

3DUWKD *DQJRSO6KGGKDUWK -DLQ

\$E VWU DFW

7KLV VWXG\ H[DPLQHV WKH VKRUW UXQ DQG WKH ORQJ UXQ UHODWLRQVKLSV E

URXS 30 HVWLPDWRU WR ILQG WKDW DQ LQFUHDVH LQ LQFRPH *LQL LQFUHDVH
UXQ +RZHYHU ZH DOVR QRWH WKDW WKH LQFRPH @ KpWQGRVfLR Lz• W '0` € T →€J

RI WKH PHGLDQ YRWHU K\SRWKHVLV RQ WKH FRQVHTXHQFHV RI LQFRPH GLVWUL
*'3 UDWLR EHFDXVH RI WKH JUHDWHU UHGLVWULEXWLRQ WKDW LV VRXJKW E\ WK

.H\ZRUGOHTXDOLW\ 7D[HV 3RROHG 0HDQ *URXS 30* \$XWRUHJUHVVLVH 'LVWULE

:HVWHUQ 6\GQH\ 8QLYHUVLWQJ\$XVWU DFWU#ZH\PDLO
:HVWHUQ 6\GQH\ 8QLYHUVLWDLQ\$XVWU DFWU(BDHO HGX DX

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$& ,

,1752'8&7,21

2YHU WKH SHULRG UHPDUNDEOH HFRQRPLF DFKLH
± GHVSLWH WKH \$VLDQ)LQDQFLDO &ULVLV DQG WKH *O
UHJLRQDO HFRQRPLHV ± DV WKH UHJLRQ JUHZ DW SHU
7KH SRYHUW\ UDWL GHFOLQHG IURP LQ WR DERXW
\$JDLQVW WKLV EDFNGURS RI HFRQRPLF VXFFHVVH
ZLWQHVVHG ULVLQJ LQFRPH LQHTXDOLWLHV VLQFH JU
KDV EHHQ KLJKHU LQ \$VLD WKDQ IRU WKH UHVV RI WKH Z
SS DQG)LJXUH)XUWKHU LQFUHDVHV LQ L
SHULRG LPSDFWHG \$VLDQ LQHTXDOLWLHV DV WKH SRSXO
WR VHH =KXDQJ .DQEXU ODOLJDOLF S 7
\$6(\$1 DORQJ ZLWK &KLQD DQG ,QGLD KDYH H[SHULHQFH
LQHTXDOLWLHV LQ WKH UHJLRQ ZKLFK PRWLYDWHV XV
LQHTXDOLWLHV RQ WD[HV IRU WKH SRSXORXV QDWLRQV R
FDOOHG WKH \$& , HFRQRPLHV

:LWK WKH XQSUFHGHQWHG *'3 JURZWK \$& , HFRQRPL
WHFKQRORJLFDQ FDKQJHV LQFUHDVHV LQ ODERXU IRUFH
GHFOLQLQJ WRS PDUJLQDO LQFRPH WD[UDWLHV ZLGHQLQ
HFRQRPLHV DQG SUHVXUHV IURP JOREDOLVDWLRQ DQG
SURGXFW PDUNHWV 7KHVH FDKQJHV DUH KHOG UHVSQV
7KH LPSDFWV RI LQHTXDOLW\ RQ RWKHU HFRQRPLF
VWXGLHG LQ WKH ,QHTXDOLWLHV DOWHUODWHV WR HVWDEO
FDQ GULYH ILVFDO WD[RXWFRPHV 2XU SULPDU\ PRWLY
XSRQ WKH SRVVLELOLW\ WKDW LQHTXDOLW\ FDQ VLJQLIL
DQG WKHUHE\ ILVFDO RXWFRPHV LQ D VRFLHW\ ,W LV D
JRYHUQPHQWV H[LVW IRU WKH SURYLVLHQ RI SXEOLF JR
FRQVHTXHGHV RI PLVVLQJ PDUNHWV LPSHUIHFV LQIR
*URVVPDQ *RYHUQPHQWV DOVR RIIHU JURZWK VWL
LQYHVWPHQW WKDW LQ WXUQ SURPRWHV SURGXFWLYLW
7KXV HIIHFWLYH JRYHUQDQFH FDOOV IRUWK DGHTX
JRYHUQPHQWV ZKHUWKHU LQ GHYHORSLQJ RU GHYHORSH
VKRUW WHUP QHHGV RI LWV SRSXODWLRQ EXW DOVR LWV
1DP /H S 2QH RI WKH PDLQ GHYHORSPHQW JR
GLVWULEXWLRQ WR ILJKW SRYHUW\ VHH *RGD *DORU
RWKHUV

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$&

HQGRJHQRXV DQG SRVLWLYHO\ UHVSRRGV WR WKH ULVL

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$& ,

WUXVW LQ SXEOLF LQVWLWXWLRQ\ PLD\HOWXW\DD\ORZHU
LQHTXDOLW\ DV D IDFWRU H[SODLQLQJ WD[LQHIILFLHQFV
7UDQ 1DP DQG /H ILQG WKDW WKH WD[SD\HUV SH
LQFUHDVHV WKH WD[OHYHO QRQ FRPSOLDQFH YLD VHYHU
,Q DQ DQDO\VLV RI WKH LVVXH LQ 2(&' FRXQWULHV F
PHGLDQ YRWHU\DD\XPM\DD QRWHG WKDW LQHTXDOL
UDWLRV DQG VXJJHVW WKDW WKH HIIHFV LV PRUH VLJQL
+RZHYHU LQ D VXEVHTXHQW DQDO\VLV RI 2(&' FRXQWU
FXPXODWLRQ\ .XKQ DUJXHV WKDW YRWHUV SHUFHL
WHQG WR EH PRUH VXSSRUWLYH RI UHGLVWULEXWLYH SR

0 27,9\$7,210(7+2'2/2*< \$1' '\$7\$

,Q ZKDW IROORZV LQ VHFWRQ EHORZ ZH SURYLGH W
DQG WKH PDLQ PRWLYDWLRQ EHKLQG WKLV VWXG\

3ROLWLFDO WUDQVDFWLRQ\WV LQHTXDOLW\

:H PDNH D GHSDUWXUH IURP WKH DQDO\VLV LQ SUHYLRXV
SROLWLFDO WUDQVDFWLRQ\WV DQG XQFRYHU WKH SUHF
WD[HV DQG LQHTXDOLWLHV)RU SROLWLFDO PDUNHWV
SROLWLFDO ULJKWV LPSHUIHFV HQIRUFHPHQW DJUHHPH
LQIRUPDWLRQ DV KLJKOLJKWHG E\ WKH 1HZ ,QVWLWXW
E 1\H 3LHUVRQ ORH DPRQJ RWKHUV ± L
DQG UXOHV RI WKH JDPH EHFRPH FUXFLDO GHWHUPLQDQV
RXWSXWV GXH WR SHUYDVLYH WUDQVDFWLRQ FRVWV VHH
SROLWLFDO WUDQVDFWLRQ FRVW OLWHUDWXUH WKDW G
µRSDTXH\ DQG µXQFOHDU\ ZLWK OLPLWHG REVHUYDELOLV
UHIOHFWHG LQ DQ HDUOLHU ZRUN RI 'DKOPDQ WKH
RI WD[SROLFLHV FDQ DVVXPH WKUHH IRUPV ILUVW VHD
WD[SROLFLHV 6HFRQGO\ EDUJDLQLQJ DQG QHJRWLDWLR
WKH HQIRUFHPHQW PRQLWRULQJ DQG SROLFLQJ FRVWV
GHWHUPLQDQWV RI WUDQVDFWLRQ FRVWV WKHQ LQHTXD
SULPDU\ PRWLYDWLRQ RI WKLV VWXG\ LV WR HPSLULFDOO
LQHTXDOLWLHV DQG WD[RXWFRPHV

7D[HIIRUW LV GHILQHG DV WKH UDWLR RI DFWXDO WD[HV DQG WKH S
7KH PHGLDQ YRWHU PRGHO LPSOLHV WKDW WKH SROLWLFDO RXWFR
SUHIHUHQFH &RQJOHWRRQ 7KH WKHRU\ SUHGLFWV WKDW XQGHU
IRU WKH PDMRULW\ RI WKH YRWHUV E\ IRFXVLQJ WKHLU DWWHQWLRQ
ZLWK D PHGLDQ LQFRPH 7KXV DQ H[SHFWHG UHVXOW LV WKDW DV L
LQFUHDVHV LQ WD[HV WR VHUYH WKH GLVWULEXWLYH LQWHUHVW RI WK
7KHVH DXWKRUV FODLP WKDW D ORQJ WHUP GHFOLQH LQ PDUNHW L
UHVXOWHG LQ KLVWRULFDO JURZWK LQ WD[UDWHV KRZHYHU VLQFH V
WD[UHYHQXHV H[HUWLQJ SUHVXUH RQ QDWLRQDO EXGJHV DQG GH
7KH UROH RI WUDQVDFWLRQ FRVWV LQ WKH SROLWLFDO SURFHVV KD
D DQG 'L[LW WKH WUDQVDFWLRQ FRVW WKHRU\ LQ SR
LQIRUPDWLRQ LL VXEMHFWLYH PRGHOV RI GHFLVLRQ PDNLQJ E\ SRO
RI DJUHHPHQWV VHH 1RUWK D S 6XFK FRVWV DULVH IRU WUD
'L[LW 3ROLWLFDO WUDQVDFWLRQ FRVWV DUH DOVR UDPSD
:HLQJDVW 0DUVKDOO (SVWHLQ 2\+DOORUDQ 6SLOOHU 7F

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$& ,

0HWKRGRORJ\

2XU PHWKRGRORJ\ LV EDVHG RQ D SRVLWLYLVW UHVHDFR
XWLOLVLQJ VHFRRGDU\ GDWD 0RUH VSHFLILFDOO\ ZH SP
GHWHUPLQH E\ LQHTXDOLWLHV DV DSSOLHG E\ ,VODP HV

OQ7\$; OQ7\$; OQ*,1, • D D

ZKHU_{LW}W; WKH VKDUH RI WD[UHYHQXWULQV'WKRU FRXQ
PHDVXUH RI LQFRPH LQHQXWULW\DRUHFRQRU\FRQWURO
± QDPHO\ XUEDQLVDSHUFDOLW\$1300QWU'DGH RSHQQHY
OQ75\$W OQ7W;WKH QDWXUJDO ORJDULWKPLF WUDQVIRU
GHFLPDO YDOXHVHQRWWH WKBWFRXWU\ IL[HG HpKO u „VW@

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$& ,

7KH UH SDUDPHWHUHQGH\$URU FRUUHFWLRQ PRGHO LV VSH

$$y_j = y_j + x_j + y_j + x_j + \mu_j$$

1RWH LQ

i « 1 tDQG « 7

$$= -(1-)$$

=

$$= - , \quad j= 1,2,\dots,p- 1$$

$$= , \quad j= 1,2,\dots,q- 1$$

,I ZH VWDFN WKH WLPH VHULHV REVHUYDWLRQV IRU HDFK

$$Y = Y_j + X_j + Y_j + X_j + \mu_j$$

$i= 1,2,\dots,N$ ZKHU (y_1, \dots, y_p) LV $T \times 1$ YHFWRU RI WKH REVHUYDWLRQ
GSHHQGHQW (x_1, \dots, x_q) KHTXK PDWUL[RI REVHUYDWLRQ
RQ WKH UHJUHVVRUV WKDW YDU\ $E = (1, 1)$ DEUTD
YHFWRU, RDQG DJSHULRG ODJYHQDORJ $R =$
 $Y, X = X - X, Y, DQG DJSHULRG ODJYHQDORJ$ RI
 $= (\dots)$

3RROHG 0HDQ *URXS 30* HVWLPDWRU

:KHQ DQDO\VLQJ SDQHO GDWD HFRQRPHWULF DSSURDFKH
FDWHJRULHV QDPHO\ WKH 0HDQ *URXS 0 * HVWLPDWRU
:KHQ DQ@pP€GpPÀ30: H0°KTE`H7DREV`HG HDQ f1PDWRU

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$& ,

FDQ EH GUDZQ HYHQ LI WKH SUHVHQFH RI FRLQWHJUDWL
LI YDULDEOHV DUH LQ ORJDULWKPV WKHQ WKH ORQJ U
HODVWLFLWLHV 3HVDUDQ HW DO

&RQVLGHU WKH IROORZLQJ \$5' / **Y** IROORZLQJ W
DW WLPH W

$$Y = Y_1 + X_1 + \mu_1$$

ZKH\ LV ~~no~~ YHFWRU RI WKH ORJDULWKPV RI WKH H[SOD
OQ75\$(OQ85%\$1 OQ85%\$1 OQ85%\$1 FRHIILFLHQW DIFRQWUOQBU
FRXQWU\ VSHFLILF HIIHFWV (TXDWLRQ DERYH FDQ EH
PRGHO RI WKH IROORZLQJ IRUP

$$Y = Y_1 - X_1 + X_1 + \mu_1$$

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$& ,

7DEOH 7KH 3RROHG 0HDQ *URXS 5HVXOWV IRU WKH \$& ,

	0RGHO	0RGHO	0RGHO	0RGHO	0RGHO	
'HSHQ	QW	QQ7*	QQ*,1	QQ75\$'	QQ85%	QQ3&*'
9DU	DEON	(T	YT	* (T	(T	1 (T
.QQ7	;					
QQ*	,					

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H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$&.

x 0RGHO VKRZV WKDW WD[HV GR QRW KDYH D ORQJ WH
ZRUGV WKHUH LV QR HYLGHQFH RI FDXVDOLW\ UXQQ

x 0RGHO VKRZV WKDW WKH LQWHUQDWLRQDOLVDWLR
QDWLRQV ± PHDVXUHG E\ OQ75\$(± KDV EHHQ GULY
LQHTXDOLWLHV ZKLOH WKHUH VHHPV WR EH HYL

H-RXUQDO RI 7D[5HVHDUFKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$&

H-RXUQDO RI 7D[5HVHDFK

H-RXUQDO RI 7D[5HVHDFK

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$ & ,
/HYLQ \$ /LQ &) &KX & 6 - μ8QLW URRW WHVWV LQ SDQH
SURSHU\UHQDO RI (FRQRPHWUQRV SS
0DK(+XL 0 / .KRU + (μ)URP 0DU[WR 0RUJDQ 6WDQOH\ ,Q
'HYHORSPHQW DQG &KDQRH SS
0DUWtQ 0D\RUDO) 8ULEH & \$ μ'HWHUPLQDQWHV HFRQYPLFR
HQ \$PpULFDQ\UHQDO\DFLyQRQRQyPQRD SS
0HJDUDYDOOL \$ 9 6DPSDJQDUR * μ0DFURHFRQRPLF LQGLFDV
LQ \$6,\$1 \$ SRROHG PHDQ JURXS DSSURDFK† &RJHQW (FRQ
0LODQRYLf % μ7KH PHGLDQ YRWHU K\SRWKHVLV LQFRPH LQ
HPSLULFDQ WHVW ZL(WKRSKHQDHRXUQHG GDVWDLWLFDQ (FRQR
SS
0LODQRYLf % μ7KH PHGLDQ YRWHU K\SRWKHVLV LQFRPH LQ
8QLYHUVLW\ /LEUDU\ RI 0XQLFK *HUPDQ\
0RH 7 0 μ3RZHU DQG SRULW\SHFDOLYLVW\XVQLRQLVSS
1RUWK ' & D μ\$ WUDQVDFW\RRQGRWRWKHFRUHQRSFDOLWRLGLV\L
SS
1RUWK ' & QVWELWXWLRQV LQVWLWXWLRQD &DFKEDUJHUH &GLYHFUQRV
3UHVV &DPEULGJH
1\H - 9 & μ7KLQNLQJ DERXW WKH 6WDWH 3URSHUW\ ULJK
DUUDQJHPHQWV LQ D ZRUOG ZLWK FRHU\KLRQ\UHQW\HURDN WK
QHZ LQVWLWXWLVFDGHILFRQRV\6DQ 'LHJR SS
2VWU\ - ' %HUJ \$ 7VDQJDULGHV & * μ5HGLVWUDEGHWLRQ
(FRQRPtD ,QVWELWXWLRQD SS
3HDFRFN \$ 6FRWW \$ μ7KH FXULR\XVODW\XVDFMLRQRRI :DJQH
SS
3HDFRFN \$ 7 :LVFRQRZWK RI SXEOLF H[SHQG\W\QFHVQRWKH 8
8QLYHUVLW\ 3UHVV 3ULQFHWRQ 1-
3HURWWL 5 μ*URZWK LQFRPH GLVWULEXWLRQDQDQGFQRPLFD
*URZWRO QR SS
3HUVVRQ 7 7DEHOOLQL * μ,V ZQHTS\SHULVFDQD(UFRQRPLFU5HY
YRO QR SS
3HVDUDQ 0 + 6KLQ < μ\$Q DXWRUHJUHVVLVH GLVWULEXWHG
DQDO\VLV† LQ(FRQRPHWUHQV DQG HFRQRPLF WKHRU\ LQ WKH
)ULVFK FHQWHQ\&DPEULGJH
3HVDUDQ 0 + 6KLQ < 6PLWK 5 3 μ3RROHG PHDQ JURXS HV
SDQH\UHQDO RI WKH \$PHULFDQ\UHQDO\DFLyQRQRQyPQRDSSVVRFLDWLRQ

H-RXUQDO RI 7D[5HVHDFRKHV LQHTXDOLW\ LPSDFW WD[FROOHFWLRQ" (YLGHQFH IURP \$& ,

3HVDUDQ 0 + 6PLWK 5 μ(VWLDPDWLQJ ORQJ UXQ UHODWLR
SDQH~~XX~~QDO RI (FR~~QR~~PHW~~QRFV~~ SS

3HVVLQR &)HQRFKLHWWR 5 μ'HWH~~HD~~PL~~QQ~~QD BR~~X~~QW~~DL~~H
(VSDxROD 5HYLVWD GHY~~FR~~QR~~Pt~~SS3~EOLFD

3LHUVRQ 3 μ,QFUHDVLQJ UHWXUQV SD~~PH~~GL~~FS~~Q~~GR~~QEW~~L~~DD~~Q~~
6FLHQFH 5~~HY~~QLHZ QR SS

5RGULN ' μ:KHUH GLG DOO WKH JURZWK JR" ([WHUQDO VKRFN
-RXUQDO RI (FR~~QR~~ROF *U~~R~~ZWK SS

6SLOOHU 3 7 7RPP~~HW~~LLQ\WLWXWLRQDO IRXQGDWLRQV RI SXEO
WUDQVDFWLRQV~~&DPEULGJH~~SSUR~~DF~~KHUVLW\ 3UHVV &DPEULGJH

7UDQ 1DP % /H 7 + μ3RWHQWLDO WD[UDWLR WD[HIIRUW
HPSLULFDO VWXG\ XVLQJ WKH \$~~XW~~W~~FK~~DD~~LV~~D~~Q~~F~~7~~DD[)RU~~X~~Q~~W~~LHU PF
SS

8QLWHG 1DWLRQV &RQIHUHQFH RQ 7UDGHR~~DQG~~ L~~Q~~Y~~H~~OR~~W~~SP~~H~~Q~~W~~U~~B~~S
&URVV ERUGHU PHUJHUV DQG ~~B~~TL~~X~~LV~~G~~W~~D~~RV~~W~~Q~~W~~G~~1~~B~~Z~~Y~~H~~RO
*HQHYD

:DJQHU \$ μ7KUHH H[WUDFWV RQ SXEOLF ILQDQFH~~↑~~ LQ 0XVJU
LQ WKH 7KHURU\ RI 3XEOLF)LQDQFH 0DFPLOODQ /RQGRQ SS

:DQ * =KXDQJ - μ0DNLQJ JURZWK PRUH LQFOXVLYH~~↑~~ LQ =K~~X~~
HG~~V~~DDQDJLQJ WKH PLGGOH LQFRPH WUDQVLWLRQ &KDOOHQJ
&KLQ~~G~~ZDUG (OJDU 3XEOLVKLQJ &KHOWHQKDP 8. DQG \$VLDQ

:HLQJDVW % 5 0DUVKDOO : - μ7KH LQGXVWULDO RUJDQL]D~~V~~
OLNH ILUPV DUH QRW-R~~X~~UD~~Q~~D~~Q~~J~~H~~G~~B~~RV~~LD~~V~~LD~~V~~V~~(~~R~~QR~~P~~SS

=KXDQJ - .DQEXU 5 0DOLJDOLF ' μ\$VLD~~↑~~V LQFRPH LQHTXD
5KHH & =KXDQ~~Q~~H~~T~~X~~D~~Q~~W~~\ LQ \$VLD DQG WKH 3DFLILF 7UHC
LPSOLF~~D~~VR~~X~~Q~~W~~HGJH /RQGRQ DQG \$VLDQ 'HYHORSPHQW %DQN