On Trust Dynamics of Economic Growth

Syed Sibghatullah Shah

School of Economics, Quaid-i-Azam University, Islamabad

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Abstract: Trust among individuals in society may have various economic and social implications. Though, worldwide data on economic growth rarely consider trust as an ingredient in manipulating economic outcomes. Thus, we include trust instigating from individual, affecting community and state thus, forming trust-based economy. In order to explore the relationship of trust with growth and its benefits implications, this study suggests a model which is validated by Markov process. Consequently, results indicate significant impact of trust on economic growth by achieving convergence in very few iterations in the case of trust-based economy. On the other hand, economy with lowest trust level shows delayed convergence and takes around 4 times more iterations to attain equilibrium. Additionally, socio-economic benefits are more visible in a trust-based economy.

Keywords: Trust, Markov process, Equilibrium, Convergence, Economic Growth
JEL Classification: C15; C53; D71; E21; H20; O47; Z10; Z13.

Introduction

Till now, studies concentrating on economic growth stress the role of incentives for individuals that are wealth maximizing. In some countries structure of incentives encourage people to either produce new wealth or prevent it from others. According to Knack (2001) "the comparative outcome of whether there is making or taking of wealth is reinforced by legal structures i.e. contracts and protecting property rights, but also by social norms and interpersonal trust". Though there is large income inequality across the globe but there is contradiction in defining role of trust in formulating output in economy. In accordance with Arrow 1972, "Virtually every commercial transaction has elements of trust within itself, certainly any transaction conducted over a period. It can be plausibly argued that much of backwardness in world can be explained by lack of mutual confidence". Trust play a key role in all kind of human interactions. It can accelerate relations whether they are personal i.e. family and friends, institutions or Government. Empirically role of trust in economy is explain by (Helliwell and Putnam 1995; Knack and Keefer 1997; Fukuyama 1995; Bjornskov (2003,2012)) that increase in social trust increase economic yield by enabling cooperation, reducing rent seeking behavior and enhancing labor productivity. Moreover, reducing monitoring and transaction costs associated with eradicating deviant behaviors and practices.

Numerous scholars developed mechanisms to associate trust with economic growth either in micro or macro perspective. When there is mutual trust among government, institutions and individuals result will be effectiveness in Government expenditure along with increase in investment incentive and economic spread as claimed by Putnam (1993). Subsequently Woolcock (1998) asserts that individuals characterizing through group generate investment by transactions and exchange with various key players in system like individual, institutions or state that accumulates trust, which increases their mutual benefit as well as confidence in each other. Consequently, in this type of

[1]S. S. Shah, MPhil Economics, School of Economics, Quaid-i-Azam University, Islamabad
Email: s.sibghats@gmail.com

system government need to worry less for rehabilitation and provide supplementary preference for improving society because of equilibrating stance provided by trust.

In this regard, there are conceptualization of trust, among them most widely interpreted is of Rotter (1980) as "generalized expectancy of individual that the word, promise, oral or written statement of another individual or group can be trusted on". Consequently (Hardin 2002; Putnam 2000; Yamagishi (2001) classify it as social trust, thin trust, emotional trust, or general trust. The knowledge about how trust among members of community or society helps economy traced back to Adam smith (1791) who discover that "a businessman or merchant frequently like to trade with his own country because he can know better the character and situation of persons whom he trusts". Additionally, researchers like (Bjornskov 2003 & Coleman (1990)) suggest that economies where people place more trust on each other result into more competent and productive public institutions, which promote businesses, voluntary efforts, happy life with better health and increase in economic growth of a country.

Since past it has been argued that without the proper trust in society, there will be less chance for economy to prosper. In this context Easterly et al. (2006) contend that "after the commencement of industrial reforms from state to individual level and trade liberalization in 1990's many developing countries failed in attainment of convergence in economic outcomes due to deficiency of trust at individual level". Moreover, it can result inefficiency in market in form of asymmetric information and moral hazard. Furthermore, there is increase in cost for individual and Government to protect transactions through contract and law enforcement. In mostly low trust societies, people are limited to their confined social networks that restrain them to use informal mechanism for transaction. Therefore, group of individuals related to trade become smaller leading to lesser exports because of lower trust on other individuals.

According to Lin (2001) there are several problems in cross country approaches in measuring and quantifying trust to economic outcomes because of variation in types of trust sustaining in societies. After the deep study of literature, it is evident that there is strong positive relation of trust and economy. Meanwhile from past various approaches like trust games, Nash equilibrium and regression analysis were used to examine economic role of trust. Moreover, this can be characterized as an attempt to formulate trust economy by use of Markov process. A system is formed based on trust including individual, institution and state in determining equilibrium level of components of economic growth. Assuming case of two economies, (A) where economy is based on solid foundation of trust and in (B) there is weaker trust among various stoke holders. Economic growth (GDP) consider as a function of trust. In our defined system Individuals interact with each other based on strong level of trust. Then these individuals become part of institutions or organization where exchange and frequent transactions take place. Institutional interaction with other by dealings of individuals in the form of reciprocity with other organizations. Whether there is democracy or any other type of government, it consists of those individual that are trustworthy as a result economic system is formed which can called as Trust Economy or system promoting society as a whole in both directions from individual to state and from state to individual creating a solidifying bond of peace harmony and integration.

The next section starts with hypothesizing trust and economic growth process where model is specified. Section 3 consist of methodology followed by an empirical evidence for both economies in section 4. Study end with conclusion.

2. Hypothesizing the Trust and Economic Growth Process

The positive relation of trust in producing economic benefits is already cited in literature. In the regression analysis comprised of trust and economy there is a missing link of how increase in trust can be cooperative in producing connectivity among various parts in an economic system. This is an endeavor to expand definition of trust-based economy where it is considered as an independent variable effecting economic growth which is dependent variable.

In a trust-based economy there are several characteristics which are not found in prevailing notion. It can boost up several characteristics at individual level like honesty, hard work, thrift. Trust is the main ingredient of the process if individual try to achieve equilibrium level of output maintaining ideal level of consumption and saving which can enhance investment. In a society when there is collective trust among each other members induce others to work hard, which increase labor participation as well as productive efficiency. Trust is considered as an independent variable a serving individual relation, reducing transaction costs, improving businesses. Moreover, trust is most important component for two countries regarding international trade, see [Guiso et. al (2006)]. So, the individuals possessing these kinds of behaviors participate in their respective groups in the form of political organization and further help in strengthening government institutions. This kind of participation expands range of society's social network and help in eradicating inequality and poverty by contributing through networks of charitable and humanitarian organization. These socially connected associations provide opportunity to poor in getting education and money, thus maximize their utility by consumption.

Ultimately, this process end at equilibrium in economic growth process. The trust helps in producing and fostering individual level relation and characteristics, then these trustworthy individuals become the part of system either private or public thus strengthening the role of institutions. At the end Through this process a government is formed which converge economy towards stable state in the form of improving components of GDP. These include consumption, saving and investment with quality of prudence, government spending that is financed by higher tax collection and international trade with trade surplus. These all are benefits associated with being a trust-based economy. In the study we are comparing two economies represented as (A) and (B). We further investigate that how presence or absence of trust can cause convergence of these economies in future. For prediction of future outcome, Markov process is applied that is important in study of random phenomenon where exact outcome is not known. In this regard Shah et al. (2011a) explore the dimensions of economic development and trust in determining equilibrium stage through Markov Process. They assert that economic activities are in the form of system initiated by state then to organization, community and individual.

Model

When individuals in a society trust each other, it will eventually lead to a trustful community as whole. We will start from a society having 'n' number of individuals. Trustworthy population is denoted by (m) and $(1-m)$ is probability of less or non-trustworthy. Keeping other factors constant there are huge benefits associated with being in (m) phase like education, job security, increase in consumption-saving-investment, psychological and health wellbeing. Conversely, if there is no or low trustworthiness prevailing, then economy of a country may suffer. During time period t individual utility is derived from consumption individual's trust T_t and B^i, the benefits associated for being a person having or being in trust phase. Now, by assuming that, if a person is

trustworthy, then have B^i =1, in case of non-trustworthy B^i = 0. Thus, the. Investment is due to saving behavior and it is important characteristic of wealthy people in world. Investment of some trustworthy individual can save time and money by reducing transaction and information costs associated with business. The trust economy followed a chain like structure where chain started from individual and ending at state level. In the future there is an increase of sustainable state of individual benefits B^i.

Trust as the base of our system is variable on which all transactions and trade take place. We define Economic growth (Y) as function of trust economy.

$$y = f(T) \text{ where, } 0 \leq T \leq 1$$

Growth is defined in term of GDP having components; consumption, investment, government spending and net exports.

$$GDP\ (y) = C + I + G + (X - M)$$

$$y = f(T) \qquad (1)$$

Equation (1) constitutes trust-based economy.

Convergence

Therefore we assume two states in economy with probability for individuals in high trust worthy state as (T_t^h) is denoted by $\mathrm{P_h}$ and probability for weak or low trust worthy state as T_t^l is denoted by $(1 - \mathrm{p_h}) = \mathrm{p_L}$.

$$\mathrm{B}T_t^h = (1 + \mathrm{E})T_t^h$$

This state shows that trust is sustained and there is benefit shown by increase in quality as well quantity of trust i.e. $(1 + \mathrm{E})$. Moving from individual to community or state level, this system will provide strong institutions, thus helping government maintain rule & law and maximizing revenues. There are several costs for individual and government in term of loss in leisure and revenue, are labeled as $\partial = (1 - \exists)$. This means,

$$\mathrm{B}T_t^h > \partial T_t^h$$

$$(1 + \mathrm{E})T_t^h > (1 - \exists)\ T_t^h$$

$$\partial \leq T_t^h \leq T_t^h * \qquad (a)$$

In this case Proportion of high trustworthy i.e., $\mathrm{p_H}$ is greater in society so by majority voter theorem, Benefits $(1 + \mathrm{E})T_t^h$ outweigh costs that are minimized, due to which convergence is achieved in a short time. All revenues are possible because of trust dynamics, profiting society collectively. It means at this level there is maximization of individual utility and government revenue in form of higher tax collection and less social spending, on rehabilitation of deviant behavior like crime, generate cooperative norms. Individuals in this state profound to join organizations, associations and charity groups thus, encouraging harmony and peace.

Delayed convergence

Now we consider a situation where it is weak trust in society denoted by T_t^l with probability p_l very high means majority of population in lower trust state, this will abolish principles of whole society, due to which costs are maximized along with minimization of benefits.

$$\mathrm{B}T_t^l = (1 + (\mathrm{E} - \varepsilon)T_t^l$$

In this case ε can be considered of very high value, due to which there is short-term persisting trust which can negatively influence economic outcomes. Now from individual level to state or community level we can see there is chance that system at this level result into corrupt institutions in which there will be individuals with trust among them that is for shorter time. Due to the fact Government formed by this system prefer policies that favor rich, creating inequality, furthermore they will have to spend more for crime eradication and rehabilitation programs.

$$\mathrm{B}T_t^l < \partial T_t^l$$

$$(1 + (\mathrm{E} - \varepsilon)T_t^l < (1 - \exists)T_t^l \qquad \text{(b)}$$

Government revenue will be minimized or will be less than state where equilibrium can be achieved. Costs are greater than benefits for remaining in this state.

Statement

Assuming Growth as a function of Trust based economy, we have used Markov process to compare two economies. If an economy achieves convergence to stationary state in fewer iterations, it is considered as significant and positive relation to economy.

3. Methodology

Generally, there is a need to determine time to achieve a point or steady state where higher economic output among two economies can be achieved. Subsequently this process of comparing involve predictions whether trust among various players in system is important determinant of economic efficiency. As a result, it is fortune to use Markov process in determining truthfulness of our statement.

Markov Chain

This process was introduced by Andrey Markov by proclaiming that results of a given experiment can cause future outcome. *It is a sequence of initial probability vectors* $m_o, m_1, m_2, m_3 \dots m_n$ *with stochastic matrix A, such that,* $m_1 = Am_o$,$m_2 = Am_1$. According to (Lay 2003) *"Probability vector is a row vector with non-negative entries adding to 1 and stochastic matrix is a square matrix whose rows are probability vectors".* Furthermore it consist of various states such as $\{c = c_o, c_1, c_2, \dots, c_n\}$ in which the process may initiate from one state and transition to other states forming a Markov chain. Moreover, if chain is currently in state c_i then it has a probability*(* P_{ij}) of moving to next state c_j. *In the case* P_{ij} *are known as transition probabilities resulting into a transition matrix. Generally, can be defined as* $P_{ij} = P(m_{t+1} = j | m_t = i), \forall\, i, j \in c$ .There are several properties of Markov process i.e. Recurrence is linked with accessibility from all states

with asymptotic probability of return equal to 1.Transcience is accessing states from where there is no return. Furthermore, there exists aperiodic states with period 1. Moreover, if chain consist of single communicating state or class is known as irreducibility.

Steady state vector:

Lay (2003) assert that "*If A is a $n \times n$ regular stochastic matrix then it has a unique steady state vector π^*. further, if m_o is any initial state and $m_{k+1} = Am_k$. Markov chain $\{m_k\}$ will converge to π^* when $k \to \infty$.''*According to Horn and Johnson (1985) The Perron-Frobenius theorem asserts that "*when irreducibility and aperiodicity exist in a state it form ergodicity or unique limiting/stationary distribution to which every initial distribution converges. A chain(uni) that is finite has a single eigen value λ1=1.The other eigen values $\lambda_i$satisfy $|\lambda_i| \leq 1, i = 2, \dots, n$.The rate of convergence to π^*depends on second largest eigen value modulus(SLEM) which can be expressed as spectral gap* $|1 - \lambda_{SLEM}|$.Greater gaps produces quicker convergence. Time required to achieve convergence is *defined* as distinctive time required for deviation from equilibrium through varying distance that can be verified by eigen value plot. With these descriptions, stationary distribution is summarized as $\pi*$, where $\pi*=\pi*P$".

By signifying the concept in terms of separate interactive systems applied through Markov process to observe which system reach their respective equilibrium positions in shorter duration of time minimizing economic and social costs. Larger time system takes to achieve equilibrium results in social and economic losses. Therefore, through random selection allocating probability values to both economies respectively, we are keen to sort out which system reaches equilibrium in shorter time.

4. Empirical Evidence I

4.1 Economy A

In General transition matrix is most suitable to categorize economy based on relation of trust found among individuals, institutions and state and its impact on components of economic growth (GDP). Economy A is defined as an economy where there are more trustworthy individuals that form strong institutions which results in a powerful state or government. Subsequently connectivity among key players of economy is shown by creating a transition matrix that consist of number of zero in designated locations based on strength of connectivity among key players of system. Subsequently zero positioned in transition matrix at (i, j) specifies that transition from state i to state j does not take place. In the case of Economy (A) there are fewer zeros in transition matrix due to coordination and higher trust between various players of economic process that is helpful in determining steady state at which economic prosperity can be achieved. Transition matrix (A) can be represented below as,

1	0.07399	0.2259	0	0.1252	0.05277	0.01009	0.1287	0.1118	0.2239	0.0476
2	0.1143	0.03737	0	0.1826	0.175	0.02331	0.04408	0.1344	0.1257	0.1632
3	0.2694	0.0417	0.03778	0	0.1179	0.06863	0.07672	0.2521	0.1156	0.02023
4	0.1094	0.2856	0.006088	0.03803	0.2644	0	0	0.04801	0.1687	0.07972
5	0.1606	0.1232	0	0.04935	0.1321	0.126	0.1315	0.003284	0.1318	0.1423
6	0.1758	0.01862	0.007393	0.1652	0.1569	0.1579	0.05512	0.01975	0.1888	0.05456
7	0	0.195	0.007306	0.2503	0.03522	0.003241	0.15	0.1255	0.06838	0.165
8	0.004082	0.1945	0.06352	0.1447	0.01546	0.01857	0.2503	0.1564	0.01711	0.1354
9	0.2058	0.2043	0.1904	0.004128	0	0	0.1875	0.1259	0.08193	0
10	0.1163	0.1197	0.09068	0.1347	0.02042	0.1628	0.04036	0.05341	0.106	0.1556
	1	2	3	4	5	6	7	8	9	10

Table 4.1.1: Transition Matrix for Economy A

This matrix designated for transition of states at various interval of time. For remaining in their own states there is probability **(0.07399) P_{11}, (0.03737) P_{22}, (0.03778) P_{33}, (0.03803) P_{44}, (0.1321) P_{55}, (0.1569) P_{66}, (0.15) P_{77}, (0.1564) P_{88}, (0.08193) P_{99}, (0.1556) P_{1010} respectively**. Transition matrix A can also be demonstrated graphically as,

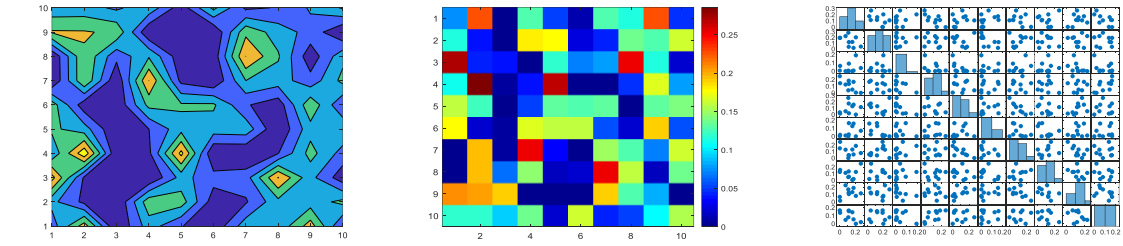

Figure 4.1.1: Graph plot and heat map for representation of Economy A's Transition Matrix

In the transition matrix (A) there are vectors based on function $y = f(T)$, where y is GDP.In order to examine change in this proportion Markov chain is preferred. Consequently, these variables process through several iterations or steps before achieving convergence. Furthermore, a theorem was formulated by Wielandt (1952) by suggesting that "Markov chain is ergodic if and only if all elements of P^m are positive for m = (n – 1)2 + 1. Whereas P is the transition and n are number of states". Further iterations demonstrate below how proportion changes independent of initial vector.

Steady state										
6 iterations	0.1109	0.1559	0.0422	0.1153	0.0960	0.0463	0.1077	0.1008	0.1202	0.1047

Table 4.1.2: Steady State after six iterations for Economy A

After 6 iterations convergence is achieved in the form of steady sate. According to Perron-Frobenius theorem in order to achieve ergodicity or stationary distribution to which every initial distribution converges we must focus on irreducibility and aperiodicity. In order to confirm whether our chain is ergodic we run a logical test on our Markov chain (A). Results for the test is logical 1 which indicate ergodicity and visually confirm this by plotting its eigenvalues on the complex plane.

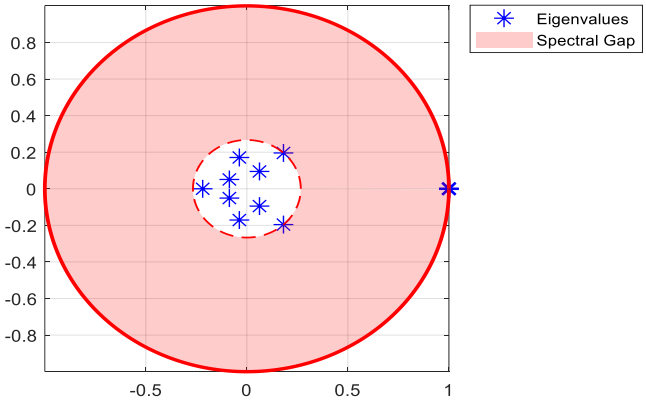

Figure 4.1.2: The pink portion explain spectral gap which is difference between the two largest eigenvalue moduli. The spectral gap determines the mixing time of the Markov chain i.e. (tmix ~0.7567). In the case of Economy, A spectral gap is very large that indicate faster mixing. This mean convergence is achieved in shorter period i.e. 7 iterations.

Now there is need to determine reducibility of chain A. According to Galler (2013) the Markov chain is irreducible "if every state is reachable from every other state in at most n – 1 steps, where n is the number of states. This result is equivalent to Q = (I + Z) n – 1 containing all positive elements. I is the identity matrix. The zero-pattern matrix of the transition matrix P is Zij = I (Pij > 0), for all i, j". Furthermore, by using *isreducible(mc1)* we have result *logical 0* which indicate that Markov chain A is irreducible. This can be demonstrated graphically as,

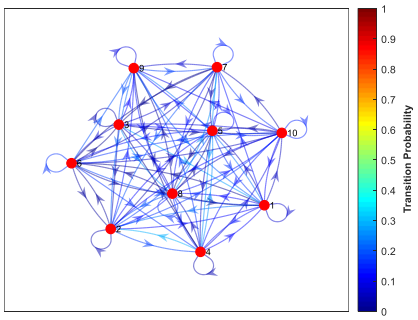

Figure 4.1.3: Structure showing irreducibility of Markov Chain A (i.e. irreducible)

Above graph as well results indicate that Economy (A) is performing better because of presence of high trust among individuals, institutions and state that lead to increase components of GDP like consumption, investment and trade. Due to the fact convergence is achieved in shorter duration of time suggesting a positive socio-economic impact of trust-based system on GDP.

4.2 Empirical Evidence II

4.2.1 Economy B

In this economy there is low level of trust prevailing among individuals which may result into weak institutions, at the long run that may cause inefficiency in Government policies and may hinder economic growth process. Subsequently less connectivity, lack of coordination and weaker trust among key players of economic process is shown by more specified number of zeros in random locations. Transition matrix (B) can be represented below as,

	1	2	3	4	5	6	7	8	9	10
1	0	0	0.2108	0	0	0.4974	0.2059	0	0.08588	0
2	1	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	1	0	0	0	0
4	0.854	0	0	0	0	0.146	0	0	0	0
5	0.2071	0	0.435	0	0	0	0	0	0	0.3579
6	0.3483	0	0	0	0.2579	0	0	0.3842	0	0.009597
7	0	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	0	0	0.03295	0.967
9	0.3733	0.02953	0.5972	0	0	0	0	0	0	0
10	0	0.2949	0	0	0.2037	0	0	0.2995	0.2019	0

Table 4.2.1: Transition Matrix for Economy B

This matrix designated for transition of states at various interval of time. For remaining in their own states i.e. ($P_{11}, P_{22}, P_{33}, P_{44}, P_{55}, P_{66}, P_{77}, P_{88}, P_{99}, P_{1010} = 0$).Transition matrix (B) can also be demonstrated graphically as

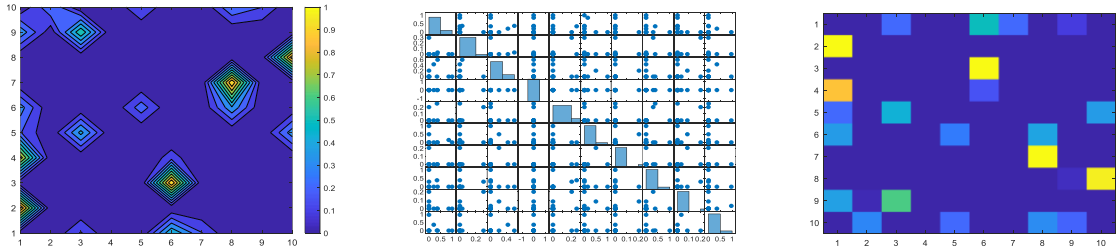

Figure 4.2.1: Graph plot and heat map for representation of Economy B's Transition Matrix

Above shows clear difference as compared to previous example. In B large gaps are visualized due to lack of trust-based economy. In the transition matrix (B) there are vectors based on function $y = f(T)$, where y is GDP. In order to examine change in this proportion Markov chain is preferred. Consequently, these variables process through several iterations or steps before achieving convergence. Further iterations confirm that how proportion changes independent of initial vector.

Steady state										
38 iterations	0.1556	0.0552	0.1020	0	0.0833	0.1794	0.0320	0.1554	0.0552	0.1818

Table 4.2.2: Steady State after Thirty-eight iterations for Economy B

After 38 iterations convergence is achieved in the form of steady state. According to Perron-Frobenius theorem in order to achieve ergodicity or stationary distribution to which every initial distribution converges we must focus on irreducibility and aperiodicity. In order to confirm whether our chain is ergodic we run a logical test on our Markov chain (B). Results for the test is logical 0 which does not indicate ergodicity and visually confirm this by plotting its eigenvalues on the complex plane.

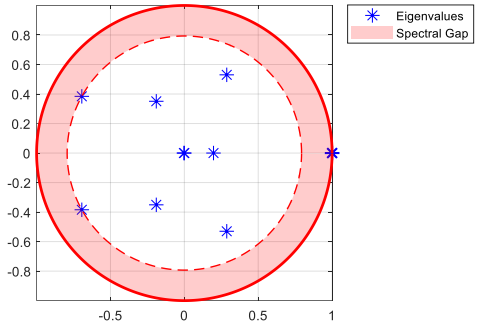

Figure 4.2.2: In case of Economy B very thin spectral gap indicate mixing time/convergence of the Markov chain i.e. (tmix ~4.3174 which is 4 times more than that of economy A) that indicate slower mixing. This mean convergence took 4 times more iterations than that of economy A i.e. 38 iterations.

Now there is need to determine reducibility of chain Furthermore by using *isreducible(mc2)* we have result *logical 1* which indicate that Markov chain B is reducible. This can be demonstrated graphically as.

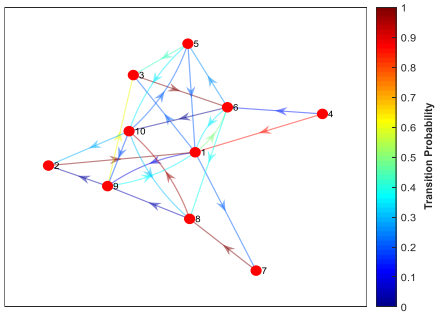

Figure 4.2.3: Structure showing reducibility of Markov Chain B (i.e. reducible)

Above graph as well results indicate that Economy B is not performing better because of presence of weaker trust among individuals, state and institutions. Therefore, this system took longer duration of time in achieving convergence suggesting a negative socio-economic impact of trust on GDP.

5. Conclusion

Trust is main ingredient in achieving efficiency in economic growth, political and social stability along with provision of rule of law, sustained increase in business investment and reducing monitoring costs (Fukuyama 1995). Concentrating on how in a trust economy component of economic growth are stimulated to increase productive efficiency. We have contended that literature that focusing on dynamics of economic growth should take greater consideration of trust a factor in determining equilibrium in economic outcomes.

If trust is a mechanism that limit negative external costs in economy, then we can expect individual who are trustworthy, irrespective of their denominations to be more productively efficient. Stronger systematic trust of individuals outweighs costs prevailing in economy. This kind of trust lead to produce strong coordination among various players in economic process. Subsequently individuals at equilibrium level become source for maximization of Government revenues by providing high level of taxes, reduction in crime rate which reduce rehabilitation and monitoring costs. Contrary with that those having either lower or weak trust were unable to drive maximum benefits in economy as Government revenue cannot be maximized due to monetary, physical and health costs that destroy benefits which are of smaller value in this case.

Unlike previous literature we conducted a study based on our model of trust economy comparing two economies A and B by means of Markov process. Therefore, Economy (A) consist of individuals and state with higher level of trust(systematic) found to be significantly influencing economic growth. Comparatively Economy B is bit complex. Consequently, with large population negatively related to systematic trust, result insignificant impact on economy in the form of delay in convergence after several iterations.

Our model evidently explores a formalized interpretation of how choices regarding trust economy can provide either a gain or loss. Our future research includes valuation of effect of trust on political and social variables that include democracy, dictatorship, health and inheritance. We will also extend our analysis by inclusion of data of developing and developed economies.

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