Tuesday, August 30, 14:00, Room H3010

Set-valued analogues of the prenucleolus for cooperative TU games

Elena Yanovskaya, Russian Academy of Sciences

The nucleolus and prenucleolus are two of the major solution concepts in game theory. Both implement the maximal principle and consist of the vectors which are minimal with respect to the same relation of the space of excesses, i. e. of coalitional negative utilities. For TU games (with transferrable utilities) both solutions are single-valued. This property is caused by the consideration of the concrete (Schmeidler) excess function, whose the values are differences between the values of characteristic function of a game and the corresponding to some payoff vector coalitional payoff. However, it is possible to consider other excess functions as well.

A class ε of excess functions being Kalai's type excess functions for TU games is considered. Two set-valued solutions for TU games are defined: the union of prenucleoli over all excess functions from ε (the united prenucleolus) and the set of minimal payoff vectors of the relation $\bigcap_{e \in \varepsilon} \succ_e$ (the extended prenucleolus) where $\succ_e$ is the relation of weak order on the payoff vector set defining the prenucleolus with respect to the excess function e.

The characterizaion of both solutions by balancedness and the axiomatic characterization of the extended prenucleolus are given.

Tuesday, August 30, 14:30, Room H3010

Minimum Cost Forest Games

Jeroen Kuipers, University of Limburg

Consider a situation where a set of customers all wish to be connected to one or more suppliers. Each supplier offers a different type of service, e.g. they offer different types of information. A customer does not necessarily want a connection to all suppliers, but it is assumed that every customer wishes to be connected to at least one supplier. Furthermore, it is assumed that all types of services can be transmitted through the same type of connection cable.

It is the goal to establish a connection between each customer and every supplier to which this customer wishes to be connected. The connection of a customer to a supplier need not be a direct one. The connection may also be established via other customers and suppliers. We formulate the problem of connecting all customers at minimal cost as a minimum cost forest problem.

We assume that the cost of this minimal forest has to be shared by the customers. In order to solve this cost allocation problem we define a cooperative cost game associated with the problem, which is called a *minimum cost forest game*. We show that the core of a minimum cost forest game may be empty when there are three or more suppliers. However, the core is always non-empty if there are at most two suppliers. Furthermore, the core is always non-empty if there exists a customer who wishes to be connected to all suppliers.

Tuesday, August 30, 15:00, Room H3010

Equilibrium Model of Transition from Centralized Economy to Competitive Market

Vadim I. Arkin, Russian Academy of Sciences, Moscow
Alexander D. Slastnikov, Russian Academy of Sciences, Moscow

The report deals with modelling changes of economic mechanism (EM). We propose an approach which allows in the framework of dynamic equilibrium theory to state and study a problem of transition from one EM to another. We focus on the following two EM: the first one associates with centralized (state-controlled) economy when the State sets up prices and distributes budgets over the agents (both producers and consumers) according some priorities; under the second EM the role of the State is eliminated, his distributive functions are moved to the Market, and agents' budgets depend on their own activities (self-financing principle). An information about possible change of EM influences on agents' behavior. Variants of instantaneous transition can be accompanied by "undesirablephenomena (such as bankruptcy, jump of prices, deficit etc.). We propose a model of gradual transition from a centralized economy to a market based one. The corresponding transition process is free from drawbacks of instantaneous transition, guarantees (under appropriate conditions) an existence of equilibrium paths, and allows producers to adapt their plans to future market.

Tuesday, August 30, 15:30, Room H3010

Noncooperative Firms R&D Strategies in an Oligopolistic Industry

Domenico Campisi, Univ. of Rome "Tor Vergat
Paolo Mancuso, Univ. of Rome "Tor Vergat
Alberto Nastasi, Univ. of Rome "Tor Vergat

This paper deals with an oligopolistic industry where firms compete to increase their market shares. The optimal R&D strategy for each firm is developed using dynamic noncooperative games theory. The relations between firms R&D investments, the extra-industry R&D activity and firms stock of technological knowledge are analysed. Furthermore, the intertemporal impacts of firms R&D expenditures on the unit costs of their outputs are evaluated. On this basis, the ambiguity of spillover effect and the positive impact of the extra-industry R&D activity on firms R&D investments are showed. Finally, numerical simulations are provided.

Wednesday, August 31, 10:00, Room H3010

Three Theorems Contradicting Economic Statements of Politicians

Wolfgang Eichhorn, Universität Karlsruhe

The theorems show that a series of statements on contemporary economic problems made by politicians and commented on by journalists are more or less wrong.

Wednesday, August 31, 10:30, Room H3010

Shapleyscher Operator

Nikolai Worobjoff, Russian Academy of Science

Der Shapleyscher Vektor beschreibt eine der gegebenen charakteristischen Funktion zugeordnete, im gewissen Sinne "gerechte" Verteilung. Diese Zuordnung wird durch bekannte Axiome der Effektivität, Symmetrie und Aggregation (Linearität) wohlbegründet. Die ersten zwei dieser Axiome verursachen die sozusagen urspüngliche gleichmäßige Verteilung, und die letzte transformiert diese Verteilung in die gerechte.

Es wird eine Erweiterung dieser Transformation auf beliebige ursprüngliche Verteilungen vorgeschlagen. Dabei wird dieser Verteilung deren "Vergerechtigung" zugeordnet. Diese Zuordnung wird als Shapleyscher Operator bezeichnet.

Die Theorie des Shapleyschen Operators wird skizziert und teilweise ausgearbeitet. Insbesondere wird der Fixpunktsatz des Shapleyschen Operators für beliebige charakteristische Funktionen festgestellt und inhaltlich interpretiert. Für einige Klassen der charakteristischen Funktion (insbesondere für die der Dreipersonenspiele) wird das Funktionieren des Operators Shapley explizit beschrieben.

Wednesday, August 31, 14:00, Room H3010

Voting Correspondences for Public Goods

Bettina-Elisabeth Klaus, University of Limburg
Ton Storcken, University of Limburg

Consider collective choice problems where a group of agents has to locate a public facility/good in a Euclidean space.

A well known solution for such problems is the coordinatewise median, which has some desirable properties such as unanimity and strategy - proofness. In order to obtain a single valued outcome the coordinatewise median is only defined for an odd number of agents or by taking additional phantom voters into account. Here, however, this solution is extended to the even number case by allowing multivalued outcomes. This yields the coordinatewise median correspondence, which also satisfies unanimity and strategy - proofness. In addition it satisfies two population variation conditions, which describe a tie - breaking and a non - dictatorial effect of a newcomer on the solution set.

The main result is that these four conditions characterize the coordinatewise median correspondence.

Wednesday, August 31, 14:30, Room H3010

Indices of Structural Changes in the Theory of the Price Index

Bernhard Olt, Universität Karlsruhe

We present a new approach in the theory of the price index, based on I. Fisher's (1911) *Product Test*. This test requires the product of a price index and a quantity index to be equal to the aggregate's value change. Introducing a third factor and interpreting this factor as an index of changes of *relative* prices or *relative* quantities, i. e. of changes in the price or quantity *structure*, the wealth of price index formula suggestions can be considerably reduced.

For this purpose, in the tradition of the *statistical* price index theory the individual price and quantity ratios are regarded as realizations of two stochastic variables $\widetilde{P}$ and $\widetilde{Q}$. Then the aggregate's value change can be interpreted as the product of the expectations of $\widetilde{P}$ and $\widetilde{Q}$ plus the covariance between $\widetilde{P}$ and $\widetilde{Q}$. Expressing the (additive) covariance as a third (multiplicative) factor, this factor is a function of the *coefficients of variation* for prices and for quantities. These in fact can be regarded as *measures of inequality* of the vector of the individual price (resp. quantity) ratios. Interpreting the expectations of $\widetilde{P}$ and $\widetilde{Q}$ as price and quantity indices, the introduction of an *index measuring changes in the price or quantity structure* results in a "small" class of price indices.

Wednesday, August 31, 15:00, Room H3010

On m-Dimensional Division Problems with Single-Peaked Preferences

Hans Peters, University of Limburg, The Netherlands

In the literature up to now, mainly single-dimensional division problems with single-peaked preferences have been considered. In this paper we study such problems for higher dimensions, i.e., involving the division of more than one good. A main result is an axiomatic characterization of the so-called coordinatewise uniform rule based on a strategy-proofness condition.

Wednesday, August 31, 15:30, Room H3010

Coincidence of Weak Sequential and Sequential Equilibria

Andres Perea y Monsuwé, University of Limburg

We provide conditions under which the sets of weak sequential equilibria and sequential equilibria for extensive form games coincide. These conditions only depend on the graphical structure of the game. Every graphical structure which violates these conditions can be extended to an extensive form game in which the sets of weak sequential and sequential equilibria are different. In this way, the conditions provide a characterization of the class of graphical structures such that the sets of weak sequential and sequential equilibria are the same in every corresponding game. This characterization can be used to show that in a finite signaling game every weak sequential equilibrium is a sequential equilibrium.

Wednesday, August 31, 16:30, Room H3010

Asymptotic values and income redestribution under transition from a non-competitive economy to a competitive one

Gennady Diubin, Russian Academy of Sciences

A version of Kannai asymptotic value is introduced. This value depends not only on the characteristic function but also on a probability measure on the space of players. Every characteristic function defines a measure on the set of all measurable subsets of the space of players. The norm of the characteristic function is the variation of this measure. The Banach space of all characteristic functions with finite variation is considered. Under some mild regularity assumptions on the existence of the value is proved. The results are used for the investigation of transition from a rigidly planned economy (typical, e. g., for the countries of the former Eastern block) to a competitive economy.

Wednesday, August 31, 17:00, Room H3010

How to Measure Skill in Casino Games?

B. van der Genugten, Tilburg University
Peter Borm, Tilburg University

Dutch law states that a license is needed to commercialize games with (monetary) prizes if the participants in general can not exercise a prepondarating influence on the chance mechanism that selects the winners.Games covered by this act are called games of chance and those not covered by this act games of skill.In the Netherlands the Holland Casino foundation holds the monopoly to exploit games of chance.As a consequence the question whether a specific game should be considered as a game of chance or as a game of skill becomes predominant in the exploitation decision of other casinos. This paper aims for an objective and operational criterium to quantify the level of skill of (casino) games in order to establish a mutual ranking.The various concepts are illustrated by means of Roulette,Blackjack,Golden Ten and (variations of) Poker.

Wednesday, August 31, 17:30, Room H3010

On Continuous-Time Two Person Full-Information Best Choice Problem with Imperfect Observation

Zdzisław Porosiński, Technical University of Wrocław
Krzysztof Szajowski, Technical University of Wrocław

A zero-sum game version of the continuous-time full-information best choice problem is considered. Two players observe sequentially a stream of *iid* random variables from a known continuous distribution appearing according to some renewal process with the object of choosing the largest one. The horizon of observation is a positive random variable independent of observations. The observations of the random variables are imperfect and the players are informed only whether it is greater than or les than some levels specified by both of them. The normal form of the game is derived. Poisson horizon case is examined in detail.

Wednesday, August 31, 18:00, Room H3010

A New Solution Concept for Cooperative Games

Tadeusz Radzik, Wrocław Technical University, Poland

In the paper "A solidarity value for n-person transferable games"(A.S.Nowak and T.Radzik, International Journal of Game Theory, 1994 - in press), a new solution conception for cooperative games with side payments has been proposed. It is introduced with the help of some natural system of axioms which is similar to the system of axioms describing the classical Shapley value. The difference is that we replace there the "dummy player property"by another one, which has more solidarity-type interpretation. This result is strongly connected with the next one. Namely, it appears that the arithmetic mean of the Shapley value and the solidarity value is such a solution of cooperative games which has very natural and desirable (at least in some models) properties. It is shown that the solution in the form of that arithmetic mean is determined by some simple system of axioms with a very natural interpretation. The basic role in this system plays the notion of the so-called "average marginal contributionöf a player in a coalition. This new notion is a counterpart of the classical "marginal contribution"which arises in the description of the Shapley value.

Thursday, September 1, 09:00, Room H3010

On the Convexity of Delivery Games

Herbert Hamers, Tilburg University

The delivery problem, which arises form the Chinese postman problem, is defined on a connected graph in which the edges (streets) are identified with players. For delivering mail to a coalition S a postman has to make a S-tour. A S-tour is a tour that visits each street corresponding to a player of S at least once and may visit streets outside S. We assign to each street deliver costs and the travel costs. Each time the postman visits a street he charges the travel costs of this street. In case the postman makes a delivery in a street he also charges the deliver costs of this street. We assume that in any S-tour each street of S pays its own specific deliver costs and also once his specific travel costs. The remaining travel costs of S have to be paid by the members of S. Obviously, a coalition S wants to be served by an S-tour which mininimizes these remaining travel costs. Such an S-tour is called a minimal S-tour.
The delivery game, introduced by *Hamers, van de Leensel* and *Tijs (1994)*, arises from the delivery problem. The cost value of a coalition S is given by the remaining travel costs of a minimal S-tour. They showed that these games are not necessarily balanced. However, they proved that delivery games arising from delivery problems corresponding to bridge connected Euler graphs are balanced. This paper provides an example in which a delivery game that corresponds to a bridge connected Euler graph is not concave. For the delivery problems corresponding to weakly cyclic graphs, which is a subclass of bridge connected graphs, it is shown that the delivery games are concave.

Thursday, September 1, 09:30, Room H3010

Dynamic Noncooperative Firms R&D Strategies in an Oligopolistic Industry

Domenico Campisi, Dept. of Electronic Eng. - Univ. of Rome “Tor Vergata”,
Paolo Mancuso, I.A.S.I. - C.N.R.
Alberto Nastasi, Universität zu Köln, Los Alamos National Laboratory

This paper deals with an oligopolistic industry where firms are engaged in R&D activity in order to maximize their market shares. The existence of an optimal R&D strategy for each firm is discussed using dynamic noncooperative game theory. Furthermore, the intertemporal relations among firms R&D investments, the unit costs of their outputs and their market shares are analyzed in connection with the extra-industry R&D activity and the spillover effect.

Semi-Plenary Lecture
Thursday, September 1, 10:30, Room H3010

How to Play Games When Utilities Change During the Play

Michael Maschler, Hebrew University
Y. Gilboa, Hebrew University
J.-L. Ferreira, Hebrew University

A concept of “Credible Equilibrium” is developed, which determines what outcomes are stable in a non-cooperative game, taking into account that utilities of the players may change during the play of the game. The set of credible equilibria in never empty and coincides with the set of Nash equilibria when no change in utilities is expected.

Thursday, September 1, 14:00, Room H3010

Learning by Genetic Algorithms in Evolutionary Games

Herbert Dawid, Technische Universität Wien

We analyze the learning behavior of a Simple Genetic Algorithm in symmetric Strategic-Form-Games. In cases of contests within one population and also between two populations the behavior of the SGA is compared with the implications of equilibrium concepts in evolutionary game theory. The notion of 'GA-deceptive' games is introduced, and it is shown, that a GA can overcome the problems arising in such games not only if mutations are added, but also if conservative nonadaptive strings are inserted into the population.

Thursday, September 1, 14:30, Room H3010

ODYSSEUS ZIEHT IN DEN KRIEG—Ein spieltheoretischer Ansatz zur Klärung mythologischer Fragestellungen

Alexander Mehlmann, Technische Universität Wien

Der Fall des Kriegsdienstverweigeres Odysseus wird in der vorliegenden Arbeit als Ergebnis der extensiven Zugfolge in einem Dreipersonen-Spiel mit unvollständiger Information gedeutet. Die mykenische Partei wird durch den Spieler Palamedes repräsentiert. Dessen Widerparte sind Odysseus der Simulant und Odysseus der Wahnsinnige. Die Information, mit welchem dieser Beiden er es in Wirklichkeit zu tun hat, geht Palamedes gleich zu Spielbeginn ab. Im Mythos siegt die Schlauheit des Handwerkers (Palamedes) über die Bauernschläue des Odysseus. Die strategischen Einsichten, die unser Model liefert, begründen dies, wobei sie mitnichten die handelnden Heroen auf einfache archetypische Schemen reduzieren.

Thursday, September 1, 15:00, Room H3010

Null Players Out

Jean J.M. Derks, University of Limburg
H. Haller, Virginia Polytechnic Institute and State University, Blacksburg

In this paper we deal with the notion of a cooperative game in characteristic function form. The characteristic function represents the maximum aggregate utility the members of each possible coalition of players can achieve through cooperation among themselves. Individuals whose net contribution to any coalition is zero are called null players. The "null player axiomör "null player propertyällocates zero utility to null players in a utility allocation or assigns zero power to null players in a power index. While the null player property means that a null player neither gains nor benefits in excess of his (zero) net contribution, the utility allocation within the rest of the society can still be affected by the presence of a null player. Therefore, it makes sense to investigate the impact of the "null player outproperty which requires that a removal (addition) of a null player from (to) the game does not influence a utility allocation among the remaining players.

We derive necessary and sufficient conditions for a linear utility allocation function on the game space to have the "null player outproperty.

Friday, September 2, 10:30, Room H3010

On The Existence of Quasi Strong Equilibria for Bimatrix Games

Henk Norde, Tilburg University, Nijmegen University

It is a well-known fact that every finite game has a Nash-equilibrium. Since the set of Nash-equilibria is too large in many cases, several refinements of the Nash equilibrium concept have been proposed. Quasi-strict equilibria are introduced by Harsanyi. Such equilibria have the property that each player puts positive weight on each of his pure best replies. Not every finite game has a quasi-strict equilibrium: there are 3-person games without quasi-strict equilibrium. In this paper we prove the existence of a quasi-strict equilibrium for every bimatrix game.

An outline of the proof is the following. For every set T of pure strategies of player 2 a polytope K_T in Δ_2 (the mixed-strategy space of player 2) is constructed, such that K_T is contained in $\overset{\circ}{\Delta}_T$, the set of complete mixtures of the pure strategies in T. Moreover, a continuous map f_T from K_T into Δ_1 (the mixed-strategy space of player 1) is obtained, which can be regarded as an approximate best response function for player 1. On the other hand we define, for every $k \in \mathbf{N}$, an approximate best response function $g_T^k : \Delta_1 \to K_T$ for player 2 (the approximations being better for increasing k). These functions can be regarded as best responses for player 2 for the special case where he is allowed to use only strategies in T. For a suitable weighted combination over T of the maps $f_T \circ g_T^k$ Brouwer's fixed point theorem yields a fixed point p_k. For a limit point $\tilde{p}$ of $\{p_k\}_{k=1}^{\infty}$ there is a complementary strategy $\tilde{q}$ such that $(\tilde{p}, \tilde{q})$ is a quasi-strict equilibrium.

Friday, September 2, 11:00, Room H3010

Das Nested-Logit-Modell der diskreten Alternativenwahl: Eine Erweiterung mit Hilfe des Arbitrage-Konzeptes

Johannes Novotný, Universität Erlangen-Nürnberg

Zur Modellierung von diskreten Alternativenwahlmodellen bei vorherrschender Unsicherheit wird häufig der Logit-Ansatz verwendet. Kritik am Logit-Modell bezieht sich zumeist darauf, daß die stochastischen Anteile in der Nutzenfunktion als unabhängig und identisch verteilt angenommen werden. Eine Möglichkeit der Abschwächung der in manchen Anwendungssituationen sehr starken Unabhängigkeitsforderung besteht in der Schachtelung der Alternativenmenge, dem Nested-Logit-Ansatz. In der vorliegenden Arbeit wird eine Abschwächung auch der Identitätsannahme und damit eine Erweiterung dieses Ansatzes vorgeschlagen. Die Grundlage dafür wird aus einem zum Logit-Modell äquivalenten Arbitrage-Problem gewonnen.

Friday, September 2, 11:30, Room H3010

The Taxidriver's Dilemma: A New Look at Illicit Work and Implicit Contract

Stephan Rometsch, Freie Universität Berlin

The relevance of illicit working has, in recent years, become a topic of public and political interest particularly with regard to real, or imagined, losses to the public purse resulting from this practice. It is therefore not surprising that this interest has also been reflected in an increasing number of academic studies dealing with the subject. Yet the majority of the work is limited to estimations of the extent of illicit work, the probable losses to governmental revenues or the social and economic conditions which are likely to encourage people to engage in the practice. However little attention has been payed to the actual conditions under which such work is done, or more precisely, what conditions must prevail for an agreement between an illicit worker and her customer to take place. With the help of a specific example represented in terms of game theory this paper will develop these conditions and, more significantly, the restrictions they are subject to. Finally it will be indicated how this approach to the problem could offer reliable indicators as to the actual extent and nature of illicit work and its effects on the legal economy.

Friday, September 2, 12:00, Room H3010

Anreizabhängigkeiten im wiederholten Gefangenendilemma

Gernot Sieg, Universität Göttingen

Simulationen und Experimente zeigen, daß im iterierten Gefangenendilemma mit unbekannter Iterationsdauer kooperative Strategien (z.B. Tit for Tat) erfolgreich sind. Durch Simulation eines evolutionären Lernprozesses unter starkem Selektionsdruck mit Hilfe eines genetischen Algorithmus wird gezeigt, daß dieser Erfolg abhängig von der kardinalen Struktur der Auszahlungsmatrix ist. Dazu wird ceteris paribus die Auszahlung bei beiderseitiger Defektion sukzessive von der minimalen bis auf die Kooperationsauszahlung erhöht. Der Kooperationsgrad, d.h. der Anteil der erreichten Auszahlungen am Kooperationspayoff, ist umso niedriger, je höher die Auszahlung bei beiderseitiger Defektion ist. Daraus folgt, daß die Ergebnisse von Gefangenendilemmasimulationen nicht ohne Sensitivitätsanalyse bezüglich der Auszahlungsmatrix interpretiert werden dürfen, insbesondere wenn bei evolutionären Betrachtungen die Höhe des Payoffs einen Einfluß auf die Überlebens- und Verbreitungswahrscheinlichkeit und somit auf den Verlauf des Evolutionsprozesses besitzt.

Friday, September 2, 15:30, Room H3010

Strategy-Proof Preference Rules

Ton Storcken, Limburg University

We consider preference rules which assign to any combination of individual preferences (being actually any complete relations) a collective preference. Strategy-Proofness is based on the Kemeny distance between complete relations: a unilateral deviation does not change the outcome of the rule such that it becomes as close or closer to the deviator. It will be shown that strategy-proof and unanimous preference rules are independent of irrelevant alternatives. Furthermore, they are characterized by monotonic simple games of blocking and winning coalitions for every set of two alternatives.

Friday, September 2, 16:00, Room H3010

The Split Core for Sequencing Games

Jeroen Suijs, Tilburg University

In one machine sequencing situations there are n agents each having one job that has to be processed on a single machine. There is an initial order in which the agents are served and each agent incurs costs for every time unit he has to wait. Given the processing times and costs functions of the agents we can define a cooperative sequencing game. The worth of a coalition are the maximal cost savings this coalition can obtain

by admissible rearrangements w.r.t. the initial order. The order which maximizes the cost savings of the grand coalition can be formed from the initial order by consecutively switching places of neighbours only. The Equal Gain Splitting (EGS) rule introduced by Curiel, Pederzoli and Tijs (1989) divides the cost savings of the grand coalition. More precisely, the EGS rule divides the gain obtained at each neighbourswitch needed to form the optimal order, equally among the two neighbours involved. In this paper we introduce Gain Splitting rules which divide the gains obtained at these neighbourswitches not equally, but arbitrarily among the two neighbours involved. The set containing all Gain Splitting allocations is called the split core. The split core is a subset of the core of the sequencing game. Further we will show that the split core is the convex hull of n! permutation based vectors and that the EGS allocation is in the bary center of the split core. Finally we characterize the split core with efficiency, the dummy property and a kind of monotonicity.

Friday, September 2, 16:30, Room H3010

A Perfectness Concept for Multicriteria Games

Freek van Megen, Tilburg University
Peter Borm, Tilburg University
Stef Tijs, Tilburg University

This paper considers a refinement of Pareto equilibria for multicriteria games based on the perfectness concept of Selten (1975). Existence of perfect Pareto equilibria is shown and several characterizations are provided. Furthermore, contrary to the result for Pareto equilibria, an example shows that there is no exact correspondence between perfect Pareto equilibria and the perfect Nash equilibria of the related trade-off games.

Friday, September 2, 17:00, Room H3010

Common-Pool Resource Extraction: Dynamic Equilibria

David W. K. Yeung, The University of Hong Kong

It is well known that the speed with which firms choose to extract a non-renewable resource depends crucially on the firms' valuations of the unextracted resource. Under well definded porperty rights, abstracting from market imperfections, the firm will extract at a rate consistent with efficient conservation. When the resource is owned in common by a number of firms (which is quite common in the petroleum industry), the incentive to conserve the resource diverges from that of an efficient outcome. Up to date, only local approximations of a (closed-loop) feedback Nash equilibrium solution for a model of oligopolistic extraction of a common-pool resource has been successfully derived.

This paper develops a differential game of common-pool resource extraction and solves for its feedback Nash equilibrium solution. The value functions of the firms, a set of state-dependent feedback Nash equilibrium strategies and the game equilibrium resource stock dynamics are derived. The outcome under common-pool extraction is compared to the efficient outcome under initized production and it is found that distortions similar to those brought about by an escalation in the discount rate and negligence in externalities are present.