P O E

PHONE:

FAX:

‹ &3:5 ± 7KH &HQWHUIRU5HVHDUFK DQG 7UDLQLQJ

5HVHDUFK IRU WKLV UHSRUW:DV &RQGXFWHG E\ &&&3QV WUXFWLRQ
7UDLQLQJ XVLQJ JUDQW 8 RQ-DO ,QVWLWXWH RI DFFXSDWLRQDO
+HDOWK 1,26+

7KH FRQWHQWV DUH VROHO\ WKH RIILFLDO YLHZV RI 1,26+

&3:5 LV D F QRQSURILW RUJDQL]DWLRQ &RQVWUXFWLRQ 7UDGHV 'HSDUWPHQW $)/ &,2 DQG VHUYH

&3:5 SURYLGHV VDIHW\ DQG KHDOWK LQIRUPDWLRQ IRU WKH F
LQGXVWU\ )RU PRUH LQIRUPDWLRQ YLVLW ZZZ FSZU FRP

)LQDO 5HSRUW WR &3:5&RQVHUYDWLRQ 7UHDWPHQW 5HVHDUFK DQG 7UD

6PDOO 6WXG\ 36

'DWHV -XO\ ± -XQH

'DWD OLQNDJH RI VWDWH UHJLVWULHV IRU DVVHVVPHQW

/HH)ULHGPDQ 3K'

3HWHU 5XHVWRZ 06F

/LQGD)RUVW 0' 03+

([HFXWLYH 6XPPDU\

7KH JRDO RI WKLV UHVHDUFK SURMHFW ZDV WR FRQGXFW D SRSXODWLRQ EDVHG VWXG\ RI FKLOGUHQ DQG DGROHVFHQWV OLQNLQJ SXEOLF KHDOWK GDWDEDVHV FRQWDLQLQJ HDFK SHUVRQ¶V HYHQWXDO GHDWK VWDWXV H[LVWLQJ GDWDEDVHV FRQWDLQLQJ GHPRJUDSKLF DQG FOLQLFDO LQIRUPDWLRQ SUHYLRXVO\ EHHQ XVHG IRU RFFXSDWLRQDO VXUYHLOODQFH WKH ,OOLQRLV 'HSDUWPHQW RI 3XEOLF +HDOWK WKH ,OOLQRLV 'LVFKDUJH GDWDEDVHV +' DQG RQH GDWDEDVH IURP WKH ,O &RPPLVVLRQ :RUNHUV¶ &RPS&RQV:DWLRQ&RPPLVVLRQ :RUNHUV¶ &RPS&RQV RI 3XEOLF +HDOWK GDWDEDVHV WR WKH ZRUNHUV¶ FRPSHQVDW

,Q RXU SUHYLRXV ZRUN ZHUH GHYHORSHG NHUV FRQVLVWLQJ FODLPV RI WKH FDVHV FRQWDLQHG VXIILFLHQW LQIRUPDWLRQ RQ GDWD OLQNDJH :RUNHUV¶ FRPSHQVDWLRQ GDWD LQFOXGHV D ZKLFK ZRXOG QRW UHVXOW LQ KLJK VSXULRXV DVVRFLDWLRQV RHU JWUHKDWRQ FXPXODWLYH WUDXPD GLVRUGHUV :H OLQNHG ZRUNHUV¶ KRVSLWDO UHJLVWULHV ±HDHQSHNDJHG DDWDEDVH RIDJH UDWH RI DSS ZLWK WKH +' DQG ,75 EDVHG RQ DQDOYLVLVRIRWKHWXGS\H RI LQM LQ WKH ZRUNHUV¶ FRPSHQVDWLRQ GDWDEDVH

$ NH\ ILQGLQJ RI WKLV SURMHFW ZDV WKDW ZKLWH QRQ +LVS DZDUGHG KLJKHU PRQHWDU\GVZKLWHHPSOR\HHVQDWLRQDOLQFKDRQEVWDUFNFWLR VSHFLILF LQMXULHVHVUFHHQWVSLSHUHDRQHDQDWDZDWLDHTXLYDOHQWWR IRU WKH QRQ +LSDQLF ZKLWHV ,Q WKH ILQDO PXOWLYDULDE PRQHWDU\ FRPSHQVDWLRQ SHUVLVWHG ,Q WKH ILQDO PXOWL FRPSHQVDWLRQ ZDV KLJKHU S &, IRU ZK WKDQ IRU PLQRULW\ ZRUNHUV ZKHQ FRQWUROOLQJ IRU RWKHU HWKQLF GLVSDULWLHV LV QHFHVVDU\ 0RUHRYHU WKH KLJKH GLIIHUHQFHV LQ LQMXU\ \RHQY HWLSH\ RDFRERWXQGDERRGRUHDVVRFLD ZLWK KLJKHU FRPSHQVDWLRQ ± QXPEHU RI GHSHQGHQWV DYH GHDWK RU WKH XVH RI DQ DWWRUQH\

$ VHFRQG LPSRUWDQW ILQGLQJ RI WKLV UHVHDUFK SURMHFW SRVLWLYHO\ DVVRFLDWHG ZLWKDWXEHLPSRRULQJXU\ LVQHYKRVSLWWE

DQG GLVFKDUJH VWDWXV QZHLFSDRWUHDU\KVRRZWODRQJGLDQDEQOLXWHG Z
WR UHWXUQ WR ZRUN RUGXOWDFHGRZKQYUHUVWUHPSVRHUGUZ\RWRWDO
VLJQLILFDQWO\ DVVRFLDWHG ZLWK KLJKHU FRPPRQ PHDVXUH
LQMXU\ XVHG LQ WUDXPDWLHYDHUDUDEOH 7KHHGLQJ LQQGPLFDWHG WKD
UHPDLQHG LQ WKHFLKDRWVSGWZDLWVKZDV DZHVRNV ¶ LQFUHDVH RI WHPS
DZDUGHG E\ WKH ZRUNHUV¶ FRPSHQVDWLRQ FRPPLVVLRQ S
FRQWLQXHG FDUH DW DQRWUKHPUWKFLKORLWSLDMDWHUHGFLHVLFYKHDGJH
WHPSRUDU\ WRWDO GLVDEOHEW\OWKEQHWSRVH GLV2FKDUHHWEDGL
WKDW VRPH LQ KRVSLWDO PRHIDIXXUHUHDPLHV JRGZSUNHGLQFGVRWRWV
GLVDELOLW\

7KLV VWXG\ SURYLGHG LQVLJKWVDLQRWWDLQWRRQ WKHH GVDWUHQJWKVDJHQ
DSSOLHG WR RFFXSDWLRQDOOLQMXUH VEXHDWZHRHSQHQWHWHRQ UHF
DQG KRVSLWDO UHFRUGVHSUVRYLGHGVHDWDLRQ WKFDRUZRUNORQ
SURYLGH 7KLV LQIRUPDWLRQ DOORZV UHVHDUFKHUV WR EHW
DFXWH LQMXU\ DQG ORQJ WHUP2RLPHQWDDQGGLVDEDLOLWHW
8QLYHUVLW\ RI ,OOLQRLVWRFKRRWDOL3XKE0LFH+XHDOWKSUHYLRX
GDWDVHWV IRU UHVHDUFK RQ FRQWULEXWLQJ FDXVHV DQG FR
HIIHFWLYHQHVVPHDQVWRWUHDW KQGGHWRKXDEORPHIRRQFFXSDWLRQ
LQMXULHV 7KH PHWKRGRORJ\ IRU REWDLQLQJ OHDQLQJ OL
WKLV VWXG\ DUH DSSOLFDEOH8WR ZKRHVUH RWLRHODVUGDWHDVVLQV

7DEOH RI &RQWHQWV

3DJH

%DFNJURXQG«««««««««««««««««««««««««

0HWKRGV«««««««««««««««««««««««««

'DWD 6RXUFHV«««««««««««««««««««««

'DWD &OHDQLQJ«««««««««««««««««««

'DWD /LQNDJH«««««««««««««««««««

&RPSDULVRQ RI 0DWFKHG DQG 8QPDWFKHG &DVHV«««««««

*HQHUDO $QDO\WLF $SSURDFK«««««««««««««««

5HVXOWV (WKQLF 'LVSDULWLHV LQ :RUNHUV¶ FRPSHQVDWLRQ

5HVXOWV ,QMXU\,6HYHULW\'LIIHUHQWLDWHG 5DWLQJ«««««««

'LVFXVVLRQ«««««««««««««««««««««

5HIHUHQFHV«««««««««««««««««««

$SSHQGL['DW&DWHJRULHV«««««««««

DQG +' ORQJ WHUP GLVDEHQHILWV RI VRFLDO ,QQRYDWLRQ ,QLWLDWLYHV RU ILQGLYLG
SUHYLRXV ZRUN ZLWK &3:5 ZRUNHUV DQG WKH RFFXSDWLRQ FODLPV F
FRQVWUXFWLRQ ZRUNHUV EHWZHHQ DQG

7KH VSHFLILF DLPV RI WKLV SURMHFW ZHUH DV IROORZV

7HVW GLIIHUHQW PHWKRGV RI GLVQRULQJ VXEFRQVFLRXV DVVHPEOH D PHJD GDWDEDVH RI VRFLDO LQQRYDWLRQ LGHDV DQG GLDJQRVHV LQMXU\ VHYHULW\ VKRUW 0€•0

0HWKRGV

'DWD 6RXUFHV

:H KDYH D GDWD VKDULQJ, DJUHHPHQW WSDUWQHUHG WKURXJK WKH 8QLF +H
,OOLQRLV :RUNHUV¶ &RPSHQVDWLRQ 5DWH DQG &RVW RI 7KG WKLV Z
WKH 5HVHDUFK &RPPLWWHH RI WKH %RDUG, :&&

,OOLQRLV 7UDXPD 5HJLVWU\

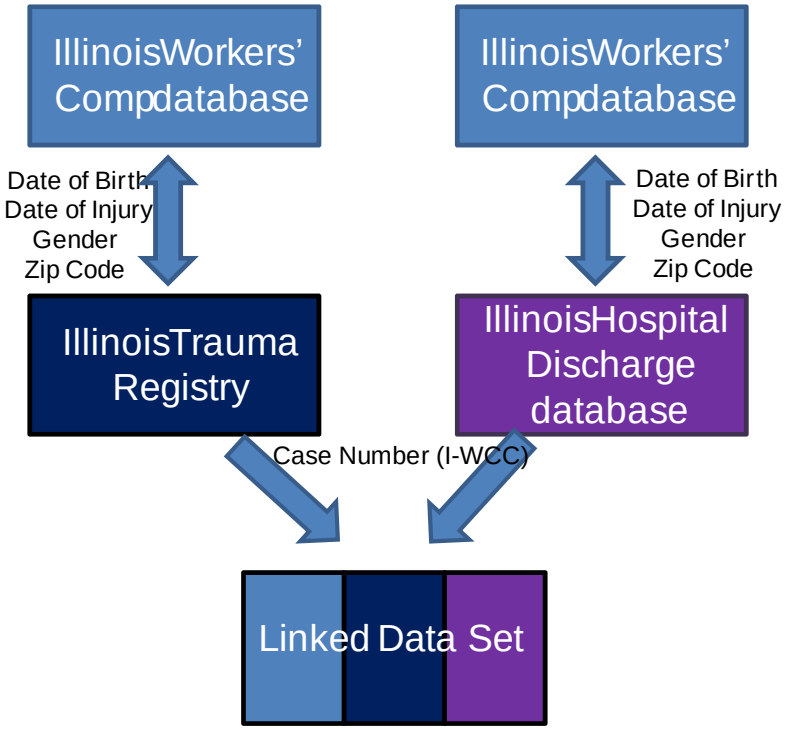
7KH ,OOLQRLV 7UDXPD 5HJLVWU\ ,75 ZDV PDQGDWHG E\ WKH
,OOLQRLV 'HSDUWPHQW RI 3XEOLF +HDOWK $OO RI WKH VWDW
UHTXLUHG WR UHSRUW DOO SDWLHQWV VXVWDLQLQJ WUDX

FHQWUDOL]HG UHSRUWLQJ V\VWHP H J :DVKLQJWRQ LQ ,OO
FODLPV LQ ZKLFK WKH HPSOR\HU LV D FRUSRUDWLRQ RU RWKHU
7KH ,:&& FODLPV GDWDVHW EHORQJV WR WKH FODLPDQW DQG
FODLP $Q\ HOHPHQW RI D FODLP VHWWOHG SULRU WR LQLWL
GLVSXWHG E\ HLWKHU SDUW\ ZLOO QRW EH OLWLJDWHG

'DWD /LQNDJH

7KH ZRUNHUV¶ FRPSHQVDWLRQ GDWDVHW RI FODLPV)UL
$IWHU H[FOXVLRQ RI FODLPV ZLWKRXW YDOLG GDWHV RI ELUW
FRQWDLQHG FODLPV Q:HDXVHPGHVWKRERORLWWRFOQN WKH
:H XVHG D GDWH RI ELUWK GDWH RI LQMXU\ JHQGHU DQG UHV
LOOXVWUDWHV WKH JHQHUDO OLQNDJH PHWKRGRORJ\ XVHG

)LJXUH 'LDJUDP RI WKH GDWD OLQNDJH PHWKRG



7DEOH 'HVFULSWLRQ RV 8KHGHIRWDDWHD'DLQDMDHWU3XRPDHSHWLYQRRVSLWDO 'LV
'DWDEDVH DQG WKH ,OOLQRLV 'HSDUWPHQW &RUUHFWLRQ &ODLPV 'DWDEDVH

'DWDEDVH	'DWD (OHPHQWV				
	,QFOXVLRQ&ULWHULD	2PPRJUDSKLFV	([SRVXUH 'DWD	+HDOWK 'DWD	(FRQRPLF
7UDXPD 5HJLVWU\	3HUVRQV WUHDWHG LQ 7UDXPD XQLWV KRXUV5DFH HWKQLFLW\ a \U	1DPH DWH RI %LUWK *HQGHU 2WKHU'HPRJUDSKLFV	,&' (FRGHV (VKRZLQJ %RG\ VLWH ORFDWLRQ 7LPH GD\ LQMXU\	,&' 1 (FRGH&RVW RI KRVSLWDOL]DWLRQ +RVSLWDO SURFHGXUHV +RVSLWDO GD\V *URVV RU 1HW 7RWDO &KDUJHV 'LVDELOLW\ VWDWXV RQ GLVFKDUJH %ORRG DOFRKRO	(FRQRPLF &RVW RI KRVSLWDOL]DWLRQ +RVSLWDO SURFHGXUHV GD\V +RVSLWDO FRVW SHU VXUFKDUJH VWDWXV
+RVSLWDO 'LVFKDUJH	$OO LQGLYLGXDOV $GPLWWHG 2Q ,OOLQRLV 5DFH HWKQLFLW\	,&' 1 DQG FRGHV	(,&' FRGHV +RVSLWDO SURFHGXUHV +RVSLWDO FRVW SHU 'LVFKDUJH	&RVW RI KRVSLWDOL]DWLRQ SURFHGXUHV GD\V VXUFKDUJH VWDWXV	
:RUNHUV &RPSHQVDWLRQ &ODLPV &	3HUVRQV ILOLQJ :RUNHUV¶ &RPSHQVDWLRQ &ODLPV IRU DUELWUDWLRQ WKURXJK ,:&& a \U	(PSOR\HU 1DPH 1DWXUH RI ,QMXU\ 1DUUDWLYH /RVV RI FLUFXPVWDQFHV	7RWDO PHGLFDO FRVWV &RVW RI 3D\HU VXUFKDUJHV &RPSHQVDWLRQ 3D\HU VXUFKDUJH	
,&' ([WHUQDO ,QMXU\ &RGH (	JLKDWWKHFLDOSDDEHSRQQXU\WRXUHG H J (LV)DUP				

8VLQJ WKH IRXU OLQNLQJ WYFDKUHLGDEUORHPV WFKDHV,H&&ZWURHERDWK WKH
VHSDUDWHO\ WR HQVXUH WFKDDWLRQWKDEWRQVDWWUFKFHWGLRQR ZDRWNOHHUD
VHW ZHUH LQFOXGHG LQ WKH ILQDO GDWD VHW $ FRPELQDWL
RXW DOO VWHSV LQ WKRQOLQNGHJH $XSVLHQQJG6$6 9HSWOO OLQNHG
YDOLGDWHG E\ PDQXDOO\ UH\SLHHZLQJ0IXOVFRGHLVQMXQWKQHGWWU
DQG KRSLWDO GLVFKDUJHG GWD\SEVRHWLVQMFXUVDHURIFLRQGHXU\XDLQQJ
7KH ZRUNHUV¶ FRPSHQVDWLRQ GDWDVHW XVHV D GLIIHUHQW F
LQMXU\

7DEOH S RXWOLQHV WKEHQOPXQDWLSCSHUFHGVXHUVHIRUHWKH OL
ZRUNHUV¶ FRPSHQVDWLRQ DQG WKH WZR VHSDUDWH PHGLFDO
PDWFKHG UHFRUGV ZHUH UHPRYHGQMUQPXWQJH ZGDWKDWWKWV\QEH[WRS
UHFRUGV PDWFKHG E\ WSDHVRILLGQHMQXU\ILH7GHP DQVLFWKHDOEHWZHHQ
PDWFKHG H[DFWO\GRDQWKSDRWHLQRMXEUGHWQKQGHOU=D3Q GRUGHVL ,Q WKH
SDVV ZH RPLWWHG =,3 FRGHWZ7KHQ DWKHUGJDHWHQRWHLQYMDXU\ DQG
ZDV ILOHG ZDV DSSUR[LPDWHOVGLQH RGRQWKVDQG LWGDWRRN PR
DQG D KDOI \HDUV RQ DYHUDJHDUPWWKHGWHLFRLWLQORQJ D Z
PD\ KDYH D GLIIHUHQW =,3 FRGH DW VHWWOHPHQW WKDQ DW V
ZH DOORZHG IRU YDULDWLGRQGDWWH WKHEGDWWKH R7IKLHQFMRXUFHDSQV RI
SDVVHV LV WR EHJLQ ZLWFKL WLRQ KDLQJKHWWKHQHPYRHGOLIRIWSKUH SUHFL
VXEVHTXHQW VWHS 7KHUHE\ HQVXULQJ WKDW KLJKHU SURED
VWHS DQG UHPRYHG IURP WXKHQGDWWDHSHGVRQ\WKEDWWFKHDXEDLQTW
DQRWKHU FDVH ZKHQ WKH PDWFKLQJ FULWHULD LV OHVV ULJR
ZHUH PDWFKHG XW SDXUL QJ WKLQ WKH VLQFRQGH SWDKLVG LQ WKH
DQG LQ WKH ILIWK

:H H[SHFWHG D OLQNDJH UDWHEDRVHDGSRQQRXDSWLHOR\W VWXG\ DQG
W\SH RI LQMXULHV FRQWDLQHG LQ WKH ZRUNHUV¶ FRPSQVDW
LQYROYH LQMXULHV DQG LOOQHVVHV WKDW GR QRW UHVXOW L
ZRUNHUV¶ FRPSQVDWLRQ UHFRUGV WR WKH WZR KRSLWD
2QH WKRXVDQG WKLUW\ QLQH FDVHV RI FODLPV LQ WKH ,
ZKLOH PDWFKHG WR WKUHH ,+' FDVHV7LKGHUQHWZLHLHG WKDW PD
WKUHH GDWD VHWV

7DEOH 6XPPDU\ RI WKH 'DWD /LQNDJH 6WHSV 8VHG IRU WKL

	'2%	'DWH RI ,QMXU\	*HQGHU	=,3 &RGH	
7UDXPD UHJLVWU\ WR :&					
VW SDVV	([DFW	([DFW	([DFW	([DFW	0
QG SDVV	([DFW	([DFW	([DFW	2PLW	0
UG SDVV	([DFW	SOXV PLQXV	([DFW	([DFW	
WK SDVV	<HDU	([DFW	([DFW	([DFW	0
+' WR :&					
VW SDVV	([DFW	([DFW	([DFW	([DFW	0
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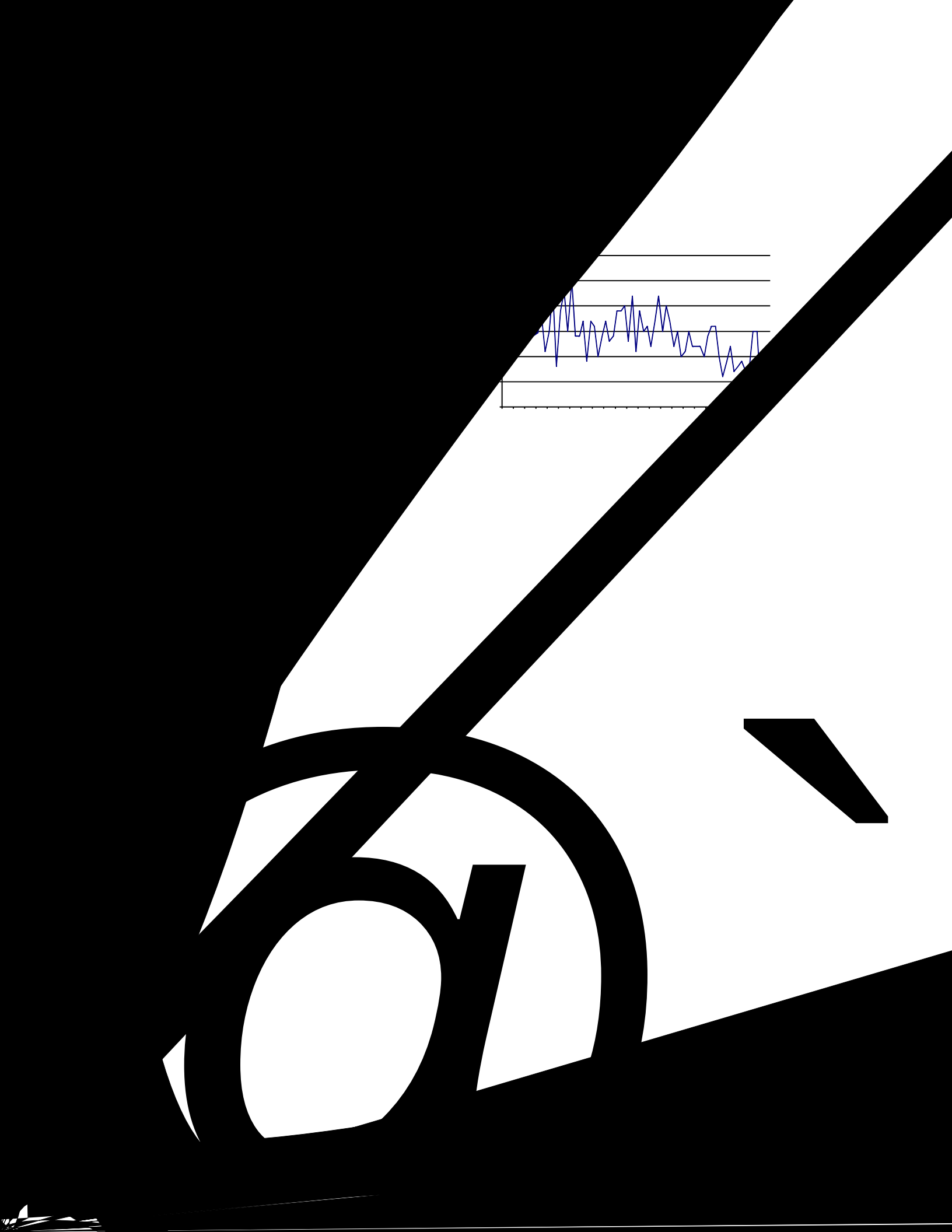
UG SDVV	([DFW	SOXV PLQXV	([DFW	([DFW	
WK SDVV	<HDU	([DFW	([DFW	([DFW	0
WK SDVV	([DFW	SOXV PLQXV	([DFW	([DFW	

&RPSDULVRQ RI 0DWFKHG DQG 8QPDWFKHG &DVHV

:H FRPSDUHG FDVHV LQ WKH OLQNHG GDWD VHW ZLWK WKRVH ZKHWKHU WKH OLQNHG VHWP SUHSURHVWKHRQ ZHDQ DFHSWD EHW @€pDWG VHHV Z0€p WHG VHW`FOHOH

7DEOH &RPSDULVRQ RIWKHFKDUDFWHULVWLFV EHWZHHQ 8QPDWFKHG &DVHV DQG 0DWFKHG &RQWURO &DVHV ,OOLQRLV :RUNHUV¶ FRPSHQVDWLRQ &ODLPV 'DWD

	8QPDWFKHG 1	0DWFKHG 1
*HQGHU		
0DOH		
)HPDOH		
8QVSHFLILHG		
0DULWDO 6WDWXV		
6LQJOH		[redacted]
0DUULHG		
:LGRZHG 'LYRUFHG	#0µÀ