

BARGAINING, COALITIONS, SIGNALLING AND REPEATED GAMES FOR ECONOMIC DEVELOPMENT AND POVERTY ALLEVIATION

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ABSTRACT

How economic agents with conflicting interests can analyse gains from bargaining, coalition, signalling and repeated games and how their pivotal positions influences the outcome of the game is illustrated using numerical examples. Dynamic Poverty game is proposed for alleviation of poverty that requires cooperation from tax payers, transfer recipients and the democratic government and the international community. These concepts are applied to analyse how the incorporation of growth pact in the constitution can set a mechanism for cooperative solution required for peaceful and prosperous Nepal without harmful conflicts that had upset the growth process over the years.

***Key words:* Bargaining, Coalition, Repeated Game, Poverty Game, Nepal**

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Introduction

In many circumstances optimal decisions of an economic agent depends on decisions taken by others. Dominant firms competing for a market share, political parties contesting for power and research and scientific discoveries aimed for path-breaking innovations are influenced by decision taken by others. In all these circumstances there are situations where collective efforts rather than individual ones generate the best outcome for the group as a whole and for each individual members of the group. Concepts of bargaining, coalition and repeated games developed over years by economists such as Cournot (1838), Bertrand (1883), Edgeworth (1925) von Neumann and Morgenstern (1944) and Nash (1950, 1953) is developing very fast in recent years following works of Kuhn (1953), Shapley (1953), Shelten (1965) Aumann (1966) Scarf (1967), Shapley and Shubik (1969), Harsanyi (1967), Spence (1974), Hurwicz (1973), Myerson (1986), Maskin and Tirole (1989), Kreps (1990), Fudenberg and Tirole (1991) and Binmore (1992), Rubinstein (1982) Sutton (1986) Cho and Kreps (1987) Sobel (1985) Machina (1987) Riley (1979) McCormick (1990), Ghosal and Morelli (2004). These have generated models that can be applied to analyse the relative gains from coalitions rather than without these coalitions. The major objective of this paper is to apply these concepts to analyse the rationality or irrationality of choices made by political parties in Nepal in process of transforming its political economic system aiming to create a peaceful and prosperous economy like her neighbours India and China. This is further refinement of the solutions discussed on bargaining and political economy and general equilibrium models analysed in Bhattarai (2006 and 2007).

It is natural that economic agents play a zero sum and non-cooperative game until they realise the benefits of coalition and cooperation. When a cooperation is achieved there is a question on whether such coalition is stable or not. There are always incentives at least for one of the player to cheat from this cooperative agreement in order to raise its own share of the gain. However, it is unlikely that any player can fool all other at all the times. Others will discover such cheating sooner or later. Therefore a peaceful solution requires credibility and a punishment mechanism by which any party that tries to cheat on the agreement is punished unless its reforms are uncooperative behaviours to others.

In the context of Nepal abolition of absolute monarchy required cooperation of all parties which was achieved under the November 2005 agreement concurred in New Delhi. Consequences of this agreement were phenomenal in terms of transformation of power among political parties. In the next stage of the game the only unifying objective of such cooperation can be the alleviation of mass scale poverty and higher rate of economic growth to catch up at least to one of her neighbours. This requires cooperative moves from all parties which can be achieved by maintaining the commitment to the growth pact among all parties. It is necessary to design an incentive compatible mechanism by which it is in the best interest of each party to stick to such commitment.

The April (2006) revolution has brought the Nepalese Congress (NC), the Maoists (CPN-M), Marxists Leninist Communist Party (UML) along with other small political parties allied to the democratic movements in the forefront of the Nepalese politics. Political progress since then has been phenomenal - it has abolished absolute monarchy, it has created fresh competitive politics based on ideas and visions for the country, compelled reforms and democratisation of each of the parties

including the unification of the breakaway fractions into their mother parties in order to survive in new era of value based and target oriented politics. Major focus of all parties has been to conduct a Constituent Assembly (CA) that would enshrine modern values, right and duties of each part of the nation and state, in the constitution of Nepalese people and open an unhindered path for rapid growth of the economy, uplifting the living standards of majority of people that would effectively eliminate illiteracy, expand education and health sectors and fulfil other basic needs to solve the problem of poverty for more than 25 million people in Nepal. No political system will be successful unless all parties commit to a “grow Nepal” contract and proceed in an agreeable way by which majority start feeling that the system is fulfilling their needs. Following sections aim to analyse these issues using bargaining and Shapley value concept in section II and III, mixed strategy concept in section IV, signalling and repeated game in section V, repeated game in VI, principal agent game in VIII, and poverty game in IX following by conclusions and references in X.

II. Gains from Bargaining and Shapley Values

When parties enter into a coalition it should fulfil individual rationality, group rationality and coalition rationality. These can be ascertained by the super-additivity property of coalition where the maximisation of gain requires being a member of the coalition rather than playing alone.

This can be explained using standard notations. Let us take three players in the current Nepalese context $N = (1= CPM \text{ and } 2 =UML, 3 =NC)$. Superadditivity condition implies that the value of the coalition of subset of players is more than value of the game only for one individual player.

$$v(1 \cup 2 \cup 3) \geq v(1) + v(2) + v(3)$$

Parties playing together generate more value than parties playing alone. When normalised to 0 and 1 the value of the gains from a coalition are:

$$v(1) = 0 \quad v(N) = 1 \quad \text{for } N = \{1, 2, \dots, n\}$$

Payoff of the merged coalition is larger than the sum of the payoff to the separate coalitions as shown in following imputations.

There are many ways the value of the game can be distributed among N different players. The imputations of values characterise these allocations

$$\Pi = (\Pi^1, \Pi^2, \dots, \Pi^n)$$

$$v(N) = \sum_{i \in N} \Pi^i = \sum_{i=1}^n \Pi^i ;$$

Group rationality implies that total payoff to each players in the coalition equals at least the payoff of the independent actions of each player.

$$\Pi^i \geq v(\{i\}) \quad i \in N$$

In the context of dynamics players like to maximise the present value of the gain from infinite period.

$$V = \int_{t=0}^{t=\infty} v(i) e^{-rt} dt$$

The imputations in the core for each member of a coalition guarantee them at least as much as it could be obtained by independent actions. At the core of the game each player gets at least as much from the coalition as from the individual action, this is equivalent to Pareto optimal allocation in a competitive equilibrium (Sarf (1967)).

Some imputations are dominated by others; the core of the game is the strong criteria for dominant imputation. Core satisfies coalition rationality.

A unique imputation is obtained by Shapley value. This reflects additional payoff that each individual can bring by extra player to the existing coalition without

this player. This is the power of that player. Consider a game of three players in which the 3rd player always brings more to the coalition than the 1st or the 2nd player.

Payoff for coalition of empty set: $v(\emptyset) = 0$

Payoff from players acting alone: $v(1) = 0$; $v(2) = 0$; $v(3) = 0$

Payoff from alternative coalitions: $v(1,2) = 0.1$ $v(1,3) = 0.2$ $v(2,3) = 0.2$

Payoff from the grand coalition: $v(1,2,3) = 1$

Power of individual in the coalition $v(S \cup \{i\} - v(S))$ where S is the subset of players excluding i , $S \cup \{i\}$ is the subset including player i . The expected values of game for i

is given by $\Pi^i = \sum_{S \subset N} \gamma_n(S) [v(S \cup \{i\} - v(S))]$ where $\gamma_n(S) = \frac{s!(n-s-1)!}{n!}$ is the

weighting factor that changes according to the number of people in a particular coalition. This is the probability that a player joins coalition, $S \in N$.

There are $(2^N - 1)$ ways of forming in N player game:

$$v(\{1\}) - v(\{\emptyset\}) = 0$$

$$v(\{1,2\}) - v(\{2\}) = 0.1 - 0 = 0.1 ;$$

$$v(\{1,3\}) - v(\{3\}) = 0.2 - 0 = 0.2$$

$$v(\{1,2,3\}) - v(\{2,3\}) = 1 - 0.2 = 0.8$$

$$\gamma_0(S) = \frac{n!(n-n-1)!}{n!} = \frac{0!(3-0-1)!}{3!} = \frac{2 \times 1}{3 \times 2 \times 1} = \frac{2}{6}$$

$$\gamma_1(S) = \frac{n!(n-n-1)!}{n!} = \frac{1!(3-1-1)!}{3!} = \frac{1}{3 \times 2 \times 1} = \frac{1}{6}$$

$$\gamma_2(S) = \frac{n!(n-n-1)!}{n!} = \frac{2!(3-2-1)!}{3!} = \frac{2}{3 \times 2 \times 1} = \frac{2}{6}$$

Shapley value for player 1 is thus

$$\Pi^1 = \sum_{S \subset N} \gamma_n(S) [v(S \cup \{1\} - v(S))] = \frac{2}{6}(0) + \frac{1}{6}(0.1) + \frac{1}{6}(0.2) + \frac{2}{6}(0.8) = \frac{19}{60}$$

For player 2

$$\Pi^2 = \sum_{S \subset N} \gamma_n(S) [v(S \cup \{2\}) - v(S)] = \frac{2}{6}(0) + \frac{1}{6}(0.1) + \frac{1}{6}(0.2) + \frac{2}{6}(0.8) = \frac{19}{60}$$

Note

$$v(\{2\}) - v(\{\emptyset\}) = 0$$

$$v(\{1,2\}) - v(\{1\}) = 0.1 - 0 = 0.1 ;$$

$$v(\{2,3\}) - v(\{3\}) = 0.2 - 0 = 0.2$$

$$v(\{1,2,3\}) - v(\{1,3\}) = 1 - 0.2 = 0.8$$

For player 3

$$\Pi^3 = \sum_{S \subset N} \gamma_n(S) [v(S \cup \{3\}) - v(S)] = \frac{2}{6}(0) + \frac{1}{6}(0.2) + \frac{1}{6}(0.2) + \frac{2}{6}(0.9) = \frac{22}{60}$$

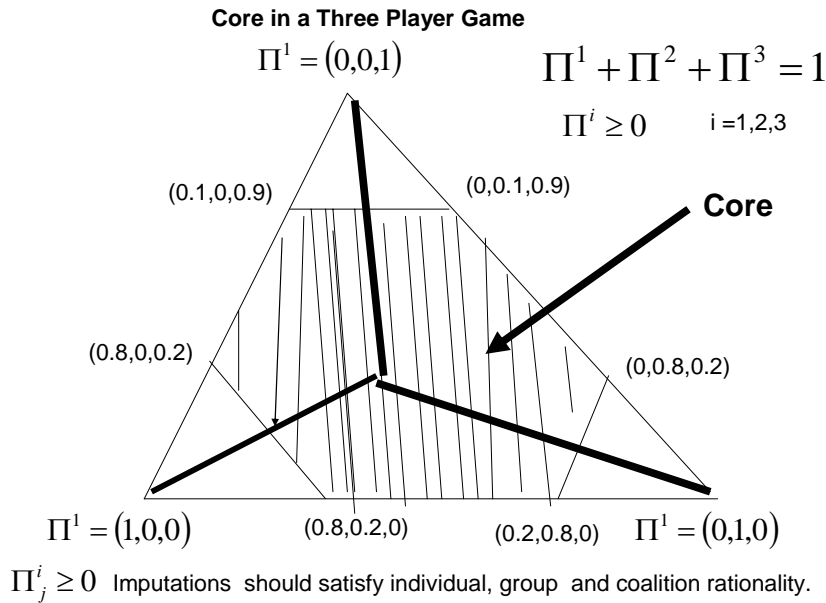
$$v(\{3\}) - v(\{\emptyset\}) = 0$$

$$v(\{1,3\}) - v(\{1\}) = 0.2 - 0 = 0.2 ;$$

$$v(\{2,3\}) - v(\{2\}) = 0.2 - 0 = 0.2$$

$$v(\{1,2,3\}) - v(\{1,2\}) = 1 - 0.1 = 0.9$$

As the player 3 brings more into the coalition its expected payoff is higher than by players 1 and 2. Similar configurations can be made where players 1 and 2 can bring more in the coalition.



Solutions towards the core are more stable than toward the corners as these are prone to conflicts. This is equivalent to finding a central ground in politics. In the most stable equilibrium all players gain in equal proportions of their supporters.

Pivotal player in a voting game

Ability of a player to influence the outcome of the game depends on the pivotal status enjoyed by that player. In a game with 3 players; power of player i is reflected by its Shapley value. Consider six possible ordering of 123 pivotal game. Player in the middle is pivotal. Three players can order themselves in $3! = 6$ ways. Each of these number can appear only twice in the middle out of six possible combinations. If parties realise this fact while bargaining, such bargaining is likely to generate a stable and cooperative solution. The player 3 is pivotal in game (2) and (4); player 3 in (1) and (5) and player 2 in (1) and (6). The marginal contribution (Shapley value) of each player can be presented then as

I. The 123 Game with Rotating Pivotal Party

Orderings	M(1,S)	M(2,S)	M(3,S)
(1). 123	0	1	0
(2). 132	0	0	1
(3). 213	1	0	0
(4). 231	0	0	1
(5). 312	1	0	0
(6). 321	0	1	0
Shapley (i)	2/6	2/6	2/6

Therefore each player has 1/3 chance of being pivotal. If 1 is pivotal into the coalition any coalition with 1 will win - player 1 is powerful. Players 2 and 3 are powerless. This outcome is reversed if other players become pivotal. There is always a chance that a pivotal player now may have to give up that position for other players later on. Another configuration is to assume that certain party is pivotal all the times. As shown in Table II, in this situation the Shapley value of player 1 is 1 and it is 0 for players 2 and 3. In the context of Nepal in recent years, players it seems that players NC, CPM and UML have equal chance of being pivotal. Thus the configurations in Table I are more applicable to configurations in table II.

II. The 123 Game with only one Pivotal Party

Orderings	M(1,S)	M(2,S)	M(3,S)
(1). 123	1	0	0
(2). 132	1	0	0
(3). 213	1	0	0
(4). 231	1	0	0
(5). 312	1	0	0
(6). 321	1	0	0
Shapley (i)	6/6 =1	0/6=0	0/6 =0

III. Solutions of a Bargaining game and risks

Once political parties realise their pivotal status they engage in power sharing game. Outcome of such game can be more easily explained by Nash bargaining game that is popularly known as a game of splitting a pie between two parties. The sum of the shares of the pie claimed by both cannot exceed more than 1, otherwise each will get zero. If we denote these shares by θ_i and θ_j then $\theta_i + \theta_j \leq 1$ is required for a

meaningful solution of the game where each get $\pi_i \geq 0$ and $\pi_i \geq 0$ payoff. When $\theta_i + \theta_j > 1$ then $\pi_i = 0$ and $\pi_i = 0$. Standard technique to solve this problem is to use the concept of Nash Product which can be formulated as following:

$$\max U = (\theta_i - 0)(\theta_j - 0)$$

subject to

$$\theta_i + \theta_j \leq 1 \text{ or by non-satiation property } \theta_i + \theta_j = 1$$

Using a Lagrangian function

$$L(\theta_i, \theta_j, \lambda) = (\theta_i - 0)(\theta_j - 0) + \lambda[1 - \theta_i - \theta_j]$$

First order conditions of this maximization problem are

$$\frac{\partial L(\theta_i, \theta_j, \lambda)}{\partial \theta_i} = \theta_j - \lambda = 0$$

$$\frac{\partial L(\theta_i, \theta_j, \lambda)}{\partial \theta_j} = \theta_i - \lambda = 0$$

$$\frac{\partial L(\theta_i, \theta_j, \lambda)}{\partial \lambda} = 1 - \theta_i - \theta_j = 0$$

From the first two first order conditions $\theta_j - \lambda = \theta_i - \lambda$ implies $\theta_j = \theta_i$ and putting

this into the third first order condition $\theta_j = \theta_i = \frac{1}{2}$. This is called focal point of the game.

Thus Nash solution of this problem is to divide the pie symmetrically into two equal parts. Many other solutions are possible but none of them are stable (see Roy Gardner (2003) for more examples) This game can easily be extended to three or more players. Nash solution provides some insight on how the gains should be distributed among player in a competitive environment.

Risk and bargaining

Economic agents like political parties are risk averse. However it pays not to reveal the attitude toward the risks in bargaining. Otherwise party that will reveal the risk will loose in the bargaining. A risk averse person loses in bargaining but the risk neutral person gains. Suppose the utility functions of risk averse person is given by

$$u_2 = (m_2)^{0.5} \text{ but the risk neutral person has a linear utility } u_1 = m_1. \quad m_1 + m_2 = M$$

$$u_1 + u_2^2 = 100$$

Using a Lagrangian function for constrained optimisation

$$L(u_1, u_2, \lambda) = u_1 u_2 + \lambda [100 - u_1 - u_2^2]$$

First order conditions of this maximization problem are

$$\frac{\partial L(u_1, u_2, \lambda)}{\partial u_1} = u_2 - \lambda = 0$$

$$\frac{\partial L(u_1, u_2, \lambda)}{\partial u_2} = u_1 - 2\lambda u_2 = 0$$

$$\frac{\partial L(u_1, u_2, \lambda)}{\partial \lambda} = 100 - u_1 - u_2^2 = 0$$

From the first two first order conditions $\frac{u_2}{u_1} = \frac{\lambda}{2\lambda u_2}$ implies $u_1 = 2u_2^2$ and putting this

into the third first order condition $3u_2^2 = 100$. $u_2^2 = \frac{100}{3} = 33.33$; $u_2 = 5.77$

$$u_1 = 2u_2^2 = 2(5.77)^2 = 66.6$$

$$u_1 + u_2^2 = 66.67 + 33.33 = 100$$

Thus the risk neutral players get 66.7 and risk averse player gets only 5.7, thus ends up paying a very high premium of risk aversion. It is better not to reveal the attitude towards risk to the opponents in a game.

IV. Minimax and Mixed Strategies

Parties linked together in a coalition agreement still can randomise their strategies in order to make game more interesting. If such games do not have solutions in pure strategies they could be solved by mixed strategies. Only zero sum or constant sum games have min-max or max-min solutions. Take a two player example for simplicity. Row player has two strategies such as CA or NCA and column player has three strategies CA, NCA and Delay. This is illustrated by an example below.

A two person zero sum game $\Pi_{i,j}^1 + \Pi_{i,j}^2 = 0$

A two person constant sum game $\Pi_{i,j}^1 + \Pi_{i,j}^2 = a$

Saddle point solution in pure strategy: $\Pi_{i,j} = \begin{pmatrix} 2 & 1 & 4 \\ -1 & 0 & 6 \end{pmatrix}$

$$\begin{array}{c} \text{RowMin} \\ \Pi_{i,j} = \begin{pmatrix} 2 & 1 & 4 \\ -1 & 0 & 6 \end{pmatrix} \begin{array}{l} 1 \\ -1 \end{array} \quad \min_j \max_i = \max_i \min_j = 1 \\ \text{Col max } 2 \quad 1 \quad 4 \end{array}$$

There is saddle point in pure strategy, $\min_j \max_i = \max_i \min_j = 1$; player 1 will play the first row and player 2nd will play the second column and solution of the game is 1.

Player 1 guarantees pay off 1 regardless what the player 2 plays.

Not all political games have saddle point in pure strategies. For instance:

$$\begin{array}{c} \text{RowMin} \\ \Pi_{i,j} = \begin{pmatrix} 6 & -2 & 3 \\ -4 & 5 & 4 \end{pmatrix} \begin{array}{l} -2 \\ -4 \end{array} \quad \min_j \max_i = 4 < \max_i \min_j = -2 \\ \text{Col max } 6 \quad 5 \quad 4 \end{array}$$

There is no equilibrium in pure strategies. Such games need to be solved using a mixed strategy. This is essentially finding the optimal mix of strategies in terms of probabilities attached to them.

$$\Pi_{i,j} = \begin{matrix} & p_1^2 & p_2^2 & p_3^2 \\ p_1^1 & \begin{pmatrix} 6 & -2 & 3 \\ -4 & 5 & 4 \end{pmatrix} \\ p_2^1 & \end{matrix}$$

where $0 \leq p_i^j \leq 1$ denotes the probability of strategy i played by player j .

$$\text{Value of this game is given by } V = p^{1*} \Pi p^{2*} = \sum_{i=1}^m \sum_{j=1}^n p_i^{1*} \Pi_{i,j} p_j^{2*}$$

$$\max_{p^1} p^{1*} \Pi p^{2*} = V = \min_{p^2} p^{1*} \Pi p^{2*}$$

In the above context the mixed strategy for person 1 can be evaluated as:

Here p_1^1 is the probability of playing the 1st row and $p_2^1 = (1 - p_1^1)$, is the probability that this player will play the second row.

$$V = p_1^1 (6p_1^2 - 2p_2^2 + 3p_3^2) + (1 - p_1^1) (-4p_1^2 + 5p_2^2 + 4p_3^2)$$

Substitute $p_3^2 = (1 - p_1^2 - p_2^2)$ in the above take derivative wrt p_1^2 and p_2^2 to find optimal mix of strategies of the row player.

$$V = p_1^1 (6p_1^2 - 2p_2^2 + 3(1 - p_1^2 - p_2^2)) + (1 - p_1^1) (-4p_1^2 + 5p_2^2 + 4(1 - p_1^2 - p_2^2))$$

$$\frac{\partial V}{\partial p_1^2} = 6p_1^1 - 3p_1^1 - 4(1 - p_1^1) - 4(1 - p_1^1) = 0$$

$$\frac{\partial V}{\partial p_2^2} = -2p_1^1 - 3p_1^1 + 5(1 - p_1^1) - 4(1 - p_1^1) = 0$$

Solving these two first order conditions one finds optimal mix strategy for player one

to is play row 1 with probability either $p_1^1 = \frac{8}{11}$ or $p_1^1 = \frac{1}{6}$.

Similarly differentiate the above function with respect to p_1^1 and p_2^1 to find optimal strategies for the column player as p_1^2 , p_2^2 and p_3^2 .

$$\frac{\partial V}{\partial p_1^1} = (6p_1^2 - 2p_2^2 + 3p_3^2) = 0 \rightarrow (6p_1^2 - 2p_2^2 + 3(1 - p_1^2 - p_2^2)) = 0 \rightarrow 3p_1^2 - 5p_2^2 = -3$$

$$\frac{\partial V}{\partial p_2} = (-4p_1^2 + 5p_2^2 + 4p_3^2) = 0 \rightarrow (-4p_1^2 + 5p_2^2 + 4(1 - p_1^2 - p_2^2)) = 0; 8p_1^2 + p_2^2 = -4$$

$$\text{and } p_3^2 = (1 - p_1^2 - p_2^2)$$

$$p_1^2 = \frac{17}{37}; p_2^2 = \frac{167}{185}; p_3^2 = \left(1 - \frac{17}{37} - \frac{167}{185}\right) = \frac{925 - 85 - 835}{185} = \frac{5}{925} = \frac{1}{185}$$

The value V simultaneously maximises the expected payoff of player 1 and minimises expected loss of player 2. For every game there exists at least one mixed strategy.

The major problem inherent in finding solution of political games discussed here remains in quantifying the payoff profiles for different players.

V. Signalling and Repeated Game

Signalling plays important roles in strategic choices of individuals, parties, communities, regions, national and the global community as a whole. Formation of payoff discussed above depends on signalling - players do not know the moves of their opponents but based on their interpretation of signal they can however, put some numerical values to payoff. An player $i \in N$ for $i = 1, \dots, N$ (ith individual, party or nation) receives a sequence of signals $\theta_{i,t} \in \Theta_t$ at every period of his life, his actions depend upon current and past signals $a_{i,l}(\theta_{i,t}) \in \Theta_t$ for $l = 1, \dots, k$. When these actions are ordered in a systematic way this leads to a level of standard $S_{i,m,t}$ for $m = 1, \dots, M$. When one action contradicts another one, marginal impacts of good action cancels out and the individual is in some stage:

$$a_{i,l}(\theta_{i,t}) = \begin{cases} a_{1,t} & a_{1,t+1} & \cdot & \cdot & a_{1,T} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ a_{n,t} & a_{n,t+1} & \cdot & \cdot & a_{n,T} \end{cases}$$

A rational individual chooses actions that support each other goes and brings him up in the progress ladder, whereas irrational actions may cancel out each other with no

change in the status or even a gradual decline in the status. Crucial steps for success in achieving the pre-set objectives needs sending the right signals and interpreting those signals correctly and translating them into actions more accurately; sending wrong signals or interpreting them incorrectly will cause a downfall; choosing actions in an uneven patten that may cancel each other cause a status quo. Status of player i , who has continuously submitted series of signal m up to time t , $S_{i,m,t}$ is explained by a stochastic process and is a cumulative results of actions taken up to time t . These results vary according to the freedom and information Ω_t that player has in gathering this information has implications on productivity of an individual, living standard of the community and the economy as a whole.

At individual level everyone wants to do well but some do better than others depending on the choice set feasible from the point of state space and the status up to point t . Choices with more information, Ω_t , can be economically more consistent and meaningful than individuals facing the asymmetric information. Public policies can change the status by making information available to the individuals. Correct decisions are conditional upon the available information and ability to process it. It essentially involves finding the optimum of the feasible set.

A community is a coalition of a set of individuals, $I_i = \{i/i \in N\}$, it is a product of public choices made up to point t , particularly on how much to spend on public and private goods. This gives rise to a collective action, similar to individual actions presented above, which need to be weighted against those actions when they contradict each other. The outcome of the choice depends upon the mechanism of choice - particularly on decision on how to avoid bad choices and promote good choices. Each member can note on the issue and decide on actions that are good for

the community. Better healthcare, education, provision of information, street lights, sports, festivals and fairs though the overall status of a particular community may depend on available information.

A country is the set of communities, $C_j = \{C_i \in I_i / I_i \in I\}$, its economy is the product of the balancing of choices of various communities with forming compromises and coalitions when the actions conflict each other by means of taxes and transfers. Status of an economy is the result of the sequence of choices conditional upon the signals sent by each community and actions that can promote the welfare of the community.

Finally the shape of the global economy is the consequence of the actions of individual economies, $W = \{w/c_i \in C\}$ and the global level actions $a_{i,t}^g(\theta_{c,t}) \in \Theta_t$.

Global actions may fluctuate significantly depending upon the interpretation of signals coming from various economies and counterbalancing the interest of one group of countries against another.

By understanding the roles of signalling all members political parties and their organisation can influence the efficiency of the outcome of the game by efficient signalling.

VI. Repeated Games

Economic agents, political parties, live for a long time and play games repeatedly. The well developed results of the classic Cournot-Nash bargaining game of oligopoly market can be applied to explain the consequences of cooperative and non-cooperative games among parties.

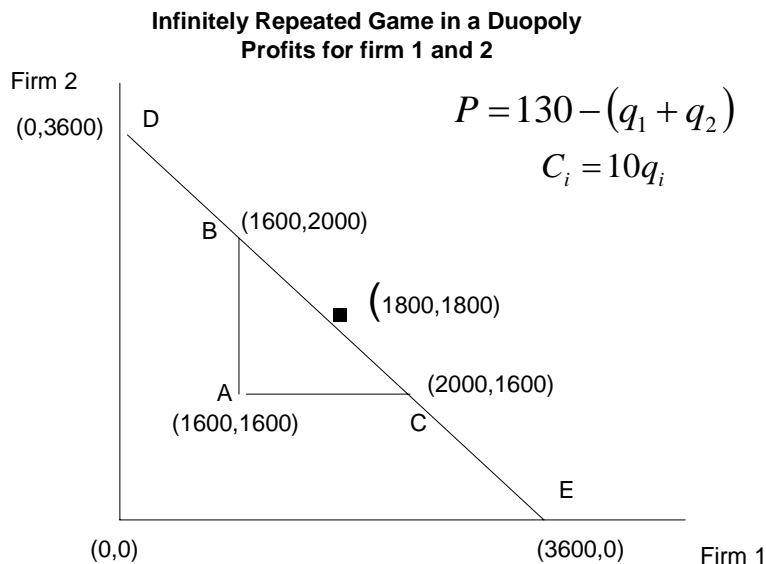
Consider a market demand for a product is $P = 130 - (q_1 + q_2)$ and cost of production for each of two firms is $C_i = 10q_i$. If the game is played infinite number of

time two firms form a cartel and monopolise the market. Each will supply only 30, set market price to monopoly level at £70 and divide total profit £3600 equally; each getting £1800. This is shown by (1800, 1800) point in the diagram. It pays to cooperate in the long run; it is sub-game perfect equilibrium.

$$\Pi = (130 - Q)Q - 10Q \quad ; \quad \frac{\partial \Pi}{\partial Q} = 130 - 2Q - 10 = 0 \quad ; \quad Q = \frac{120}{2} = 60 \quad ;$$

$$P = 130 - Q = 130 - 60 = 70 \quad ; \quad C = 10Q = 600 \quad ;$$

$$\Pi = PQ - C = 70 \times 60 - 10 \times 60 = 4200 - 600 = 3600$$



If any firm cheats and tries to supply more in order to get more profit; it will be found out by another firm. It will react this. Game will be non-cooperative with resulting in a Cournot Nash equilibrium; with each firm producing 40 units, market price of 50 and each getting £1600 profits.

$$\Pi_1 = (130 - (q_1 + q_2))q_1 - 10q_1 \quad \text{and} \quad \Pi_2 = (130 - (q_1 + q_2))q_2 - 10q_2$$

with reaction functions $2q_1 + q_2 = 120$ and $q_1 + 2q_2 = 120$

Total supply 80, each supplying 40 and making profit 1600 and market price 50.

Now suppose firm 1 plays Cournot game but firm 2 still plays cartel and supply just

30. Then from the firm 1' reaction function $2q_1 + q_2 = 120$

$$q_1 = 60 - \frac{1}{2}q_2 = 60 - \frac{1}{2}(30) = 45$$

. If firm 1 supplies 45, market price will be $P = 130 - (q_1 + q_2) = 130 - 45 - 30 = 55$; This makes profit margin of firm 1 to be 45

and its profit $\Pi_1 = 45 \times 45 = 2025$. Firm 2 will find out that firm 1 has cheated. This

will also produce according to its reaction curve. Thus the Nash equilibrium will result with each firm producing 40 and earning 1600 profit for the rest of the periods.

Does firm 1 gain or lose by deviation from the agreement. For this evaluate the infinite series of profits in deviation and in compliance with agreement.

Present value of profit in case of cheating

$\Pi_1 = (1 - \delta)[2025 + 1600\delta + 1600\delta^2 + \dots + \dots]$ by adding and subtracting 1600 and applying the formula for infinite series

$$\Pi_1 = (1 - \delta)[2025 - 1600 + 1600 + 1600\delta + 1600\delta^2 + \dots + \dots] = (1 - \delta)\left[425 + \frac{1600}{1 - \delta}\right]$$

$$\Pi_1 = 425(1 - \delta) + 1600 = 425 - 425\delta + 1600 = 2025 - 425\delta$$

By comparing profits with and without cheating

$$2025 - 425\delta < 1800 \text{ or } 425\delta > 2025 - 1800; \quad \delta > \frac{225}{425}; \quad \delta > \frac{9}{17}$$

. Whether the firm 1 will stick to agreement or not depends on whether its discount factor is greater than

$$\delta > \frac{9}{17} \text{ . For discount factor } \delta < \frac{9}{17} \text{ it benefits from sticking to the agreement.}$$

VII. Principal Agent Game

People are principals who want better standard of living, peace and prosperity in a country. Political parties are agents. They elect political parties in the parliament and

government to fulfil their collective interest. Political contracts are as similar as wage contracts that are designed to match efforts put by a worker to their productivities in the labour market. Political parties know their type but the people do not. The principals know the distribution of quality of various political parties $F(s)$, where s denotes either good or bad state. For simplicity one can assign probability of 0.5 for observing good and of 0.5 for bad state..

People offer parties a power contract $W(q)$. The party can accept or reject this contract based on self-selection and participation constraints. Basically parties evaluate the utility from the power and disutility from effort required to achieve it and decide the amount of effort to put in. Output from good states to parties is $q(e, good) = 3e$ and from bad state is $q(e, bad) = e$. Both people and parties are risk neutral. If parties reject the contract there is no work both parties and principal get zero payoff otherwise the $\pi_{agent} = U(e, w, s) = w - e^3$ and $\pi_{principal} = V(q - w) = q - w$. Agents maximise following two functions in good and bad states to set the level of efforts

$$\text{Max}_{e_g} \quad 3e_g - e_g^3$$

The first part is wage income and the second part of disutility of work. The optimal level of efforts in good state is therefore given by the first order condition $3 - 2e_g = 0$

$$e_g = 1.5 \quad . \text{ Similarly for a bad party}$$

$$\text{Max}_{e_b} \quad e_b - e_b^3$$

$$1 - 2e_b = 0 \quad ; \quad e_b = 0.5$$

The principals do not know what levels of efforts are appropriate for good and bad parties. They ideally like to maximise the expected profit from running this business

$$\underset{q_g, q_b, w_g, w_b}{Max} \quad [0.5(q_g - w_g) + 0.5(q_b - w_b)]$$

by designing two separate contracts for good and bad parties (q_g, w_g) and (q_b, w_b) .

Self selection constraints are based on relative rewards and cost of efforts in good and

bad states $q(e, good) = 3e$ or $e = \frac{q_g}{3}$ in good state and $e = q_b$ in the bad state.

Contract in the good state must satisfy self selection constraint as

$$\pi_{agent}(q_g, w_g / good) = w_g - \left(\frac{q_g}{3}\right)^2 \geq \pi_{agent}(q_b, w_b / good) = w_b - \left(\frac{q_b}{3}\right)^2$$

Contract in the bad state must satisfy self selection constraint as

$$\pi_{agent}(q_b, w_b / bad) = w_b - (q_b)^2 \geq \pi_{agent}(q_g, w_g / bad) = w_g - (q_g)^2$$

The participation constraints are similarly stated as

$$\pi_{agent}(q_g, w_g / good) = w_g - \left(\frac{q_g}{3}\right)^2 \geq 0$$

$$\pi_{agent}(q_b, w_b / bad) = w_b - (q_b)^2 \geq 0$$

Participation constraint is binding for the bad state. Therefore

$$w_b = (q_b)^2$$

Self selection constrain is binding for the good state. Therefore:

$$w_g = \left(\frac{q_g}{3}\right)^2 + w_b - \left(\frac{q_b}{3}\right)^2 = \left(\frac{q_g}{3}\right)^2 + (q_b)^2 - \left(\frac{q_b}{3}\right)^2$$

Putting these wage rates in the principal's objective function:

$$\underset{q_g, q_b, w_g, w_b}{Max} \quad [0.5(q_g - w_g) + 0.5(q_b - w_b)]$$

Now maximising this

$$\text{function } \underset{q_g, q_b}{\text{Max}} \left[0.5 \left(q_g - \left(\frac{q_g}{3} \right)^2 - (q_b)^2 + \left(\frac{q_b}{3} \right)^2 \right) + 0.5 (q_b - (q_b)^2) \right] \text{ with respect to}$$

q_g and q_b we get

$$0.5 \left(1 - \frac{2q_g}{9} \right) = 0 \quad \text{or } q_g = 4.5$$

$$0.5 \left(-2q_b + \frac{2q_b}{9} \right) + 0.5(1 - 2q_b) = 0 \quad \text{or } \left(-2q_b + \frac{2q_b}{9} \right) + (1 - 2q_b) = 0$$

$$\left(-4q_b + \frac{2q_b}{9} + 1 \right) = 0 \quad ; \quad 34q_b = 9 \quad \text{or } q_b = 0.265$$

Now rewards can be found from the constraints

$$w_b = (q_b)^2 = (0.265)^2 = 0.07$$

$$w_g = \left(\frac{q_g}{3} \right)^2 + (q_b)^2 - \left(\frac{q_b}{3} \right)^2 = \left(\frac{4.5}{3} \right)^2 + (0.265)^2 - \left(\frac{0.265}{3} \right)^2 = 2.32$$

Thus in the presence of information asymmetry, the efforts by the good party is at the first best level as the bad effort by him is not as attractive as the good effort, it is not profitable for a good party to pretend as bad party. Good party is not attracted by the contract for the bad party. People as principals can monitor and make the political game as incentive compatible as possible.

VIII. Dynamic Poverty Game

Putting all above elements of strategic considerations and interdependency of choices of moves available to individual players one can formulate a poverty game that can be applicable to country like Nepal (Bhattarai (2007a)).

Each player in the model (poor, rich and government) has a set of strategies available to it (s,l, and k respectively). The outcome of the game is the strategy contingent income for poor and rich, $y_t^p(s,l,k)$ and $y_t^r(s,l,k)$. The probability of being in particular state like this is given by $\pi_t^p(s,l,k)$ and $\pi_t^r(s,l,k)$ respectively. The state-space of the game rises exponentially with the length of time period t. The objective of these two players is to maximize the expected utility and government can influence this outcome by means of taxes and transfers. More specifically, following conditions should hold in this poverty alleviation game.

Condition 1: The state contingent money metric expected utility of poor is less than that of rich, which can be expressed as:

$$\sum_{s=1}^s \sum_{l=1}^l \sum_{k=1}^k \sum_t^T \pi_t^p(s,l,k) \cdot \delta_t^p u(y_t^p(s,l,k)) < \sum_{s=1}^s \sum_{l=1}^l \sum_{k=1}^k \sum_t^T \pi_t^r(s,l,k) \cdot \delta_t^r u(y_t^r(s,l,k))$$

where $\pi_t^p(s,l,k)$ gives the probability of choosing one of strategies by poor given that the rich and the government has chosen l and k strategies. Utility is derived from

income as given by $u(y_t^p(s,l,k))$ and $\delta_t^p = \frac{1}{(1+r_t^p)}$ is the discount factors for poor

and $\delta_t^r = \frac{1}{(1+r_t^r)}$ the discount factor for rich.

Condition 2: Transfer raises money metric expected utility of poor and reduces the utility of rich.

$$\sum_{s=1}^s \sum_{l=1}^l \sum_{k=1}^k \sum_t^T \pi_t^p(s,l,k) \cdot \delta_t^p u(y_t^p(s,l,k) + T_t^p(s,l,k)) < \sum_{s=1}^s \sum_{l=1}^l \sum_{k=1}^k \sum_t^T \pi_t^r(s,l,k) \cdot \delta_t^r u(y_t^r(s,l,k) - T_t^p(s,l,k))$$

Condition 3: Incentive compatibility requires that

$$\sum_{s=1}^s \sum_{l=1}^l \sum_{k=1}^k \sum_t^T \pi_t^p(s,l,k) \cdot \delta_t^p u(y_t^p(s,l,k) + T_t^p(s,l,k)) > \sum_{s=1}^s \sum_{l=1}^l \sum_{k=1}^k \sum_t^T \pi_t^p(s,l,k) \cdot \delta_t^p u(y_t^p(s,l,k))$$

and

$$\sum_{s=1}^s \sum_{l=1}^l \sum_{k=1}^k \sum_t^T \pi_t^R(s, l, k) \cdot \delta_t^R u(y_t^R(s, l, k) - T_t^P(s, l, k)) < \sum_{s=1}^s \sum_{l=1}^l \sum_{k=1}^k \sum_t^T \pi_t^R(s, l, k) \cdot \delta_t^R u(y_t^R(s, l, k))$$

Condition 4: Growth requires that income of both poor and rich are rising over time:

$$T_t^P(s, l, k) < T_{t+1}^P(s, l, k) < T_{t+2}^P(s, l, k) < .. < T_{t+T}^P(s, l, k)$$

$$Y_t^P(s, l, k) < Y_{t+1}^P(s, l, k) < Y_{t+2}^P(s, l, k) < .. < Y_{t+T}^P(s, l, k)$$

$$Y_t^R(s, l, k) < Y_{t+1}^R(s, l, k) < Y_{t+2}^R(s, l, k) < .. < Y_{t+T}^R(s, l, k)$$

Condition 5: Termination of poverty requires that every poor individual has at least the level of income equal to the poverty line determined by the society. When the poverty line is defined one half of the average income this can be stated as:

$$Y_{t+T}^P(s, l, k) \geq \frac{1}{2} \sum_{p=1}^p Y_{t+T}^P(s, l, k)$$

Above five conditions comprehensively incorporate all possible scenarios in the Poverty Game mentioned above. Conditions 2-5 present optimistic scenarios for a chosen horizon T.

IX. Conclusion

How economic agents with conflicting interests can analyse gains from bargaining, coalition and repeated games and their pivotal positions in the game with minimax or mixed strategies and how signalling affects the outcome is illustrated using numerical examples. Dynamic Poverty game is proposed for alleviation of poverty that requires cooperation tax payers, transfer recipients and the democratic government and the international community. The concepts are applied to analyse how the incorporation of growth pact in the constitution can set a mechanism for cooperative solution required for peaceful and prosperous Nepal.

X. References:

- 1 Acemoglu Daren (2001) A Theory of Political Transitions, the American Economic Review, 91:4:938-963
- 2 Bardhan Pranab (2002) Decentralization of Governance and Development, *Journal of Economic Perspective*, 16:4:185-205.
- 3 Basu Kaushik (1986) One Kind of Power, *Oxford Economic Papers*, 38:2:259-282.
- 4 Besley T and M Ghatak (2001) Government versus Private Ownership of Public Goods, *Quarterly Journal of Economics*, 116:4:1343-1372.
- 5 Binmore K (1999) Why Experiment in Economics? *The Economic Journal* Vol. 109, No. 453, Features Feb. pp. F16-F24
- 6 Bhattarai K. (2007a) Adding strategic and general equilibrium model in poverty measurement, mimeo, University of Hull, Business School.
- 7 Bhattarai K. (2007b) Static and Dynamic General Equilibrium Model of the UK Economy, Serials Publication, New Delhi.
- 8 Bhattarai K. (2007c) Models of Economic and Political Growth in Nepal, Serials Publication, New Delhi.
- 9 Bhattarai K. (2006) Consequences of April 2006 Revolutionary Changes in Nepal: Continuation Nepalese Dilemma, *Indian Journal of Economics and Business*, 5:2:315-321.
- 10 Biswas T and J McHardy (2007) Asking price and price discounts: the strategy of selling an asset under price uncertainty, *Theory and Decision*, DOI 10.1007/S11238-007-9031-9
- 11 Caminal R. (1990) A Dynamic Duopoly Model with Asymmetric Information *Journal of Industrial Economics* Vol. 38, No. 3 (Mar., 1990), pp. 315-333
- 12 Cho I.K. and D.M. Kreps (1987) Signalling games and stable equilibria, the *Quarterly Journal of Economics*, May 179-221.
- 13 Coase R. H. (1937) The Nature of the Firm, *Economica*, 386-405, November.
- 14 Debreu, G. (1954) *The Theory of Value*, Yale University Press, New Haven.
- 15 Dixit Avinash (1987) Strategic Behaviour in Contests, American Economic Review, Dec., 77:5:891-898.
- 16 Fundenberg D and J.Tirole (1995) Game Theory, MIT Press.
- 17 Gardener R (2003) Games of Business and Economics, Wiley, Second Edition.
- 18 Ghosal S and M. Morelli (2004) Retrading in market games, *Journal of Economic Theory*, 115:151-181.
- 19 Harsanyi J.C. (1967) Games with incomplete information played by Bayesian Players, *Management Science*, 14:3:159-182.
- 20 Hurwicz L (1973) The design of mechanism for resource allocation, American Economic Review, 63:2:1-30.
- 21 Jin J. Y. (1994) Information Sharing through Sales Report *Journal of Industrial Economics* Vol. 42, No. 3 (Sep., 1994), pp. 323-333
- 22 Lockwood B. A. Philippopoulos and A. Snell (1996) Fiscal Policy, Public Debt Stabilisation and Politics: Theory and UK Evidence *Economic Journal* Vol. 106, No. 437 (Jul., 1996), pp. 894-911
- 23 Machina M. (1987) Choice under uncertainty: problems solved and unsolved, *Journal of Economic Perspective*, 1:1:121-154.
- 24 Mailath G. J. (1989), Simultaneous Signaling in an Oligopoly Model *Quarterly Journal of Economics* Vol. 104, No. 2 (May, 1989), pp. 417-427
- 25 Maskin E and J Tirole (1989) The principal-agent relationship with an informed principle, *Econometrica*,
- 26 McCormick B. (1990) A Theory of Signalling During Job Search, Employment Efficiency, and "Stigmatised" Jobs *Review of Economic Studies* Vol. 57, No. 2 (Apr., 1990), pp. 299-313
- 27 **Mookherjee D and D Ray (2001) *Readings in the theory of economic development*, Blackwell.**
- 28 Moore J. (1988) Contracting between two parties with private information, *Review of Economic Studies*, 55: 49-70.

- 29 James A. Mirrlees (1997) Information and Incentives: The Economics of Carrots and Sticks *The Economic Journal* , Vol. 107, No. 444 Sep., pp. 1311-1329
- 30 Mailath G. J. and L. Samuelson (2006) Repeated Games and Reputations: long run relationship, Oxford.
- 31 Milgrom P., J. Roberts (1986) Price and Advertising Signals of Product Quality *Journal of Political Economy* Vol. 94, No. 4 (Aug., 1986), pp. 796-821
- 32 Myerson R (1986) Multistage game with communication, *Econometrica*, 54:323-358.
- 33 Nash J. (1953) Two person cooperative games, *Econometrica*, 21:1:128-140.
- 34 Rasmusen E (2007) Games and Information, Blackwell, ISBN 1-140513666-9.
- 35 Rodrik D. (1989) Promises, Promises: Credible Policy Reform via Signalling *Economic Journal* Vol. 99, No. 397 (Sep., 1989), pp. 756-772
- 36 Rogerson W.P.(1988) Price Advertising and the Deterioration of Product Quality *Review of Economic Studies* Vol. 55, No. 2 (Apr., 1988), pp. 215-229
- 37 Riley J.P. (1979) Noncooperative Equilibrium and Market Signalling *American Economic Review* Vol. 69, No. 2, Papers and Proceedings of the Ninety-First Annual Meeting of the American Economic Association (May, 1979), pp. 303-307
- 38 Rubinstein A (1982) Perfect equilibrium in a bargaining model, *Econometrica*, 50:1:97-109.
- 39 Ryan M.J. (1998) Multiple criteria and framing of decisions, *Journal of Information and Optimisation Sciences*, 19:1:25-42.
- 40 Sobel J. (1985) A Theory of Credibility *Review of Economic Studies* Vol. 52, No. 4 (Oct., 1985), pp. 557-573
- 41 Sutton J. (1986) Non-Cooperative Bargaining Theory: An Introduction *The Review of Economic Studies*, Vol. 53, No. 5., pp. 709-724
- 42 Spence M. (1977) Consumer Misperceptions, Product Failure and Producer Liability *Review of Economic Studies* Vol. 44, No. 3 (Oct., 1977), pp. 561-572