Endogenous Trade Networks: Example - Labor Market Study

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Labor Institutions and Market Performance: What does ACE have to offer?
www.econ.iastate.edu/tesfatsi/alabor.htm

Illustration: (M. Pingle/L. Tesfatsion, 2003)

Implemented via the Trade Network Game (TNG) Lab
Labor Institutions and Market Performance:

Some Key Issues:

- Labor contracts typically incomplete
- Supplemented by government programs with numerous eligibility restrictions
- Difficult to test program effects by means of conventional analytical and/or statistical tools
Example: U.S. Programs Providing Unemployment Benefits (UB)

- UB only paid to “no fault of their own” unemployed
- UB recipients must continue to seek employment
- UB levels based on past earnings
- UB of limited duration
- UB financed by taxes imposed on employers
- Additional UB often granted when unemployment rate is abnormally high for prolonged periods
Empirical Findings
(Handbook of Labor Economics, Elsevier, 1999)

- Higher benefit **level** increases duration of unemployment spells.

- Increased benefit **duration** increases unemployment rate (unemployed as percentage of labor force).

- Evidence of other impacts of UB is considerably more mixed (small sample bias problems, confounding effects, ...)

Common Approach to UB Modeling

- Dynamic Programming (DP)
  - Representative worker uses DP to maximize lifetime expected utility
  - Jobs arise and end randomly, and unemployment benefit received if unemployed
  - At each time t that a job arises, worker compares DP value of new job vs. DP value of staying in current situation (old job or unemployment)
  - Precise predictions, empirical support unclear.
Potential Contributions of an ACE Approach

- Both workers & employers can be modeled as utility-seeking interacting agents
- Matching process can be preferential (endogenous hires, quits, and firings)
- Learning can be calibrated to data (empirical, human-subject experimental)
- Evolution of behaviors/interaction networks
- Relatively easy to incorporate realistically detailed structural features (market protocols, policy rules, program eligibility requirements,...)
An ACE Study of Unemployment Benefits

“Evolution of Worker-Employer Networks and Behaviors under Alternative Non-Employment Benefits: An ACE Study”

- Joint work with M. Pingle (U of Nevada-Reno)
- Published in *New Directions in Networks, Edward Elgar, 2003*, edited by Anna Nagurney
- Pre-print available at [www.econ.iastate.edu/tesfatsi/alabmplt.pdf](http://www.econ.iastate.edu/tesfatsi/alabmplt.pdf)
- Parallel human-subject experiment conducted
ACE Labor Market Framework

Preferential job search with choice/refusal of partners: 
Red directed arrow indicates refused work offer.
12 workers with same \textit{observable} structural attributes in initial period $T=0$

12 employers with same \textit{observable} structural attributes in initial period $T=0$

Only \textit{observable} source of heterogeneity among workers and among employers is their expressed behaviors on the work-site
Each worker can work for at most one employer in each period \( T \)

Each employer can provide at most one job opening in each period \( T \)

Work-site strategies in initial period \( T=0 \) are randomly determined and private information
Each worker and employer has...

- **Publicly available information** about various market/policy protocols (e.g., UB eligibility rules)
- **Private behavioral methods** that can evolve over time
- **Privately stored data** that can change over time
A Computational Worker

Public Access:

// Public Methods
Protocols governing job search
Protocols governing negotiations with potential employers
Protocols governing unemployment benefits program
Methods for receiving data
Methods for retrieving Worker data

Private Access:

// Private Methods
Method for calculating my expected utility assessments
Method for calculating my actual utility outcomes
Method for updating my worksite strategy (GA learning)

// Private Data
Data about myself (my history, utility fct., current wealth...)
Data recorded about external world (employer behaviors,...)
Addresses for potential employers (permits communication)
A Computational Employer

**Public Access:**

// **Public Methods**
- Protocols governing search for workers
- Protocols governing negotiations with potential workers
- Protocols governing unemployment benefits program
- Methods for receiving data
- Methods for retrieving Employer data

**Private Access Only:**

// **Private Methods**
- Method for calculating my expected profit assessments
- Method for calculating my actual profit outcomes
- Method for updating my work-site strategy *(GA Learning)*

// **Private Data**
- Data about myself (my history, profit fct., current wealth...)
- Data recorded about external world (worker behaviors,...)
- Addresses for potential workers (permits communication)
Flow of Activities in the ACE Labor Market

- Workers make offers to preferred employers at a small cost per offer (quits allowed)
- Employers accept or refuse received work offers (firings allowed)
- Each matched pair engages in one work-site interaction (PD game - cooperate or defect)
- After 150 work periods, each worker and employer updates its work-site IPD strategy
Flow of Activities in the ACE Labor Market

Initialization

Work Period:
- Search/Match
- Worksite Interactions
- Update Expectations

Evolution Step:
- Evolve Worksite Strategies

Do 1000 Loops

Do 150 Loops
Worksite Interactions as Prisoner’s Dilemma (PD) Games

Employer

C

D

C

Worker

C

(40,40)

(10,60)

D

(60,10)

(20,20)

D = Defect (Shirk);  C = Cooperate (Fulfill Obligations)
How do changes in the level of a “non-employment payment” NEP affect...

- **Worker-Employer Interaction Networks**
- **Worksite Behaviors:** Degree to which workers/employers shirk (defect) or fulfill obligations (cooperate) on the worksite
- **Market Efficiency** (total surplus net of UB program costs, unemployment/vacancy rates,...)
- **Market Power** (distribution of surplus)
Experimental Design

- **Treatment Factor:** Non-Employment Payment (NEP)
- **Three Tested Treatment Levels:**
  - NEP=0, NEP=15, NEP=30
- **Runs per Treatment:**
  - 20 (1 Run = 1000 Generations; 1 Gen.=150 Work Periods)
- **Data Collected Per Run:** Network patterns, behaviors, and market performance (reported in detail for generations 12, 50, 1000)
Three NEP Treatments in Relation to PD Payoffs

1. \( \text{NEP}=0 \ < \ L=10 \)

2. \( L=10 \ < \ \text{NEP}=15 \ < \ D=20 \)

3. \( D=20 \ < \ \text{NEP}=30 \ < \ C=40 \)

- **NOTE:** Work-site PD payoffs given by:
  - \( L \text{ (Sucker)}=10 \ < \ D \text{ (MutualD)}=20 \)
  - \( < C \text{ (MutualC)}=40 \ < H \text{ (Temptation)}=60 \)
Market Efficiency Findings

As NEP level **increases** from 0 to 30...

- **higher** average unemployment and vacancy rates are observed; **Known Effect**
- **more** work-site cooperation observed on average among workers and employers who successfully match. **New Effect**

**Note:** These outcomes have potentially **offsetting** effects on market efficiency.
Efficiency Findings...

*Market Efficiency (Utility less NEP Program Costs) Averaged Across Generations 12, 50, and 1000 for three different NEP treatments*
Efficiency Findings...

- NEP=15 yields *highest efficiency*
- NEP=0 yields *lower efficiency* (too much shirking)
- NEP=30 yields *lowest efficiency* (NEP program costs too high)
Multiple Attractors

Two distinct “attractors” observed for each NEP treatment...

- NEP=0 and NEP=15:
  - First Attractor = Latched network supporting *mutual cooperation*;
  - Second Attractor = Latched network supporting *intermittent defection*

- NEP=30:
  - First Attractor = Latched network supporting *mutual cooperation*
  - Second Attractor = Completely disconnected network (*total coordination failure*)
The Following Diagrams Report...

① Two-sided (W-E) network distributions

0 = Stochastic fully connected network

12 = Latched in pairs

24 = Completely disconnected

② Worksite behaviors supported by these network outcomes
Network Distribution for NEP=0 Sampled at End of Generation 12

Network Distribution for ZeroT:12

Network Distance

Number of Runs

- Intermittent Defection
- Mutual Cooperation
Network Distribution for NEP=0
Sampled at End of Generation 50

Network Distribution for ZeroT:50

Network Distance

Number of Runs

- Intermittent Defection
- Mutual Cooperation
Network Distribution for NEP=0
Sampled at End of Generation 1000

Network Distribution for ZeroT:1000

- Intermittant Defection
- Mutual Cooperation
Network Distribution for NEP=15
Sampled at End of Generation 12

Network Distribution for LowT:12

![Network Distribution Chart]

- **Network Distance**
- **Number of Runs**

Legend:
- Intermittent Defection
- Mutual Cooperation

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Network Distribution for NEP=15
Sampled at End of Generation 50

Network Distribution for LowT:50

Network Distance

Number of Runs

- Intermittent Defection
- Mutual Cooperation
Network Distribution for NEP=15
Sampled at End of Generation 1000

Network Distribution for LowT:1000

Network Distance

Number of Runs

0 2 4 6 8 10 12 14 16 18 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Network Distance

- Intermittent Defection
- Mutual Cooperation
Network Distribution for NEP=30
Sampled at End of Generation 12

Network Distribution for HighT: 12

Network Distance vs. Number of Runs

- Intermittent Defection
- Mutual Cooperation
- Coordination Failure
Network Distribution for NEP=30
Sampled at End of Generation 50

Network Distribution for HighT:50

Network Distance

Number of Runs

Mutual Cooperation  Coordination Failure
Network Distribution for NEP=30
Sampled at End of Generation 1000

Network Distribution for HighT:1000

Number of Runs

Mutual Cooperation ▶ Coordination Failure

Network Distance
Summary of Findings

- Changes in NEP *systematically* affect unemployment, vacancy, worksite behaviors, and welfare outcomes
- Worker-employer networks tend to be either *fully latched in pairs* or *completely disconnected*
- But… even fully latched networks support *multiple peaked* behavioral distributions (potential pooling problems)