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Econometrica, . 86, N . 1 (J , 2018), 263 288

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IDEN IF ING EFE ENCE IN NE K I H B NDED DEG EE

E DE A A
C L , E , C MMA , IF , CE

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ELIE AME
H

A

((2014), M (2016), L (2015)).[2] (., -), . A (C . (2010), M (2017), B (2013)).[3] C J (2014) - . A , (..,) - (C (2017), G (2017), D (2014)).

B , - . (., C (2006), F (2010, 2018), G (2009), E , L , (2010), C , G , (2016), M (2015)). - : - , - , ( ). A J (1996) , .

2. NE K F MA I N M DEL

. - , - , .[4] , i

$u_i(G, \mathbf{X}) = u(G, \mathbf{X}; \varepsilon_i)$, $\varepsilon_i = (\varepsilon_{ij})_{j \neq i}$. ( ) $u(G, \mathbf{X}; \cdot)$ G $\mathbf{X}$.

A ION 1: *Only connections up to distance* D *affect utility, and preferences are such that players will never choose more than a total of* L *links.*

$d(i, j; G)$. I $D = 1$, (. . ., C , J , (2009)). $D > 1$, $D = 2$ (. . ., –). L (. ., L). . N (. .,) (. ., F).[7] A 1 . F , $D = 2$, L $L \times (L - 1)$ . . I ,

A ION 2: *Individuals are endowed with* $L \times |\mathcal{X}|$ *preference shocks, denoted* $\varepsilon_i(x)$, $l = 1, \ldots, L$, $x \in \mathcal{X}$, *which correspond to the possible direct connections and their characteristics. This vector of preference shocks is independent of* X *with a known distribution (possibly up to some finite-dimensional parameter). In addition, the support of* X *is finite.*

( ) (. . ., K (2004), M (2016)) (. . ., C (2006), G (2009)). . I ,

[7]F , N L A A H (A H –), . I I J , -B (2012), 1 1,000 5 8 , , (37, . 1879).

.[8]

D. I , $|\mathcal{X}| \times L \sum_{d=1}^{D} (L-1)^{d-1}$ (
$L >$

$N(i)$ i (.., $N(i) \equiv \{j : G(i, j) = 1\}$) $|\cdot|$. I , $l(j)$ j l i .[11] $(N(i))$ $(\{i\})$. , . L , $D = 2$, .

A , . (J - (1996)).

DEFINITION 1 : A ij i j , - :

$$\forall i, j : G(i, j) = 1, \quad u_i(G, \mathbf{X}) \geq u_i(G_{-ij}, \mathbf{X}) \quad u_j(G, \mathbf{X}) \geq u_j(G_{-ij}, \mathbf{X}); \quad ( )$$

$$\forall i, j : G(i, j) = 0, \quad u_i(G_{+ij}, \mathbf{X}) > u_i(G, \mathbf{X}) \quad u_j(G_{+ij}, \mathbf{X}) < u_j(G, \mathbf{X}) \quad ( )$$

I , G_{-ij} $(k, l) \to G_{-ij}(k, l) = G(k, l)$ $(k, l) = (i, j)$ $(k, l) \to G_{-ij}(k, l) = 0$ $(k, l) = (i, j)$. A , G_{+ij} $(k, l) \to G_{+ij}(k, l) = G(k, l)$ $(k, l) = (i, j)$ $(k, l) \to G_{+ij}(k, l) = 1$ $(k, l) = (i, j)$. ; B J (2006) J (2009). A - , , , - . N , .

3. E IE F E

H , (1). I , ($L = 1$, $D = 1$), : B ( ) W ( ). , . , .

, (x, y), , (x) $(y$, $y = 0$). F , (B, W) *network types* . (M , (B, W), .) , (x, y). (1) $u_i(x, y) = f_{xy} + \varepsilon_i(y)$, f_{xy}, $x, y \in \{B, W\}$, ,

2 10.4608 0 1 8 0.4608 -24 322(08 J/ 11 1 -0.0 2.22 0 ()) 6.4757 0 0 6.4

(-).

f_{xy}.

F , (G X)

, *type shares*. F ,

500 , 50

(B W) 0.1 ((W B) 0.1,).

f_{xy}

.

,

(..,). F ,

,

, : , $f_{BB} + \varepsilon_i(B) \geq 0$

$f_{BW} + \varepsilon_i(W) < 0$. H , (B W) -

, (B B)

preference classes,

H. F , H = {(B 0) (B B)}. (B

, . ., (B 0), -

.)

: H_1 = {(B 0)}, , ; H_2 = {(B 0) (B B)},

, ; H_3 = {(B 0) (B W)}, , ;

H_4 = {(B 0) (B B) (B W)}, , .

, W.

E , ε, -

–

(.., H -

H, H).

H , -

, -

. I , ε(B) ε(W)

f_{xy} . , -

, M C (

7 M A D.7.1 (, , - , ,

(2017))).

G -

,

, *allocation parameters*,

$\alpha_H(\cdot)$, ,

H ·–. F , -

, (B W), (H$_1$|B)α_{H_1}(B W) +

(H$_2$|B)α_{H_2}(B W) + (H$_3$|B)α_{H_3}(B W) + (H$_4$|B)α_{H_4}(B W) (-

).

. H ,

. F ,

4. NE K -E AND - EFE ENCE CLA E

N . *network types.*

( )

D

L

.

(. .,),

. I , ,

,– ,–

,–

M , A,

, v. A

D , *ego* . I

,

D.

1 , 0 . L

, $L(L-1)$ 2,

. $1 + L + L(L-1) + L(L-1)^2 + \cdots + L(L-1)^{D-1} =$

$1 + L\sum_{d=1}^{D}(L-1)^{d-1}$.[12] v

, A. v

, v_1.

, $\mathcal{X} \in \{0\}$, 0

.[13] :

DEFINITION 2 N. : F D, L, $\mathcal{X}$. A t

$t = (A, v)$, A $1 + L\sum_{d=1}^{D}(L-1)^{d-1}$ v

A.

- t. v

. 70 310.4603

IDEN IF ING EFE ENCE

1. 2. 3. 4.

N , A 1 2, - . A 1 A, A 2 - v, . A , $u_i(G, \mathbf{X}) = u(A, v; \varepsilon_i)$. ε_i - (.., L × $|\mathcal{X}|$). I E 1, : $\varepsilon_i = (\varepsilon_{i1}(B), \varepsilon_{i1}(W), \varepsilon_{i2}(B), \varepsilon_{i2}(W))$.[15] F F 2, -

$$f(B, B) + \varepsilon_{i1}(B) + f(B, W) + \varepsilon_{i2}(W) + \omega$$

$$f(B, B) + \varepsilon_{i1}(B) + f(B, W) + \varepsilon_{i2}(W) + \nu$$

(ω ν).

I , . F , *preference classes*, . ' . I , , . N , ε: ( )

$\varepsilon_{i2}(B)$ i

t : $\mu_{v_1(t)} \sum_H P_{H|v_1(t)} \alpha_H(t)$, $\mu_{v_1(t)}$ $v_1(t)$ (t). t μ. , .

5. IDEN IFICA ION I H NE K E

I , (, *type shares*) , . I , , , . , , ( ):

CONDI ION 1 E L : A . F t H, t H = $\alpha_H(t) = 0$.

CONDI ION 2 N L B D I : 2D ($d(i j; G) > 2D$). F t s L , $\bar{t} \bar{s}$ 2D ,

$$\left(\mu_{v_1(t)} \sum_{\tilde{H} \in \mathcal{H}} P_{\tilde{H}|v_1(t)} \alpha_{\tilde{H}}(t) 1_{\bar{t} \tilde{H}}\right) \cdot \left(\mu_{v_1(s)} \sum_{\check{H} \in \mathcal{H}} P_{\check{H}|v_1(s)} \alpha_{\check{H}}(s) 1_{\bar{s} \check{H}}\right) = 0$$

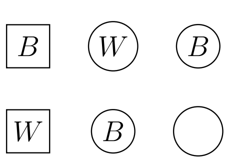
. I , $P_{\cdot|\cdot}$, . (..,) . ' $\pi \equiv (\pi_t)_{t \in \mathcal{T}}$, π_t t. .[17] F π , $\{P_{H|v_1}\}$

C 1 2 . A , . B M A B. H , C 1 2 .

C 1 ( ) . I , ( ). A C 1 , . I C 1 ($\alpha_H(t) > 0$ H t H), C 2 ( ) . I *who are at a distance greater than* 2D *from each other* . 2D (M A B). C 2, (t s), (t t), L . , ($\bar{t}$ $\bar{s}$), t s 2D . F t s F 3, E 1 (D = 2 L = 2). I 2D, $\bar{t}$ $\bar{s}$. ( ) 2D + 1, D. I , (2D), C 2 G.

( ) I ( )

Initial Types



(a) I (b)

Initi

t ($\alpha_{\tilde{H}}$(t) $\tilde{H}$) $\bar{t}$ ($1_{\bar{t}\tilde{H}}$). ( ), $f_{BW} + \nu + \varepsilon_2(W) \geq 0$.[18] s $\bar{s}$. I t ( ), s ( ). I t s $\bar{t}$ $\bar{s}$, . , C 1 2 t s. H , (., t $\bar{t}$ s $\bar{s}$).

1 , ( ) ( ) , C 1 2 . ( ). I C 1 2. I , . I *no* C 1 2, .

6. IM LEMEN A I N

1 . F , ( ) .[19]

6.1. *Formulation as Quadratic Programming Problem*

C 2 . , 1 .

[18] $\bar{t}$ $2f_{BW} + 2\nu + \varepsilon_1(W) + \varepsilon_2(W)$, t ($\bar{t}$) $f_{BW} + \nu + \varepsilon_1(W)$. H , $\bar{t}$ $f_{BW} + \nu + \varepsilon_2(W) \geq 0$. , $\bar{s}$ $f_{WB} + \nu + \varepsilon_2(B) \geq 0$.

[19] A – H (2006) . F K (2013).

C 1: $\{\alpha_H(t) : t \in H\}$, α .
C 2 $\alpha' Q\alpha$, Q
. A
$(\frac{1}{\mu}\sum_H \mu_{v_1(t)} P_{H|v_1(t)}(\theta)\alpha_H(t) = \pi_t)$.
-

$$\min_{\{\alpha_H(t):t\in H\}} \alpha' Q\alpha \quad :$$

$$\frac{1}{\mu}\sum_H \mu_{v_1(t)} P_{H|v_1(t)}(\theta)\alpha_H(t) = \pi_t \quad \forall t; \tag{3}$$

$$\sum_{t\in H}\alpha_H(t) = 1 \quad \forall H; \qquad \alpha_H(t) \geq 0$$

A , 1 . , - θ (, $\{P_{H|v_1}(\theta)\}$), , .

Q, C 2. (-) Q - $\alpha_H(t)$ $\alpha_G(s)$. 1 C 2, 0. , $Q_{[\alpha_H(t)\alpha_G(s)]} = 1_{\bar{t}\in H}\cdot 1_{\bar{s}\in G}$, $\bar{t}$ $\bar{s}$ t s ( ). $(\alpha_H(t)1_{\bar{t}\in H})\cdot(\alpha_G(s)1_{\bar{s}\in G})$ $\alpha' Q\alpha$. - , C 2 $(\mu_{v_1(t)} P_{H|v_1(t)}\alpha_H(t)1_{\bar{t}\in H})\cdot(\mu_{v_1(s)} P_{G|v_1(s)}\alpha_G(s)1_{\bar{s}\in G})$. H , $\mu_{v_1(\cdot)}$ $P_{\cdot|\cdot}$.[20] Q 3.

E AM LE 2: L (1), $D = 1$, $L = 1$, $\mathcal{X} = \{B, W\}$. H , $v = (v_1, v_2)$. -
P(1 Tf 0 Tc 0.969 1013j /T1_1H1 8Tf 6.4757 0 0 6.4757 1382.12723 6.3657m 3102.2014271(2316.Tf

A , $H_1 = \{(B\,0)\}$, . H , $1_{\bar{t}H_1} = 0$ $\bar{t}$. ( ) Q: $\alpha_2(B\,0)$, $\alpha_3(B\,0)$, $\alpha_4(B\,0)$, $\alpha_6(W\,0)$, $\alpha_7(W\,0)$, $\alpha_8(W\,0)$. . (B L = 1, .) F , $\alpha_3(B\,0)$, 1' $\alpha_7(W\,0)$ $\alpha_8(W\,0)$. $H_3 = \{(B\,0)(B\,W)\}$, $H_7 = \{(W\,0)(W\,B)\}$, $H_8 = \{(W\,0)(W\,W)(W\,B)\}$, . , $t = (B\,0)$ ( ) $s = (W\,0)$ ( ), $\bar{t} = (B\,W)$ ( ) $\bar{s} = (W\,B)$ ( ), t s. , $1_{\bar{t}H_3} \cdot 1_{\bar{s}H_7} = 1$ $1_{\bar{t}H_3} \cdot 1_{\bar{s}H_8} = 1$.

Q $1_{\bar{t}H} \cdot 1_{\bar{s}G}$. G $\alpha_H(t)$ $\alpha_G(s)$, t s $\bar{t}$ $\bar{s}$, $\bar{t}$ $\bar{s}$ H G, . H , . I , S, Q, $S_{[\alpha_H(t)\alpha_G(s)]}$ $1_{\bar{t}H}$ $1_{\bar{t}H} \cdot 1_{\bar{s}G}$. C , S Q S , . S - - - . Q H (..,) S : $Q = S \circ S$. (M A D.7.2 .)

Q , . (A A.)

HE EM 2: *Given a probability distribution of preference classes* $\{P_{H|v_1}(\theta)\}$, *there exists a vector of allocation parameters* α *yielding type shares* $\{\pi_t\}$ *while satisfying Conditions* 1 *and* 2 *if and only if the optimal value of QP problem* (3) *is zero.*

. B , , . I , . – ,[21] C 1 2.

[21]

F , $\alpha' Q \alpha$, Q , .[22] I 7, KNI . I (.., $\alpha' Q \alpha = 0$), , .

6.2. *Consistency of Type Shares*

, θ, . 1 2 , *knowing the type shares* π, θ. π .

A (π), . . H , . I , ( ) . G (1961), ,[23] .745 0 (),)34411 1 .6(A)19(,6( )6 0 ( ))-70 0 21 20() / 10 1

I ION 1: *Under random sampling* (*on the underlying*,

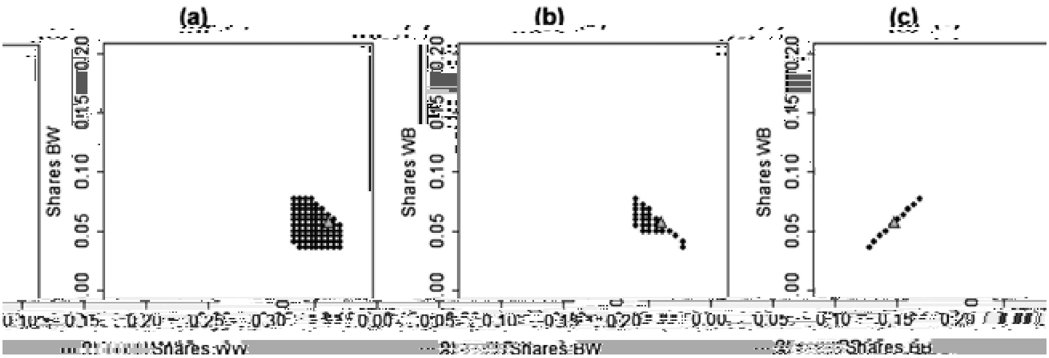


FIG 5. E . *Notes*: f_{BB}

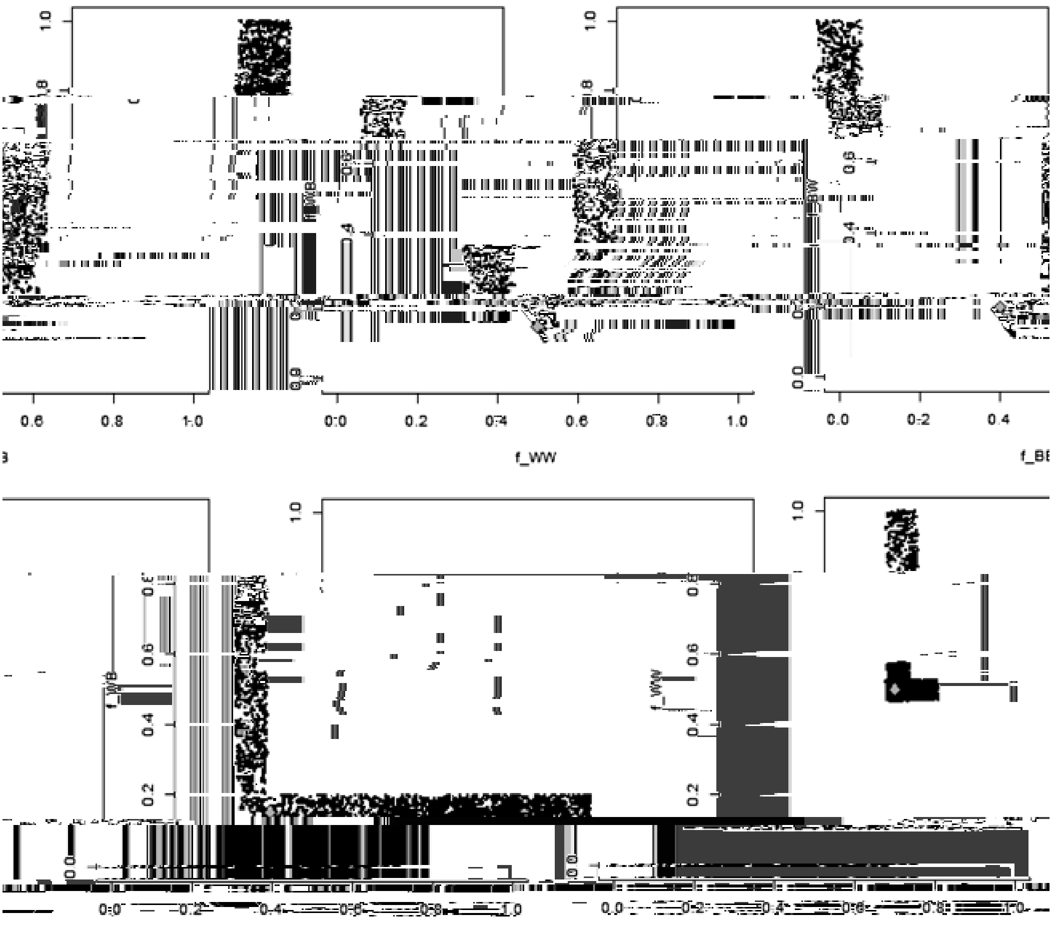


FIG E 6. L . *Notes*: (F 5). D : $f_{BB} = 0.40$, $f_{BW} = 0.20$, $f_{WB} = 0.15$, $f_{WW} = 0.50$.

(M A B).[29] ( ). , (A v), (M A D.3).

, $n = 500$ (100 400 , $\mu_B/\mu_W = 1/4$), M A D.4. F 7 , ,

[29] $(f_{BB}, f_{BW}, f_{WB}, f_{WW}) = (-0.9, -1.5, -1.7, -0.7)$, $\nu = 0.2$, $\omega = 0.2$. F D.7 M . A. H .

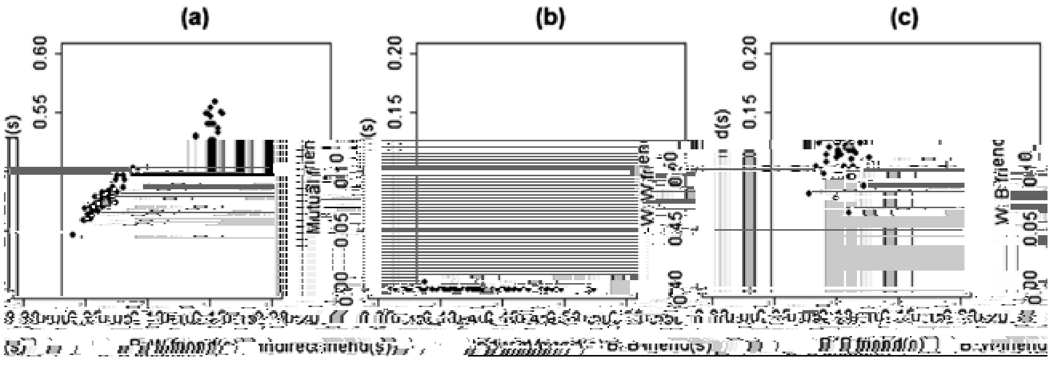


FIGURE 7. E . *Notes*: F - : - (x: x ( )), - (x: y ( )),

(F 7). M A D.6 D.8 ( ) (..,). M C M C (MCMC) (M A D.8). F 8. f_{WB} f_{BW} . A , (.., $f_{BB} > f_{BW}$ $f_{WW} > f$ W B B B f_{BB} f_{WW}

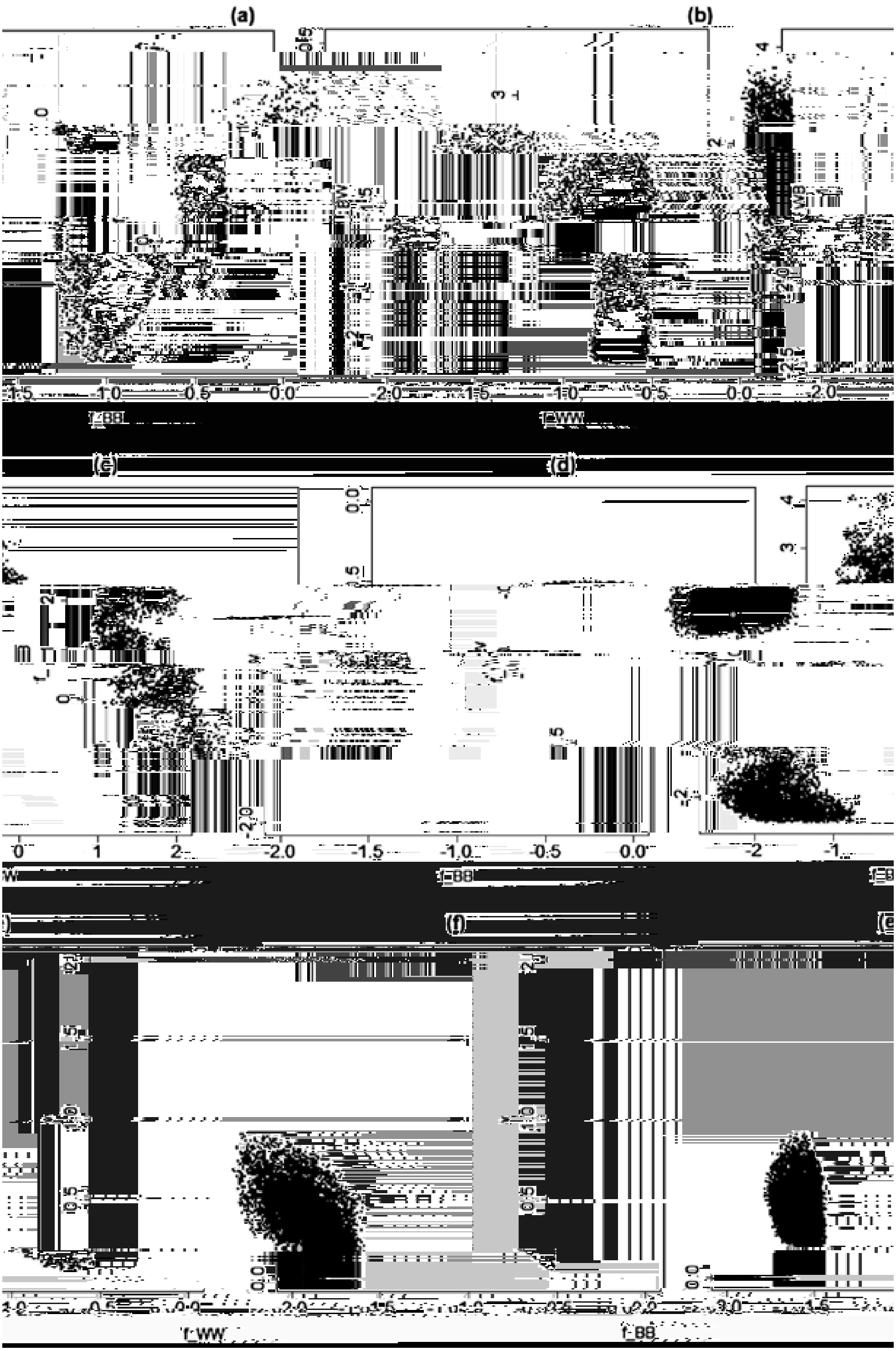


FIG E 8. L . *Notes*

8. CONCL ON

( ), . F J , -B , (2012), 5 8 . . N (. ., –) . E , . I ,

A ENDI A: OF OF HE EM 1 AND 2

A.1. *Theorem 1*

OF: G G, X, ε ( ), H $\alpha_H(t)$ H t. ; , $(\mu_{v_1(t)}/\mu)\sum_H P_{H|v_1(t)}\alpha_H(t) = \pi_t$. L G , ( ) D 1. H , i, (A v), $u(A v;\varepsilon_i) \geq u(A_{-l} v;\varepsilon_i)$ l = 1 L. B , . H , $\alpha_H(t) > 0$ t H, C 1 . C 2 , (t s) L . L ($\bar{t}$ $\bar{s}$) s.) ■ .88.C 3H 645)

S

$\mu_{v_1(s)} \sum_{\breve{H} \in \mathcal{H}} P_{\breve{H}|v_1(s)} \alpha_{\breve{H}}(s) 1_{\bar{s} \in \breve{H}}$

(t s) C 2 , . *Q.E.D.*

A.2. *Theorem 2*

OOF: C 2

$\mu_{v_1(\cdot)}$ P ,

$$\mu_{v_1(t)} \mu_{v_1(s)} \sum_{\tilde{H} \in \mathcal{H}} \sum_{\breve{H} \in \mathcal{H}} P_{\tilde{H}|v_1(t)} P_{\breve{H}|v_1(s)} \alpha_{\tilde{H}}(t) \alpha_{\breve{H}}(s) 1_{\bar{t} \in \tilde{H}} 1_{\bar{s} \in \breve{H}} = 0$$

$$\Leftrightarrow \quad \sum_{\tilde{H} \in \mathcal{H}} \sum_{\breve{H} \in \mathcal{H}} \alpha_{\tilde{H}}(t) \alpha_{\breve{H}}(s) 1_{\bar{t} \in \tilde{H}} 1_{\bar{s} \in \breve{H}} = 0$$

(3)

(π_t).

1 . F , C 1 (..,

$\{\alpha_H(t) : t \in H\}$, $\{\alpha_H(t)\}$). H , -

, *Q.E.D.*

EFE ENCE

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B E , ., AND M (2017): M F F F A : A N , *Econometrics Journal*, 20 (3), 14 46. [265]

B E A

ECHEN [redacted] F., . LEE, AND M. H [redacted]