Electric Vehicle Innovation

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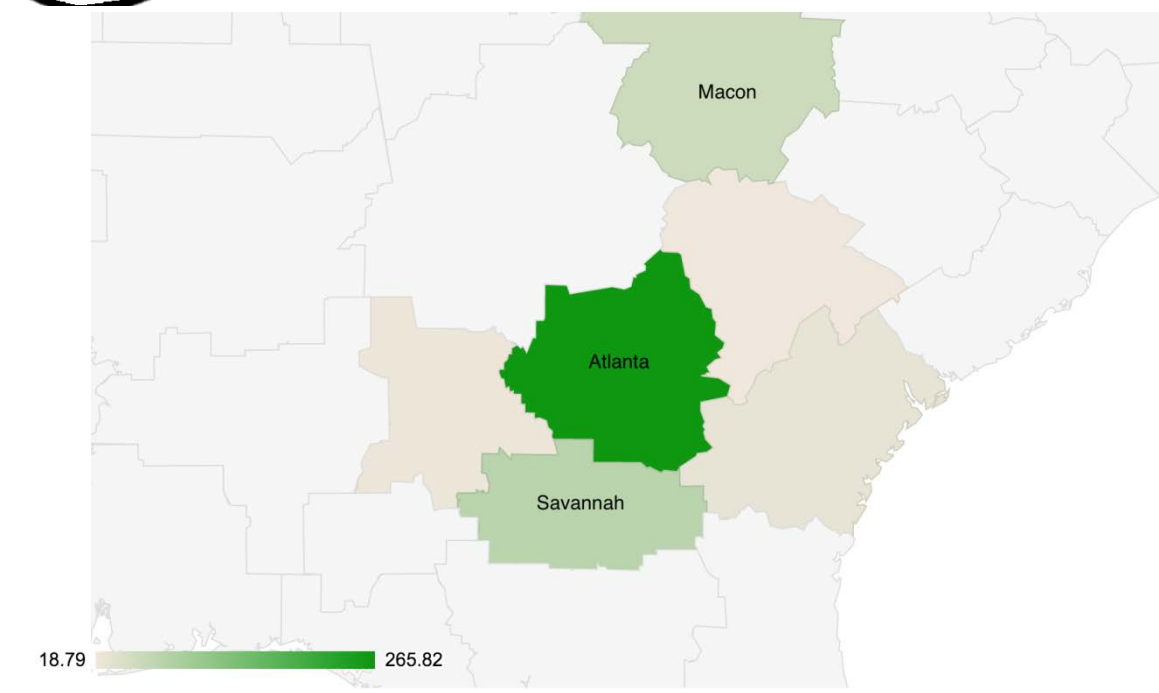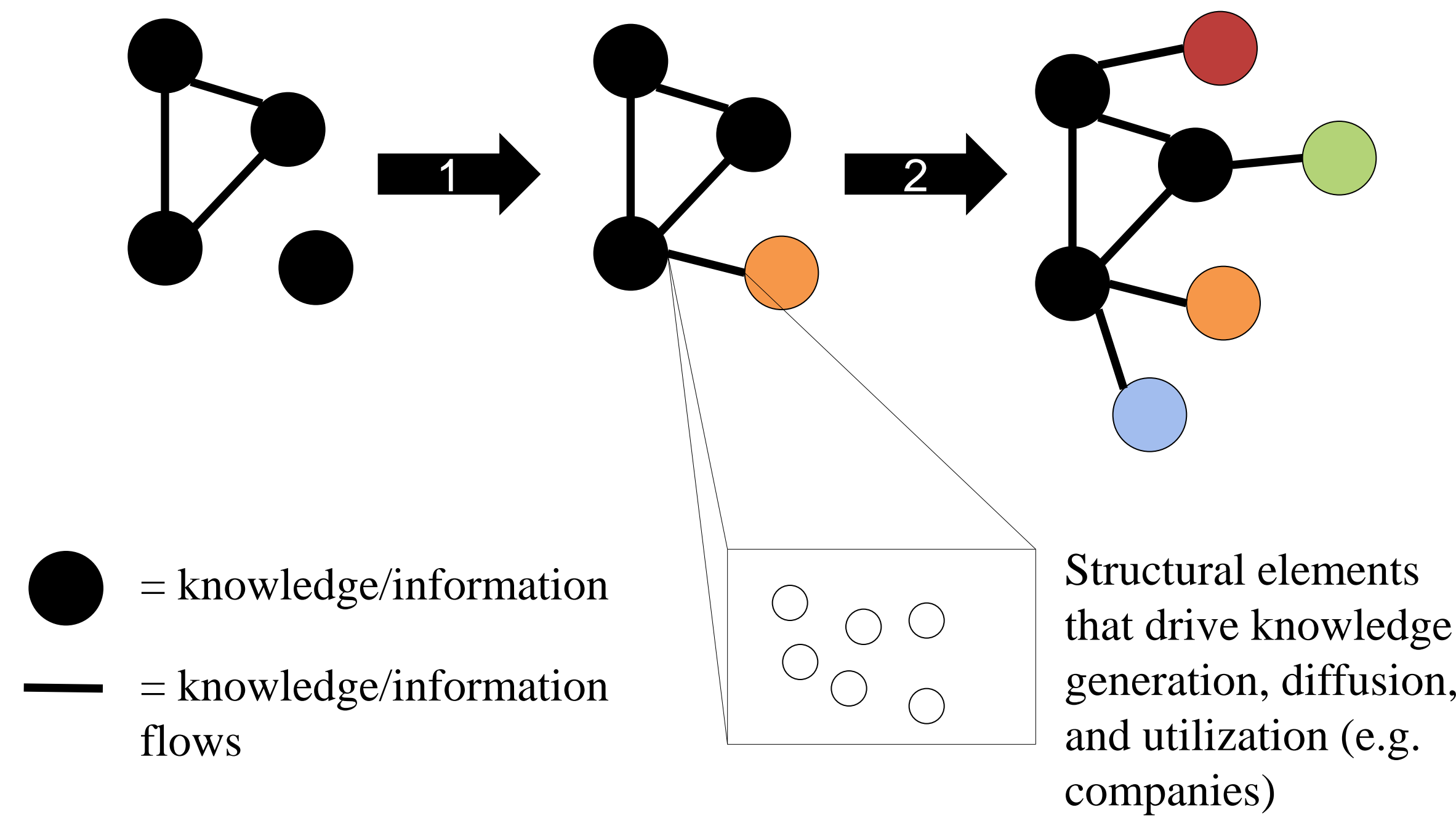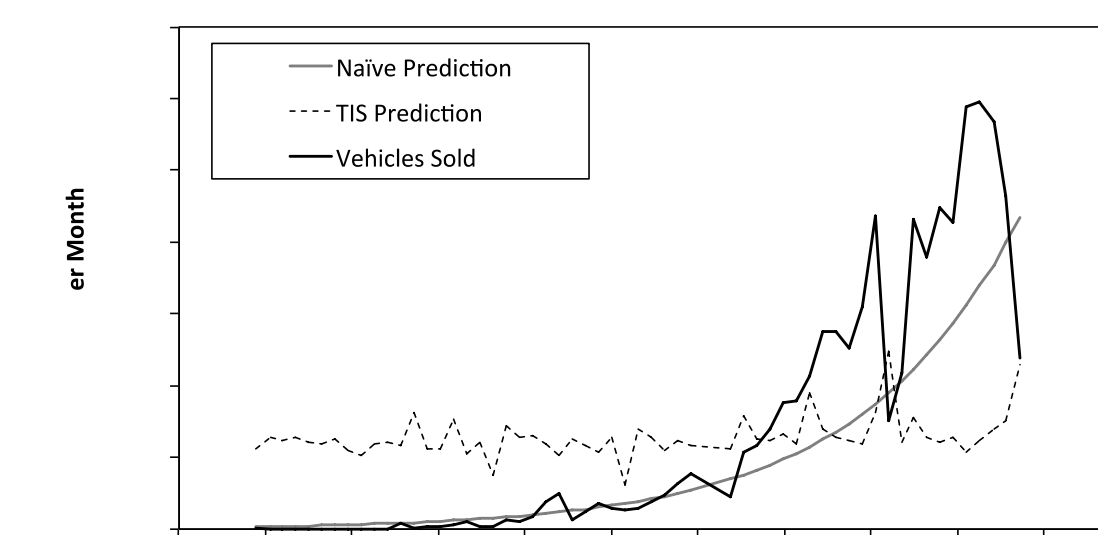Institute of Transportation Studies, University of California, Davis - *December 2015*

The Technology Innovation System (TIS) framework takes the view that the generation, dissemination, and use of information is what ultimately drives innovation. With a strong enough knowledge sharing network, the physical manifestations of innovation become guaranteed and trivial.
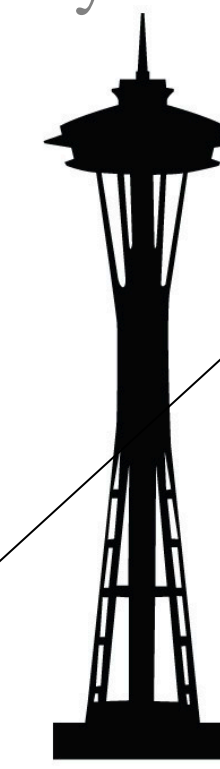
1. Actions can be taken that promote the diffusion or linking of knowledge

2. Actions can be taken (e.g. policy implementation) to generate new knowledge, or novel links or applications

● = knowledge/information

— = knowledge/information flows

Structural elements that drive knowledge generation, diffusion, and utilization (e.g. companies)

Types of actions that can be taken (Innovation Functions)

Resource Mobilization – actions that promote the use of specific capital or labor

Market Formation – actions that guarantee demand for a product or process

Legitimation – actions that improve public perception of the technology

Knowledge Development and Diffusion – actions that promote basic knowledge creation, or work to disseminate that knowledge to broader networks (e.g. educational outreach)

Influence the Direction of Search– actions that promote research or support for specific technologies in a specific way

Entrepreneurial Experimentation– actions that promote new businesses or new business decisions concerned a technology

Development of Positive External Economies– actions that indirectly promote the technology's network

We held meetings with knowledgeable EV experts (n=31) in three different states (Washington, Colorado, and Georgia). These meetings helped us gain insight into what factors experts thought were driving or detracting from EV diffusion in the state. We utilized the TIS framework to gain information and insight into the actions that have or have not been taken to support EV innovation. We compare these results to a TIS modeling approach.

TIS Modeling Approach

Step 1: collect a large quantity of data associated with the flow of information for a specific technology

Step 2: Classify the actions associated with generating that type of information (e.g. entrepreneurial experimentation, knowledge development/diffusion events, statements of positive support for the technology)

Step 3: See how the actions associated with information flow for one technology or one region compares to a different technology or a different region

Georgia

The measured TIS in Georgia shows some peaks and troughs, but appears to mimic the TIS in the U.S. EVs were first supported through policy in the late '90s, and more recently incentives and support for EVs has been removed.

Atlanta is featured heavily in EV information flow. Vehicles were also viewed as "future" technology

EV Diffusion in Georgia was primarily driven by a generous income tax credit of $5,000 that could be applied to leasing arrangements. This allowed for individuals to lease the Nissan Leaf, practically for free, for 2-years – the duration of the lease.
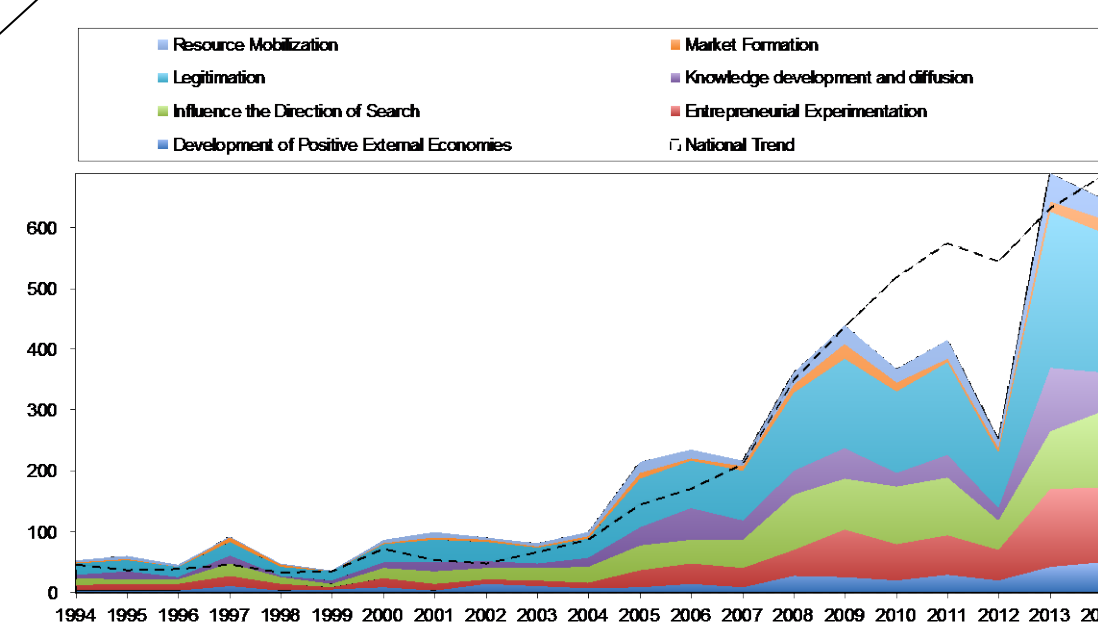

EV deployment in Georgia followed an exponential diffusion curve. Most deployment took place in Atlanta
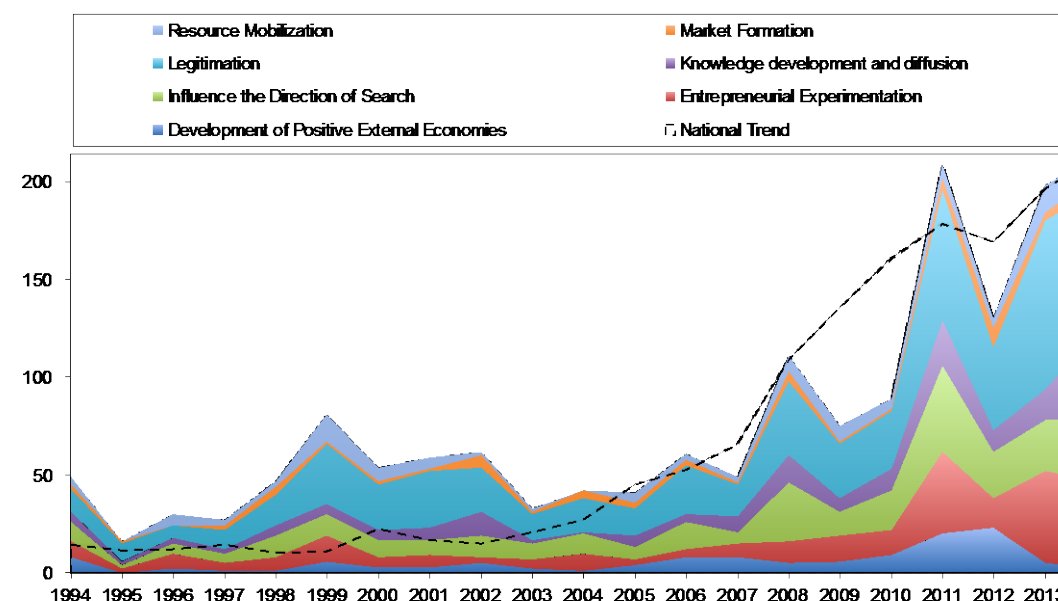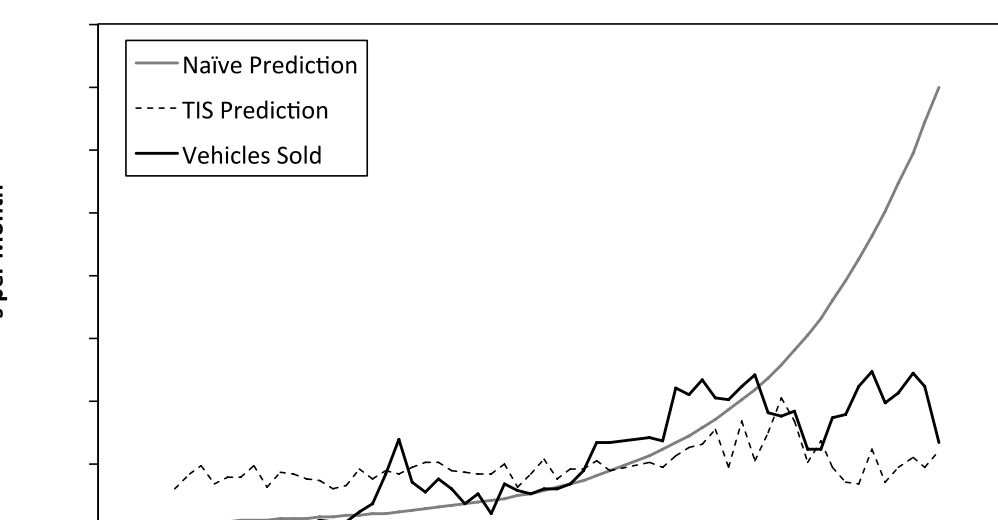
Washington

In meetings, the Washington EV purchaser was still described as an "early adopter," and a "technophile," interested in the EV as a new technology that they would replace every 2 to 3 years, making leasing ideal.

Modeling results indicate that Entrepreneurial Experimentation has been significantly better supported in Washington than elsewhere in the nation. This means that there is considerable interest in EVs from the private sector and private industry; this includes discussion of joint ventures, commercialization activity, business mergers and acquisitions, and launching of new products associated with electric vehicles.


From 2012 (left) to 2013 (right), EV technology transitioned from a "future" technology to one that was in use. New vehicles, like the Tesla Model S became available, significantly impacting the market.

Gorgia has had substantially worse support for Influence the Direction of Search and Legitimation compared to other states. This functional weakness may be what contributed to the recent removal of the considerable income tax credits associated for EV purchases and leases.
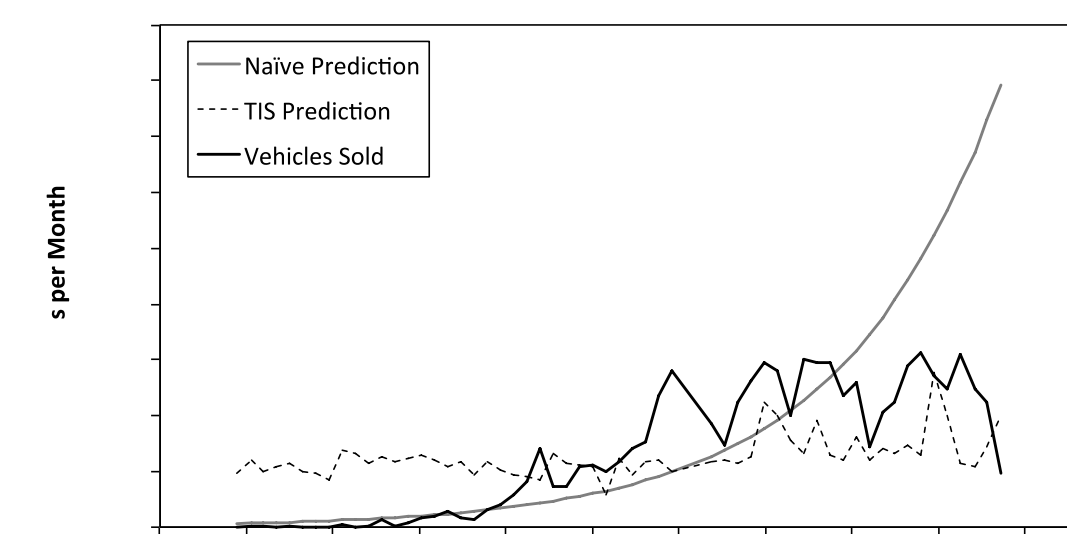

Despite a fully refundable state income tax credit of up to $6,000, EV diffusion in Colorado has not been significantly different compared to elsewhere in the United States.

Colorado

In meetings, participants suggested that new efforts were underway to increase information and knowledge about EV technology and EV incentives.

We determined that the current income tax credit in Colorado is too complicated for dealers to clearly advertise or promote, and that information and knowledge about EVs in Colorado is not significantly better than elsewhere. Model results suggest that this can greatly impact deployment.
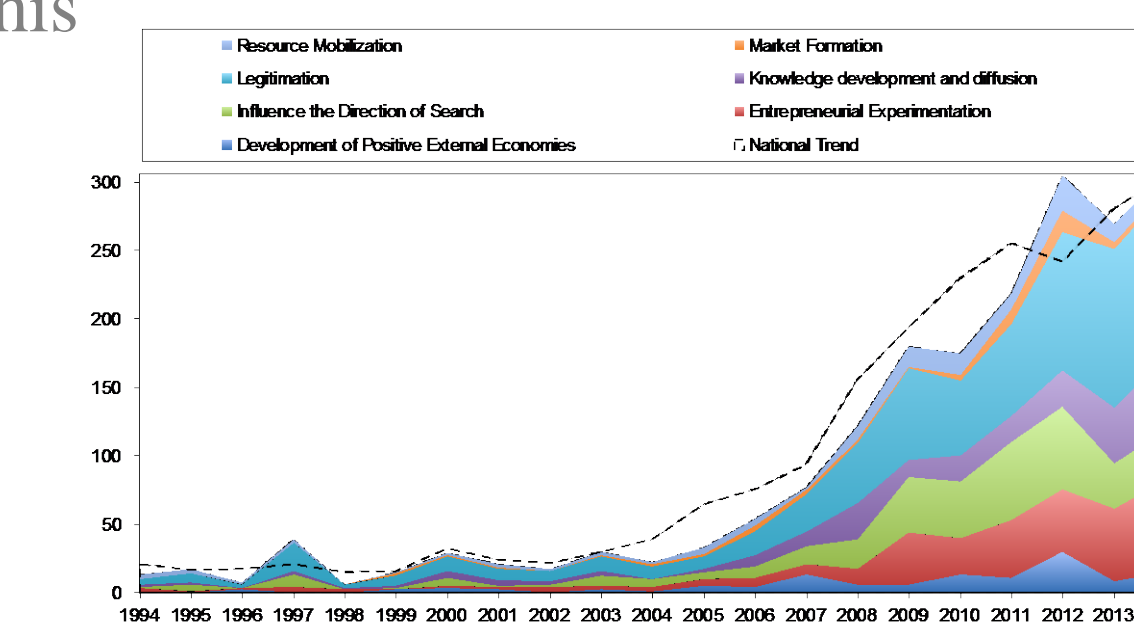
States with substantially better legitimation and knowledge development and diffusion actions seem to have significantly higher EV penetration.

	Dependent variable:
	Vehicles_Sold
Legitimation	0.024***
	-0.006
InfD	-0.046***
	-0.009
MarketFormation	-0.019
	-0.024
EntExp	0.01
	-0.01
KnowD	0.049***
	-0.009
PosEx	-0.034**
	-0.013
ResMob	-0.023
	-0.014
StateCALIFORNIA	1.705***
	-0.496
StateCOLORADO	-0.119
	-0.242
StateCONNECTICUT	-0.571**
	-0.242
StateFLORIDA	0.854***
	-0.243
StateGEORGIA	1.319***
	-0.241
StateILLINOIS	0.38
	-0.242
StateINDIANA	-0.848***
	-0.243
StateMAINE	-1.787***
	-0.245
StateMARYLAND	0.207
	-0.241
StateMASSACHUSETTS	-0.064
	-0.244
StateMICHIGAN	0.517*
	-0.265
StateMINNESOTA	-0.560**
	-0.242
StateNEW JERSEY	0.293
	-0.241
StateNEW MEXICO	-1.883***
	-0.245
StateNEW YORK	0.012
	-0.282
StateNORTH CAROLINA	-0.251
	-0.242
StateOREGON	0.309
	-0.241
StateRHODE ISLAND	-2.351***
	-0.247
StateTENNESSEE	-0.434*
	-0.242
StateTEXAS	0.685***
	-0.244
StateVERMONT	-1.604***
	-0.244
StateVIRGINIA	-0.155
	-0.242
StateWASHINGTON	0.985***
	-0.243
Constant	4.148***
	-0.172
Observations	1,368
Log Likelihood	-6,986.19
theta	0.608*** (0.023)
Akaike Inf. Crit.	14,034.38
Note:	*p<0.1; **p<0.05; ***p<0.01

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