Popcorn Pricing, the Hippocratic Oath, and Health Care Innovation

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Many industries characterized by remarkable cost-reducing innovations

Goods

- Computers
- Cell phones
- Electric cars
- Solar panels

Services

- Translation services via internet
- Banking by phone
- Engineering/Accounting/web design/data entry
- Retail purchases
- Uber
- Lawyers

Why not health care?

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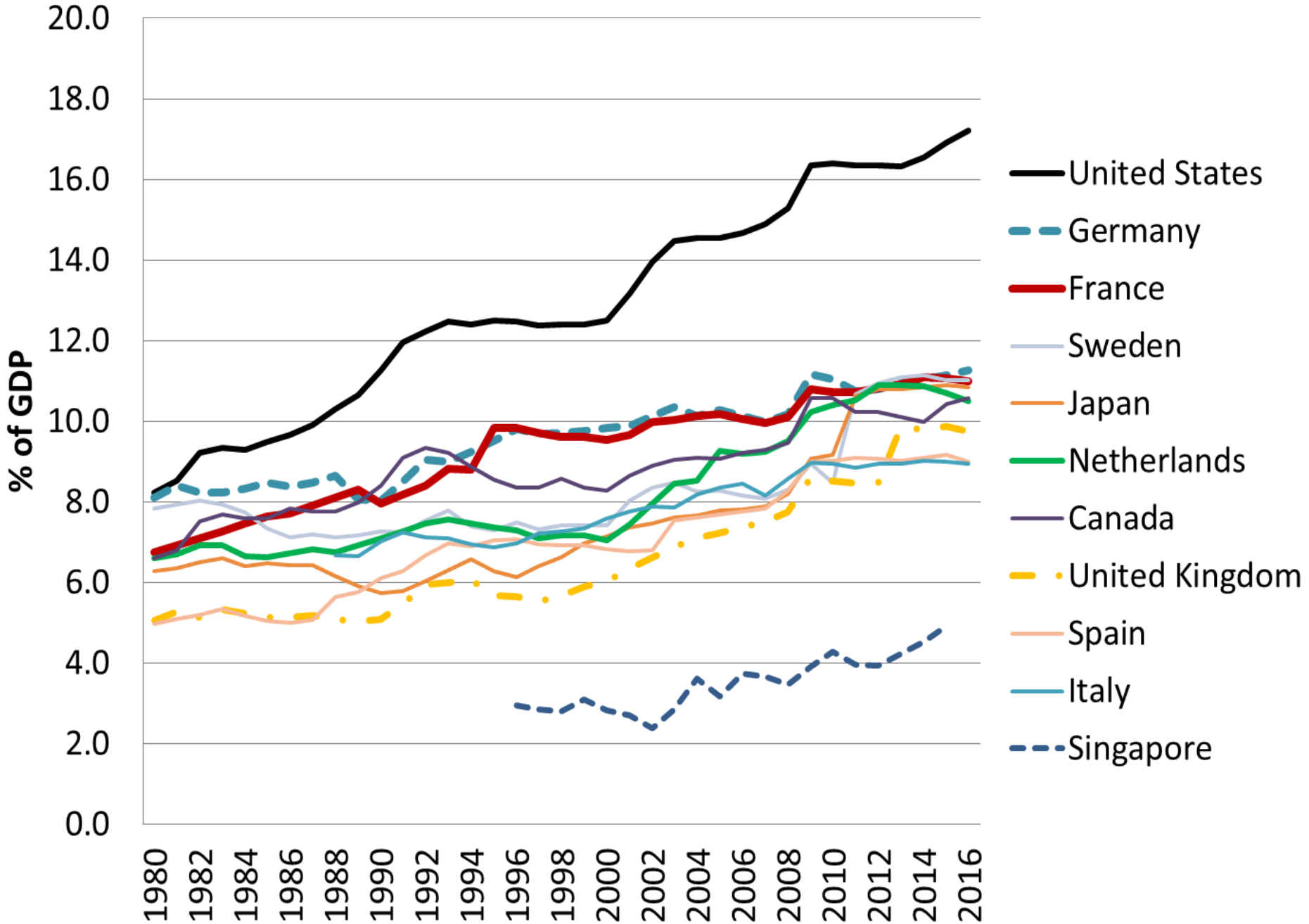
Health Care Spending as Percent of GDP, 1980-2016



Arguments of this paper

- Patients defer to their expert Doctors
- Doctors choose prices, quality, *AND* quantities
- Insurance $\Rightarrow$Excessive prices, quantity, and quality
- Altruism + Hippocratic Oath $\Rightarrow$ MDs maximize patient benefits without regard to costs

  $\Rightarrow$ Innovators avoid cost-reducing innovations

  $\Rightarrow$ Innovators rewarded with full surplus of new products, not incremental value

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Motivational Example

Movie theatre popcorn

Quiz: What is special about it?

Movie Theatre Popcorn

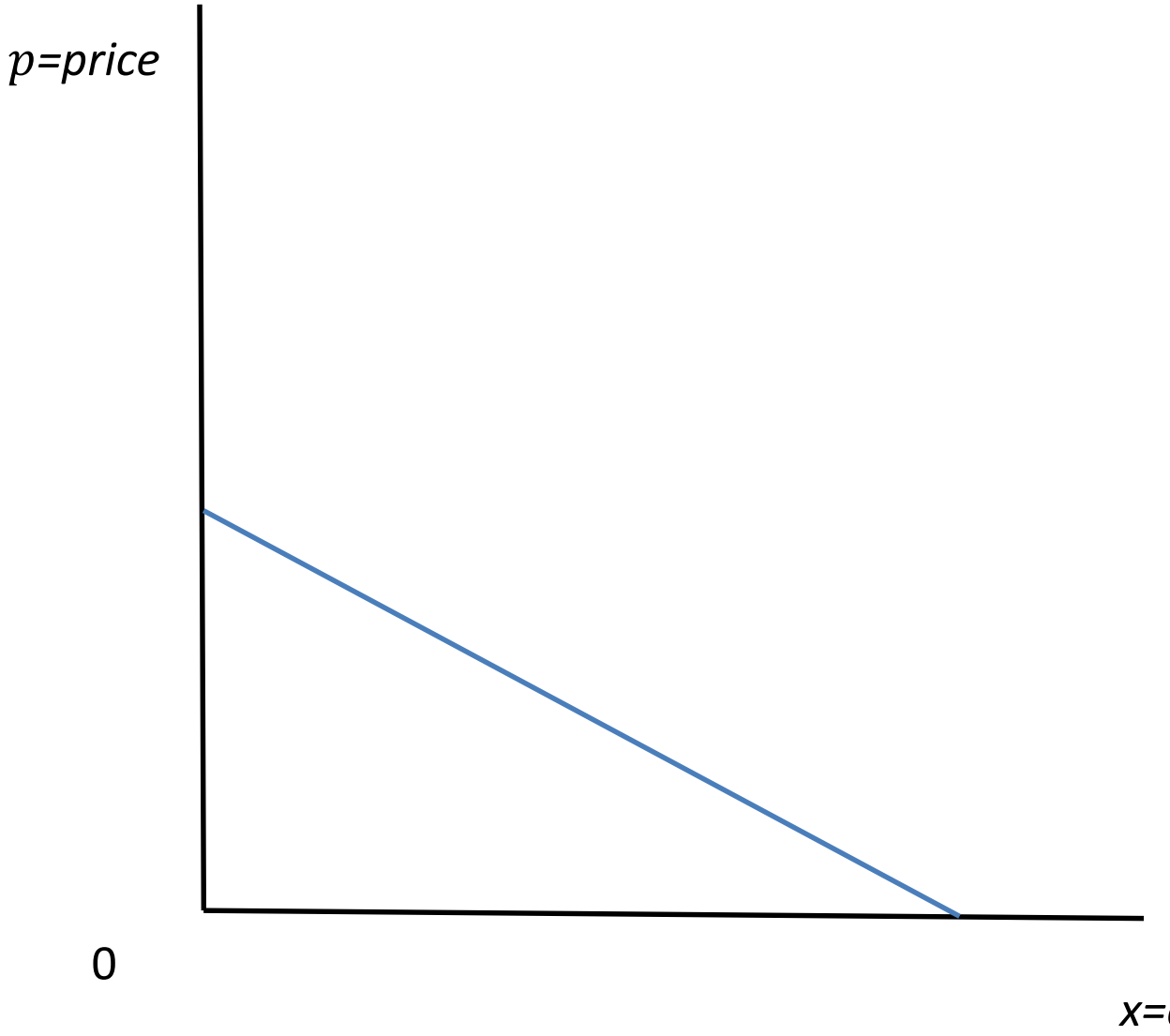
Five key features:

Don't let you carry in your own food ⇒ Monopoly
Prices are high
Quantities are large
Quality is excellent
Choices are limited

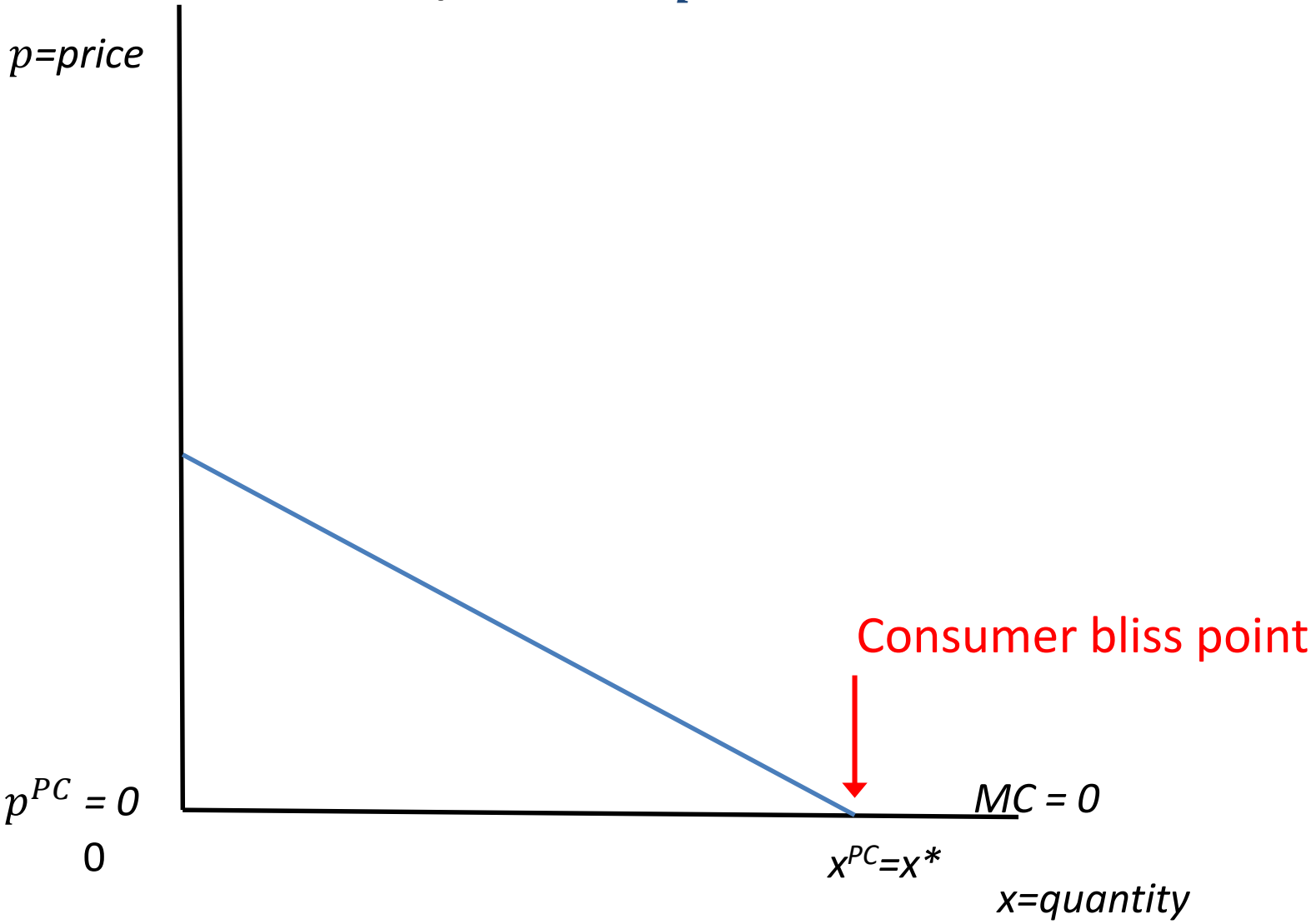
	Boston USA	Lyon France	Lisbon Portugal	Barcelona Spain	Tokyo Japan
5.0 liters ---		7.20 €	5.00 €	7.00 €	
3.75 liters	$8.00	6.30 €	4.40 €	6.00 €	
2.5 liters	$7.50	5.30 €	4.10 €	5.00 €	¥ 700 ($6.00)
1.25 liters	$7.00	4.20 €	3.80 €	4.00 €	

- Theatres never offer 1 liter of popcorn at 2.00 €
- This is willingness-to-pay pricing!

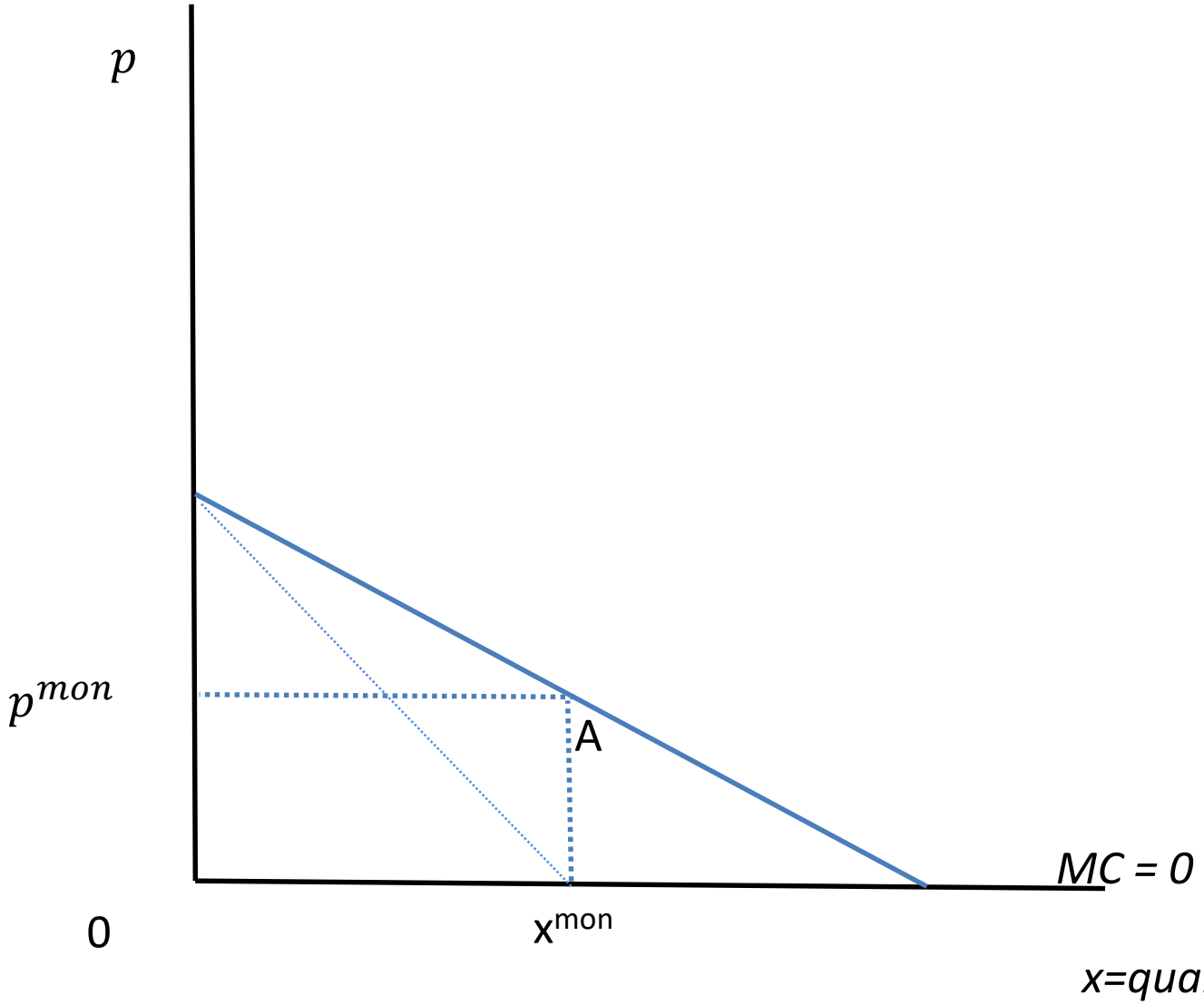
Per Capita Demand Curve for Movie Theatre Popcorn



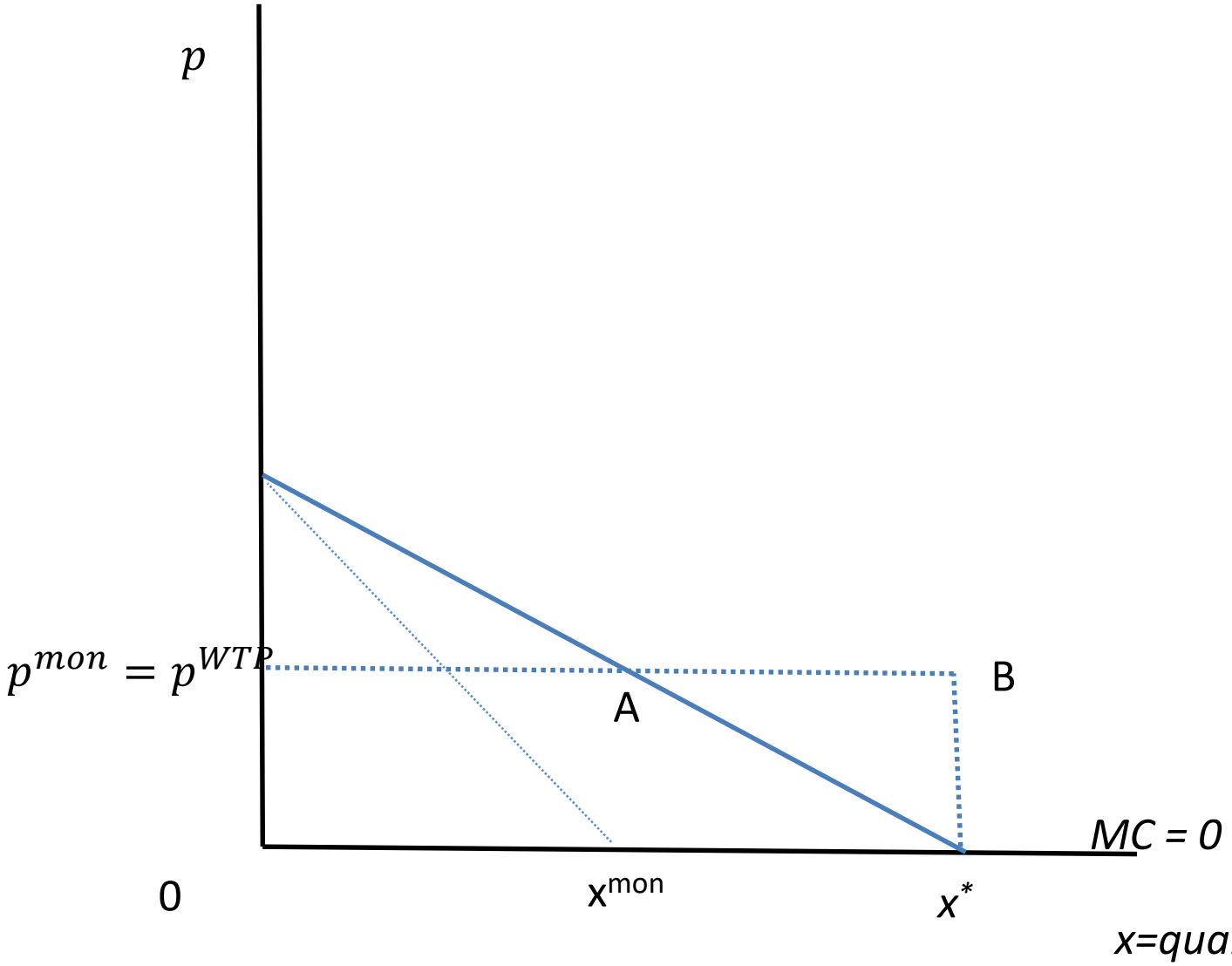
With zero marginal cost, perfect competition would predict {p^{PC}=0, $x^{PC} = x^*$}



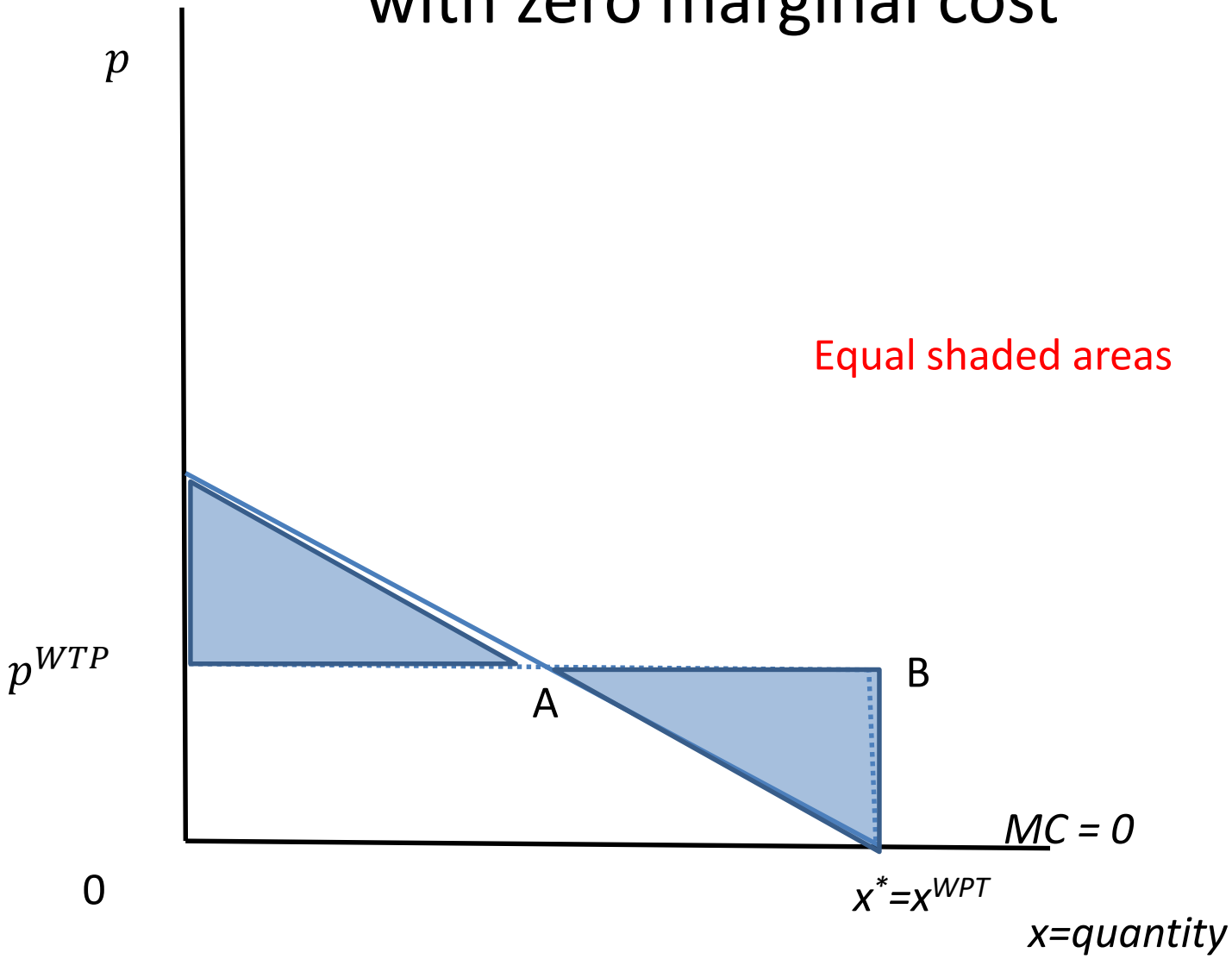
Monopoly outcome when firm chooses {p^{mon}} with zero marginal cost



Price- and quantity-setting monopoly outcome: Willingness to pay (WTP) pricing



Price- and quantity-setting monopoly outcome with zero marginal cost



What about insurance?

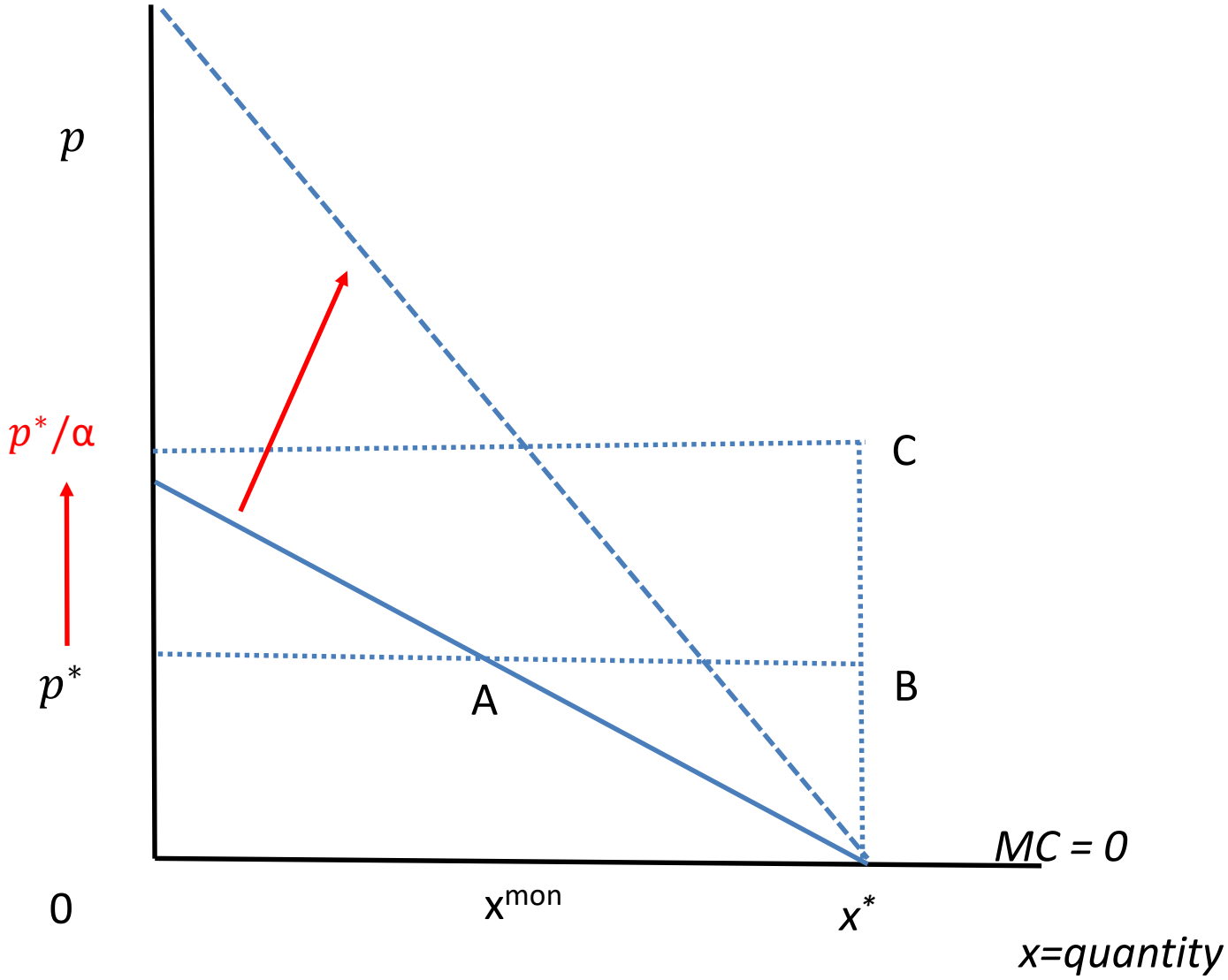
Preceding example assumes no insurance (α=1)

Assume the optimal popcorn price is $8

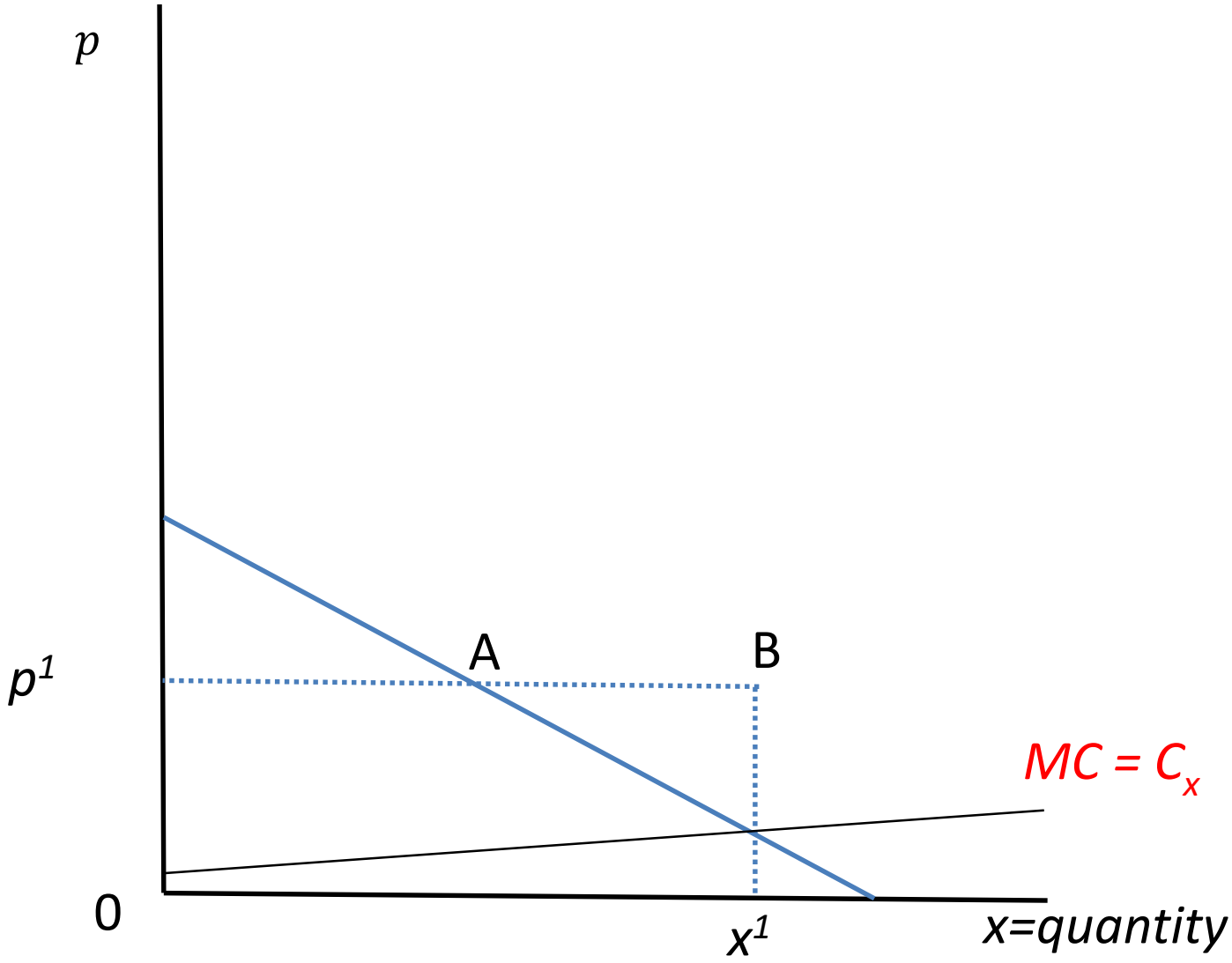
Quiz:

What price would movie theatres charge for popcorn if consumers only had to pay 10% of the price?

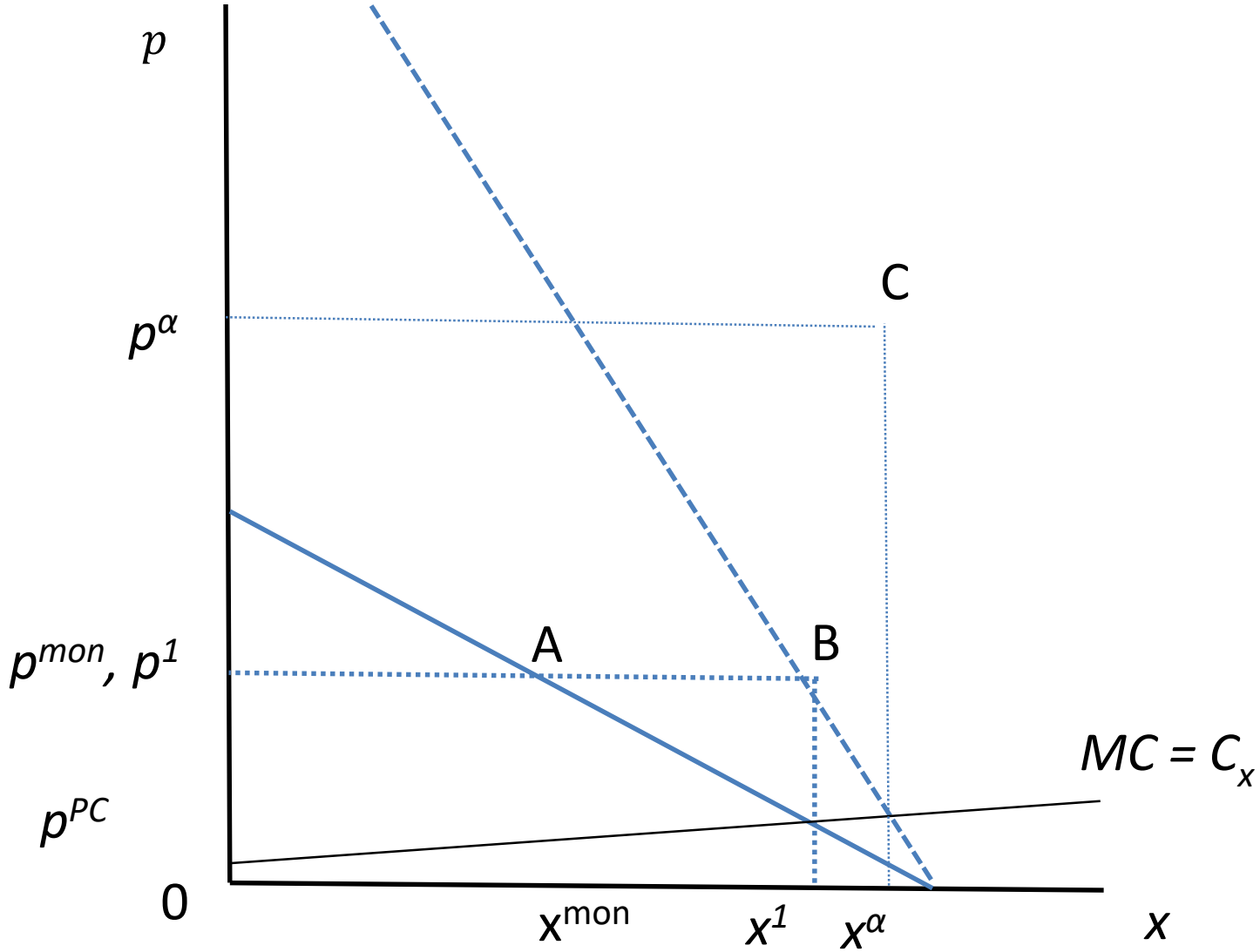
Profit-maximizing price- and quantity-setting outcome, $p^D = \alpha\, p^S$, for $\alpha = 1$ and $\alpha < 1$ pure coinsurance, MC=0



Picture changes only slightly with a nonzero, upward sloping marginal cost



Price and quantity outcomes: monopoly, no insurance, and partial insurance



Another example of the Popcorn model with insurance!

- Seminar speakers are given a nice dinner by hosts
- Meal is paid for by a third party (the university)$\Rightarrow \alpha = 0$
- Prediction: a very high quantity and quality dinner, costing more than twice as much as we would buy if we were each paying for our own dinner.
- Third party payment makes us price insensitive
- Lower costs does not lower prices
- Restaurants serving mostly business meals know this, provide high quality and charge high prices
- The same thing happens with health care

Formal Model Notation

x = quantity of care

q = quality of care

p = price per unit of x

α = share of supply price p paid by consumer

$B(x, q)$ = patient utility from care

$C(x, q)$ = provider cost of care for one patient

β, λ = relative efficiency of new technology in utility and costs

Patient utility: $U = \beta B(x, q) - \alpha p x$

Provider profit: $\Pi = px - \lambda C(x, q)$ - F

A. Proportional Insurance constant coinsurance

$p^D = \alpha\, p^S$

α = share of supply price p paid by consumer

A. Monopoly provider objective function

$$\max_{p,x,q} \Pi = N\big(px - C(x,q)\big)$$
$$s.t.\ \ B(x,q) - \alpha px \geq 0$$

At profit max, participation constraint is always binding!
Substitute it in:

$$\max_{x,q} \Pi = N\left(\frac{B(x,q)}{\alpha} - C(x,q)\right)$$

A. Solution for Monopoly provider, constant coinsurance

FOC: $$p^* = \frac{B(x^*,q^*)}{\alpha x^*}$$

$$B_x(x^*, q^*) - \alpha\, C_x(x^*, q^*) = 0$$

$$B_q(x^*, q^*) - \alpha\, C_q(x^*, q^*) = 0$$

Result 1. *For an unregulated monopoly provider facing constant coinsurance, the quality, quantity, provider's price and profit are increasing in the generosity of insurance. The consumer's price is invariant to the generosity of insurance.* *McGuire (2000)*

B. Price x quantity ceiling set as a fraction γ of total consumer surplus

$\overline{p^S}x = \gamma B(x, q)$ (Does γ=1?, γ= 2?, γ= 10?)

$\overline{p^D}$

B. *Full insurance, or fixed consumer copayment with price ceiling on supply price* $\overline{p^S}$

$$\max_{x,\,q} \Pi = N\left(\overline{p^S}x - C(x,q)\right)$$

$$s.t. \quad B_x(x,q) \geq 0 \qquad \textit{patient quantity acceptance}$$

$$B(x,q) \geq \overline{p^D} \qquad \textit{patient participation constraint}$$

$$\gamma B(x,q) - \overline{p^S}x \geq 0 \qquad \textit{negotiated price constraint}$$

Assuming only 1st and 3rd constraints binding, can write as:

$$\max_{x,\,q} \Pi = N\left(\gamma B(x,q) - C(x,q)\right)$$

$$s.t. \quad B_x(x,q) \geq 0$$

B. *Full insurance, or fixed consumer copayment with price ceiling price* $\overline{p^S}x = \gamma B(x,q)$

$$\max_{x,q} \Pi = N\big(\gamma B(x,q) - C(x,q)\big)$$

$$B_x(x,q) \geq 0$$

Solution:

$$B_x(x,q) = 0$$

$$\gamma B_q(x,q) = C_q(x,q)$$

Key result is that consumer surplus is maximized, and prices are unaffected by costs.

C. Sequential Rather than Simultaneous Choices of p, q, and x

$Lemma\ 1$: Let $\{p^*, q^*, x^*\}$ be the solution to the problem $\max_{p,q,x} \Pi(p, q, x)$

and let $\{p^1, q^1, x^2\}$ be the solution to the two stage problem

$\max_{p,q} \Pi(p, q|x^2)$ s.t. $\{x^2$ is the solution

Preceding used a static framework

- Innovation is a dynamic issue
- Economists have poor models of innovation in the presence of insurance
- Insurance and the Hippocratic Oath affect innovations

V. Dynamic Innovation Model

Consider an Innovator, I, choosing whether to develop a new product to compete against the Established firm, E.

$U^I = \beta\, B(x, q) - \alpha\, p\, x$

$C^I = \lambda\, C(x, q) + F$

β is the utility efficiency

λ is the cost efficiency

Doctors choose new technology, caring about OOP

$$\max_{x_I, q_I, p_I} \Pi = N\left(p_I x_I - \lambda C(x_I, q_I)\right) - F$$

$$s.t.\ \ \beta B(x_I, q_I) - \alpha p_I x_I \geq B(x_E, q_E) - \alpha p_E x_E$$

Can be rewritten as:

$$\max_{x_I, q_I} \Pi = N\left(p_E x_E + \frac{\beta B(x_I, q_I) - B(x_E, q_E)}{\alpha} - \lambda C(x_I, q_I)\right) - F$$

Solution to dynamic model with constant coinsurance when either: p_E^* is based on WTP pricing or OOP costs are ignored

$$p_I^* = \frac{B(x_I^*, q_I^*)}{\alpha x_I^*}$$

$$\beta B_x(x_I^*, q_I^*) - \alpha\lambda\, C_x(x_I^*, q_I^*) = 0$$

$$\beta B_q(x_I^*, q_I^*) - \alpha\lambda\, C_q(x_I^*, q_I^*) = 0$$

Solution to dynamic problem

If $p_E^* = \frac{B(x_E^*, q_E^*)}{\alpha x_E^*}$ then

$p_I^* = \frac{\beta B(x_I^*, q_I^*)}{\alpha x_I^*}$ which is the static case

Boston University Medical School Hippocratic Oath, 2018

…I will do no harm;

…Into whatever home I enter it shall be for the good of the sick and the well to the utmost of my powers;

…I will exercise my Art solely for the cure of my patients and the prevention of disease…

Hippocratic Oath in our model

French Medical Code of Ethics, 2013:
"My overriding concern shall be to restore, preserve or promote health in all respects, physical and mental, individual and collective."

Boston University Hippocratic Oath (2018):

"I will exercise my Art solely for the cure of my patients and the prevention of disease…"

In Economic terms:

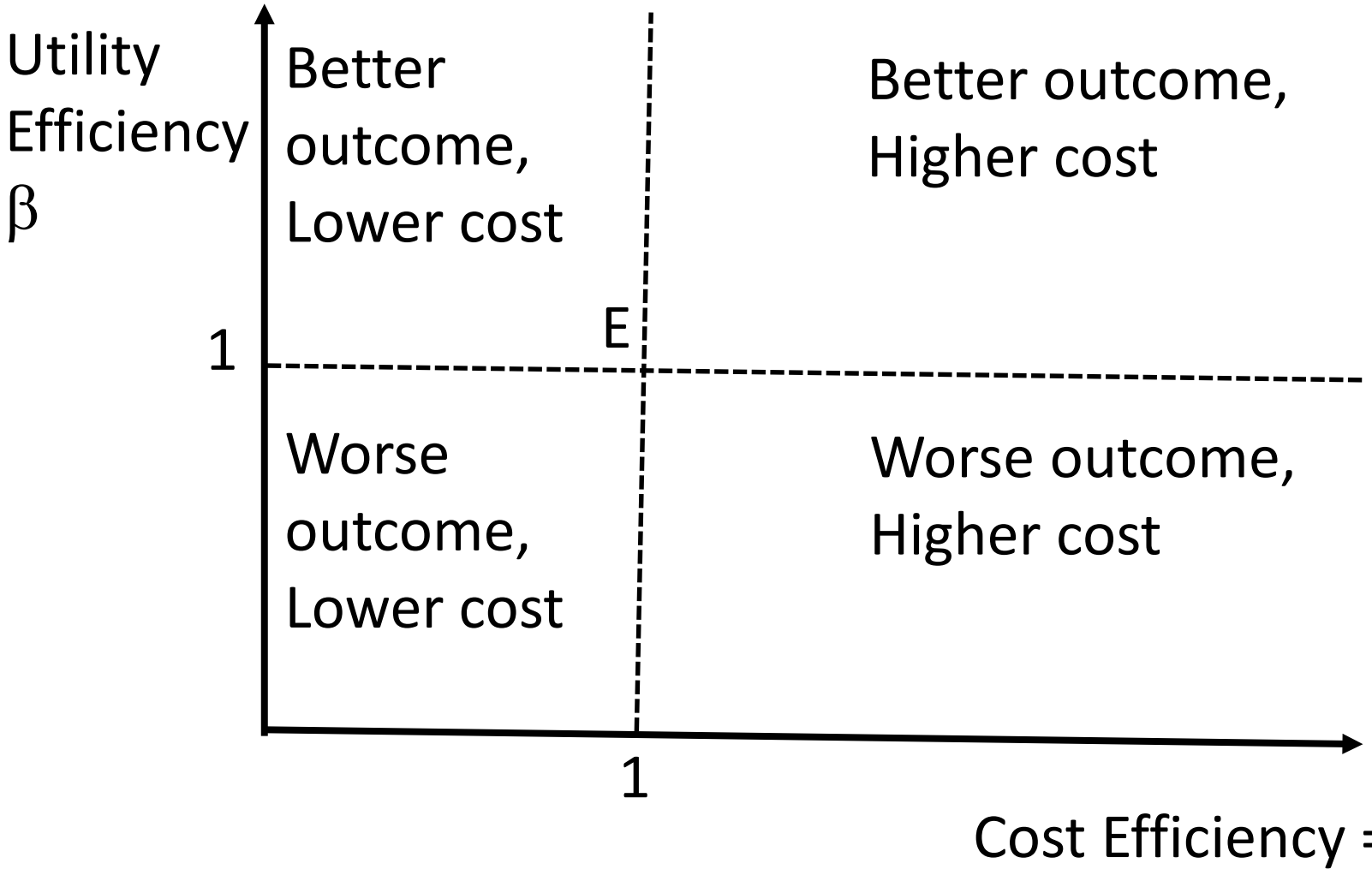
$$\beta B(x_I, q_I) - \mathrm{B}(x_E, q_E) \geq 0$$

provider willingness to recommend

"Do no harm."

$B_x(x_I, q_I) \geq 0$ patient quantity acceptance

Efficiency relative to established technology, E



Efficiency relative to established technology, E

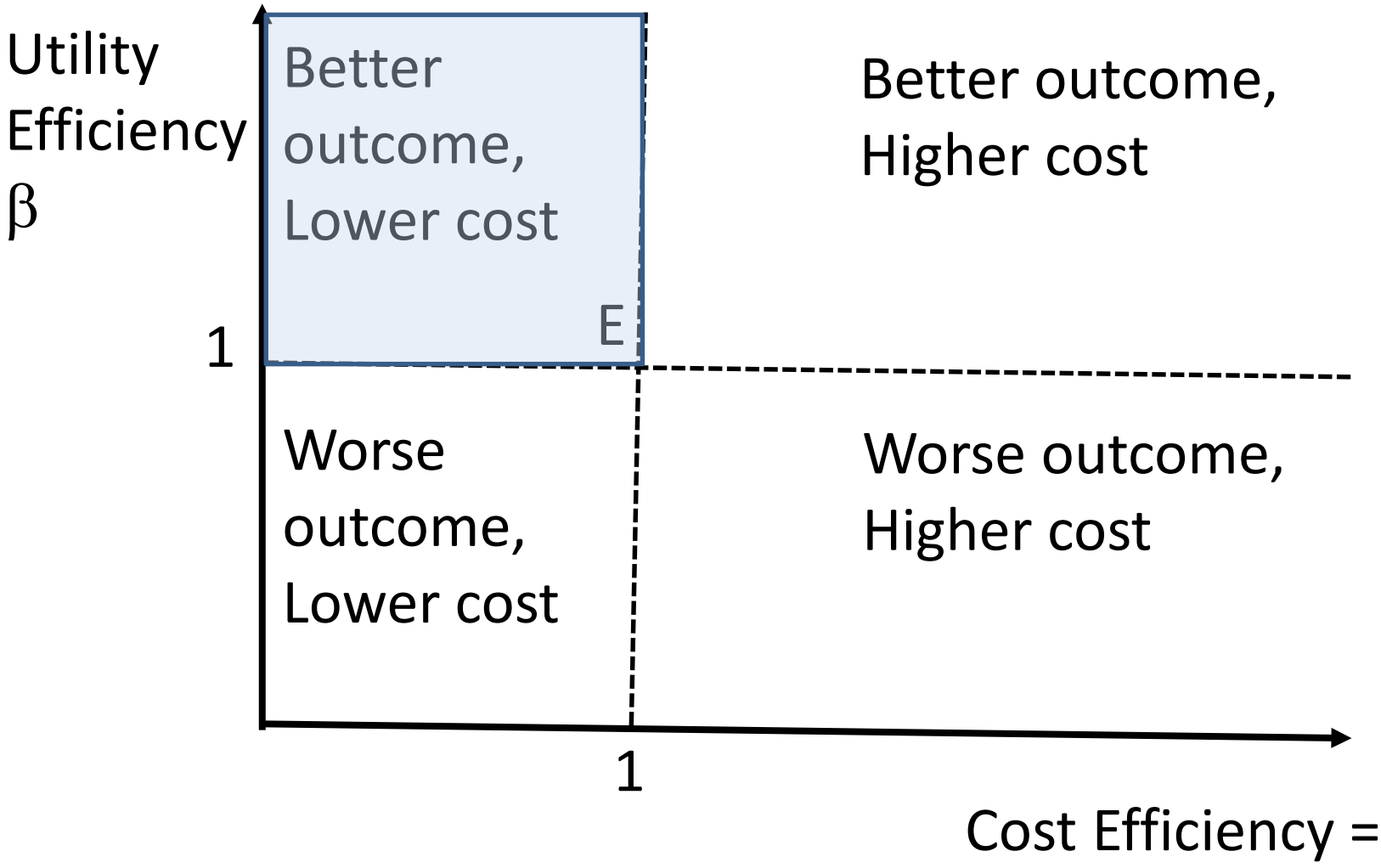
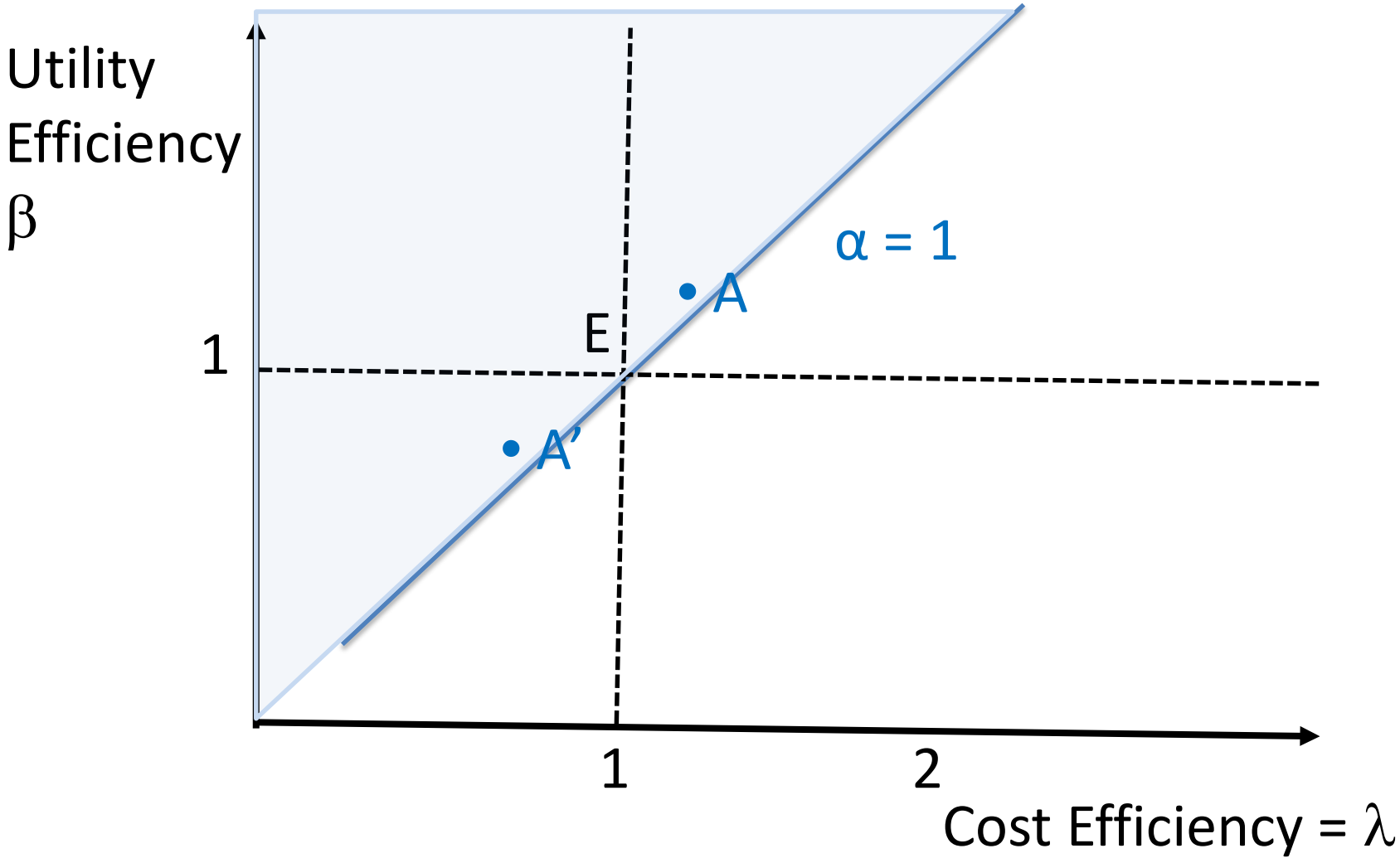


Figure 4. Welfare improving innovations



Hippocratic Oath means utility-worsening innovations are never recommended by doctors

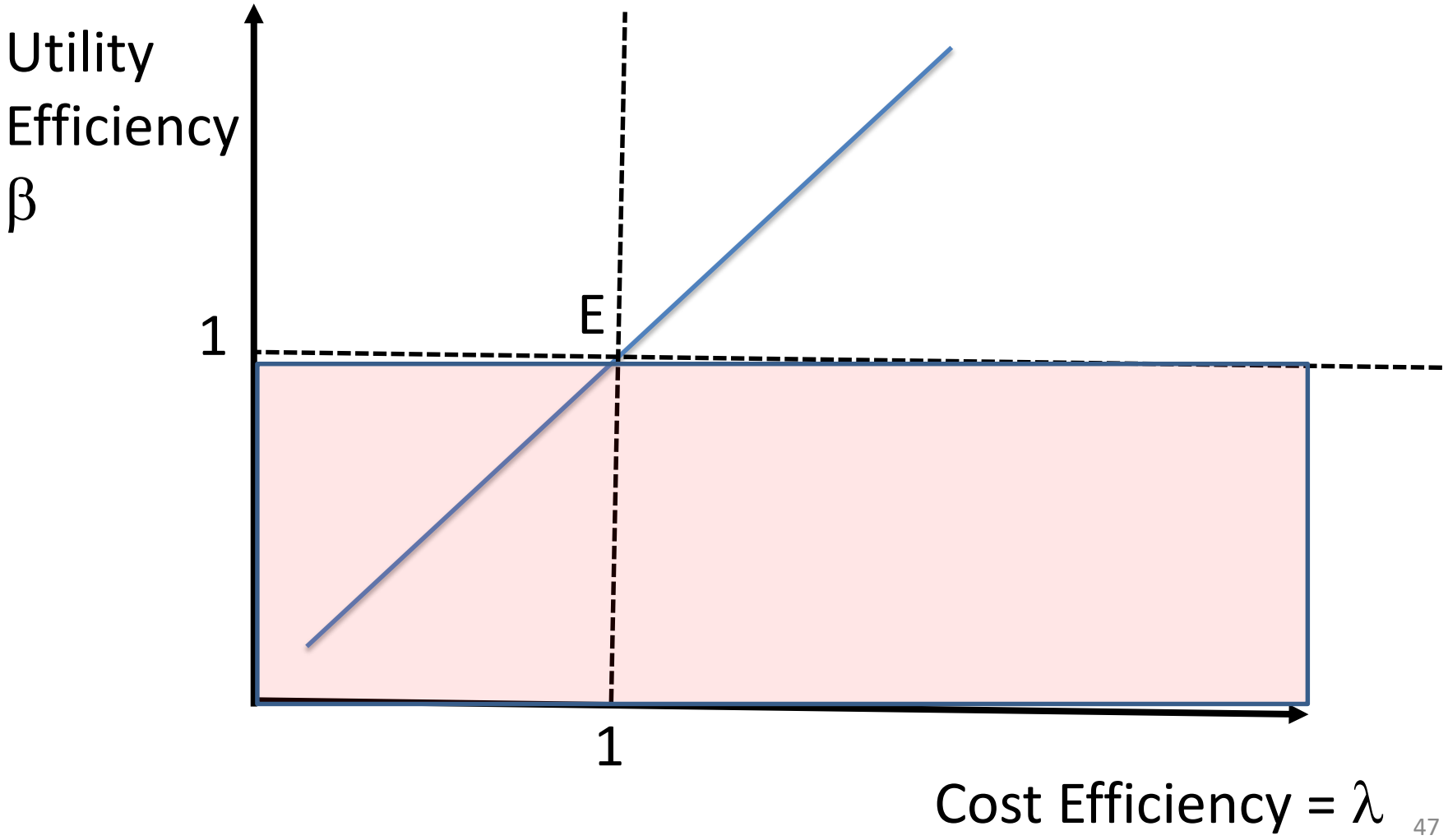
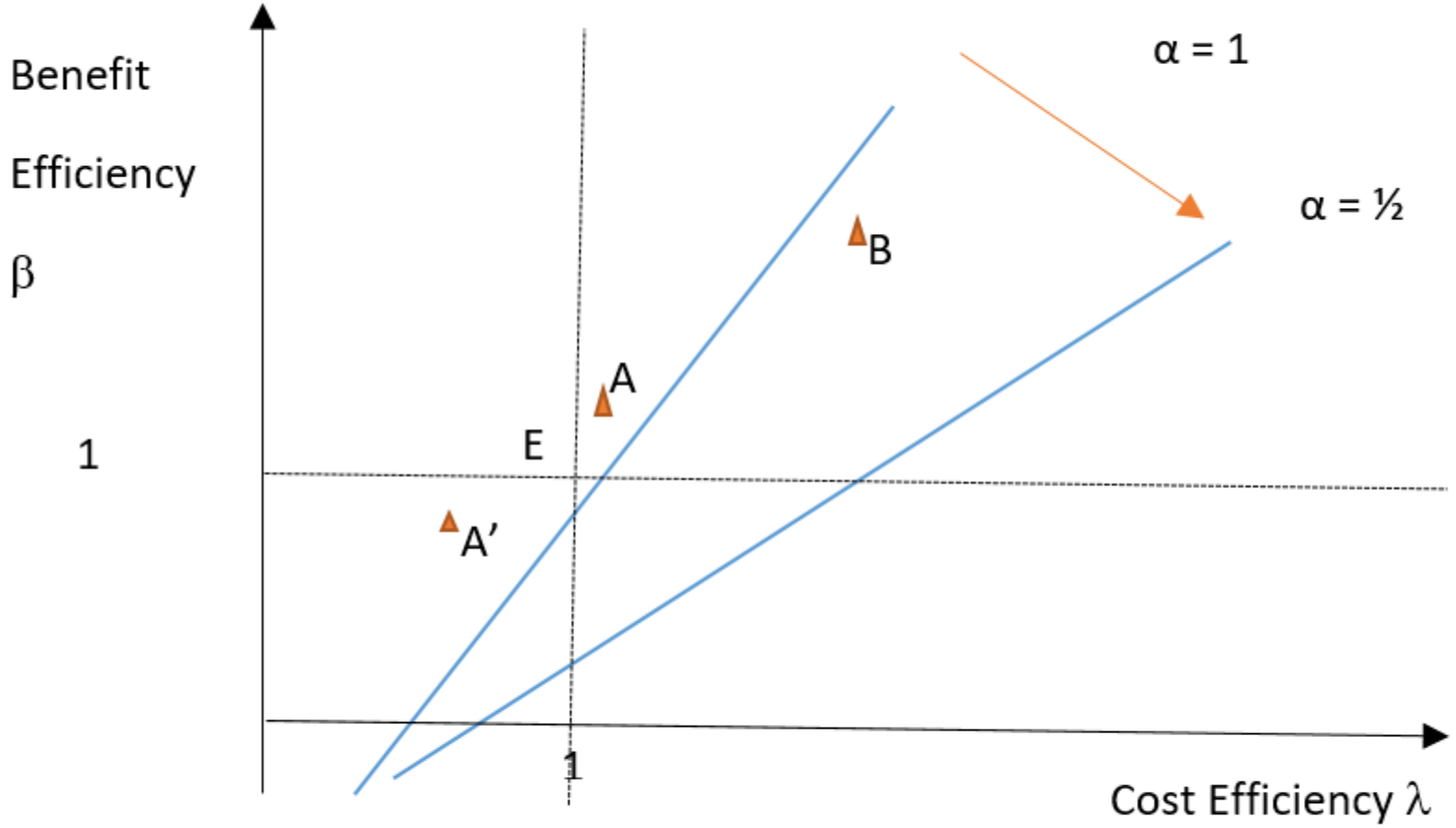


Figure 4: Effect of insurance on innovation profitability based on iso-profitability isoquants



Notes: E is the cost efficiency and benefit level of the established technology. Without insurance point A or A' are preferred to point B, while with insurance point B will be preferred.

Pure Hippocratic Oath solution, in which doctors do not care about OOP

$$\max_{x_I, q_I, p_I} \Pi = N\left(p_I x_I - \lambda C(x_I, q_I)\right) - F$$

$$s.t. \quad \beta B(x_I, q_I) \geq B(x_E, q_E) \qquad \text{Hippocratic Oath}$$

$$\beta B(x_I, q_I) - \alpha p_I x_I \geq 0 \quad \text{Patient participation constraint}$$

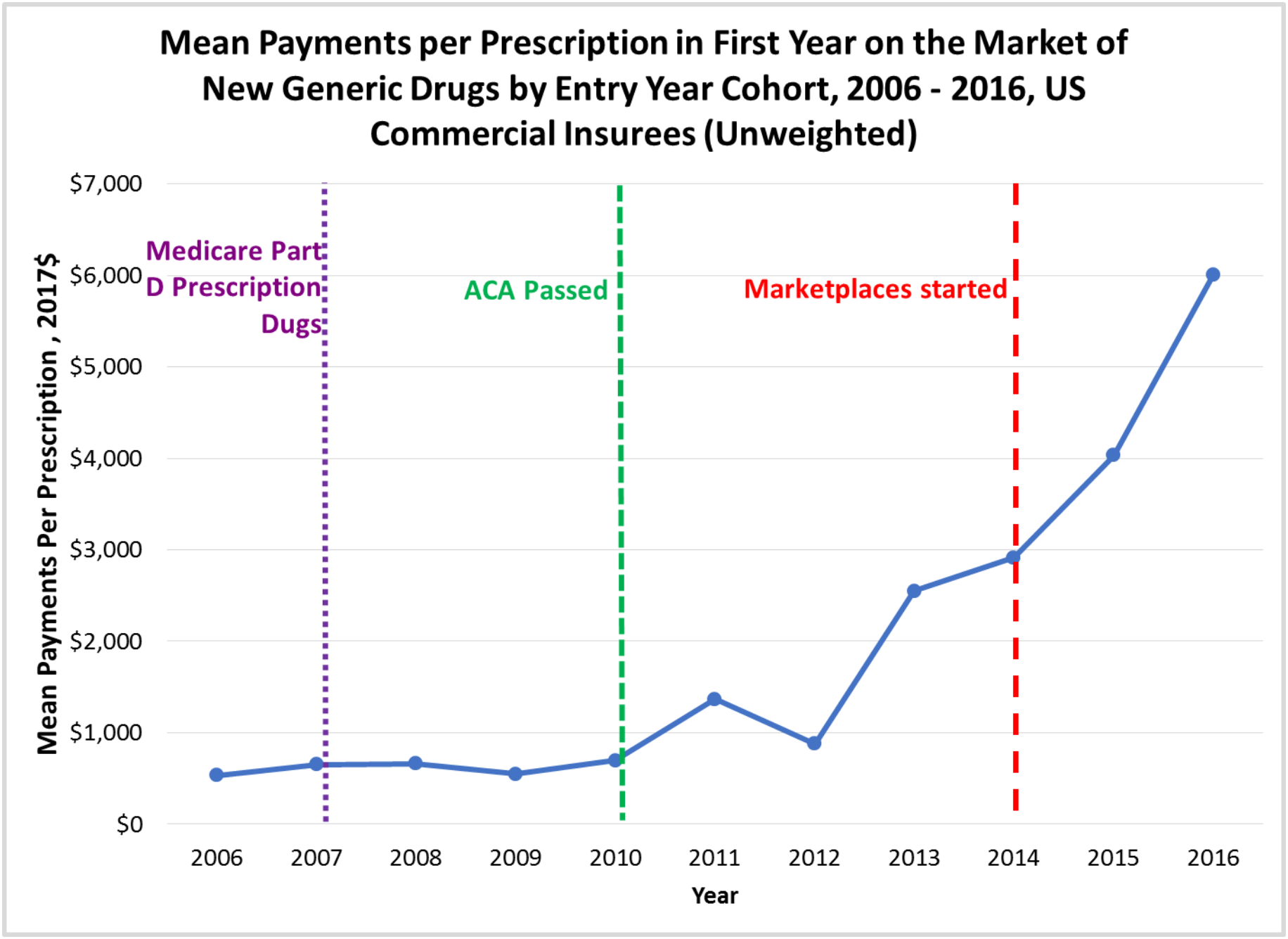
Results in WTP pricing/quality/quantity choices

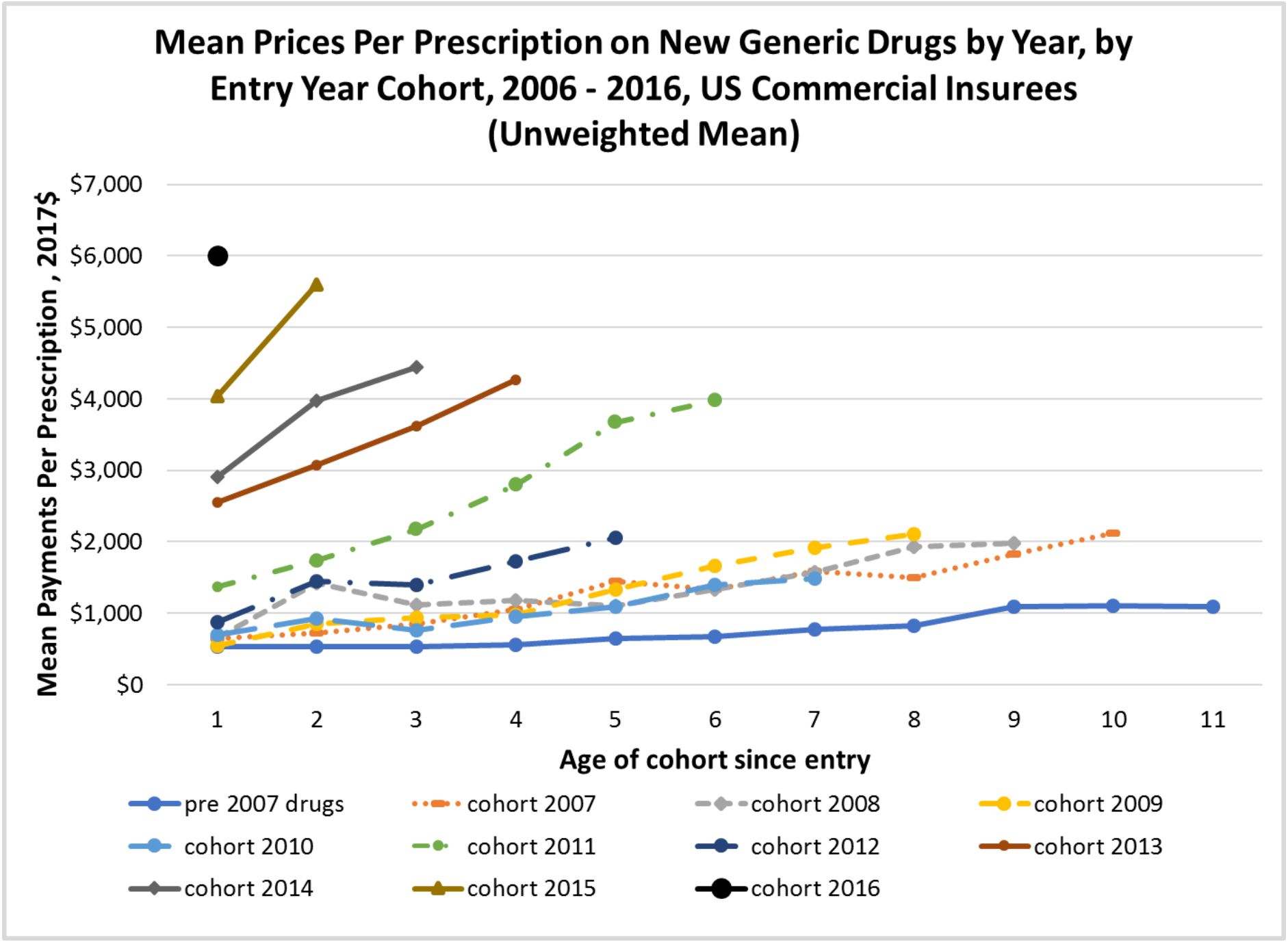
Empirical Predictions of WTP Model

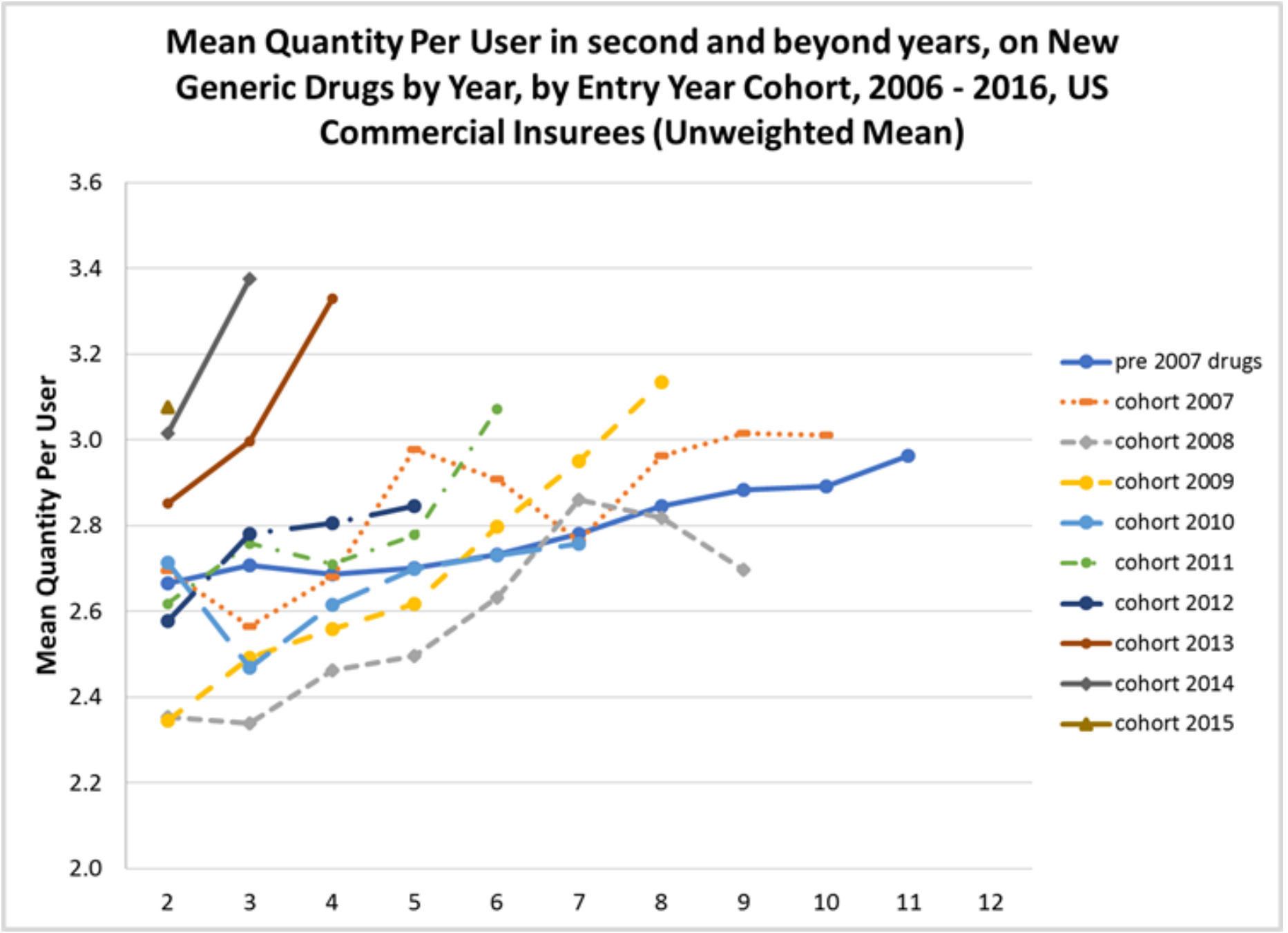
- H1. New drug prices will be increasing over time because of growing US drug insurance coverage.
- H2. New drug quantities per user will increase along with increased insurance, contrary to a monopoly model.
- H3. Drug and new technology prices will be higher in health plans with more generous insurance coverage.
- H4. Plans that charge a fixed fee rather than a fraction of the drug price will have higher drug and provider prices.
- H5. WTP pricing means that different dosage and package sizes of new drugs will be similarly priced, since prices are based on their value to the consumer, not on costs.
- H6. The existence of an existing substitute drug or technology in a market does not constrain the prices of improvements, since the improvement is priced at its WTP price, not its incremental value to consumers.
- H7. Drugs are sold at a social cost that is greater than any meaningful number of uninsured consumers would be willing to pay.

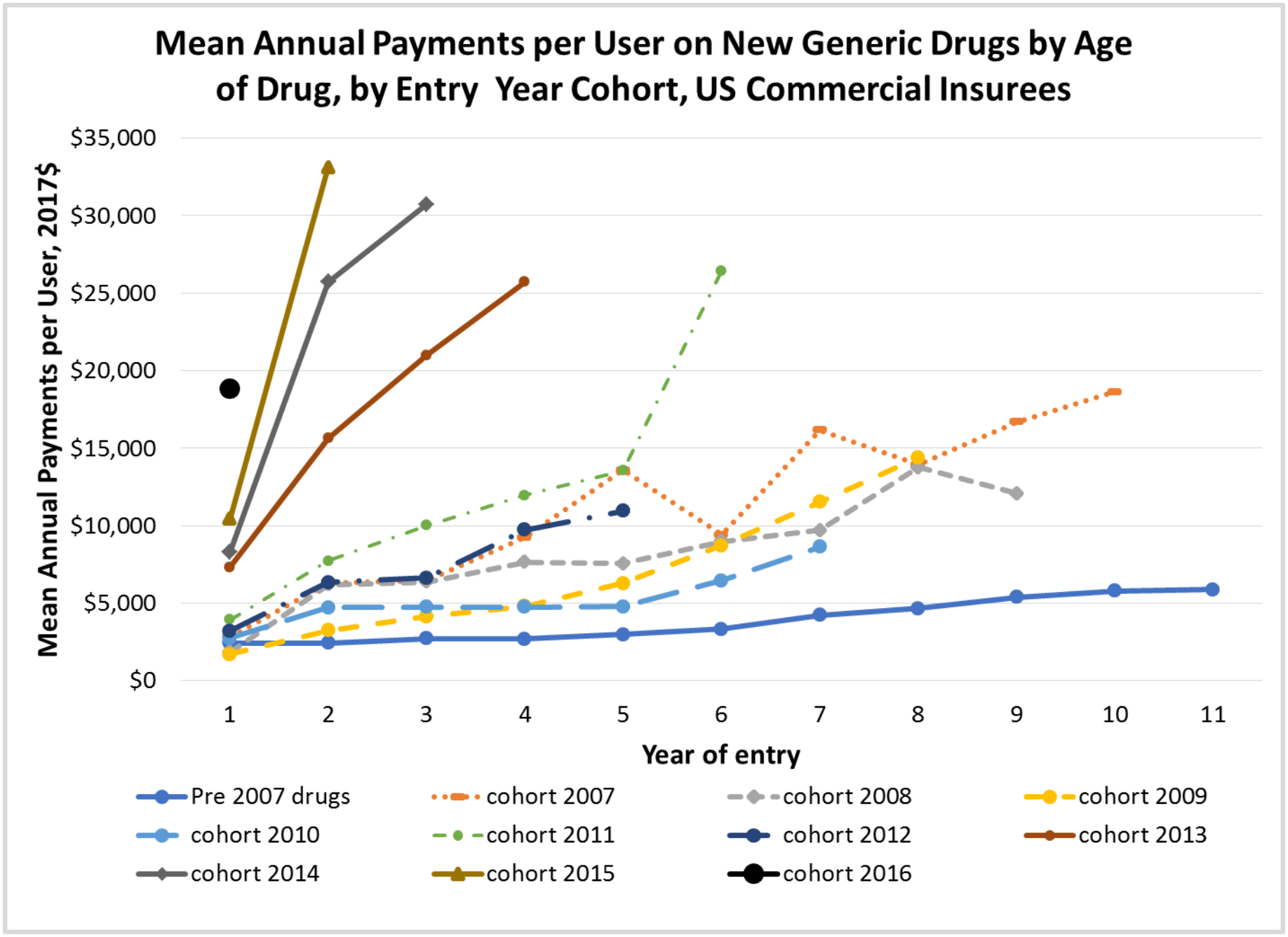
VI Data

- IBM/Watson Truven MarketScan US Commercial claims and encounter data, 2006-2016
- Drug claims for the privately-insured population with drug insurance coverage
- Mostly large employers
- Variety of health plans
- N of 6-20 million person-years each year


Mean Payments per Prescription in First Year on the Market of New Generic Drugs by Entry Year Cohort, 2006 - 2016, US Commercial Insurees (Unweighted)
Mean Payments Per Prescription , 2017$
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
Medicare Part D Prescription Dugs
ACA Passed
Marketplaces started
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year


Mean Prices Per Prescription on New Generic Drugs by Year, by Entry Year Cohort, 2006 - 2016, US Commercial Insurees (Unweighted Mean)
Mean Payments Per Prescription , 2017$
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
1
2
3
4
5
6
7
8
9
10
11
Age of cohort since entry
pre 2007 drugs
cohort 2007
cohort 2008
cohort 2009
cohort 2010
cohort 2011
cohort 2012
cohort 2013
cohort 2014
cohort 2015
cohort 2016


Mean Quantity Per User in second and beyond years, on New Generic Drugs by Year, by Entry Year Cohort, 2006 - 2016, US Commercial Insurees (Unweighted Mean)
Mean Quantity Per User
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
2
3
4
5
6
7
8
9
10
11
12
pre 2007 drugs
cohort 2007
cohort 2008
cohort 2009
cohort 2010
cohort 2011
cohort 2012
cohort 2013
cohort 2014
cohort 2015

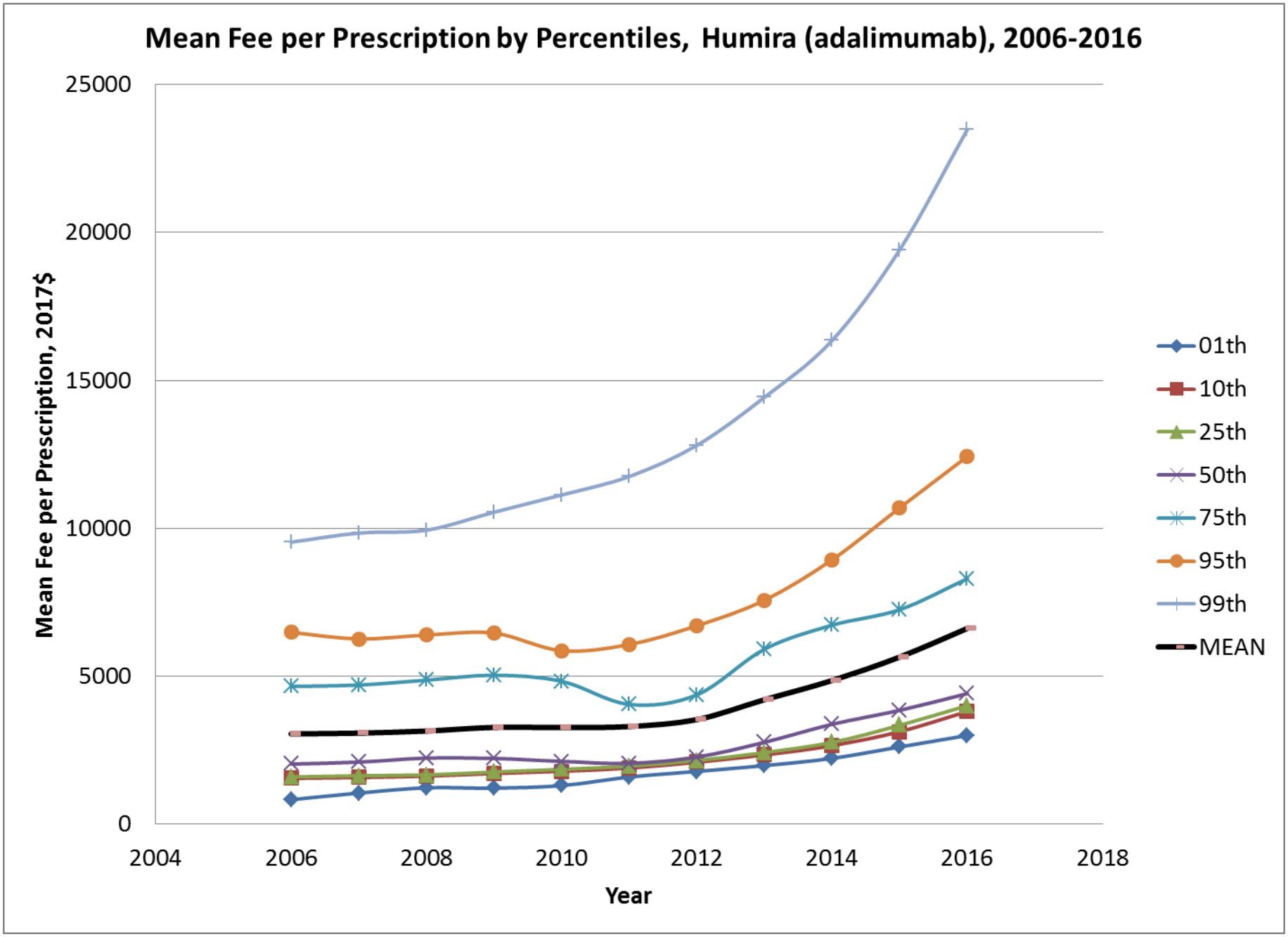

Mean Annual Payments per User on New Generic Drugs by Age of Drug, by Entry Year Cohort, US Commercial Insurees
Mean Annual Payments per User, 2017$
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
1
2
3
4
5
6
7
8
9
10
11
Year of entry
Pre 2007 drugs
cohort 2007
cohort 2008
cohort 2009
cohort 2010
cohort 2011
cohort 2012
cohort 2013
cohort 2014
cohort 2015
cohort 2016

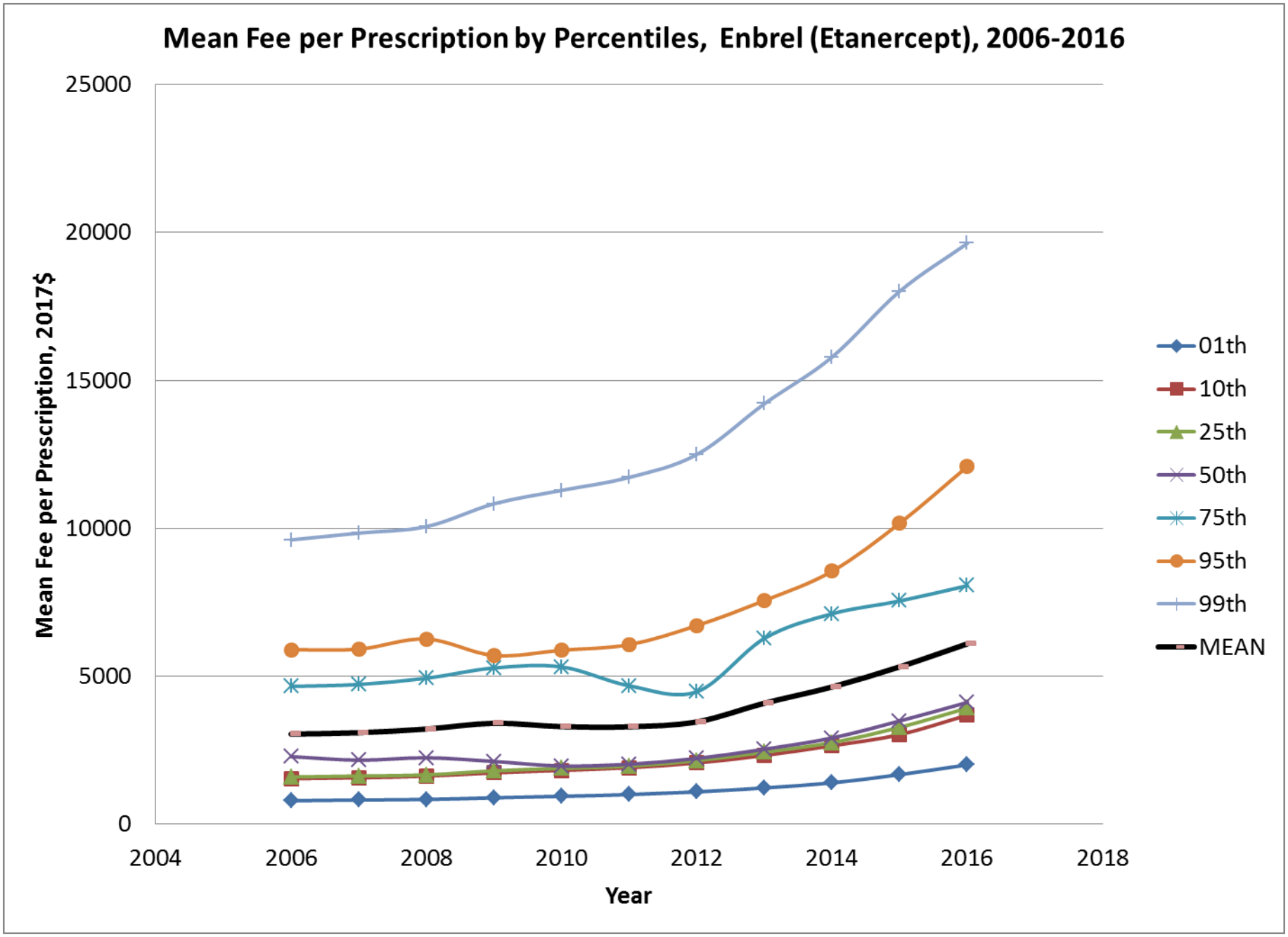
(1) Fee = (cohort dummies)+ (year dummies)
(2) Fee = (cohort dummies)+ (year trend linear variable)

Regressions using generic drug mean fees as the dependent variable, 11 years, 2748 generic drugs

	(1)	(2)
VARIABLES	OLS	OLS
2007.cohort	481.2***	461.5***
	(138.8)	(138.2)
2008.cohort	519.6***	478.9***
	(145.1)	(144.2)
2009.cohort	374.4**	333.4**
	(155.0)	(154.0)
2010.cohort	128.4	88.38
	(196.4)	(195.3)
2011.cohort	1,518***	1,475***
	(183.8)	(182.6)
2012.cohort	435.9**	410.6**
	(210.0)	(208.7)
2013.cohort	2,190***	2,208***
	(233.0)	(231.6)
2014.cohort	2,519***	2,603***
	(248.6)	(246.6)
2015.cohort	3,425***	3,544***
	(318.3)	(314.8)
2016.cohort	4,648***	4,809***
	(451.7)	(444.6)
Constant	534.4***	256.0***
	(105.1)	(66.95)
Observations	28,576	28,576
R-squared	0.024	0.024
Year Dummies	Yes	
Linear Year Trend		Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1


Mean Fee per Prescription by Percentiles, Humira (adalimumab), 2006-2016
Mean Fee per Prescription, 2017$
25000
20000
15000
10000
5000
0
2004
2006
2008
2010
2012
2014
2016
2018
Year
01th
10th
25th
50th
75th
95th
99th
MEAN


Mean Fee per Prescription by Percentiles, Enbrel (Etanercept), 2006-2016
Mean Fee per Prescription, 2017$
25000
20000
15000
10000
5000
0
2004
2006
2008
2010
2012
2014
2016
2018
Year
01th
10th
25th
50th
75th
95th
99th
MEAN

Regressions on Drugs in Therapeutic Class: Immunosuppressants, NEC

Plan type	Payment (1)	Ln(payment) (2)	Ln(payment) (3)	Ln(payment) (4)
EPO	-135.333***	-0.074***	-0.012***	
	(6.000)	(0.002)	(0.002)	
HMO	-288.327***	-0.138***	-0.068***	
	(3.615)	(0.001)	(0.001)	
POS	26.250***	-0.022***	0.048***	
	(3.923)	(0.002)	(0.002)	
PPO	-98.658***	-0.065***	-0.003**	
	(3.298)	(0.001)	(0.001)	
CDHP	17.631***	-0.020***	0.004**	
	(3.792)	(0.002)	(0.002)	
HDHP (omitted group)	.	.	.	
Any coinsurance	-127.890***	-0.011***		-0.013***
	(2.650)	(0.001)		(0.001)
Copay no coinsurance	92.890***	0.084***		0.068***
	(1.953)	(0.001)		(0.001)
Deductible only	-234.057***	-0.132***		-0.113***
	(4.715)	(0.002)		(0.002)
Free (omitted group)	.	.		.
Generic drug name (330)	x	x	x	x
Age group (5)	x	x	x	x
Gender of patient (2)	x	x	x	x
Relation to Employee (4)	x	x	x	x
Region (5)	x	x	x	x
State (54)	x	x	x	x
Date year incurred (11)	x	x	x	x

Note: N=8,754,347 for all regressions

VII. Discussion and Policy Implications

- Absent tight regulation, prices, quantity and quality will be too high.
- Weak regulations are allowing pharmaceutical companies to price at more than the value of the drug to a typical consumer.
- Entire world is focused on high cost, low incremental value drugs given high US profits from them.
- Regulators in US and elsewhere should ensure prices justified by incremental value, not by the total value of the innovation.
- Hippocratic Oath is inconsistent with cost containment.
- Current demand side insurance reforms in the US and elsewhere will not be successful, since consumers are well-insured, rely on their expert doctor agents, and the Hippocratic Oath

Work in progress! Comments welcome.

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