Technological Innovation and Per-Mile Automobile Insurance: Effects on Patterns of Vehicle Usage

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Broader Motivation

...the manner in which [auto insurance] premiums are computed and paid fails miserably to bring home to the automobile user the costs he imposes in a manner that will appropriately influence his decisions - William Vickrey, 1968

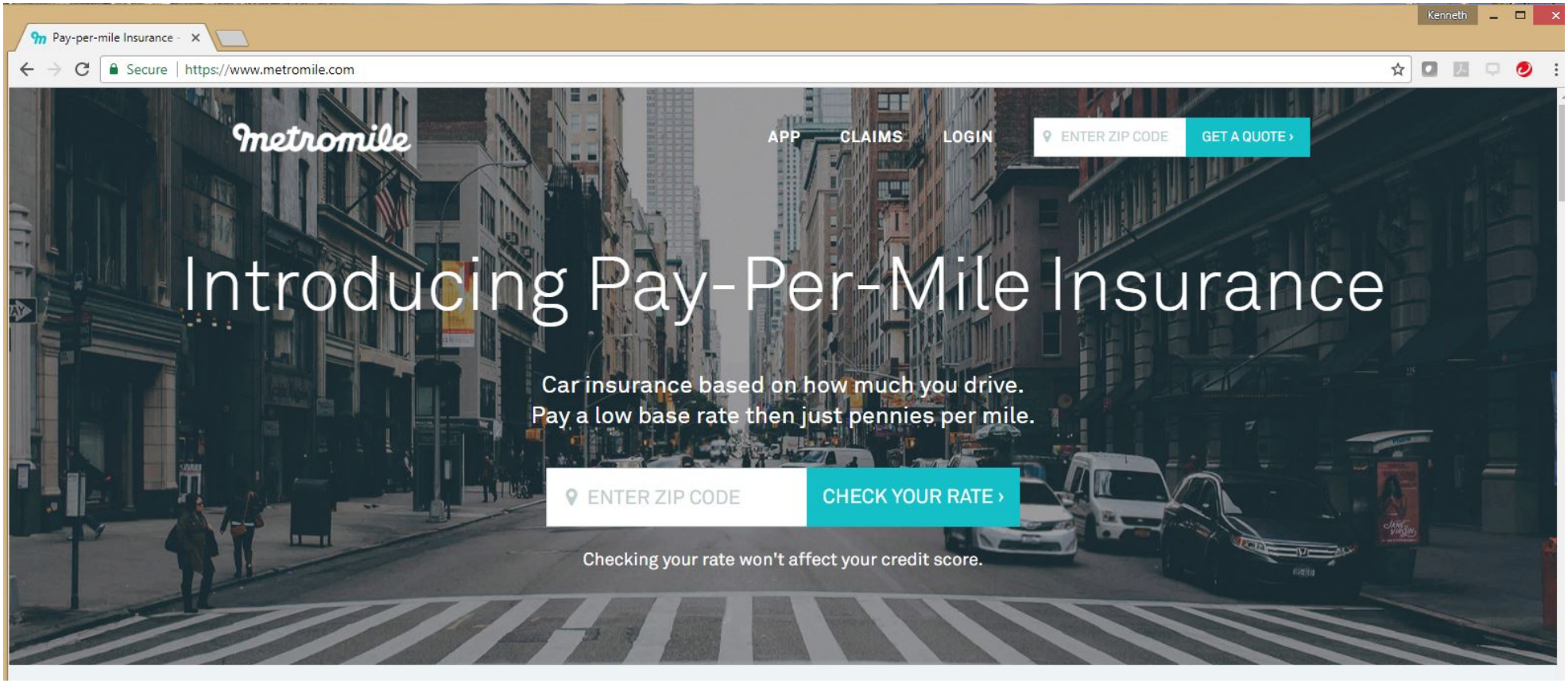
- The current relationship between driving and automobile insurance premiums is weak.
- If you drive more, you are more likely to get in an accident, but you are not fully charged accordingly.

Per-Mile Insurance

Pay-as-you-drive (PAYD) or per-mile insurance aims to better internalize the cost of driving.

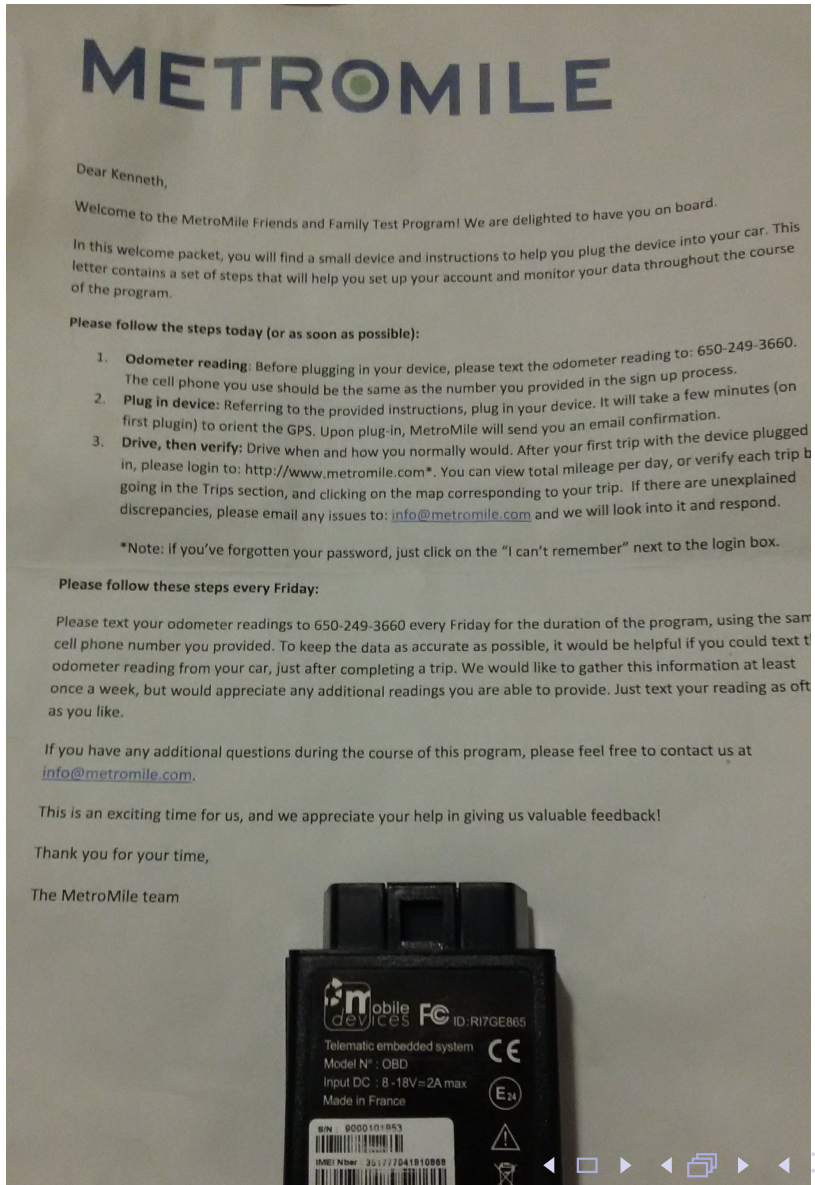
- It has for years been discussed as a sensible option
  - Edlin 2003, Parry 2004.
- Only recently has it become an actual option for many consumers.
- The technological innovation of low-cost GPS technology makes it possible.

Example: MetroMile



GPS Tracker Technology

You just plug it into your car's computer.



METROMILE

Dear Kenneth,

Welcome to the MetroMile Friends and Family Test Program! We are delighted to have you on board.

In this welcome packet, you will find a small device and instructions to help you plug the device into your car. This letter contains a set of steps that will help you set up your account and monitor your data throughout the course of the program.

Please follow the steps today (or as soon as possible):

1. **Odometer reading**: Before plugging in your device, please text the odometer reading to: 650-249-3660. The cell phone you use should be the same as the number you provided in the sign up process.
2. **Plug in device**: Referring to the provided instructions, plug in your device. It will take a few minutes (on first plugin) to orient the GPS. Upon plug-in, MetroMile will send you an email confirmation.
3. **Drive, then verify:** Drive when and how you normally would. After your first trip with the device plugged in, please login to: http://www.metromile.com*. You can view total mileage per day, or verify each trip b going in the Trips section, and clicking on the map corresponding to your trip. If there are unexplained discrepancies, please email any issues to: info@metromile.com and we will look into it and respond.

*Note: if you've forgotten your password, just click on the "I can't remember" next to the login box.

Please follow these steps every Friday:

Please text your odometer readings to 650-249-3660 every Friday for the duration of the program, using the sam cell phone number you provided. To keep the data as accurate as possible, it would be helpful if you could text t odometer reading from your car, just after completing a trip. We would like to gather this information at least once a week, but would appreciate any additional readings you are able to provide. Just text your reading as oft as you like.

If you have any additional questions during the course of this program, please feel free to contact us at info@metromile.com.

This is an exciting time for us, and we appreciate your help in giving us valuable feedback!

Thank you for your time,

The MetroMile team

Effects of PAYD Insurance?

- The per-mile cost of driving increases, so it is widely assumed that it will reduce driving.
- California even considered adding per-mile insurance to the Draft Plan under AB 32 (Nichols & Kockelman 2015).
- But to date there has been no empirical work on PAYD insurance.
  - Some white papers with discussions (Bordoff & Noel 2008, Ferreira & Minikel 2010, Litman 2011).
  - Some calibrated analytical models (Edlin 2003, Parry 2005).
  - Most previous work caveated their findings by suggesting that monitoring costs were too high.

Two Important Aspects

1. A behavioral response - marginal cost of driving increases $\Rightarrow$ driving (and emissions) decrease.
2. A selection effect - those who drive the least are most likely to opt for per-mile insurance.
    - As accident risk is proportional to miles driven, this may leave legacy insurers with a riskier pool (adverse selection).
    - In the extreme, it could lead to a “death spiral” of legacy insurance policies.
    - The dynamics of this transition may be important for changing patterns of vehicle usage.

Research Questions

1. What is the reduction in driving when customers face a higher cost per mile of driving under per-mile insurance?
2. What is the degree of selection of customers into per-mile insurance?
3. How could such selection lead to an evolution of the fixed-rate insurance business and a shift to per-mile insurance?
4. What would such a shift to per-mile insurance mean for accidents, congestion, and emissions?

Data

- Minute-level data on trip and premiums by VIN.
  - For MetroMile customers and “testers” (those who have the GPS and are testing the service before signing up).
  - In states: CA, IL, OR, and WA.
- Vehicle inspection data from these states.
  - Odometer readings at time of inspection.
- Accident fatality data.
  - U.S. DOT State Data System.
- Data on insurance policies
  - Will use multiple sources, such as www.ValuePenguin.com.

Simple Preliminary Model

Consider the utility for consumer i from a given insurance policy j:

$$u_{ij} = \delta_j - \alpha_i p_j(Z_i) + Z_i \gamma_j + \varepsilon_{ij}$$

where

- α_i is the marginal utility of money.
- $p_j(Z_i)$ is the insurance premium.
- Z_i is a vector of attributes (miles, car age, car type, location).
- ε_{ij} is an error term.

Methodology

Our overall approach:

1. Estimate insurance demand.
2. Estimate behavioral response.
3. Estimate supply.
4. Explore dynamics of potential unraveling of legacy insurance.
5. Estimate net effects on driving, emissions, etc.

Estimating Insurance Demand

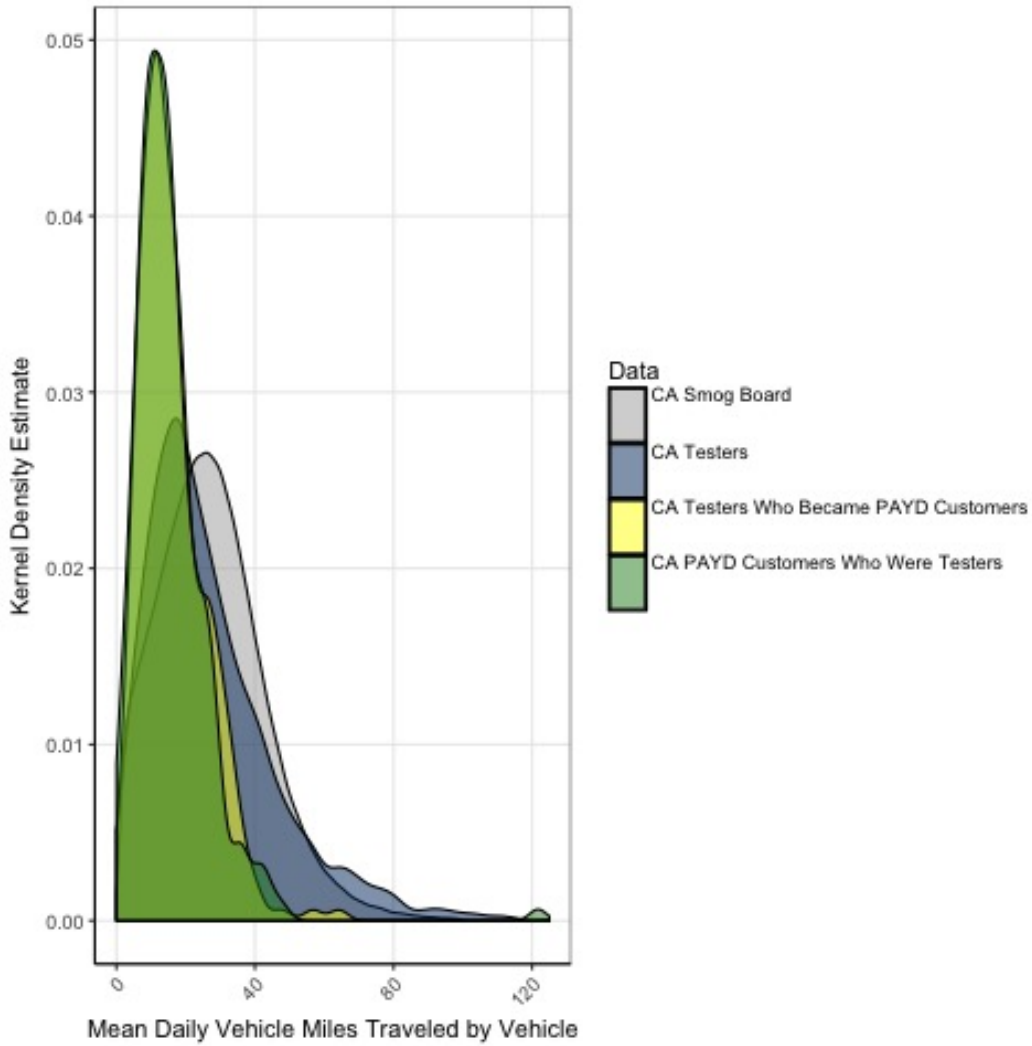
- We can estimate this simple demand for *j* by making assumptions about ε_{ij}.
  - If we assume an i.i.d. Type I extreme value distribution, we can run a logit.
  - Can also use a more flexible distributional assumption (e.g., Souza-Rodrigues 2018).
- This gives us a set of demand parameters for PAYD insurance and legacy insurance policies.
  - One would expect δ_j to be much higher for legacy insurance policies now, as the market share of PAYD is very low.

Preliminary Logit Results for CA

	(1)	(2)	(3)
δ_{PAYD}	-11.59***	-11.66***	-11.86***
	(0.109)	(0.088)	(0.080)
Daily VMT	-0.007***	-0.008***	-0.004***
	(0.003)	(0.003)	(0.002)
State Farm premium	0.020***	0.021***	0.022***
	(0.001)	(0.001)	(0.001)
MetroMile premium	-0.010***	-0.007***	-0.006***
	(0.001)	(0.001)	(0.001)
MetroMile customers	4,316	6,191	7,308
Total Vehicles	34.5m	34.5m	34.5m

Notes: Dependent variable is 1(MetroMile). An observation is a vehicle. Robust standard errors in parentheses. *** denotes $p < 0.01$.

Behavioral Response?



Supply Side

- Consider a set of legacy firms/policies and MetroMile.
- Assume a competitive market with a zero-profit condition:

$$\underbrace{\sum_{\mathscr{Z}} p(Z)M(Z)N(Z)}_{\text{Revenues}} - \underbrace{\sum_{\mathscr{Z}} C(Z)M(Z)N(Z)}_{\text{Claims Paid}} - F = 0$$

where

- $M(Z)$ is miles driven.
- $N(Z)$ is number of vehicles in bin Z.
- $C(Z)$ are average claims paid per mile.

Planned First Cut at Counterfactual

Basic idea:

1. Adjust δ_{PAYD} up towards zero over time.
2. This will change the average claims of customers in policy j (a function of miles)
3. This will require raising the premiums for legacy insurances.
4. Then the utility and market share of PAYD insurance will increase.
5. As consumers switch into PAYD insurance, their driving will change.

We then iterate to get the time path of driving, emissions, etc.

Planned Results

- We will investigate how the industry will evolve with the introduction of PAYD insurance.
  - This includes deriving the conditions under which we will see a major market switch to PAYD insurance.
- We will then examine the implications of this switch by modeling driving.
  - Our highly disaggregated data allow for a geographically disaggregated lens into potential changes.
- We will finally explore policy options relevant to PAYD insurance, and the full welfare implications.