

Labor Institutions and Market Performance

An Agent-Based Computational Economics Approach

Presenter:

Leigh Tesfatsion

Professor of Economics and Mathematics

Department of Economics

Iowa State University

Ames, Iowa 50011-1070

<http://www.econ.iastate.edu/tesfatsi/>

tesfatsi@iastate.edu

Outline

- ★ What is Agent-Based Computational Economics (ACE)?
- ★ Labor Institutions and Market Performance: What does ACE have to offer?
- ★ Illustration: (M. Pingle/L. Tesfatsion, 2003)
“Evolution of Worker-Employer Networks and Behaviors Under Alternative Non-Employment Benefits”

What is Agent-Based Computational Economics (ACE)?

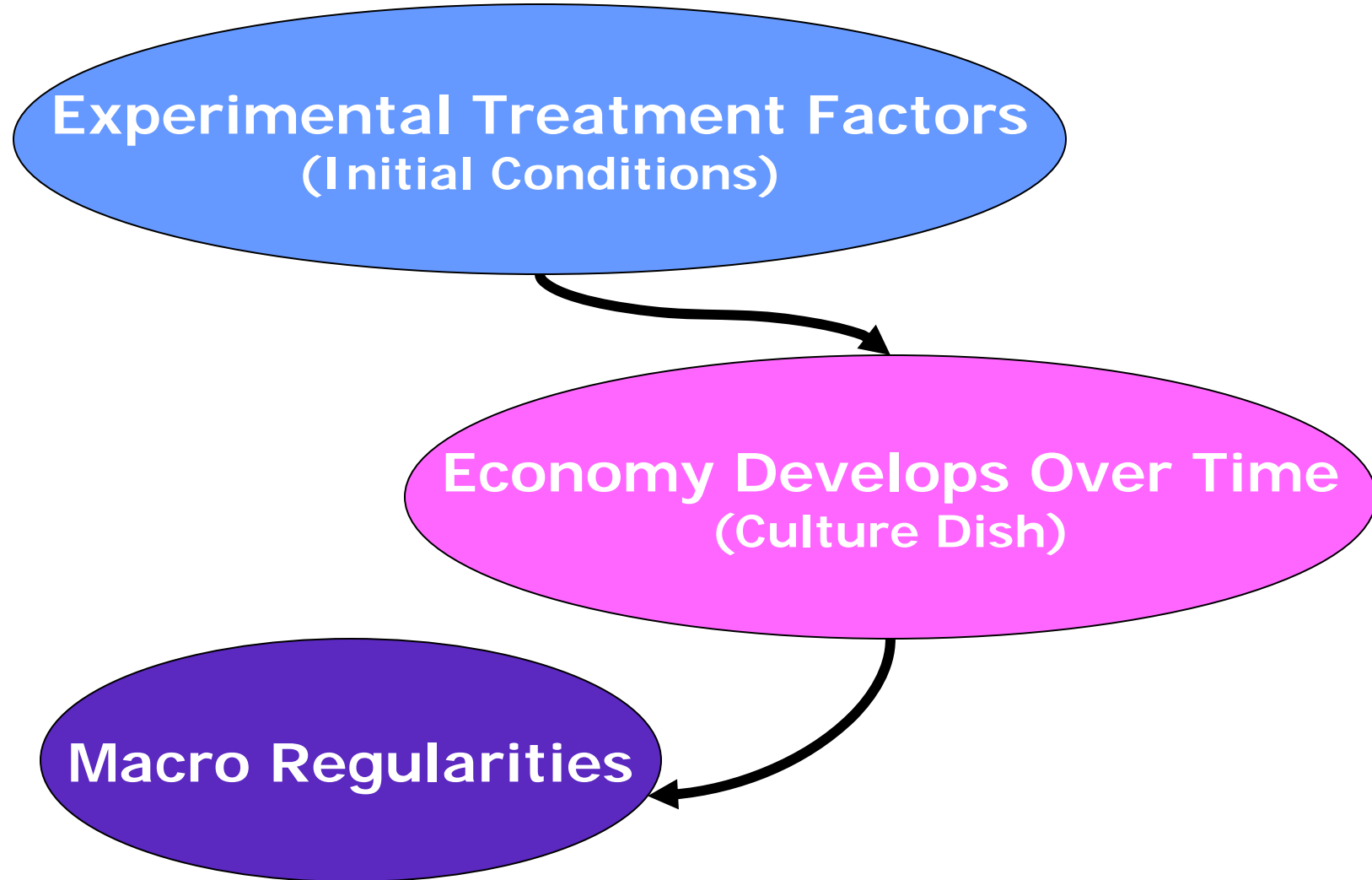
- ◆ **Culture-dish approach** to the study of decentralized market processes
- ◆ **Computational study** of economic processes modeled as dynamic systems of interacting agents
- ◆ **ACE Resource Site:**

www.econ.iastate.edu/tesfatsi/ace.htm

ACE Modeling: Culture Dish Analogy

- ◆ Modeler constructs a **computational economic world** populated by various types of agents (economic, social, biological, & physical)
- ◆ Modeler sets **initial conditions**
- ◆ The world then **develops over time** without further outside intervention
- ◆ World driven solely by **agent interactions**

ACE Modeling: Culture Dish Analogy



Key Characteristics of ACE Models

- ◆ **Agents** are encapsulated software programs capable of
 - *Adaptation* to environmental conditions
 - *Social communication* with other agents
 - *Goal-directed learning*
 - *Autonomy* (self-activation and self-determinism based on private internal processes)
- ◆ Agents can be situated in **realistically rendered problem environments**
- ◆ **Behaviour/interaction patterns can develop endogenously over time**

Current ACE Research Areas

(<http://www.econ.iastate.edu/tesfatsi/aapplic.htm>)

- * Embodied cognition
- * Network formation
- * Evolution of norms
- * Labor Markets
- * Industrial organization
- * Multiple-market modeling
- * Technological change and economic growth
- * Market design
- * Automated markets and software agents
- * Parallel experiments (real and computational agents)
- * **Many others...**

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** (endogeneity, small sample bias problems,...)

Common Approach to UB Modeling

- ◆ Dynamic Programming (DP)
- ◆ Jobs arise and end randomly
- ◆ Unemployed receive UB
- ◆ Workers compare DP value of new job vs. current job or unemployment
- ◆ Each worker maximizes lifetime expected utility
- ◆ **Precise predictions, but empirical support unclear.**

Potential Contributions of an ACE Approach to Labor Research

www.econ.iastate.edu/tesfatsi/alabor.htm

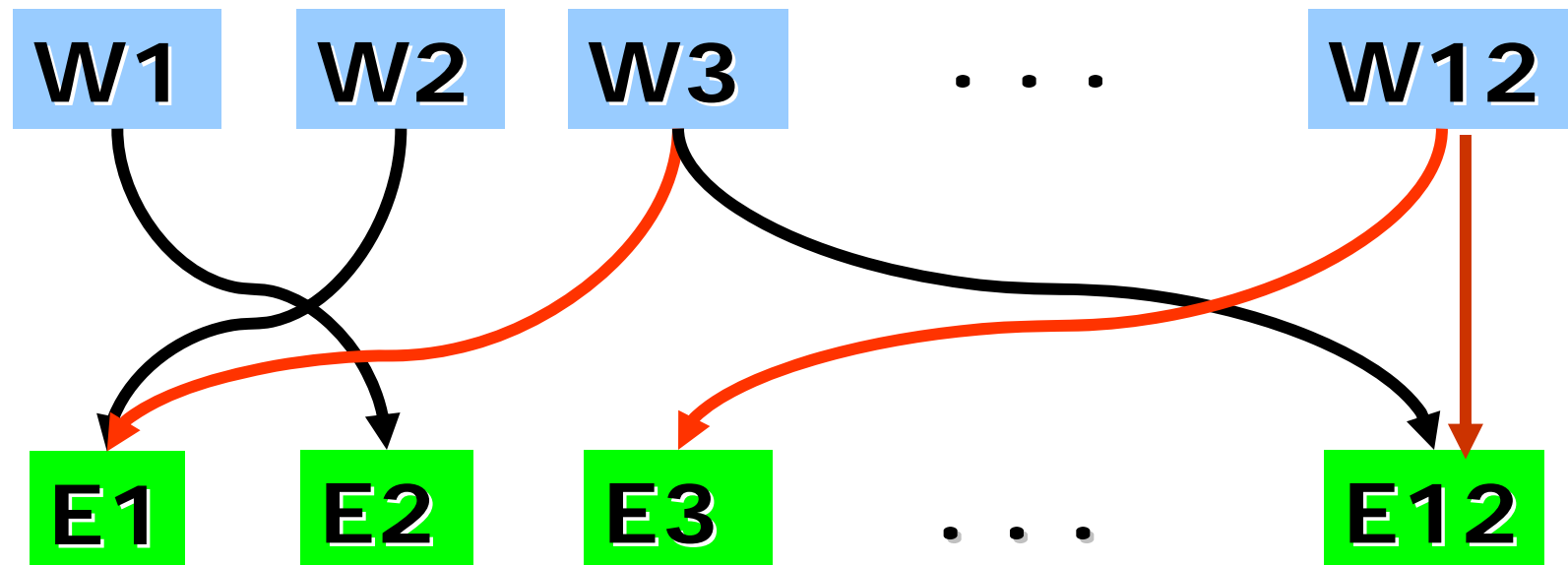
- ◆ Employers/workers can be modeled as **autonomous interacting agents**
- ◆ Matching process can be preferential (**endogenous hires, quits, and firings**)
- ◆ **Learning** can be calibrated to data (empirical, human-subject experimental)
- ◆ **Evolution** of behaviors/interaction networks
- ◆ Relatively easy to incorporate **realistically detailed structural features** (market protocols, policy rules, program eligibility requirements,...)

An ACE Study of “Non-Employment Payments” (NEP)

“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*, 2003, Edward-Elgar volume, edited by A. Nagurney
- ◆ Pre-print available at <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**.

ACE Labor Market Framework...

- ❁ 12 workers with same **observable** attributes in initial period $T=0$
- ❁ 12 employers with same **observable** attributes in initial period $T=0$
- ❁ 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
- ❁ Worksite strategies in initial period $T=0$ are **random and private info**

Each worker and employer has...

- ❁ ***Publicly available information*** about various market/policy protocols (e.g., NEP 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 non-employment payments program

Methods for retrieving stored Worker data

Private Access Only:

// **Private Methods**

Method for calculating my expected utility assessments

Method for calculating my actual utility outcomes

Method for updating my worksite strategy (**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 non-employment payments program

Methods for retrieving stored 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 worksite strategy (**learning**)

// **Private Data**

Data about myself (my history, profit fct., current wealth...)

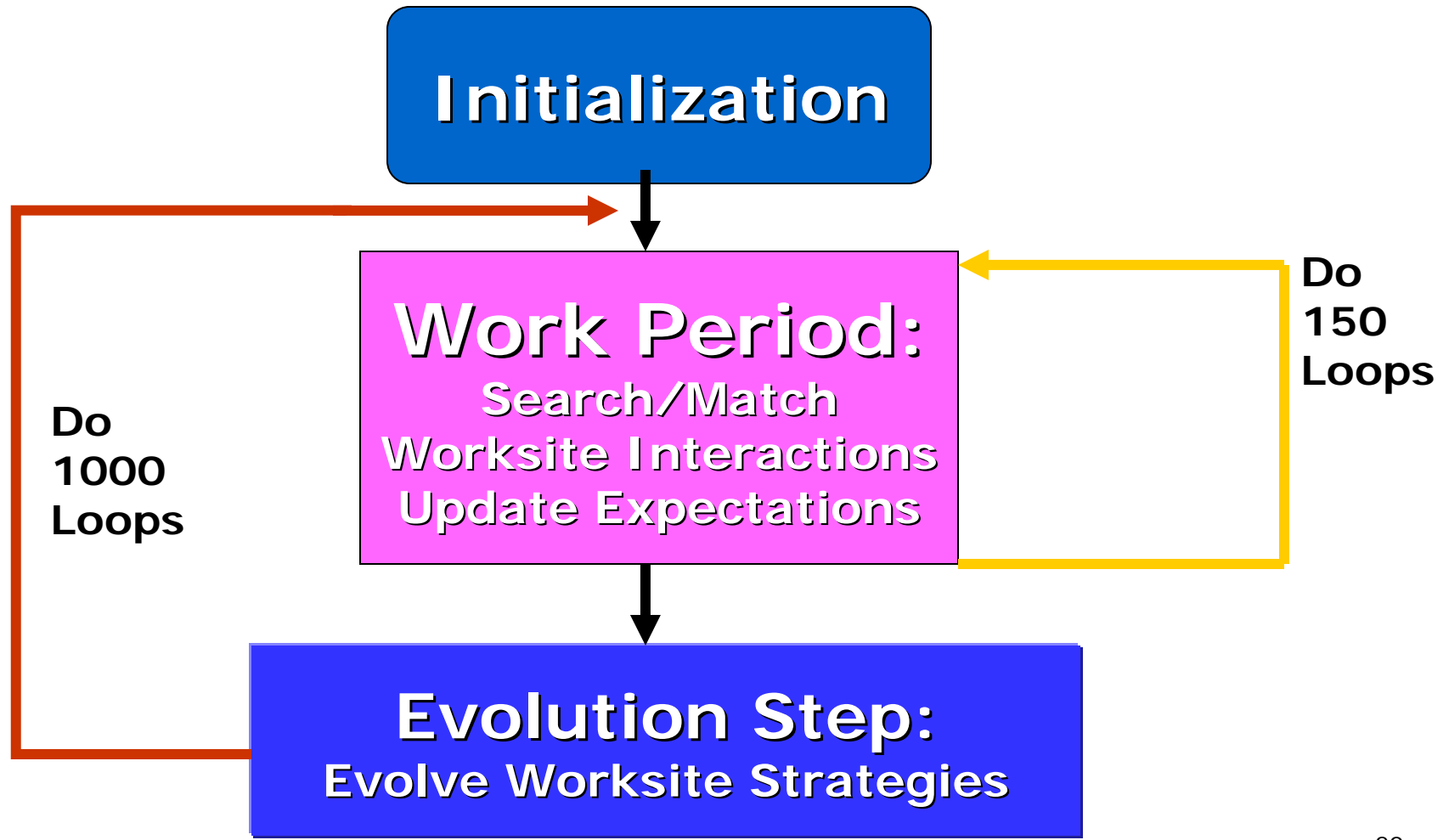
Data recorded about external world (worker behaviors,...)

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 worksite interaction (**PD game - cooperate or defect**)
- ❁ After 150 work periods, each worker and employer updates its worksite IPD strategy

Flow of Activities in the ACE Labor Market



Worksite Interactions as Prisoner's Dilemma (PD) Games

		Employer	
		C	D
Worker	C	(40,40)	(10,60)
	D	(60,10)	(20,20)

D = Defect (Shirk); C = Cooperate (Fulfill Obligations) 21

Key Issues Addressed

How do **changes** in the level of the 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 NEP program costs, unemployment/vacancy rates,...)
- ✦ **Market Power** (distribution of total net 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:

$$L \text{ (Sucker)} = 10 < D \text{ (Mutual-D)} = 20 \\ < C \text{ (Mutual-C)} = 40 < H \text{ (Temptation)} = 60$$

Market Efficiency Findings

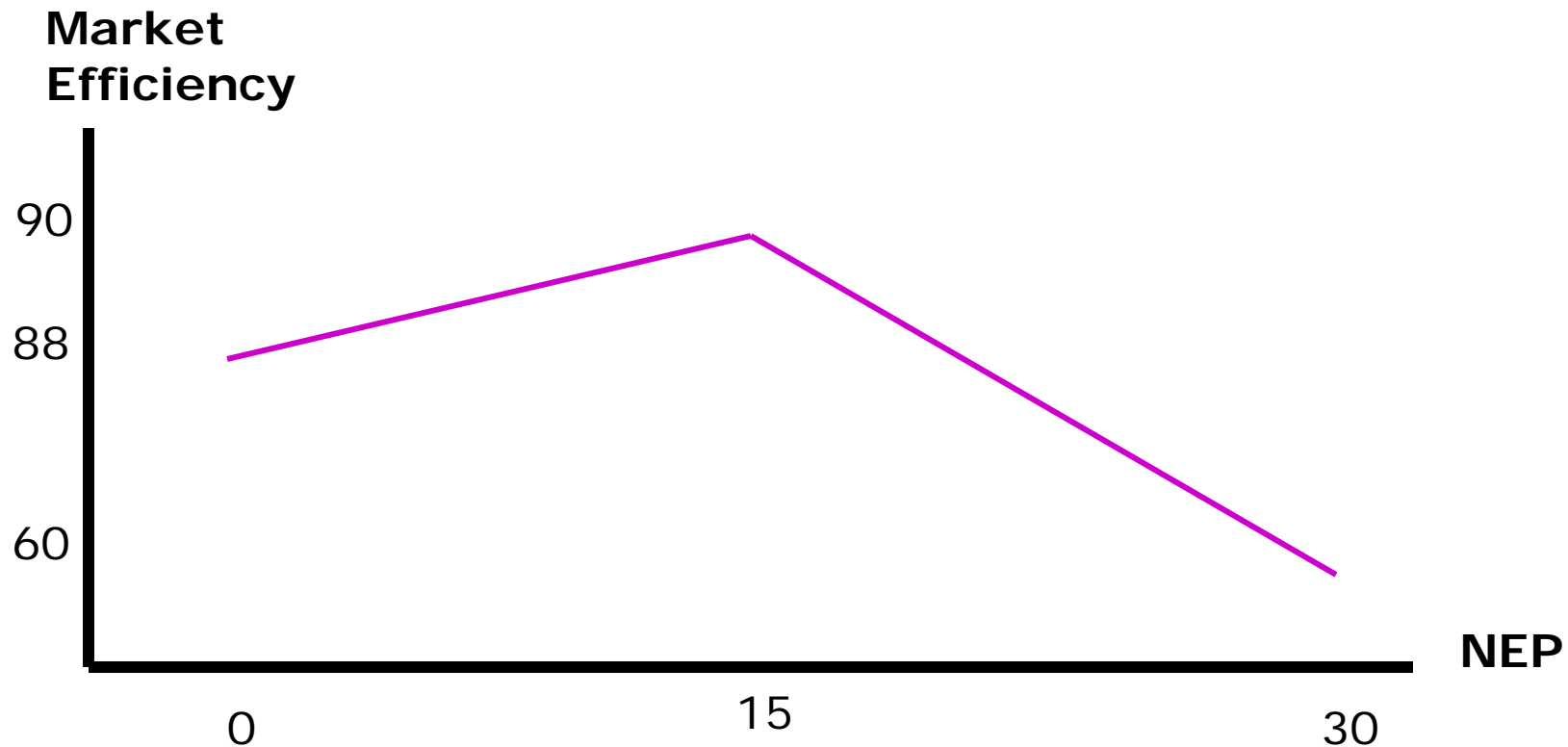
As NEP level **increases** from 0 to 30...

- ⊗ *higher* average unemployment and vacancy rates are observed; ← **KNOWN EFFECT**
- ⊗ *more* work-site cooperation observed on average among workers & employers who match. ← **NEW EX POST 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*
(UB program costs too high)

Multiple Attractors

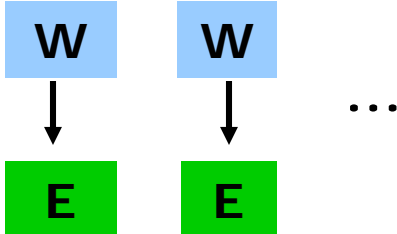
- * Two distinct “attractors” observed for each NEP treatment...
 - NEP=0 and NEP=15:
 - ◆ *First Attractor* = Latched network supporting *mutual cooperation*;
 - ◆ *Second Attractor* = Latched network supporting *intermittent defection*
 - NEP=30:
 - ◆ *First Attractor* = Latched network supporting *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



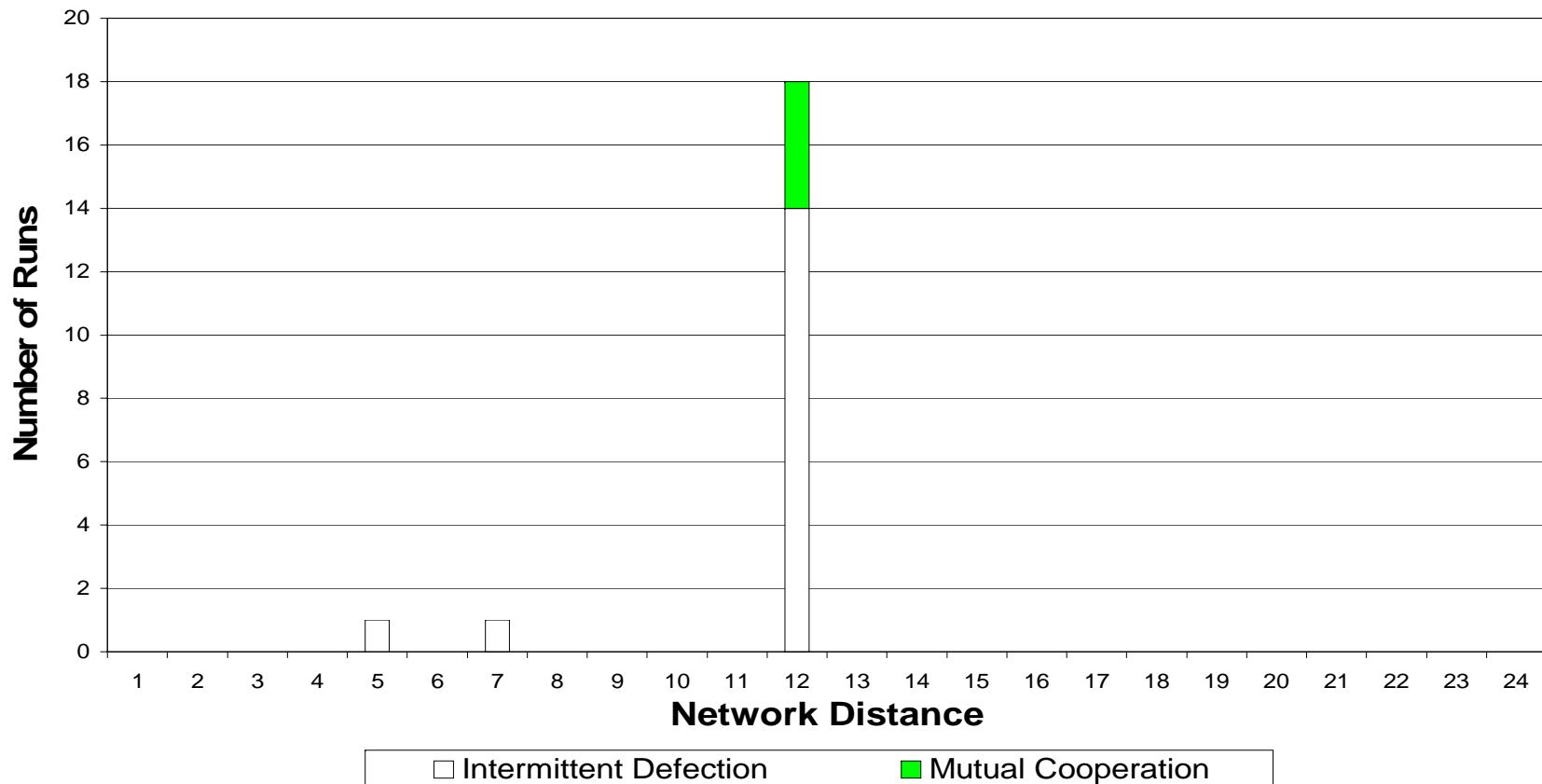
The diagram illustrates a latched pair of nodes. It consists of two blue rectangular boxes, each containing the letter 'W', arranged horizontally. Below each 'W' box is a black arrow pointing downwards to a green rectangular box containing the letter 'E'. To the right of the second 'E' box is an ellipsis (...).

24=Completely disconnected

② Worksite behaviors supported by these network outcomes

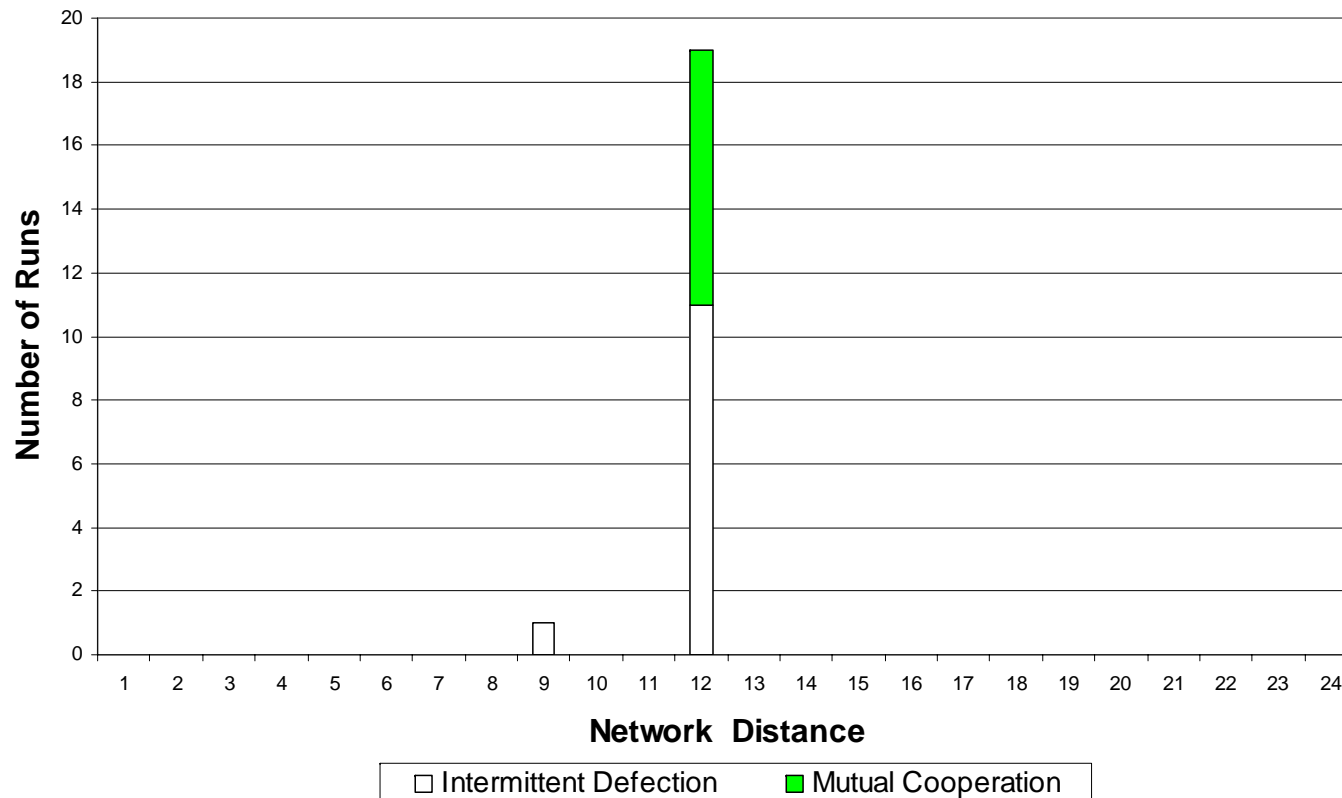
Network Distribution for NEP=0 Sampled at End of Generation 12

Network Distribution for ZeroT:12



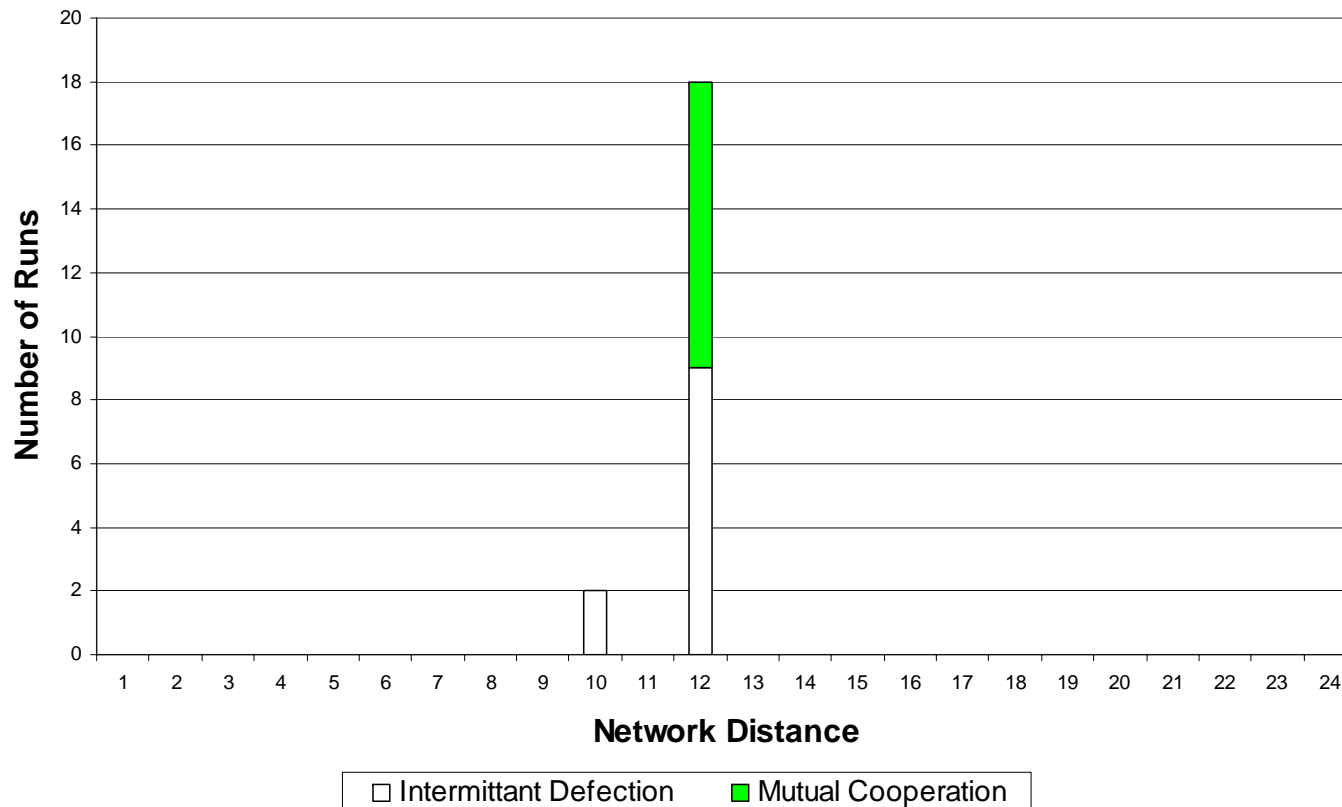
Network Distribution for NEP=0 Sampled at End of Generation 50

Network Distribution for ZeroT:50



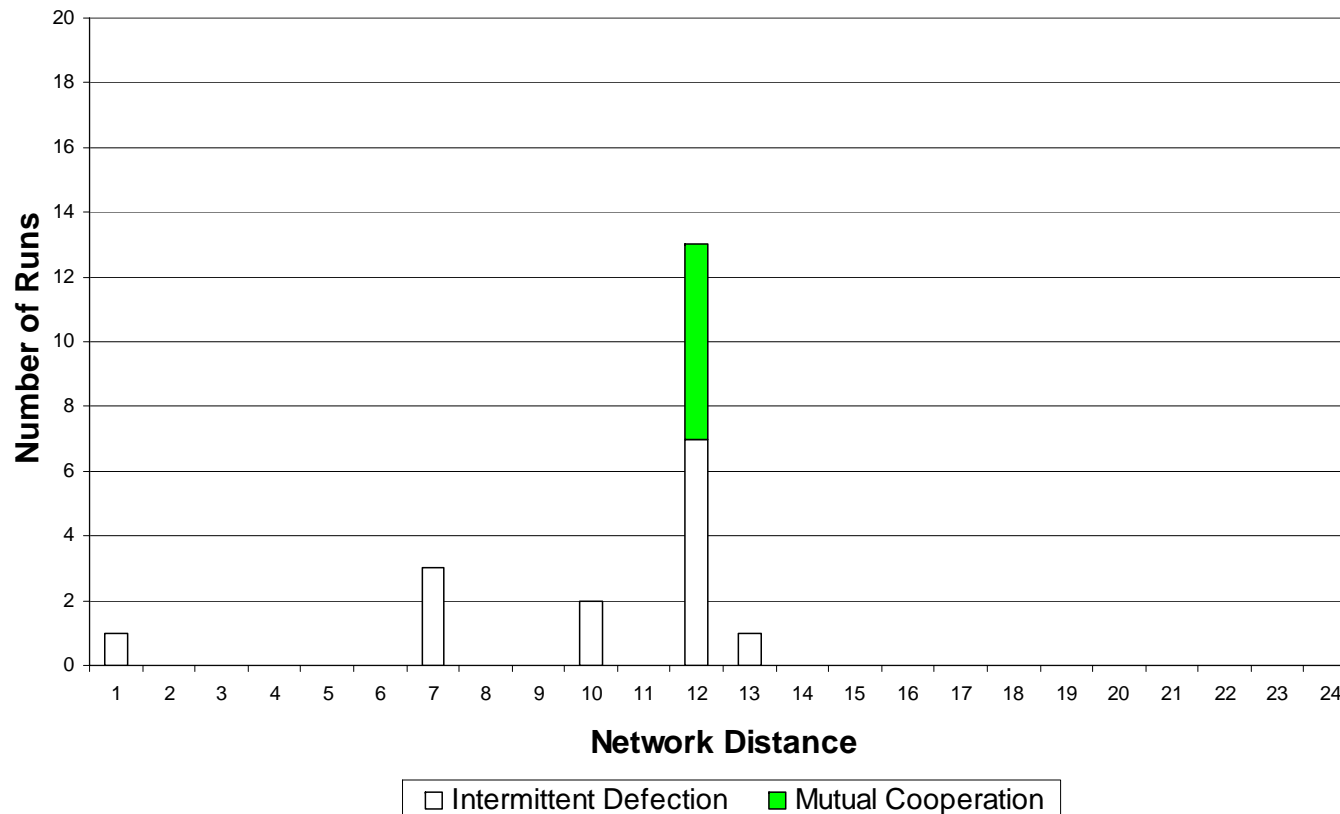
Network Distribution for NEP=0 Sampled at End of Generation 1000

Network Distribution for ZeroT:1000



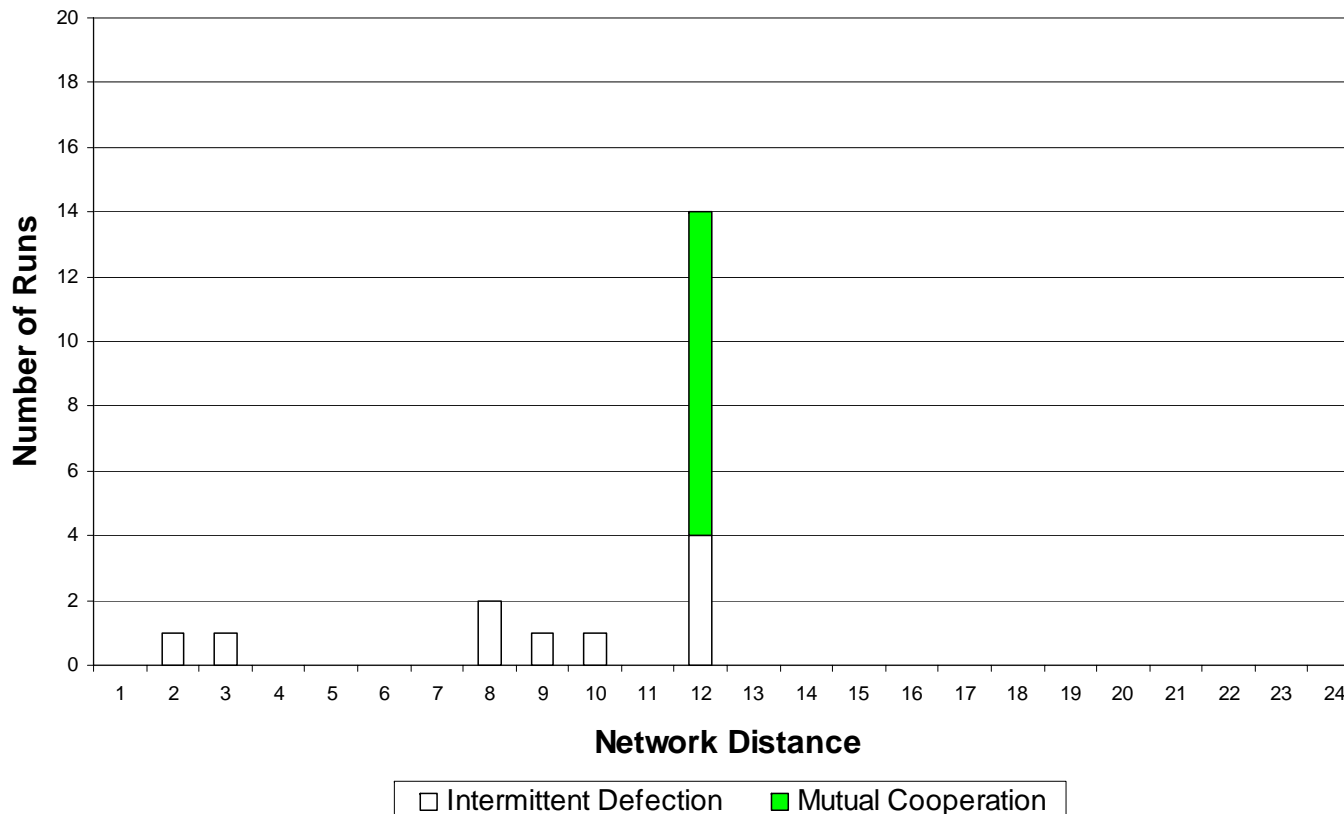
Network Distribution for NEP=15 Sampled at End of Generation 12

Network Distribution for LowT:12



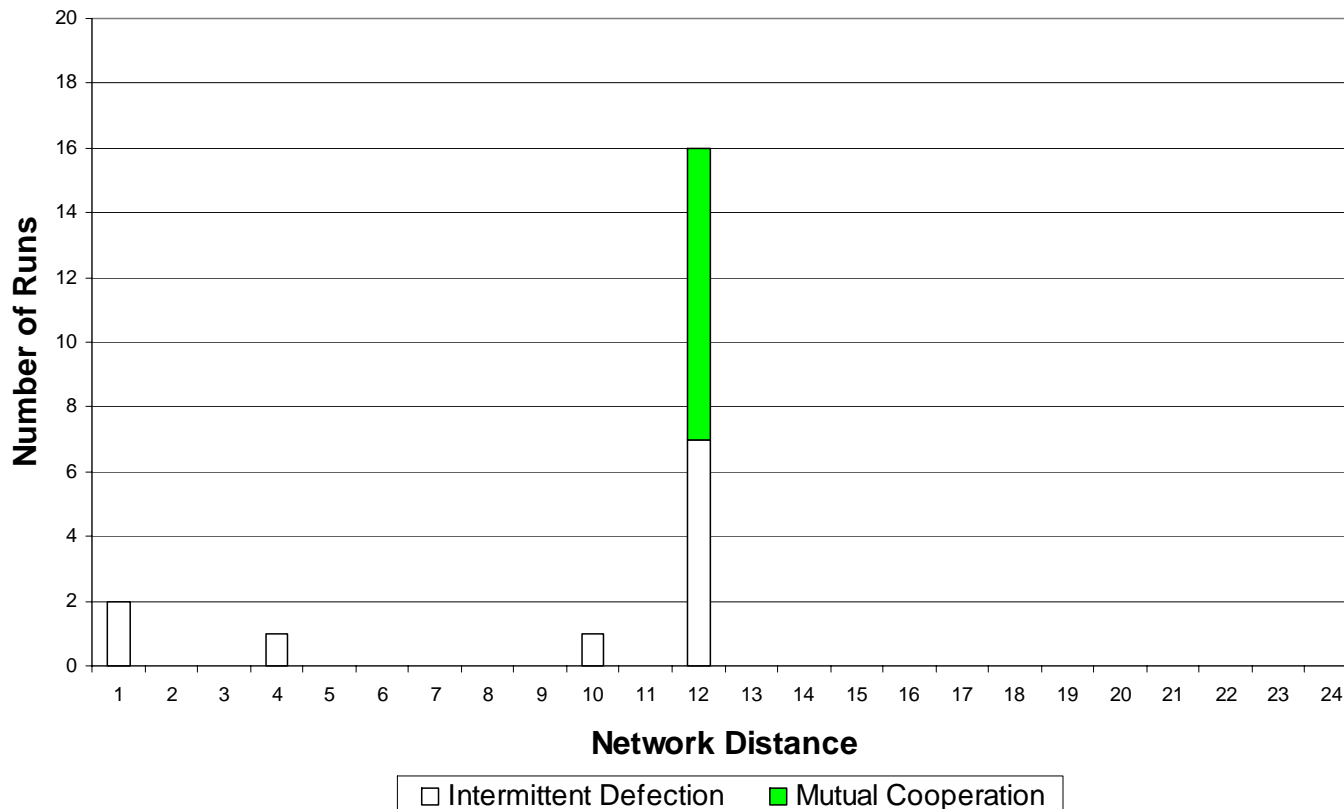
Network Distribution for NEP=15 Sampled at End of Generation 50

Network Distribution for LowT:50



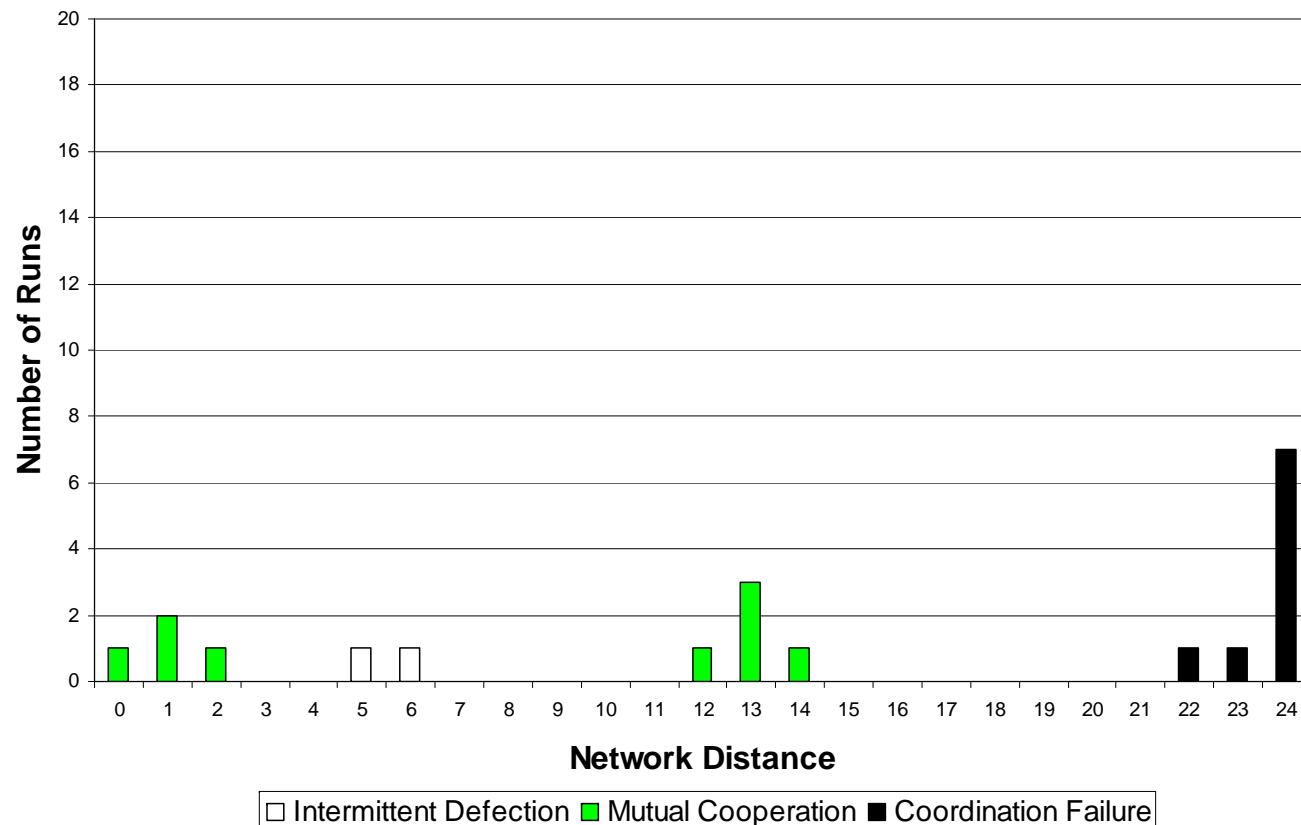
Network Distribution for NEP=15 Sampled at End of Generation 1000

Network Distribution for LowT:1000



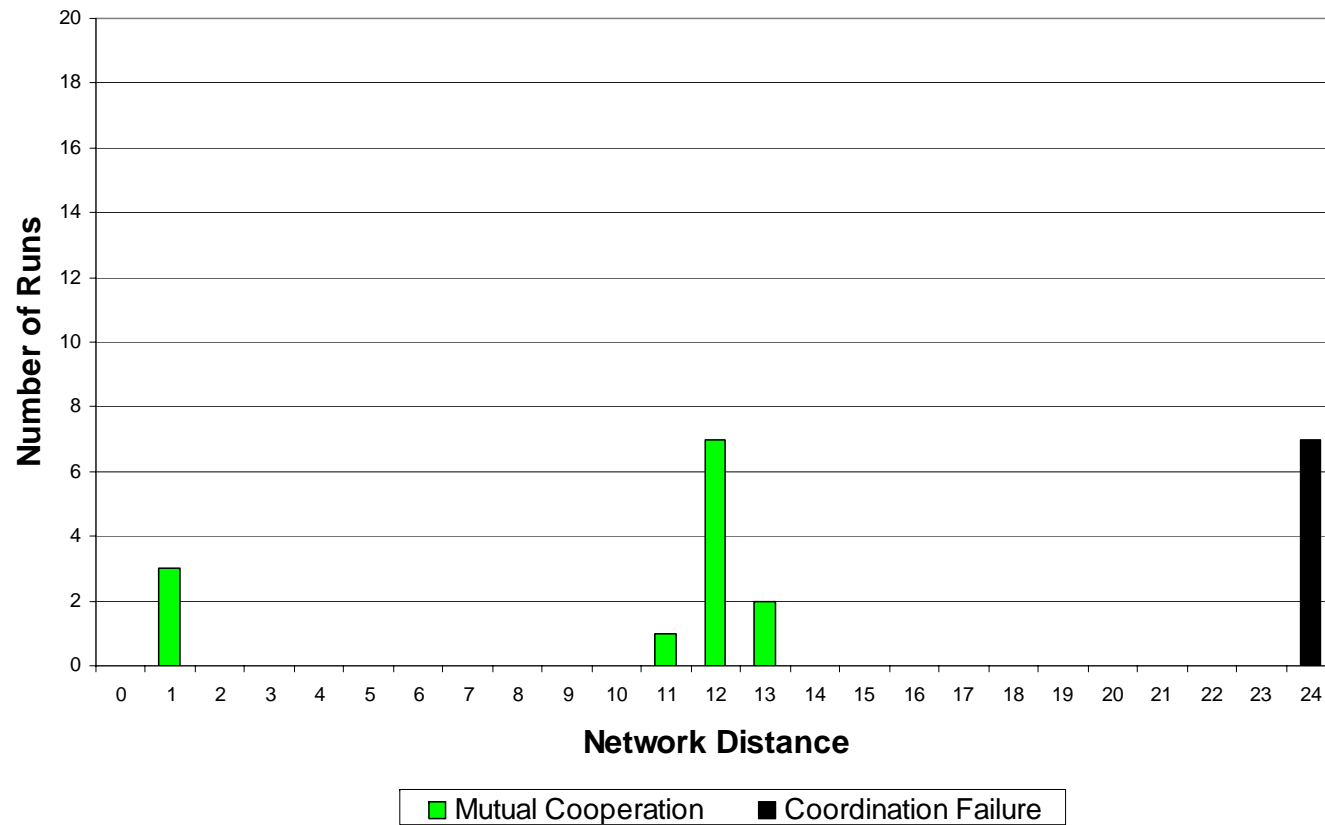
Network Distribution for NEP=30 Sampled at End of Generation 12

Network Distribution for HighT:12



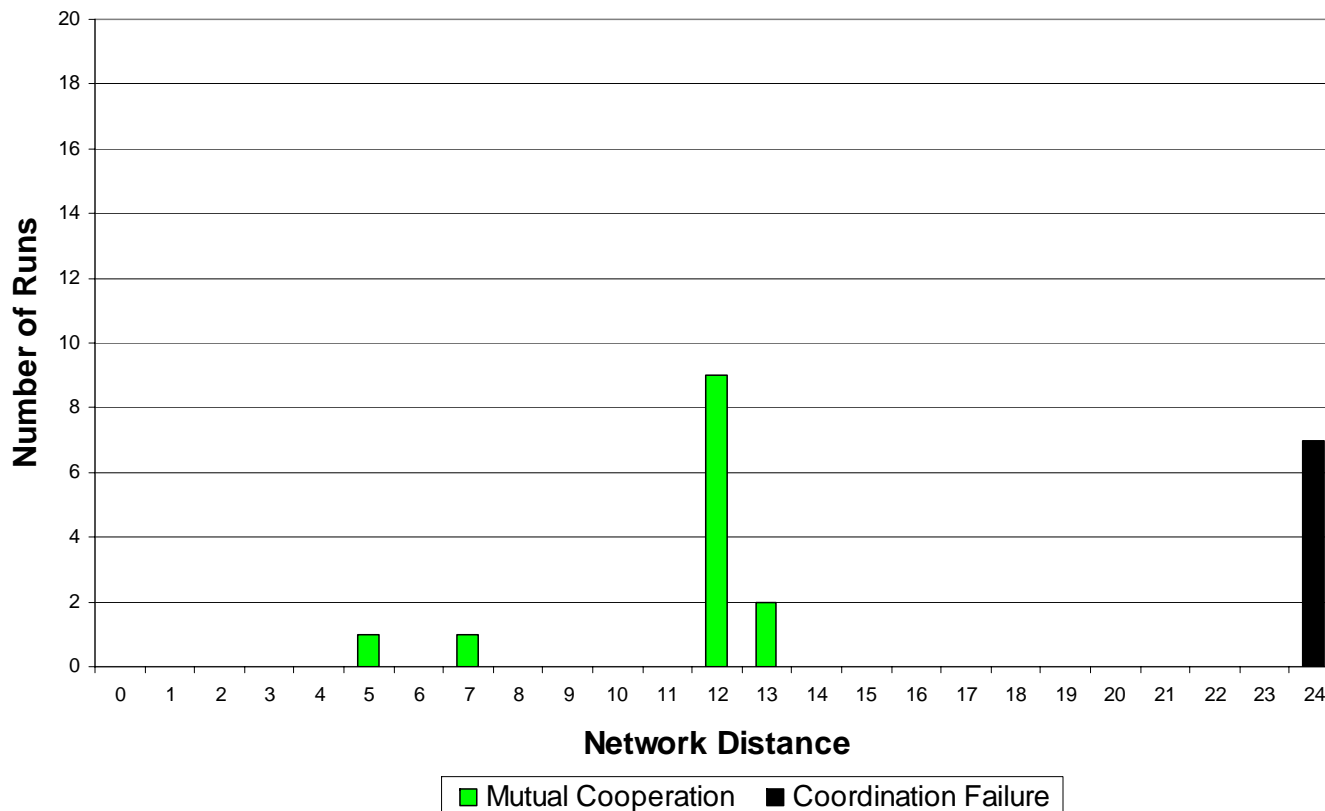
Network Distribution for NEP=30 Sampled at End of Generation 50

Network Distribution for HighT:50



Network Distribution for NEP=30 Sampled at End of Generation 1000

Network Distribution for HighT:1000



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)