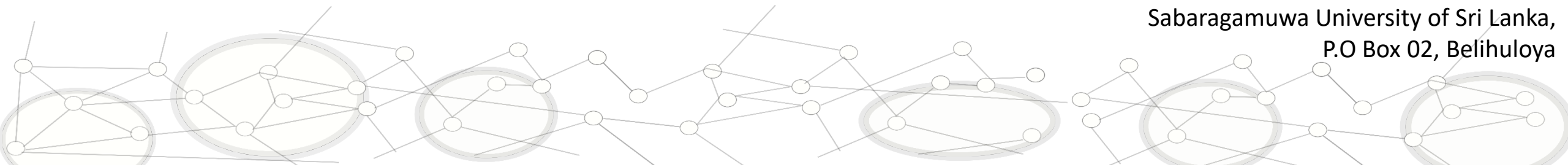# Agent-Based Simulation Modeling Approach for Tenure Security Dynamics

By
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Overview

- Introduction
- Problem and hypothesis
- Objectives
- Methodology
- Results and discussion
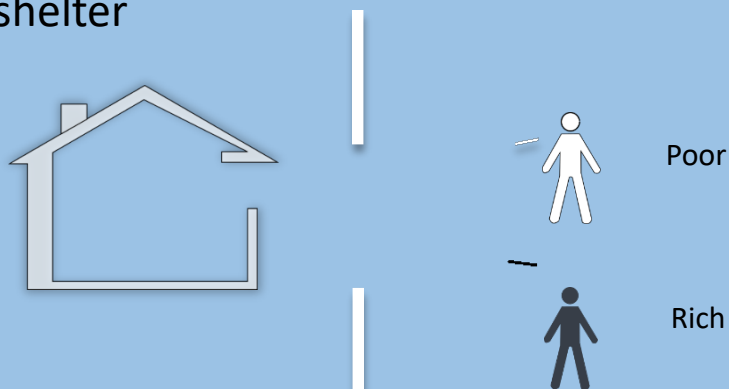- Conclusion and recommendations

Introduction

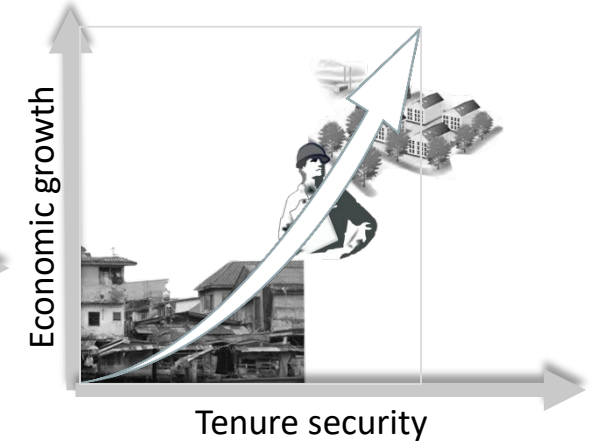- What is the link between LADM and LTS?

Introduction
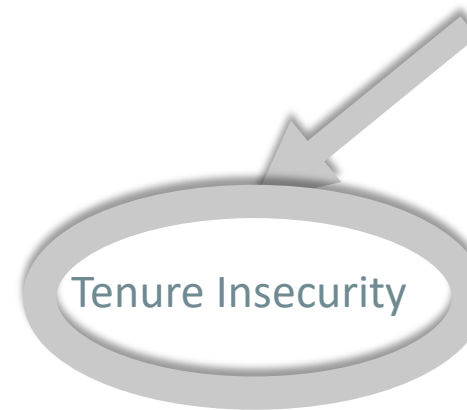
Human-land relations (dialect) governed by the market forces and resulting social relations marginalize the urban poor from accessing shelter

Poor

Rich
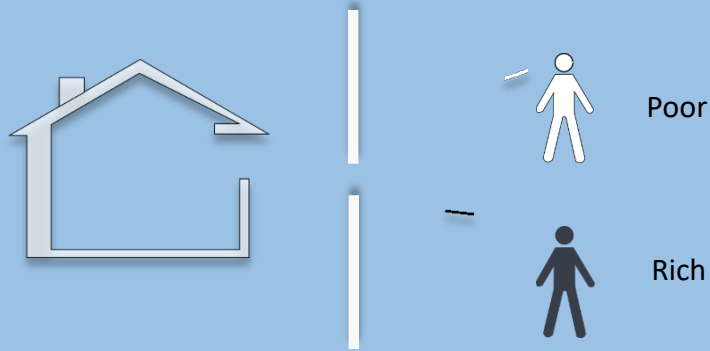
This is causing for formation of informal land market and other informal means to access shelter

Poor

Rich

- Urban Sprawls
  - Slumps
  - Favelas
  - Squatters
  - Gecekondus
  - Etc

Tenure Insecurity

Economic growth

Tenure security

Investment

Title registration

Right recognision

Land market

Tenure Security

Total – Element Relations

Tenure category

Eg: Cebu city in Philippines (Thirkell)

Cognition
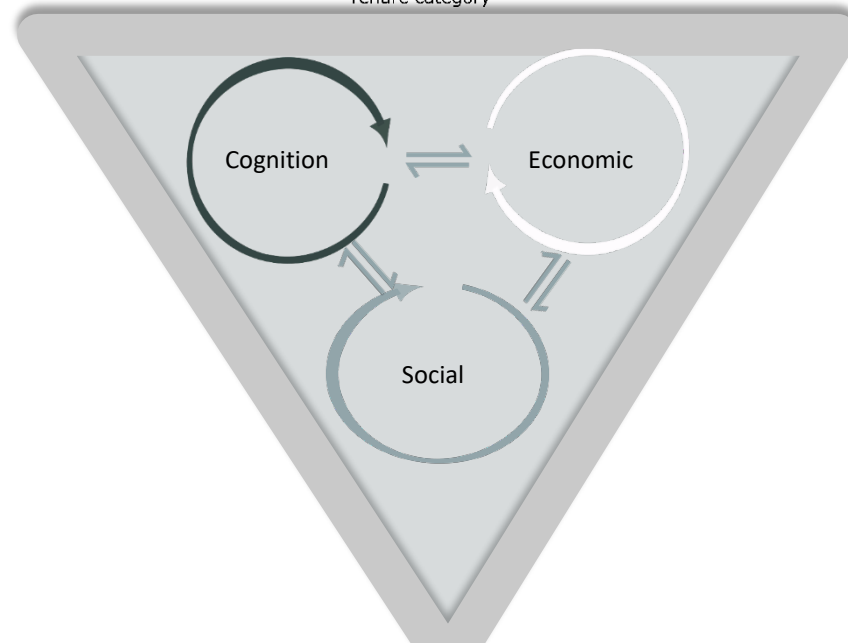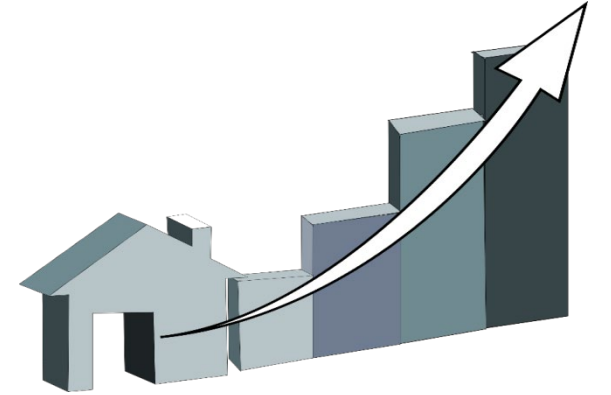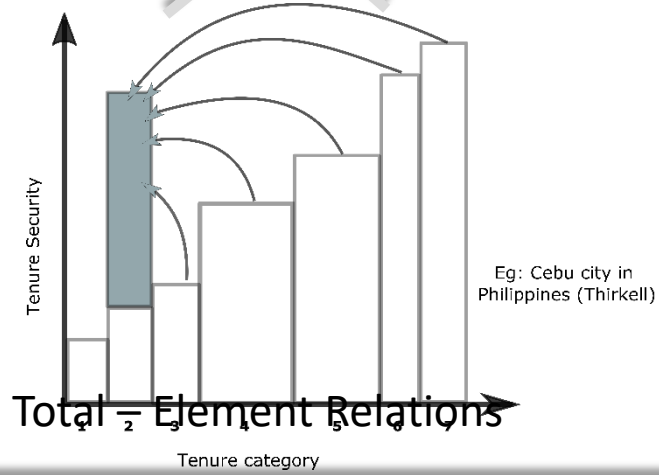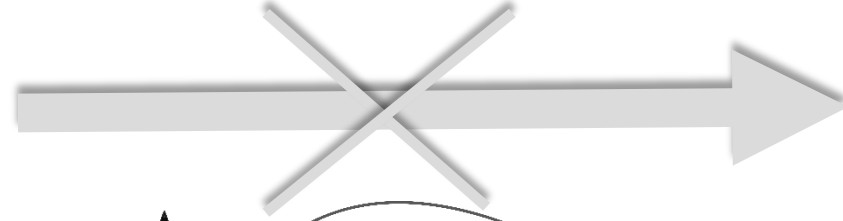
Economic

Social

Problems :

- General econometric models of utility of land tenure have largely overlooked the aspects that underpin the perceptual and social components.

Hypothesis:

- Utility of land tenure that derived from general econometric models which overlook cognitive and social components not suitable for deriving effective land policies

Objective

Objective: Identify the role of perceptual and social components of land tenure system in defining the utility of land tenure

Objective

Hypothesis

Literature Framework

ABSM

Test the hypothesis

Conclusion

LTS , Cognitive Systems and ABSMs

- LTS: Perceived uncertainly associated with returning the expected benefits from land resources
  - Modeling the LTS
    - Econometric modeling :Economic parameters
    - Modeling the cognitive system: Rules of behavior of cognitive structures
    - Modeling the social Feedback structures

Defining the utility of land tenure: Secure Land Tenure Elements (SLTE)

Element	Main Economic Function	Objective Uncertainty Depends	Subjective Uncertainty Depends	Effect on Investment	Effect on Land Value
01- Duration of Rights	Ensure rights are long enough to reap the benefit from an investment	Past behaviour of the formal organizational setup in evicting people and resources allocated for the purpose	Dynamics of the Perception on Community Strength	Yes	Yes
02- Boundary Definitions by institutions	Establish boundaries to eliminate the externalities	Dynamics in land policy objectives and resources allocated	Ability of informal organizations to define boundaries	Yes	Yes
03- Subject of Rights	Define the attributes of the property regime to eliminate the externalities	Element 02, Element 04, Element 05	Element 02, Element 04	Yes	Yes
04- Properties of Enforcing Organizational Setup	Assurance of punishments against violation of boundaries	Performance of formal organizational setup to monitor and punishment	Performance of informal organizational setup to monitor and punishment	Yes	No
05- Evolution of the institutional setup	Change the institutional setup to new cost-benefit structure	Degree of awareness of the formal organizational setup to changes and wiliness to change	No practical relevance	Yes	No

Deinniger 2009, Piyasena & Eckardt 2013

utility of land tenure with respect to above SLATE can be defined as;

$$(C_I + \pi S_I)y(k)T + (C_V + \pi S_V)P_sT$$

Where;

$C_I = 1 - O_I^{e1}\phi_{e1} - O_I^{e2}\phi_{e2} - O_I^{e4}\phi_{e4} - O_I^{e5}\phi_{e5}$

$C_v = 1 - O_v^{e1}\phi_{e1} - O_v^{e2}\phi_{e2}$

$S_I = S_I^{e1} + S_I^{e2} + S_I^{e4}$

$S_v = S_v^{e1} + S_v^{e2}$

$S_I^{ei} = \dfrac{Income\ Reduction - Subjective\ Uncertainty\ i^{th}\ Element}{Total\ Income}$

$S_o^{ei} = \dfrac{Income\ Reduction - Objective\ Uncertainty\ i^{th}\ Element}{Total\ Income}$

$S_V^{ei} = \dfrac{Value\ Reduction - Subjective\ Uncertainty\ i^{th}\ Element}{Land\ Value}$

$O_V^{ei} = \dfrac{Value\ Reduction\ Objective\ Uncertainty\ of\ i^{th}\ Element}{Land\ Value}$

$Where, i = 1,2,...5$, $\pi = \psi_{e1} = \psi_{e2} = \psi_{e4}$, $\psi_{ei} - Perceived\ subjective\ uncertainty\ associated\ with\ i^{th}\ element, i = 1,2,...,5$, $T - Total\ amount\ of\ land$,

$P_s = Price\ of\ the\ squartting\ land$, $\phi_{ei} - Perceived\ objective\ uncertainty\ associated\ with\ i^{th}\ element, i = 1,2,...,5$

Piyasena and Eckardt (2013),

- **Utility of land tenure under uncertainty (Jimenez, 1984, Piyasena, 2015)**

- Evicted
- Not-evicted

Maximize: Current consumption and next period wealth
Constrain: Income, initial wealth, and barrowed money use for investment and consumption

$$V^s = \pi v^e + (1 - \pi)v^n \qquad \text{.................Eq-A}$$

$$v^e \equiv \left[\left(\frac{a_1 + a_2 p_s T - k_n T - A}{(T+1)}\right)^{(1-\rho)} \Big/ (1-\rho)\right].(T+1) + T(p_f - p_s) - R.a_2.p_s T$$

$$v^n \equiv \left[\frac{\left(\frac{a_1 + a_2 p_s T}{T + 1 / piel^{1/\rho}}\right)^{(1-\rho)}}{(1-\rho)}\right]\left[T.piel + \frac{1}{\left(piel^{1/\rho}\right)^{(1-\rho)}}\right] + p_s.T.pieV - R.a_2.p_s T$$

$$piel = (1 - \pi B_i)$$
$$pieV = (1 - \pi B_v)$$
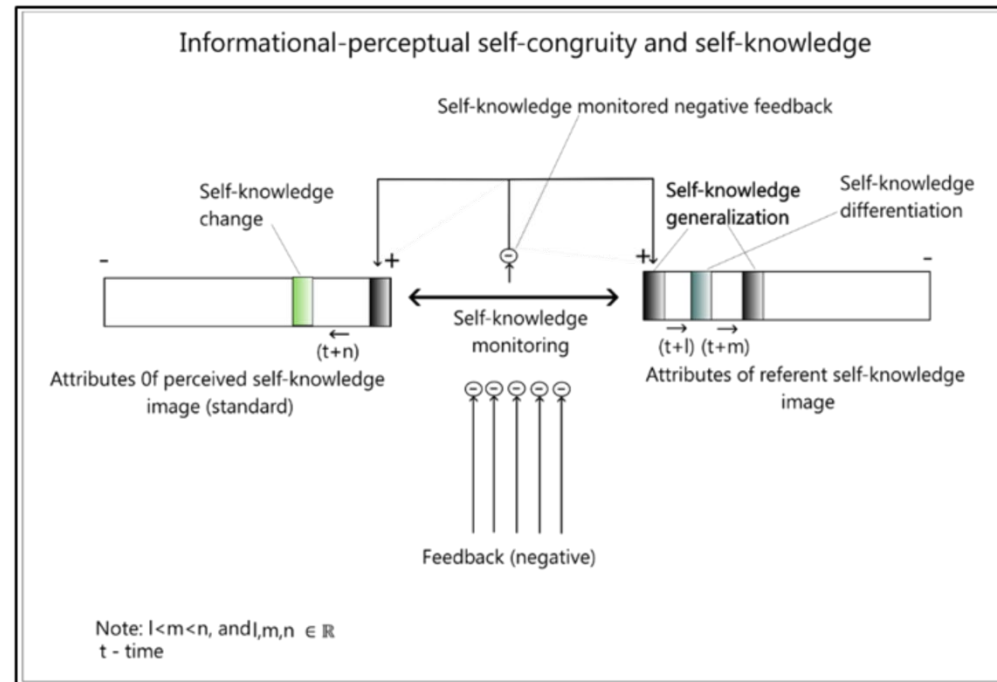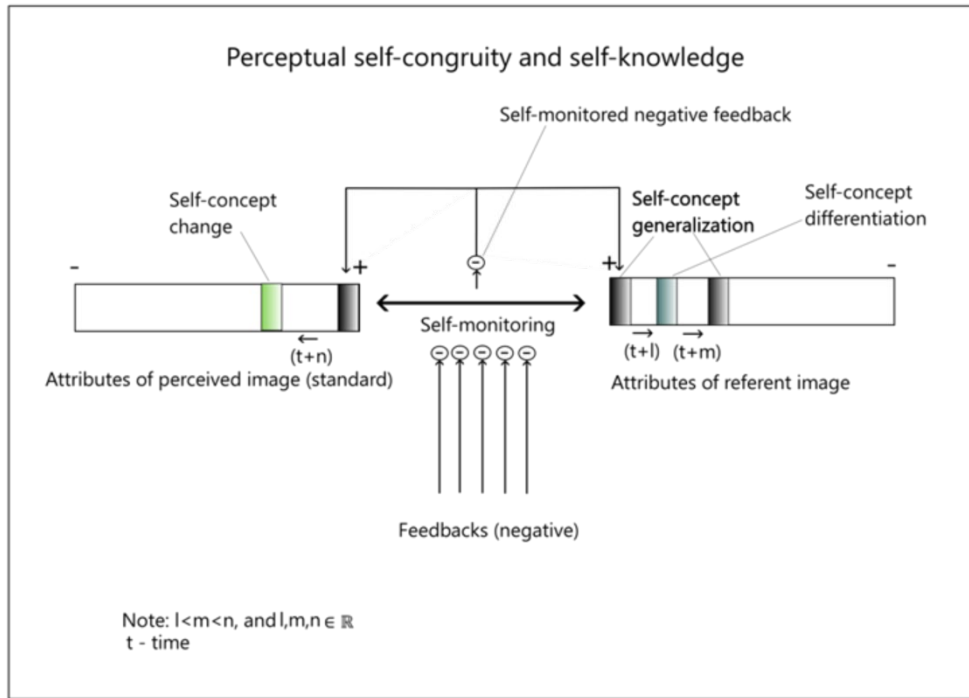$$a_1 = W_0 + I$$
$$a_2 = s(1 - \pi)$$
$$R = (1 + r)$$
$$B_i = I_{e3} + I_{e4} + I_{e5}$$
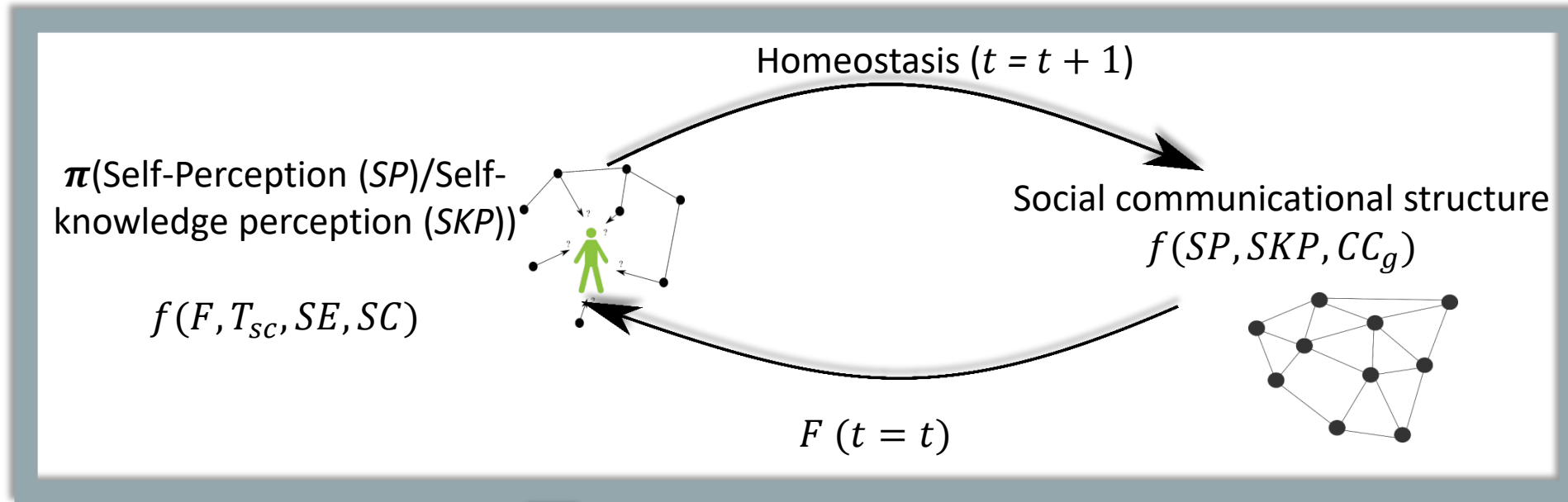$$B_v = V_{e3} + V_{e5}$$

V^s - Marginal utility of land tenure
π − Perceuved uncertainty that result SLATE
W_0 − Initial wealth
I − Income
S − Credit ration
r − Interest rate
I_{e3} − Percentage of income reduction due to uncertainty in element 3
I_{e4} − Percentage of income reduction due to uncertainty in element 4
I_{e5} − Percentage of income reduction due to uncertainty in element 5
v_{e3} − Percentage of land value reduction due to uncertainty in element 3
v_{e5} − Percentage of land value reduction due to uncertainty in element 5
p_f − Price of formal land
p_s − Price of informal land
T − Total amount of lands
k_n − Capital to land ratio (not evicted)
ρ − Risk aversion factor

- **Self-Concept and Perceptual &self-knowledge perceptual self-congruity process**

Creation of Self-concept on Land Tenure security

Homeostasis $(t = t + 1)$

π(Self-Perception (SP)/Self-knowledge perception (SKP))

$f(F, T_{sc}, SE, SC)$

Social communicational structure
$f(SP, SKP, CC_g)$

$F\ (t = t)$

π

V^S

$$U(q)_c = \max_{r=1}^{n_q} \left\{ \; (v_{q(r)}^p \cdot s_{q(r)}^p - v^r(q)_{j(i)} s^r(q)_{j(i)}) SC.SE \; + \; (v_{q(r)}^{kp} \cdot s_{q(r)}^{kp} - v(q)_{j(i)}^{kr} s(q)_{j(i)}^{kr}) SC.SE \; - \; f(d_{j(i)q(r)}) \; \right\}$$

SP- Self-perception
SKP − Self-knowledge perception
T_{sc} - Threshold values for self-concept dynamics
SE − Self-esteem effect
SC − Self-consistency effect
CC_g - Cost of connecting in geographical space
F - Feedback

TUUD Agent base simulation

- **Objective: Indentify the impact of change of property of agent on the land tenure system**
- **Agent types**

  - Impactors

  - 8 Agents within the community 01

  - Agents within community 02, 03, and 04

LAND TENURE CONTINUUM

1. Pavement dweller
2. Squatter tenant
3. Squatter 'owner' –un-regularised
4. Tenant in unauthorized subdivision
5. Squatter'owner' –regularised subdivision
6. Owner-unauthorized subdivision
7. Legal owner-unauthorized construction
8. Tenant with contract
9. Lease-holder
10. Free-holder

ECONOMETRIC PROPERTIES

- Income reductions associated with SLATE
- Land value reductions associated with SLATE
- Total amount of lands
- Capital to land ratio
- Income
- Consumption
- Initial wealth
- Cost of squatting
- Price of lands (formal and informal)

SOCIOMETRIC PROPERTIES

- Properties associated with self-images
- Properties associated with learning rate
- Geographical location

Agent Type 01

Agent Type 02

Agent Type 03

Agent Type n

- **Econometric parameters of agents**

Econometric parameter	Possible range
Total amount of land	5 -100 (m²)
Capital to land ratio	7-10 (US$/m²)
Income	360-2160 (US$/annum)
Consumption	250 -1500 (US$/annum)
Initial wealth	700 -5000 (US$)
Cost of squatting	0 -1000 (US$)
Price of land (formal and informal)	700 -7000 (US$/m²)

- **Sociometric properties**
  - Scaling the valance of self-perception images (perceived and reference)

Self-perception image	Possible valance range
Strong +ve	+4 to +5
Moderate +ve	0 to +3
Moderate -ve	0 to -3
Strong -ve	-4 to -5

- **Sociometric properties**
  - **Scaling the valance of self-knowledge images (perceived and reference)**

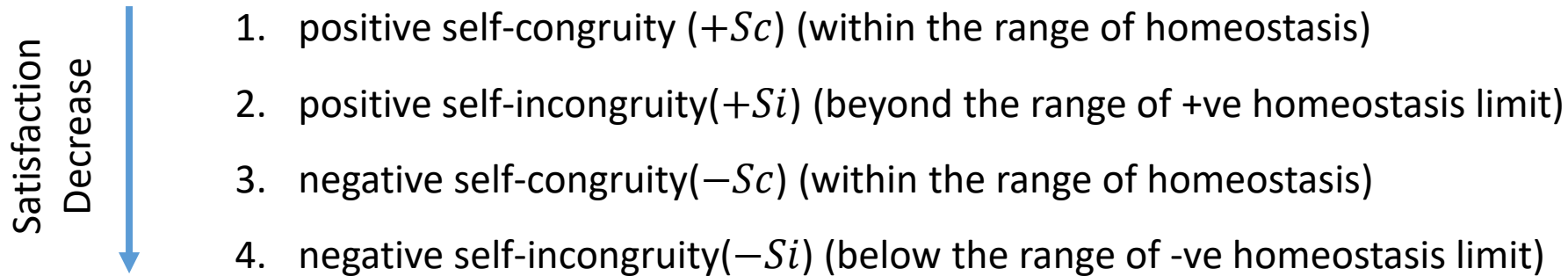| Self-knowledge image	Possible valance range
Strong	+7 to +10
Moderate	+4 to +6
Weak	1 to +3

  - **Scaling the strength of self-knowledge images (perceived and reference)**

Agent type	Degree of authoritativeness (i.e. strength of self-knowledge image)
Impactors	7-10
Leaders within a community	4 -6
Normaltenants	1-3

- **Sociometric properties**
  - Determine the factors for self-esteem and self-consistency

Satisfaction Decrease

1. positive self-congruity ($+Sc$) (within the range of homeostasis)
2. positive self-incongruity($+Si$) (beyond the range of +ve homeostasis limit)
3. negative self-congruity($-Sc$) (within the range of homeostasis)
4. negative self-incongruity($-Si$) (below the range of -ve homeostasis limit)

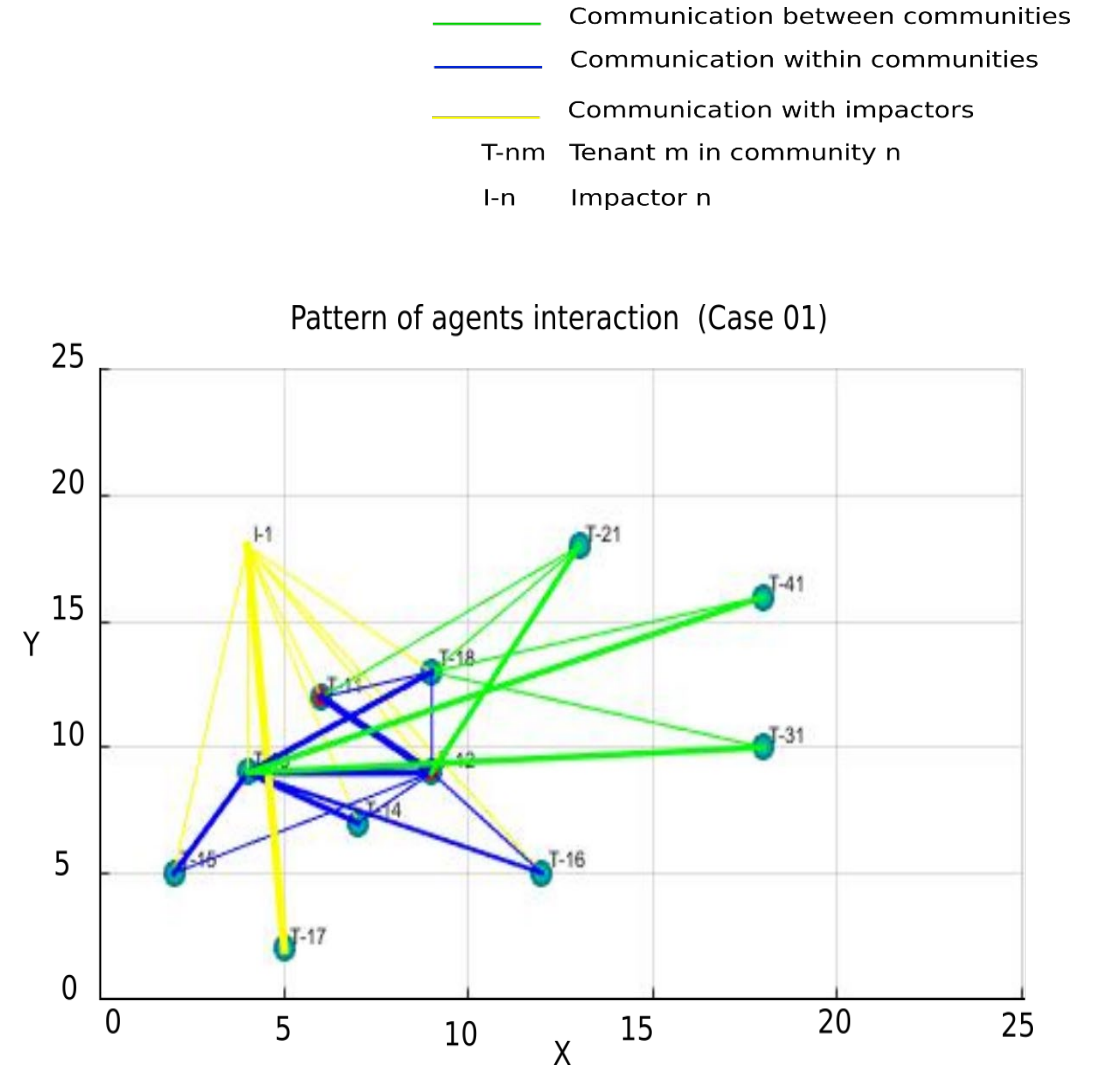| Self-congruity condition(SCC)	Value for self-esteem motive(SE)	Value for self-consistency motive(SC)
+ve self-congruity	SE2: 0.700	SC2: −0.007
+ve self-incongruity	SE1: 0.500	SC1: 100
-ve self-congruity	SE3: 0.500	SC3: 100
-veself-incongruity	SE4: -7160.000	SC4: -0.007

- **Outcome of the TUUD simulation**
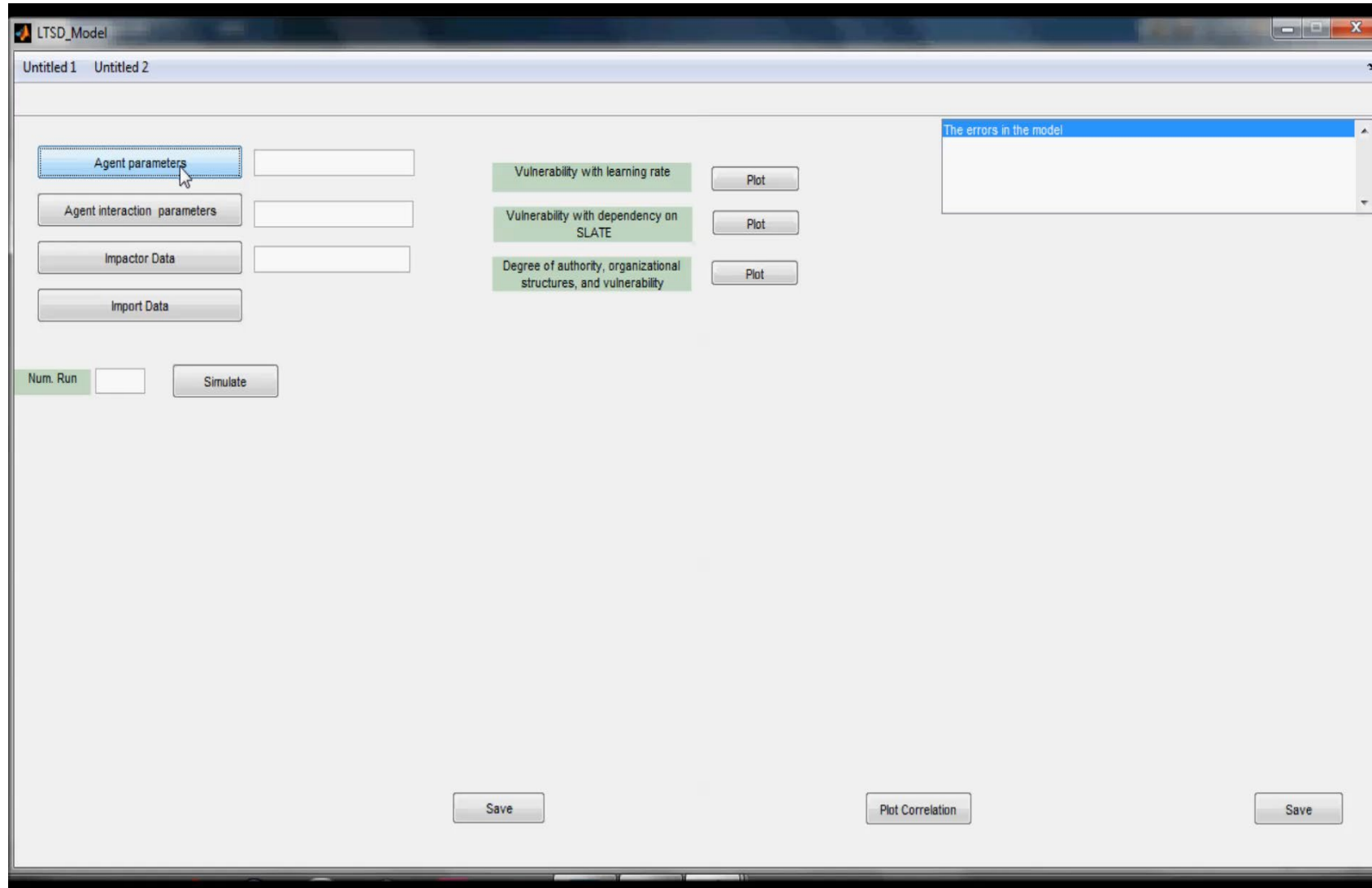
- **Outcome of the simulation**

Correlationbetween Marginal Utility of Eviction and Agent Learning Capacity (Case 01)
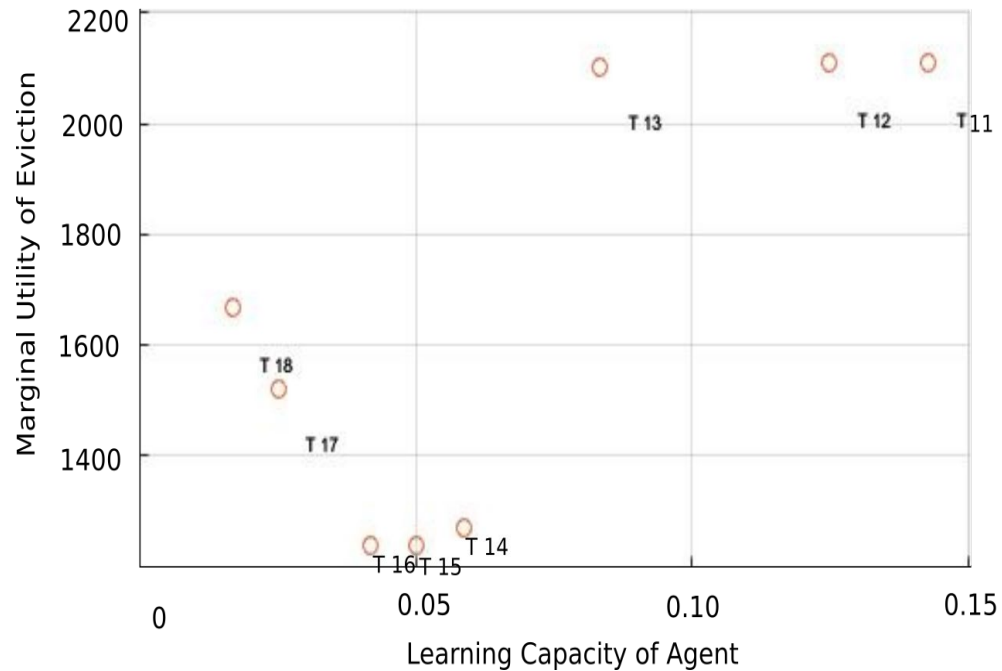
Pattern of agents interaction (Case 01)

- **Outcome of the simulation**

Correlation between Marginal Utility of Eviction and Agent Learning Capacity (Case 02)
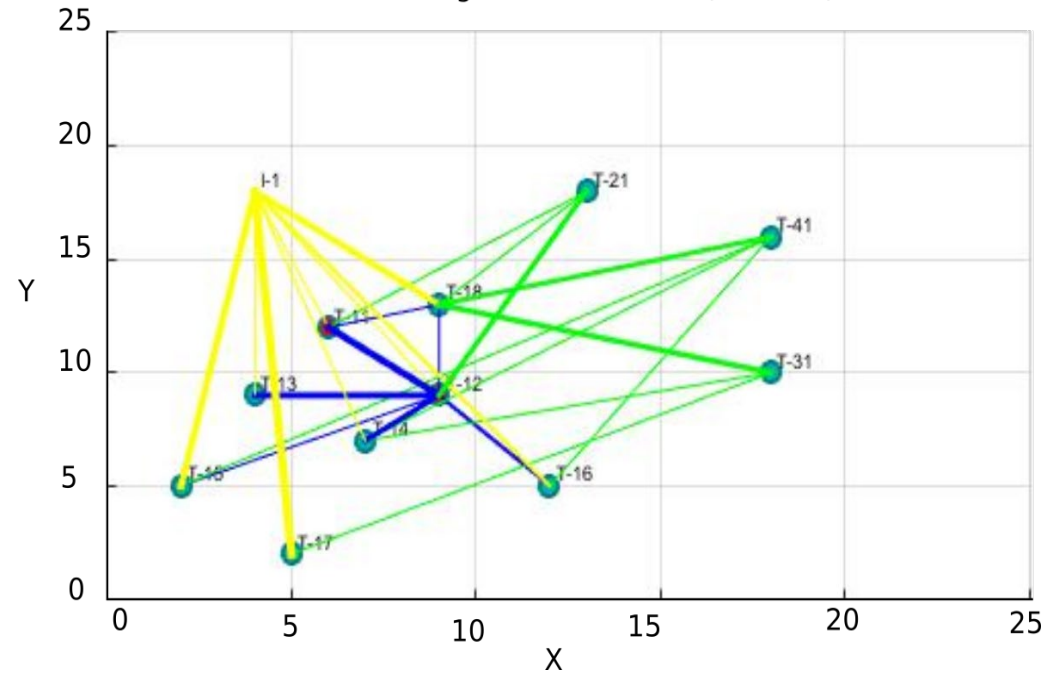
Pattern of agents interaction (Case 02)

Legend:
- Communication between communities
- Communication within communities
- Communication with impactors
- T-nm Tenant m in community n
- I-n Impactor n

Conclusion

- **Land tenure System** can be interpret as a **Autopoietic System**

- Its **Elements** represents **Economic, Cognitive and Communicative/Feedback** Structures

- These **elements** consists of **complex relation** which may not be able to interpret in leaner methods

- Change of the **properties of one element** may impact the **behaviour of total** (Total-element relation)

- **Tenure security** condition of a person (agent) is therefore, a **product of total – element relation** (Cognitive-Feedback structure relation)

- **Cognitive and Feedback structures** of land tenure system are very important in defending the **utility of land tenure**

Thank you for your attention