

# \$ 6WXG\ RI \$UWLILFLDO , QWHOOLJHQFH LQ

3HLPLQJ 6XQ

%HLMLQJ ;LQ )X[ D\$ FODGHIDQ D%HLRMLDQ J &KLQD

\$EVWUSDFVD NH\ EUDQFK RI WKH LQWQHOL\$H,Q Q F HD IWHHIGQL\$FUDV LVEEH  
WKH JRDO RI XQGHUVWDQGLQJ WKHJQDHWXWMSRMLRQWLHQVHLOHQDQFHQDQWBDIE  
DFW VLPLODUO\ WR KXPdq LQWHOOLJHQHQGHFKHU RERKGLFR I \$,DWKIBO  
SURFHVVVLQJ VSHHFK DQG LPDJH \$HFRDQ IEMHROU DSHLGO,QGUHYHROV HED  
GHSOR\HG LQ D YDLRQHWLORIGDISOXBIDWDLQ OXVWRQLRFR XV GULYLQJ KH  
ILQDQFLDO VHUYRSHXFWDRQG IZKHP \$SSOLFDQWL RQ RW\$GLHG LQ WKLV D  
DFFRUGLQJ WR DQDO\VLV LW FDR EHL ERQFWRKXFGW WRD WS L QVHWKHQSO  
DGYDQWDJHV LQ LQFUHDVLQJ HIILF RSHQFR EXCFV ERQW, WIFDQV DQVGHVQKID  
TXDOLW\ RI ILOPV LPSUHVVVLQJ WKIHIDFKV LHQDGH \$EVRYHQHLLQDQWILQD P RVSNH  
WRROV DQG WHFHQDGH XH\$HW RPHI(\$O ZLHWKH FKHDFQRJLQDIOBQVR KDV LWV GLV  
VXFK DV D ODFN QG KXPSDQKWLQXFK IDGVKH \$,RUNV SURGXF

,QWURGXFWRQ

7KH DSSOLFDWLRQ RI \$, LQ

7KH ZLQWHU RI VDZ WKH SXEVDWLRQV RIDIEORNSURGXFWLRQ  
3DUDOOHO 'LVWULEXWHG 3URFHVVVLQJ 5HVHDFK \*URXS ZKLFK  
PDUNHG WKH EHJLQQLQJ RI DUWLILFLDO LQWHOOLJHQFH \$, \$,  
GHVLJQDWHV WKH DFKLHYHPPHQQV RFWLWV LQVWLVSDWRHQ QDPHO\  
WKH FDSDFLW\ IRU PDFKLQHV WR SHURUP YDULRXV WDVN > @ D VF  
7KHUH DUH PDQ\ GHILQLWLRQV RI \$, LQVWLVSDWRHQV RYHU 7KH DY  
RI WKHP FDQ EH FODVVLHG  
FDWHJRULHV V\WHPV WKDW WKH DQDNH KXPdqV V\WHPV WKDW  
DFW OLNH KXPdqV V\WHPV WKDW WKH DQDNH KXPdqV V\WHPV WKDW  
V\WHPV WKDW DFW UDWLRQDOO\ XEGLY%GHG LQWR V\WHPV DQG VRP  
ZLWK KXPdq LQWHOOLJHQFH WKH XWH RKHU LV ZLGHVSHHG  
7KLV SDSHU PDLQO\ H[DPLQHV WKH DSSOLFDWLRQV RI \$, LQVWLVSDWRHQV  
GLIIHUHQW VWDJHV RI ILOP PDNLQJ LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
SUHSDUDWLRQV DQJBUHSDUWHQV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
WKH SRVW SURGXFWLRQ VWDJH LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
RI \$, LQ ILOP PDNLQJ DUH SURSRQVWV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
PDQ\ EHQHILWV WR WKH ILOP ILHQDQGV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
OLPLDWLRQV :LWK DGYDQFHPPHQQV LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
SRLVHG WR UHYROXWLRQL]H WKH RIWZLQV YDULRXV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
FRQLQXHV WR GHYHORS LWV LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
ZLOO SXVK WKH ERXQGDULHV RI DUWLILFLDO LQWHOOLJHQFH RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
WKH IXWXUH RI ILOP PDNLQJ > @ XWRPDWLRQV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
VLJQLILFDQW LPSDFW RI \$, RQ WKH LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
OLJKW RQ WKH SURPRWLRQ RI UHDFRQDGHV DQGHV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
DSSOLFDWLRQV RI \$, LQ WKH ILHQDQGV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV RI \$, LQVWLVSDWRHQV  
VFULSW LV FUHDWHG W\SLFDOO\ LW  
D VFULSW DOORZLQJ WKH FUHDWRU  
VFULSW PRUH VZLIWO\ 6HFRQG \$, VF  
JDWKHU UHOHYDQW IDFWV DQG GDW  
XQFRYHULQJ GHSHU SORW KLQWV

FRPSHOOLQJ QDUODWLSYHVFSGLSMLWZLBSMDLCHVLDVDRFLDWHG ZLWK PDNLQJ  
 QRYHO HQGHYRU WKDW PDI LQVRS LWKH DUFULWVWOSVDR\ HYSORSHU LFRURI V  
 RULJLQDO FUHQGLSHU RFRXQFH SVRVIDF W\FDHO OIHOFPVVKRRW WKH SD\ RI WKH  
 ZRUNV FRVW RI ILOP SRVW SURGXFWLRQ DQ  
 +RZHYHU WKHUH DUH GUDZEDFNSHWVRHWKHWZVHWYLVQV BV \$ERWK WKH  
 3DUWLFXODU YLHZHUV PDI IHHO DQGDV DWIKHH VZ RLSNHU SWRBSQV HDG EHZOO D  
 \$, ODFN KXPdq WRXFK DQG GHSWK JQXHL FDRQ W KUHIMKURHUQVFRH B/BQDNQ WR US  
 RI SDUWLFXODU \$, DOJRULWKP VUHSOGLLWLRQ DLOO E \$GJHMDLWLRQH DVV  
 V W U X J J O H V L Q VGBVWUHEXWFLRQU DQGS RKR RWIDQD FEI HV  
 FRPSOH[LW\ RIRKWLURDFW BQGT FHD QKRFX SVRBSQGLQMHWWZLUVQ EQWSURWH  
 FDSWXUH KXPdq QDWXUH \$, FDQ EH D JUHDW WRRO WR KHO  
 WKHLU EXGJHWV DQG PDNH LW PRU  
 FRPSXWH PRYLH VZKBUHWWV ,D FKDQ  
 RYHUVSHQGLQJ DUWLILFLDO LQWHOO  
 3UH SURGXFWLRQ LV WKH SURFHVR R\WSDU BQHDU BQ IHOQFLDO KDID  
 HDFK WDVN WKDW KDV WR EH FRRVKOHWWP DQGS B VKHUWWR DWKHLQ PXO  
 FRPPHQFH PHQW RI SURGXFWLRQ/DYOVH WKHOFVYHQSWKH LULJKW LV  
 FRPSOHWHG WKDWGRJWHDFSKRU SURFHWHOSODIUYWROOVZBQSH IKDV D VI  
 DVVLVWDQW GLUHFWRU SURGXFWLHV VV DQDFKBRVHS SHUFRUPLRUV 7K  
 FRRUGLQDWURUV DQG VLWH VFRKRRVHM TWKRDOWRHWKHLQ FROWDFWH  
 'HSHQGLQJ RQ WKH EXGJHW DQG XQLRQVRSQ ZLQRH WKURQXFKRLRQH WK  
 HYHU\ SURMHFW LV XQLTXH EXW QWTHUHHZU FDFHWBQQWKH SUBGQFV  
 DSSOLFDEOH ENMWSLUDPWQGHVWRLSHFVXRUWLRQVFXFHUQWDEG WKHQDFW  
 FDQ EH GLYLGHGQDQWQ\ ORVNSWKPHNKKR WKHJ ILQDO LQWHUYLHZ SDQ  
 VFULSW ILQDOLJH WKH EXGJHW FRUWHUHQIZDHP SVQLFRLOO NYHG WR  
 GHSDUWPHQW KHDGV EUHDN GRZQWVHLRQVLSWKHVFRUIERBUBDQORR  
 VKRW OLVW VFHQHV VFRXW DQGZHYKXUHDGRFBWKRQJHWBUADDQFWRU  
 DQG KLUH FUHZ JHW SHUPLWV DQSLQVQVUBDQPH WKKKKBQBHVVKRW PD  
 GDIV SHUIRUP D WHFK VFRXW WKK\DKDYDQJPSHWKHTQUBBHSWQCRQ WK  
 UHQWDOV > @ :KHQ UHFRUGLQJHFHB YHGOVKKHISHLIRQW RHUHV EDFNJ  
 SUH SURGXFWLRQ PDI KHOS FXW FRVWV DQGVHOPWHLQSDUWV DQG KL  
 \$, FDQ WKH UH \$, RFDQVKKHUIRUP EHWWHU PVLDQ  
 HIIHFWLYHQHVVRGXEWRQUH7S WLVWDFVZLWVFRUWV DQG DFWUHVHV  
 EUHDNLQJ GRZQ WKH VFULSW LV DQKHWKHVDFVFRUWVDFRWDVWHSQDQD  
 SUH SURGXFWLRQ ORVW VFULSWFRGQHWHPWKLVLQDWRHQBFRQFRWRQ  
 EHHQ GRQH PDQXDOO\ 7KH FDV DQGLDQJHZ DQGVSHUHBPPQFH LQ R  
 VFULSW ZRUG IRU ZRUG PDQXDOO\ SURILQHVZKHPHQHYLWQVSHUIRUPH  
 DFFRUGDQFH ZLWK WKH FRQWHQW RQ DQGHVLDQVWLV\OHQWRQVFRQFHV  
 VKHHW 7KLV ODERULRXV DQG HUKHUSURQH SURFHVV WDNHV D ORW  
 RI WLPH DQG HIIRUW DQG LI WKH VFULSW LV UHYLVHG LW FDQ EH  
 VLPSON WR RYHUORRN WKH FKDQJH FRVW SURGXFWLRFQRIOLFWV ZLWK  
 RWKHU FRQWHQW  
 \$V D UHVXOW \$, VFULSW GBRQWVWRKXWLVQRSDV\WKH ODVW VWI  
 VLJQLILFDQW SDUW LQ WKH SURGXFWLRFQJH IDQPHVDPZIRIGLKHOPPO  
 UDLVH WKH VW DQGBUEXRILQMKV DQRWLVQVFDQFHPDWRJUDSKHUV DVVLV  
 FHUWDLQ VRIWZDUH FDSDELOLWERYPH FDRJHWQKQDQWR FWKHWH WKH  
 HIIHFWLYHQHVWIRV DQGLSWFQDQSRVWV BNRG XFWHLRQ LQFOXGHV WKH  
 XVH RI QDWXUDHVIDQJ DQGHPSURKVAQMQGHVWDLQJDV ZHOO DV WKH XW  
 RIIHULQJ D PRUH GHSHQGDEOHVQBQVZQJHQDWIHLFLDOHYHONKRIHH GLPH  
 SURGXFWLRQ VXSSRUW 7KH VHFROQKHLVD ER RWFHFQHW HXGSHHWL DSOHHU  
 \$FFRUGLQJ WR \*KLDVVL HW DOHYHDERVXWQJ WKKDQVVKZVWKR EH GRQH  
 SURGXFWLRQ EXGJHWV LQ H\FHVV QRQH VPLFKODRQWZHLBFLQJ WKH G  
 UHOHDVHG LQ WKH 8QLWHG 6WDXWLQJEHWZHRQVUDFDQGSODFLQJ PXVL  
 DQG WKH PDMRULW\ RI WKHP GRLOHQGDQMRUHUFRLXSG WRHEERYHUV :  
 SURGXFWLRQ FRVWV YLD JURVV SRRWRWUBSER[ RILLVH VUHYHQQXHKDV L  
 7KLV LV GXH WR D ODFN RI VXIILKIDQQRVDFEJXDQSPWLDVSRKPHHRLVWMDQDHO  
 GHFLVLRQ VXSSRUW VVWHPV IRUZSLFKSKURGXJEWDRVDQBGXFLHGDKGH FI  
 JUHHQ OLJKWLQJ GHFLVLRQV VRDGMRLVDBQ PVNSRWVLEQOWKMRILVQRW  
 LQG X VWU\ FDQQRW EH ZHSROLVLRQVWDEGSDVQHVZGHLCRJIWWV  
 FUXFLDO VHSV LQ WKH SURGXFWLRFQRIOLFWVXGFFHWVORSDDQJWKHV  
 EXGJHW 7KH WHUP ILOP EXGJHWXQWLVHEDPWRD WFKHDQXHPVRRIDVQHOHQV

SURJUHVV LQ WKH ILOP :LWK W KSHD VPKXOUV MSKOLC DEWL RQ Q DR G HWFLG LQJ I D  
VKRRWLQJ PDWHULDO WKH ILOP VHKRLXVORGU EM RYVHIGZ KHVO FDH GV RDRQG IZW DF  
EHFRPHV DQ LPSRUWDQW MRE IR S UR KX FVGLRQR UF DVOR XLV G D W W H I PRLVD L  
VXLWDEOH PDWHULDO DPRQJ W KWH D P D Q O E D M S U E M X V H S D Q P D \ V L V D Q G  
VLJQLILFDQWO\ OHVVHQ WKH ORDFG H R D W W Y K H I S G I R W H Q V G M S D O O V P H D W W W R  
FKRRVH PDWHULDOV LI LW LV Z H O P R V P D Q D J H G V M S H Q G R V K M X R V O U S G \ J H Q I  
VKRRWLQJ PDWHULDOV PDWHULDO FUHDWRUV VKRXOG NHH  
7KH SRVVLELOLW\ RI DUWLILFLDO HLZSRHQ V W J H D D F H Z R V N I Q Q W L D M C H V  
HGLWRU KDV DOVR PDWHULDOL] H G W D L F L D U H V X O M D P I L R V Q R H T V S F M K C H O  
DGYDQFHPHQW RI WHFKQRORJ\ P R W M K H S F R F W X U D H V R I J K W K H U H V X O W  
1DWLRQDO 'D\ FHOEUDWLRQV L Q H V X O W S D S W R F I D K L K H S H I Q U M S O L K H I C S F  
YLGHR RI &&79 1HZV ZDV FRPSOH R W H G H D O S V M G E W L L O X D Y R U H I I H F W V E X V  
WKH WLPH EHLQJ WKH H [ W H Q V L Y G H X M D R S H G U W H G R V H L R P R D H E D O W K L Y Q D F E  
WHFKQRORJ\ DW WKH IRUPHU -DGLHQ Y H V O L Y J H Q F G R H L W R Y W U D X V O R S Z W R K H U  
IRUPHU GLUHFWRU WR EH FRPSOH V D Y O \ W K H O L Y H L Y I Z G U R I H K I O L Q J F R I O G D C  
GXWLHV EXW LW GRHV JLYH WKHV X D O P H U H S W U H R W R K H D P R I R I G V K R X C  
DVVLVWDQW ZKR KHOSV WR LQFUHDV H E B O G V S K H U W R U D R H H P R L W H F F W R U M  
SURGXFWLYLW\ DQG WKH FDOLEHU Q R M H O H L J H Q P H L Q W K H G H Y H O R S P H Q  
%HIRUH WKH GHYHORSHPHQW RI J G Y L W D D W H F K Q R Q R I G H M S H F L B Q W R  
HIIHFWV ZHUH QRUPDOO\ SK\VLFD O R M S H F H D O L F I H H B W V D X O W Q O W K H L P S  
DSSHDUDQFH Terriina M K Z H L Q O P K H V R F K V L Q J V R O H G \ R I Q V W K H D I O M L V P V S O H Q C  
ILOP PDGH DXGLHQFHV JHQHUD W H I H J E M D W K L O X O G U E M W X L H G Y W R X I D Q W K  
HIIHFWV IRU WKH ILUVW WLPH 7 K K I D W I R A K H R S H F L D L O P H Z U H E W N E W F A K U  
DUH GHYRWHG WR WKLV QHZ Z D L Q R M H S U R G X F W D R Q G W L K F H H P R W L M R Q D O  
VSHFLDO HIIHFW FDQ EULQJ SHR S O M H Q R S P H Q Z R Q G H S V P X O W 7 K O R V H O  
WHUP <sup>3</sup> GLJLWDO VSHFLDO HIIHFW V H D R W L Y H R S I O N <sup>3</sup> GLJLWDO HIIHFWV  
UHIVU WR WKH XVH RI FRPSXWHU JUDSKLFV LPDJH WHFKQRORJ\  
WR FUHDWH YLUWXDO YLGHR HIIHFWV RI ILOP HGLWLQJ WHFKQRORJ\  
LQFOXGLQJ WKH FUHDWLRQ RI WKH H D U O \ I L O P F R P S R V L W L R Q  
FKDUDFWHU GHVLJQ DQG PLGGOH RI WKH YLUWXDO V F H Q  
DWPRVSKHUH UHQGHULQJ DQG SRVWH S O R F H I V O L T Q J L Q R P O W K S H F L S D M M R C  
HIIHFW DQLPDWLRQ SURGXFWL S O H S O U D W L R Q G S U H J S U H S P O D W L R Q  
RI PHGLFDO LPDJHV LQG XVWULDO V S H D U L G X O D W K R Q D Q G R W K U V S H F W V  
VHFWRUV DOO HPSOR\ GLJLWDO V S H F L D O J H Q F H V D U H U H Q V C H F W H G \ O  
WKH SURFHVV RI ILOP SURGXFWL R O F U H D W L R Q V F U H S W Y D Z K D O H W K K P D G Q C  
DUH H [ S H Q V L Y H G D Q J H U R X V D Q G G L I T E X O W V F U H S W Y D Z K D O H W K K P D G Q C  
OLIH , Q W U D G L W L R Q D O I L O P V S H F L D O H I I H F W V W K H S U R G X F W L R Q  
VSHFLDO HIIHFW M G W R P R U H L W X Q W Q S K R W R J D S K I R U H I D P S O H Q R W U  
PLQLDWXUH PRGHO SKRWRJUDSK D U W E Y S F L D O L F W P G O L O H Q F H Q W R F U  
FRPSRVLWH VWXQWV VWXQW R D W E Y S F L D O L F W P G O L O H Q F H Q W R F U  
WKHVH SUREOHPV \$IWHU WKH FRPSXWHU WKH FRPSXWHU WKH FRPSXWHU WKH FRPSXWHU  
ILHOG RI ILOP VSHFLDO HIIHFW W K H I S P F G W O S U R G X F W L R Q G F H O L W K H U H  
ILOP VSHFLDO HIIHFWV LV J U H W L W O R Q H D Q F R O W L O X H G W K H F R S H  
RI GLJLWDO ILOP VSHFLDO HIIH Q Z W H F K Q R O R J I W D O V Y H D Q G H F R S H  
LQ GHSWK Z L O O X Q G R X E W H G O \ E H E U R J J K W D E R  
DUWLILFLDO LQWHVBLJHGHFLQWKURGNK  
6XJJHVWLRQV RQ WKH DSSOLEDFWLRQ L R M S O L Q H Q F H W H F K Q R  
ILOP SURGXFWLRQ V I V W H P E D V H G R Q D U W I X W X U H V W X C  
DQG FUHDWLYH JURZWK RI \$ , W I  
7KH XVH RI \$ , RIIHUV VHYHUDO E H O P R D W V Q J O R S K U D W L R Q J R Q F U H D V L C  
PRYLHV LQFOXGLQJ WKH FUHDWLRQ L R Q L R S U R Y H L D O L Q R I H X D O L W K H  
DELOLW\ WR DQDO\]H LPDJHV DQG WKH DELOLW\ WR SURGXFH  
VFULSW FRQFHSWV 7KH DSSOLEDFWLRQ R I H \$ J W R W K H I L O P  
LQG XVWU\ P D \ U H V X O W L Q W K H G H V W U X F W L R Q R I R U L J L Q D O L W \ \$ ,  
ODFNV FUHDWLYLW\ DQG HPRWLRQ U M V S L W O W K H Z R E W W K N W W R H F S C  
OHDUQ IURP PDVVLYH YROXPHV R R G W K P S X O L K X U V B O G F S R I H V V R U Y  
LQVSLUDWLRQ DQG RULJLQDOLW Z U L W L O H G H G I B U H W K H V S R D W E H I  
SURFHVV RI GHYHORS IDUWD V R V Y L S U N M G E W H F W R D G G L W L R Q , Z R X O G O I  
DQG VFUHHQZULWHUV 7KH P R Y L H P E C K W W H D F K W R W D D H L S D W O F W V D  
LGHQWLW\ DQG FUHDWLYLW\ LI LW X S R S O H W D Q E H F S L D L R Q R V S L L E W K  
LQWHOOLJHQFH S W O R D S U R G L X H F W R W H W I Q R W V H W F

KHOS DV ZHOO DV WKHLU HQOLJKWHQPHQW , ZRXOG QRW EH DEOH  
WR FRPSOHWH WKLW SDSHU

### 5HIHUUHQFHV

7XIIpU\ 6 \$UWLILFLDO ,QWHOOLJHQFH ,Q 'HHS  
/HDUQLQJ 6 7XIIpU\ (G  
GRL FK  
.RN - 1 %RHUV ( - .RVWHUV : \$ 9DQ GHU  
3XWWHQ 3 DQG 3\$UWLILFLDO LQWHOOLJHQFH  
GHILQLWLRQ WUHQQV WHFKQLTXHV DQG FDUVH \$UWLILFLDO  
,QWHOOLJHQFH  
+XVQDLQ \$ 7KH LPSDFW RI DUWLILFLDO  
LQWHOOLJHQFH RQ ILOPPDLQJ LQ  
KWWSV WHFKQLTXHV RI DUWLILFLDO LQWHOOLJHQFH  
LJHQFH RQ ILOPPDLQJ LQ  
/DQRP 6 +RZ WR ZULWH D PLYH VFULSW  
6FUHHQSOD\ IRUPDW DQG H[DPSOHV  
KWWSV ZZZ VWXGLRELQGHU FRP EORJ KRZ WR ZULWH D V  
FUHHQSOD\  
0XUWDJK ) \*DQJ \$ DQG 0F.LH 6 7KH  
VWUXFWXUH RI QDUUDWLYH WKH FDUVH RI ILOP VFULSW  
3DWWHUQ 5HFRJQLWLRQ  
6XQ 7 \$SSOLFDWLRQ RI DUWLILFLDO LQWHOOLJHQFH  
LQ WKH ILHOG RI ILOP DQG WHOHYLVLRQ PHGLD -RXUQDO RI  
-RXUQDOLVP 5HVHDFK  
6WXGLR%LQGHU :KDW LV SUH SURGXFWLRQ LQ ILOP  
2 \$ EOXHSULQW IRU VXFFHVV  
\*KLDVVL 0 /LR ' DQG ORRQ %  
3UH SURGXFWLRQ ILOP HIIHFWLYH ZLWK D  
G\QDPLF DUWLILFLDO QHXUDO QHWZRUN ([SHUW 6\VVHPV  
ZLWK \$SSOLFDWLRQV  
0DWW Q G :KDW ,V 3RVW 3URGXFWLRQ" 'HILQLWLRQ  
7XWRULDOV +RZ 7R 'R ,W 5LJKW  
KWWSV ILOP RI DUWLILFLDO SURGXFWLRQ  
+X . 7KH HIIHFW RI GLJLWDO YLGH  
WHFKQRORJ\ RQ PRGHUQ ILOP 'RFRUDO 'LVVHUWDWLRQ  
'UH[HO 8QLYHUVLW\