

**Department of
Economics and Finance**

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60#8,!#+'(',+!(.+'!)044'(#+0.6,!+%'9: '\$+')!'9\$5.#; '!(.+'!\$5.#; ',<!.#)<!#!: .(+\$=6.(<!0+:(')0\$+,!
+5.+! 50;5! 10'6)! \$=((#\$0',!,5%=6)!) ':('\$0.+>! ? .(0%!=,! @ '+5%),! 5.& '! A' '#!=,') ! +%! +' ,+! 0+!
' @ :0(0\$.6617! +5' ,! 0#\$6=) '! ,0@ :6' ! B()0#. (1! C' .,+! DE=. (' ,! 2BCD3! 4%(! ' ,+0@ .+0#;!

@ '+5%)%6%;1<! A=#! P0+5!)044'('##!+(.#,0+0%#! &.(0.A6',!(6.+')!+%! \$=(('#\$1!+(.)0#;! ,+(.+';0',<! V.0660'!.#)IN5.#;!2RJHH3!,5%P')!+5.+!"*/!5%6),!%#61!P5'#!\$.((1!+(.)'!,+(.+';0',!.('!: '\$0&')!) ..,!:(%40+.A6'!M! P5'#!+5'1!.(!#%+!+5'0(!(',=6+,!\$%#40(@!+5%, '!%4!C1%#,!2RJJH3!.#)!:(%&0)'!.))0+0%#.6!,=: :%(+!4%(!#%#60#'.(0+0',!0#+5'!'*/!(6.+0%#>C0!'!+.6!2RJHX3!4%66%P')!..,0@06.(! ..::(%.\$5!.#)!4%#=)! '@:0(0\$.6!,=: :%(+!4%(!"*/!P5'#!=,0#;! '9\$5.#; '!(.+'!&%6.+060+1!.#)!+5'! D5.(:'!(.+0%.,!+(&.#,0+0%#!&.(0.A6',<!A=#!#%+!P5'#!=,0#;!0#,+'.)!+5'!0#+'(',+!(.+'!)044'('#+0.6!! !
 ^#%+5'(!0,,='!0#&',+0;.+')! @%('!('\$#+61!0#!+5'!'\$%#+'9+!%4!'*/!0,!+5'!(\$6'!%4!0#+'(',+!(.+'! '9:'\$+.+0%#, <!P50\$5!5.)!A' '#!4%#=)!:('&0%=,61!+%.44'\$!+5'!,6%: '!%4!+5'!10'6)!\$=(&!2N%8!.#)! b.5#<HIIJ3<!40#.#\$0.6!(.+.+0%,!2N5'#!.#!)^0#0#. <HIIc3!.#)!+5'!'9\$5.#; '!(.+'!2S.=6'e#<HIIY3> Q=,'60=,!.#)!D+066P.;%#!2RJHY3!(':%(')+5.+!0#+'(',+!(.+'!4%('\$.+,!.('!+5'!: (0@.(1!,%=('\$!%4!)'&0.+0%#,!4(%@!+5'!'9\$5.#; '!(.+'!.#)!0#+'(',+!(.+'!E=060A(0=@!.#)!4%#=)!.#!0@:%(+.#+!(%6'!4%(! ,:\$=6.+0&'! A=AA6',>! D'&'(.6!,+=)0',!:(%&0)'! '&0)'#\$'!+5.+!\$'#+(.6! A.#8!.##%=\$'@'#+,! ,+(%#;61!0#46='#\$'!0#+'(',+!(.+'!9:'\$+.+0%#,!2S%#0W!.#)!a'!Q%#;<RJHc3<.#!)!+5.+!,%@'!\$'#+(.6! A.#8,! '&#!=,'!+5'!'\$%#+'#!%4!+5'0(! .##%=\$'@'#+,!0#+'#+0%#.661!+!0#46='#\$'!0#+'(',+!(.+'! '9:'\$+.+0%#,!2G0'+W<RJHI3!^##%=\$'@'#+,!\$%#+.0#0#;! :%60\$1!(.+'!)'\$0,0%#,!5.&'!A' '#!4%#=)! +%15.&'!..!:(.+\$=6.(61!,+(%#;!44'\$+!%#!.,,'+!:(\$',<!0#\$6=)0#;!+5'!'9\$5.#; '!(.+'!.#)!0#+'(',+!0.2(+).0.2(5.)0.2(&')

$$\prod_{i=1}^n \Gamma_i \Delta_{-i} \Phi$$

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P5'('! !0,!..!&'\$+%(!P0+5!+5'!', '(0',!=#)'(!'9. @0#. +0%#<!g!0,!+5'!)044'('#\$'!%:'(.+%(<!Pi
 ,!..!@ .+(09!;0&'#!A1!+5'!:(%)=\$+!%4!+P%!&'\$+%(, !0#\$6=)0#; !+5'!.)T=,+@ '#!.#)!+5'!\$%0#+'; (.+0#;!
 \$% '440\$0'#+,!(',: '\$+0&'61<!Gi!0,!+5'!\$% '440\$0'#+!@ .+(09!%4!+5'!: .@ +'(,!;%&'(#0#; !+5'!,5%(+M(=#!
 A'5.&0%=(! %4! +5'! &. (0.A6',<! !0,! ..!&'\$+%(! %4! '9%; '#%=,!)=@ @1! &. (0.A6',! .#)! Φ! +5'!
 \$%((', :%#)0#;!\$% '440\$0'#+!@ .+(09!G5'!@%) '6!5.,,!(\$%0#+'; (.+0#;!('6.+0%,! .#)! :!'#)% ; '#%=,!
 &. (0.A6',7!04!\$%0#+'; (.+0%#!5%6),<!P5 '#'&'(!5

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 \ '!40(,+!: '(4%(@!+5'! a FMZCD!.#)!] / DD!=#0+(%%+!+,+,!%#!+5'!#%@0#.6!'9\$5.#; '!(.+.!.#)!+5'!
 #+'(,+(.+'!)044'(#+0.6!, '(0',>G5'!(',=6+,!%4!+5', '!+',+,!.('!(':(+)!0#!G.A6', !H.!.#)!HA!.#)!
 \$%#40(@!+5.+!.66!, '(0',!.('!0#+';(.+')!%4!%() '(! 1 >!!
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1 2 3 4 5 6 ! %/,				
7 8 6 6 ! %/,				
>. ? +*!"\$@A<B"!C%&- ",%/				
! "#\$%&'	(*)+,)'	()-*, .///'	,+*0///'	1*1.0'
! "#%2&'	(*)+13'	()3*431///')15///'	1*1343'
! "#67&'	(0*3)3'	()3*-5, ///'	3,* ,///'	1*15)-'
! "#89 :'	(0*5).'	().*,0.///'	+.*4///'	1*1503'
\$%&%2&'	(0*-50'	()5*1,+///'	-)*5///'	1*10+0'
\$%&67&'	(0*4.)'	()-*0), ///'	50*0///'	1*10,0'
\$%&89 :'	(0*0.)'	()-*),3///')4*..///'	1*1),)'
%2&67&'	(0*-0.)'	().*355///'	,1*4///'	1*15,0'
%2&89 :'	(0*4,+')	()5*034///'	-+*0///'	1*1015'
67&89 :'	(0*155'	()-*-30///')+///'	1*1)55'
28&92 ;'	()-*-5'	().*)50///').+///'	1*134-'
28&\$<='	(0*11-'	()-*++5///').1///'	1*10+'
92 ;\$<='	()-*+,)'	()3*4-.///'	+4*4///'	1*13-5'
D*, %: %/, - ", %&1+; %: %*, +!"\$/				
2 : (\$>?>@>'	(0*15,)'	()4*104///'	.1*-///'	1*113)'
2 : (%ABCD>EF>'	(1*1-3'	()3*5-)///')55///'	1*1)1-'
2 : (6GH'7G>E>?@'	(1*.5'	()4*)10///')05///'	1*115)'
2 : (8HG@G?'	(*)114'	()-*400///'	3)*4///'	1*1-,4

(. #8! 0,! r 1<! 0>'>! +5 ('! '90,+,! .! ,0#;6'! \$%0#+';(. +0%#! ('6.+0%#! 0#! '. \$5! \$., '! P50\$5! \$.#! A '! 0#+'(:('+'!)..,!+5'!"*/!'E=060A(0=@>!!

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!"#\$%&E(@F.B"*/%*! :;"<%!*=@+C%*9"#\$0%&!%/,/k;. :G.+*,%C;"+,.*k		@+C%*9"#\$0%&!%/,k		
k	! :"<%!%/,k	@+C%*9"#\$0%&!%/,k		
! %/,k'k	! %/,&E&	! %/,k'k	! %/,&E&	
2 :(\$>?>@>k	1*1115//k	1*..,4+k	1*111)///'	1*..,4+
2 :(%ABCD>EF>				

!'"#\$%&'#(%%)*+%"',&-.*+/%0,"/%1&2&3/.,&45/.,%0,%66&7&8 .1%&9&65\$/6:&.,&:+\$"/*.+&!'",0%/*+0&- .5+/,*%6!
! | <=> - 4 ?& | <=>4 @ ?& | - 4 ?AB ?& | 4 @ ?AB ?& | 4 @ ?CDE&
;+1%F%+1%+/&
2",*!"#\$%6!

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! "#\$% &"% '"()*(+%,% -"(.%"-*%) /.,01*-\$2% \$"-\$-% \$*%"-\$,34.-5% &5"\$5"(\$5%"4.1",(% +*/"4% .-% /,\$,%
2*10(6"1\$%85"-%"(-64\$-%,(%"('*(\$/%.1%8,34%"9%,1/%-5*&%\$5,\$%1*1%"*)\$5%"+"*/"4-%-6))"(%)(*+%

-"(.,4%2*(("4,\$.*1%*(% ',(,+\$\$("%1-\$,3.4.\$:7% ; *&"<(%0.<"1%\$5%"1/.10%*)%,%4*&% ,/>6-\$+"1\$%

-'"%/%.1%\$5%"2,-%"*)\$5%"4.1",(%+*/"4-%&%'"()*(+%1*14.1",(.:\$%"-\$-%\$*%"&5"\$5"(%,%1*14.1",(%

),(,+&*(?%2,1%'(*<./%"-\$(%10"(%<./"12%"*)(\$5%"+"'.(2,4%<,4./.%:*)%@AB%3*\$5%.1%\$5%"-5*(\$%

,1/%\$5%"4*10%(617%

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3:\$,%4*&"(\$,/>6-\$+"1\$%-'"\$/\\$5,1%\\$5"%1)4,\$.*1%,(0"\$.10%*1"-=%&5.25%-600"--\$-%\\$5,\$%.1\$"("-%(\$,\$%"#'"2\$,.\$.*1-%'4,:% ,% +*(%" .+ '*(%,1\$% (*4%" .1% \\$5"% ,/>6-\$+"1% \$*&,(/-% @AB% 61/"(% .1)4,\$.*1% \$,(0"\$.10%Y1\\$5"%&5*4"=%\\$5%"(-64\$-%.1%8,34%"0%.1/.2,\$%"\\$5,%%\\$5%"-:-\$"+%+*<"-%3,2?%\$*&,(/-%.-% 4*10D(61%"R6.4.3(.6+%%\\$5(*605%,/>6-\$+"1\$-%.1%\\$5%"1\$"("-%(\$,\$%"R6,\$.*1-%36%*14:%&5"1%\\$5%" + ,(?"\$%"#"2\$-%\\$5%"2"1\$(,%3,1?%\$*%,/*'\$%,%2*1\$(,2\$.*1,(:%+*1"\$,(:%'*4.2:%-\$,12%"3:(%,..-10%\\$5%" .1\$"("-%(\$,\$%.1%\\$5%"1",(%6\$6("7%%

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F.1,44:=% \$*% 25"2?% \\$5%" ,/"R6,2:% *)% \\$5%" 1*14.1",(% Z [\8] E% +*/"4% &% 2*1/62% L,0(,10%" ^ 64\$. '4."(% PL ^ Q% 8"--%

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85.-% ', '"(("D"#, +.1"-%%\$5"%@AB("4,\$.*1%3:\$.-\$.+,\$.10%).(-\$,13"125+, (?%4.1", (%Z*.1\$"0(\$,\$/ %
[] E%.1246/.10%\$5%"1*+.1,4%"#25,10%"(\$%",1/%\$5%"1\$("\$-\$%(\$%"/.))"("1\$.,4%,-%&"4%,-%2"1\$(,4%
3,1?%,11*612"+"1\$-%,1/%\$5"1%,%Z*.1\$"0(\$,\$/ \% +**\$5% 8(,1-\$.*1% [] E%PZ [\%

] +(.=%\7=%`UUM7%] 1,4:-.10%\$5%"*)*(&,(/%'("+.6+%,1*+,4:%6-.10%,%L*0.-\$.2%\ +**\$5%8(,1-.\$.*1%
E"0(--.*1+* /"47% "#\$%\$&'#() *+,,-.%=%/P`H0=%' '7TDTM7%

] (05:(*6=% ^7d7% ,1/% B*6('*6(./-=% B7=% `UTH7% A1)4,\$.*1% ,11*612"+"1\$-% ,1/% ,-:++"\$(.2%
"#25,10%" (,\$%" ("-*1--7%0\$+1%2,) \$3) 4%.-1%2.'\$%2,) 5%2%#2,) 6 217-.(8) 4%(.'.+'\$%() 2%9)
6 \$%-:=%;<=%' '7MUDMW7%

N,.44."=%E787%,1/%Z5,10=%\7\7=%`UTT7%Z,((:\$:,/-=%+*+"1\$6+\$(\$,/.10%,1/%\$5%"*)*(&,(/%'("+.6+%,
1*+,4:7%0\$+1%2,)\$3)5%2%#2,)6 217-.(=%;PXQ=%' '7WWTDWHW7%

N,.44."=%E787%,1/% a.4.2=% E7=% `UUH7%] -:++"\$(:\$:,1/% 1*14.1",(\$:\$:.1% 612*<"(/%.1\$"(-\$% (\$,\$%"
' ,(\$:7%0\$+1%2,)\$3)4%.-1%2.'\$%2,)6 \$%-:)2%9)5%2%#-=%>?P`Q=%' '7^`DWK7%

N,1"(>""=%] 7%,1/%\105=% ^7^7=%`UUH7%@-(.%A)I-2,)%".-1-(.)B2I'.:)'%)-&-IA '%A)&217-.(%P ! *7%HD
`WOQ7%A1\$" (1,\$.*1,4% ^*1"\$,(:%F61/7%



$\wedge *1.c\%] 7\%, 1/\%/"\%J*10-\%F7-\`UTW=\% \wedge , :7\%B("/.2$.10\%$5"\%.+' ,2$\%*)\%2"1$(,4\%3,1?\%2*++61.2,$.*1-\%*1\%).1,12.,4\% +,(?"$% .1<"-$*(-n\% .1$"(,-$% (,$%" "#'"2$,.$.*1-7\% A1%" +1\$B-2\%) N-&2\%. #') X-Y) T\$%3-1-%#-\%P' '7\%TWWDT9907\% \ '(.10"(=\%Z5 ,+7\%$

$\wedge **("=\% \wedge 7\% ,1/\%E*25"=\% \wedge 7\%-\`UTU7\% \ *4<.10\%"#25,10"\% (,$%" 6cc4"-%\&.$5\%1".$5"(%-.2?:% '(.2"-1*($(, /"\%2*-$-7\%0$+1\%2,)\$3)4\%.-1\%2.'\%2,)6 \$%-:)2\%9)5 \%2\%#-=%>PPHQ=\% '7\%TT9TDTKU7\%$

$!"6+,11=\% \wedge 7\% ,1/\% [*1\% ; ,0"1=\%J7-\`UU^7\%Z$-() \%3,2. '$%).21A-. \%A)&2.. -1I\%P ! *7\%N\%UTD`UU^Q7\% b IA\%&*(?.10\%', ''(7\%$

$Y3-$)"4/-\% \wedge 7\%TOMK\%F-($)BI\$Y,-&(8)Y+YY,-(8)2\%9)I'(7)\%).I-)-\&B'I'\#2,)2((-((&-%.)\$3)-R\#I2\%A-K 12.-)Y-I2D'\$I\%P ! *7\%&` UXQ7\% ! ,$.*1,4\%N6(",6\%*)\%I2*1*+.2\%E"-", (25\%$

$E,*=\%Z7E7-\%TOWM\%8"--$-4\%)\%-01.).2,12"\%.1\%+64\%.<,(.,$%" ,1,4:-.-7\%*' \$\&-.I'72=\%U?PTI`Q=\% '79MDKO7\%$

$E.\',\$.\%] 7\%` UUT7\% ["2\%*(\%,6\%*("0(--.<"\% (*2"--"-%\&.$5\%1*14.1",(\%$.+"%$("1/-\%.1\%2*.1\$"0(,\$.10\% ("4,\$.*1-7\% \wedge ,2(*"2*1*+.2\%_1,+.2-=%9PWQ=\% '79KKD90K7\%$

$E*-,=\%Z7\%,1/\% ["(0,-\%d7-\`UTM7\%85"\%.+' ,2$\%*)\%2"1$(,4\%3,1?\%,11*612"+"1$-\%*1\%,--"\$%" '(.2"-1\% (" ,4\%$.+"%@I'1.--%.I)'((+-)\$0\%-.><<WJ)\$3).I-)4\%.-1\%2.'\%2,)0\$+1\%2,)\$3)T-.12,) *2\%7\%A7\%$

$\backslash ,0"(\% \wedge 7\% ,1/\%8 ,:4*(=\% \wedge 7B7-\`UUW7\%85"\%.+' ,2$\%*)\%I6(*' ",1\%Z"1$(,4\%N,1?\%d*<"(1.10\%Z*612.4\%,11*612"+"1$-\%*1\% $5\%)*(."01\% "#25,10"\% +,(?"$% ,% +.2(*-$(62\$6(,4\% ,1,4:-.-7\%0\$+1\%2,) \$3) 4\%.-1\%2.'\%2,)6 \$%-:)2\%9)5 \%2\%#-=%>UPKDMQ=\% '7\%TUWXDTU9T7\%$