Pricing Mechanisms for Multi-Indication Drugs

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I-PRIX
Health Innovation Next Generation
Payment & Pricing Models

Introduction

- **Setting**: Multi-indication drugs treating diverse patient groups
- **Challenge**: Different valuations for essentially the same product
- **Constraint**: Need above-marginal cost pricing for R&D incentives
- **Questions**: Why not price discriminate across indications? More broadly, how should these drugs be priced?

Introduction

How are multi-indication drugs priced today (Mills & Kanavos, 2023; Di Brino et al., 2023)?

- Single price based on the first approved indication (Turkey and, to some extent, the US)
- Average price across all indications—weighted by volume alone (Spain) or by volume and value (Germany, France, Canada, Belgium)
- Indication-based pricing: Different price per indication, achieved through either differential discounting from a single list price (UK, Switzerland) or separate brand names with distinct pricing

Model Setup

- A drug with n indications (potentially known ex ante) is produced by a single, profit-maximizing manufacturer at zero marginal cost
- Indication i is covered by a monopolist health plan if its price, p_i, does not exceed its **expected therapeutic benefit**—or a combination of the expected therapeutic benefits of other indications
- This aligns with applications of standard Health Technology Assessment (HTA) methodology and cost-effectiveness criteria

Model Setup: Pricing and the HTA-Based Coverage Criterion

- Formally, the health plan's coverage criterion is given by

$$p_i \leq \mathcal{P}\Big(\mathbb{E}[g_1(x_1)|x_1 \leq \hat{x}_1], ..., \mathbb{E}[g_i(x_i)|x_i \leq \hat{x}_i], ..., \mathbb{E}[g_n(x_n)|x_n \leq \hat{x}_n]\Big),$$

  where

  - $\mathcal{P}$ is a non-decreasing function of $\mathbb{E}[g_i(x_i)|x_i \leq \hat{x}_i]\ \forall\ i$
  - $g_i(x_i)$ gives the therapeutic benefit patients derive from indication i, with $g_i'(x_i) < 0$
  - $x_i \in [0, 1]$ denotes patients' therapeutic mismatch with the drug, with density $f_i(x_i)$ and distribution $F_i(x_i)$
  - Without loss of generality, $g_i(x_i) = v_i - \tau x_i$, where $0 < v_i < \tau_i$, and τ_i is the degree of patients' heterogeneity
  - $\hat{x}_i$ is threshold of therapeutic mismatch below which patients are included in clinical trials when developing the drug and estimating its therapeutic benefit

Model Setup: The Manufacturer's Strategic Variable

- The manufacturer chooses $\hat{x}_i$ to determine the breadth of the indication's label in terms of clinically eligible patients
  - Clinical trial inclusion/exclusion criteria are often poorly justified (Schmidt et al., 2014; Cherubini et al., 2011)
- Expected benefit $\mathbb{E}(v_i - \tau_i x_i | x_i \leq \hat{x}_i)$ decreases as $\hat{x}_i$ increases
  - Broader age/comorbidity criteria reduce average benefits (Nordon et al., 2023)
- Manufacturers can strategically influence expected benefit—and hence price—through patient selection
  - Trials typically enroll low-risk patients (Jin et al., 2017), especially when industry-sponsored (Van Spall et al., 2007; Duma et al., 2019)
  - Industry-sponsored trials report favorable results more frequently (Lundh et al., 2017)

A Note on the Manufacturer's Problem

- The health plan purchases and offers the drug to all clinically eligible patients
- The coverage criterion creates a "modified demand curve" where the relationship between (realized) demand, $F(\hat{x}_i)$, and price, p_i, is mediated through expected therapeutic benefit rather than consumer willingness-to-pay
- This generates the key trade-off: expanding the eligible population (higher $\hat{x}_i$, more patients $F(\hat{x}_i)$) reduces the price through lower expected therapeutic benefit
- The monopolist still optimizes by selecting a price-quantity pair!

Indication-Based Pricing

- When allowed to charge different prices for each indication, the manufacturer solves:

$$\max_{\hat{x}_1,\ldots,\hat{x}_n} \Pi = \sum_{i=1}^{n} p_i F_i(\hat{x}_i)$$

$$\text{s.t. } p_i = \mathbb{E}(v_i - \tau_i x_i | x_i \leq \hat{x}_i)$$

- This can be rewritten as:

$$\max_{\hat{x}_1,\ldots,\hat{x}_n} \Pi = \sum_{i=1}^{n} \mathbb{E}(v_i - \tau_i x_i | x_i \leq \hat{x}_i) F_i(\hat{x}_i)$$

$$= \sum_{i=1}^{n} \int_0^{\hat{x}_i} (v_i - \tau_i x_i) f_i(x_i) dx_i$$

- The objective function equals total therapeutic benefit across all indications
- The manufacturer maximizes and extracts the total therapeutic benefit through indication-specific prices

Weighted Average Uniform Pricing

- When a single price applies to all indications, constrained not to exceed the population-weighted average of expected therapeutic benefits, the manufacturer solves:

$$\max_{\hat{x}_1,\ldots,\hat{x}_n} \Pi = \sum_{i=1}^{n} pF_i(\hat{x}_i)$$

$$\text{s.t.} \quad p = \sum_{i=1}^{n} \omega_i \, \mathbb{E}(v_i - \tau_i x_i | x_i \leq \hat{x}_i), \quad \omega_i = \frac{F_i(\hat{x}_i)}{\sum_{j=1}^{n} F_j(\hat{x}_j)}$$

- This can be rewritten as:

$$\max_{\hat{x}_1,\ldots,\hat{x}_n} \Pi = \sum_{i=1}^{n} \omega_i \, \mathbb{E}(v_i - \tau_i x_i | x_i \leq \hat{x}_i) \cdot \sum_{i=1}^{n} F_i(\hat{x}_i) = \sum_{i=1}^{n} \int_0^{\hat{x}_i} (v_i - \tau_i x_i) f_i(x_i) dx_i$$

- The objective function equals total therapeutic benefit across all indications
- The manufacturer maximizes and extracts the total therapeutic benefit through a single price

Two-Part Tariffs

- In addition to unit prices p_i for each indication, the health plan makes a lump-sum payment T. The manufacturer solves:

$$\max_{\hat{x}_1,\ldots,\hat{x}_n} \Pi = \sum_{i=1}^{n} p_i F_i(\hat{x}_i) + T$$

$$\text{s.t. } p_i \leq \bar{p}_i \quad \forall i, \qquad T = \sum_{i=1}^{n} \int_0^{\hat{x}_i} (v_i - \tau_i x_i) f_i(x_i) dx_i - \sum_{i=1}^{n} p_i F_i(\hat{x}_i)$$

- The manufacturer sets the fixed fee to extract the health plan's entire surplus, defined as the total therapeutic benefit minus expenditures on unit prices
- Substituting into the objective function, the problem reduces to maximizing total therapeutic benefit across all indications
- The manufacturer maximizes and extracts the total therapeutic benefit through two-part pricing, regardless of specific unit prices

Inefficient Mechanisms

- **Unweighted Average Uniform Pricing**:
  - High-benefit indications with few patients have their populations inefficiently restricted, pushing the price upwards
  - Low-benefit indications with many patients are made available to inefficiently large populations to increase revenues
- **"Anchor" Pricing**: When a uniform price is anchored to a single indication's expected therapeutic benefit (e.g., maximum or minimum), the manufacturer inefficiently restricts the price-setting indication's eligible population while opting for full coverage in all other indications

Pricing Constraints With a Myopic Manufacturer

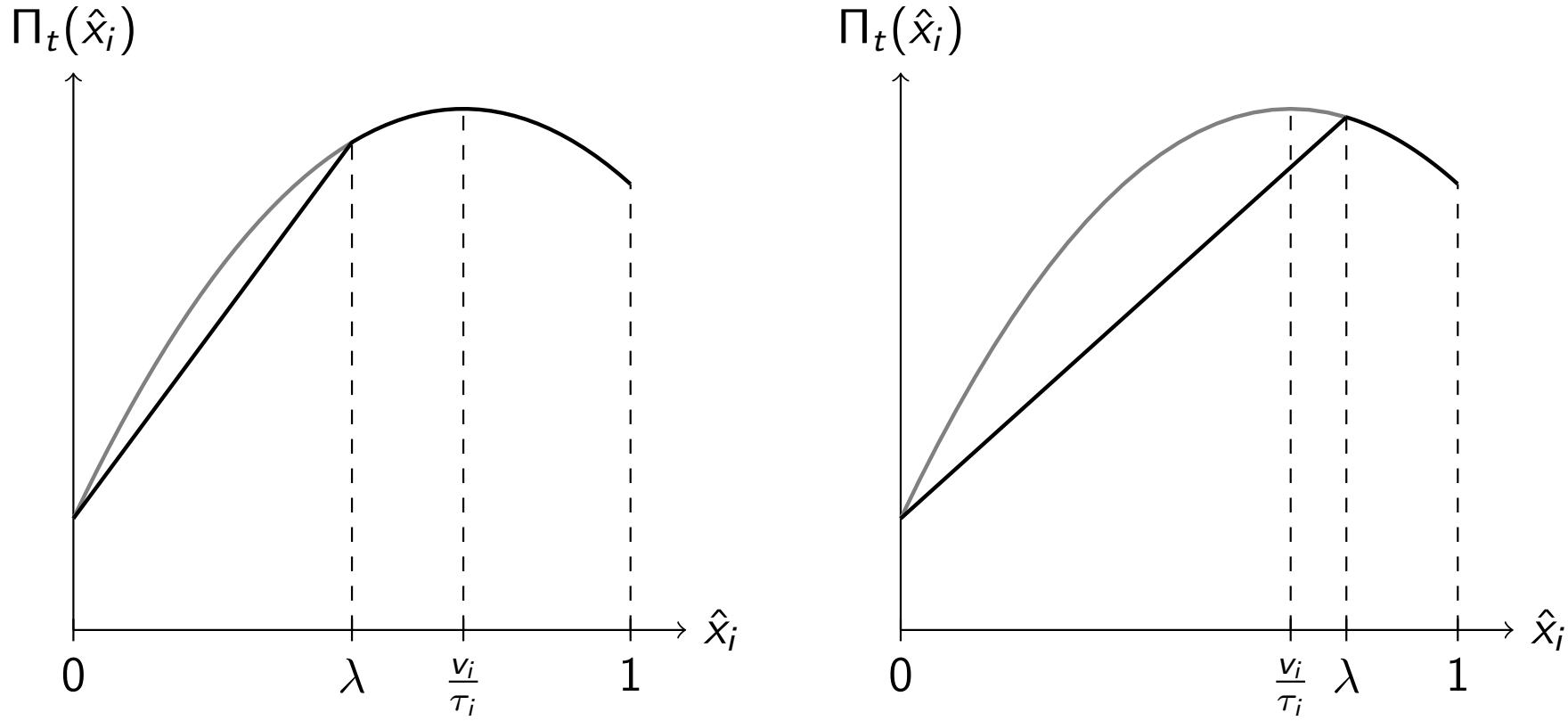

Figure: Illustrative examples of manufacturer's profits in period t. The price cap is binding for $\hat{x}_i < \lambda$, and v_i/τ_i is the efficient outcome. The solid gray line shows the "unconstrained" profit function were the price cap absent.

Pricing Constraints With a Forward-Looking Manufacturer

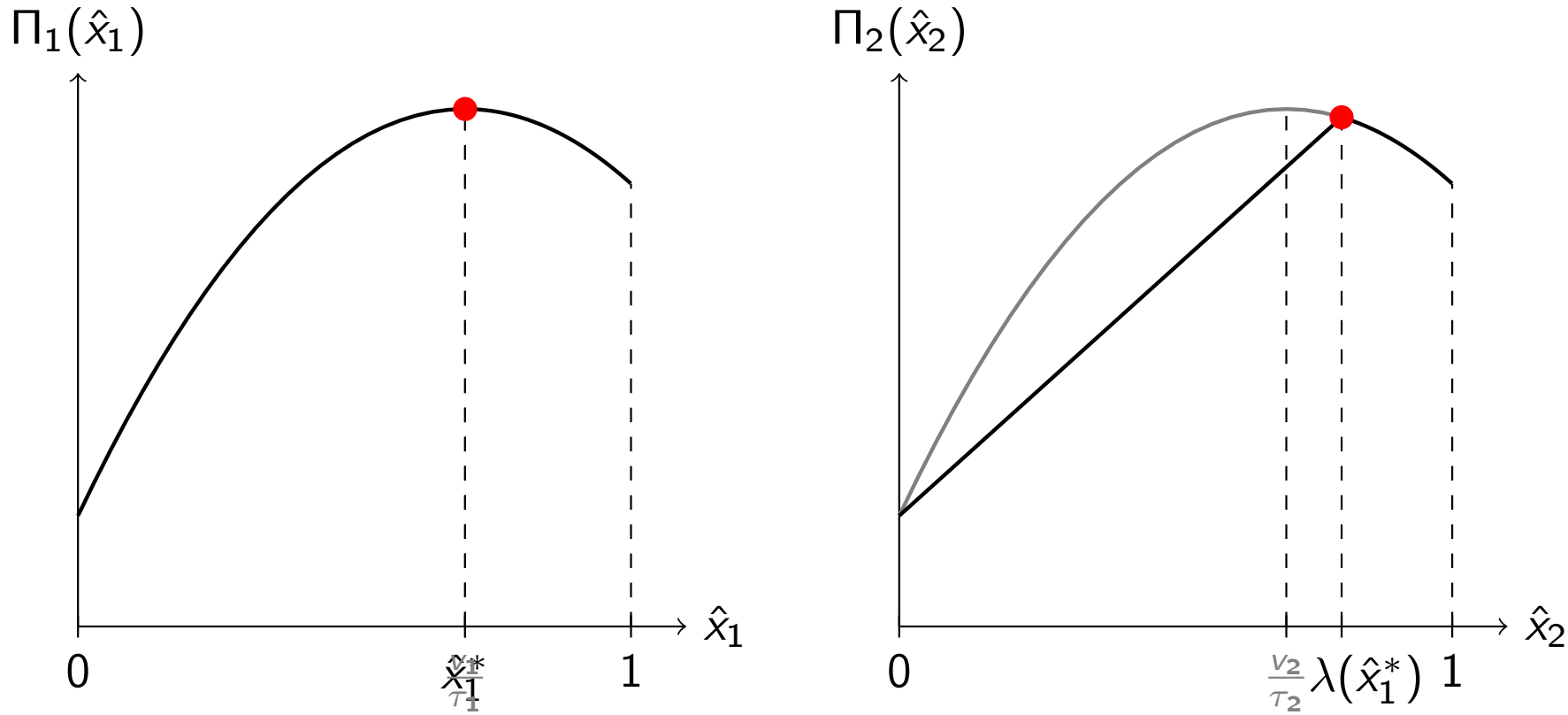

Figure: Manufacturer's *instantaneous* profits with two sequentially introduced indications. In $t = 2$, the price cap is binding for $\hat{x}_2 < \lambda(\hat{x}_1^*)$, where $\lambda(\hat{x}_1^*)$ is an increasing function of the manufacturer's choice of $\hat{x}_1$.

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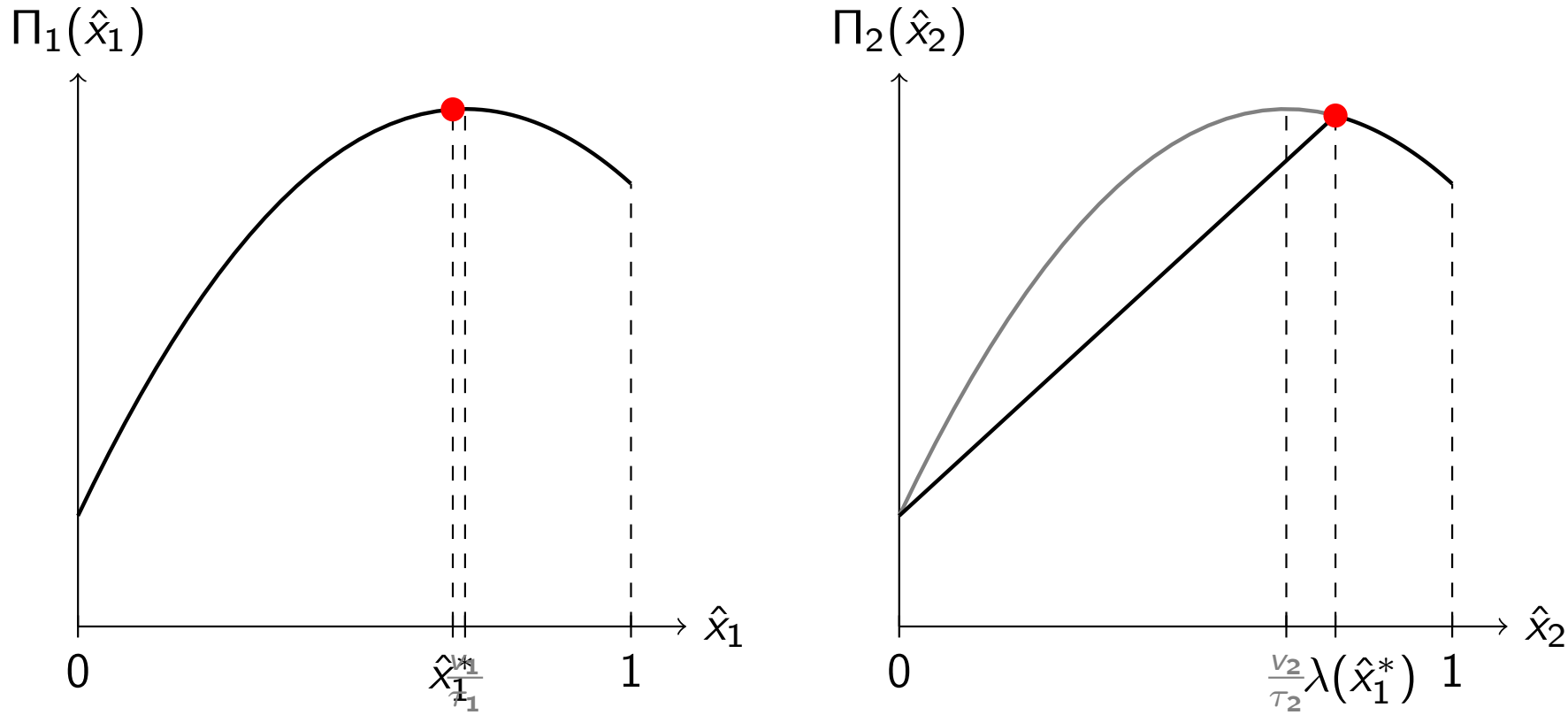

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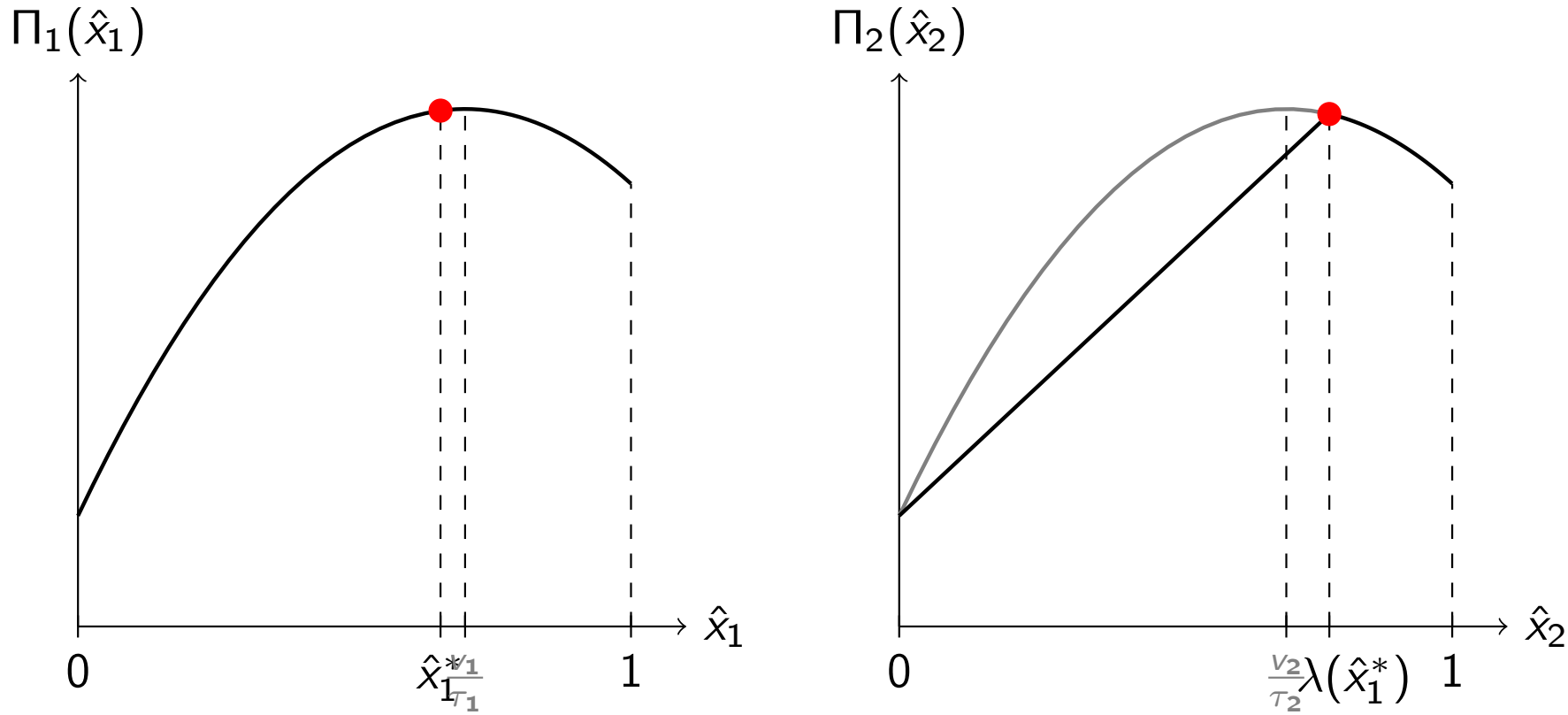

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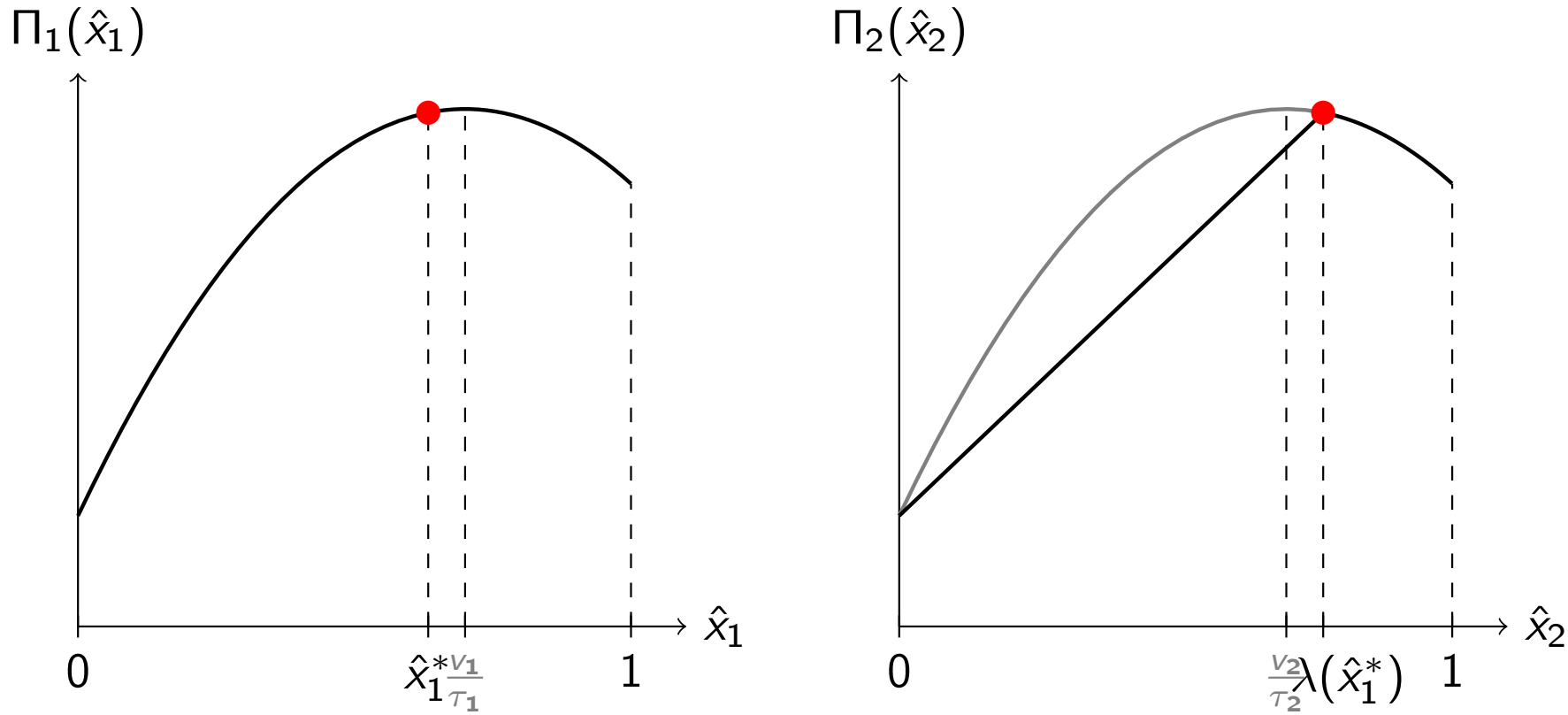

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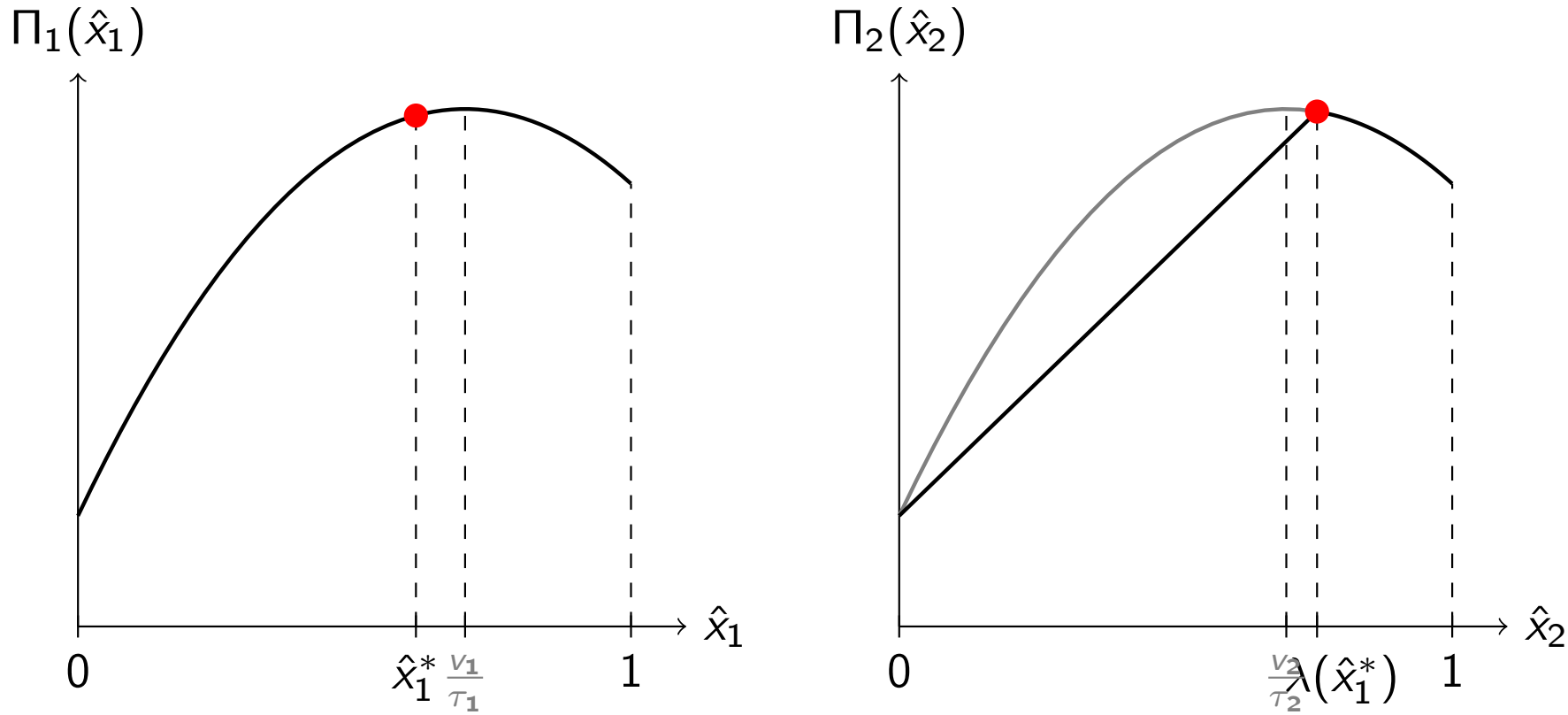

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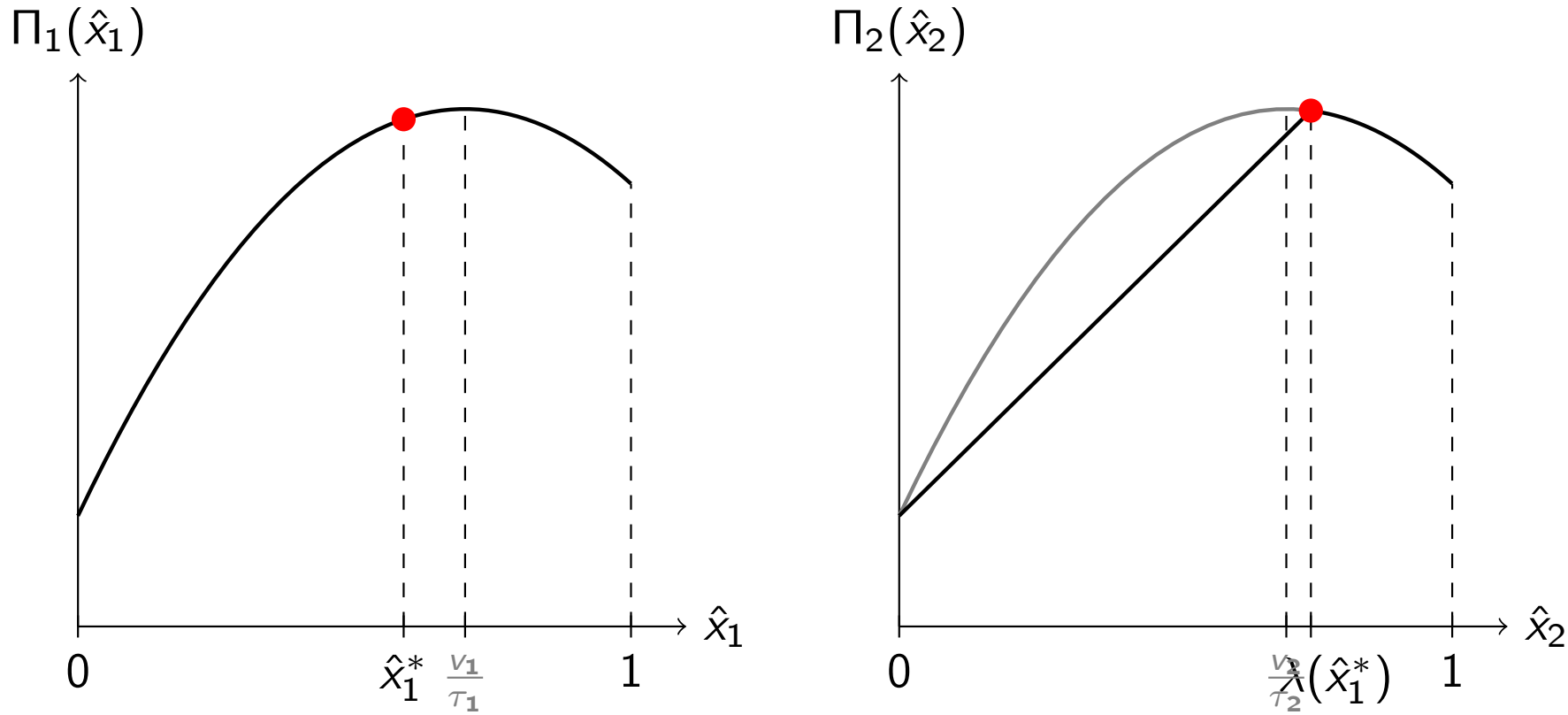

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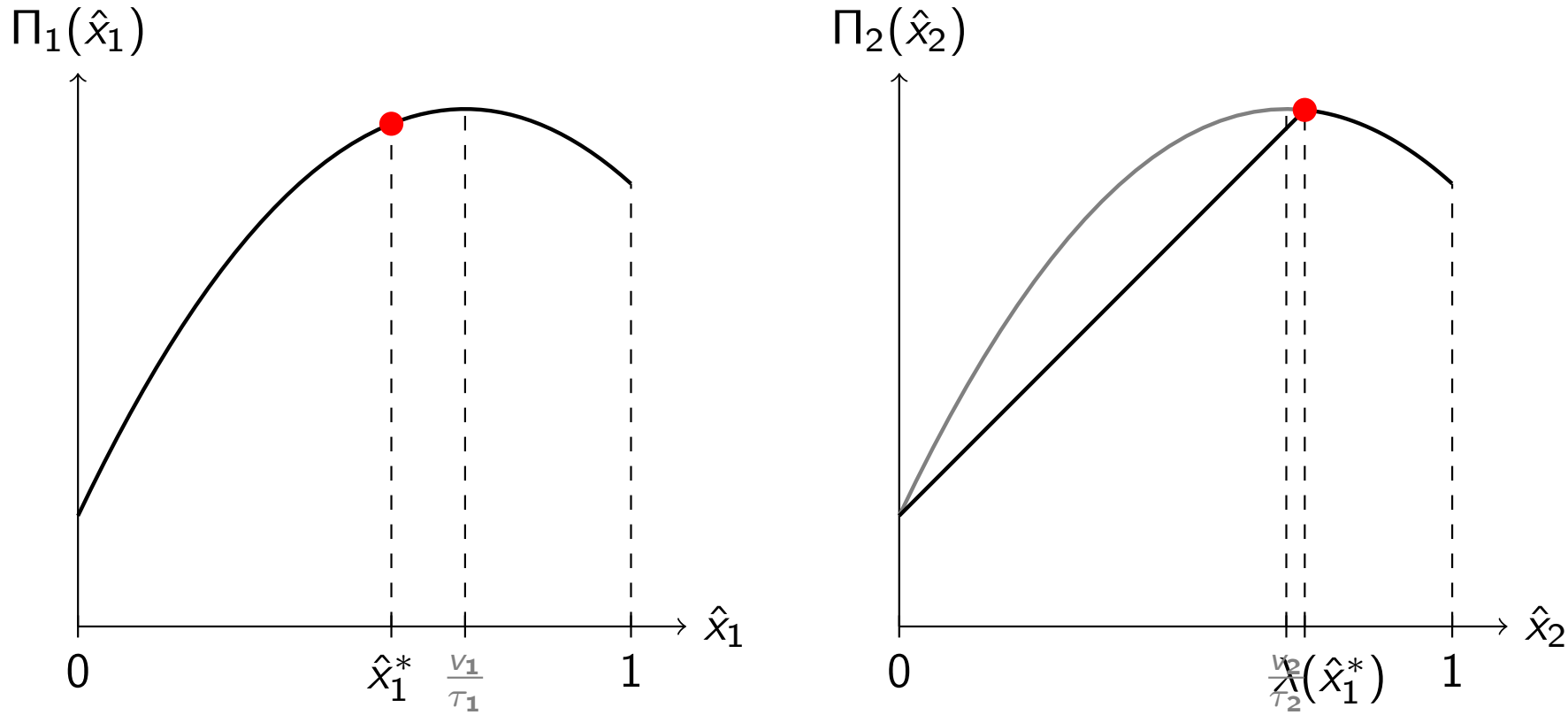

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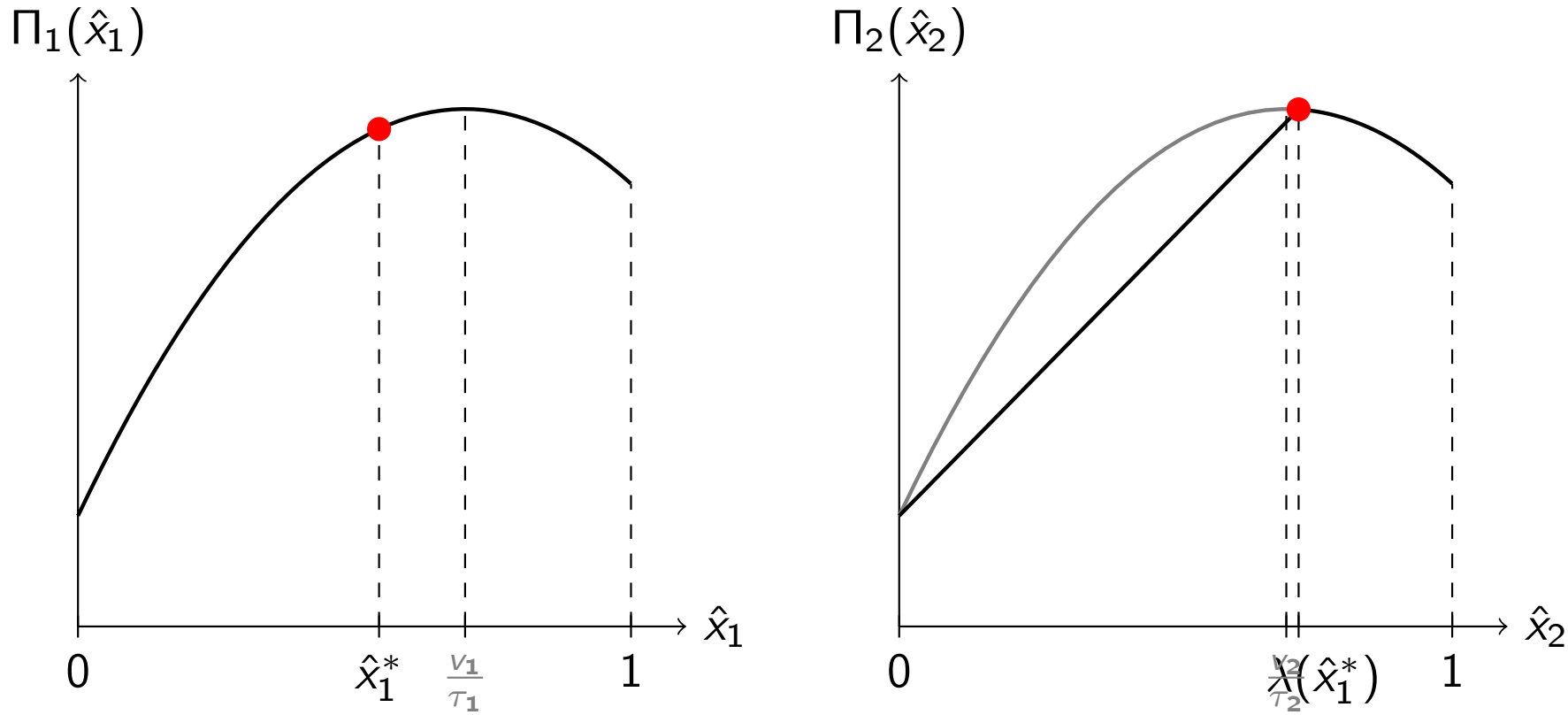

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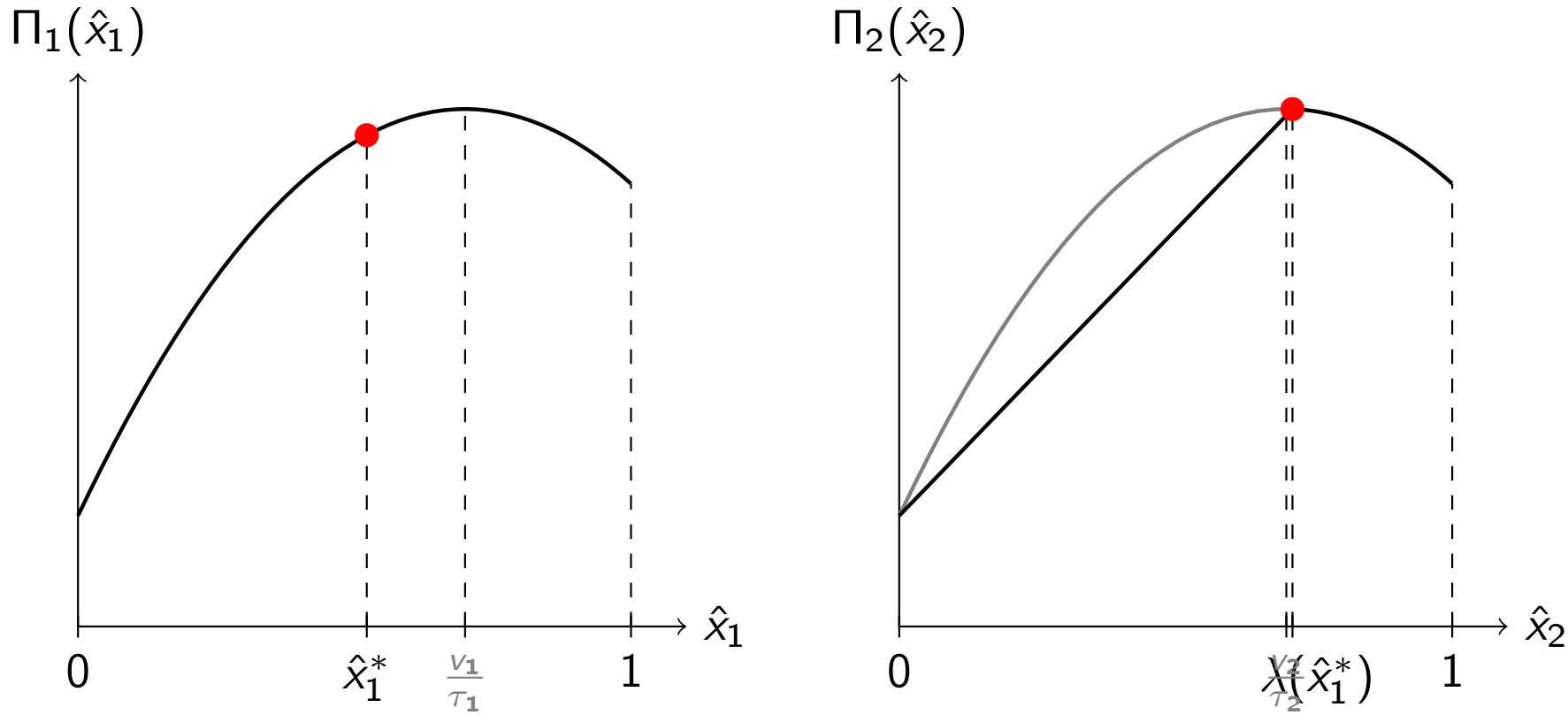

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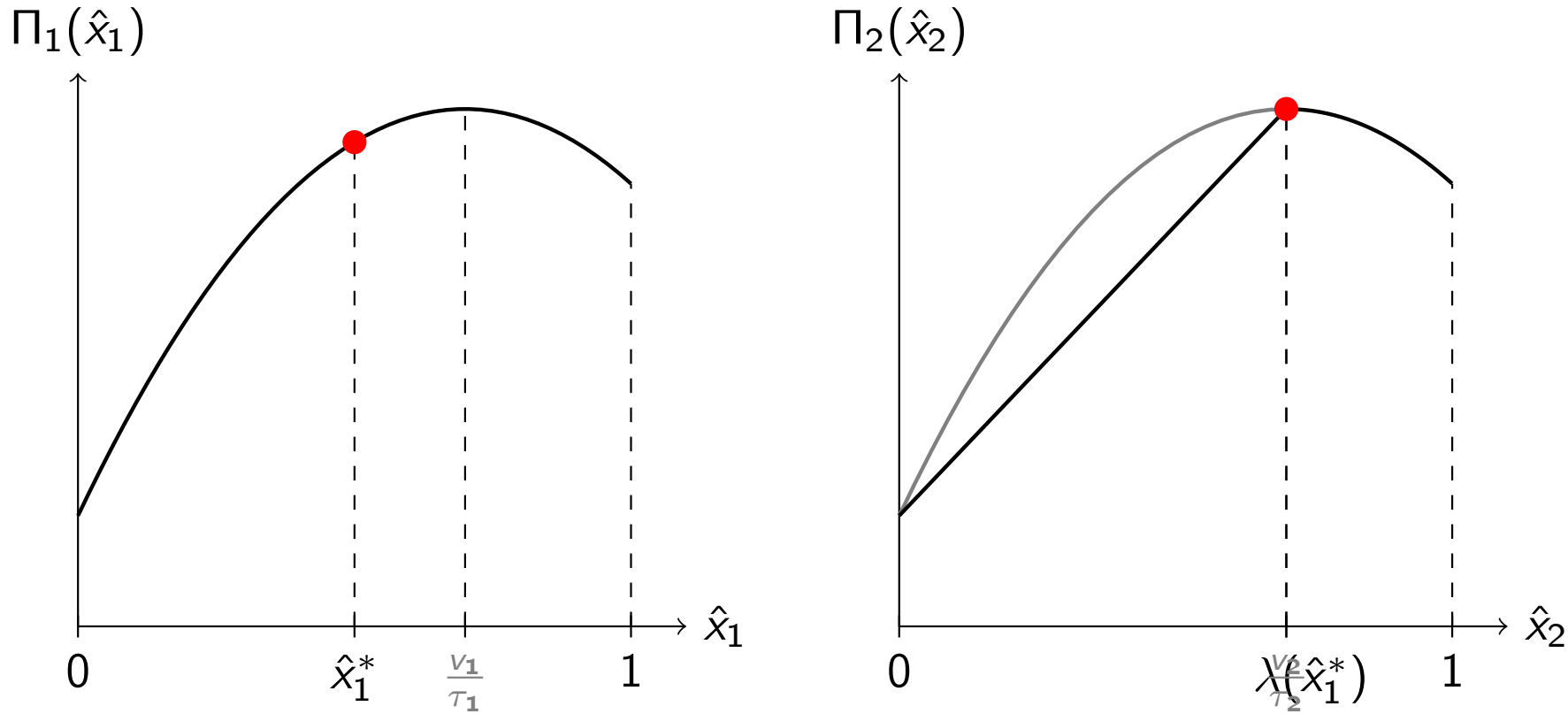

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- First indications often generate a higher clinical benefit and target a narrower population (Michaeli et al., 2022)

Key Takeaways

- **Three pricing mechanisms achieve efficient allocation** by maximizing therapeutic benefit and ensuring only patients with non-negative therapeutic benefit receive treatment:
  - Indication-based pricing
  - Uniform pricing with weighted average expected therapeutic benefit criteria
  - Two-part tariffs
- **Dynamic efficiency is maintained** when indications are introduced sequentially, **provided prices can adjust both upward and downward** over time
- **Policy flexibility exists**: While all three mechanisms deliver identical efficient outcomes, they differ conceptually and in practical feasibility

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