



5-RXU QDO RI & CQLQLFLD 'LDJQRVLF
N.F.Ko 2376-0311 RVL

/HDUQLQJ &XUYH IRU 8OWUDVRXQG \$VVHVVPH

7XGRUDFKH RRUHHDUDJXVLG FULODD WUX \$SOH[DQGG &XUD D/QG ,OLHVFX '*
'HSDUWPHQW RI 2EVVHWULFV DQG *AQHFRORJ\ 3UHQDWDQ 'LDJQRVWLF 8QLYHUVLW\ RI 0HGLFLQH DQG 3
8QLYHUVLW\ (PHUJHQF\ +RVSLWDO &UDLRYD 'ROM 5RPDQLD
'HSDUWPHQW RI ,QIRUPDWLFV 8QLYHUVLW\ RI 0HGLFLQH DQG 3KDUPDF\ RI &UDLRYD &UDLRYD 'ROM 5R
'HSDUWPHQW RI 3XEOLF +HDOWK 8QLYHUVLW\ RI 0HGLFLQH DQG 3KDUPDF\ RI &UDLRYD &UDLRYD 'ROM
&RUUHVSQRGLQJ DXWKRU 0RQLFD /DXUD &DUD 'HSDUWPHQW RI 2EVVHWULFV DQG *AQHFRORJ\ 8QLYH
&UDLRYD &UDLRYD 'ROM 5RPDQLD 7HO GDLP DQLTXHOOH#\DKRDLFRP
5HFHLYHG-GDWH \$FFHSDWIG GDWH 3XEOLV-DCG GDWH
&RSULJKW < 7XGRUDFKH 6 HW DO 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHW
XQUHVWULFWHG XVH GLVWULEXWLRQ DQG UHSURGXFWLRQ LQ DQ\ PHGLXP SURYLGHG WKH RULJLQDO D

\$EVWUDFW

%DFNJURXQG DLP RI RXU VWXG\ ZDV WR HYDOXDWH WKH FKDUDFWHULVWLFV RI W
)7 IHWDO KHDUW VFDQ DQG WR GHWHUPLQH WKH UHTXLUHG QXPEHU RI XOWUDVR
DFFXUDWHO\ DVVHVW WKH QRUPDO IHWDO KHDUW DW ± ZHHNV JHVWDWLRQ E

0HWKRGV :H VHOHFWHG IRXU WUDLQHHV UHVLGHQW GRFWRUV ZLWK WKRUH
)7 67 VFDQ EXW ZLWKRXW SULRU H[SHULHQFH LQ SHUIRUPLQJ ILUVW WULPHVWHU I
IHWDO KHDUW XOWUDVRXQG VFDQQLQJ LQ D FRKRUV RI FRQVHFXWLYH IHWXVH
WUDQVOXFHQF\ 17 VFDQ XSRQ D SUH HVWDEOLVKHG SURWRURO 7KH VXSHUYL
VXFFHHGHG LQ REWDLQLQJ DQ LQIRUPDWLYH ' ' & GXSOH[VZHHS RI WKH IHWDO K
PLQXWHV 7KH GDWD ZHUH DQDO\HG LQ WKUHH JURXS RI H[DPLQDWLRQV ,QGLY
PRYLQJ DYHUDJH PHWKRG

5HVXKÁ Q•D# u\RhU'Rp 'Q'q0' ÉÁ óbvl} .H\ZRUGV

LUVW WULPHVWHU)HWDO KHDUW 8OWUDVRXQG 6FUHHQLQJ
1XFKDO VFDQ &RQJHQLWDO KHDUW GHIFWV

,QWURGXFWRQ

&DUGLDF VFDQ LV SUHVHUYHG PDLQO\ WR WKH VFRQG WULPHVWHU HVSHFLDO
GXH WR QRZDGD\ JXLGHOLQHV DQDQDQG GXH WR WHFKQLFDO DQG
OLPLWDWLRQV 6WLOO IHWDO QXFKDO WUDQVOXFHQF\ WKLFNQHVV 17
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)UVW WULPHVWHU)7 VFDQ JUHZ LQWR WKH UHDO DQG PRVW LPSRUWDQW
DQDQDQ\ VFDQ > @ 5HFHQW \HDU V UHVHDUFK SURYHG WKDW DOPRVW DOO
PDMRU VWUXFWXUDO DQRPDOLHV DUH GHWHFWDEOH DW WKLV JHVWDWLRQDO DJH
OHVV WKH FRQJHQLWDO KHDUW GLVHDVH &+'V > @ GHVSLWH WKH IDFW
WKDW WKH\ DUH DPRQJ WKH PRVW IUHTXHQW RI DOO FRQJHQLWDO DQRPDOLHV

0DQ\ UHVRQV VKRXOG FRQLQFH XV WR ORRN HDUO\ LQ SO...QD•@XDEOH WKH
GHPRQVWUDWHG WKH IDFW WKDW LI DQ XUYH IRU LQHSHULHQFHG WUDLQHHV DQ
RI D VWUXFWXUH KH ZLOO EH PRUH OLNHQ\ WR VXSHFW DQ DQRPDO\ RI WKDW
VWUXFWXUH LI SUHVHQW > @

H SXUSRVH RI WKLV VWXG\ ZDV WR DVVHVW WKH HYROXWLRQ RI WKH OHDUQLQJ
F

SUDFWLFLQJ DQG WUDLQHHdV VXFFHV V LQ REWDLQLQJ LQWHUSUHWDEOH LPDJHV I
IHWDO KHDUW

:H K\SRWKHVLJHG WKDW UHSHDGLHBUHQDQV ZLOO LQFUHDVH WKH
VNLOOHG REVVHWULFLDQdV DELOLW\ WR DFTXLUH JRRG TXDOLW\)7 IHWDO KHDUW
GLJLWDO FOLSV \$QRWKHU DLP ZDV WR GHWHUPLQH WKH QXPEHU RI XOWUDVRXQ
H[DPLQDWLRQV QHFHVVDU\ IRU WUDLQLQJ VRQRJUDSKHUV WR H[DPLQH
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XOWUDVRXQG

ODWHULDOV DQG OHWKRGV

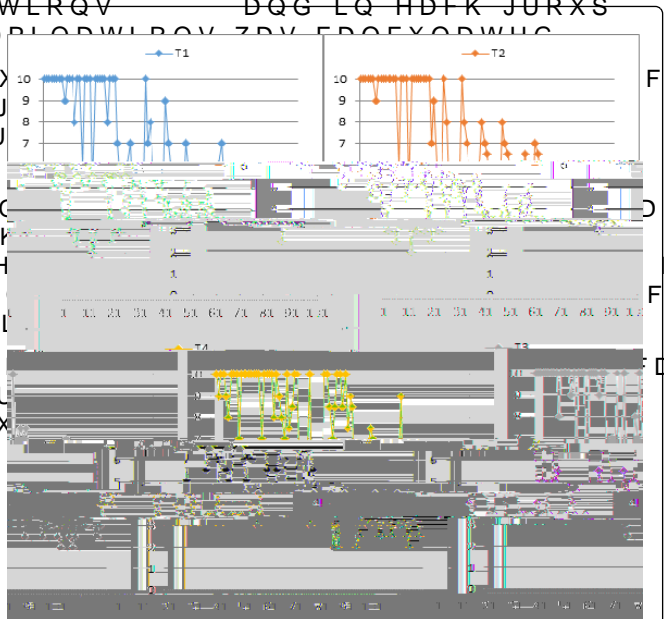
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WKHUH DUH SHUIRUPHG RQ HYHULQDQV DRQF QXFKDO VFDQV
FULWHULD ZHUH DQG YHUZHUW SUHJQDQFLHV
WULPHVWHU

JURXS & ODVW WKLUG RI H[DPLQDWLRQV DQG LQ HDFK JURXS WKH SHUFHQWDJH RI XQVFFHVVIXO H[DPLQDWLRQV ZDY FROEXORWULG

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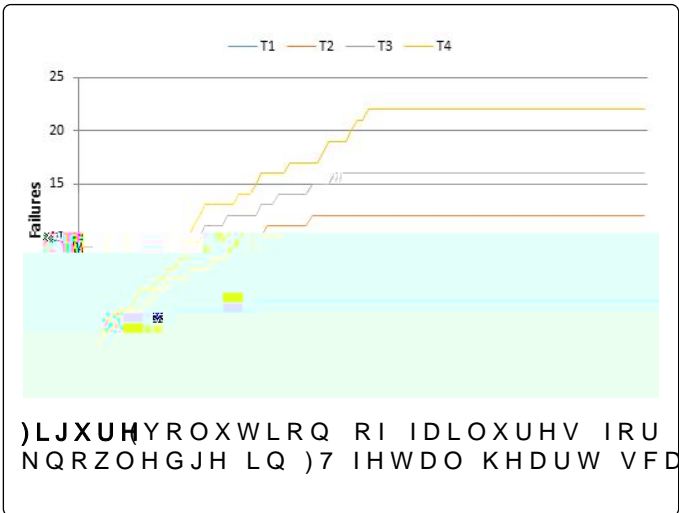
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6XFFHVVIXO H[DPLQDWLRQ RI WKH IRXU WKLWUWDLQHVVFDQV E\ WKHWHFRQWU E\ WKH WKDWUWDLQHVVFDQV E\ WKHWHFRQWU VFDQV)LJXUH



)LJXUH OHDUQLQJ FXUYHV HDFK RI WK

% DQDO\VLQJ WKH VKDSH RI WKH UHVXOW DVHUQ LQLWDO SODWHX OLNH UHJLRQ LV VORSH DW D'ARXLDV WKLWUWDLQHVV RI WKH QHFHVVDU\ VNLOO WR SHUIRUP WK IHDXULQJ JUHDW YDULDELOLW\ DSGWRQ OHVV YDULDELOLW\ PRVW WKLWUWDLQHVV X HDFK WUDLQHVV ZLWKRXW SUHYLRXV)URP WKLWUWDLQHVV WKHUH LV D QHZ SOD HQG RI WKH OHDUQLQJ SURFHVV



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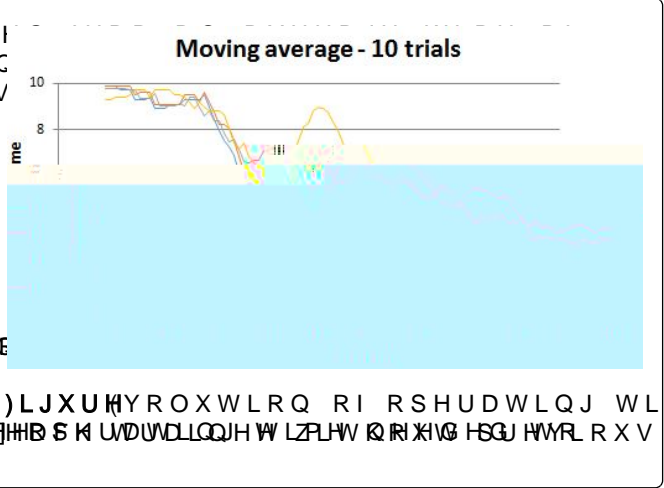
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	7	7	7	7	7RWDO
1R RI WULDOV					
)LUVW WKLUG	"	"	"	"	"
/DVW WKLUG	"	"	"	"	"

7DEOH HDQ RSHUDWLQJ WLPH GHFUHDV WKLUG RI H[DPLQDWLRQV

:H DOVR SURFHGHG WR DQDO\VLQJ WKH WHFRQWU WKLWUWDLQHVV VZHH

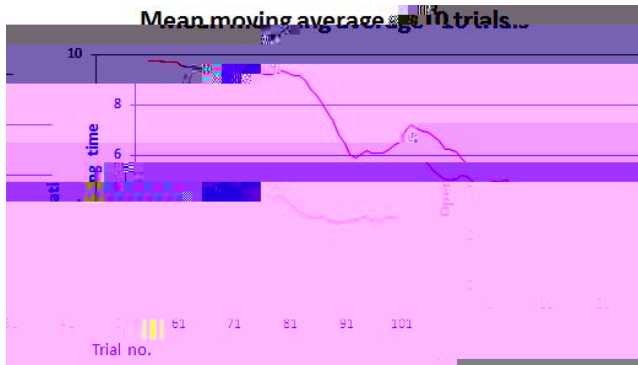
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)LJXUH HYROXWLRQ RI RSHUDWLQJ WLPH DF

HDFK RI WKH IRXU WUDLQHVV DUH QRW YL LQIRUPDWLYH IRU WKH JOREDO WUHQG RI WKH OHDUQLQJ SURFHVV)LJXUH ZH FRPSXWHG WKH PRYLQJ DYHUDJH IRU WULDOV IRU HDFK RI WKH IRXU WUDLQHVV)LJXUH DQG DV DQ DYHUDJH IRU DOO RI WKHP)LJXUH

Mean moving average μ in trials...



CRUPDO VWUXFWXUH ZLOO QRWLFH IDVWHU WKH DEQRUPDOLW\ RI WKDW VWUXF
LVLGHD LV WKH JURXQG ZKLFK SHUPLWV WKH fH[SHUWL]Hg FRQFHSW

2XU DVVXPSWLRQ ZDV WKDW OLNH LQ PDQ\ RWKHU LVVXHV LI D VWDQGDUG
SURWRFRJ LV XVHG)7 LPDJHV RI WKH KHDUW DUH PRUH LQWHUSUHWDEOH
ORUHRYHU WKH GLUHFWRU DQG WKH VSDWDO DUUDQJHPHQW RI WKH JUHDW
DUWHULHV DUH HDV\ WR}V\WXV\OLPH\SSW\WQH HQG RI WKH
FRORU 'RSSOHU ERWK LQ ' XOWUDVRXQG DQG LQ FRORU UHQGHUHG 67,&
GDWDVHV > @

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FRQWDLQ GHWDLOHG LQIRUPDWLRQ RQ WKH FKDUFDWHULVWLFV RI SDUWFLSDQW
KHOS WHVW WKH K\SRWKHVLV WKDW WUDLQLQJ LV LPSRUWDQW LQ JDLQLQJ VNLQ
)7 VFDQQLQJ DQG RWKHU K\SRWKHVLV OLNH WKH RQH WKDW WKH LQGLYLGXDO
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)XWXUH UHVHDFK RQ WKHVH WRSDFV LV FUXFLDO IRU UHVHDFKHU LQWHUHV
LQ XVLQJ WKH ZRUNSODFH DV D VFUHHQLQJ IRU &+' FHQWU

HUHUHVZL)FDLWDLRQV RI WKLV VWXG\ 7R EHJLQ ZLWK LV
WKH VPDOO QXPEHU RI WKH SDUWFLSDQWV 2Q WKH RWKHU KDQG ZH GLG QRW
VWUDWLI\ IRU RWKHU FRQIRXQGUV VXDOO\ SUHVHQW LQ UHDO OLIH VFDQQLQJ
VXFK DV DQWHULRU SRVWHULRU SODFHQWD DFRXVWF FKDUFDWHULVWLFV RI H
SDWLHQW IULHQGO\ XQIULHQGO\ WLVVXH VXEMHFWLYH DPRXQW RI DPQLRWLF
~XLGRZHOOLW\HUXV SRVLWLRQ LQFRPSOHWH DQWHYHUVLRQ RU
DQWH~HVEDQHG XWHUXV RU VFDUHG DEGRPLQDO ZDOO ZH FRQVLGHU
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2XU VWXG\ FDUULHV ELWKHWHV\OUIHQVWV\WKDWLUVV
WKH FRKRU RI WUDLQHO\GSHFRQJ\WLLRQ RI
UHVGHQW ZKR HQW\HOBIGSWKEDFKDO\GHOJLQJ
VSHFL\HJRJUDSKLF UHJLRQ LQ D GHYHORSQJ FRXQWU\ WKDW VWUXJJOHV ZLWK
D FKURQLF XQGHUHQGLQJ LQ KHDOWKFDUH WKUHE\ UHGFLQJ ELDVHV LQKHUO
LQ FRQYHQHQFH RU RWKHU\WUFSOLV\SRIRFHGXUH
ORQJLWXGLQDO VWUXFWXUH ZHUH H[SORLWHG WR FRQWURO IRU RWKHU FRQVW
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VXFK DV WKH WLPV VSHQW WR RSWLPL]H WKH VHWWLQJ RI WKH PDFKLQV
WUDQVODWHG LQ WKH WLPV UHTXLUHG WR REWDLQ WKH VZHHS ZKLFK WR RXU
NQRZOHGJH KDV QHYHU EHHQ SHUIRUPHG EIRUH)LQDOO\ WKH VDPSOH ZDV
DQ XUEDQ EDVHG FRPPXQLW\ FRKRU RI D 8QLYHUVLWDU\ (PHUJHQF\
+RVSLWDO 5HVHDFK RQ ZRUN LQ WKLV SRSXODWLRQ LV OLPLWHG DQG RXU VWX
OHQGV HYLGHQFH WR WKH QRWLRQ WKDW WKH OLQN EHWZHHQ SUDFWLFHQJ DQG
LV JHQHUDOL]DEOH WR VHWWLQJV RI YDU\LQJ HFRQRPLF FRGLWLRQV

&RQFOXVLRQV

\$OWKRJK)7 IHWDO KHDUW VFDQQLQJ LV QRZDGD\V VWLOO VHHQ DV D VXSHULR
WHFKQLTXL W•p0rWsUHFRPFLHQ DW@ QV W•DUH RWKDW WœPøH RHKR €... H

&LWDWZKGRUDFKH 6)ORUHD 0 'UDJXVLQ 5 =RULOD / 3DWUX &/ HW DO /HDUQLQJ &
1XFKDO 6FDQ - &OLQ 'GRUQ 5HV

3DJH RI

-°UJHQVHQ '(6 9HMOVWUXS 1 -°UJHQVHQ & WDDG XQD/LGDVCHHFKRFDWJGLRHWDSK\ LQ DQ)
3UHQQDWO GHWHFWLRQ RI FRQJHQLWRSKUDVW HCSMHDVGFHQ 8DWORZVRLQ 2EVW
SRSXODWLRQ}WDDGJRHRQG WULPHVWHU /RPHHQGLQ&03UHQQDWRWL 0)HVVORYD 9
'LDJQ HFKRFDUGLRJUDSK\ DW WKH WLPH RI WKH QX
\$EXKDPDG \$ &KDRXL 5 \$ SUDFWLFDVOWHWLGGHFRD IHWDO
HFKRFDUGLRJUDSK\ QRPDO DQG DEQRUPDQV 3XELHRYFKLQD(2HOSKLD.KDQ .6
3\$:ROWHUV .OXZHU +HDOWK /LSSLQFRWW :LQWHPD WLFONLQYL 82 RJUWKHWUDFHWUDHURXR
%HFNHU 5 6FKPLW] / .LODYX] 6 6WXPP 0 H[DQDQDWRGWRDOGHWHFWLQJ PDMRU FRQJ
1RUPDO QXFKDO MXUDQVGRFHWLQDQ IURP GHZEDWOHG *VGBRO
\$QDO\VLV RI FDVHV ZLWK VSHFLDO UHFRGLWR 5HW 54EPGRVSHFWV 3UHQQDWOGL
'LDJQ a XOWUDVRQRJUDSK\ LQ SUHJQDQF\ :+2 V\WV
\$OODQ / %HQDFHUUDI % &RSHO -\$ &DUYDOKR P W B KDRXL 5 VLHV 8ODVUDVRXQG 2EVWHW
,VRODWHG PDMRU FRQJHQLWDO KHDUW GLV%RV 3\$OWRQGRXQ G+2ENWHW *&RFRPHUDLQ
WHUPLQDWLRQ RI SUHJQDQF\ IRU IHWDO DQ
7XGRUDFKH 6 &DUD 0 ,OLHVFX '* 1RYDF %0-&HUQH 1)LUVW
WULPHVWHU WZR DQG IRXU GLPHQVLRQDO F%HOLODFWFDQ 4AWWDRYD G9LQVSHRELVH YH
DJUHHPHQW FRPSDULVREHGHVZHFRORUWKS\$VHDDG ELOLWVVRWVWBHGVDF VFDQ E\ XOWU
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2UODQGL (5RVVL & 3HULQR \$6LPSQJHVG 2UODQVH HQW IURP WKH \$PHULFDQ +HDUW
WULPHVWDO FDUGLDF VFUHHQLQJ IRXU FKDPEHU YLHZ DQG YHQWULFXODU
RXW-VZDFWV LQ D ORZ ULVN SRSXODWLRQ +3UHQQDWR 'DSDQ 6 /LEHUWKVRQ 55 3U
7XGRUDFKH 6 ,OLHVFX '*)ORUHD 0 'UDJXKHU 5W 3DWUX & HW DO -
2& 7ZR SODQJHWWBUPWVWU PDMRU FRQJHQLWDO KHDUW /' %RWWLQJ % 0DVWURL
GLVHDVHV VFUHHQLQJ 8OWUDVRXQG 2EVWHW *QHFRQHQLWDO DQRPDOLHV IURP V
5XVWLF 0\$ %HQHWWRQL \$ ' 2WWDYLR * \$HUFKHLFDLQUR (SLGRFRHQRV
'& HW DO (DUO\ VFUHHQLQJ IRU IHWDO FDUGLDF DQRPDOLHV E\