TAX AVOIDANCE
On a Social Network

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CONTENT

OVERVIEW

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Tax Avoidance and Reference Dependence

- → Tax avoidance causes significant losses in public revenue
- → Economic agents are often driven by positional concerns
- → Central role of social interactions in shaping reference points
- → Tax avoidance is a means to improve agents' relative standing

RELATED LITERATURE

→ Kahneman and Tversky 1979
Reference dependence of utility

→ Gali 1994
"Keeping up with the Jones"

→ Myles and Naylor 1996
Tax evasion and group conformity

→ Ballester, Calvo, Zenou 2006
Network game with local payoff complementarities

→ Quah 2007
Monotone comparative statics on network games

RESEARCH GOALS

Provide a Model where:

→ Agents are heterogeneous in income

→ Taxpayers may engage in costly **tax avoidance**

→ **Self** and **social** comparison shape the reference income

→ **Social** comparison depends on agents' **social network**

MODEL

MODEL

Relevant parameters and variables:

$t \in (0,1)$	Linear tax rate
$\phi \in (0,1)$	Per-unit linear fee on avoided tax
$p_i \in (0,1)$	Probability of audit
$W_i \in [\underline{W}, \overline{W}]$	Exogenous income
$X_i = (1-t)\,W_i$	Honest after-tax income
$A_i \in (0, tW_i)$	Avoided income
R_i	Reference Income

THE AVOIDANCE PROBLEM

Taxpayer's problem is:

$$\max_{A_i} \mathbb{E}[U] = (1 - p_i)\, U(W_i^n - R_i) + p_i U(W_i^a - R_i)$$

After-tax income if not audited

$$W_i^n = X_i + [1 - \phi] A_i$$

After-tax income if audited

$$W_i^a = X_i - \phi A_i$$

Utility is quadratic

$$U(z) = z[b - \frac{az}{2}]$$

Optimal Avoidance at an interior solution is:

$$A_i^* = \frac{1 - p_i - \phi}{a\zeta_i}\{a[R_i - X_i] + b\}, \zeta_i > 0$$

REFERENCE DEPENDENCE

Agents' reference income is a weighted average of habitual income and the average of her reference group

Taxpayer i expected after-tax income when avoiding A_i is:

$$q_i = X_i + [1 - p_i - \phi] A_i$$

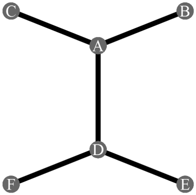
And the reference income may be expressed as:

$$R_i = \iota_h D_i + \iota_s \sum_{j \neq i} g_{ij} q_j$$

ι_h	Relative importance of habit
D_i	Habit income
ι_s	Relative importance of peers
g_{ij}	weight of agent j in i reference group

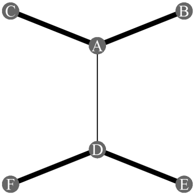
NETWORK AND ADJACENCY MATRIX

Undirected Network



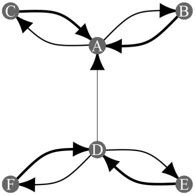
$$\begin{array}{c} \\ A \\ B \\ C \\ D \\ E \\ F \end{array} \begin{array}{c} \begin{array}{cccccc} A & B & C & D & E & F \end{array} \\ \begin{pmatrix} 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix} \end{array}$$

Weighted Network



$$\begin{array}{c} \begin{array}{cccccc} A & B & C & D & E & F \end{array} \\ \begin{pmatrix} 0 & 1 & 1 & .2 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ .2 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix} \end{array}$$

Directed Network



$$\begin{array}{c} \begin{array}{cccccc} A & B & C & D & E & F \end{array} \\ \begin{pmatrix} 0 & .5 & .5 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ .2 & 0 & 0 & 0 & .4 & .4 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix} \end{array}$$

NETWORK INTERACTIONS

ACCOUNTING FOR SOCIAL NETWORK

Expanding A_i^* using the definitions of R_i and q_i we solve à la **Cournot-Nash**:

$$A_i = \alpha_i + \iota_s \sum_{j \neq i} g_{ij}^{'} A_j =$$

$$\mathbf{A} = \boldsymbol{\alpha} + \mathbf{G}^{'} \boldsymbol{\beta} \mathbf{A}$$

Where:

$$\alpha_i = \frac{1 - p_i - \phi}{a\zeta_i} \{a[\iota_h D_i + \iota_s \sum_{j \neq i} g_{ij} X_j - X_i] + b\}$$

$$\boldsymbol{\beta} = Diag(\iota_s)$$

$$g_{ij}^{'} = \frac{[1 - p_i - \phi][1 - p_j - \phi]}{\zeta_i} g_{ij}$$

BONACICH CENTRALITY AND AVOIDANCE

The nash equilibrium is then:

$$\mathbf{A} = [\mathbf{I} - \mathbf{G}^{'}\boldsymbol{\beta}]^{-1}\boldsymbol{\alpha} = b(\mathbf{G}^{'}, \boldsymbol{\beta}, \boldsymbol{\alpha})$$

$b(\mathbf{G}^{'}, \boldsymbol{\beta}, \boldsymbol{\alpha})$ is the weighted Bonacich centrality defined on:

$\mathbf{G}^{'}$	Edge weights scaled by agents' relative ER of A
$\boldsymbol{\beta}$	Scales weight of longer paths
$\boldsymbol{\alpha}$	Weights centrality by agent characteristics
$[\mathbf{I} - \mathbf{G}^{'}\boldsymbol{\beta}]^{-1}$	Well defined by row-scaling

TAXPAYERS' INTERACTION AS A GAME

The game arising from taxpayers interaction is:

Smooth Supermodular Game (Milgrom and Roberts 1990)

Bounds on strategies	$A_i \in (0, tW_i)$
Differentiability	$\mathbb{E}[U]_i$ is of class C^2
Strategic Complements	$\frac{\partial^2 \mathbb{E}[U]_i}{\partial A_i \partial A_j} \geq 0$

MONOTONE COMPARATIVE STATICS

Smooth Supermodular Games can be analyzed using **Monotone comparative statics**

Following Quah (2007) we exploit the **weaker** condition of **local supermodularity** around the Nash equilibrium point:

Then, for a given parameter z, it holds:

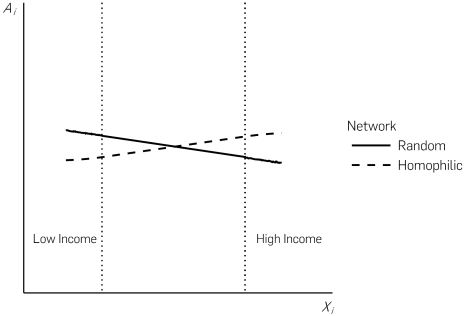
$$\left.\frac{\partial^2 \mathbb{E}[U]_i}{\partial A_i \partial z}\right|_{A_i=A_i^*} \geq 0 \Leftrightarrow \frac{\partial A_i^*}{\partial z} \begin{cases} > 0 \text{ if } \left.\frac{\partial^2 \mathbb{E}[U]_i}{\partial A_i \partial z}\right|_{A_i=A_i^*} > 0 \\ \geq 0 \text{ if } \left.\frac{\partial^2 \mathbb{E}[U]_i}{\partial A_i \partial z}\right|_{A_i=A_i^*} = 0 \end{cases}$$

MONOTONE COMPARATIVE STATICS

	A_i^*		A_i^*
a	$-$	t	$+$
b	$+$	ϕ	$+/-$
D_i	$+$	R_i	$+$
p_i	$-$	X_i	$-$
p_j	$-/0$	X_j	$+/0$
ι_h	$+$	ι_s	$+/0$

Monotone comparative statics for interior A_i^*

NETWORK STRUCTURE AND INCOME



The pure effect of X_i on A_i^* is negative

However, if:

- → X_j increases with X_i
- → ι_s is high enough

The positive peer-effect may cause a reversal

If taxpayers with similar income tend to **group together** (homophily) and **social comparison plays a relevant role** in shaping reference income, the model predicts **avoidance to be increasing in income**

CONCLUSIONS

CONCLUDING REMARKS

→ Comparison utility included in tax avoidance model

→ Network structure plays a major role

→ Network (Bonacich) centrality and avoidance are closely linked

→ Assumption of quadratic utility crucial

FURTHER RESEARCH

→ Effect of network structure on enforcement policies

→ Investigate the model as a dynamic game

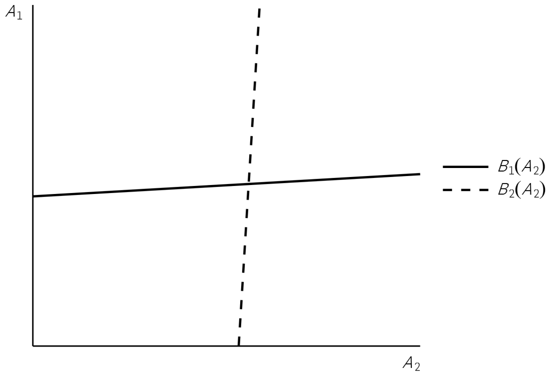
→ Allow for joint avoidance/evasion decision

Thank You!

Questions?

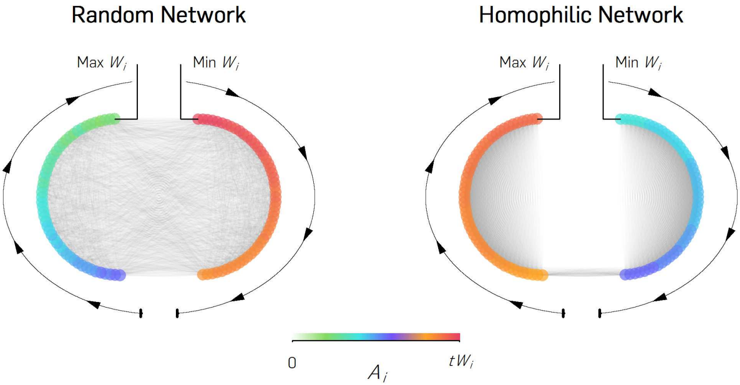
BEST RESPONSE

Quadratic utility leads to linear best response



Positive slope of best response functions follows from strategic complementarity in A_i, A_j

NETWORK STRUCTURE AND INCOME



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AUDIT EFFECT

Audits performed on **high income** taxpayers **are more effective** than the ones performed on low income ones