Reputation and Product Recalls

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Introduction

This paper

1. estimates a model of “reputation building.”

$$\text{Reputation} \equiv \text{time elapsed since the last product recall}$$

2. uses product-recalls and stock-price evidence to estimate the model and to draw welfare conclusions

Model: Long lived seller meets customers one at a time
Output = a "car;" its breakdown rate, $\tilde{\rho}$

$$\tilde{\rho} = \begin{cases} 0 & \text{with prob. } x, \\ \rho & \text{with prob. } 1-x. \end{cases}$$

(Keller & Rady TE '15) where

$$x = \text{ effort} \qquad \text{cost} = \frac{1}{2}x^2$$

u = Flow utility of owning a car

$$\begin{aligned} p_t &= E_t\left(\frac{u}{r+\tilde{\rho}}\right) = x\frac{u}{r} + (1-x)\frac{u}{r+\rho} \\ &= \frac{u}{r+\rho} + \frac{\rho}{r(r+\rho)}ux \\ &= B + Ax \end{aligned}$$

First best

$$\begin{aligned} & \arg\max_x \left\{ \frac{u}{r+\rho} + \frac{\rho}{r\left(r+\rho\right)} ux - \frac{1}{2}x^2 \right\} \\ = \quad & A = \frac{\rho}{r\left(r+\rho\right)} u \end{aligned}$$

μ = detection rate (only for new cars)
recall hazard $= \mu(1-x)$.
Bellman eq.

$$rv = B + Ax^* - \frac{1}{2}x^2 + \mu(1-x)(v_0 - v) + \frac{dv}{dt}$$

FOC

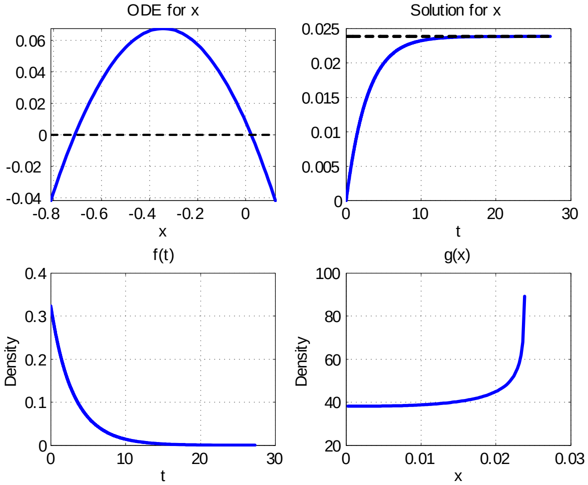
$$x = \mu(v - v_0),$$

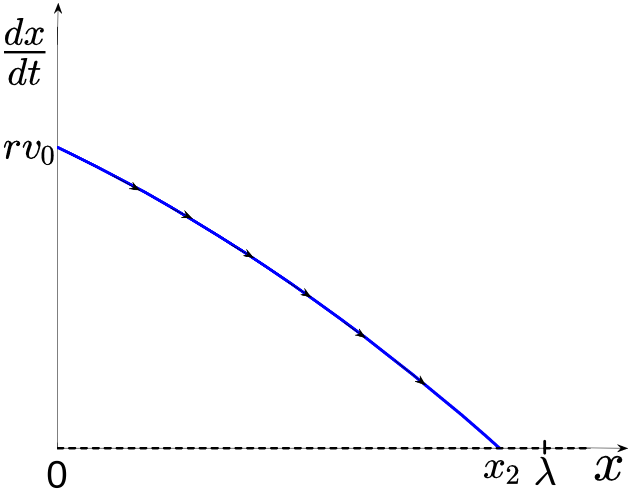
ODE for x is

$$\frac{dx}{dt} = \mu\left[r\tilde{v}_0 - B + \left(1 - A + \frac{r}{\mu}\right)x - \frac{1}{2}x^2\right].$$

$$x_t = x_2 + \frac{\frac{x_2}{x_1}(x_2 - x_1)\exp\{-\frac{1}{2}\mu(x_2 - x_1)t\}}{1 - \frac{x_2}{x_1}\exp\{-\frac{1}{2}\mu(x_2 - x_1)t\}}.$$

Rob & Fishman (JPE '05)


ODE for x
0.06
0.04
0.02
0
-0.02
-0.04
-0.8
-0.6
-0.4
-0.2
0
x
Solution for x
0.025
0.02
0.015
0.01
0.005
0
0
10
20
30
t
f(t)
0.4
0.3
0.2
0.1
0
Density
0
10
20
30
t
g(x)
100
80
60
40
20
Density
0
0.01
0.02
0.03
x



$\frac{dx}{dt}$
rv_0
0
x_2
λ
x

The two roots of $\frac{dx}{dt} = 0$ are

$$x_1 = 1 - A + \frac{r}{\mu} - \sqrt{\left(1 - A + \frac{r}{\mu}\right)^2 + 2\left[r\tilde{v}_0 - B\right]} < 0, \quad \text{and}$$
$$x_2 = 1 - A + \frac{r}{\mu} + \sqrt{\left(1 - A + \frac{r}{\mu}\right)^2 + 2\left[r\tilde{v}_0 - B\right]} > 0,$$

Initial condition $x(0) = 0, \Rightarrow$

$$x_t = \frac{x_2\left(1 - \exp\{-\frac{1}{2}\mu(x_2 - x_1)t\}\right)}{1 - \frac{x_2}{x_1}\exp\{-\frac{1}{2}\mu(x_2 - x_1)t\}} \tag{1}$$

CDF of recall time:

$$F(t) = 1 - \exp\left(-\mu\int_0^t (1 - x_\tau)\, d\tau\right)$$

MLE estimation

$$\max_{(A,B,\mu,\tilde{v}_o)} \prod_i f(t_i) \quad s.t. \quad E(v - v_0) \geq 0.027$$

Table: ML Estimates

r	A	B	μ	$\tilde{v}_0$
0.05	1.0345	0.1215	0.2927	2.4295

and we can then solve (ρ, u) from (A, B)

$$\begin{aligned} \rho &= 0.4258 \\ u &= 0.0578 \end{aligned}$$

Welfare: First best is

$$A = 1.03$$

Maximal x_t is

$$\begin{aligned} x_2 &= 1 - A + \frac{r}{\mu} + \sqrt{\left(1 - A + \frac{r}{\mu}\right)^2 + 2\left[r\tilde{v}_0 - B\right]} \\ &= -.03 + \frac{.05}{.29} + + \sqrt{\left(-.03 + \frac{.05}{.29}\right)^2 + 2\left((.05)\,2.43 - .12\right)} \\ &= .295 \end{aligned}$$

Estimates assume that expected (i.e., average over the recalls) value lost at recall is 2.7%

$$E\left(v_t - v_0\right) \geq 0.027$$

Source: Jarrell & Peltzman JPE ‘84

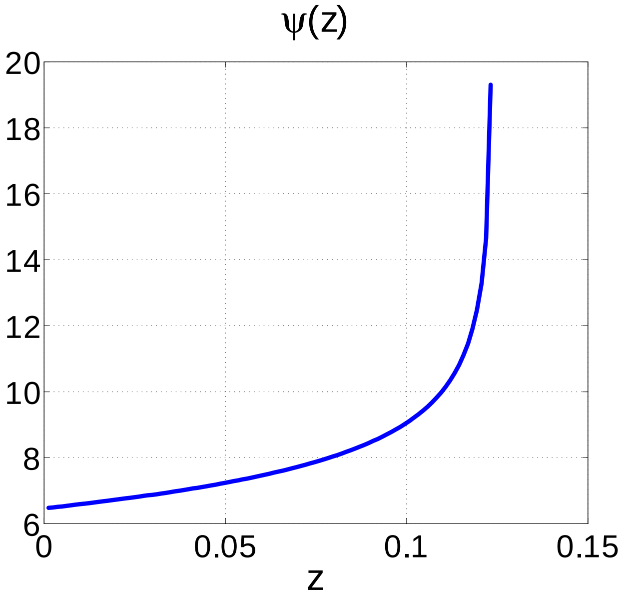
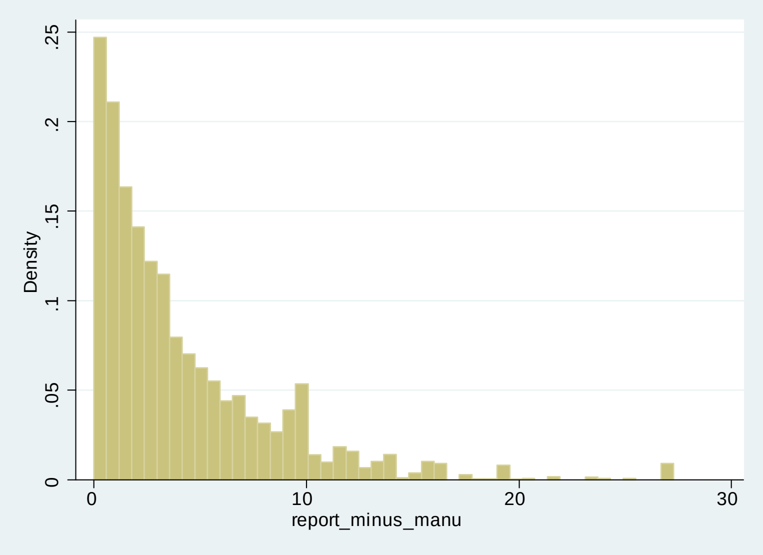


Figure: Distribution of value losses at recall



Density
0
.05
.1
.15
.2
.25
0
10
20
30
report_minus_manu

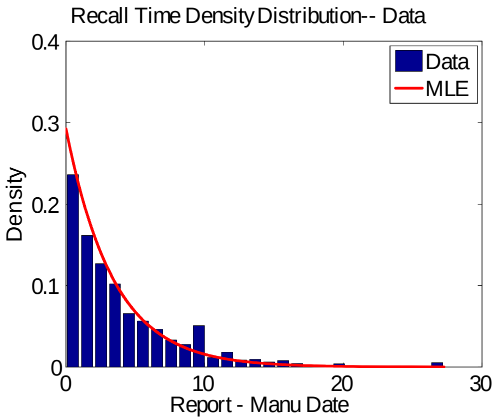
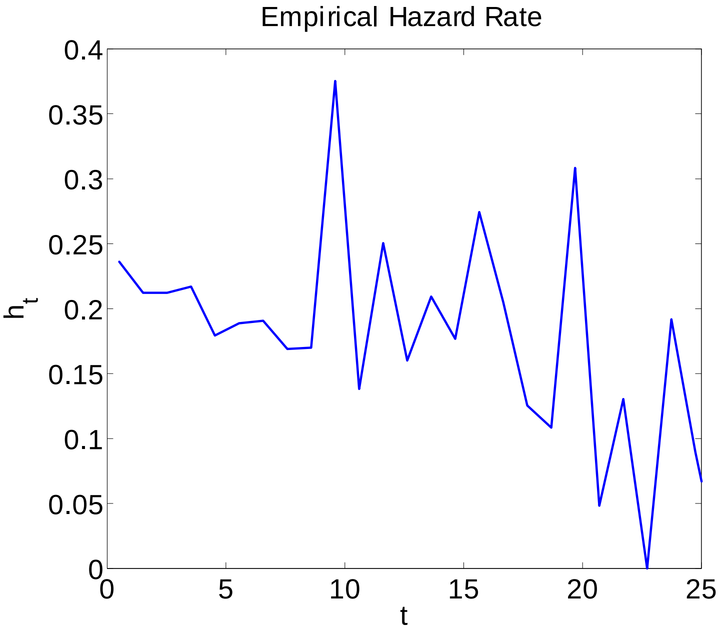
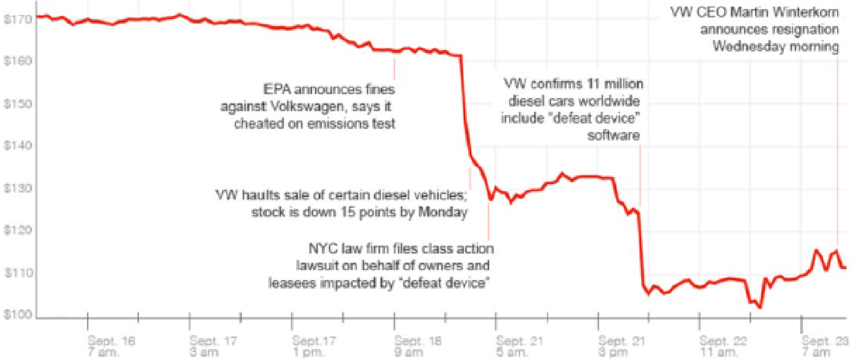


Figure: Durable


Empirical Hazard Rate
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
h_t
0
5
10
15
20
25
t

Investors' reaction to Volkswagen emissions saga



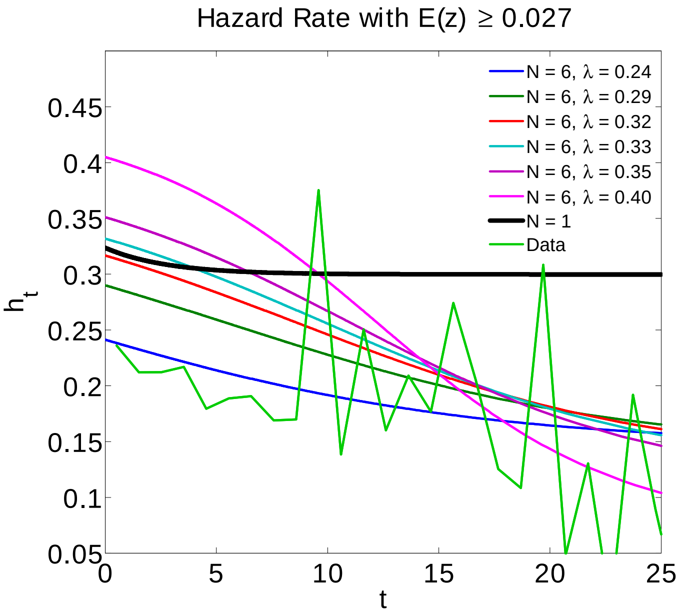


Figure: The 6 hazards together with the single-hazard version

Bass '69 –model borrowed from epidemiology lit.
Let $X \equiv$ the fraction of informed people in the population, and

$$\frac{dX}{dt} = b(1 - X) + qX(1 - X)$$

$q =$ the copying parameter
$b =$ information arrival from the outside
Ricatti equation, i.e., quadratic.
Sultan, Farley & Lehmann '90: copying far more important than inventing.

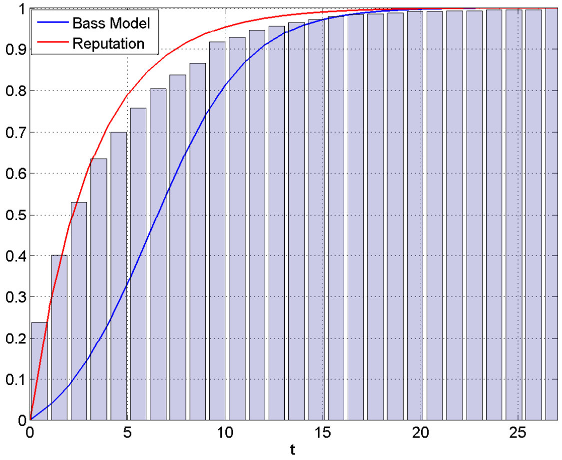
$$\begin{aligned} b &= 0.03 \\ q &= 0.38 \end{aligned}$$

Lucas & Moll JPE '14.

Not quite the same because in our model

$$F(t) = 1 - \exp\left(-\mu \int_0^t (1 - x_s)\, ds\right)$$

and x_t is logistic, so this is a concave transform of the integral of a linear function of x_t But, ...


Bass Model
Reputation
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
t

If only the public signal is observed, fewer equilibria than if x_t was ex-post inferable. I am aware of 3 other equilibria

1. $x_t = 0$ for all t
2. Grim trigger (larger punishment, higher x
3. sequence of punishments v_0^k $(k = 1, 2, \ldots)$ E.g., in grim trigger $v_0^1 = 0$

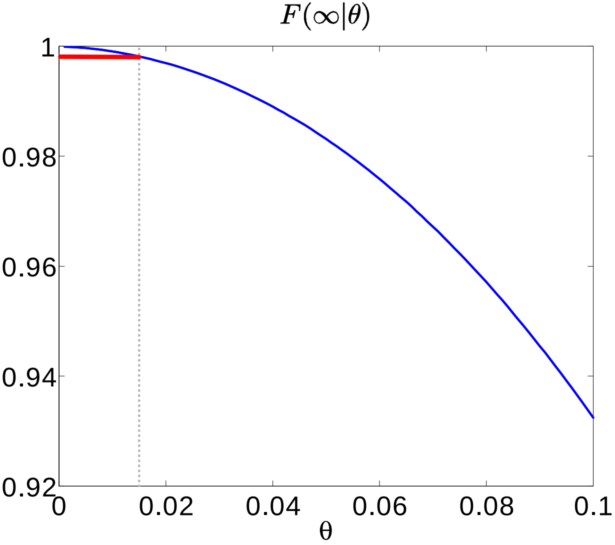


Figure: Probability that recall will ever take place

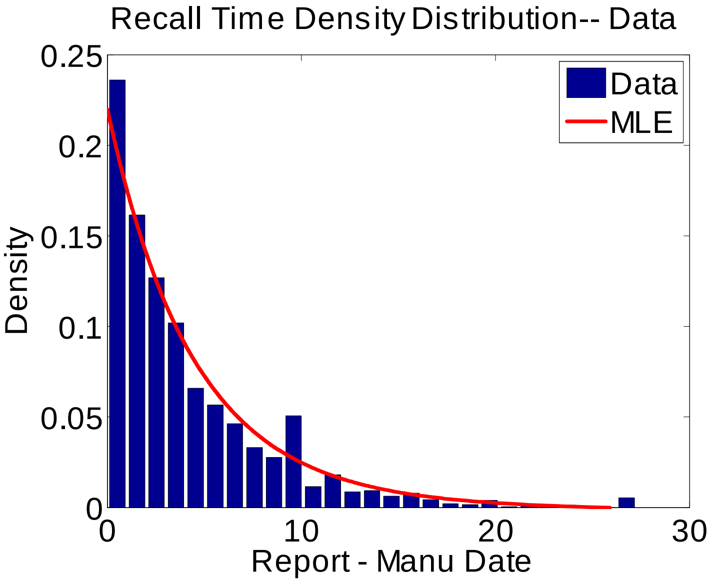


Figure: 6 HAZARDS WITH $\theta>0$

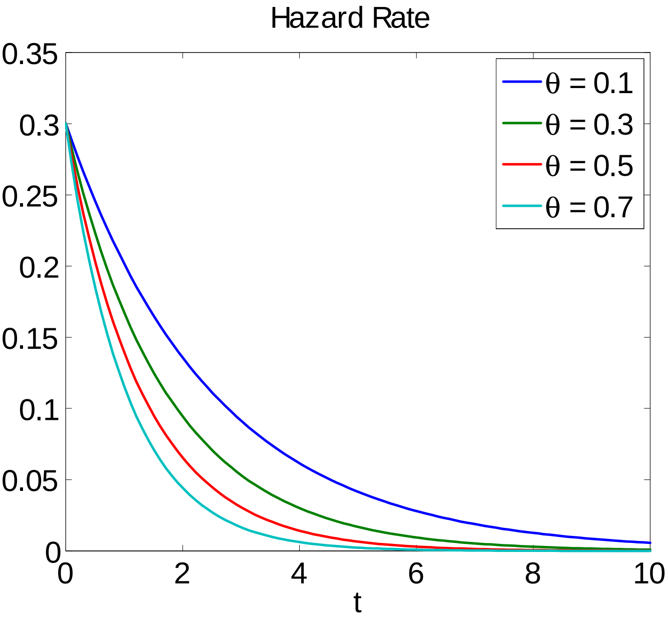


Figure: Recall hazard as a function of θ