

WORKING PAPERS

A BIDDING ANALYSIS OF SPECIAL INTEREST REGULATION REVISITING RIVALRY COSTS IN A RENT SEEKING SOCIETY

Steven C. Salop, David E. Schefman, and Warren Schwartz

WORKING PAPER NO. 114

September 1984

The Bureau of Economic Analysis working papers are preliminary materials and are not suitable for distribution outside the Bureau. A full and final version of the paper is published in the *Journal of Economic Surveys*. The information contained in this paper is preliminary and is not to be used for official purposes. The views and conclusions are those of the author(s) and do not necessarily reflect the views of the members of the Bureau of Economic Analysis or the Commission on the Organization of the Executive Branch of the Government. The information contained in this paper is preliminary and is not to be used for official purposes. The views and conclusions are those of the author(s) and do not necessarily reflect the views of the members of the Bureau of Economic Analysis or the Commission on the Organization of the Executive Branch of the Government.

BUREAU OF ECONOMIC ANALYSIS
FEDERAL TRADE COMMISSION
WASHINGTON, DC 20580

A BIDDING ANALYSIS OF SPECIAL INTEREST REGULATION:

RIISING RIVERS' COSTS IN A RENT SEEKING SOCIETY ******

$$\frac{dL}{d\tau} = \frac{1}{\Delta} \left[\frac{\partial L}{\partial \tau} + \frac{\partial L}{\partial \tau} \frac{\partial \tau}{\partial \tau} \right]$$

$$\frac{dL}{d\tau} = \frac{1}{\Delta} \left[\frac{\partial L}{\partial \tau} + \frac{\partial L}{\partial \tau} \frac{\partial \tau}{\partial \tau} \right]$$

$$\frac{dL}{d\tau} = \frac{1}{\Delta} \left[\frac{\partial L}{\partial \tau} + \frac{\partial L}{\partial \tau} \frac{\partial \tau}{\partial \tau} \right]$$

***** $\frac{dL}{d\tau} = \frac{1}{\Delta} \left[\frac{\partial L}{\partial \tau} + \frac{\partial L}{\partial \tau} \frac{\partial \tau}{\partial \tau} \right]$

****** $\frac{dL}{d\tau} = \frac{1}{\Delta} \left[\frac{\partial L}{\partial \tau} + \frac{\partial L}{\partial \tau} \frac{\partial \tau}{\partial \tau} \right]$

^Š w'~"i fff'~'~

w' ~L' 1 Ž° Ž " ' %' ~ž ~'ž ~L " ~' 1 ~"°~l1 ~' " ~'~ // f~f'°/
l * /~ž! ~'~'~ "l " ~'ž°~ ° %~' " f~l "1 ~"°~l'~ž ~' " ~L
Ž" fl 11 ~L" fžL 'L' flL " ~"!1 °~' !Ž' ~' " °//D " ~'~1 %\$ ~'°~'~ž
" žf/°~'~' ~'L' flL ' !Ž" * 1 ~L " fl!Ž ~'~'~* Ž' 1 ~'~'~' + y' ~' " ~L
~' ~' %l' 1 ~' " ' ~'2 fž~' ~'L' flL ' l"°' l °/1 ' ~'L ° ŽL ~'! ~'~'
2~' ' ~' °1 U' ~' 1 2'~ž(U %\$ U1 Ž fl'°/ ~'~' " 1~U " žf/°~'~'~' + w'
" flfl 1 ~' ~'L " " ~'~'1 ~' " Ž"~'~'°~' °ž ~'†1 ~'ž°~' " ~'~'1 %\$
%/ fl2'~ž ~'~'~' \$ ~L" fžL ž' * ~'! ~'~'°/ °f~'~'~' + bL

C aQ

J8°!Ž/ 1 ~ fl/fl ~*~! ~°/ ~ žf/°~ ~°l / ž'1/°~
!Ž,1~ž " :fi" ! ~1 " ~L 1°" ~\$ °~l ""·fl°fl\$ " "l °~l
l~fiž1+ bL " 1(L' * "(/°°/ l ~"!~°°~* !Ž'~·fl°/ *·l7
~fl " 1fflL " ~ 1 2~ž(°° / °1~ °1 ~L 8fl/fl ~* 8Ž/°~°~
" ~ 1fflL / ž'1/°~°~+ H" ~* "(~L " 1 ° Ž/°fl ~% °/~ ~°°~*
8Ž/°~°~°~ " ~L 1 ~\$



) n 5L J" " fl" " A fl" °1 l > žfi/°° &_ ~ _) O1 > 1& fi° / W!°~l
Ffi" 6

5L " 1& fi° / l !°~l ffi" 6 " fl&ž) & 1& Ž/ S ~L L_ " &D_ ~°° /
l & " " ~fl % ~' ~ & l fi ~ ~ S l !°~l °~l ž" _ fiŽ / O1 1 fiŽŽ/ S(&n n(
> -Ž(" . = W Ž. a c / -Ž(" . n A" °° & fl" °1 & " žfi/°° &_ ~ 1 L&" ~1 / O1
1 fiŽŽ/ S ffi" 6 fiŽ ~ _ ~L / " (~L& L°1 ~L " " fl" _ " 1 L&" ~ & fiŽ
/ O1 " 1& fi° / l !°~l ffi" 6 (~L " %\$ & Ž" _ 6&ž & 1 Ž" _ " &
_ ŽŽ" _ ~ fi" & & 1 n 5_ & / fi ~ ~ °° (fl_ ~ 1& " " & 1 ~ ° 1& fi" ~ &_ ~ &
' L&flL ~L !°~2 ~ l !°~l ffi" 6 & Ž " " fl" / S & / °1 ~ & fl °° Wn A
€&žfi" 1(> &) O1 " 1& fi° / l !°~l ffi" 6 " _ " žfi/°° &_ ~ " n A
" žfi/°° &_ ~ & & fl" °1 l ~ _ " O(/ O1 1 fiŽŽ/ S ffi" 6 1 L&" ~1 % fl2 ~ _
/ -Ž(" O °~l) O1 " 1& fi° / l !°~l ffi" 6 1 L&" ~1 fiŽ ~ _ > O n i _ ~ & fl
~ L° ~ ~L " 1& fi° / l !°~l ffi" 6 1 L&" ~1 fiŽ °° ° flL Ž" ~ ~ & fl / °°
_ fi ~ Žfi" / 6 / ° " _) (%\$ 8° fl" / S ~L fiŽ' °° l 1 L&" ~ & / O1 1 fiŽŽ/ S
ffi" 6 °° _ fi ~ Žfi" % = W 7 ° n

F_ ~ 1& " ~ 8° ~L fl°1 _ " ° l _ ' ~ ' °° l 1 / _ Ž&ž !°~2 ~ l !°~l
ffi" 6 & / fi ~ ~ °° l & Q&žfi" 9n A ~ L& fl°1 (~L fiŽ' °° l 1 L&" ~ &
~L " 1& fi° l !°~l ffi" 6 & 6 " S' L " / 11 ~L° ~ ~L fiŽ' °° l
1 L&" ~ & / O1 1 fiŽŽ/ S ffi" 6 n R&L ° l _ ' ~ ' °° l 1 / _ Ž&ž l !°~l (&
& fl" °1 1 & Ž" & fl fl° ~ _ / S °° & " _ ! " l ffl" &_ ~ 1 & °žž" ž°°
_ fi ~ Žfi" â) ~ ~L 8° " ! ~L " ° l " fl° ~ " ° l & / S fl_ ~ " & ! ~L° ~ (&
~L !°~2 ~ l !°~l ffi" 6 & Ž " " fl" / S / °1 ~ & fl() O1 " 1& fi° / l !°~l
ffi" 6 ' & / ~ _ ~ 1 L&" ~ fiŽ °° ° // n

5L 8° ~ ~ _ " ~L 6 ~ ~ & fl° / 1 L&" ~ &) O1 " 1& fi° / l !°~l
ffi" 6 fl° ~ % l ~ & 6 l " _ !) O1 & 6 ~ 1 " 1& fi° / l !°~l ffi" 6 (&
ž&6 ~ %\$ ~L & Ž/ & fl& : fi" ~ &_ ~ (

Fig 1

p

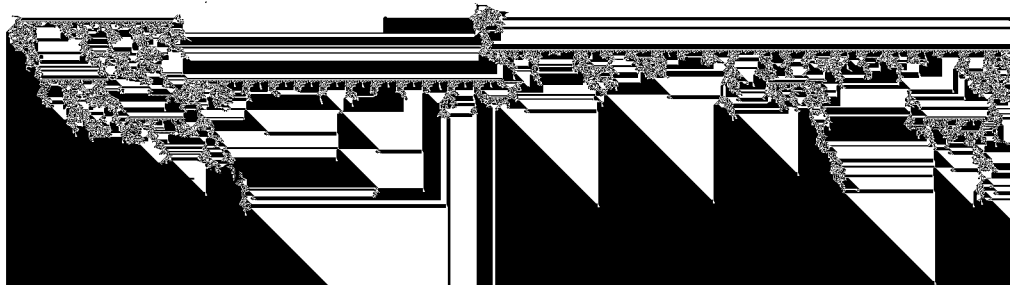
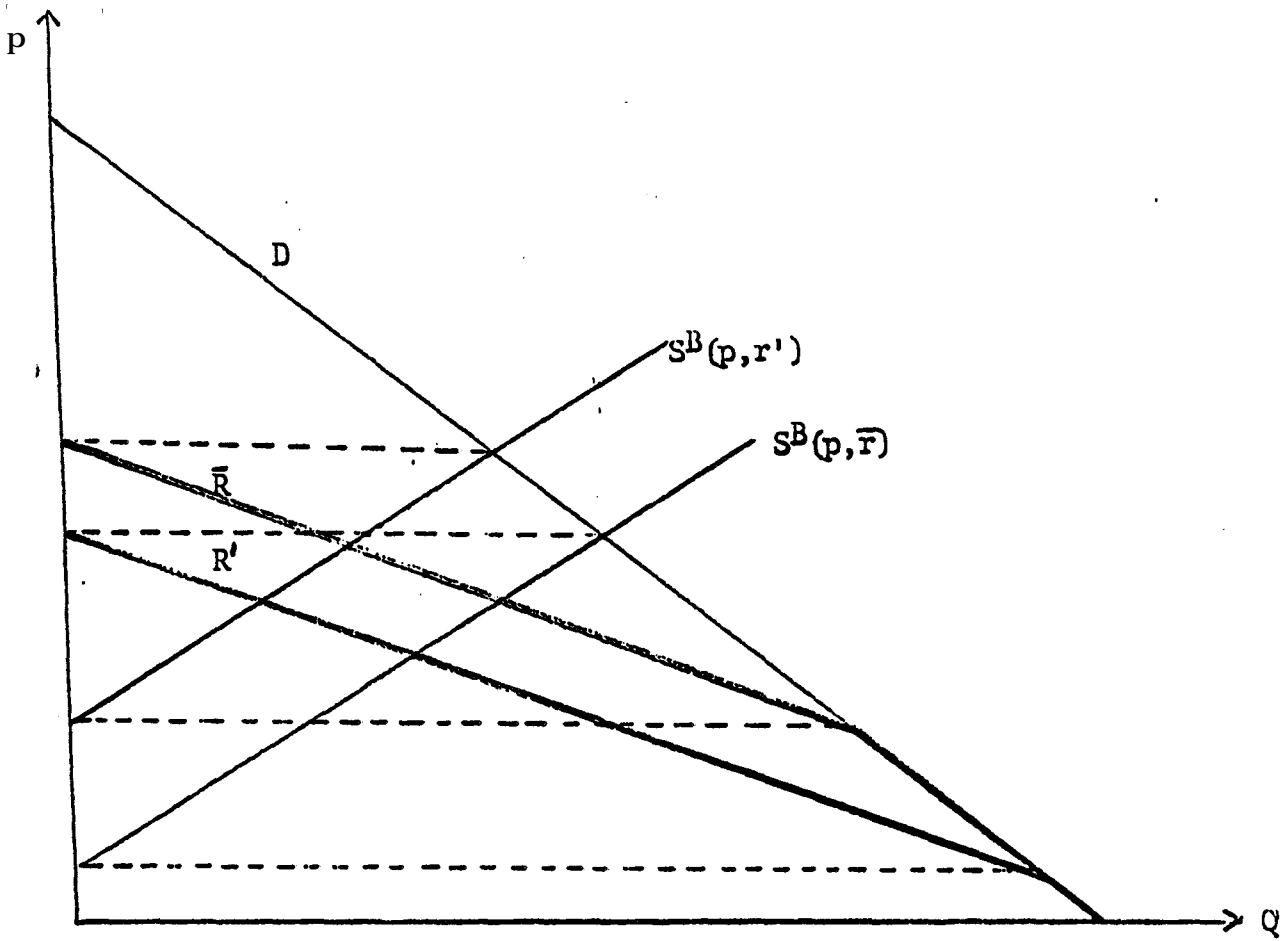
I /

B
s (,r'l
B
s (,r

.....

Q

Fig e 2



R ' // 1 ! ~ ! 1 ' ~ ~ ~ ~ L 1 fižž/\$ " fi fl ~ ~ ~ ~ " ž ~ fiž) ° 1
) -ž(~ . (' L ~ c) v 1V) // c) v 7) 19V) 11-

Q ~ 1 ! ž / fl ~ S (' ° 11 fl ! ~ L ~ : fi / ~ % ~ ~ 6 / 6 ž 1 ~ ~ 6
fi ž fi ~ 1 " ~ % ~ L) ° ~ l / 4 5L ~ " ~ ° ~ S " ž fi / ° ~ ~ ~ ~ (~ L ! ° ~ 2 ~
: fi / ~ % ~ fi ! ~ 1 ž ~ 6 ~ % S ~ L ~ L ~ 1 ~ ° ~ l ° ~ l : fi ~ ~ ~ ~ 1 (

- . ž v) / - ° (~ .

- . . ž v / 1 - % (~ . - Z

- . . . ž v " - ° j %

5L " " fl ~ ~ " ° ~ ~ fl ° 1 ~ ~ " ž fi / ° ~ ~ ~ ~ ~ L : fi / ~ % ~ fi !
6° / fi 1 ~ " -ž(° (% fl ° ~ % l ~ " ! ~ l % S l ~ " " ~ ~ ~ ~ ~ ž : fi ~ ~ ~ ~
1 \$ l ~ ! -Z ' ~ ~ L ~ 1 ž fl ~ ~ ~ 4) / ~ L fiž L ~ L ° / ž % ° ~ 1 ~ l ~ fl (~
~ L ~ 1 fi / ~ 1 ° ~ 1 ~ ~ ~ ž L ~ " ~ ~ ~ l 4 A ~ ~ l ~ ~ ~ 1 ! ž / ~ " S (' ' //
~ ~ ~ ~ l fi fl ~ L " // ~ ~ ž ~ ~ ~ ~ ~ 4

i ~ ~ ~ ~ ~

^W K ~ fl J / ° 1 ~ fl ~ S ~ " H ~ 2 ~ W ! ° ~ l - ° % a ~ / fi ~ 6° / fi .

^) K ~ fl J / ° 1 ~ fl ~ S ~ ") O i < fižž / \$

^ / K ~ fl J / ° 1 ~ fl ~ S ~ " / Ō i < fižž / \$

o) O i H ~ 2 ~ < L ° ~ - ° V } . -

^ < K ~ fl J / ° 1 ~ fl ~ y ~ " 5 ~ ° / H ~ 2 ~ - . 4 4 () j / .
c fižž / S - ^ < v u A j - 1 mu . ^ / .

W " " ~ ~ ~ ~ ~ ž -Z , ~ L fl ! ž ° ~ ~ ~ 6 1 ~ ~ ~ fl ~ ° ž ~ 6 ~ ° 1

" // ~ ' 1 '

$$\therefore I^{\circ VI} = (\delta Q \epsilon^A / p) \left[\frac{(B_{12} - A_{12})(1 - \delta) \epsilon^B - A_{12} \epsilon^D}{(\delta \epsilon^A + (1 - \delta) \epsilon^B) \epsilon^D} \right]$$

... I %VI "

I ŽVI " _____

_____ ϵ^S

BM" cH < u) 19j -/7u. / 19 ' 4 4(~L !°"2 ~71 L°" 7B 'žL~ I

°* "°ž flL°ž ~ !°"ž'°/ fl,1 ~ 4 5Lfn (~L

-

$\dot{z} = \dot{z}_1 + \dot{z}_2$
 $\dot{z}_1 = \dot{z} - \dot{z}_2$
 $\dot{z}_2 = \dot{z} - \dot{z}_1$
 $\dot{z}_1 = \dot{z} - (\dot{z} - \dot{z}_1)$
 $\dot{z}_1 = \dot{z} - \dot{z} + \dot{z}_1$
 $\dot{z}_1 = \dot{z}_1$

$$\dot{z}_1 = \dot{z} - \dot{z}_2$$

- 1P.

$$\dot{z}_1 = \dot{z} - \dot{z}_2$$

W&" " " ~ ~ & ~ & ž : fi° ~ & ~ - 11. (~ L & fl° ° 1 & ~ ~ L 1 fižž/\$ ž" &fl
 " fi° fl° & ~ " ~ " ° ~ \$ " &8 l ~ fi° žfi° -&4 4(~ L * ~ ~ &fl° / 1 L¾' ~ & ~ ~ L
 ! ° ~ 2 ~ 1 fižž/\$ ffi" * . &a ž&* ~ %\$

$$\partial p_S / \partial r = \frac{ud)) 19j - / 7u. d' / 19}{-udä - 17u. d' /} \quad - 19.$$

~ ! ž° ~ & ž - 19. ° ~ l - N (& " // ' 1 ~ L° ~ l žVl" sž<, s" (&4 4(~ L & fl° ° 1 & : fi& % & fi! ž" &fl fi° ~ ~ ~ 8fl l ~ L
 * ~ ~ &fl° / 1 L&" ~ & ~ ~ L ! ° ~ 2 ~ 1 fižž/\$ ffi" * 4 q1 & ž ~ L&a "° fl° &
 fl ~ fi° fl° & ~ ' & L : fi° ~ & ~ - 1P. (' L° * ~ L " // ' & ž ~ fl 11 ° ~ \$
 fl ~ l & & ~ 1 (

fi† ~ 1P-

- & ~ l Ä) , l ~ > P ~ : fi& ~ 1 sž<, s" ≥) 9V°

- && ~ l Ä / , l ~ > P ~ : & ~ 1 sž< s" ≥ / 9V%

9 ° 1

< fi! ! ° ~ & D& ž : fi° ~ & ~ - 1P. ° ~ l - 1E. (' L° * ~ L " // ' & ž
 ; l 1 fi / ~ ê L! ° 1 a V& - ŸÚ! sf

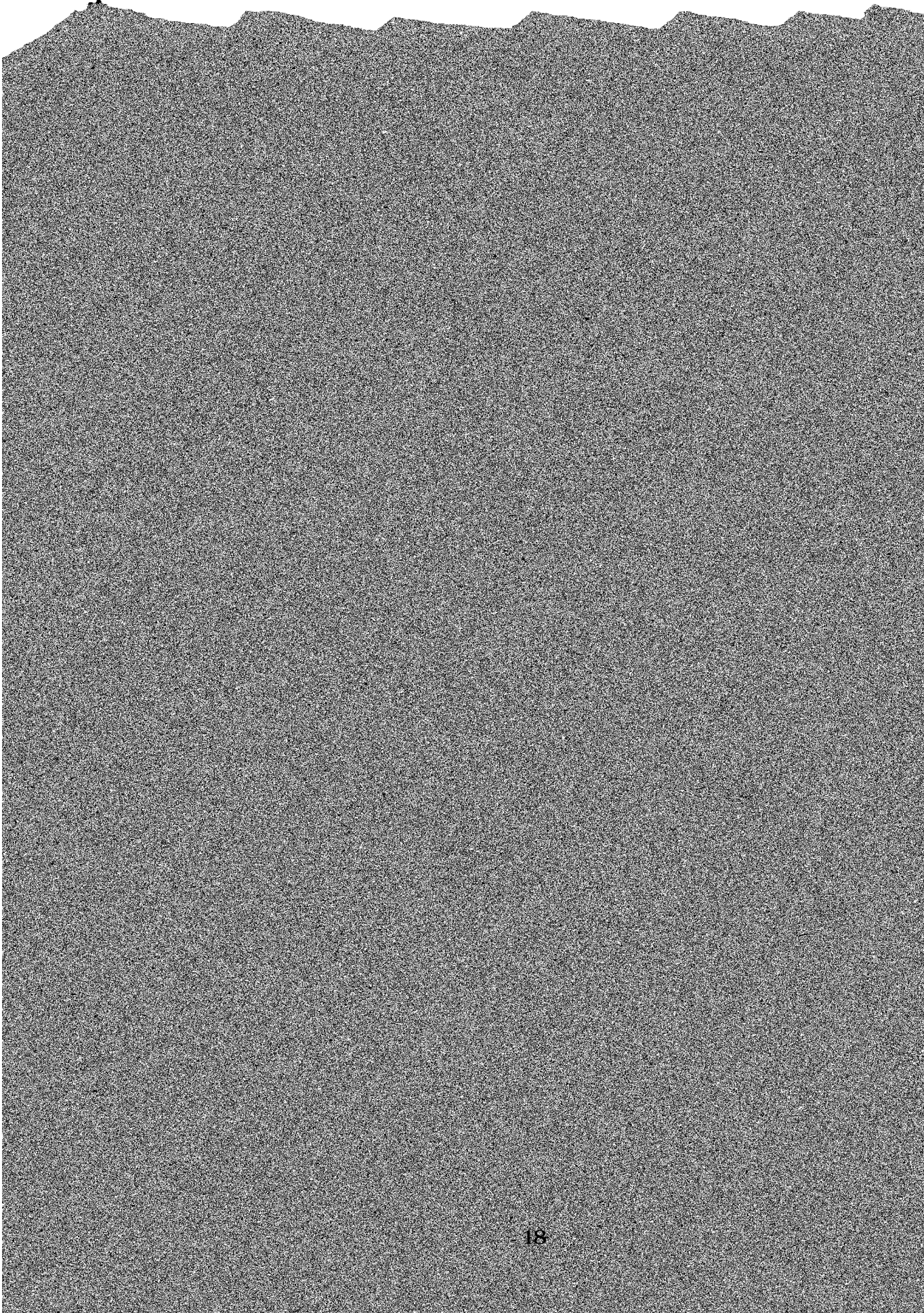
! TM

Ú!

1

fi

L



!Ž/ fl° ~ 1 4 Q "1 (Ž " ° ° % " žfi/ ° ° ~ 1 ° " ~ 1 ~ L° ~
 ~ fl° ° 1 " ° ° / 1 L ! ° ° ž ° ° / fl_1 ~ 1 4 / < fl_1 l (% fl° fl_1 ! ° ° ž ° ° / fi° ° 1
 ° ° ° ~ 1 (~ 1 ~ L 8° ~ ~ ~ L° ° ° " žfi/ ° ° ~ 1 ~ fl° ° 1 1 " ° ° / 1
 fl_1 ~ 1 ~ / \$ ~ ! ° ° ž ° ° / fi° ° 1 (Ž " l fl fl " 1 ~ " ~ L 1 ! ° ° ž ° ° / fi° ° 1
 ! ° \$ ~ / ~ 1 1 ž ° ° " fl° ° ~ ~ 1 ° 1 ° " 1 fi/ ~ " ~ L ~ fl° ° 1 ~
 " žfi/ ° ° ~ 1 4 Q " 8 ! Ž / (° 11 fi! ~ ž ~ L° ~ ž " fi Ž / L° 1 ~ 1 fi ~ 2
 fl_1 ~ 1 (° ° ~ fl° ° 1 ~ " žfi/ ° ° ~ 1 ~ L° ° 1 L " ~ 1 fi Ž ~ L q 1 ž! ~ ~
 " žfi" E / ° * 1 / ~ B_1 " " ° ° " ~ L " žfi/ ° ° " \$ fl° ° ž 4
 e " fi Ž / ° ° ~ 1 U " ! ° / U - " UD " U Ž " " ~ 1 ~ ~ L q 7 fi° ° 1 ~
 ~ L " fl° 1 (% fl° fl_1 ~ L Ž " fl " 1 1 % \$ ~ L ° ! fi° ~ " ~ L " fl_1 ~
 ~ fl° ° 1 4

~ 1 l " ~ 8° ° l " " " ~ ~ ~ " Ž " ° ° ~ 1 " Q žfi" E +
 < fi Ž Ž_1 ~ L° ~ ~ L ~ B_1 ž! ~ ~ 1 < ~ 1 q ~ ž ~ L " " Ž " 1 ~ ~) L_1
 Ž " l fl fl " (° ° l 5 " Ž " 1 ~ ~ 1 / L_1 Ž " l fl fl " ~ 4 A ~ L_1 fl° 1 () fl° ~
 ž ° ° % \$ ° ° ~ fl° ° 1 ~ " žfi/ ° ° ~ 1 ~ L° ° ~ fl° ° 1 1 ~ L fl_1 ~ 1 " ° ° 1
 ! ° ° ž ° ° / fi° ° 1 - 1 ž! ~ ~ q. 4 A l l (~ ~ L_1 fl° 1 1 fi fl L ° fl° ° ž
 ~ " žfi/ ° ° ~ 1 1 % ~ ~ " ") ~ L° ° ° fl° ° ž ~ ~ " žfi/ ° ° ~ 1 ~ L° °
 ~ fl° ° 1 1 / L_1 fl_1 ~ 1 Ò 5 L_1 fl fl fl " " ~ B_1 " ° 1 ~ 1 4 Q " 1 (~ L
 ! ° ° 2 ~ Ž " fl " 1 1 % \$ ~ L " fi / / ° ! fi° ~ " ~ L ~ fl° ° 1 ~ ~ L fl_1 ~
 ") L_1 ! ° ° ž ° ° / fi° ° 1 4 c fl_1 l (% fl° fl_1 ž " fi Ž) 1 ~ 1 fi Ž fi ~
 fl_1 ! Ž ~ ° ° * / \$ (~ fl° ° ~ (% \$ ° 11 fi! Ž " ~ (fl° ° ! ~ Ž / \$ Ž " " ~ 1
 % \$ ° ž " ~ ž ~ " l fl fl " ~ 1 fi Ž fi n A ~ L_1 fl° 1 (~ L " žfi/ ° ° ~ 1
 1 " * 1 ° 1 ° 1 fi % ~ ~ fi " " 1 fi fl L ° ° ° ž " ! ~ 4 A ~ " ! 1 "

1 i ~ ~ L° ~ " " ° Ž " ~ ~ ° / ~ ~ ~ (° fl° ° ž ~ ~ ° * " ° ž fl_1 ~
 ° " fl_1 ~ 1 ~ ~ \$ l fl_1 ~ 4 5 L fl_1 (~ ~ ~ ~ 1 L ° * " ° ž fl_1 ~ 1 ° °
 U! ° ° ž ° ° / fl_1 ~ 1 U " " ~ L Ž fi Ž_1 1 " " fi " ° ° / \$ 1 ~ 1 4

" 1&fif/ l !°~l (°~ ~ff" °1 & " žfi/°~'~'~ ff°~ % Ž"~" &°% " ") 6 ~ &" ~L &ff" °1 & " žfi/°~ &~ ~ l~ 1 Ā~ 1L~"~ fiŽ) L1

" 1&fif/ l !°~l ffif 6 4

5° 2~ž ~L~1 °~°/S1~1 ° 1~ Ž "fi~L~" (%~L) °~l / !&žL~ ž°~ " " ! °~ ~ff" °1 ~ " žfi/°~'~'~ 4 Q~ " 8°!Ž/ (") L1 1fiŽŽ/S & Q&žfi" E ~1 ž&6 ~ %S ~L 1 ž! ~~1 < °~l u, °~ &ff" °1 & ~L fl~1~ ") L1 !°ž~°/ fi~~1 ' fi/l % ~ "& %~L) °~l / 4 A~ ž ~ "°/(%~L ff°~ ž°& " ~L &ff" °1 & ~L & fl~1~1 " !°ž&°/ fi~&~1 8fl l1 ~L ~ff" °1 & fl~1~1 ~L & " " " !°ž&°/ fi~&~1 4 cfi!!°&D&ž(' L°6 ~L " // ' &ž " 1fi/ 4

> 1fi/~ E

/~L) L1 °~l /L1 ~ ~~1 ff°~ ~ff" °1 " " ! fl~1~m~ff" °1&ž " žfi/°~ &~ " ~L " žfi/°~'~'~ &ff" °1 1 !°2 ~ !°ž&°/ fl~1~ ! " ~L°~) %!~L w

i fižž/s flfi"* (~L !°"2 ~ Ž"·fl B'// "1 °~l)I1 ,fi Žfi~ B'//
·~ fl" °1 4 5Lfi (:fi°~·~ -]. ·!

9G W!~::~~ €"! Hl /

A~ ~L Ž" fl l~ž 1 fl~ (B °11 ! l ~L°~ %~L) °~l / °fl
fl!Ž ~::~* /\$ ~ ~L Ž" fl fl! !°2 ~ (+ +(~L ~ ~fiŽfi1 °~
l ~ "l~ l %\$ ~L fl fl/ Ž" fl ? : fi°/1?!°ž~°/?fl1~ fl~l~ + A~
~L1 1 fl~ (B !,l "\$ ~L°~ !,l /+ R fl~ ~fi ~ °11 fl! ~L°~
ž" fiŽ / °fl1 fl!Ž ~::~* /\$+ l B * ~ (B ~ B °11 fl! ~L°~ ž" fiŽ)
fl~1~1 1 / /\$ " ° 1~ž/ l!~::~ " " ! ~ " Ž " fl fl~ /+
5L1 ! °~1 ~L°~) Ž" fl * 1 ~L°~ ~1 ~ 1 fl/ l !°~l ~1 ~
Ž" fl /\$ /°1~ fl °~l 1 ~1 ~1 ~fiŽfi °fl fl~ž/\$ ~ !°8!°D ~1
Ž" ~1+ 5L1 ~1 ~ fl~ ~°1 ~ ~L fl!Ž ~::~* !,l / BL "

~ 1~!



) ~ : fi / % fi ! ~ ~ L i ! ~ ~ ~ " ~ ! ! i / i i ž fi i ~ Q ž fi ~
T(' L " > i) L i ~ i i fi / i ! ~ i fi ~ * " fi ~ ž) (H)

p

p*

----- T

I
I

I
I

b* a*

?gá?

1+ > žfi/°~č" S FL°°° ~ "1~ fl o

-° i" " fl ~ č" H° ž°°°/ Fč1~ -)/g /1gé

5L ž°°° "1~ L " žfi/°~č" ?~l ffl l ~ fl" °1 ~ ~ L

!°ž°°°/ flč1~1 č" ~ L " " !1 ~ ~ L ~ l ffl ~ S, ~ L ž°°° "1~ L

" 1 fl/°~č ž ~ l ffl ~ S Ž°°° fl ~ fl" °1 +) L žL " Ž°°° fl , fl ~ "1

Ž°°° % fl, "°°1 1 ~ L Ž°°° "1~1 č" °// " " !1, / ° l ~ ž ~ č" ° ž°°° "

/ 2 / ~ Lč1 ~ L° 1 fflL " žfi/°~č" 1 ~ // % ° l Ž°°° l +

-% J "1 fl ~ č") * ~°ž°1 Fč1~1 -) gV°, /gV%

5L ž°°° "1~ L " žfi/°~č" ?~l ffl l ~ fl" °1 ~ ~ L

* ~°ž flč1~1 č" ° ž°°° fl Ž, ~ L / 11 Ž°°° "1~1 °% ' // % ° " žfi/° X

č" S flL°ž ~ č" ~ L " " !1 ~ ~ L° ~ Pž°°° fl Ž+ A° °1 ~1 , ° "1 ~

* ~°ž flč1~1 ~1 ~ L Ž°°° fl " " !1 Ž°°° S "č" ~ L Ž°°° fl ?~ fl" °1 ~ ž

"1 1 ~ !°ž°°°/ .flč1~1 + 5L fl, " žfi/°~č" 1 ~ L° ~ "°1 !°ž°°°/

flč1~1 " /°°° * ~ č" °°ž flč1~1 °° !č" / 2 / S ~ č" %

Ž°°° "1~1 °% +

g+ A l fl ~ S FL° ° fl ~ "1~° fl,

-° W!°° l J/° l ~ fl ~ S - W

5L / 11 / °1 ~ fl ~1 !°°2 ~ l !°° l, ~ L ž°°° "°° ~ L

Ž°°° ~°°°/ " ~ 1 ~ L° ~ fl°° % °°° l ~ ~ L ~ l ffl ~ S+ Hč" č" * "

~ L / 11 / °1 ~ fl ~1 ~ L l !°° l ~ L ž°°° " ' // % ~ L Ž°°° fl "1

" 1 fl/°~č ž "č" ! °° S Ž°°°° fl fl/°° " žfi/°~č" ?~l ffl l ~ fl" °1 ~

!°ž°°°/ flč1~, °° l 1č" ~ L !č" Ž°°° "1~1 °% ' // % °° S Ž°°°° fl fl/°°

" žfi/°~č ~ č" °// " " !1 ~ ~ L ~ l ffl ~ S, ~ fl/fl ~ ž ~ Lč1 ~ Lč1

flč1~1 °° "°°1 l % S ~ L " žfi/°~č" +

B !°2 #L °l Ž#~ " #L " žfi/°#~ °~ ~l ž ~ fi *°°°%/ +
 ^~ Ž°~#·ff/°", ' l * / Ž !l /1 " " žfi °#~ \$ fl°~ž 'L " "°!1
 !°2 %l1 ~ ~l " #~ ~fl" °1 - " l fl" °1 . #L /·2 /·L~l " "
 " žfi/°#~ \$ fl°~ž + 5L 1 %l1 !žL# ~fl/fl / %S~ž °~l /·#ž°X
 #~ 8Ž ~1 1, / ž°/ °~l fl~!·fl " Ž~#1, °~l fl!Ž°ž~ fl~#~%fX
 #~1 " °/# ~°#* /\$, #L \$!°\$ fl~1·1# " fl" l·% #L" °#1 #
 fl~l ~#°2 1ffL 8Ž ~l·#fi" 1+)/#L fižL #L 1 U%lH~žU !l /1 °~
 ~ 1 ŽL·1#·fi# l ž°! #L ~ #·fl !l /1, #L \$ l fi Ž#fi" 1!
 ·!Ž~#°~# / ! ~#1 " #L°# !~ " "ž~ fi °°°/\$1·1 °~l / °l # °
 1#~ž 1 # " ~ fl 11°°\$ °~l 1fi"·fi· ~# fl~l·#~1+

RL ~ ž~ fiŽ) !fi # fi#%l ž~ fiŽ / " " fl#~ž 4 " žfi/°ff·1 S fl fi
 flL°ž , ·#1 l fl·1·~ fl°/ff/fi !fi # 1! L' ~ fl~Ž~°# #L /#/ X / # A



O" " /O# l #, #L O!l' #' ~O/ 8 Ž₁# /,11 1 ' !Ž₁ l ~ #L l' 1 X
O! * O~ #Ož l ž" fiŽ+) L1 ,%\ fl# * ' 1 #, !O8' !' D ' #1 Ž" " ' #1 +
5L " O" #' , 1 # Ž1 #, #L' 1 Ž" , " ' #?! O8' !' DO# , ~ +

S° 1 + 5L 1 1 #L

R !fi ~ O/1, fi ~ 1 l " ~ L =ž" . fl = ~ LO ~ ~ L " ~ ~ ž fi O/ ~ ~ ~
 ! fi ~ Ofi ~ fi O/ \$ ŽOS " " O " žfi/ O ~ " \$ fl LO ž + A ~ 1 ~ ~ O ~ O/ /
 fl/ O ~ ~ LO ~ ~ L =ž" . fl = ' L fl L ' ' // fi ~ ! O ~ / \$ LO* ~ % ŽO l ' ' //
 * " : fi O/ ~ L Œ fi ~ ~ LO ~ ~ L ž" . fi Ž, * ~ ~ Os ~ ž Ofi fi ~ " "
 " ~ l " l " " fl/ ~ 1, " 1 ž" ŽO l " ž OS + 5L 1 " // " 1 % flofi O
 ž" . fi Ž ~ LO ~ O ~ fi ŽO l l " O ~ ~ ~ L Ž / ~ fi O/ O ~ O ! OS fl L 1
 ~ ~ ~ ' O l ~ ~ 1 " 1 fi fl 1 ' Ož ~ ž O " fi ~ / ~ 1 ~ fi ž ž / + A" ~ L 1
 l fi 1 ~ ~ 1 ! O l , ~ L Ž" * O / ~ ž 1 l fi O l ffi" ~ L " žfi/ O ~ ~
 O ~ O fi 1 ~ ' // % / " ' LO ~ ~ " fi / l % Ž" ŽO l " ž OS + A 1 ~ O l ,
 ~ L =ž" . fl = Ofi ~ fi O/ \$ ŽO l ' fi / l : fi O/ ~ / \$ ~ L fi 1 ~ " ! Os ~ ž O
 fi l % ~ L O l ~ " fi ~ ž ~ l " ~ * O / 1 +

< ~ O ž fi fl ! Ž / fi O ~ ~ 1 O/1 8 1 ~ ~ ~ L 1 / \$ fi O / ! 1

O/1

1 fiŽŽ/ & " !&žL#, " " 8°!Ž/ , fl!Ž # %S fi&ž 1 ŽL&a #&fi° # l
° ž ~l° fl~#" / ! °1fi" 1 # ' & #L =fl!Ž #&#&~ = °ž°&~1# #L "
1 fiŽŽ/ & "1 G A~ #L °°/S1 & #L°# " // '1, ' &ž~" 1 fflL
1 #° # ž&fl fl!Ž/ &fi° #&~1 °~l °11fi! , &~1# °l, °° &~1#&#fi#&~°/
1 #~ ffl#fi" & ' L&flL #L 1 fiŽŽ/ & "1 " " žfi/° #&~ °° "°&~/S
Ž°11&* G 5L&a °11fi! Ž#&~ °/1 " °// '1 fi1 # " flfi1 ~ #L " fl#1
~ #L fi#fl! " #L " /° #&* 1#°2 1 " #L ž~ fiŽ1 " Ž~ l ffl "1
& #L &~ l fi1 #° S G

FG)/# ~° #&* H l /1 " > žfi/° #~ S FL°~ž

R % ž&~ %S fl~1&d " &ž ° 1&#fi° #&~ & ' L&flL ° / ž&a /° #&*
" " žfi/° #~ S % l S &a fl~1&d " &ž ° " žfi/° #~ S flL°~ž G Q~ #L
#&! % &ž, ' l ~ # fl~1&d " L' #L ~ ' Ž" Ž1° / ° "1 G R
" flfi1 1 / / ~ L' #L " fl#1 " #L&a " žfi/° #&~ ~ ž~ fiŽBL

~°~· fi #L ~· 1 C ~ žfi/° #~ S flL°ž fi° ~ % fl~1 #~ fl# l %S

—

~_ " :fi" ! ~ ~ L° ~ ° S Ž° ~ ~ fl/° ~ Ž° fl % Ž° l + H_ " 6 ", ~L:1
fi~fi! ~ 1 ~ ° K° ~ _?1fiŽ " ~_ " °//_fi° ~_ ~ + / fl° fi) l_ 1 ~_ ~
fi!È ~1° ~ /,) ~ 1 !° l ~ ~ fl/\$ % ~ ~ " ~_ %fi / ~ 1 !° l
1 ~ ~ fl/\$ ' ~_ " ~_ " + i_ " !fi ~ 1_ fi° / ' °/~L ~ fl° ° 1 + |_ 11 1
%_ ~ ~ %S fi~1fi! "1 ~_ " „~_ lfi fl "1 ~_ fi~1~1 ~L ~ ~ lfi ~ \$ ° ~ ~ ~L ~
fi!Ž ~1° ~ l ~_ " 6 ~ ~ 2 ~ ~ ~_ ° fl fi ~ ~ ~ ~L l fi~1~_ fi°/flfi/fi
1 ~ ~ fi ~ L " + A ~ ~L:1 fl° 1 , fi!Ž ~ ~ ~_ " ~_ " ~ ~ 1 l_ 1 ~_ ~ / ° l
~_ " ~ ~ fl ~ fl\$, %fi ~ ~ ~L fi ~ ~ / ~ fi~fi! +
ó_ " !°//\$, / ~ [] -". ° ~ l [/ -". % ~ L fl° ~ ž ~ ~ " ~ ~ 1 " ~_)
° ~ l / " 1 fi/° ~ ž " ~_ ! ° fl° ~ ž ~ ~ " ž fi/° ~ ~ ~_ " + 5L ~ ~ " f) -".
° ~ l f/ -". ° ~ ~L ~_ ~° / " ~ ~ 1 ° fl fl fi ~ ž ~_) ° ~ l / ° ~ " ž fi/° ~ ~ ~
/ 6 / " ° ~ l ~L ~ ~ ~ ° / / 6 /

- 1 fi/ h

) 1 fi" &fl' ~ fl_~l &~' ~ " ~ t" fiŽ) ~ ž° &
! ~ ~L° ~ t" fiŽ / /_1 1 ~ 1 ~L° ~ ž" fiŽ) t° &1
°~l °tt" ž° ~ " 6 ~fi 1 ! ~fi1 °žž" ž° ~ fl_1~1
~fl" °1 'L " " 6 ~fi 1 °~l fl_1~1 °" fl°/ffl/°° l
°° Ž" 7" t fi/°°' ~' ~ fi Žfi~ / 6 /1 " ~) °~l /+

- 1 fi/ Y, & ... & fl&Ž/ , ' fi/l °//_1' fl°/ffl/°° &~' ~ " °
1 fi" &fl' ~ fl_~l ~ &~' ~ ~L_ fi~ fl_! Ž/ ~ l ~ " ! &°° &~' ~ " ~L
" fl~1 ~ " & fl" °1 l " žfi/°° &~' ~ ~L ~ ~ & " °°ž ~ ") I1 °~l
/O 1 fiŽŽ/\$ flf" 6 1, °1 /_ž °1 ~L Ž_1~7" t fi/°°' ~' ~ fi&°% &fi!
Ž" &fl fl_ fi/l % fl°/ffl/°° l+)/~ ~°° &6 /\$, ~L " fl~1 ~"
& fl" °1 l " žfi/°° &~' ~) I1 °~l /I1 fl_1~1, °11 fi! &ž " & l ~ fi Žfi~ ,
fl° ~ % °1 &\$ fl°/ffl/°° l+ 5L ~ - 1 fi/ h fl° ~ % fi1 l

Ü°1

&

ê l



° fl~fi°//S ı fi~%ı / %S Ž°S'~ž !ı" ~M~)Oı !°8'!fi! %ı ı" so, "9

ı)Oı Ž" " " ı °/~ "°°~ı* +

5M 8° fl~ S ı fi~) !fiı ~ Ž° S

-

· fi%a ~ ~ ~ fi ~ ~ ~ ž " ~ ! - 1] . (' L ° 6

[) - ~ . ? [/ - ~ . = oee - ~ . j oee / - ~ . - K, -99Ö

' L ~

K = IIB(r̄) - IIA(r̄), a constant -9E.

bLfiu, ~L ~ ~ ~ ~ fi ~ ~ ~ ž ~ fiŽ) : fi° / 1 ~ ~ ~ / ~ ~ I fi ~ ~ \$ Ž ~ " ~ ~ 1
/ 11 ° fi ~ 1 ~ ~ ~ I ~ ~ ! ~ ~ I % \$ ~L ~ ž fi / ° ~ ~ \$ 1 ~ ~ ~ fiu : fi + bL' 1
/ ° 11 ~ ~ ~L " ~ // ~ ~ ž 1 fi " ~ fi ~ ~ fi ~ 1 ~ ~ ~ ~ " ~ ~L 1 ~ ~ ~ ž
~ ~ ~ ? 1 2 ~ ž , 1 Ž fi ° / ~ ~ ~ ~ 1 ~ ~ 1 fi / ~ +

- 1 fi / ~ 1P

e ~ , fiŽ) L ° 1 ~ ~ ~ ~ fi ~ ~ ~ 6 ~ ~ fiL ~ 1 ~ ~L
Ufi° ~ ~ / U ~ ž fi / ° ~ ~ ~ , ~L° ~ ~ 1 , ~L Ž ~ Ž ~ 1 ° / ~L° ~
! ° 8 ! ° D 1 \ ~ ~ ~ ~ I fi ~ ~ \$ Ž ~ " ~ ~ 1 , ~ ") ! 1Ů Qe ° A Aqf " fi ~ }

Q ~ ° // S, ' L° 6 ° 11 fi! l 1, " ° ~ L° ~ % ~

5Lfi, ' L* ° Ž' ~ ~ ~ ° 3 8 ~ ~ ? Ž'1 ~ fi ~ "3' fi ~ L ~ ,
i ~ fl) '1 % H ~ ž fi1 ~ i l Ž ~ l ~ / ~1 ex post ~ ~ fl ~ ! ~ ~ ° 3 3,11 i
' L' flL l Ž ~ l ~) '1 ex post l fi' i ~ ~ 1 + 5L' i fi ~ "3' fi ~ ~ * ~ fi 3\$
~ i ~ 3* i ~ i 3" ~ ") ! fi ~ ~ fi % l ~ L ~ " ~ ž ~ ° flL Ž ~ ~ i +) 3 ~ " X
~ ~ ~ * 3\$, ~ L fi ~ "3' fi ~ ~ fi3l % 3 ! ~ ~ ~ l ~ ") ' ~ ~ ~ i 2
~ ž fi3 ~ ~ \$ flL ~ ž i ~ L ~ ~ fi3l ~ i fi ~ ~ L fl ~ l ~ % 3 ~ \$ ~ " ~ i 8
Ž'1 ~ ° fl ~ ~ ~ 1 +

A") fi fi3l i 2 ~ ž fi3 ~ ~ \$ flL ~ ž i ~ L ~ fl ~ l ~ % 3\$ ~ i fi ~
=L' žL= Ž ~ fl i 8 Ž'1 ~ , ~ L ~ " ~ ž ~ ~ fi3l % ~ ~ ~ , ° l ~ Lfi, ' fi3l
~ l fi fl ~ L CE ~ fi ~ ~ ~ L ~ " ~ i ~ ~ fi3l % l ~ ~ l " ° ~ ~ L ! ° i fi ~ % \$
~ L ° H l ~ * ~ fi ~ ~ ~ fi3l ~ ° 3' D % fl° fi ~ ~ " ~ L L' žL ~ ~ l fi ~ ~ \$
Ž ~ fl + 5Lfi, ~ ~ fl ~ % Ž ~ " ~ ~ ° 3 ~ ") ~ ~ 3, fi2 ~ i 3" ~ ~ ~
° fl ~ ~ ~ i ~ L ~ ~ fi3l ~ ~ L ~ " ~ i ~ ~ ~ % Ž ~ " ~ ~ ° 3 ~ " q1 _____

! „ ~ ~ Ľ Ž~ fl ~ Ž° S; „ ~ Ľ ~ žfi3° ~ ~ Ľ ~ ~ 3 „ ; ; „ ~ !
° Ľ Ž~ ~ ž ~ Ľ 3 ; ; „ ~ fl ~ ~ ~ fl Ľ ~ 3 „ ž \$ + P

w ě ; ! fl ; ; „ fl fi ě ; „ ~ Ľ Ľ ! ~ ~ ~ ~ „ ~ ! ! ° \$ ° fl Ľ *
fl Ľ Ľ % 3 ~ \$ % S Ž~ Ľ Ž ; ~ ž ° ~ ž fi3° ~ ~ Ľ ~ ! ~ Ľ ~ ; Ľ ~ fl ~
ž „ * ~ ! ~ ~ 3, Ž~ fl ~ ž fi3° ~ ~ Ľ ~ © ~ ~ ~ Ľ fi; ~ \$ Ž~ „ ~ ~ 7
! ° 8 ! ° D ~ ž 3 * 3 + q ~ „ ~ ~ fl ~ ~ 3 \$, Ľ „ * ~ „ Ľ ~ fl ~ Ž~ fl ~ ž fi3° 7
~ ~ ! ° \$ Ž~ „ * Ľ 3 ; ; ; fl Ľ ~ \$ ~ Ľ ~ „ ~ ~ ž ~ Ľ ~ Ľ 8 ~ ~ ~ Ľ ~
~ Ľ Ľ ! ~ ~ ~ ~ „ ~ !, 8 Ž~ ; ~, Ľ fi3 Ľ * ° ; ~ „ ~ ž ~ fl ~ ~ * ~
fl ~ fl ! * ~ ~ ~ % S fl ~ fl ° 3 ~ ž Ž~ fl fl Ľ ; „ ! Ž~ „ * ~ ž Ž~ Ľ fl fl
: fi 3 ~ \$, „ ~ ~ „ ; ~ ~ fl ~ ~ ž Ľ fi Ž fi ~ Ľ ~ fl ; ; ° \$ 3 * 3 + w“,
~ Ľ ~ Ľ ~ Ľ ~ Ľ ~ Ľ ~ Ľ Ľ ! ~ ~ ~ ~ „ ~ ! ! ~ „ fl Ľ ~ ~ * ~ ; ° % 3 \$ ~
° Ľ Ž~ ~ ~ fl Ľ ~ 3 „ ž \$ ~ ~ Ľ Ľ ž Ľ * ~ ~ ~ % 3 fl ; ~ ; „ ~ Ľ fi3 Ľ ~ ~ ; ~
; 3 ~ ~ ~ ; ~ fl Ľ ; ° Ľ ž Ľ ~ Ž~ fl + 9

w ě ; ~ ~ fl ~ Ľ ~ ~ „ ~ ! ; fl fi3 Ľ ; ° 3 \$! ° 2 ~ „ ~ fl ° % 3 Ž~ fl
~ Ľ Ž~ Ľ fl fl ~ ~ fl Ľ ! ~ ~ ! ~ ~ ; „ Ľ fl ; ~ 3 \$ ~ ž fi3° ~ ~ ; „ ~ Ľ ; ~ ~
~ ~ 3 \$ D Ľ ~ Ľ fi ž Ľ fi ~ Ľ ; Ž° Ž ~ Ľ fi3 % fi ~ fl ; ; ° \$ + w ; ~ Ľ ,
~ Ľ ~ ~ ~ ž ~ fi3 ; ! Ž 3 \$ Ž~ Ľ Ž ; ° ~ ž fi3° ~ ~ Ľ ~ ~ : fi ~ ; °
Ľ ! ~ ~ ~ ~ „ ~ ! ~ ; ~ Ľ © ~ ~ Ž~ „ ~ ~ 7 ! ° 8 ! ° D ~ ž Ž~ fl ~ Ľ
° 3 3 fl ~ ; ~ ~ ~ ° Ž Ž~ Ľ Ž ~ ~ ~ Ľ fi Ž fi ~ : fi ~ ° ~ ; fi Ž Ž ~ ~ Ľ ~ Ž~ fl +
5 Ľ ; ~ ž fi3° ~ ~ Ľ fi3 ~ Ľ fl fl ~ Ľ Ľ ! ~ ~ ~ ~ „ ~ ! I ; Ž~ „ ~ ; % S 3 ; ;
~ Ľ ~ ~ ~ Ľ fi3 ~ ~ ; ~ Ľ ~ ~ ~ ž I ; Ž~ „ ~ ~ 3 * 3 ; + Ľ „ * ~ „ fi 3 ; ;

1 Q ~ ~ ~ 3 „ ž fi ; % Ľ * ~ ~ % S ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ fi ~ ž fi3° Ľ
~ * ~ ~ ! ~ ~ ; e 3 ! ~ ~ ~ Ľ < ° 3 „ Ž - 1 @ YE. j

9) 3 Ľ ~ ~ ~ fi " 3 \$, „ fl fi ě ; „ ~ ~ ž fi3° ~ ~ „ fl e " 3 ä Qf ~ ~ Ž Q f ž fi3° ! ~

~L "~~~~ž ~l l!~~~~ "!! fl~ % ~ :f~ l, Ž.;, ~. " lffl
~L ~. ~f~žf~, ~L; " žf/~~~~ ~. f/l ~. % "" fl~6 + 5L; ;
~L ~./ ~. "" fl~ fl\$?" lffl~ž " žf/~~~~; + /\$ "" ;~ž ~L
!~ž~/ fl;~; ~. ~L ""!; ~ ~L ~lfi;~\$, ° fl~ l~% fl!!~
! ~ ~. / ~. " ~f~žf~ ; ; ; f~ l+ ^" !~ž~/ fl;~; ° ~ fl~ °; l
%\$! ~ ~L~ °6 ~ž fl;~; ~l l !~l ; ~. ~. /° ; fl, ~L;
" žf/~~~~\$; ~ž\$; Ž"~~~~% +

>òQJ>Ji FJ<??F_c ~ ~ ~ ~ fi x

¶.ž "1_c ~, R+K+, =) i_c ~ ~ ~ ~ L A fl ~ ~ ~ * " ~ ~ ° H_c ~ Ž_c 3' 1 ~ ~
A fl ~ ° 1 Q 8 x F_c 1 ~ 1 ° 1 ° / ~ ~ ~ ~ ~ J ~ ~ S, = ÷ fi ~ ~ ~ ~ 3S
μ_c fi ~ ~ 3 ~ " Jfl_c ~ ! ~ fl_c, H \$ 1@YT(@@(ŽŽ+ E@7TPgG

¥° 3. Ž, <+F+, < ~ ~ ~ ž ~ fl J ~ ~ S W ~ ~ ~ fl, è ~ ~ fl ~ Jfl_c ~ ! ~ fl
> * ~ ~, H \$ 1@N@ -] @. (ŽŽ+ EEZ?EEh 4

_____, =A ~ ~ x fl fl ~ ~ ~, = ~ ~ <+F+ <° 3. Ž ~ ~ ° 3+, < ~ ~ ~ ž S,
Predation ~ ~ x) ~ ~ ~ fl ~ ~) ~ ~ 3S1 ~ 1, Q x ~ ~ 3 5 ~ ~ x F_c !! ~ 11 ~ ~
> Z_c ~ ~, 1@Y1(ŽŽ+ 17TgG

¥° 3. Ž, <+F+, ~ ~ x <flL ~ ~ ! ~ ~, W+5+, =>° 1 ~ ž > ~ *° 3i I F_c 1 ~, =
)! ~ ~ fl ~ Jfl_c ~ ! ~ fl > * ~ ~, H \$ 1@YE(ŽŽ+ g] N7gN1G

Ū ~ ~ ~, =Hfi3 ~ ?H ~ 2 ~ < ~ ~ ~ ž ~ 1 ~ ~ ° W ! ~ ~ ~ Q ~ ! A ~ x fl ~ ~ S, ®
Ū ~ ° 3 5 ~ ~ x F_c !! ~ 11 ~ ~, 1@YT G

¥ ~ ž 3 ~, eG =5L 5L ~ S ~ " Jfl_c ~ ! ~ fl > ž fi 3 ~ ~ ~, = / 33 z_c fi ~ ~ °,
g(<Ž ~ ~ ž 1@N1(ŽŽ+ E7g1G

5fi33. fl2, eG =5L R 3" ~ F_c ~ 1 : fi ~ fl 1 ~ " 5 ~ ~ ~ " 1, H_c ~ Ž_c 3' 1 ~ ~ x
5L ~ ~, = R 1 ~ ~ Â Jfl_c ~ ! ~ fl z_c ~ ~ ° 3, 1@] NG

R 33' ° ! 1 ~ ~, o. ., =R° ž > ~ ~ 1 ~ 1 ° / ~ ~ ~ ~ ~ J ~ ~ So 5L
K ~ ~ ~ ž ~ ~ F° 1 ~, = } fi ~ ~ ~ 3S μ_c fi ~ ~ ° 3 ~ " Jfl_c ~ ! ~ fl_c, Q % fi ~ ~ S
1@] Y(ŽŽ+ YZ? 11] G