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)!*+(, - ./ (012345&62741(24(8 & 9 \$1'(71() :7\$2741(

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, -\$.!/01#.2!\$342.5\$6752.!873329!74\$75\$03!739!-0 : !\$5!-7.!\$8 ;7/529!01#!<\$42.=!

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> 2! ?26\$3! ?@!#24\$2 : \$36!5-2!-.50#@!0A!873329!74\$75\$03!\$3!%&BC! : \$5-!5-2!D03560<A\$2#E.!739! ;#0/229!
5-#016-!5-2!87F0#!-.50#\$/!24235.!5-75!-742!79473/29!7\$#/#7A5!9242<0 ; 8235.=!> 2!/03.\$92#!-0 : !27/-!
32 : !-.50#\$/!8\$<2.5032!\$3!7\$#/#7A5!9242<0 ; 8235!-7.!\$8 ;7/529!.0/\$25@!739!01#!7//2 ;573/2!0A!873329!
A<\$6-5-!

!
G519235.! : \$<!67\$3!73!1392#.5739\$36!0A!F1.5!-0 : !#7 ;\$9<@!74\$75\$03!-7.!9242<0 ;29!042#!5-2!<7.5!
/2351#@!739!-0 : !/-7<<236\$36!\$5!-7.!?223!50!797 ;5!01#! ;. @/-0<06\$/7<!739! ;-.@.\$0<06\$/7<!<\$8\$575\$03.!
50!.1/-!97362#01.!234\$#038235!> 2! : \$<!90!5-\$.!?!@!<00H\$36!75!74\$75\$03!7//9235.!A#08!5-2! ;0.\$5\$03!
0A!-1873!2##0#-!!

!
> 2!5-23!2I ;<0#2!5-2!.0/\$0)2/0308\$/\$8 ;7/5.!0A!#2/235!74\$75\$03!#2<7529!24235.!1/-!7.15-2! ;0.5!*)
%#!7\$#!5#742<!A7<<015!J!5-2!K75#\$37!#2/042#@!739!#2./12!2AA0#5.!739!5-2!L/2<739\$!/M0</730!> 2! : \$<!<
7<.0!9\$. /1..!5-2!A151#2!0A!74\$75\$03!739!-0 : !\$5! : \$<!7AA2/5!01#!<\$42.=!

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01'23&6243;!N73H!G/055J!O2/51#2#PL3.5#1/50#!

Q87\$<'!'"#\$%&'()**+(,)-#.)&/ .0!

<3=3=>&'72=' ;!\$) \$/!0 ;23!50!7<!87F0#!.75!73@!<242<!

?=@2%44A' ;!!

B(D#7EF2(2F=(G49H#2=(87'243''/R@!S=T!T#735!UK!V1?\$. -\$36!/123345k(0! I +JB- ;!(&+WW%*(X+!
YS!D#7EF2;(B--(K=\$3'(4L() :7\$2741!R@!S=T!T#735!UK!V1?\$. -\$36!ZX((&[!0! I +JB- ;!(&+WW+C\W(!
ZV#255@!81/-!5-2!.782! ?00H[!

MC!8\$15%44A(4L() :7\$2741(8 & 9 \$1(D\$6243'N(M15>(*572741!ZN1873!"7/50#!.!\$3! , #73. ;0#575\$03!
> \$.2!J!NO ;H\$3.!739!T7#<739!1"#!-. ()6/-!123375k!
89:9*#,! ;)<=!'9!>9\$!/!>)-!*'9!?!?)%@ ; A!,9?-#-="#!.9:9*#,!()<9/'B!
<http://dx.doi.org.colorado.idm.oclc.org/10.1201/b10401>

V<27.2!3052!5-75!@01!87@!?!#36!<7 ;50 ;.J!Q)#2792#.J!57?<25.!0#!.87#5 ; -032.!50!5-2!X!2I78.!50!#279!
5-2!2<2/5#03\$!/42#.\$03.!0A!5-2!52I5! ?00H.=!

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!
C=!DkEk!E-#\$*!8F!GO?,9''9\$:!!123345k!

O3\$571E(I3=\$A54P1;((

- G2/5\$03!%!QI78!X(] !!
- D\$9) , 2#8!V7 ;2#!!ZX(((! : 0#9.[!C(] J!Z ;7 ;2#!. : \$<! ?2!.1?8\$5529!\$3!^7347.!U#0 ; ?0I[!

!

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- G2/5\$03!X!QI7 8 !X(] !
- T#01 ; !V#2.23575\$03!C(] !

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G4&3'=(Q=%'72=;!03!^7347.!

R=>&73=5(R=\$571E';((

- , 2I5?00H.!<\$.529!7?042!A0#!G2/5\$03 .!%!739!X=!!
- M7#501 .!7#5\$/<2.! ; #04\$929!\$3!/<7 .!739!747\$<7?<2!03!5-2!/01#.2! : 2?.\$52! : \$<!?2!15\$<_29!91#36!
G2/5\$03 .!X!739!C=!

S=62&3=(?4H76';(

!

BC(87'243''(4L(T\$11=5(D#7EF2(

, -2!L34235\$03!0A!` 4\$75\$03!

Q7#<@!.1//2..2.!739!A7\$<1#2.!

> #56-5!R#05-2#.!

, -2!Q7#<@!a 042<5@!0A!` 4\$75\$03!739!> > L!

, -2!T0<923!` 62!` 4\$75\$03!A\$39.!7! ; 1#; 0.2! 8 7\$<J!/0 8 ?75!739!/0 8 8 2#/\$7<15#73. ; 0#575\$03=!

> > LL!

V0.5) : 7#!S b UJ!5-2!^0<9! > 7#J!` \$#<\$32.!739!5-2!c25!` 62!

, -2!V#\$4752!` 4\$75\$03! ; -230 8 2303!

N\$.50#\$/7<!#24\$2 : !0A!/\$4\$<73!7//2 ; 573/2!0A!` 4\$75\$03!

!

MC(D#7EF2(!L=2''(\$15(8 & 9 \$1(*3343!

N1 8 73!"7/50#. !S3!^0 8 ; <2I!G@.52 8 .!

Y#673\$.75\$037<!R2-74\$0#!Z739!5-2!S27.03!D092<[!!

, -2!S0<2!0A!^1<1#2!d!V0 : 2#)U\$.573/2!^1<1#2!

, -2!S0<2!0A!N1 8 73!V2#A0# 8 73/2!O\$ 8 \$575\$03.!

T#01 ; !R2-74\$0#!739!G0/\$7<L352#7/5\$03!\$3!^0 8 ; <2I!G@.52 8 .!

^#2 : !S2.01#/2!D73762 8 235!ZG5#2. .J!G\$5175\$037<!` : 7#232. .J!L3A0# 8 75\$03!V#0/2. .36[!

G0/\$7<L 8 ; 7/5.!0A!` 4\$75\$03!` //9235.!

` //9235!L342.5\$675\$03!#2/0 8 8 23975\$03. !739!5-2!Q5-\$/ .!4.=!Q/030 8 \$/ .!92?752!!

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, -2!S0<2!0A! , #7\$3\$36!d!O27#3\$36! , -20#@!\$3!` 4\$75\$03!G7A25@!!

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,C!4674J*6414976(09H\$62'(4L() :7\$2741(

S261<75\$03!739!5-2!#0<2!6042#3 8 235!#261<75\$03!d!902. !5!-\$392#0#!-7 8 ; 2#!6#0 : 5-e!

O\$A2! : \$5-015!74\$75\$03!7 . .2. .15-2!V0.5!*)% !74\$75\$03!A#22_2J!L/2<739\$ /!40</73\$ /!9\$. #1 ; 5\$03.!

L 8 ; 7/5!0A!74\$75\$03!0A!5-2!234\$#03 8 235!739!5-2!/<\$ 8 752!

` 4\$75\$03!\$3!U242<0 ; \$36! a 75\$03.!

` 4\$75\$03E. !#0<2!\$3!N1 8 73\$57#73!` \$9P!Q 8 2#623/@!S2<\$2A!Z/7.2!.519@!0A!N7\$5\$!Q7#5-f 17H2J!K75#37!

739!5-2!` .73! , .137 8 \$[!

"151#2!\$. .12. !\$3!` 4\$75\$03!Z/0362.529!7\$#. ; 7/2J! a Qg TQ a J!6#223! ; #0 ; 1<.\$03[!

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)22=15\$16=;(

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LA!5-2!/01#.2!\$.!042#!.1? . /#\$?29!5-2! : 7\$5<\$.5! : \$<!?2!A\$<<29!?@!5-2!#2 8 047<!0A!73@!.519235.!: -0!90!

305!755239!5-2!A\$#.5!X!97@.!0A!/<7. .=!

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)=34'H\$6=(* 1E71==371E(!67=16='(U(V17:=3'72''(<4#767='(
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G#\$' '344 9 (I=F\$:743(

R05-!.519235.!739!A7/1<5@!7#2!#2. ;03.\$?<2!A0#! 8 7\$357\$3\$36!73!7 ; ;#0;#\$752!<27#3\$36!234\$#03 8 235!\$3!
7<<!\$3.5#1/5\$037<!.255\$36.J! : -25-2#!\$3!;2#.03J!#2 8 052!0#!03<\$32=!, -0.2! : -0!A7\$<!50!79-2#2!50!.1/ -!
?2-74\$0#7<!.57397#9.! 8 7@!?!2!.1?F2/5!50!9\$. /\$; <\$32=!V#0A2. .037<!/01#52. @!739!.23. \$\$4\$5@!7#2!
2. ;2/\$7<<@!\$ 8 ;0#5735! : \$5-!#2. ;2/5!50!\$39\$4\$917<.!739!50;\$/ .!927<\$36! : \$5-!#7/2J!/0<0#J!375\$037<!
0#\$6\$3J!.2IJ!;#26373/@J!762J!9\$.7?<\$5@J!/ #229J!#2<\$6\$03J!.2I17<!0#\$23575\$03J!62392#!\$9235\$5@J!62392#!
2I;#2..\$03J!4252#73!.5751 .J!;0<\$5\$/7<!7AA\$<\$75\$03!0#!;0<\$5\$/7<!; -<\$<0.0; -@=!!"0#! 8 0#2!\$3A0# 8 75\$03J!.22!
5-2!;0<\$/\$2.!03!/<7..#008!?!2-74\$0#!739!5-2!G519235!^0391/5!b!^03A\$/\$5!S2.0<15\$03!;0<\$/\$2.=!!

(
R=>&73= 9 =12'(L43(GWX0YJBZ(

` .!7! 8 7552#!0A!; 1?<\$/!-27<5-!739!.7A25@!912!50!5-2!; 7392 8\$/J!7<<!8 2 8 ?2#. !0A!5-2!^ h!R01<92#!
/08 8 13\$5@!739!7<<!4\$. \$50#. !50!/7 8 ;1. ! 8 1.5!A0<<0 : !13\$42#. \$5@J!92; 7#5 8 235!739!?!1<9\$36!
#2f1#2 8 235.!739!7<<!; 1?<\$/!-27<5-!0#92#. !\$3!; <7/2!50!#291/2!5-2!#\$. H!0A!.; #279\$36!\$3A2/5\$01.!

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<3=l=33=5(!2&5=12(+ \$ 9 ='(\$15(<3414&1'('

^ h!R01<92#!#2/063\$_2.!5-75!.519235.!<267<!\$3A0# 8 75\$03!902.315!7< : 7@.!7<\$63! : \$5-!-0 : !5-2@!
\$9235\$A@=!G519235.! 8 7@!1 ; 9752!5-2\$#! ; #2A2##29!37 8 2.!739! ; #03013.!4\$7!5-2!.519235! ; 0#57<m!5-0.2!
; #2A2##29!37 8 2.!739! ; #03013.!7#2!<\$.529!03!\$3.5#1/50#.!!/<7..!#0.52#.=!L3!5-2!7?.23/2!0A!.1/-!
1 ; 9752.!J!5-2!37 8 2!5-75!7 ; ; 27#!.03!5-2!/<7..!#0.52#!\$.!5-2!.519235!.!<267<!37 8 2=!

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