International price regulations and endogenous product quality

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Introduction

- Widespread concern throughout the world regarding the market power of firms selling patented pharmaceuticals and their high prices. This concern has motivated a variety of price regulations.
  - Two commonly used regulations: **external reference pricing (ERP)** and **price controls (PCs)**.
- PCs are fairly straightforward but how does ERP work?
  - If a country adopts an ERP policy with respect to a product, the price it permits the seller to charge in its market is based on prices charged by the seller in a set of foreign countries (called its "reference basket").
  - Unlike a PC, ERP only relevant when a firm sells in multiple countries.
  - 24 of 30 OECD countries and approximately 20 of 27 EU countries use ERP.
  - Some compare lowest price in reference basket; others use average or median.

Trade-off studied in the paper

- While price regulations may ease consumer access to existing products, they can simultaneously reduce incentives for innovation and product improvement (i.e., lead to fewer or lower quality products). Short run benefit versus long-run cost.
- To capture this trade-off, we analyze ERP and PCs in a two-country (home and foreign) setting where a single home firm (potentially) sells in both markets and its R&D investment determines the quality of its product.
- Governments set policies taking into account (a) the firm's pricing behavior and (b) its R&D incentive.

Major questions addressed

- How do PCs and ERP affect pricing and product quality?
- What is a country's optimal PC in the absence of trade? And how does trade alter it?
- What type of *international* product market spillovers do *national* price regulations generate?
- Wich price regulation is preferable from a national welfare perspective: ERP or PC?
- *Strategic policy interdependence*: How does the use of price regulations by home affect the effectiveness of related policies in foreign?
- Does international policy interaction affect the choice between ERP and PC?
- What is the nature of jointly optimal price regulations? Any reasons to prefer one instrument over the other?

Exhaustion policies/PIs, reference pricing, & R&D

- Literature focuses mainly on *internal* reference pricing (RP).
  - Brekke et. al. (2007): compare generic and therapeutic RP; latter policy generates stronger competition.
  - Brekke et. al. (2011): whether RP based on market prices or exogenous benchmark matters since behavior of generic producers differs.
- Geng and Saggi (2017 & 2020): endogenize ERP; 2020 paper accommodates generic competition; but both abstract from innovation.
- Li and Maskus (2006): investigate the linkage between PIs and innovation in a vertical-pricing model in which a manufacturer competes with PIs from a distributor. PIs reduce the manufacturer's incentive to invest in cost-reducing R&D.
- Grossman and Lai (2008): study interaction between PCs and exhaustion policies. Innovation can be faster if North chooses IE since South picks a more lax PC when PIs are allowed by North.

How price regulations affect R&D

- Large R&D literature: a variety of approaches used but a common finding is that price regulations reduce R&D incentives. Also the position of the industry (*PhRMA*) and some think-tanks/institutes/politicians in the US.
- Berndt (2002): reduced freedom to set prices in the US would have a substantial negative impact on drug R&D, reducing the future supply of new products and price competition among them.
- Scherer (2001): high short-run correlation between trend-adjusted R&D expenditures and profit margins for US pharma firms 1962-96.
- Abbott & Vernon (2007): a micro-simulation and Monte Carlo techniques to estimate how PCs affect product development: cutting prices by 40-50% in the US will lead to 30-60% fewer R&D projects.

Price regulations & R&D (contd.)

- Giacotto et. al. (2005): US data from 1980-2001; a 10% increase in growth of real drug prices associated with a 6% increase in growth of R&D intensity. R&D spending would have been 30% lower if the government had allowed drug prices to (only) increase at the rate of CPI.
- Brekke et. al. (2007): internal RP effective in reducing prices but it also reduces innovation incentive.
- Bardey et al. (2009 & 2010): firms invest in R&D prior to negotiating prices. Again, RP hurts R&D incentive.
- Filson (2012): builds a computable dynamic equilibrium model of the pharmaceutical industry to quantify the effects of the US adopting PCs that resemble the ROW. PCs benefit consumers but R&D declines and flow of new drugs falls by almost 40%.

International spillovers of price regulations and launch delay

- Goldberg (2010): overview of international price spillovers caused by price regulations and their implications for drug launches in world markets – pharma companies take price spillovers into account when making entry and product launch decisions.
- Kyle (2007): studies drug launches in 21 countries and highlights international spillovers using data on 1444 drugs produced by 278 firms from 1980-1999:
  - Firms from countries with price regulations reach fewer markets than those without.
  - Companies avoid price-controlled markets, and are less likely to introduce products in additional markets after entering a price-controlled market. Also less likely to follow product launch in a high-price country with launch in a low-price country.
- Similar findings reported by others, notably Cockburn et. al. (2016): countries with strong PCs experience longer launch lags for new drugs.

Outline of talk

- A two-country model of price controls with endogenous product quality.
- Optimal price control under autarky.
- How trade (exporting) alters optimal PC.
- Optimal ERP policy.
- ERP vs PC.
- International strategic policy interaction.
- Globally optimal policies.
- Conclusion.

Underlying economic environment

- Two countries: Home (H) and Foreign (F).
- A home firm develops a product (x) of quality q where q is determined by costly R&D $c(q) = q^2/2$. Product protected by a patent that confers monopoly status on the firm.
- Number of consumers (market size): n_i in country $i = H, F$, where $n_H = n \geq 1 = n_F$.
- Each consumer buys (at most) one unit of the product.
- Utility function of a typical consumer in country i: $u_i = t_i q - p_i$.
  - t_i - an individual consumer's taste for quality in country i, uniformly distributed over $[0, v_i]$ with $v_H = v \geq 1 = v_F$.
  - Composite measure of market size $\mu_i = v_i n_i \geq 1$.
- Differences in demand across countries generate a rationale for international price discrimination.

Pricing given quality

- If firm can set prices freely in both markets, it chooses market specific prices to maximize profits in each market separately:

$$\max_{p_H} \pi_H(p_H, q) \equiv \frac{n}{v} p_H(v - p_H/q); \ \max_{p_F} \pi_F(p_F, q) = p_F(1 - p_F/q)$$

- Optimal monopoly prices $p_H^m = vq/2$ and $p_F^m = q/2$ with associated profits $\pi_H^m = \mu q/4$ and $\pi_F^m = q/4$.
- Observe $p_H^m/p_F^m = v$ – an upper-bound on the degree of price discrimination.
- Let $\pi(p_H, q) = \pi_H(p_H, q) + \pi_F(p_H, q)$.

Price control

- Let $0 \leq \theta \leq 1$ be the home PC so that $p_H(\theta) = \theta p_H^m$. When $\theta = 1$ firm charges p_H^m whereas if $\theta = 0$ it sets price equal to marginal cost (normalized to zero).
- As in Filson (2012), the PC θ is the markup the government permits (fraction of optimal markup/price p_H^m). Formulation implies price under the PC (i.e., $p_H(\theta) = \theta p_H^m = \theta vq/2$) increases in quality q and consumer willingness to pay v.
- Price/quality ratio $p_H(\theta)/q = \theta v/2$ increasing in θ and v.
- Firm's home profit under PC θ equals

$$\pi_H(q;\theta) = \theta(2-\theta)\pi_H^m = \theta(2-\theta)\mu q/4$$

where $\pi_H(q;\theta) \geq \pi_H^m(q)$ with equality at $\theta = 1$.

How PC affects quality under autarky

- Given θ, firm solves the following problem at the R&D stage:

$$\max_q \; V_H(q;\theta) = \pi_H(q;\theta) - c(q) \tag{1}$$

with the associated FOC

$$\frac{dV}{dq} = 0 \Leftrightarrow \frac{d\pi_H(q;\theta)}{dq} = c'(q) \tag{2}$$

- Straightforward to show that the solution is

$$q^A(\theta) = \theta(2-\theta)\mu/4 \tag{3}$$

- **Lemma 1**: *The firm's optimal quality under autarky $q^A(\theta)$ is increasing in the level of the home PC θ and in the size of the home market μ.*

Effect of price control on consumers

- **Lemma 2**: *Home's autarkic consumer surplus is inverse U shaped in its PC θ: it increases in θ at $\theta = 0$; decreases in it at $\theta = 1$; and is maximized at $\theta = 1/2$.*
- **Negative direct effect on price**: holding quality constant, a more lax price control (i.e., a higher θ) implies a higher price.
- **Positive indirect effect on quality**: a higher θ also implies superior product quality.
- Quality effect dominates when PC is tight (i.e., $\theta \approx 0$) whereas price effect dominates when it is lax (i.e., $\theta \approx 1$).

Home government's problem

- Home government solves

$$\max_{\theta} W_H(q(\theta);\theta) = \max_{\theta} CS_H(q(\theta);\theta) + V_H(q(\theta);\theta) \tag{4}$$

- Using $\partial V_H/\partial q = 0$, the FOC becomes

$$\frac{dW_H(\theta)}{d\theta} = \frac{\partial CS_H}{\partial q}\frac{dq(\theta)}{d\theta} + \frac{\partial CS_H}{\partial \theta} + \frac{\partial \pi_H}{\partial \theta} = 0 \tag{5}$$

- Trade-off: $\frac{\partial CS_H}{\partial \theta} < 0$ but $\frac{\partial CS_H}{\partial q}\frac{dq(\theta)}{d\theta} > 0$ and $\frac{\partial \pi_H}{\partial \theta} > 0$.
- **Proposition 1**: *Home's welfare maximizing PC under autarky is* $\theta^A = 2/3$.
- **Intuition**: Setting $\theta = 1$ maximizes quality but also results in monopoly pricing where price/quality ratio increases in θ. When θ is sufficiently big, welfare declines with θ since indirect benefit of higher quality is outweighed by the direct loss caused by the price increase.

Optimal quality under trade

- Firm's total profit under trade (given no price regulations abroad):

$$\pi(q;\theta) \equiv \pi_H(\theta) + \pi_F^m = \theta(2-\theta)\mu q/4 + q/4 \tag{6}$$

- Firm chooses its quality q to maximize $v(q;\theta) = \pi(q;\theta) - c(q)$ which yields optimal quality under trade as

$$q^T(\theta) = q^A(\theta) + 1/4 \tag{7}$$

- (i) $q^T(\theta)$ strictly increasing in θ and μ and (ii) $q^T(\theta) > q^A(\theta)$ b/c MB of R&D is higher under trade due to larger market size.

How trade affects Home's optimal PC

- Home government solves:

$$\max_{0 \leq \theta \leq 1} W_H(q^T(\theta), \theta) = V(q^T(\theta); \theta) + CS_H(q^T(\theta); \theta) \tag{8}$$

- **Proposition 2.** *Home's optimal PC under trade θ^T has the following properties:*
  - *(i)* $0 < \theta^T < 1$.
  - *(ii)* $\partial\theta^T/\partial\mu > 0$ *and* $\partial^2\theta^T/\partial^2\mu < 0$.
  - *(iii)* $\theta^T < \theta^A$.
  - *(iv) The imposition of the PC θ^T at home makes foreign consumers worse off relative to when the firm charges optimal monopoly prices in both markets.*
- Part (*iii*): foreign profits also incentivize innovation and firm free to charge p_F^m there – creates a free-riding incentive for home.
- Part (*iv*): Home's PC generates an **international externality** and lowers foreign welfare (highest at $\theta = 1$ since that maximizes quality).

Globally optimal PC

- Jointly/globally optimal PC θ^G under trade:

$$\begin{aligned}\theta^G &= \underset{0 \leq \theta \leq 1}{\arg\max}\ W(q^T(\theta), \theta) \\ &= \underset{0 \leq \theta \leq 1}{\arg\max}\ V(q^T(\theta); \theta) + CS_H(q^T(\theta); \theta) + CS_F(q^T(\theta); \theta)\end{aligned}$$

- **Proposition 3.** *The globally optimal PC θ^G under trade is more lenient than home's nationally optimal PC θ^T, i.e. $\theta^G > \theta^T$. Furthermore, as home's market size μ becomes arbitrarily large both PCs converge to home's optimal autarkic PC θ^A.*
- **Intuition**: foreign market matters less for total profit and R&D incentive as μ gets larger. When μ gets arbitrarily large, influence of foreign market on firm choices and welfare vanishes leading to the convergence of θ^H and θ^G to θ^A.

Firm's optimal pricing under ERP

- **ERP policy** δ: a constraint on the degree of international price discrimination that the firm can practice.
- Home government requires $p_H \leq \delta p_F$ where $\delta \geq 1$. Allowing ERP abroad is redundant since $p_F^m < p_H^m$.
- Firm problem under ERP:

$$\max_{p_H,\, p_F} \pi(p_H, p_F) \text{ subject to } p_H \leq \delta p_F$$

where

$$\pi(p_H, p_F) \equiv \frac{n}{v} p_H (v - p_H/q) \; + p_F (1 - p_F/q)$$

- Denote solution by $(p_H^\delta(\delta),\, p_F^\delta(\delta))$.
- Let $\pi^E(\delta) \equiv \pi(p_H^\delta(\delta), p_F^\delta(\delta))$ be the firm's maximized global profit under ERP policy δ if it sells in both markets.

Sales decision

- Firm: *sell in both markets or only at home*? $\pi^E(\delta) \geq \pi_H^m \Longleftrightarrow \delta \geq \underline{\delta}$ where $\underline{\delta} \equiv (\mu - 1)/2$ is the **export-inducing ERP policy**. When facing the ERP constraint $p_H \leq \delta p_F$ firm exports iff ERP policy is less stringent than $\underline{\delta}$ (i.e., $\delta \geq \underline{\delta}$).
- An increase in μ makes home market more lucrative and δ needs to increase for firm to export. Observe that if $\mu \leq 3$, the firm exports even when $\delta = 1$. Firm won't drop foreign market when its similar in size even if it must set the same price in both.
- Given that the firm exports (i.e. $\delta \geq \underline{\delta}$), we have: (i) $p_H^\delta \leq p_H^m$ and $p_F^\delta \geq p_F^m$; (ii) $\partial \pi_G^\delta / \partial \delta > 0$ but $\partial p_H^\delta / \partial \delta > 0$; and (iii) $\partial p_i^\delta / \partial \mu > 0$.
- **International spillover**: ERP raises foreign price **above** p_F^m.

Quality choice under ERP

- Firm makes a forward-looking R&D decision taking ERP policy into account.
  - For $\delta < \underline{\delta}$ selling only at home is optimal for the firm and its quality choice is q^A.
  - If $\delta \geq \underline{\delta}$ firm chooses q to maximize its global profit given δ which yields its optimal quality choice $q^E(\delta)$.
- **Proposition 4.** *(i) For all* $1 \leq \delta < \underline{\delta}$*, the firm does not export and its product quality equals* q^A *where* $q^A < q^E(\delta)$ *and* $\partial q^A / \partial \delta = 0$*. (ii) For all* $\underline{\delta} \leq \delta \leq v$*, the firm sells in both markets and its product quality equals* $q^E(\delta)$ *where* $\partial q^E / \partial \delta > 0$*.*

Trade-off facing home when setting ERP policy

- Firm cares only about global profit net of R&D costs but local welfare also depends upon whether profit comes at the expense of domestic or foreign consumers.
- **Trade-off**:
  - If ERP policy is too tight ($\delta < \underline{\delta}$), firm does not export $\Rightarrow$ home consumers face p_H^m – so, it is never optimal to set $\delta < \underline{\delta}$.
  - Conditional on exporting (i.e., for $\delta \geq \underline{\delta}$), tightening ERP lowers domestic price *and* product quality.
  - When quality is exogenous, $\underline{\delta}$ is optimal – Geng and Saggi (2017). Want to "just induce" exporting. But endogenous quality calls for loosening ERP at $\delta = \underline{\delta}$.
- **Proposition 5.** *Home's optimal ERP policy δ^* is more lax than the export-inducing level $\underline{\delta}$ but it is binding from the firm's perspective in the sense that the firm is unable to engage in complete international price discrimination under it, i.e., $\underline{\delta} < \delta^* < v$.*

Jointly optimal ERP policy

- Joint welfare: $W(.) \equiv W_H(.) + CS_F(.)$
- Home and foreign interests not aligned: foreign welfare highest when no ERP policy at home.
  - Two reasons: foreign price (holding quality constant) lowest and quality maximized when firm can fully price discriminate.
- **Proposition 6.** *Under the globally optimal ERP policy δ^G, the firm is free to fully price discriminate across markets, i.e., $\delta^G = v$. As a result, home's nationally optimal ERP policy δ^* is too tight from a global welfare perspective: i.e., $\delta^* < \delta^G$.*

Intuition for Proposition 6

- Absent innovation, nationally and globally optimal ERP policies coincide at $\underline{\delta}$:
  - When quality is exogenous, sole purpose of ERP is to influence prices, and it is optimal for both home and the world to maintain the export-inducing price difference across countries.
  - For $\delta < \underline{\delta}$, it is optimal to increase δ to $\underline{\delta}$ in order to induce the firm to export.
  - But raising δ above $\underline{\delta}$ is counterproductive since that widens the international price differential and therefore lowers global welfare – standard intuition for benefits of price equalization across markets applies.
- In current model, ERP also affects welfare through firm's R&D incentive/product quality. But since home ignores the benefit from quality improvement accruing to foreign consumers, its ERP is too tight from a global perspective.

ERP vs PC: for a given quality level

- Let home's ERP policy be δ where $\delta < v$; firm prices are $p_H^\delta(\delta, q)$ and $p_F^\delta(\delta, q)$.
- If home were to use a *PC* θ instead, it can induce the firm's domestic price to equal $p_H^\delta(\delta, q)$ by setting $\theta = \theta_\delta$ where

$$\theta_\delta \equiv p_H^\delta(\delta, q) / p_H^m \tag{9}$$

  where $\theta_\delta < 1$ since $p_H^\delta(\delta, q) < p_H^m$.
- Firm's domestic profit under the *PC* θ_δ is the same as that under the *ERP* policy δ.
- **Key difference between the two policies**: Firm charges p_F^m abroad under *PC* θ_δ whereas under *ERP* δ its foreign price $p_F^\delta(\delta, q)$ *exceeds* $p_F^m \Rightarrow$ foreign profit under δ is **lower** than that under θ_δ.
- Thus, holding quality constant, home consumers fare no worse under θ_δ relative to δ while firm is strictly better off $\Rightarrow \theta_\delta$ yields higher home welfare than δ under the two policies holding q constant.

ERP vs PC: endogenous quality

- But quality is actually higher under θ_δ relative to δ, tilting the preference further toward θ_δ. Why?
- By the definition of θ_δ, $\pi_H(\theta_\delta) = \pi_H(\delta)$ whereas $\pi_F(\delta) < \pi_F(\theta_\delta) = \pi_F(p_F^m)$.
- Firm's MB of R&D is higher under θ_δ because $\partial\pi_F(\theta_\delta)/\partial q > \partial\pi_F(\delta)/\partial q$.
  - Intuition: a small increase in R&D boosts foreign profits more under θ_δ relative to δ when firm enjoys unconstrained monopoly status abroad under θ_δ (recall $p_F^m(\delta) > p_F^m$).
  - Thus, quality is higher under θ_δ relative to $\delta \Rightarrow$ both global profit and home consumer surplus under θ_δ are higher.
  - Since $\partial W_F/\partial\delta > 0$ foreign welfare is also strictly higher under θ_δ.
- **Proposition 7.** *In the absence of a PC abroad, for any given ERP policy δ, there exists a home PC $\theta_\delta \equiv p_H^\delta(\delta, q)/p_H^m$ where $\theta_\delta < 1$ such that both countries enjoy higher welfare under it relative to the ERP policy δ.*

(PC, PC) game

- *What is the nature of strategic interaction between countries?*
- **Stage 1**: countries simultaneously choose their PCs.
- **Stage 2**: firm invests in quality.
- **Stage 3:** firm sets prices and trade and consumption occur.
- Given PCs set by governments, firm sells in both markets and its prices across markets are not linked.

Firm profits and quality choice

- Let $\gamma \in [0,1]$ be foreign PC $\Rightarrow$ foreign price equals γp_F^m, where $p_F^m = q/2$. Global profit under (θ, γ):

$$\pi(\theta,\gamma) = \pi_H(\theta) + \pi_F(\gamma) = \theta\mu q(2-\theta)/4 + \gamma q(2-\gamma)/4 \tag{10}$$

- **Lemma 3.** *$\partial q^T(\theta,\gamma)/\partial\theta > 0$ and $\partial q^T(\theta,\gamma)/\partial\gamma > 0$.*
- $q^T(\theta,\gamma)\Big|_{\theta=\gamma=1} = q^m = (\mu+1)/4$ is quality choice in the absence of PCs. As expected, PCs reduce quality below q^m.
- A tightening of θ can be offset by a loosening of γ (works both ways).
- *Strategic policy incentives*: each country prefers that the *other* country set a lax PC so that it can tighten its own.

Strategic interaction

- **Proposition 8.**
  - *(i)* $d\gamma^R(\theta)/d\theta < 0$ *and* $d\theta^R(\gamma)/d\gamma < 0$.
  - *(ii) Home's best response* $\theta^R(\gamma)$ *has the following properties:* $\theta^R(\gamma)\Big|_{\gamma=0} = \theta^A = 2/3$ *and* $0 < \theta^R(\gamma)\Big|_{\gamma=1} < \theta^A$.
  - *(iii) Foreign's best response function* $\gamma^R(\theta)$*: (a)* $\gamma^R(\theta)\big|_{\theta=0} = 1/2$ *and (b)* $\gamma^R(\theta)\big|_{\theta=1}$ *is a decreasing function of* μ *where* $\gamma^R(\theta)\big|_{\theta=1,\ \mu=2} = 0$.
  - *(iv) In the* (θ, γ) *space, home's reaction function is steeper than that of foreign.*
  - *(v) There exists* $\widetilde{\mu}$ *such that for* $\mu \leq \widetilde{\mu}$ *both countries adopt strictly interior PCs in equilibrium (i.e.* $0 < \gamma^* < 1$ *and* $0 < \theta^* < 1$*) whereas for* $\mu > \widetilde{\mu}$ *home implements its optimal autarkic PC (*$\theta^* = \theta^A$*) while foreign sets its PC equal to marginal cost (i.e.,* $\gamma^* = 0$*). For both cases, home's PC is more lax than foreign's, i.e.,* $\theta^* > \gamma^*$.

Figure 1

(ERP, PC) game

- Firm's profit equals

$$\pi(\delta,\gamma)=\pi_H(\delta,\gamma)+\pi_F(\gamma)=\delta n\gamma q(2v-\delta\gamma)/4\mu+\gamma q(2-\gamma)/4 \quad (11)$$

- We have $\partial q^T(\delta,\gamma)/\partial\delta>0$; and $\partial q^T(\delta,\gamma)/\partial\gamma>0$.
- Reaction functions again downward sloping: a looser ERP policy lets foreign tighten its PC since home bears more of the burden of incentivizing R&D.
- **Proposition 9.** *Suppose markets are symmetric (i.e., $\mu=1$). Then, the Nash equilibrium of the (ERP, PC) game (δ',γ') is unique and involves interior solutions (i.e., $\delta'>1$ and $0<\gamma'<1$).*

Figure 2

The two games from the firm's perspective

- When foreign sets its PC γ in (ERP, PC) game, it takes into account that γ affects prices in *both* markets (since home price is simply δ times the foreign price).
- Firm's global profit in the (ERP, PC) game equals

$$\pi(\delta, \gamma) = \pi_H(\delta, \gamma) + \pi_F(\gamma) = \delta\gamma nq(2v - \delta\gamma)/4v + \gamma q(2 - \gamma)/4$$

  All else equal, an increase in γ increases *both* $\pi_H(\delta, \gamma)$ and $\pi_F(\gamma)$.
- Since a given increase in γ raises global profit and the firm's R&D incentive more when it results in price increases in both markets, foreign has an incentive to pick a more lax PC in the (ERP, PC) game than in the (PC, PC) game.

A welfare comparison of the two games

- There exists a *direct* linkage between prices in the two markets only in the (ERP, PC) game. Indirect R&D driven linkage arises in both games.
- **Lemma 4.** *Suppose $\delta = \theta/\gamma$ so that, for a given quality level, price outcomes in the two markets under the (ERP, PC) game and the (PC, PC) game are the same. Then, the impact of a marginal increase in γ on foreign welfare is higher under the (ERP, PC) game.*
- We have

$$\left.\frac{\partial CS_F(\delta,\gamma)}{\partial \gamma}\right|_{\delta=\theta/\gamma} > \frac{\partial CS_F(\theta,\gamma)}{\partial \gamma}$$

- **Proposition 10.** *Suppose markets are symmetric (i.e., $\mu = 1$). Then, the equilibrium PC of the foreign country in the (ERP, PC) game is more lax than that in the (PC, PC) game: $\gamma' > \gamma^*$. Furthermore, equilibrium quality, home welfare, and global welfare are all higher in the (ERP, PC) game relative to the (PC, PC) game while foreign welfare is lower.*

Why do ERP policies arise?

- Imagine a prior stage to the policy game where home can commit to the type of price regulation it wants to follow. Then, home *better off* committing to ERP since that confers a strategic advantage by inducing foreign to adopt a more lax PC.
- Such an advantage *only* arises when the foreign PC is endogenous: if foreign PC exogenous or absent, home prefers PC to ERP (Proposition 7).
- **Model's key insight**: one possible way of understanding the existence of ERP policies is to recognize that they may be *explicitly motivated by strategic international considerations that arise in the setting of national price regulations.*
- ERP is attractive only when its use by a country affects price regulations in *other* countries.

Policy coordination

- Suppose countries coordinate their choices to maximize their joint welfare:

$$\max_{\theta,\,\gamma} W(\theta,\gamma) = \max_{\theta,\,\gamma} W_H(q^T(\theta,\gamma),\theta,\gamma)) + W_F(q^T(\theta,\gamma),\theta,\gamma))$$

- **Proposition 11.** *The globally optimal pair of PCs is given by* $(\theta^G = \gamma^G = 2/3)$.
  - Even if markets are asymmetric (i.e., $\mu > 1$), optimal to set the same PC in each because μ simply scales up the social MB and the social MC cost of θ relative to γ.
  - Since $\theta^G = \gamma^G$, ratio of home to foreign price equals v (the same ratio prevails in the absence of PCs as well under the socially optimal ERP policy). Firm's R&D incentive best maintained by a proportional reduction in prices in the two markets.
  - Propositions 8 and 11 indicate that Nash equilibrium PCs are too stringent: each country has an incentive to free-ride on the other by choosing a PC that is stricter than what is jointly optimal.

ERP policy under coordination

- Suppose countries coordinate over home's ERP policy (δ) as well as their PCs (θ and γ).
  - As long as they can coordinate over any two policies, the third policy is redundant.
  - For a given pair (θ, γ) price ratio across two markets equals

$$\frac{p_H^m(\theta,\gamma)}{p_F^m(\theta,\gamma)} = \frac{\theta v q/2}{\gamma q/2} = \frac{\theta v}{\gamma}$$

    which leaves no degrees of freedom to set an independent ERP policy δ.
- Fixing one of the PCs and the ERP policy leaves no degrees of freedom to set the other PC. For example, if countries coordinate over home's ERP policy δ and the foreign PC then jointly optimal policies are $\delta^G = v$ and $\gamma = \gamma^G$.
- Under the policy pair (δ^G, γ^G) equilibrium outcomes are exactly the same as those under (θ^G, γ^G).

Conclusions

- **Benchmark model**: home is the only policy active country.
  - Home's autarkic consumer surplus is inverse U shaped in its PC: optimal PC balances benefits of price reduction for a given quality level against the welfare cost of lower quality.
  - Trade induces home to tighten its PC since foreign market also incentivizes R&D: home can free-ride some.
  - Jointly optimal PC more lax than what home picks: home's unilateral choice ignores the benefits of higher quality for foreign.
  - With trade, ERP becomes a viable policy and home's chosen policy is too restrictive relative to what is jointly optimal.
  - ERP dominated by a PC since the price linkage inherent to it undermines the firm's R&D incentive by raising foreign price above monopoly price.

Conclusions (contd.)

- **International policy interaction**:
  - We consider two scenarios: (PC, PC) and (ERP, PC).
  - National PCs are *strategic substitutes*: free-riding incentive arises b/c incentivizing R&D requires tolerating a higher price. Since firm profits count as part of home welfare, home more willing to tolerate a higher price.
  - Nash equilibrium PCs too restrictive relative to jointly optimal PCs.
  - In the (ERP, PC) game too, policies are strategic substitutes: a more lax ERP policy by home induces a tighter PC abroad.
  - Foreign picks a more lax PC in the (ERP, PC) game than in the (PC, PC) game b/c its choice affects prices in *both* markets when home has an ERP policy in place.
  - ERP policies may be motivated by strategic considerations that arise in the setting of national price regulations. In our model, home prefers an ERP policy to a direct PC only if its use affects foreign's choice of its PC.