

"
DEARDORFF : WELFARE EFFECTS OF GLOBAL
 PATENT PROTECTION"

①

SINGLE INVENTION IN A SINGLE COUNTRY

BASIC SET UP :

R = RESEARCH COST

C = MARGINAL COST OF PRODUCTION

- IF AN INVENTOR SPENDS "R" DOLLARS, IT OBTAINS A NEW PRODUCT THAT CAN BE PRODUCED BY ANYONE AT A MC OF PRODUCTION "C".

- ASSUME n IDENTICAL CONSUMERS. IF INDIVIDUAL DEMAND IS $p = a - b q_i$; FOR CONSUMER i , THE MARKET DEMAND IS :

(2)
$$p = a - \frac{b}{n} Q$$
 (WHERE $Q = \sum q_i$ = MARKET PRODUCTION = INDUSTRY)

CASES :

(A) NO PATENT GRANTED TO FIRST INVENTOR (\Rightarrow COMPETITIVE PRODUCTION)

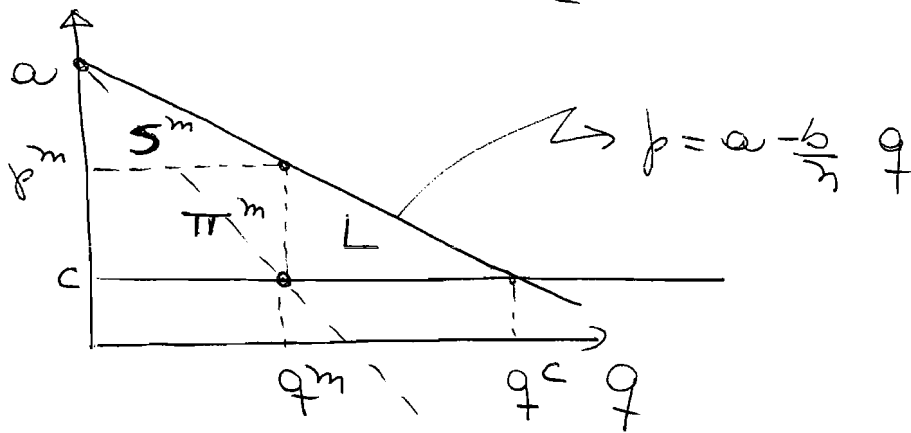
WE CALCULATE TOTAL INDUSTRY OUTPUT

$$p = MC \Rightarrow \underbrace{a - \frac{b}{n} Q}_p = \underbrace{C}_{MC}$$

(3)
$$\Rightarrow Q^C = n \left(\frac{a-c}{b} \right)$$

S^0 = CONS. SURPLUS UNDER P. COMPETITION = OPTIMAL CONS. SURPLUS =
 = CONS. SURPLUS AT Q^C = AREA BELOW DEMAND CURVE & ABOVE C =

(4) = AREA OF TRIANGLE (Sⁿ + Πⁿ + L) =
$$\frac{(a-c) \times Q^C}{2} \stackrel{\text{USING (3)}}{=} \frac{(a-c)^2}{2b} n$$



SINCE THE INVENTOR WILL EARN ZERO PROFITS, THE INVENTION WILL NOT BE UNDERTAKEN.

(B) PATENT GRANTED TO INVENTORS

(\Rightarrow INVENTORS WILL ACT AS A MONOPOLIST)

WE CALCULATE TOTAL INDUSTRY OUTPUT

$$MR = MC \Rightarrow a - \underbrace{\frac{b}{n} \cdot 2 \cdot q}_{MR} = c$$

\Rightarrow

(6) $q^m = \frac{1}{2} n \left(\frac{a-c}{b} \right)$, (7) $p^m = \frac{a+c}{2}$

(8) $\pi^m = \frac{1}{4} n \frac{(a-c)^2}{b}$

$\pi^m = \frac{1}{2} S^0$ (8')

COMPARING (4) & (8) WE HAVE

CONS. SURPLUS UNDER MONOPOLY:

$S^m = \text{AREA BELOW DEMAND CURVE \& ABOVE } p^m = \text{AREA RELIANGLE } S^m$

(9) $= \frac{(a-p^m) \cdot q^m}{2} = \frac{1}{8} n \frac{(a-c)^2}{b}$ $\rightarrow S^m = \frac{1}{4} S^0$ (9')

COMPARING (4) & (9) WE HAVE

BENEFIT FOR SOCIETY OF MONOPOLY IN THIS CASE:

$$b^m = \pi^m + S^m = \frac{3}{4} S^0$$

\Rightarrow DEADWEIGHT LOSS TO SOCIETY BECAUSE OF

MONOPOLY PRICING:

$$L = S^0 - b^m = S^0 - \frac{3}{4} S^0 = \frac{1}{4} S^0$$

WILL THE MONOPOLIST UNDERTAKE THE INVENTION?

YES: IF $\pi^m > R$

NO: IF $\pi^m < R$

INVENTION SHOULD BE UNDERTAKEN FROM SOCIETY'S POINT OF VIEW IF:

$$S^0 > R$$

SINCE $\pi^m = \frac{1}{2} S^0$ EVEN WITH A PATENT SOME

WORTHWILE INVENTIONS (FROM SOCIETY'S POINT OF VIEW) WILL NOT BE UNDERTAKEN.

CONCLUSION:

PATENTS ARE AN IMPERFECT METHOD TO DEAL WITH INVENTIONS

WHY? BECAUSE: • NOT ALL WORTHWILE INVENTIONS (FROM SOCIETY'S POINT OF VIEW) WILL BE UNDERTAKEN

• MONOPOLY PRICING PRODUCES A DEADWEIGHT LOSS (L) -

MULTIPLE INVENTIONS

SINGLE COUNTRY

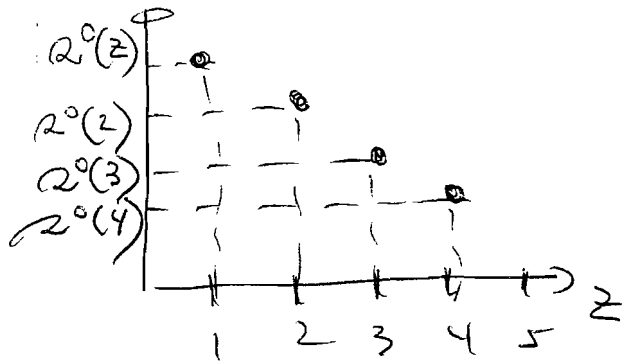
INVENTIONS ARE INDEXED (RANKED) BY THE PARAMETER z

DEFINITION:

OPTIMAL CONSUMER SURPLUS FOR INVENTION z NORMALIZED BY

$$(11) R^0(z) = \frac{\text{ITS RESEARCH COST}}{R(z)} = \frac{S^0(z)}{R(z)}$$

ASSUME WE ORDER THE MANY INVENTIONS ACCORDING TO THEIR R^0 'S (LOWER NUMBERS IDENTIFY INVENTIONS WITH HIGHER R^0 'S) *



SUPPOSE INVENTIONS $1, 2, 3, \dots, \hat{z}$ ARE UNDERTAKEN IN A COUNTRY.

Question: WHAT IS THE TOTAL INVESTMENT IN RESEARCH IN THE COUNTRY?

$$\begin{aligned}
 I(\hat{z}) &= \text{TOTAL INVESTMENT IF LAST INVENTION IS } \hat{z} = \text{TOTAL COST OF RESEARCH} \\
 &= R(1) + R(2) + \dots + R(\hat{z})
 \end{aligned}$$

IF THIS FUNCTION IS "NICE" WE CAN WRITE \hat{z}^0 (LAST INVENTION) AS A FUNCTION OF THE TOTAL INVESTMENT (I) AND

(EQUATION 11 IN PAGE 4)

THEFORE z^0 CAN BE WRITTEN NOW AS

A FUNCTION OF I:

$z^0(I)$ = OPTIMAL CONSUMER SURPLUS PER DOLLAR OF RESEARCH OBTAINABLE FROM THE LAST (OR MARGINAL) DOLLAR OF RESEARCH INVESTMENT.

USING OUR PREVIOUS WORK ON SINGLE INVENTION (PAGE 2)

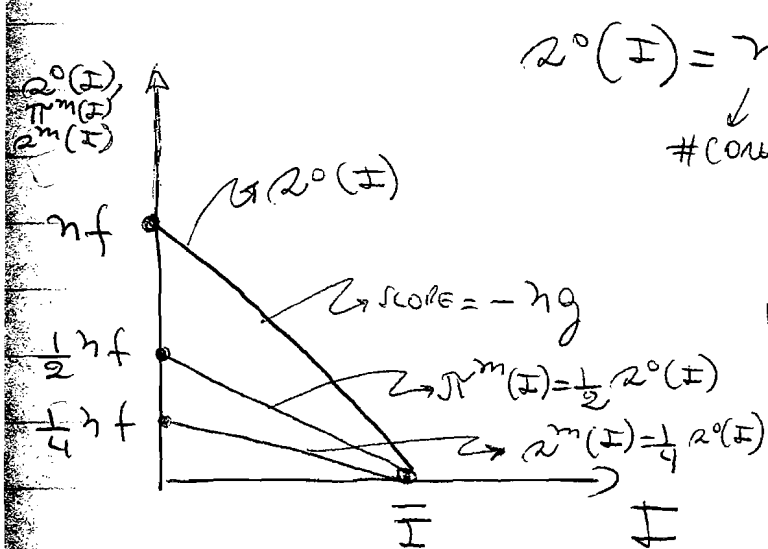
WE USE EQUATIONS (8') AND (9') TO DEFINE THE FOLLOWING:

(15) $\boxed{J^m(I)}$ = MONOPOLY PROFITS PER DOLLAR OF RESEARCH OBTAINABLE FROM THE LAST DOLLAR OF RESEARCH INVESTMENT = $\boxed{\frac{1}{2} z^0(I)}$

(16) $\boxed{Q^m(I)}$ = CONSUMER SURPLUS PER DOLLAR OF RESEARCH UNDER MONOPOLY OBTAINABLE FROM THE LAST DOLLAR OF RESEARCH INVESTMENT = $\boxed{\frac{1}{4} z^0(I)}$

(SEE DIAGRAMS NEXT PAGE WHEN WE ASSUME LINEAR FUNCTION FOR $z^0(I)$)

ASSUME THERE IS A LARGE NUMBER OF INVENTIONS ("ONE AS CLOSE TO THE NEXT AS POSSIBLE") SO WE CAN ASSUME THAT $R^0(I)$ IS A NEGATIVE SLOPED LINE:



$$R^0(I) = n \left(f - g I \right) = nf - ng I$$

CONSUMERS OPTIMAL CONSUMER SURPLUS

PER UNIT OF RESEARCH OBTAINED FROM THE LAST DOLLAR OF RESEARCH INVESTMENT.

$I\text{-bar}$ = VALUE OF I WHEN $R^0 = 0$
 $\Rightarrow I\text{-bar} = \frac{f}{g}$

I HAVE DRAWN $\pi^m(I)$ & $R^m(I)$ USING EQUATIONS (5) & (6) FROM PAGE 5 -

NO PATENT PROTECTION:

(THIS IS PERFECT COMPETITION IF AN INVENTION IS AVAILABLE)

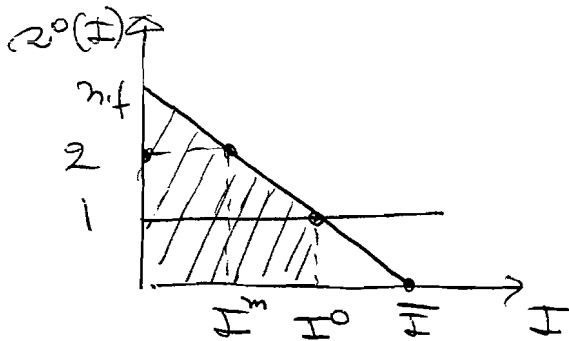
P.C. $\Rightarrow \pi^c = 0$ SO NO INVENTION TAKES PLACE.
 i.e. $I^c = 0 \Rightarrow R^c(0) = 0$

OPTIMAL INVENTION

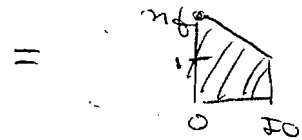
INVEST AS LONG AS OPTIMAL CONSUMER SURPLUS OF INVENTION \geq LARGER THAN RESEARCH COST OF INVENTION \geq (i.e. $R^0(I) \geq 1$).

IN OTHER WORDS, STOP WHEN $R^0(I) = 1$ WE CALL THE OPTIMAL LEVEL OF RESEARCH

INVESTMENT: I^0 , SEE DIAGRAM;



S^0 = TOTAL CONSUMER SURPLUS WHEN OPTIMAL AMOUNT OF RESEARCH INVESTMENT IS UNDERTAKEN
 = AREA BELOW $R^0(I)$ FROM 0 TO I^0



PATENT GRANTED TO INVENTOR

(MONOPOLY).

INVEST AS LONG AS ^{MONOPOLY} PROFITS OF INVENTION \geq LARGER THAN RESEARCH COST OF INVENTION \geq (i.e. $\pi^m(I) > 1$).

IN OTHER WORDS STOP WHEN

$$\pi^m(I) = 1 \Rightarrow \frac{1}{2} R^0(I) = 1$$

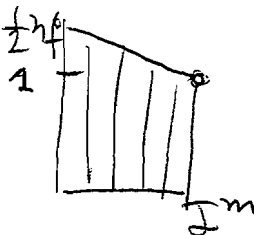
↓
 USING (15) IN PAGE 5

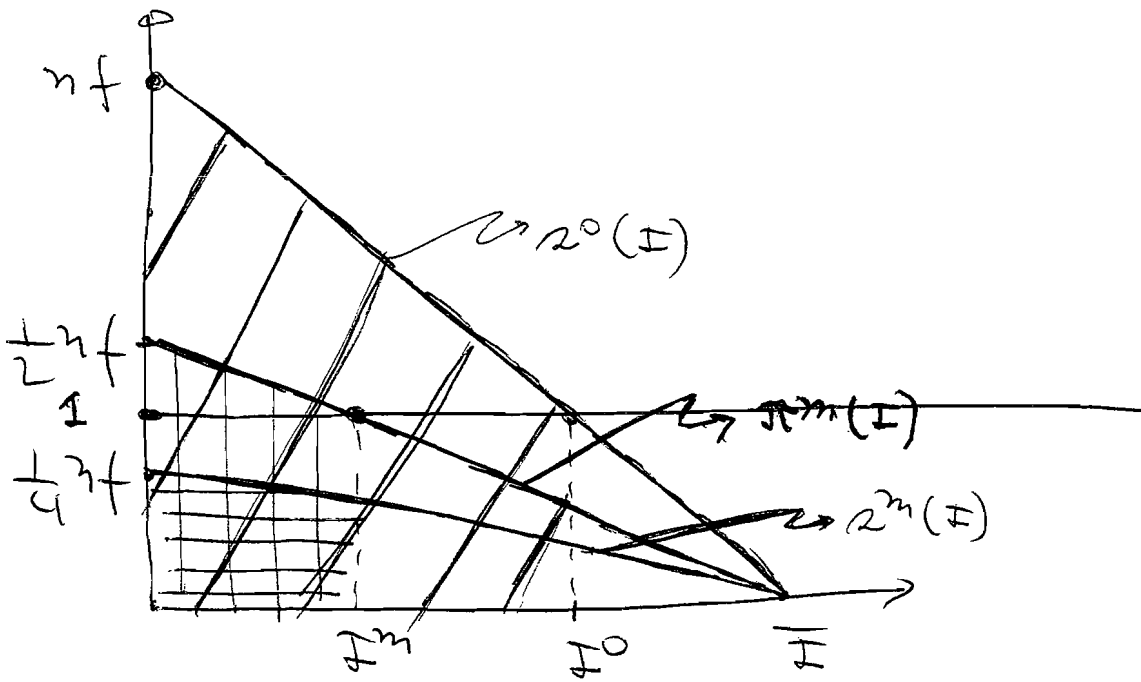
$$\Rightarrow \boxed{R^0(I^m) = 2}$$

(SEE DIAGRAM ABOVE)

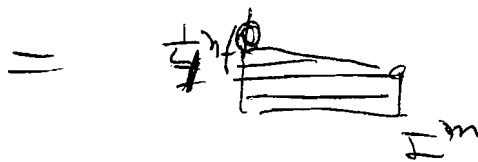
TOTAL RESEARCH INV. UNDERTAKEN BY MONOPOLIST.

π^m = TOTAL MONOPOLY PROFITS PER DOLLAR OF RESEARCH INVESTMENT = AREA BELOW $\pi^m(I)$ FROM ZERO TO $I^m = \frac{1}{2} \frac{n}{4}$





$S^{im} = \text{TOTAL CONS. SURPLUS} =$
 $= \text{AREA BELOW}$
 $r^m(I) \text{ FROM ZERO TO } I_m$



SOCIETY'S WELFARE GAIN

$$N = S + \pi - J$$

\downarrow
 NET GAIN FOR SOCIETY

\downarrow
 RESEARCH COST

OPTIMAL:

$$N^0 = S^0 + \underbrace{\pi^0}_0 - I^0 =$$

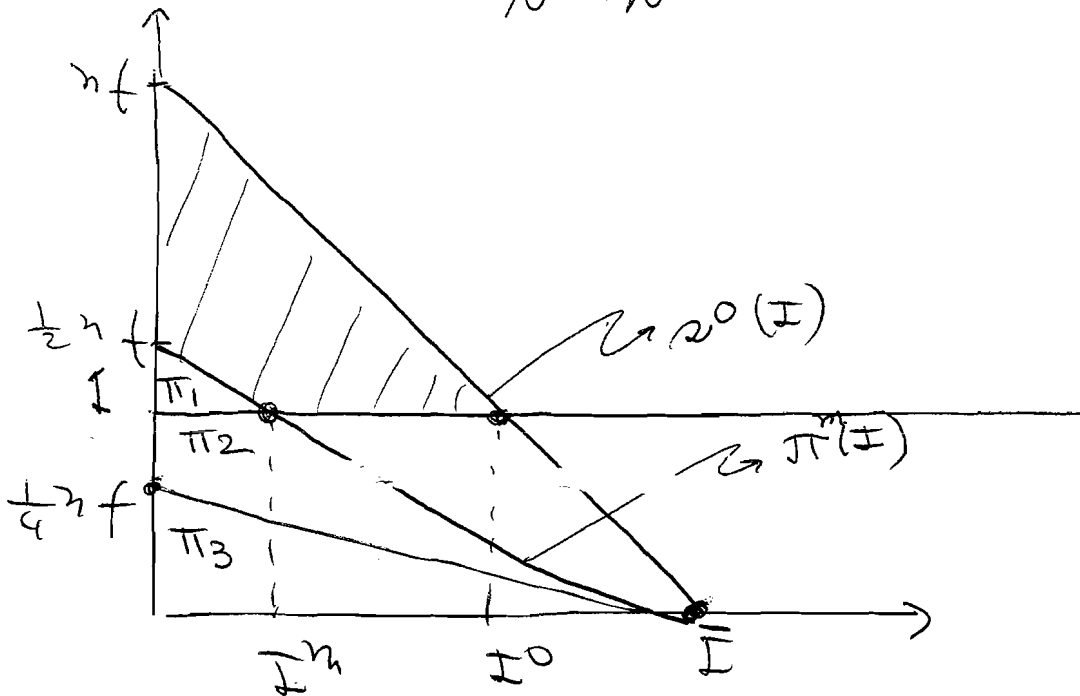
$I^0 \times 1 = \text{AREA OF RECTANGLE BASE } I^0 \text{ HEIGHT OF } 1.$

MONOPOLY

$$N^m = S^m + \pi^m - I^m$$

DEAD WEIGHT LOSS OF MONOPOLY:

$$N^0 - N^m$$



$$N^m = \underbrace{S^m}_{\pi_3} + \underbrace{\pi^m}_{\pi_1 + \pi_2 + \pi_3} - \underbrace{I^m}_{\pi_2 + \pi_3} = \pi_1 + \pi_3$$

DIAGRAM

$$N^0 = S^0 - I^0 = \pi_1 + \text{shaded triangle}$$

$$DWC = \text{shaded triangle} - \pi_3$$

III TWO COUNTRIES
MULTIPLE INVENTIONS

COUNTRY A: ALL INVENTIONS TAKE PLACE HERE

COUNTRY B: NO INVENTIONS / ONLY CONSUME GOODS.

ASSUME COUNTRY B IS SMALLER THAN COUNTRY A.

WE WILL STUDY 2 REGIMES:

① RESTRICTED PATENT PROTECTION

PATENTS ARE ONLY GRANTED IN COUNTRY A.
SINCE COUNTRY B DOES NOT HAVE PATENTS
LEVEL OF PRODUCTION IS AT $p=MC$

② EXTENDED PATENT PROTECTION

BOTH COUNTRIES GRANT PATENTS
(\Rightarrow MONOPOLY PRICING IN BOTH COUNTRIES)

① RESTRICTED PATENT PROTECTION (π)

SINCE PROFITS FROM COUNTRY B ARE ZERO, THE INVENTOR DECIDES HIS INVESTMENT LEVEL LOOKING ONLY AT π^A .

PROFIT MAXIMIZATION \Rightarrow

$\pi^A(I^A) \Rightarrow$ INVENTION LEVEL I^A IS THE SAME AS IN THE CLOSED ECONOMY CASE

COUNTRY: NET GAIN FOR SOCIETY:
A

$$\begin{aligned} N^A &= S^A(I^A) + \pi^A(I^A) - I^A \\ &= \underbrace{w_1}_{\text{See Fig 3}} + \underbrace{w_1 + \mu_2 + \mu_3} - (\mu_1 + \mu_2) \\ &= \boxed{w_1 + \mu_3} \end{aligned}$$

COUNTRY: ONLY CONSUMES \Rightarrow
B

NET GAIN FOR SOCIETY: $N^B = S^B(I^A) = \boxed{w_1 + \mu_2 + \mu_3}$

② EXTENDED PATENT PROTECTION

NOW THE FIRM DECIDES ON HIS INVESTMENT LEVEL LOOKING AT $\pi^A + \pi^B$.

PROFIT MAX \Rightarrow

$$\pi^A(I^e) + \pi^B(I^e) = 1$$

SO EXTENDING PATENT PROTECTION IN COUNTRY B INCREASES RESEARCH INVESTMENT SINCE THE NEW EQUILIBRIUM INVESTMENT LEVEL I^e IS LARGER THAN I^A .

COUNTRY A: NET GAIN FOR SOCIETY:

$$NAE = S^{MA}(I^e) + \pi^A(I^e) + \pi^B(I^e) - I^e$$

SEE FIG. 3

$$= \underbrace{w_1 + w_5}_{A} + \underbrace{w_1 + w_2 + w_3 + w_4 + w_5 + w_6 + w_7 + w_8}_{A} - \underbrace{(w_1 + w_2 + w_3 + w_4)}_{A}$$

$$= w_1 + w_3 + w_4 + w_5 + w_8$$

THIS IS LARGER THAN NA^A (SEE PAGE 7)

$$\text{SINCE } NA^A = w_1 + w_3$$

SO COUNTRY A GAINS WHEN PATENT PROTECTION IS EXTENDED

COUNTRY

B: NET GAIN FOR SOCIETY:

$$NBe = S^{MB}(I^e) = w_1 + w_4$$

COMPARING NBe WITH NB^B (SEE PAGE 7), WE SEE

$$\text{THAT } NB^B = w_1 + w_2 + w_3 > NBe = w_1 + w_4$$

SINCE

$$w_2 + w_3 > w_4 \quad (\text{LOOKING AT DIAGRAM})$$

SO COUNTRY B LOSES WHEN PATENT PROTECTION IS EXTENDED

HOW ABOUT WORLD WELFARE?

NEED TO COMPARE

GAINS FOR A: $w_4 + w_5 + w_8$

WITH

LOSSES FOR B: $w_4 - (w_2 + w_3)$

THE RESULT DEPENDS ON THE RELATIVE SIZES OF THE COUNTRIES -

IF COUNTRY A IS HUGE & B VERY SMALL
) EXTENDING PATENT PROTECTION \downarrow WELFARE -

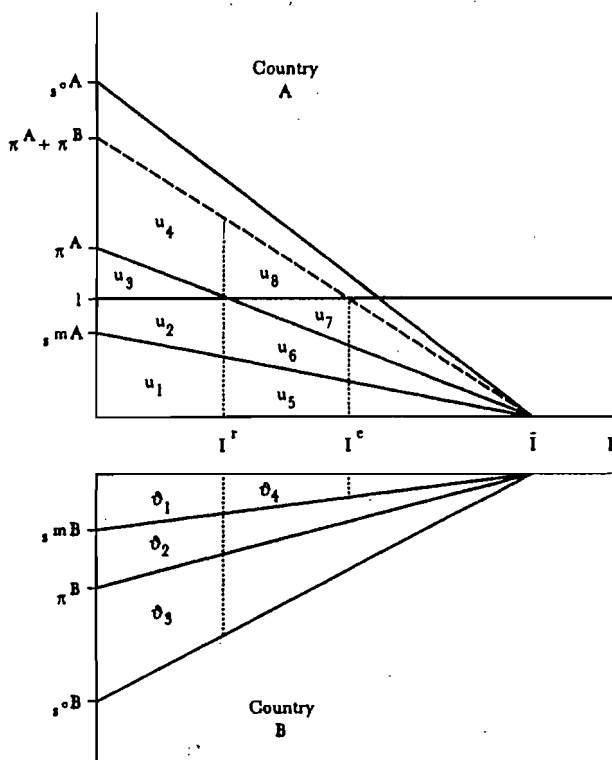


FIGURE 3. Welfare effects in two countries of inventions in one, with restricted and extended patent protection.