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The Toll of Tobacco

Two ways to sell a tobacco tax

David Bishai, HKU School of Public Health | Dalian, 2026



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01 | The question



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What arguments can motivate higher tobacco taxes?

- Stakeholders
 - Citizens
 - Tobacco industry
 - Government officials
- Case 1: South Korea
 - Smokers' costs spread to all citizens
 - Aging population→This is growing
 - Measure costs of tobacco related disease
- Case 2: Chinese Tobacco Industry
 - Greed argument
 - Chinese government will make more money
 - Economics to measure the profit maximizing tobacco price

Case 1: South Korean Tobacco Costs

Yoo KJ, et al.. *Lancet Reg Health West Pac* 2026;70:101843

The toll of tobacco: smoking-attributable health spending in South Korea, 2014–2024. National claims evidence for cost recovery



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Summary

Background South Korean policymakers are weighing tobacco control and financing options amid rising health-care costs. This study estimates the direct medical expenditure attributable to active and second-hand smoking (SHS) using Korea's National Health Insurance Service (NHIS) claims data (2014–2024) and quantifies the fiscal burden borne by the public insurer vs. households.

Methods Annual NHIS claims data for all beneficiaries for the period 2014–2024 were linked with disease-specific Population Attributable Fractions (PAFs) derived from the Global Burden of Disease (GBD) study. Costs were stratified by sex, age, income group, and payer (NHIS vs. out-of-pocket) and expressed in 2024 US dollars.

The Lancet Regional Health - Western Pacific 2026;70:101843

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Korea as a study setting

- Single-payer system with universal coverage
- Complete claims record for the entire population
- Male smoking prevalence above 60% in the late twentieth century
- Rapid demographic ageing
- Prior cost-recovery litigation against tobacco manufacturers (2014)



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Cost incidence and the case for taxation

- Public insurer finances 82.5% of attributable expenditure
- Costs recovered through premiums and general taxation
- So smokers' costs are spread to all of society
 - Past smoking leads to future costs



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Data sources

- National Health Insurance Service claims, 2014-2024
- All beneficiaries; no sampling
- 23 conditions causally linked to smoking or second-hand smoke
- Expenditure disaggregated by payer
 - NHIS reimbursement and statutory copayment
 - Stratified by sex, 10-year age group, and income group

NHIS and Medical Aid cover 60-65% of national health expenditure



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Attribution and cost estimation

- Population attributable fractions (PAFs) from Global Burden of Disease (GBD) 2023
- PAFs specific to risk, sex, age, condition, and year
- Attributable cost = $\sum (PAF_k) \times (\text{Observed expenditure}_k)$ for each condition k , by stratum
- Costs inflated to 2024 KRW using Korean CPI, then converted to USD
- Sensitivity analysis across GBD upper and lower risk bounds



Scope and limitations

- Reimbursable services only
 - Non-covered services and private providers excluded
- Indirect costs excluded
 - Productivity loss and premature mortality not captured
 - Literature indicates indirect costs exceed direct by 2-3 fold
- Estimates therefore represent a lower bound



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03 | Results



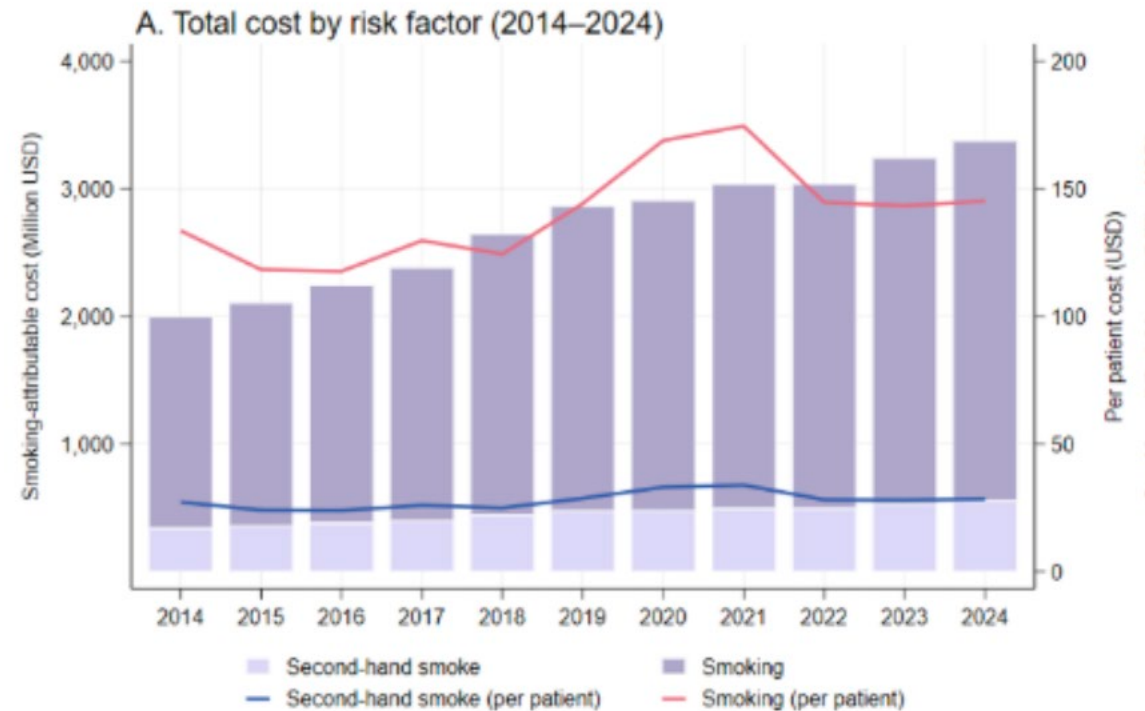
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Aggregate expenditure

- Annual expenditure rose 69.0% in 11 years
- USD 2.00bn (2014) to USD 3.38bn (2024)
- Cost per patient rose from USD 161 to USD 174





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Distribution by disease category

- Top 10 conditions account for 88.2% of attributable expenditure
- Cancers: 35.2% of the total
 - Tracheal, bronchus and lung cancers: USD 5.81 billion
- Cardiometabolic conditions: USD 12.46 billion (41.7%)
 - Stroke, ischaemic heart disease, diabetes mellitus



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Demographic and socioeconomic gradients

- Men account for 80.1% of cumulative expenditure
 - Per-patient cost USD 275.69 (men) vs USD 69.08 (women), 2024
- Adults aged 50-79 account for 80.7%



Second-hand smoke exposure

- Attributable expenditure: USD 4.94 billion (16.5% of total)
- Annual costs rose 63.9%, from USD 338m to USD 554m
- Accounts for 48% of expenditure among women, 9% among men
 - 83% of attributable breast cancer costs in women
 - 55% of attributable otitis media costs



Erosion of the real cigarette price

- Retail price fixed at KRW 4,500 since 2015 but spending power more than doubled
- Hourly minimum wage rose from KRW 5,580 (2015) to KRW 10,320 (2020)

6th National Health Promotion Comprehensive Plan (2026-2030)



Policy implications

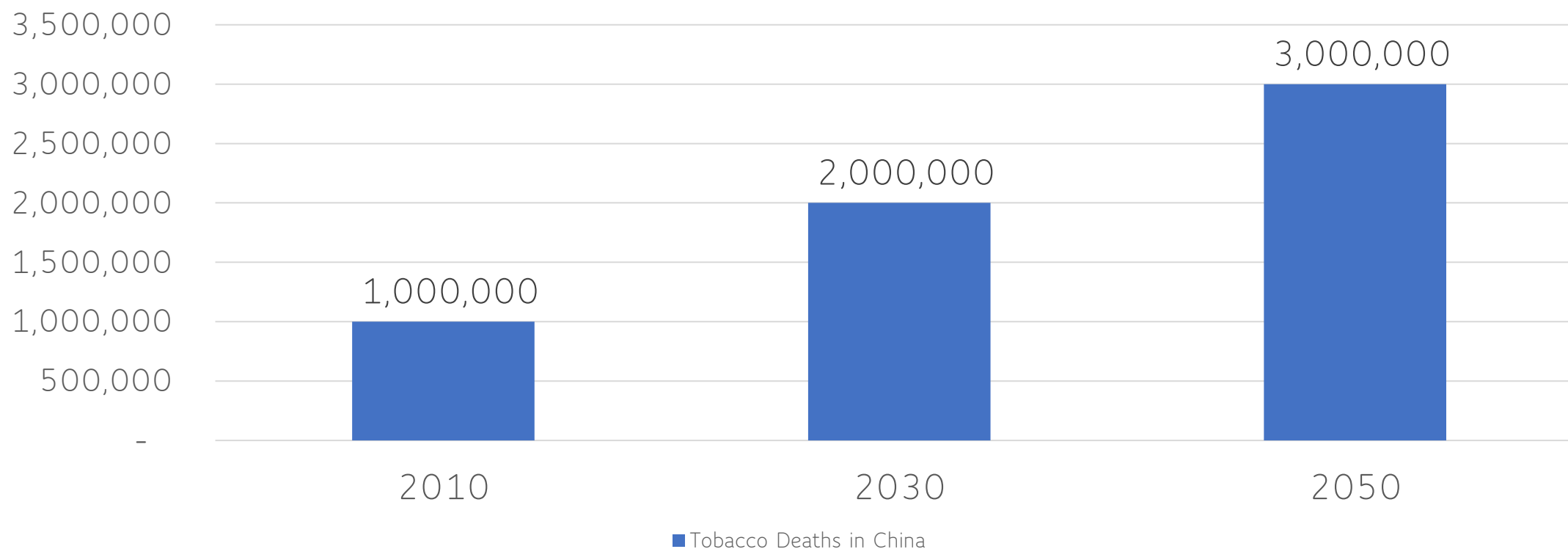
- Quit intention at 12.7% in 2024, lowest in two decades
- Sixth National Health Promotion Plan proposes raising the health promotion levy
- Need to index taxes to inflation preserves the real price over time
- Survey evidence indicates 63% support for higher tobacco taxation
 - Majority favour a phased increase

Case 2: Profit Maximizing Price of Tobacco in China



Slow Tsunami: China's Biggest Epidemic

Tobacco Deaths in China

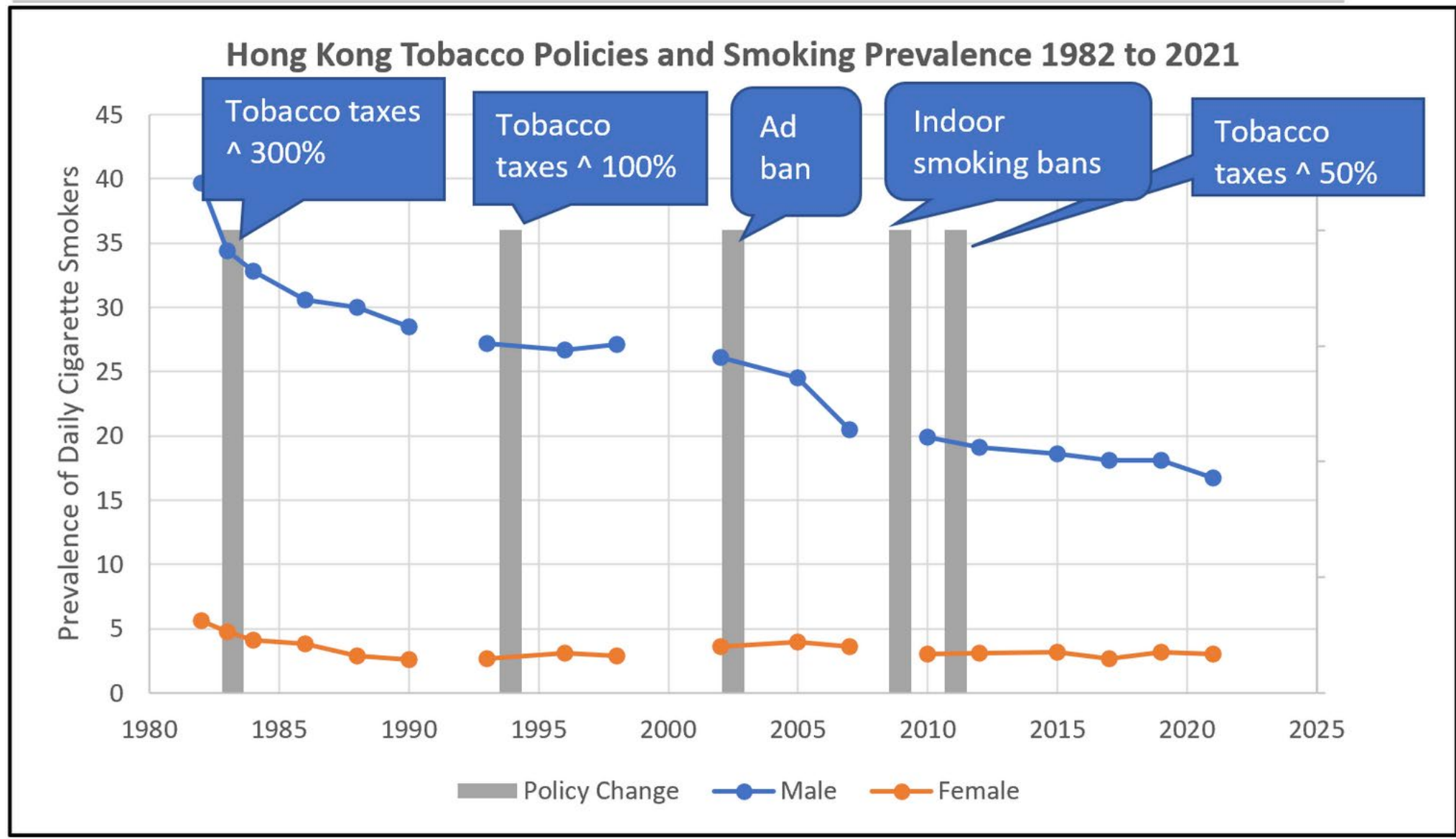


The Biggest Epidemic in China is Preventable

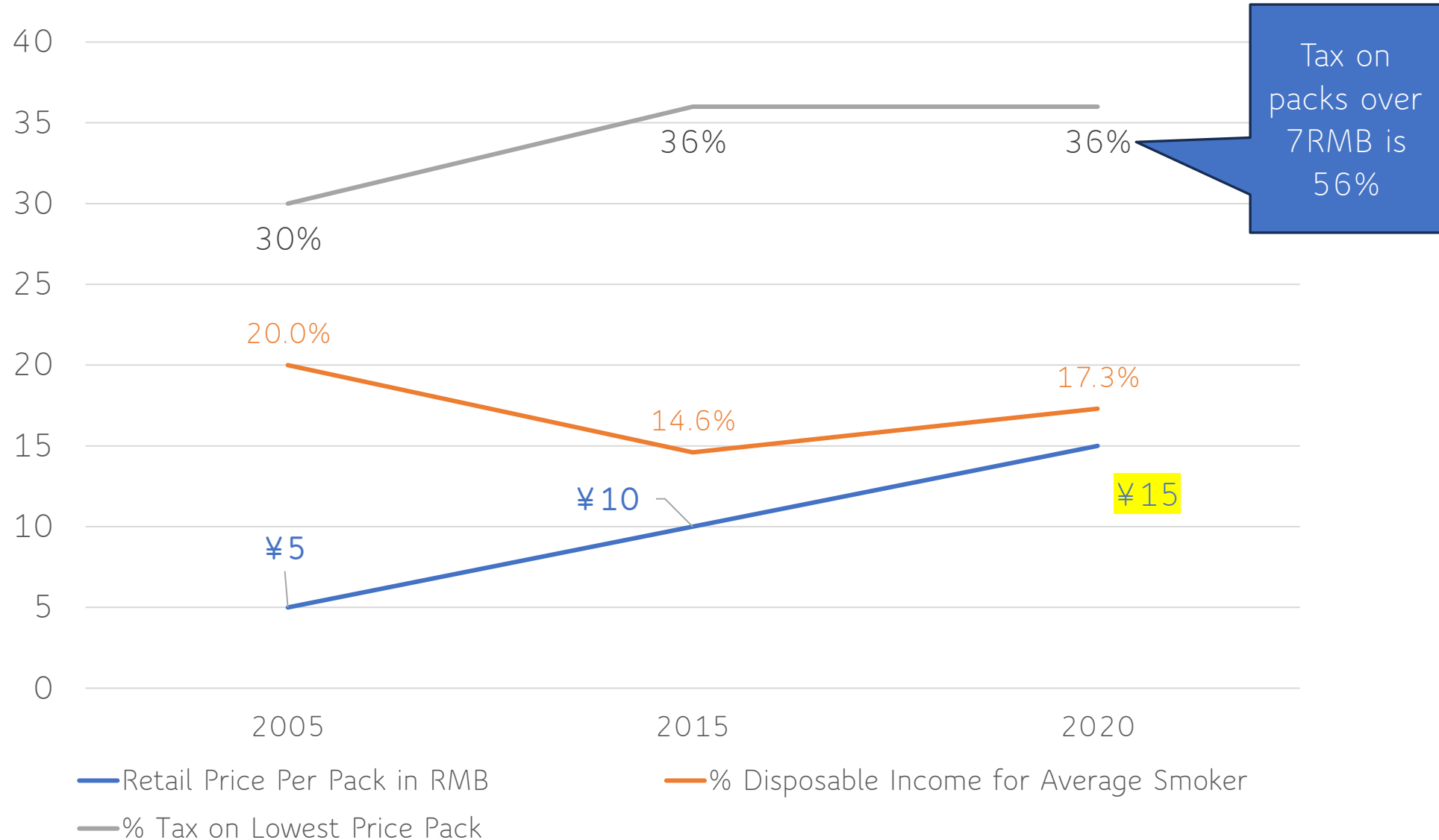
Adult Male Smoking Prevalence	50%
Total Smokers	300 million
Tobacco's % of adult male deaths.	20%

- ☐ Lung cancer
- ☐ Cardiovascular disease
- 🧠 Stroke
- ☐ COPD

Higher Tobacco Prices Saved Lives in Hong Kong



China's Tobacco Prices



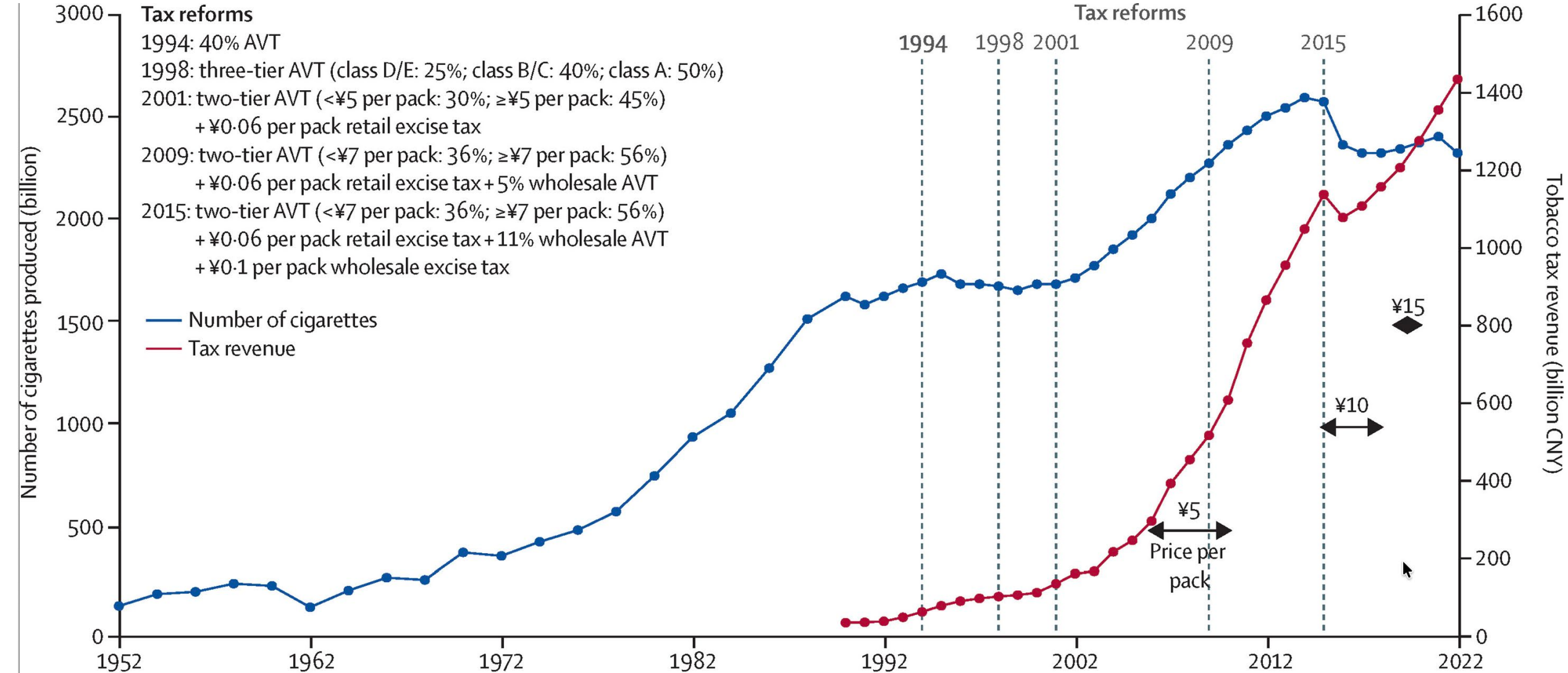
Economic Burden of Tobacco in China

Economic Indicator	Estimate
Direct healthcare costs	- ¥53 billion/year. (1.5% of total)
Indirect costs (lost productivity)	- ¥296.5 billion/year
Total economic burden	- ¥349.5 billion/year
Tobacco tax revenue to government	+¥1,442 billion/year
Net economic gain after health costs	+¥1,050 billion/year

The "ICER" is 525 million RMB (\$USD 77,000) gained per death

But there is a way to make China earn more money and have less death

Time trends in the epidemic



Summarizing China's Tobacco Dilemma

Taxes Stalled



But State Monopoly Gathers “Non-Tax” Revenue

CNTC-STMA

China National Tobacco Corporation and State Tobacco Monopoly Administration (CNTC-STMA) controls manufacturing, distribution and retail sales

What if Higher Tobacco Prices Can Make CNTC More Money?

1. Sometimes raising price earns more money (if demand does not fall)
2. How much money could China earn if CNTC set a higher price?
3. How many lives saved at a higher price?

Methods

Theory of Competitive Prices

HOW MONOPOLIES THINK



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Price Theory

Competitive Markets

- Free entry of suppliers
- Consumers fully informed
- Compete solely on price

→ Price set at marginal cost (MC)

Profits Zero

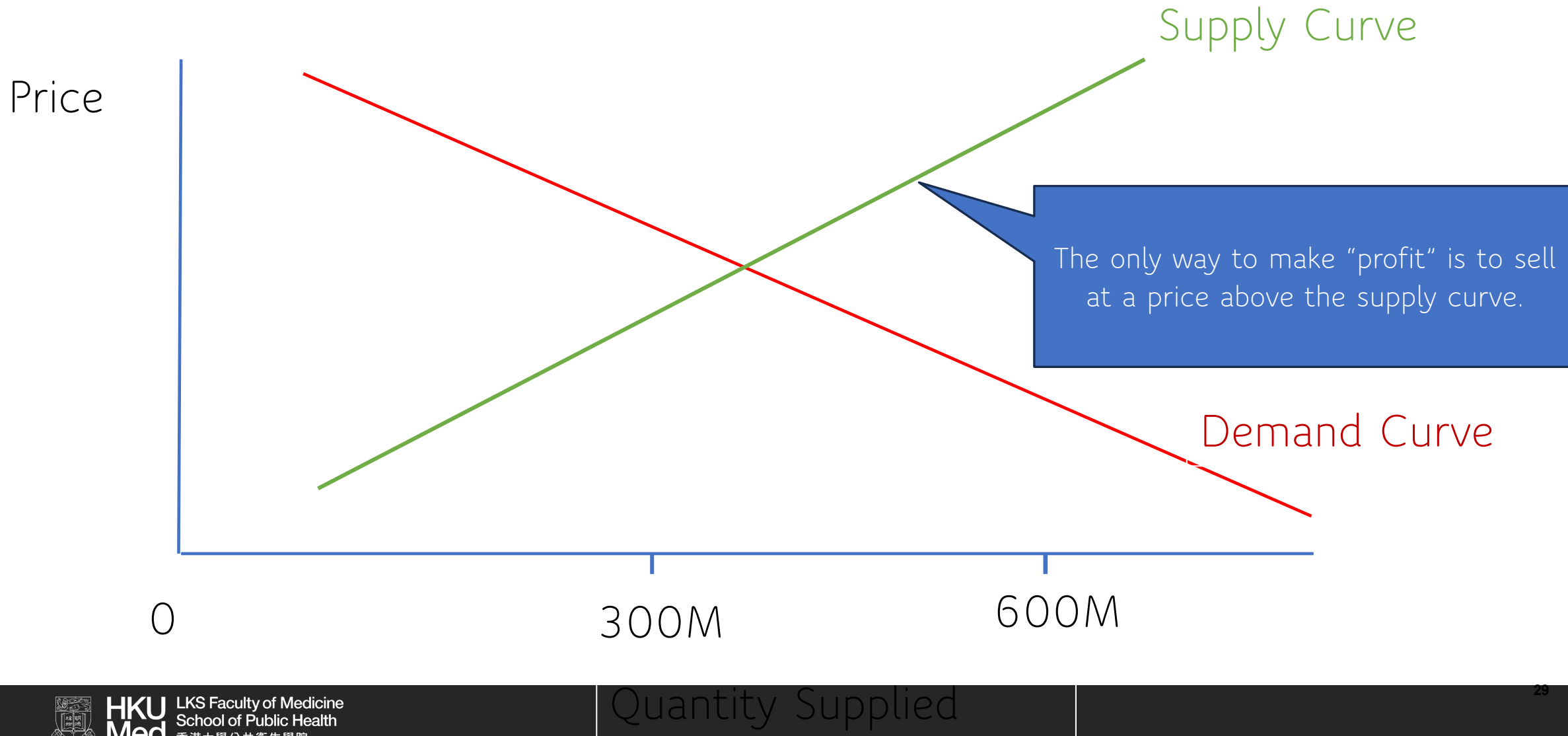
Monopolist Markets

- One supplier controls units sold
- One supplier controls information
- One supplier controls the price

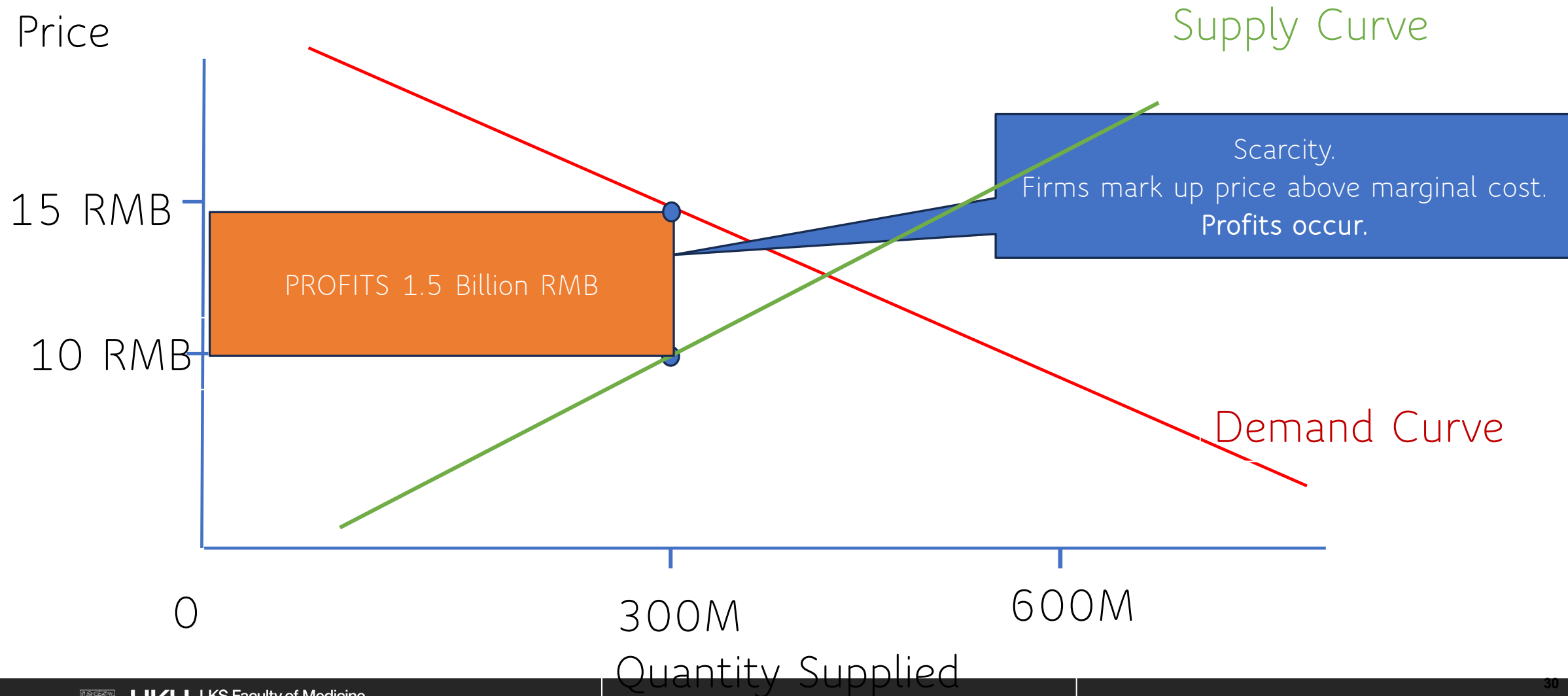
→ Price marked up over MC

Profits Maximized

Competitive Market



Suppose a Cartel Restricts Supply to 300M



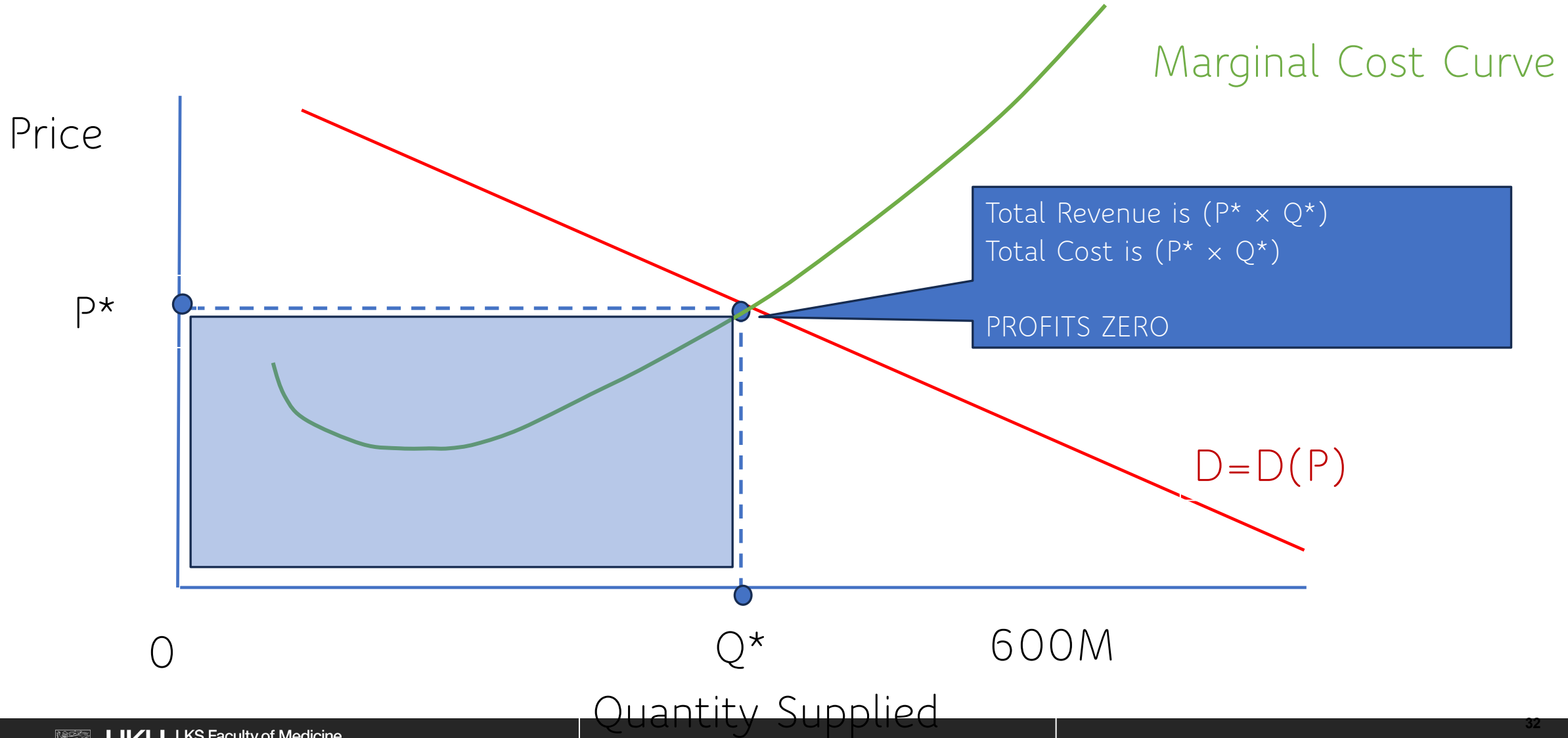
Theory of Monopoly



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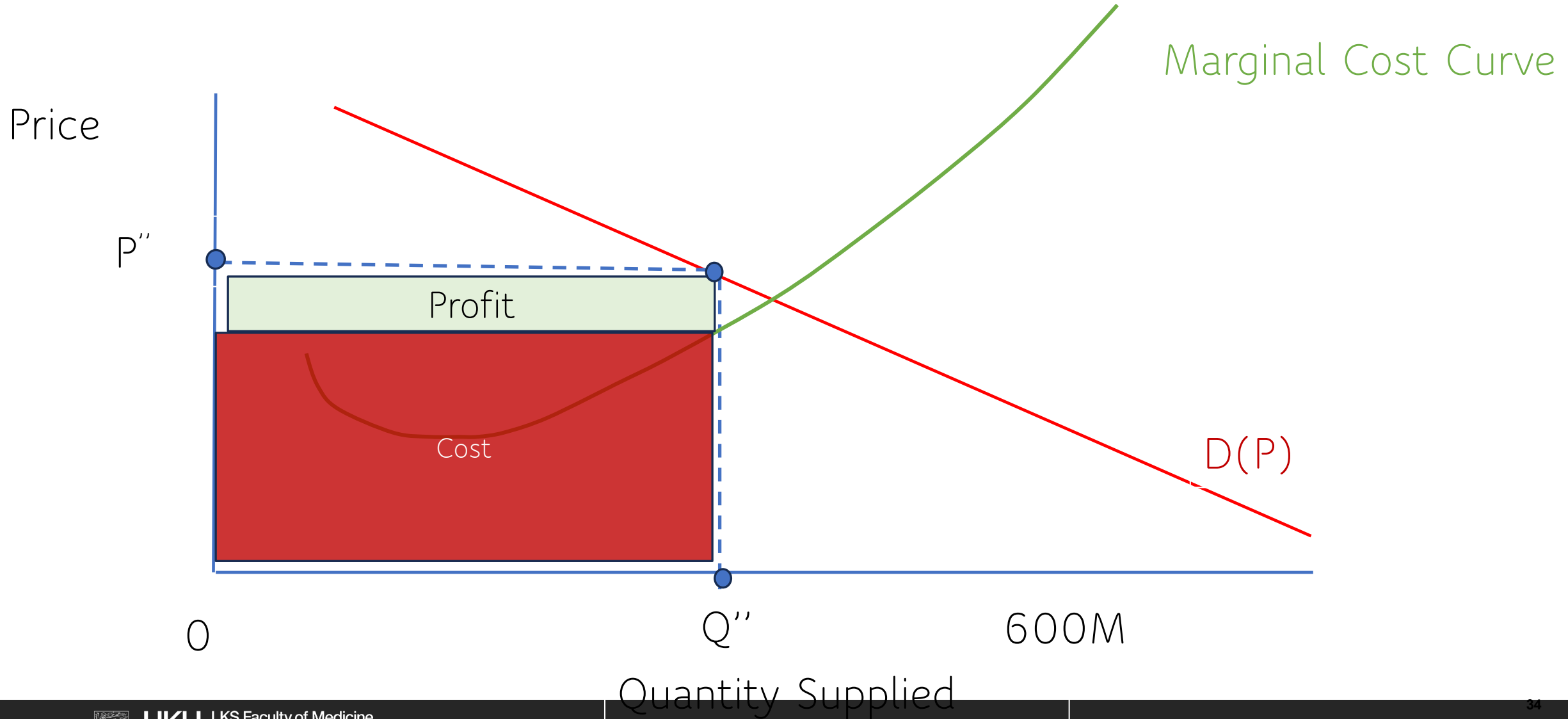
Monopolist Can Do Better than P^* and Q^*



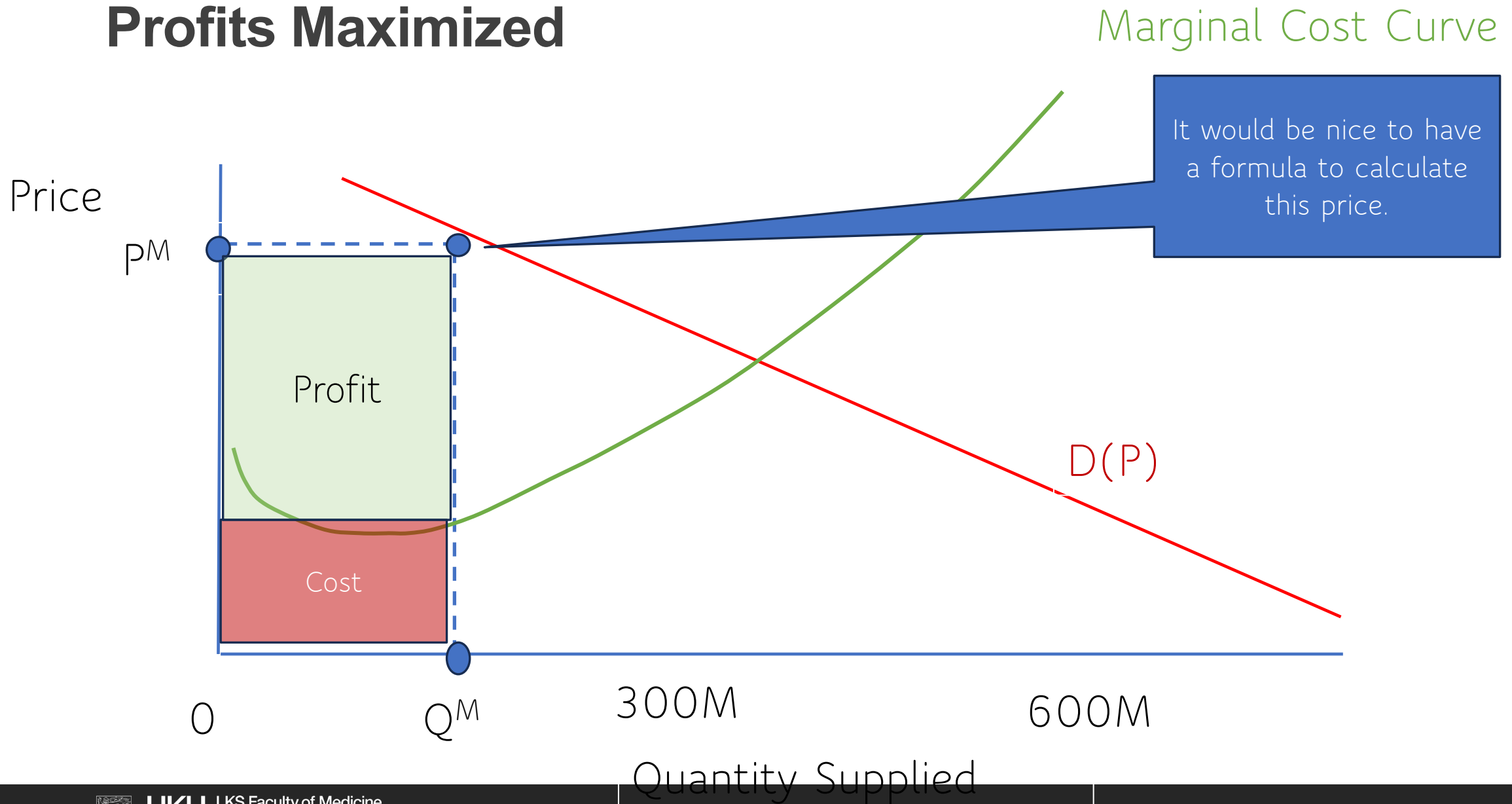
Price too high $\rightarrow$ sales fall too much



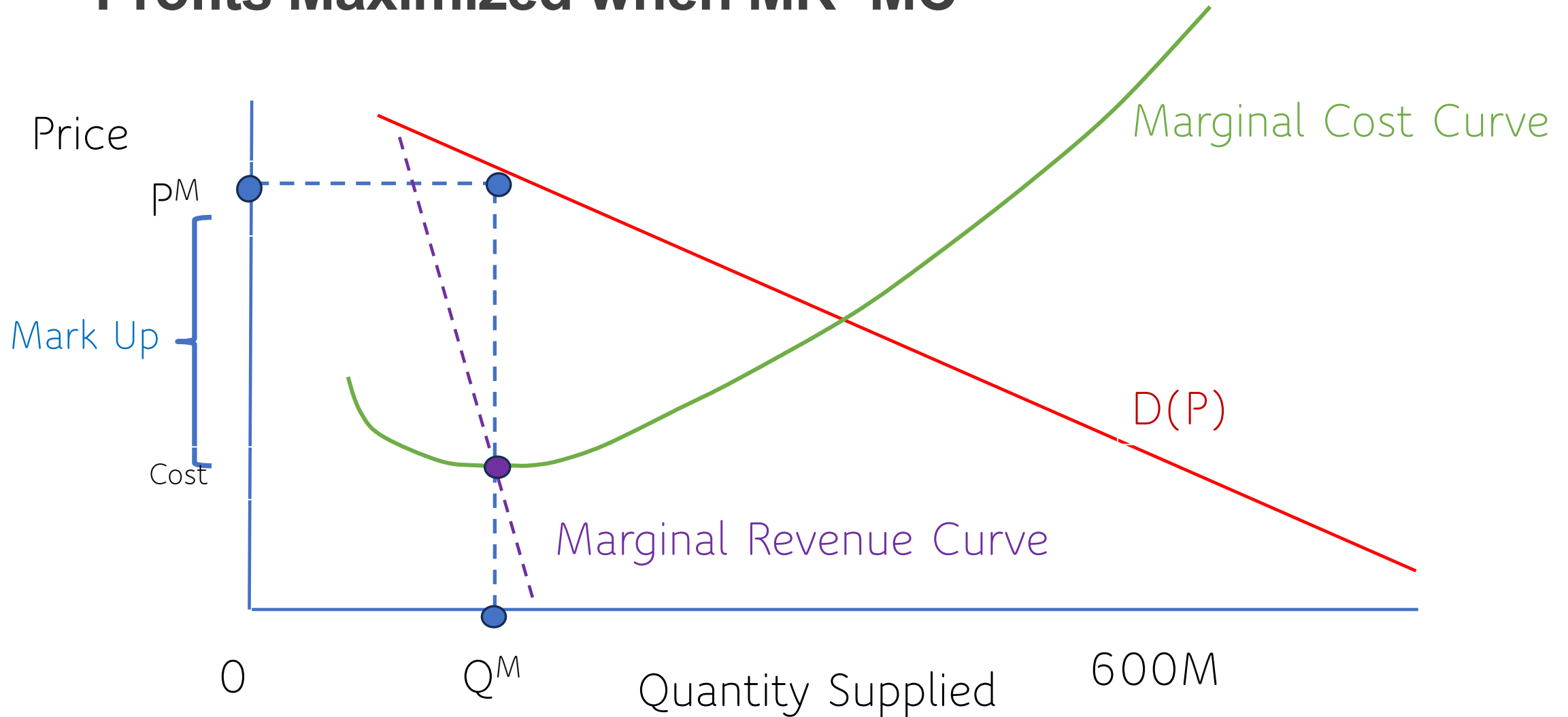
Price not high enough → Profit not maximized



Profits Maximized



Profits Maximized when $MR=MC$



In Algebra

Profit(Q)=Total Revenue-Total Cost

What is profit maximizing Quantity?

- Set derivative of profit to Zero
- So slope of revenue curve=slope of cost curve
- Can also say “marginal revenue of each new sale”=“marginal cost of each”

$$\frac{d(\pi(Q))}{dQ} = \frac{d(Q \times P(Q))}{dQ} - \frac{d(Cost)}{dQ} = 0$$

Calculus Problem $\frac{d(Q \times P(Q) - TC)}{dQ} = 0$

$$[1] P + Q \frac{dP}{dQ} - MC = 0$$

$$[2] P + \frac{P}{Q} Q \frac{dP}{dQ} - MC = 0$$

$$[3] P \left(1 + \frac{Q}{P} \frac{dP}{dQ} \right) - MC = 0$$

Simplification Problem. Notice $\frac{Q}{P} \frac{dP}{dQ}$

$$[4] P^M \left(1 + \frac{Q}{P} \frac{dP}{dQ}\right) - MC = 0$$

DEFINITION OF PRICE ELASTICITY

$$[5] P^M \left(1 + \frac{1}{\varepsilon_P}\right) = MC$$

$$\varepsilon_P = \frac{\frac{dQ}{Q}}{\frac{dP}{P}} = \frac{P}{Q} \frac{dQ}{dP}$$

To maximize profit mark up cost by

$$[6] P^M = \frac{MC}{1 + \frac{1}{\varepsilon_P}} \quad \frac{\varepsilon_P}{1 + \varepsilon_P}$$

$$\frac{1}{\varepsilon_P} = \frac{Q}{P} \frac{dP}{dQ}$$

Study design

Approach: Constructed counterfactual monopoly prices using the **inverse elasticity rule** from standard monopoly theory.

Theoretical foundation: First-order condition for monopoly profit maximization.

$$\frac{P^* - MC}{P^*} = -\frac{1}{\varepsilon} \quad \rightarrow \quad P^* = -\frac{MC * \varepsilon}{\varepsilon + 1}$$

P^* : Monopoly price; MC: Marginal cost; ε : Price elasticity

Key inputs: Estimated price elasticity of demand and marginal cost.

Estimation of price elasticity of demand

- **Systematic Review:** Conducted in accordance with PRISMA guidelines
- **Data Sources:**
 - Peer-reviewed literature from Jan 2020 – May 2026
 - Databases:
 - ✓ Medline
 - ✓ Embase
 - ✓ CNKI
 - ✓ grey literature
- **Data Extracted:**
 - Study characteristics; elasticity point estimates; data source; sample period

Estimation of marginal cost

- Marginal cost (MC) was estimated using **component-based summation**
Marginal cost was computed by aggregating the per-unit costs of primary production inputs:
 - ✓ Tobacco leaf material cost
 - ✓ Filter rod cost
 - ✓ Cigarette paper cost
 - ✓ Packaging materials cost
 - ✓ Labor and other variable manufacturing costs
- **Data Source:**
Cost data were obtained from published academic literature and the China Tobacco Yearbook

Theoretical monopoly prices

- **Price computation**

Theoretical monopoly prices were calculated using marginal cost and price elasticity estimates:

$$P_t = - \frac{MC_t \times \varepsilon}{\varepsilon + 1}$$

P_t : Monopoly price in year t ; MC_t : Marginal cost in year t ; ε : Price elasticity

- **Revenue and profit assessment**

Counterfactual monopoly revenue and profit are subsequently computed by applying the derived optimal prices to the estimated demand function, incorporating both marginal cost and elasticity parameters.

Results



Price elasticity of demand

Study	Elasticity	Data source	Sample period
Hu et al (2002) [4]	-0.54	National aggregate time series data	1980 to 1996
Lance et al (2004) [5]	-0.08 (conditional estimates)	China Health and Nutrition Survey	1993 to 1997
Bishop (2007) [6]	-0.46	Chinese Household Income Project	From 1995
Kostova et al (2014) [7]	-0.53	Global Adult Tobacco Survey	2008 to 2011
Liu et al (2015) [8]	-0.49	Global Market Information Database and China Tobacco Year Book 2005–2010	2005-2010
Verguet et al (2015) [9]	-0.38	Mean elasticity from published studies	2010
Huang et al (2015) [10]	-0.12 to -0.14 (conditional estimates)	International Tobacco Control (ITC) Policy Evaluation Project—China Surveys	2006-2010
Yang et al (2024) [11]	-0.54	A hypothetical CPT at baseline assessments of a trial	2023
He et al (2025) [12]	-0.72	China Family Panel Survey 2012	2012
Mean (exclude conditional estimates): -0.54			

Marginal cost

Variable	Value	Data source
FCV tobacco worlds price (average)	3.40 USD/kg (23.80 RMB)	[13]
Tobacco leaf per stick	0.62 - 0.67 g	[3]
Production cost estimate	3.08 RMB	[14]
Non-tobacco materials (filter, paper and packaging, etc) cost percentage	25-45%	[15]
Labor and other variable manufactural cost percentage	~21%	[16-17]
Calculated tobacco leaf cost per package (20 sticks)	0.30 - 0.32 RMB	
Calculated non-tobacco materials (filter, paper and packaging, etc) cost	0.77 - 1.39 RMB	
Calculated labor and other variable manufacturing costs	0.65 RMB	
Physical MC	1.72 - 2.36 RMB	
Sensitivity range ($\pm 15\%$)	1.46 – 2.71 RMB	
Median MC	2.09 RMB	

Theoretical monopoly prices

- Table presents theoretical monopoly prices under different combinations of price elasticity of demand and marginal cost (unit: RMB per pack)

	$\epsilon=-0.72$	$\epsilon=-0.54$	$\epsilon=-0.53$	$\epsilon=-0.49$	$\epsilon=-0.46$	$\epsilon=-0.08$
MC=1.46	17.5	20.7	20.9	22.0	23.0	26.2
MC=2.09	17.8	21.0	21.3	22.3	23.3	26.5
MC=2.71	18.1	21.3	21.6	22.7	23.6	26.8

Table 3. Theoretical monopoly prices by elasticity and marginal cost

- Observed Market Price**

According to published data, the median cigarette price per pack in the Chinese market was **15.0 RMB**

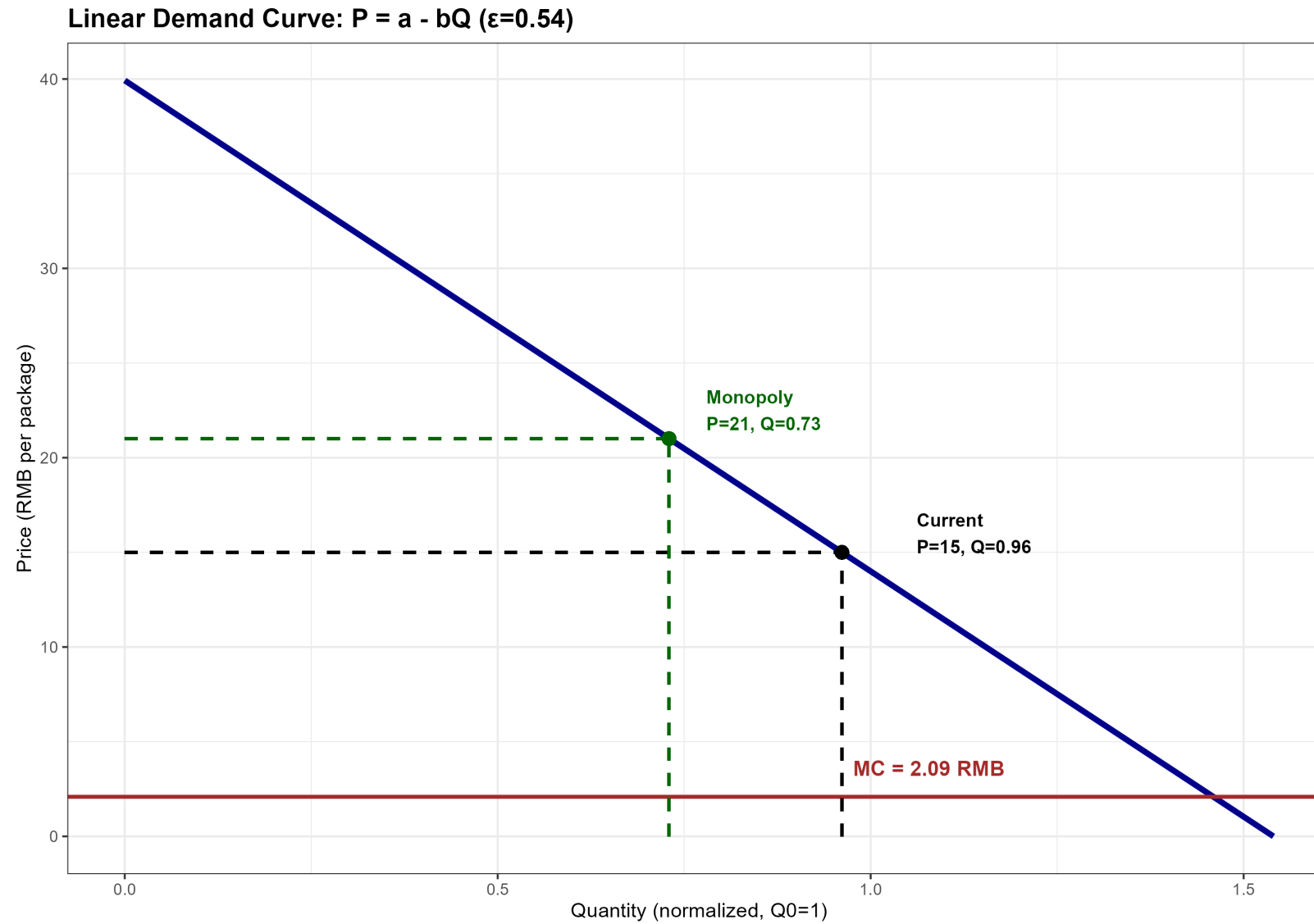


Figure 1. Linear Demand Curve: Current vs. Monopoly

Revenue assessment

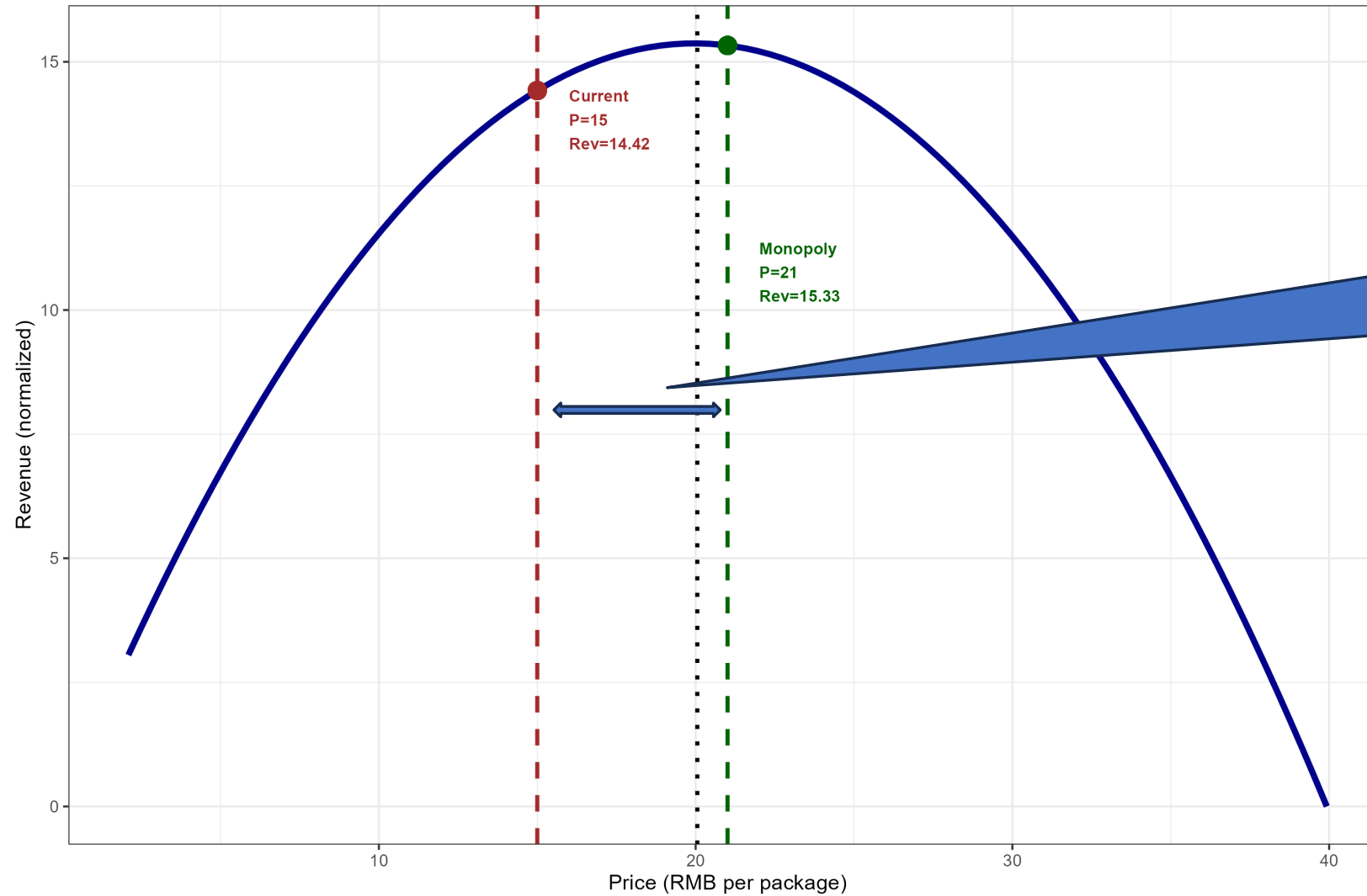
- In this Table ,each cell reports the percentage change in revenue from adjusting current market pricing ($P_0 = 15.0$ RMB) to monopoly profit-maximizing levels.

	$\epsilon=-0.72$	$\epsilon=-0.54$	$\epsilon=-0.53$	$\epsilon=-0.49$	$\epsilon=-0.46$	$\epsilon=-0.08$
MC=1.46	0.9%	6.4%	7.0%	9.4%	11.7%	20.1%
MC=2.09	0.7%	6.3%	6.8%	9.3%	11.6%	20.2%
MC=2.71	0.4%	6.1%	6.6%	9.1%	11.4%	19.9%

Revenue gains to marginal cost and demand elasticity

Revenue Curve: Revenue vs Price

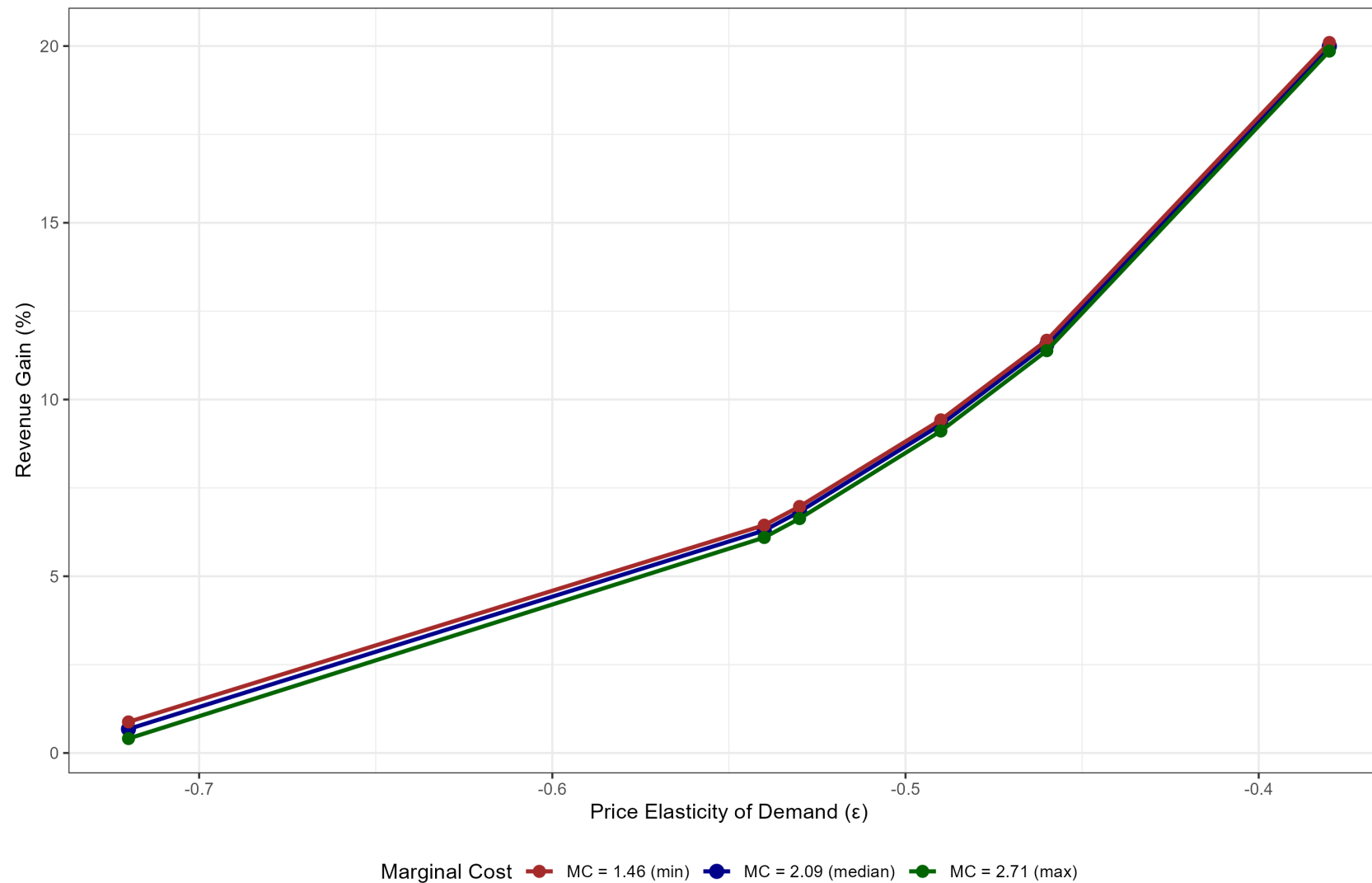
Linear demand calibration | $\varepsilon = -0.54$ | $MC = 2.09$ RMB



Revenue Gap
91 Billion RMB
(\$13.39 B USD)

Revenue Gain from Monopoly Pricing

Current price: 15 RMB → Monopoly optimum | MC range: 1.46-2.71 RMB



Profit Assessment

- Table presents the percentage change in profit from adjusting current market pricing ($P_0 = 15.0$ RMB) to monopoly profit-maximizing levels.

	$\epsilon=-0.72$	$\epsilon=-0.54$	$\epsilon=-0.53$	$\epsilon=-0.49$	$\epsilon=-0.46$	$\epsilon=-0.08$
MC=1.46	2.4%	9.6%	10.2%	13.2%	15.8%	25.6%
MC=2.09	3.2%	11.2%	11.9%	15.1%	18.0%	28.4%
MC=2.71	4.2%	13.0%	13.8%	17.2%	20.3%	31.5%

Profit gains to marginal cost and demand elasticity

Discussion



Key findings:

If it acted like a monopolist

CNTC-STMA could earn ¥ 91 billion more and cut tobacco sales 24%

Public Health Impact

Input	Value
Smokers in China	300 million
Tax-induced reduction in purchases	24%
Smokers who quit entirely	28.8 million (9.6%)
Smokers who reduce consumption	271 million (14.4% fewer cigarettes)
Deaths averted from quitting (by 2050)	~5.6 million
Deaths averted from reduction (by 2050)	~5.4 million
Total lives saved by 2050	~11 million

How about the farmers?

20 million farmers grow tobacco in China

- 24% reduction in sales means 5 million farmers need to grow something else
- **¥ 91 billion divided by 5 million provides ¥ 18,200 per person to convert crops**

Limitations & Future Research

Price heterogeneity:

- Wide range across brands (economy to premium)
- Different elasticities by tier require segmentation

Demand specification

- Linear demand assumption → May not hold at extreme prices
- Constant elasticity → Likely more elastic at high prices

Dynamic effects

- Static model → No addiction dynamics
- Short-run vs. long-run elasticity differs

Future research:

- **Flexible** demand systems with nonlinear elasticity
- Provincial variation & multi-tier pricing analysis
- Dynamic structural model
- Welfare analysis with healthcare externalities

Take-home message

- China can save lives and increase earn more money for state monopolies
- Current prices significantly below the profit maximizing price
- China can earn ¥91 billion government revenue each year that it is missing out on
- And save 11 million lives
- China could **simultaneously improve people's health and increase tobacco tax revenue** through raising the price to the optimal point dictated by economics

Conclusion



Synthesis: Think Like Your Stakeholder

South Korea

Governments

- Facing fiscal crunch
- Fear of rising costs from aging

Citizens

- Worry about fairness
- Why should I pay for risks I did not take

Measure and display the costs

China

State Monopoly

- Make lots of money
- Keep farmers happy
- Prosperity and well being



Role of Economics in Tobacco Control

Consider incentives of policy makers

Consider who pays what and how they feel about it

Model counterfactuals of what life would be like with and without tobacco

Calculate people's response to prices

Thank you



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