Parallel Imports and Cost Reducing Research and Development [*]

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Abstract: In this paper, we develop a model of cost-reducing innovation in the context of parallel imports with endogenous investment. It is shown that the difference between the profits when innovation is successful or not takes a U-shaped curve in terms of the cost of parallel imports. This result is very important because the difference between these two levels of profitability reflects the manufacturer's incentives to innovate. Consistent with the existing intuitive analysis, we find that parallel imports or distortions associated with parallel imports inhibit cost-reducing innovation. If parallel trade occurs, then banning parallel imports has ambiguous effect on the expected global welfare; if parallel trade is deterred but there are distortions associated with parallel trade, then the policy of restricting parallel trade raises the expected global welfare.

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The timing of the game is as follows: The manufacturer first decides whether he should invest in a cost reducing process innovation, then he makes the distributor a take-it or leave-it offer in the form of (w,T), w is the wholesale price and T is a transfer government passes a law to legally ban parallel imports or the government raises the tariff to prevent parallel trade have the impact of increasing the parallel traders' transportation cost.

Let q_A denotes the quantities sold by M in country A, q_B is the quantity sold by D in market B. When the distributor accepts the offer, she chooses her output q_B in market B and M simultaneously determines his output in A. Throughout this paper, subscripts of w_i and c_i will denote the type of the wholesale price and cost, $i = H, L$.

M's profit and D's gross profit through sales in country A and B are

$$\pi_A = (1 - q_A - c_i)q_A \tag{1}$$

$$\pi_B = (a - q_B - w_i)q_B \tag{2}$$

It follows that M needs to choose the optimal contract. Once a contract is accepted, the transfer payment, T is sunk, and does not impact upon D's incentives. Hence, T may be set entirely to extract all D's profit. w_i on the other hand, is D's marginal cost of making sale in country B, it does have an impact upon D's incentives. Consequently, w_i is set only to impact incentives, while T is set only to extract profit.

To get the optimal wholesale price, M should solve

$$_{w_i} \quad _M\ w_i\ c_i \quad _A\ c_i \quad _B\ w_i \quad w_i - c_i\ q_B\ w_i\ - k$$

4 0 0 11.9894 307.3197 34 T7 T67c

Where $R_M(w_L, c_L)$ and $R_M(w_H, c_H)$ are evaluated at the optimal wholesale prices w_L and w_H respectively. Suppose $\alpha^{/}(0) = d$ is large enough to guarantee that it is not optimal to set k =0. Let

$$\Delta R_M = R_M(w_L, c_L) - R_M(w_H, c_H) = \pi_M(w_L, c_L) - \pi_M(w_H, c_H) = \frac{(c_H - c_L)[(1+a) - (c_H + c_L)]}{2}$$

, then the first order condition of the investment problem (5) yields

$$k = \frac{1}{2b}(d - \frac{1}{\Delta R_M}) \qquad (6)$$

To formulate our idea, we make the following assumption:

A1: We assume that $\alpha^{/}(0) = d$ is large enough.

This assumption is one of the conditions that ensure the manufacturer has incentives to invest in process innovation.

2.2. The case in which we allow parallel imports

We have presented the case where there is not parallel trade in the above subsection. Now we focus on the case in which parallel imports are allowed.

M's profit and D's gross profit through sales in country A are

$$\pi_{AM} = [1 - (q_{AM} + q_{AD}) - c_i]q_{AM} \qquad (7)$$

$$\pi_{AD} = [1 - (q_{AM} + q_{AD}) - w_i - t]q_{AD} \qquad (8)$$

By taking the first order conditions with respect to M and D's sales, we get some interesting results. [3] They are interesting for several reasons: First, in the presence of parallel imports, it is not surprising that is increasing in and decreasing in c . As

increases, the volume of parallel trade, , decreases, under the Cournot

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We should make clear that parallel imports stop at a certain point of transportation cost. This introduces a kink in all of these expressions, such as q_{AM}, q_{AD}, $q_{AM} + q_{AD}$, w_i, T, π_{AM} and π_{AD}.

In country B, D maximizes $\max_{q_B} \pi_B = (a - q_B - w_i)q_B$ (9)

The manufacturer's problem is to solve

$$\max_{w_i \geq 0} \pi_M(w_i, c_i) = \pi_{AM}(w_i, c_i) + \pi_{AD}(w_i, c_i) + \pi_B(w_i, c_i) + (w_i - c_i)[q_{AD}(w_i, c_i) + q_B(w_i, c_i)] - k^p \quad (10)$$

The manufacturer's expected profit becomes [4]

$$E_M^p = \alpha(k^p)R_M^p(w_L, c_L) + [1 - \alpha(k)]R_M^p(w_H, c_H) - k^p \quad (11)$$

Where $R_M^p(w_{L,} c_L)$ and $R_M^p(w_{H,} c_H)$ are M's respective total revenues when cost-reducing innovation is successful or not in the presence of parallel trade. They are evaluated at the optimal wholesale prices w_L and w_H respectively. Let $\Delta R_M^p = R_M^p(w_L, c_L) - R_M^p(w_H, c_H) = \pi_M^p(w_L, c_L) - \pi_M^p(w_H, c_H)$, then the first order condition of the investment problem yields

$$k^p = \frac{1}{2b}\left(d - \frac{1}{\Delta R_M^p}\right) \quad (12)$$

To show that whether parallel imports reduce the manufacturer's incentives to invest in innovation, we need to compare (6) and (12) and show whether by comparing with . That is, if , then . Parallel imports reduce the manufacturer's incentive to innovate. If , then . Parallel imports encourage the manufacturer to engage in process innovation. If , then . Parallel trade does not matter fdaa a a

When the manufacturer offers his contract to the distributor, he offers his optimal wholesale price higher than his marginal cost. If $c_i \geq 1+4t$, then the marginal cost is larger than one which is the market size of country A. Hence the production in market A is inactive. Under the assumption 1, this case never happens.

Proposition 1: *The relationship between T and c_i is not monotonic.*

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$+c_i)$ $+11c_i$

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(3). If $t \geq \frac{1-c_i}{2}$, then M’s problem in (13) becomes

$$\max_{w_i \geq} \quad {}_{M} = \frac{(1-c_i)^2}{4} + \frac{(a-w_i)^2}{4} + \frac{(w_i - c_i)(a-w_i)}{2} - k^{p}$$

Corollary 1. There exists a unique t^*, $0 \le t^* < \frac{3(1-c_i)}{14}$ *such that* π_M *decreases in* t *when* $0 \le t < t^*$, *increases in* t *when* $t^* \le t < \frac{1-c_i}{2}$ *and is constant when* $t \ge \frac{1-c_i}{2} > t^*$.

The proof of this corollary is in appendix E. It is clear that π_M is U-shaped in terms of transportation cost. This is shown in figure 3.

(Insert Figure 3 here)

Thus the manufacturer's *profit curve* takes U-shape with respect to the cost of engaging in parallel importing. This result is similar to Maskus and Chen (2000), who find a similar U-shaped *global welfare curve.* [8] Though our model is different, [9] we share the same intuition with theirs. When the trade cost t is low, there are parallel imports. Parallel trade forces the manufacturer to raise the wholesale price, which creates a distortion in vertical pricing. On one hand, high wholesale price increases the cost of parallel trade, reduces the gray marketer's competition ability in country A and increases the manufacturer's profit in country A; On the other hand, high wholesale price lowers the sale and profit in market B. The net effect on the manufacturer's profit could be negative. Thus when $0 \le t < t^*$, the effect of high wholesale price on market A is dominated by the effect on market B, and the manufacturer's profit decreases with t.

However when $t^* \le t < \frac{3(1-c_i)}{14}$, as t increases, the effect of high wholesale price on market A outweighs that on market B, and the net effect on the manufacturer's profit is positive. π_M increases with t. When $\frac{3(1-c_i)}{14} \le t < \frac{1-c_i}{2}$, M chooses the wholesale price $\quad_i = \frac{c_i}{} - t$

$$t \quad \frac{1 \quad c_i}{2}$$

One question we need to answer: why the manufacturer has the incentive to invest in cost-reducing innovation? To answer this question, we must show that the profit when M gets success in process innovation is larger than that when he fails the innovation. Given assumption 1, we only need to show that $\pi_M^p(w_L, c_L) \geq \pi_M^p(w_H, c_H)$ or $R_M^p(w_L, c_L) \geq R_M^p(w_H, c_H)$. In other words, we should prove that, for every $c_j \in [c_L, c_H]$, we have $\pi_M^p(w_j, c_j)$ or $R_M^p(w_j, c_j)$ decreases with c_j. We provide our results with two propositions.

To simplify our analysis, we make another assumption:

Assumption 2: Assume that $4 - 7c_H + 3c_L > 0$.

As usual assumption plays the role in simplifying our analysis. It is a reasonable assumption if the marginal costs are much smaller that the market sizes of country A.

Proposition 3: $\frac{\partial \pi_M^p(w_j, c_j)}{\partial c_j} < 0 \ all \ t \geq 0$.

We put the proof of proposition 3 in appendix F. This proposition tells us that the manufacturer's profit function is decreasing in his marginal cost. Thus, to increase his profit, the manufacturer does have incentives to engage in process innovation. Hence proposition 4 follows immediately.

Proposition 4: *Given assumption 1, the manufacturer has incentives to make investment in cost-reducing innovation.*

If $0 \leq t < \frac{3(1-c_H)}{14}$, then M sets the optimal wholesale price $w_H = \frac{2+8t+11c_H}{13}$, parallel trade occurs. M may wish to reduce the marginal cost by engaging process innovation. Lower marginal cost, on one hand, reduces the distortion in market B because it enables the manufacturer to offer lower wholesale price; on the other hand, it increases the total sales and profit in market A. However, lower wholesale price strengthens D's competition ability in market A and encourages parallel imports. Provided assumption 1, the second effect is dominated by the first effect in this case. Therefore the manufacturer's profit decreases with marginal cost, it is better for the manufacturer to invest in cost-reducing activity.

If $\frac{3(1-c_H)}{14} \leq t < \frac{1-c_H}{2}$, then the optimal wholesale price is $_H = 1419e$ is $+ c_H - t$

In region 1, there are parallel imports regardless process innovation is successful. In region 2, parallel trade occurs when M gets success in innovation but parallel trade is deterred when M fails innovation. In region 3, parallel imports are deterred by the high wholesale price in the case of either innovation is successful or not. In region 4, parallel imports are blocked by the high transportation cost when M does not succeed in innovation and parallel imports are deterred by the high wholesale price when M succeeds in innovation. In region 5, transportation cost is so high that it blocks parallel trade no matter process innovation is successful or not.

The intuition tells us successful process innovation should lower the wholesale price and reduce the distortions in market B. Is it true? The next proposition formally investigates this possibility.

Proposition 3. *Successful cost-reducing innovation is helpful in reducing the wholesale price.* [10]

Because the difference between the profit functions when the innovation is successful or not represents the manufacturer’s incentive to innovate, so it is important to analyse these two levels of profitability. 8

competition, free ride on the manufacturer's investment and lower the manufacturer's incentive to innovate. We have modeled this issue and our results support these arguments. Intuitively if there is not parallel trade or distortions associated with parallel trade regardless the innovation is successful, the manufacturer's profit is higher than that with parallel imports, successful cost-reducing innovation results in higher increase in M's total profits through more sales in both countries than that with parallel trade. It is obvious that, in the case of no parallel imports or no distortions associated with parallel imports, the manufacturer is willing to make more investment in cost-reducing innovation.

Proposition 6 is about the difference between the profit functions for different transportation cost when process innovations is successful or not. Proposition 7 tells us the manufacturer's incentive variation with the change in transportation cost t. Given transportation cost t, I turn to figure out the manufacturer's optimal investment levels by discussing M's expected profits with and without parallel imports. Also the analysis on M's expected profit is very useful when we analyse the expected welfare comparison in the following subsection.

Corollary 4: *For every*

From proposition 7 and corollary 4 and 5, we can easily know the relationship between E_M and E_M^p. This is provided by figure 10.

(Insert Figure 10 here)

3.5. Impact of restricting parallel imports on expected welfare

It is obvious that process innovation could change expected global welfare and expected welfare of both countries. It is easy to imagine that gray market activities should have impact on the changes of expected welfare. In this subsection, we will focus on this question and discuss the effect of restricting parallel imports on the changes of expected welfare. The results are summarized in following proposition.

Proposition 8: *Under assumption 1 and 2, restricting parallel imports*

(i). reduces the expected consumer surplus in country A, raises the expected consumer surplus in country B and has ambiguous impact on expected global welfare when $0 \le t < \frac{3(1-c_H)}{14}$;

(ii). lowers the expected consumer surplus in country A, increases the expected consumer surplus in country B and has ambiguous impact on expected global welfare when $\frac{3(1-c_H)}{14} \le t < \frac{3(1-c_L)}{14}$;

(iii). does not impact on the expected consumer surplus in country A, but raises the expected consumer surplus in country B and increases expected global welfare when $\frac{3(1-c_L)}{14} \le t < \frac{1-c_H}{2}$;

(iv). has no impact on the expected consumer surplus in country A, but increases the expected consumer surplus in country B and raises the expected global welfare when $\frac{1-c_H}{2} \le t < \frac{1-c_L}{2}$;

(v). does not impact on the expected consumer surplus in both countries and the expected global welfare when $t > \frac{1-c_L}{2}$.

The proof of this proposition is in appendix K.

In region 1 of figure 7, the transportation cost some insights. The model was chosen to be as simple as possible, and could be easily managed.

Our first result implies that if the cost of parallel imports, i.e. the transportation cost, varies, then the manufacturer's profit curve appears to be U-shaped. The variation of transportation cost can affect parallel trade by changing the gray marketer's competition ability; it can also affect the manufacturer's incentive in setting the wholesale price. When the tr

Appendix

A. If we do *not* allow parallel imports, then M's profit and D's gross profit through sales in country A and B are

$$\pi_A = (1 - q_A - c_i)q_A \qquad \text{(A1)}$$

$$\pi_B = (a - q_B - w_i)q_B \qquad \text{(A2)}$$

Where $i = L, H$. The first order conditions yield

$$q_A(c_i) = \frac{1-c_i}{2}, \quad p_A(c_i) = \frac{1+c_i}{2} \quad \text{and} \quad \pi_A(c_i) = \frac{(1-c_i)^2}{4} \qquad \text{(A3)}$$

$$q_B(w_i) = \frac{a-w_i}{2}, \quad p_B(w_i) = \frac{a+w_i}{2} \quad \text{and} \quad \pi_B(w_i) = \frac{(a-w_i)^2}{4} \qquad \text{(A4)}$$

To get the optimal wholesale price, M should solve

$$\max_{w_i \geq 0} \pi_M(w_i, c_i) = \pi_A(c_i) + \pi_B(w_i) + (w_i - c_i)q_B(w_i) - k$$

$$= \frac{(1-c_i)^2}{4} + \frac{(a-w_i)^2}{4} + \frac{(a-w_i)(w_i-c_i)}{2} - k \qquad \text{(A5)}$$

The first order condition is $\frac{-(w_i - c_i)}{2} = 0$, thus M tends to choose $w_i = c_i$.

$$T_i = \frac{(a-c_i)^2}{4} \quad \text{and} \quad \pi_M(w_i, c_i) = \frac{(1-c_i)^2}{4} + \frac{(a-c_i)^2}{4} - k. \qquad \text{(A6)}$$

B. When we *allow* parallel imports, M's profit and D's gross profit through sales in

$$T_i = \begin{cases} (C1) & if \quad 0 \le t < \frac{3(1-c_i)}{14} \\ \frac{(2a+2t-1-c_i)^2}{16} & if \quad \frac{3(1-c_i)}{14} \le t < \frac{1-c_i}{2} \\ \frac{(a-c_i)^2}{4} & if \quad t \ge \frac{1-c_i}{2} \end{cases}$$

M’s profit is

$$= \begin{cases} \frac{}{} \quad + \quad - \quad - \quad + \quad - \quad + \quad + \quad - & \le \quad < \frac{-}{} \\ \frac{}{} \quad + \; - \quad + \quad - \quad -6 \quad -4 \quad +7 \quad) - & \frac{3(1- \quad)}{14} \le \quad < \frac{1-}{2} \\ \frac{(1- \quad) \; + (\quad - \quad)}{4} - & \ge \frac{1-}{2} \end{cases}$$

becomes $w_L = \frac{1+c_L}{2} - t$. When $\frac{1-c_H}{2} \le t < \frac{1-c_L}{2}$, we have

$$w_L = \frac{1+c_L}{2} - t \le \frac{1+c_L}{2} - \frac{1-c_H}{2} = \frac{c_H + c_L}{2} < c_H .$$ [12] ♠.

$$\lim_{t\to(\frac{3(1-c_H)}{14})+} \Delta R_{M2}^{p} = \frac{1}{364}(156c_H + 182ac_H - 163c_H^2 - 156c_L - 182ac_L - 12c_H c_L + 175c_L^2) = \lim_{t\to(\frac{3(1-c_H)}{14})-} \Delta R_{M1}^{p}$$

$$\lim_{t\to(\frac{3(1-c_L)}{14})-} \Delta R_{M2}^{p} = \frac{1}{112}(48c_H + 56ac_H - 49c_H^2 - 48c_L - 56ac_L - 6c_H c_L + 55c_L^2)$$

$= \frac{1}{52}(c_H - c_L)[2 + 8t - (c_H + c_L)] > 0$. Thus we have $\Delta R_M > \Delta R_{M1}^{p}$ and $k > k_1^{p}$.

(2). If $\frac{3(1-c_H)}{14} \le t < \frac{3(1-c_L)}{14}$, then $\Delta R_M - \Delta R_{M2}^{p} = \frac{(c_H - c_L)[(1+a)-(c_H + c_L)]}{2}$

$$\frac{1}{208}[9 \quad 104a(c_H \quad c_L) \quad 84t \quad 196t^2 + 78c_H - 96c_L + 52tc_H + 32tc_L - 91c_H^2 + 100c_L^2]$$

Because $\frac{\partial(\Delta R_M - \Delta R^p_{M4})}{\partial t} = -4 + 8t + 4c_L = \frac{1}{8}(t - \frac{1-c_L}{2}) < 0$, Thus $\Delta R_M - \Delta R^p_{M2}$ gets minimum at $t = \frac{1-c_L}{2}$. Hence we have $\Delta R_M - \Delta R^p_{M2} > (\Delta R_M - \Delta R^p_{M2})\big|_{t=\frac{1-c_L}{2}} = 0$, $\Delta R_M > \Delta R^p_{M4}$ and $k > k^p_4$.

(5). If $t \geq \frac{1-c_L}{2}$, then and k .

$$ECS_{A1}^{p}=\frac{1}{328}(8-7t-8c_L)^2\alpha(k)+\frac{1}{328}(8-7t-8c_H)^2[1-\alpha(k)] \text{ and}$$

$$ECS_{B1}^{p}=\frac{1}{1352}(13a-2-8t-11c_L)^2\alpha(k)+\frac{1}{1352}(13a-2-8t-11c_H)^2[1-\alpha(k)].$$

First, because $\frac{1}{8}(1-c_i)^2-\frac{1}{328}(8-7t-8c_i)^2$ is increases in t, thus


w_i

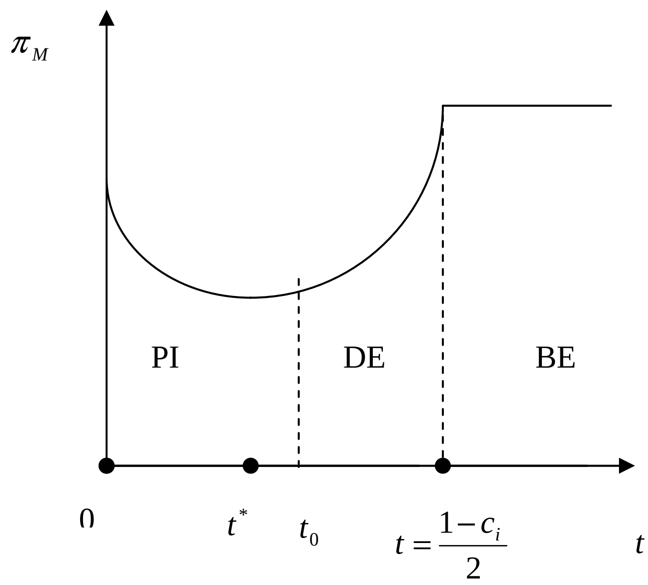
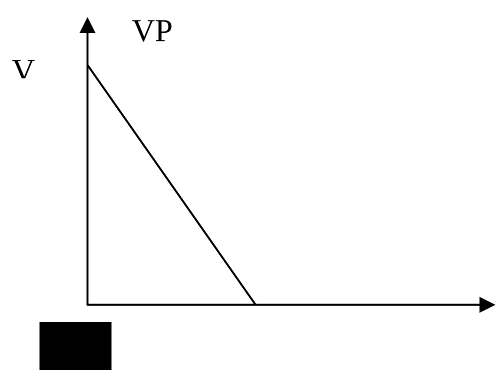


Figure 3: the U-shape of π_M

In figure 3, PI denotes parallel imports. DE represents deterrence equilibrium. BE is the blocked equilibrium. $t^* = \frac{1-c_i}{9}$ and $t_0 = \frac{3(1-c_i)}{14}$.



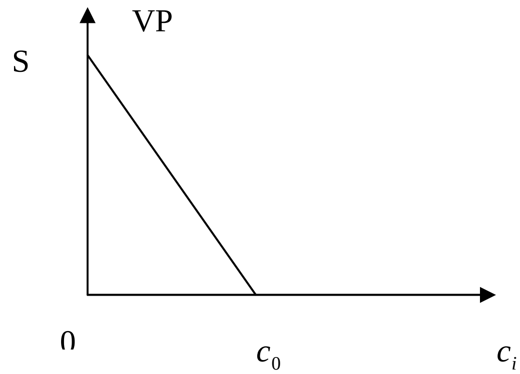


Figure 5

In figure 5, S= $\frac{3-14t}{13}$ and $c_0 = 1 - \frac{14t}{3}$. VP is the volume of parallel trade.

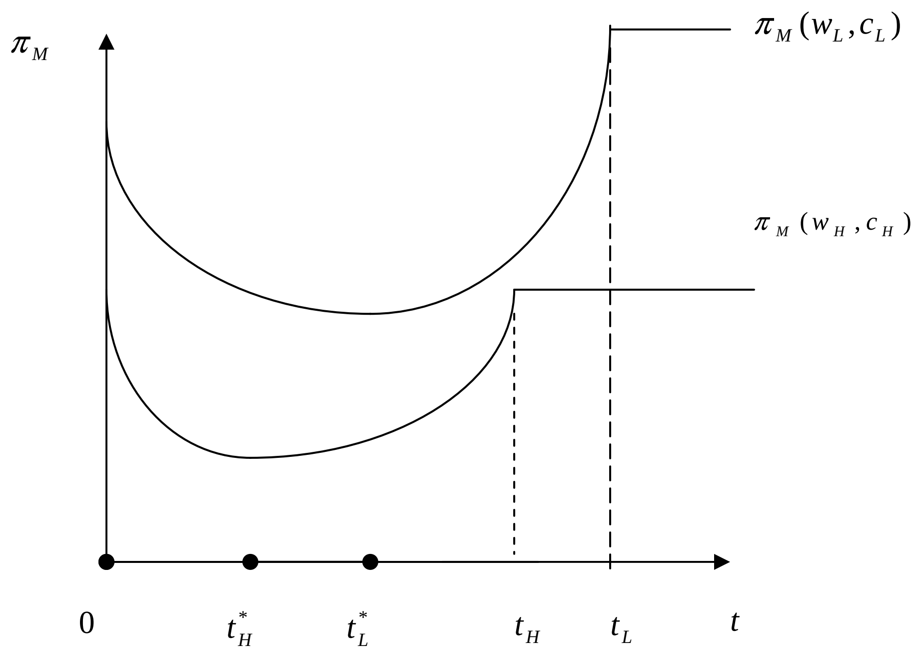
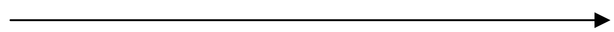


Figure 6

In figure 6, $t_H^* = \frac{1-c_H}{9}$, $t_L^* = \frac{1-c_L}{9}$



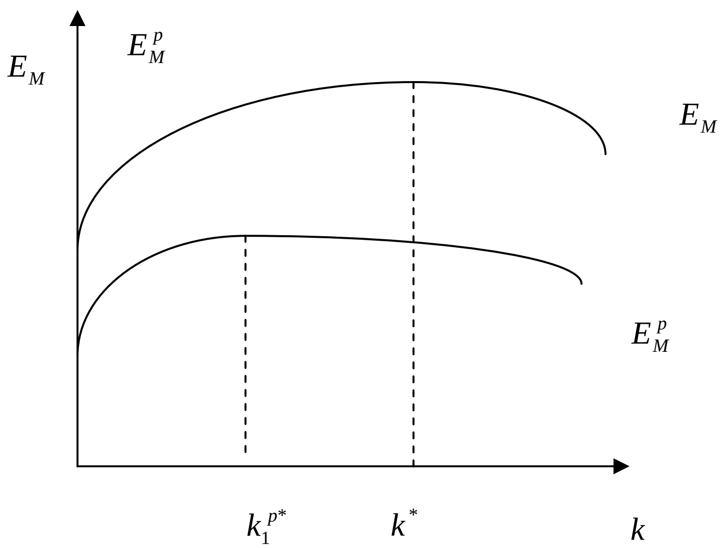


Figure 10

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