

# The Economics of Federal Reserve Monetary Policy

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Abstract

Keywords

JEL Classification

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# 1 Introduction





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## 2 Model

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$p_1; p_2$

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$$\begin{aligned}
& \left[ \frac{S_1}{1}; S_1 \geq S_1 \right] \\
& \left[ \frac{F_S S_1}{1} \right] \\
& \left[ \frac{U_1 - E_S}{1} \right] S_1 - S_1; \\
& \left[ \frac{E_S S_1 \leq S_1}{1} \right] ; e_2 - 2' \quad V_1 ; 2' - E_S S_1 S_1 \leq S_1 ; \\
& \left[ \frac{E_S S_1 \leq S_1}{1} \right]
\end{aligned}$$

fi

$$V_1 \left[ \frac{1}{p_1} \right] p_1; p_2 ; \left[ \frac{U_1}{e'} \right] \left( \left[ \frac{1}{1} \right]; D_1 p_1; p_2 ; ; D_2 p_1; p_2 ; \right) ;$$

$$\left[ \frac{\Pi_1 p_1; p_2 ;}{1} \right] \left[ \frac{U_1}{e' \neq e} \right] \left( \left[ \frac{1}{1} \right]; D_1 p_1; p_2 ; ; D_2 p_1; p_2 ; \right)$$

p1

$$\begin{aligned}
& \frac{\left[ \frac{1}{1} \right] p_1; p_2 ;}{@p_1} \\
& \left[ \frac{U_1}{e' \neq e} \right] \left[ \frac{1}{1} \right] \left[ \frac{1}{1} \right]; D_1 p_1; p_2 ; ; D_2 p_1; p_2 ; \frac{@D_1 p_1; p_2 ;}{@p_1} ; \\
& \left[ \frac{U_1}{e' \neq e} \right] \left[ \frac{1}{1} \right] \left[ \frac{1}{1} \right]; D_1 p_1; p_2 ; ; D_2 p_1; p_2 ; \frac{@-D_2 p_1; p_2 ;}{@p_1} ;
\end{aligned}$$

<sup>7</sup>See the Online Appendix for closed-form expressions for  $E[X_1 | X_1 \geq X_1(e')]$  in equation (1) and  $E_S[S_1 | S_1 \leq S_1(e')]$  in equation (2).

$$\begin{aligned}
 & \text{ } -D_2 p_1; p_2 \qquad D_2 p_1; \\
 & p_1 \qquad p_1 \qquad \text{fi} \\
 & \text{ } \text{fi} \text{ } 1 p_1; p_2 ; \\
 & \text{ } \text{fi} \text{ } p_1 \text{ } \text{ff} \\
 & \text{ } \text{fi} \text{ } p_1 \text{ } q_2 \\
 & \text{ } \text{fi} \text{ } q_1 \text{ } p_1 \text{ } q_2 \\
 & \text{ } \text{fi} \text{ } - \text{ } \text{ } \text{ } \\
 & p_1 \qquad q_1 \\
 & \text{ } \text{fi} \\
 & p_1 \qquad q_2 \\
 & \text{ } \text{fi}
 \end{aligned}$$

### 2.3 Learning-by-doing

The learning-by-doing process is modeled by the following set of equations:

$$e_n = \dots; M;$$

$$c e_n \left[ \begin{array}{l} \log_2 e_n \leq e_n < m; \\ \log_2 m \leq e_n \leq M; \end{array} \right]$$

<sup>8</sup>Empirical studies show that organizations can forget the know-how gained through learning-by-doing due to labor turnover, periods of inactivity, and failure to institutionalize tacit knowledge (Argote, Beckman & Epple 1990, Darr, Argote & Epple 1995, Benkard 2000, Shafer, Nembhard & Uzumeri 2001, Thompson 2007). Besanko et al. (2010) show that organizational forgetting predisposes firms to price aggressively. Omitting organizational forgetting from the model therefore "stacks the deck" against finding predation-like behavior.

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$$q_n = D_n \sum_{k=0}^{\infty} \frac{-p_n}{-p}^k;$$

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$$\Pi_1(p_1; p_2) = -p_1 - c e_1 D_1(p_1; p_2) U_1$$

$$D_1(p_1; p_2) U_1 e_1 + e_2 - U_1 \quad D_2(p_1; p_2) U_1 e_1; e_2 - U_1$$

$$\Pi_1(p_1; p_2) = p_1 \quad p_2$$

$$mr_1(p_1; p_2) = -c e_1 U_1 e_1 + e_2 - U_1 \quad p_2 U_1 - U_1 e_1; e_2 -$$

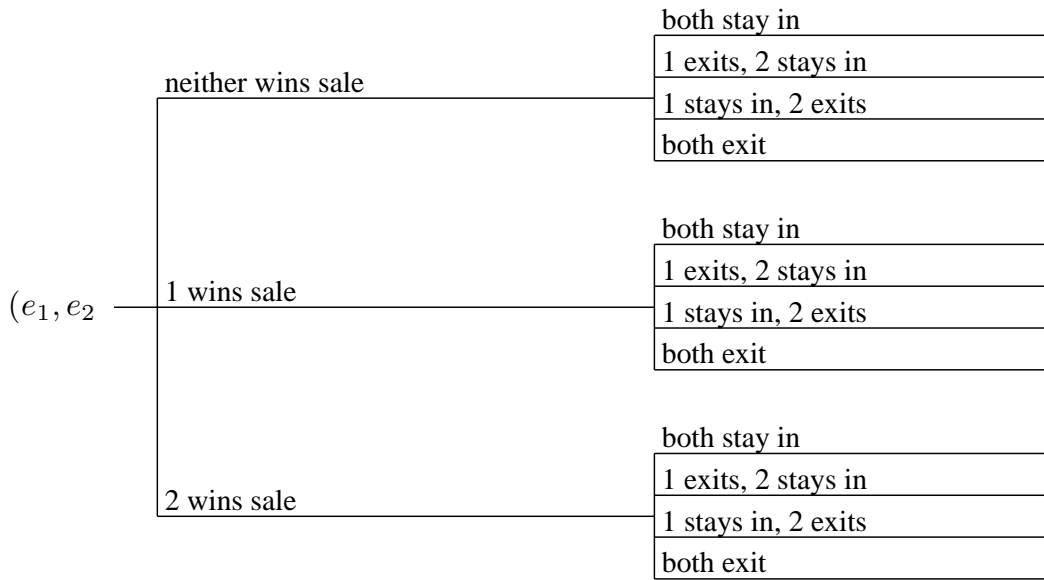
<sup>9</sup>We obviously have to ensure  $e_n \leq M$ . To simplify the exposition we abstract from boundary issues in what follows.

<sup>10</sup>Formally, our learning-by-doing model is a special case of the general model with the probability that the industry's state changes from  $e$  to  $e'$  during the price-setting phase set to

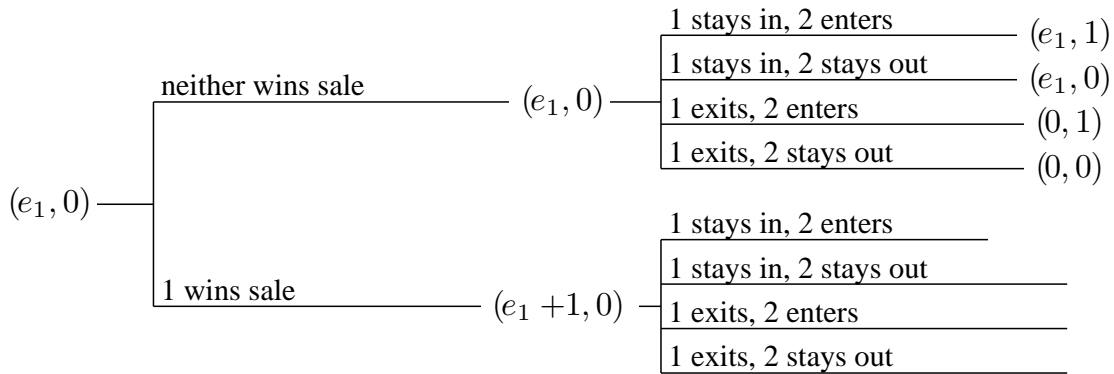
$$\Pr(e'|e; q) = \begin{cases} q_1 & \text{if } e' = (e_1 + 1; e_2); \\ q_2 & \text{if } e' = (e_1; e_2 + 1); \\ 1 - q_1 - q_2 & \text{if } e' = e; \end{cases}$$

where  $q_n$  is the probability that incumbent firm  $n$  makes the sale as given in equation (6).

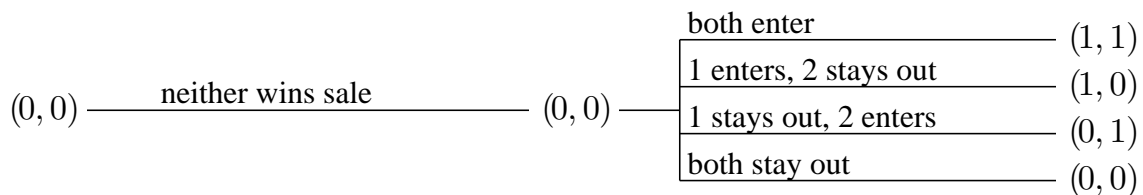
e — price-setting phase —> e — exit-entry phase —> e  
**duopoly: both firms are incumbents**



**monopoly: firm 1 is incumbent, firm 2 is entrant**



**empty: both firms are entrants**



$$m r_1(p_1; p_2) = \frac{p_1}{1 - D_1(p_1; p_2(e))}$$

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### 3 Equilibrium and computation

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$e_1; e_2$     $ff$     $-e_1; e_2$     $ff$

$H x; !$     $H^{-1} !$     $-x H x; !$     $H x; !$     $-x H x; !$

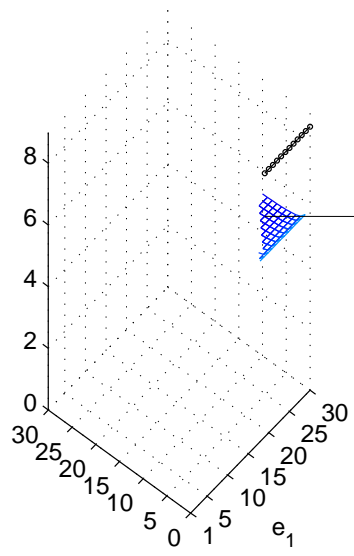
$H^{-1} !$     $-x H x; !$     $H x; !$     $x; !$

$H^{-1} !$     $-x H x; !$     $H x s; ! s$

$\frac{\partial H(x(s);! (s))}{\partial x} X' S$      $\frac{\partial H(x(s);! (s))}{\partial x} !' S$      $X S ;! S$   
 ff     $X$      $H X ;!$   
 $H^{-1} !$      $-x ;!$      $H X ;!$      $H X ;!$   
 $\omega$      $;\bar{X};::: 15$      $-V_1; 1; 1;\phi_1$      $-1 \omega$   
 $;\omega$      $\phi_1$   
 $-1$







$\dots$ ;  $T$   $\dots$   $\dots$  fi  $\dots$   $\dots$   $\dots$   $\dots$  fi  $\dots$   $\dots$

$p_1$  ;  $\phi_1$  ;  $T$  ;  $\mu^T$  ;  $\mu^{1000}$  ;  $\mu^\infty$  ;  $T$  ;  $\mu^T$

assesses its prospects in the industry. In this particular equilibrium,  $\mu_2(e_1; 0) = 1.00$  for  $e_1 \in \{2; \dots; 30\}$ , so that the potential entrant does not enter if the incumbent firm has moved down from the top of its learning curve.

<sup>19</sup>The multiple closed communicating classes that may arise for a particular equilibrium are conceptually different from multiple equilibria. A closed communicating class is a set of states from which there is no escape once the industry has entered it. The transient distribution in period 1000 accounts for the probability of reaching any one of these classes, starting from state (1,1) in period 0.

$T$	$p_1$	$p_2$	1	2	$\ddot{p}_1$	$\ddot{p}_2$	1	2
-----	-------	-------	---	---	--------------	--------------	---	---

$$\bar{p} = \sum_{n=1}^{\infty} \frac{D_n p_1 ; p_2}{D_1 p_1 ; p_2 + D_2 p_1 ; p_2} p_n ;$$

where  $E$  is the expected value of  $\bar{p}$  given by:

$$E[\bar{p}] = \sum_{e=1}^{\infty} CS(e) ;$$

where  $CS(e)$  is the expected value of  $\bar{p}$  given by:

$$E[\bar{p} | CS(e)] = \sum_{n=1}^{\infty} PS_n ;$$

where  $PS_n$  is the expected value of  $\bar{p}$  given by:

$$E[\bar{p} | PS_n] = \sum_{T=0}^{\infty} TS^T ;$$

where  $TS^T$  is the expected value of  $\bar{p}$  given by:

$$E[\bar{p} | TS^T] = \sum_{n=1}^{\infty} PS_n ;$$

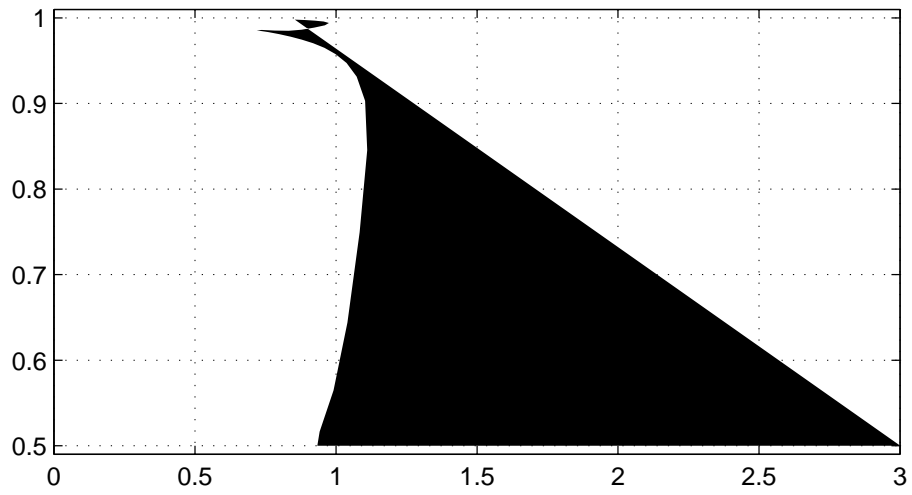
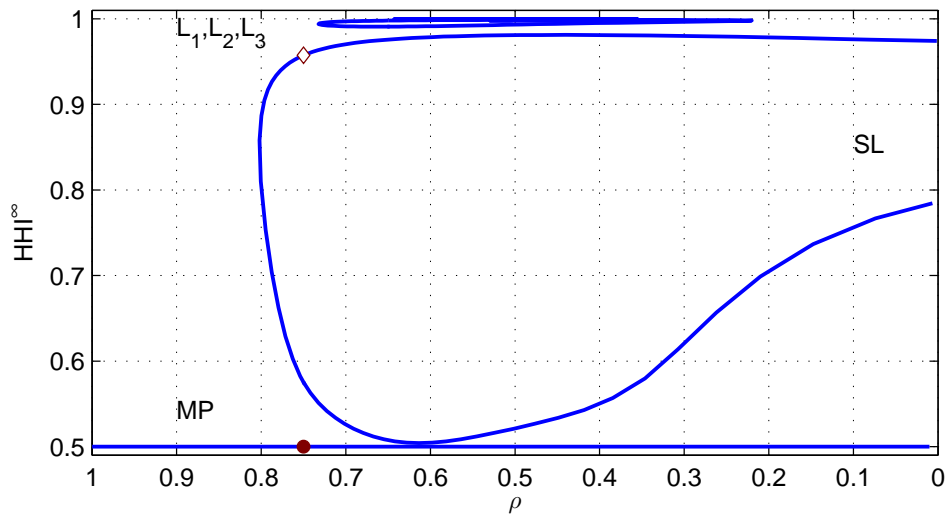
where  $\mu^0$  and  $\mu^1$  are the expected values of  $CS^{NPV}$  and  $TS^{NPV}$  respectively, given by:

$$E[\bar{p} | \mu^0, \mu^1] = \sum_{e=1}^{\infty} CS(e) ;$$

<sup>20</sup>See the Online Appendix for expressions for  $CS(e)$  and  $PS_n(e)$ .

$HHI^\infty$		
$\bar{p}^\infty$		
$CS^\infty$		
$TS^\infty$		
$CS^{NPV}$		
$TS^{NPV}$		

## 4.2 Equilibrium correspondence



$I \sim \text{ff} \sim \text{ff} \cdot \quad \text{ff} \quad \text{ff} \quad \text{HHI}^\infty$   
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## 5 Isolating predatory incentives

The first part of the proof shows that the incentive to engage in predatory pricing is positive. To see this, note that the profit function is given by
 
$$\Pi_1(p_1; p_2) = \frac{p_1 - c_1}{p_1} \left( \frac{p_1 - c_1}{p_1} \right)^{\frac{1}{\sigma_1}} \left( \frac{p_2 - c_2}{p_2} \right)^{\frac{1}{\sigma_2}}$$
 where  $c_1$  and  $c_2$  are the marginal costs of the two firms. The first-order condition for the profit function with respect to  $p_1$  is
 
$$\frac{\partial \Pi_1(p_1; p_2)}{\partial p_1} = \frac{1}{p_1^2} \left( \frac{p_1 - c_1}{p_1} \right)^{\frac{1}{\sigma_1} - 1} \left( \frac{p_2 - c_2}{p_2} \right)^{\frac{1}{\sigma_2}} > 0$$
 which implies that the profit function is increasing in  $p_1$ . This means that the firm has an incentive to raise its price, which is the opposite of the usual result in a standard Bertrand competition.

The second part of the proof shows that the incentive to engage in predatory pricing is positive. To see this, note that the profit function is given by
 
$$\Pi_1^0(p_1; p_2) = \frac{p_1 - c_1}{p_1} \left( \frac{p_1 - c_1}{p_1} \right)^{\frac{1}{\sigma_1}} \left( \frac{p_2 - c_2}{p_2} \right)^{\frac{1}{\sigma_2}}$$
 where  $c_1$  and  $c_2$  are the marginal costs of the two firms. The first-order condition for the profit function with respect to  $p_1$  is
 
$$\frac{\partial \Pi_1^0(p_1; p_2)}{\partial p_1} = \frac{1}{p_1^2} \left( \frac{p_1 - c_1}{p_1} \right)^{\frac{1}{\sigma_1} - 1} \left( \frac{p_2 - c_2}{p_2} \right)^{\frac{1}{\sigma_2}} > 0$$
 which implies that the profit function is increasing in  $p_1$ . This means that the firm has an incentive to raise its price, which is the opposite of the usual result in a standard Bertrand competition.

The third part of the proof shows that the incentive to engage in predatory pricing is positive. To see this, note that the profit function is given by
 
$$\Pi_1^0(p_1; p_2) = \frac{p_1 - c_1}{p_1} \left( \frac{p_1 - c_1}{p_1} \right)^{\frac{1}{\sigma_1}} \left( \frac{p_2 - c_2}{p_2} \right)^{\frac{1}{\sigma_2}}$$
 where  $c_1$  and  $c_2$  are the marginal costs of the two firms. The first-order condition for the profit function with respect to  $p_1$  is
 
$$\frac{\partial \Pi_1^0(p_1; p_2)}{\partial p_1} = \frac{1}{p_1^2} \left( \frac{p_1 - c_1}{p_1} \right)^{\frac{1}{\sigma_1} - 1} \left( \frac{p_2 - c_2}{p_2} \right)^{\frac{1}{\sigma_2}} > 0$$
 which implies that the profit function is increasing in  $p_1$ . This means that the firm has an incentive to raise its price, which is the opposite of the usual result in a standard Bertrand competition.

$$\frac{p_1 - c e_1 D_1(p_1; p_2)}{\partial_{(-p_1)} U_1(e_1; e_2)} > \frac{\partial_{(-p_1)} U_1(e_1; e_2)}{\partial_{(-p_1)} U_1(e_1; e_2)} >$$

$$\frac{\partial_{(-p_1)} U_1(e_1; e_2)}{\partial_{(-p_1)} U_1(e_1; e_2)} > \frac{\partial_{(-p_1)} U_1(e_1; e_2)}{\partial_{(-p_1)} U_1(e_1; e_2)}$$

$$\rightarrow \frac{\partial_{(-p_1)} U_1(e_1; e_2)}{\partial_{(-p_1)} U_1(e_1; e_2)} > \frac{\partial_{(-p_1)} U_1(e_1; e_2)}{\partial_{(-p_1)} U_1(e_1; e_2)}$$

$$\frac{\partial_{(-p_1)} U_1(e_1; e_2)}{\partial_{(-p_1)} U_1(e_1; e_2)} > \frac{\partial_{(-p_1)} U_1(e_1; e_2)}{\partial_{(-p_1)} U_1(e_1; e_2)}$$

$$\begin{aligned} & \left( \frac{c e_1}{U_1 e_1} \right)^{\alpha} (e_2 - U_1) \quad ; \quad m r_1 p_1 ; p_2 < c m \\ & \left( \frac{c e_1}{U_1 e_1} \right)^{\alpha} (e_2 - U_1) \quad ; \quad m r_1 p_1 ; p_2 < c e_1 \left( \frac{c e_1}{U_1} \right)^{\alpha} \end{aligned}$$

	$f_1$	$f_2$	$f_3$	$f_4$	$f_5$	$f_6$	$f_7$	$f_8$	$f_9$	$f_{10}$
$\Gamma_1^1$	$V_1$	$e_1$	$\times$	$e_2$	$-$	$V_1$				
$\Gamma_1^2$	$V_2$	$e_1$	$\times$	$e_2$	$-$	$V_2$				

$\times V_1 e_1 \times e_2 - V_1$   
 $\times V_2 e_1 \times e_2 - V_2$

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$\Gamma_1^1$  ;

$e_1$ ;

$\Theta_1^1 e_1$ ;

$\Gamma_1^2$  ;

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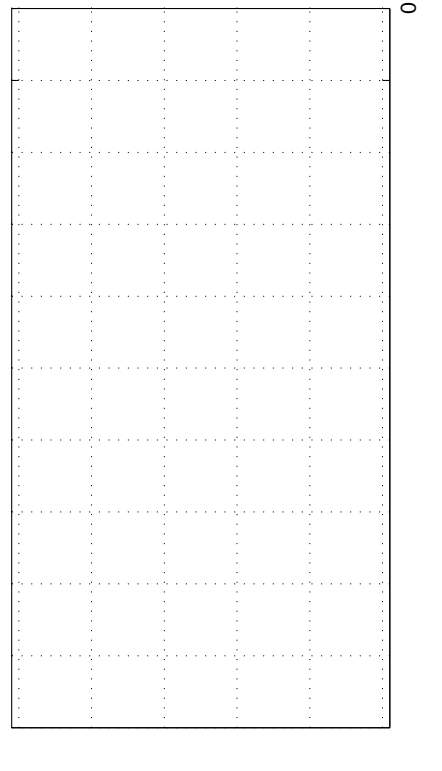
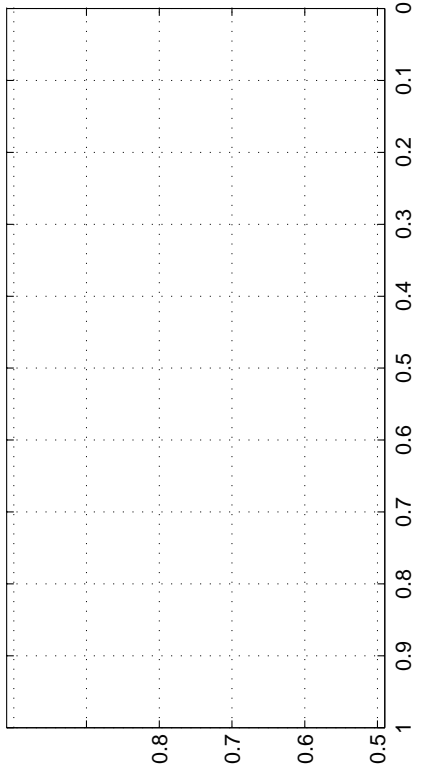
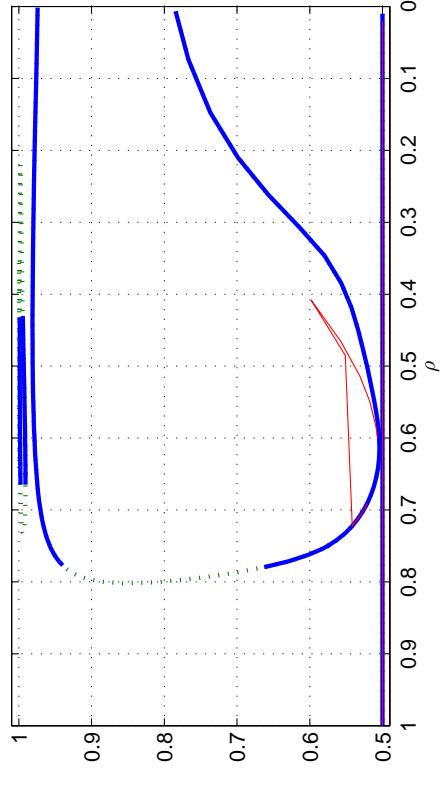
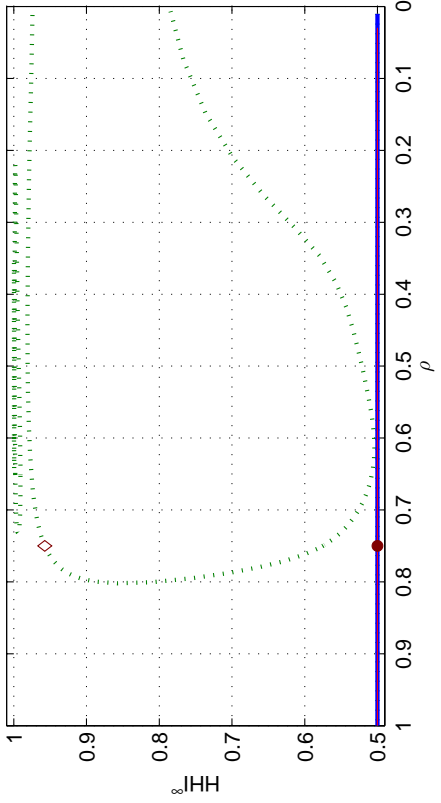
$p_1$	$c_{e_1}$	$\Gamma_1^1$	$\Gamma_1^2$	$\Gamma_1^3$	$\Gamma_1^4$	$\Gamma_1^5$	$\Theta_1^1$	$\Theta_1^2$	$\Theta_1^3$	$\Theta_1^4$	$f_i$			
											✓✓	✓✓	✓✓	✓
											✓✓	✓✓	✓✓	✓✓
											✓✓	✓✓	✓✓	✓✓
											✓✓	✓✓	✓✓	✓✓
											✓✓	✓✓	✓✓	✓✓

$$\begin{aligned}
 & \text{fi } \Xi_1(p_1; p_2) : -mr_1(p_1; p_2) - c e_1 \left[ \begin{aligned} & \text{fi } \Theta_1^k \quad -U_1 - U_1 e_1; e_2 \quad \text{fi} \\ & \text{fi } \Gamma_1^k \quad -mr_1(p_1; p_2) \end{aligned} \right] \\
 & c e_1 \nearrow U_1 e_1 \nearrow; e_2 - U_1 \quad \text{fi}
 \end{aligned}$$

### 6.1 Counterfactual and equilibrium correspondences

$$\begin{aligned}
 & \text{fi } ; \bar{X} \quad ; \bar{X} \quad \text{fi} \\
 & \text{fi } \text{fi} \quad \text{fi} \quad \text{fi} \quad \text{fi} \\
 & \text{fi} \quad \text{fi} \quad \text{fi}
 \end{aligned}$$





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$HHI^{\infty}$   $\rightarrow$   $HHI^{\infty}$

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$HHI^{\infty}$   $\rightarrow$   $HHI^{\infty}$

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ff

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$\bar{X}$

$HHI^{\infty}$   $\rightarrow$

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	;		;		;
	%	%	%	%	%
	%	%	%	%	%
HHI <sup>∞</sup>					
p <sup>∞</sup>					
CS <sup>∞</sup>					
TS <sup>∞</sup>					
CS <sup>NPV</sup>					
TS <sup>NPV</sup>					

$$X = \frac{1}{n} \sum_{i=1}^n x_i$$

$$X^2 = \frac{1}{n} \sum_{i=1}^n x_i^2$$

$$s^2 = \frac{1}{n} \sum_{i=1}^n x_i^2 - X^2$$

$$s = \sqrt{s^2}$$





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;X;	;X;	;	

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1. The first part of the document discusses the importance of maintaining accurate financial records. It emphasizes that proper bookkeeping is essential for understanding the financial health of a business and for making informed decisions.

2. The second part of the document focuses on the calculation of various financial metrics. These include:

- $CS^{\infty}$  (Cash Flow)
- $TS^{\infty}$  (Total Sales)
- $TS^{NPV}$  (Total Sales Net Present Value)
- $CS^{NPV}$  (Cash Flow Net Present Value)

The document provides detailed explanations of how these metrics are derived and how they relate to the overall performance of the business. It also discusses the impact of different financial strategies on these metrics.

3. The final part of the document concludes by summarizing the key findings and providing recommendations for businesses looking to optimize their financial performance. It stresses the importance of regular financial reviews and the use of advanced financial modeling techniques.





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