Pharmaceutical Patents

Analysis

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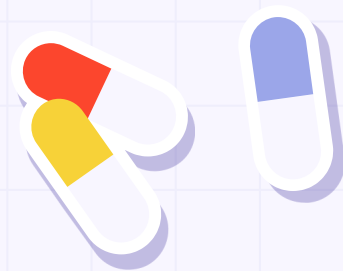
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Motivation

Drug Price Increases

Jan 2022: average price increase was **$150/drug** (10%)
July 2022: average price increase was **$250/drug** (7.8%)

1,216 drugs
showed an average price increase of 31.6%
from Jul '21 to Jul '22

July 2021 -> July 2022

1,216 drugs whose price increases exceeded the inflation rate of 8.5% for that time period. The average price increase for these drugs was **31.6%**.

In 2022, several drugs increased their list prices by more than **$20,000** or by more than 500%. (ASPE)

01

U.S. Patent System
Patent system rewards innovation by barring generics from being created
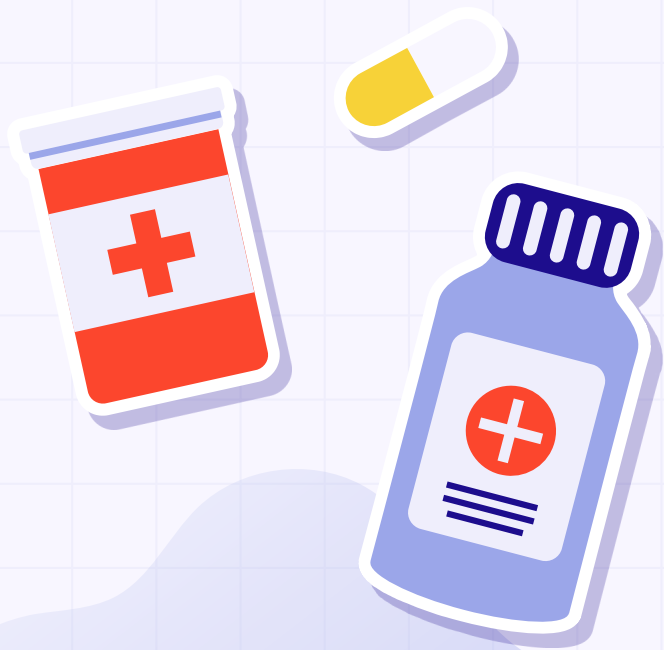
02

Drug Monopolies
Monopolistic power is granted to companies for on-patent products, leading to higher prices (CAP)

03

Patent Expiration
When patents expire, drugmakers often extend them to maintain exclusivity

Current News: Price Manipulation

Evergreening: drugmakers often extend their patents by making small tweaks to the drugs, sustaining their monopolies for several years.

Evergreening is **not illegal**, but a **clear manipulation** of the patent system (NBC).

Pay-for-delay agreements: a brand-name company shares profit with a generic drugmaker to delay release of generic drugs for a set period of time, allowing monopoly to maintain pricing power.

Pay-for-delay is good for companies but bad for consumers, **costing consumers ~$3.5 billion/yr** (FTC).

Current News: Affordability Challenges

Patients are often **forced to skip or delay** filling their needed prescriptions due to high drug prices. Nearly **1 in 2 adults** report difficulty affording their health care expenses, including their prescribed medications (KFF).

About 1 in 3 Americans on Medicare who don't qualify for low-income subsidies don't fill prescriptions for their cancer drugs (HA).

Inflation Reduction Act: enacted by President Biden to lower the costs of prescription drugs through government negotiation on the behalf of the Medicare population beginning in 2026 (NBC).

Current News: Big Pharma

Big Pharma M&A: between 1995 and 2015 **60 firms** consolidated to **10 firms**, decreasing innovation and increasing prices for consumers (WS)

US companies completed **114** M&A in only **3 months** in 2022, leading world in pharma M&A. Second most - China with 28 M&A (PT)

M&A should lower costs as two firm's R&D costs reduce to one lower cost. Instead, drugs sold by acquired companies face price increases at higher rates than non-acquired companies (WS)

Research Question

Because of patents and exclusivity in the drug industry, monopolies tend to form, raising prices for consumers, while driving profits for pharma companies. We want to explore other options for the industry that would give similar results to pharma companies, while bringing prices down for consumers.

Will another rewards system, such as a royalties program, still give pharma companies incentives for innovation while also allowing other companies to enter the market, driving down costs to consumers?
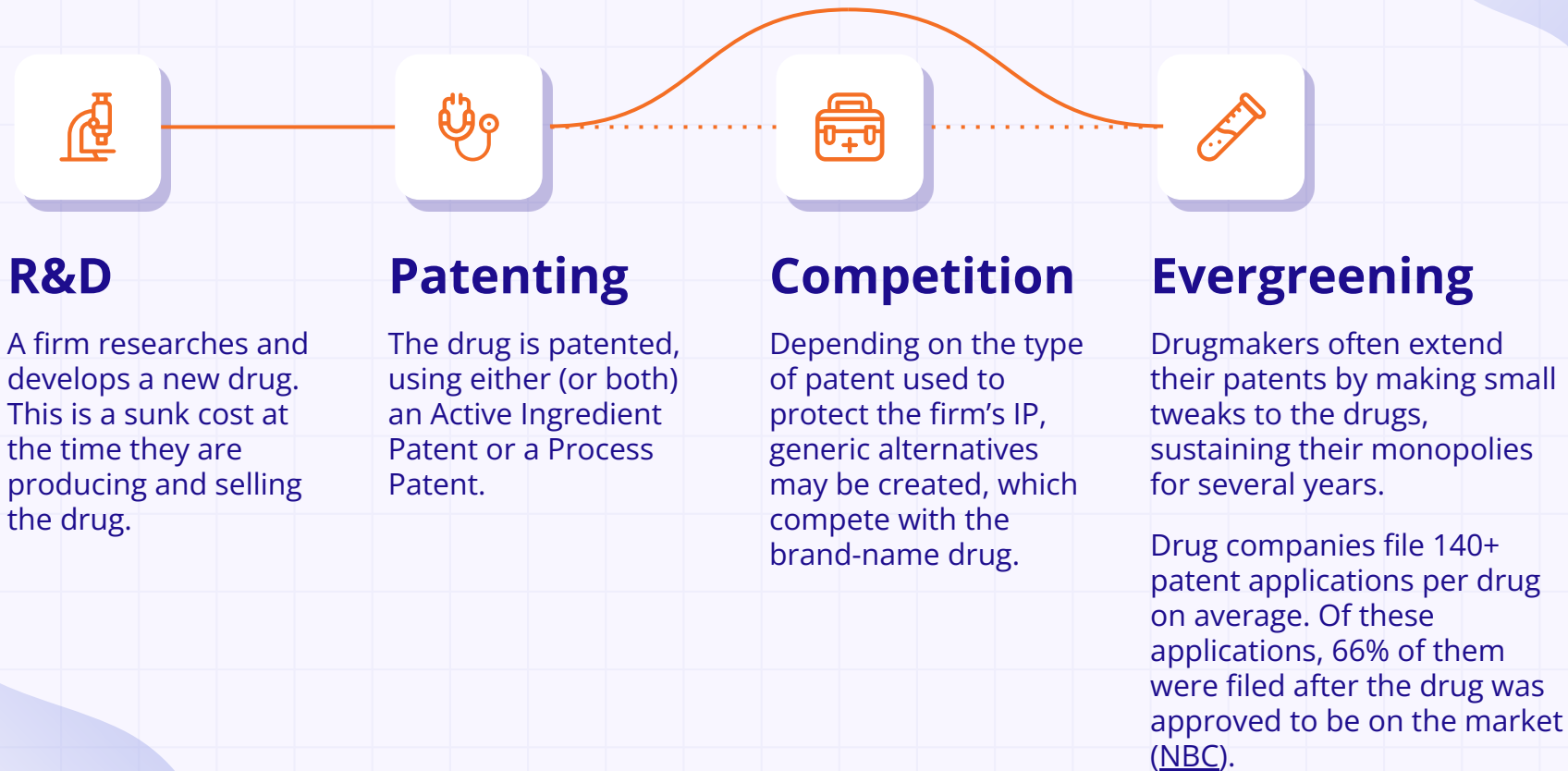
Drug-Development Process

R&D

A firm researches and develops a new drug. This is a sunk cost at the time they are producing and selling the drug.

Patenting

The drug is patented, using either (or both) an Active Ingredient Patent or a Process Patent.

Competition

Depending on the type of patent used to protect the firm's IP, generic alternatives may be created, which compete with the brand-name drug.

Evergreening

Drugmakers often extend their patents by making small tweaks to the drugs, sustaining their monopolies for several years.

Drug companies file 140+ patent applications per drug on average. Of these applications, 66% of them were filed after the drug was approved to be on the market (NBC).

Types of Patents

Active Ingredient Patents

This type of patent protects the **active ingredient** of a new drug. This effectively creates a monopoly, as competitors are not allowed to recreate the drug.

Process Patents

This type of patent protects the **chemical processes** and methods used for creating a drug. This protects the original drug from being replicated, but allows for generics to be created with a different process.

Why Not Use Process Patent Model?

Process Patent - One firm has a brand name drug.
Generics may use the active ingredient to enter the market.

Price Effects — First-mover advantage

Cost Effects — Higher costs to entry by generic drug firms

Type of Model

Stackelberg

 # Firms

N

Exclusivity?

No

03

Our Models

Patent Model and Royalty Model

Active Ingredient (API) Patent Model

Active Ingredient Patent - One firm has a brand name drug.
No other firms are able to enter the market.

Price Effects Price-setting due to monopoly

Cost Effects None

Type of Model

Monopolistic

 # Firms

1

Exclusivity?

Yes

Royalty Model

All firms competing for same drug
One firm receiving royalties from all other firms' profits - company with original FDA approval

Price Effects

Cost Effects

Price competition

Increased cost for franchising firms due to royalties

Type of Model

Bertrand

 # Firms

N

Exclusivity?

No

04

Results

Model Results and Analysis

Demand Assumptions

We will use random utility to model demand for each model:

$$s_i = \frac{exp(a_i - bp_i)}{1 + \sum\limits_{i=1}^{n} exp(a_i - bp_i)}$$

$With\ q_i = s_i M\ \ Assume\ M = 1\ \ so\ \ q_i = s_i$

API Patent Model Assumptions

Patent Extension

Drugmakers continuously extend patents by "evergreening" so exclusivity does not expire.

Barriers to Entry

Other firms are unable to enter the market due to the patent.

Price-Setting

There is only one price for the drug, because there is only one firm.

Differentiation

Each consumer is horizontally differentiated for the preference for the produce.

Price Discrimination

The monopolistic firm cannot price discriminate.

API Model: Patented Firm

$$\pi_1 = s_1(p_1 - c)$$

As MC moves toward 0, this becomes:

$$\pi_1 = s_1 * p_1$$

Takeaway: Simple monopoly model

$$s_i = \frac{exp(a_i - bp_i)}{1 + \sum\limits_{i=1}^{n} exp(a_i - bp_i)}$$

API Model: Patented Firm FOC

$$\frac{d\pi_1}{dp_1} = s_1 + (p_1 - c)(-bs_1)(1 - s_1) = 0$$

Royalty Patent Model Assumptions

Royalties

Firm giving royalties will compete with other firms they give royalties to.

Selective Barriers to Entry

Other firms may enter the market with by signing a royalty contract with the patented firm. In our model, we will have 2 franchising firms.

Price Competition

If there are multiple firms in the market, the firms participate in a price competition.

Types of Firms

The market consists of two types of firms: large and small. Large firms are considered higher quality via brand equity.

Price Discrimination

No firm can price discriminate.

Differentiation

Consumers are differentiated both vertically and horizontally.

Royalty (%) Model : Patented Firm

$$\pi_1 = s_1\big(p_1 - c\big) + t \sum_{i=2}^{n} p_i s_i$$
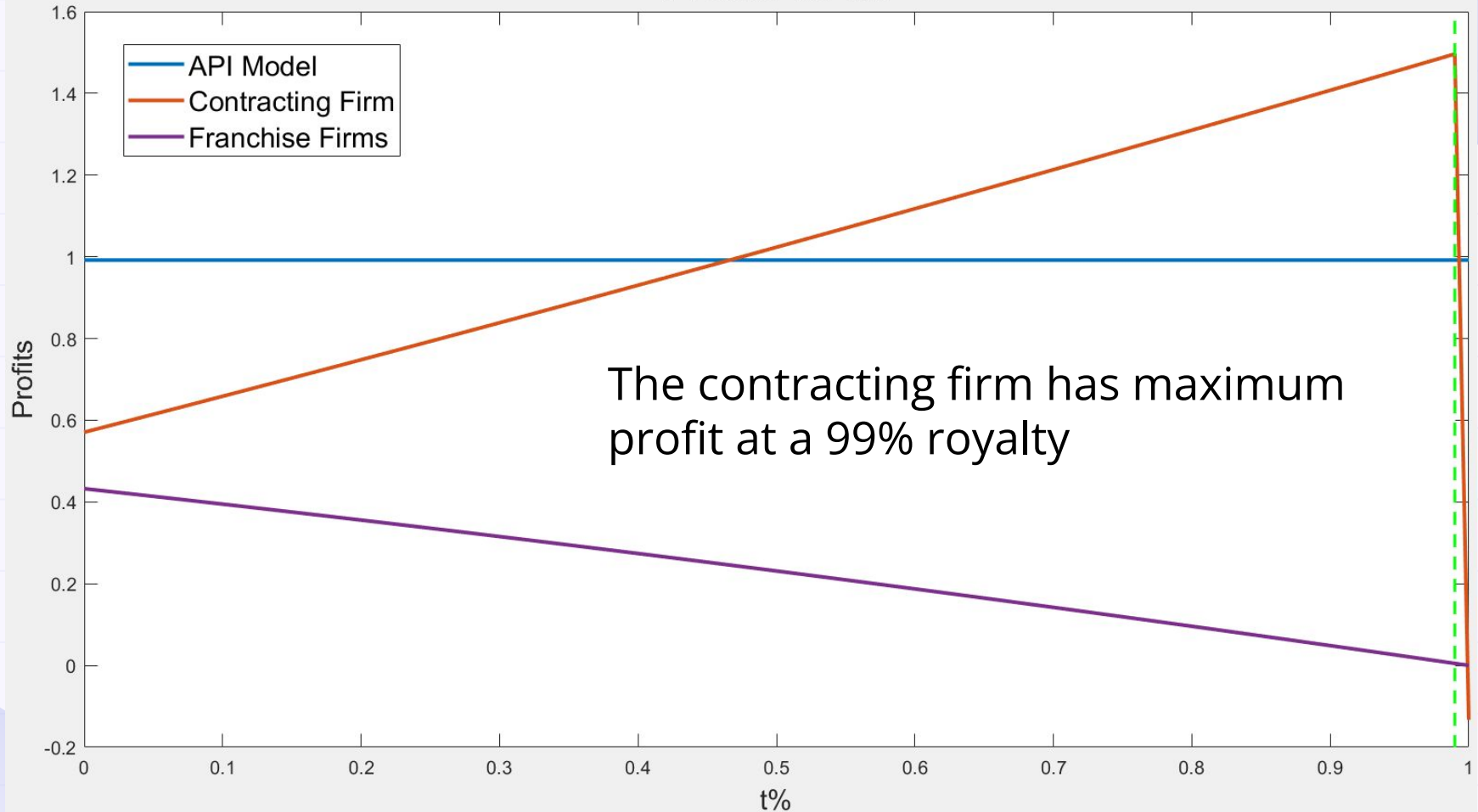
$$s_i = \frac{exp(a_i - bp_i)}{1 + \sum_{i=1}^{n} exp(a_i - bp_i)}$$

Takeaway:
Additional profit
from royalties

Royalty (%) Model: Patented Firm FOC

$$\frac{d\pi_1}{dp_1} = s_1 + \left(p_1 - c\right)(-bs_1)\left(1 - s_1\right) + (tbs_1)\sum_{i=2}^{n} p_i s_i = 0$$

Royalty (%) Model: Franchising Firm

$$\pi_i = s_i((1 - t)p_i - c)$$

$$s_i = \frac{exp(a_i - bp_i)}{1 + \sum\limits_{i=1}^{n} exp(a_i - bp_i)}$$

Takeaway:
Reduction in profit
from royalties paid

Royalty (%) Model: Franchising Firms FOCs
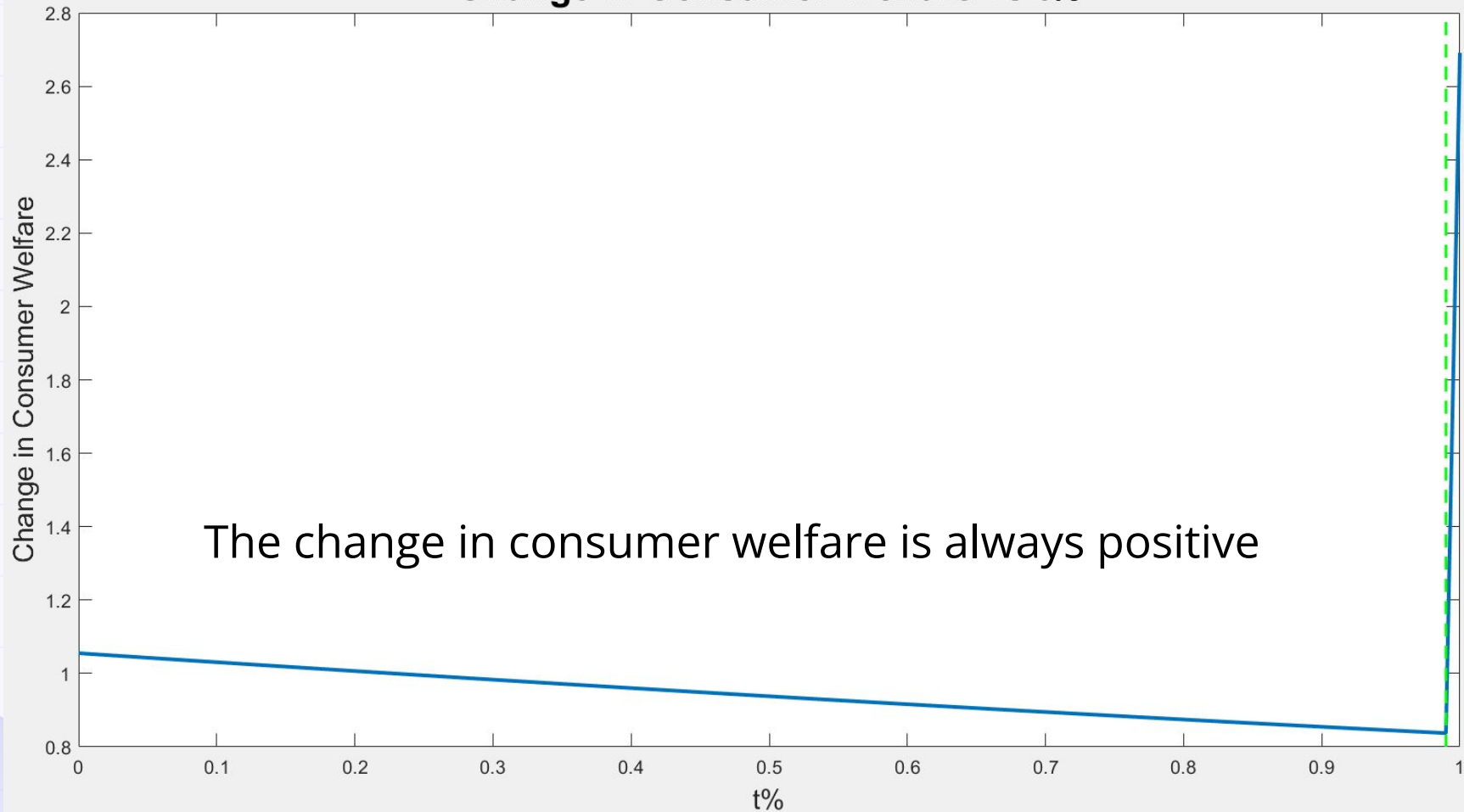
$$\frac{d\pi_i}{dp_i} = (1 - t)s_i + \left((1 - t)p_i - c\right)(- bs_i)\left(1 - s_i\right) = 0$$

The contracting firm has maximum profit at a 99% royalty

The franchising firms' prices are always lower than that of the original patented firm

Change in Consumer Welfare vs t%

The change in consumer welfare is always positive

Prices vs b

Prices

- API Model
- Contracting Firm
- Franchise Firms

b (elasticity)

Profits vs b

Profits

- API Model
- Contracting Firm
- Franchise Firms
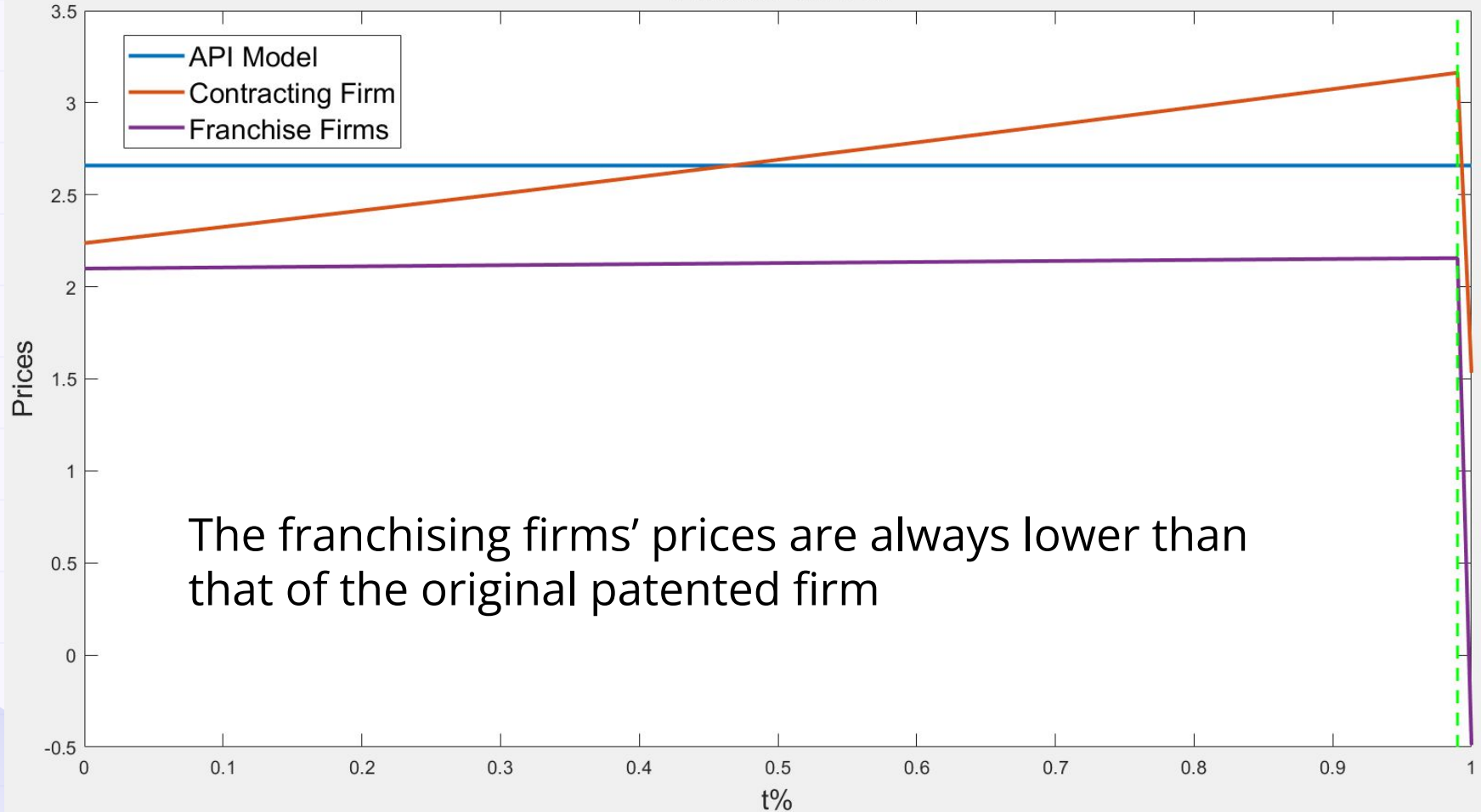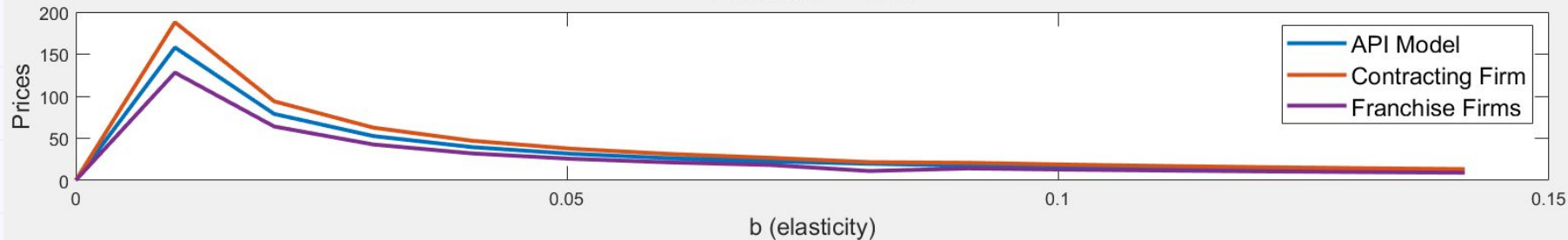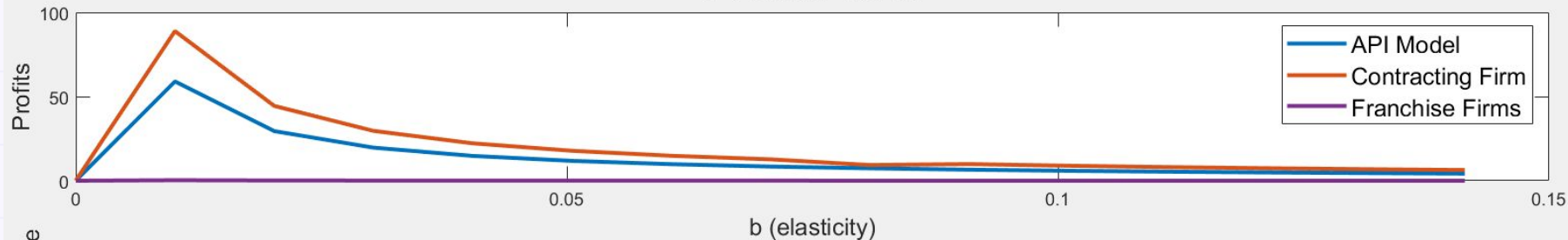
b (elasticity)

Change in Consumer Welfare vs b (elasticity)

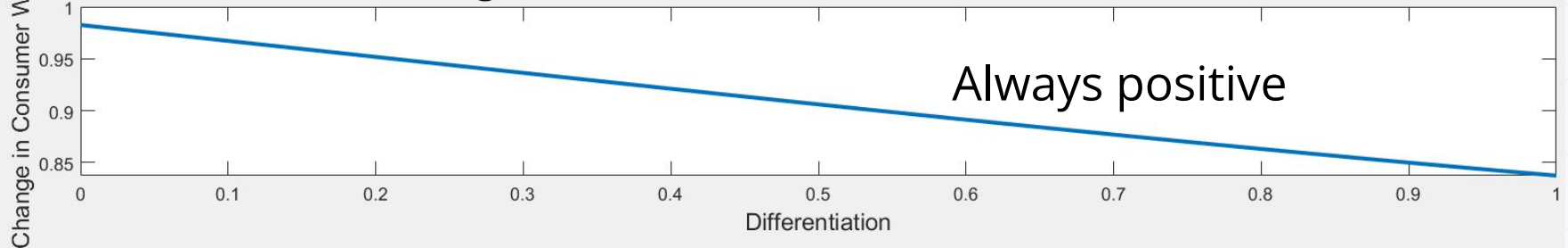Change in Consumer Welfare

Always positive

b (elasticity)

Prices vs Differentiation
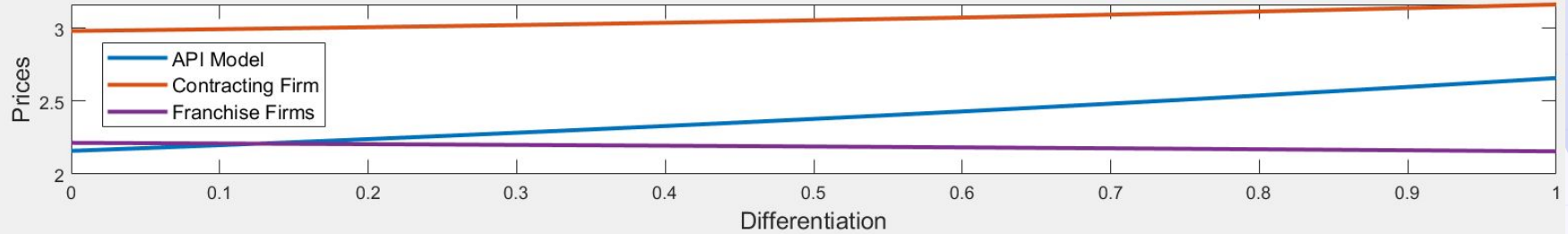
Profits vs Differentiation
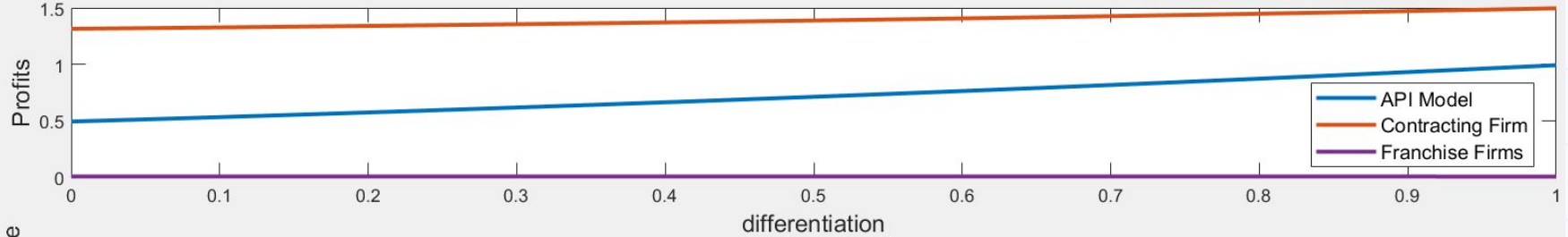
Change in Consumer Welfare vs Differentiation

Always positive

Royalty (Fixed) Model : Patented Firm

$$\pi_1 = s_1\big(p_1 - c\big) + t$$

$$s_i = \frac{exp(a_i - bp_i)}{1 + \sum\limits_{i=1}^{n} exp(a_i - bp_i)}$$

Takeaway: Additional profit from royalties

Royalty (Fixed) Model: Patented Firm FOC

$$\frac{d\pi_1}{dp_1} = s_1 + \left(p_1 - c\right)\left(-bs_1\right)\left(1 - s_1\right) = 0$$

Royalty (Fixed) Model: Franchising Firm
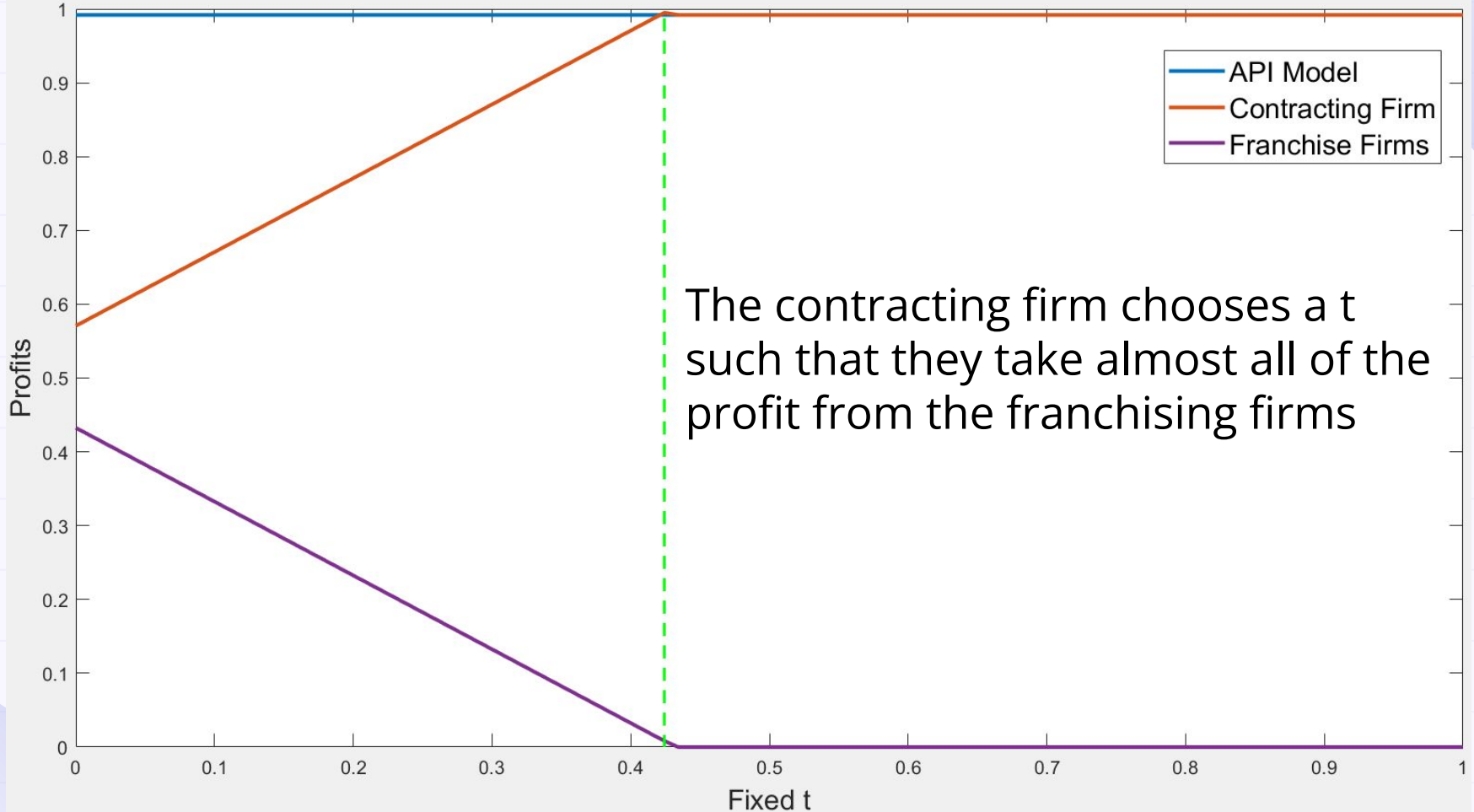
$$\pi_i = s_i\big(p_i - c\big) - t$$

$$s_i = \frac{exp(a_i - bp_i)}{1 + \sum\limits_{i=1}^{n} exp(a_i - bp_i)}$$
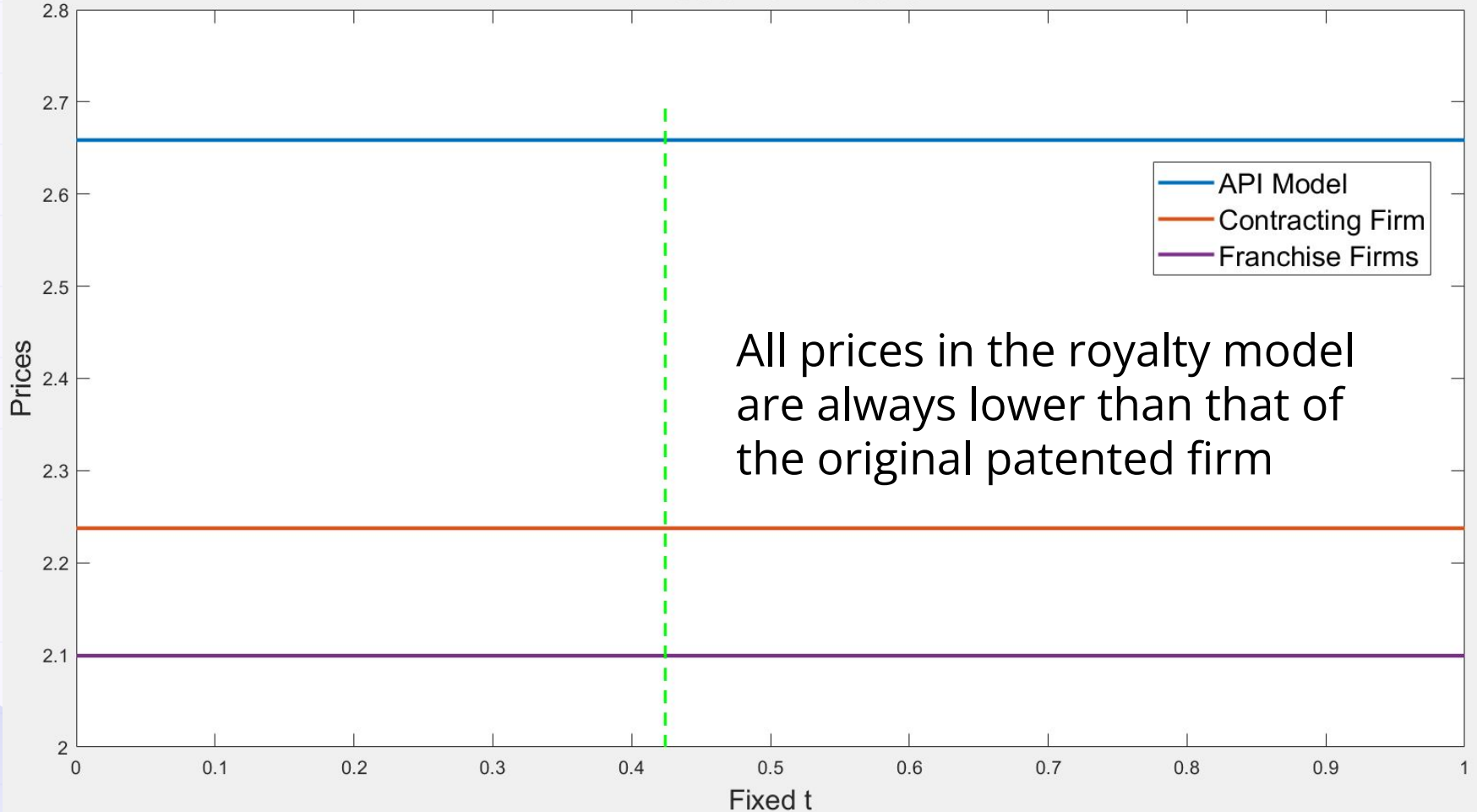
Takeaway:
Reduction in profit
from royalties paid

Royalty (Fixed) Model: Franchising Firms FOCs
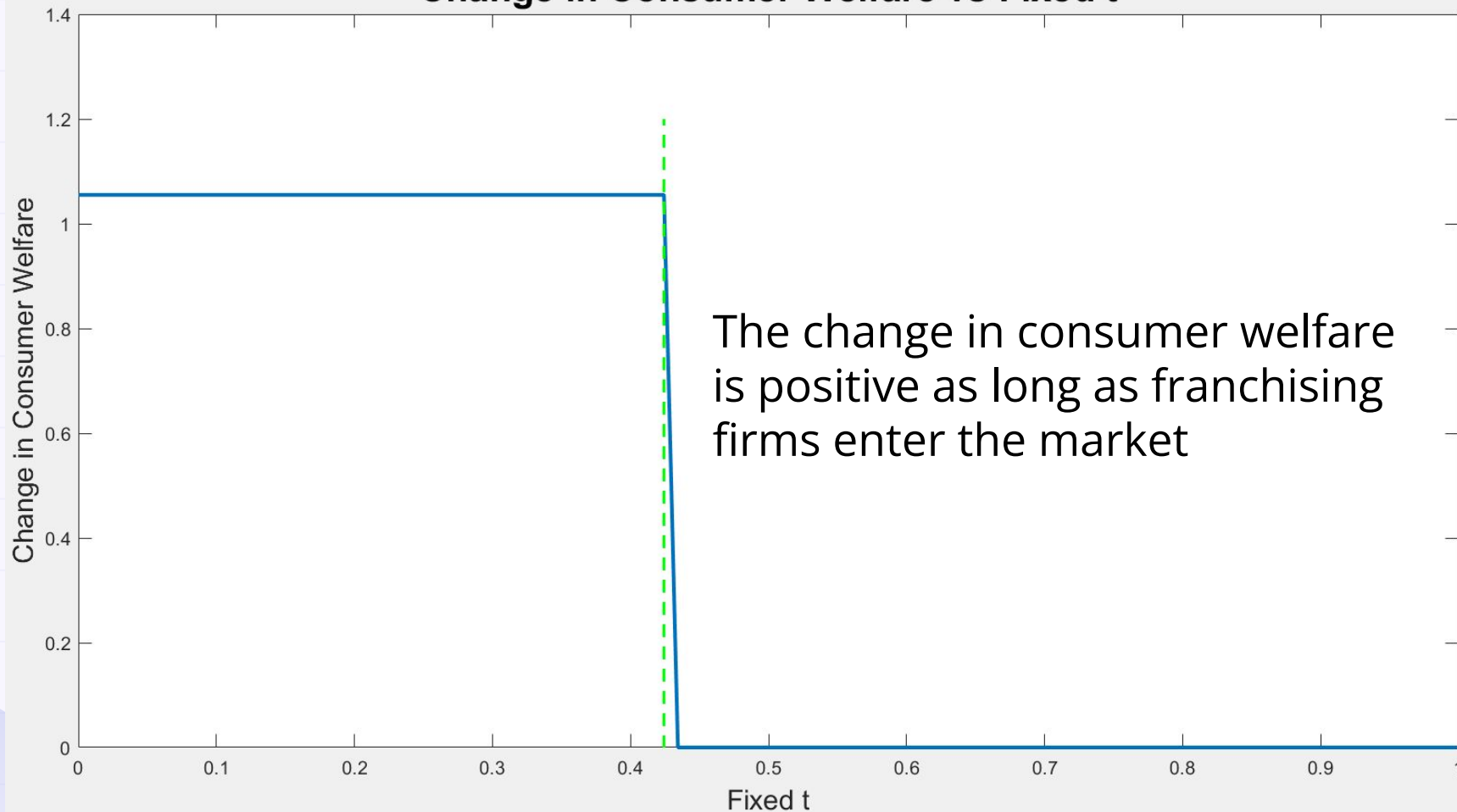
$$\frac{d\pi_i}{dp_i} = s_i + \left(p_i - c\right)\left(-bs_i\right)\left(1 - s_i\right) = 0$$

Profits vs Fixed t

The contracting firm chooses a t such that they take almost all of the profit from the franchising firms

Change in Consumer Welfare vs Fixed t

The change in consumer welfare is positive as long as franchising firms enter the market

Our Team

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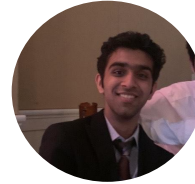
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