$$

DID-KT represents the cross term between the construction of test demonstration zone and key technologies in city *i* and year *t;*
DID-TS represents the cross term between the construction of test demonstration zone and test scenarios in city *i* and year *t*.

02 Methodology

1. **Explained variable : Commercial Operation (CO) of AVs**

Technology cost; Technology maturity; Scenario standardization degree; User acceptance

2. **Core explanatory variable : Construction of Test Demonstration Zone (DID)**

investment scale, road mileage, site area, number of scenarios (from simulation experiments to closed test sites, semi-open roads, and open roads)

3. **Mediator variables: Key Technology & Test Scenario**

4. **Control variables**

The level of economic development; The degree of government intervention; The level of transportation infrastructure construction; Industrial structure; The degree of investment in scientific research

03 Results

3.1 Benchmark regression analysis

Variable	Commercial operation of autonomous vehicle					
	(1)	(2)	(3)	(4)	(5)	(6)
DID	0.217***	0.086***	0.093***	0.074***	0.062***	0.058***
	(0.014)	(0.029)	(0.018)	(0.025)	(0.047)	(0.031)
Control variable	No	No	Yes	Yes	Yes	Yes
Key Technology	—	—	—	—	0.025***	—
					(0.042)	
DID-KT	—	—	—	—	0.037***	—
					(0.006)	
Test Scenario	—	—	—	—	—	0.046***
						(0.083)
DID-TS	—	—	—	—	—	0.029***
						(0.065)
City/Year FE	No	Yes	No	Yes	Yes	Yes
Observations	2232	2232	2232	2232	2232	2232
R-squared	0.152	0.379	0.426	0.453	0.545	0.568

Note: *** $p < 0.001$. ** $p < 0.01$. * $p < 0.05$.

Regression results

H1: The construction of test demonstration zones has promoted the commercial operation of autonomous driving at the urban level

H2: The construction of test demonstration zones can promote the commercial operation of autonomous driving through key technology innovation

H3: The construction of test demonstration zones can promote the commercial operation of autonomous driving through test scenario innovation

3.2 Mechanism test

Variable	(1) Technical cost	(2) Technical maturity	(3) Degree of scenario standardization	(4) User acceptance
DID	-0.176**	0.268***	0.274	0.283***
	（0.469）	（0.627）	（0.315）	（0.646）
Control variable	Yes	Yes	Yes	Yes
City/Year FE	Yes	Yes	Yes	Yes
Observations	2232	2232	2232	2232
R-squared	0.457	0.623	0.582	0.665

Note: *** p < 0.001. ** p < 0.01. * p < 0.05.

Mechanism test result

The construction of test demonstration zones mainly promotes the development of commercial operation of AVs in the city by **reducing technology costs**, **improving technology maturity**, and **enhancing user acceptance**, which does not significantly promote the degree of scenario standardization.

3.3 Heterogeneity test

Variable	Commercial operation of autonomous vehicles	
	(1)	(2)
DID	0.185**	0.206***
	(0.064)	(0.053)
*DID * market index*	0.027***	
	(0.052)	
*DID * Internet*		0.034***
		(0.079)
Control variable	Yes	Yes
City/Year FE	Yes	Yes
Observations	2232	2232
R-squared	0.529	0.577

Variable	Commercial operation of autonomous vehicle			
	Eastern region	Central region	Western region	Northeast region
DID	0.287***	0.135	0.118	0.106
	(0.056)	(0.042)	(0.013)	(0.074)
Control variable	Yes	Yes	Yes	Yes
City/Year FE	Yes	Yes	Yes	Yes
Observations	765	427	834	206
R-squared	0.536	0.462	0.428	0.507

Note: *** $p < 0.001$. ** $p < 0.01$. * $p < 0.05$.

Heterogeneity test result

The higher **degree of market development** in the city, the more obvious the policy effect of the construction of the test demonstration zone

The higher **degree of industrial agglomeration** in the city, the more obvious the policy effect of the construction of the test demonstration zone

In the **eastern region**, the construction policy of test demonstration zones has a significant positive impact on the commercial operation of autonomous driving, which is related to the high market development level, large economic development scale, and strong administrative intervention ability of pilot cities

04 Conclusions

The results of benchmark regression show that the construction of test demonstration zones has **an obvious promotion effect** on the commercial operation of AVs in pilot cities during the sample period, and this conclusion is still valid after a series of robustness tests.

The results of mediating effect test show that **key technology** and **test scenario**, as important elements in the construction of test demonstration zones, play **a positive mediating role** in the process of promoting the commercial operation of AVs in the construction of the test demonstration zones.

The results of mechanism test show that the construction of test demonstration zones can promote the commercial operation of AVs by **reducing the cost of technology**, **improving the maturity of technology** and **enhancing user acceptance**.

The results of heterogeneity test show that the promotion effect of the construction of test demonstration zones on the commercial operation of AVs is significantly heterogeneous due to **the differences in the degree of market development**, **industrial agglomeration** and **geographical location of cities,** and the promotion effect is strongest in the **eastern region**.

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THANK YOU