

Lahiri, Somdeb

Working Paper

The Cooperative Theory of Two Sided Matching Problems: A Re-examination of Some Results

Nota di Lavoro, No. 109.2004

Provided in Cooperation with:

Fondazione Eni Enrico Mattei (FEEM)

Suggested Citation: Lahiri, Somdeb (2004) : The Cooperative Theory of Two Sided Matching Problems: A Re-examination of Some Results, Nota di Lavoro, No. 109.2004, Fondazione Eni Enrico Mattei (FEEM), Milano

This Version is available at:

<https://hdl.handle.net/10419/117977>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

**The Cooperative Theory of Two
Sided Matching Problems:
A Re-examination of Some Results**

Somdeb Lahiri

NOTA DI LAVORO 109.2004

JULY 2004

CTN – Coalition Theory Network

Somdeb Lahiri, *School of Economic and Business Sciences, University of Witwatersrand*

This paper can be downloaded without charge at:

The Fondazione Eni Enrico Mattei Note di Lavoro Series Index:
<http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm>

Social Science Research Network Electronic Paper Collection:
<http://ssrn.com/abstract=XXXXXX>

The opinions expressed in this paper do not necessarily reflect the position of
Fondazione Eni Enrico Mattei

The Cooperative Theory of Two Sided Matching Problems: A Re-examination of Some Results

Summary

We show that, given two matchings of which say the second is stable, if (a) no firm prefers the first matching to the second, and (b) no firm and the worker it is paired with under the second matching prefer each other to their respective assignments in the first matching, then no worker prefers the second matching to the first. This result is a strengthening of a result originally due to Knuth (1976). A theorem due to Roth and Sotomayor (1990), says that if the number of workers increases, then there is a non-empty subset of firms and the set of workers they are assigned to under the F – optimal stable matching, such that given any stable matching for the old two-sided matching problem and any stable matching for the new one, every firm in the set prefers the new matching to the old one and every worker in the set prefers the old matching to the new one. We provide a new proof of this result using mathematical induction. This result requires the use of a theorem due to Gale and Sotomayor (1985 a,b), which says that with more workers around, firms prefer the new optimal stable matchings to the corresponding ones of the old two-sided matching problem, while the opposite is true for workers. We provide an alternative proof of the Gale and Sotomayor theorem, based directly on the deferred acceptance procedure.

Keywords: Two-sided matching, Stable

JEL Classification: C 71

I would like to thank Tamas Fleiner and Tali Diamant for comments and discussion. An earlier version of this paper was presented at the IBM-Taj International Conference on Game Theory held at Mumbai, from January 8-10, 2003. I would like to thank all those who attended the talk for their participation.

Address for correspondence:

Somdeb Lahiri
School of Economic and Business Sciences
University of Witwatersrand
Private Bag 3
WITS 2050
South Africa
E-mail: lahiris@sebs.wits.ac.za

1. Introduction : A salient feature of many markets is to match one kind of agent with another. This is particularly true, in the case of assigning workers to firms. Such markets are usually studied with the help of “two sided matching models” introduced by Gale and Shapley (1962). The emphasis in that work was on college admissions and marriage. None the less, the model is general enough to accommodate several other types of assignment problems.

The solution concept proposed by Gale and Shapley (1962), called a stable matching, requires that there should not exist two agents, each on a different side of the market, who prefer each other, to the individual they have been paired with. Gale and Shapley (1962) proved, that given any such two sided matching model, with one set consisting of firms and the other set consisting of workers, there was always a stable matching which no firm thought was inferior to any other stable matching, and there was always a stable matching that no worker thought was inferior to any other stable matching. The first was called an F – optimal stable matching (i.e. stable matching optimal for firms) and the second one a W – optimal stable matching (i.e. stable matching optimal for workers). An overview of the considerable literature that has evolved out of the work of Gale and Shapley (1962), is available in Roth and Sotomayor (1990).

The first significant result that we present here is a strengthening of a result originally due to Knuth (1976). The original result said that given any two stable matchings for a two-sided matching problem, if no firm prefers the first matching to the second, then no worker prefers the second matching to the first. In this paper we show that, given two matchings of which say the second is stable, if (a) no firm prefers the first matching to the second, and (b) no firm and the worker it is paired with under the second matching prefer each other to their respective assignments in the first matching, then no worker prefers the second matching to the first.

A theorem due to Roth and Sotomayor (1990), says that if the number of workers increases, then there is a non-empty subset of firms and the set of workers they are assigned to under the F – optimal stable matching, such that given any stable matching for the old two-sided matching problem and any stable matching for the new one, every firm in the set prefers the new matching to the old one and every worker in the set prefers the old matching to the new one. We provide a proof of this result using mathematical induction. Whereas the original proof used graph theory, our proof does not. In fact, the original proof was non-inductive. This result requires the use of a theorem due to Gale and Sotomayor (1985 a,b), which says that with more workers around, firms prefer the new optimal stable matchings to the corresponding ones of the old two-sided matching problem, while the opposite is true for workers. This result was originally proved in Gale and Sotomayor (1985 a,b), by using the lattice structure of stable matchings. Following recent approaches by Roth (2001), to arrive at new proofs of several existing results by directly appealing to the deferred acceptance procedure used by Gale and Shapley (1962), as for instance the Weak Pareto Optimality Property of F - optimal stable matchings and the Blocking Lemma of Demange, Gale and Sotomayor (1987), we provide an alternative proof of the Gale and Sotomayor theorem discussed above, based directly on the deferred acceptance procedure. Our proof does not rely on the lattice structure of stable matchings. Wolfstetter (1999) has a lucid discussion of such problems, where every matching is required to map the set of firms, bijectively onto the set of workers. In the traditional literature on matching theory, such models are known as marriage models. Moulin (1995) also contains an easily accessible discussion of the marriage model.

2. The Model : There are two non empty finite and disjoint sets: F of firms and W of workers. Each firm $f \in F$ has preferences over $W \cup \{f\}$ represented by a linear order R_f (: a binary relation R on a non empty subset of $F \cup W$ is said to be a linear order if it is reflexive, complete, anti- symmetric and transitive) and each worker $w \in W$ has preferences over $F \cup \{w\}$ represented by a linear order R_w . Given a binary relation R on $F \cup W$ and a non-empty subset S of $F \cup W$, let $R|_S = R \cap (S \times S)$ and let $P(R) = \{ (x,y) \in R / (y,x) \notin R \}$ denote the asymmetric part of R . A two-sided matching problem G is an array $\langle F, W, (R_x)_{x \in F \cup W} \rangle$. Given a two-sided matching problem G , $f \in F$ and $w \in W$, the acceptable set for f , denoted $A(f) = \{w \in W / (w,f) \in R_f\}$ and acceptable set for w , denoted $A(w) = \{f \in F / (f,w) \in R_w\}$. A pair $(f,w) \in F \times W$, is said to be mutually acceptable if $w \in A(f)$ and $f \in A(w)$. Given, $x,y,z \in F \cup W$, we denote $(y,z) \in R_x$ by $y \geq_x z$ and $(y,z) \in P(R_x)$ by $y >_x z$. Given a two-sided matching problem G , a matching for G is a bijection μ from $F \cup W$ to itself such that :
 - (i) for all $x \in F \cup W$: $\mu(x) \in A(x) \cup \{x\}$;
 - (ii) for all $x \in F \cup W$: $\mu(\mu(x)) = x$.
 Since the identity function on $F \cup W$ is a matching every two-sided matching problem admits at least one matching.

Given a matching μ for a two-sided matching problem G , a pair $(f, w) \in F \times W$ is said to block μ , if $f \succ_w \mu(w)$ and $w \succ_f \mu(f)$. The matching μ is said to be stable if it does not admit any blocking pair.

Given two matchings μ, μ' for G and a non-empty subset S of $F \cup W$, we write:

- (i) $\mu \geq_S \mu'$ if $\mu(x) \geq_x \mu'(x)$ for all $x \in S$;
- (ii) $\mu >_S \mu'$ if $\mu \geq_S \mu'$ but $\mu \neq \mu'$.

In the case where S is a singleton, $S = \{x\}$, we write $\mu \geq_x \mu'$ to denote $\mu \geq_{\{x\}} \mu'$ and $\mu >_x \mu'$ to denote $\mu >_{\{x\}} \mu'$.

A stable matching μ_F for G is said to be F - optimal (i.e. optimal for firms) if $\mu_F \geq_F \mu$, whenever μ is any stable matching for G .

A stable matching μ_W for G is said to be W - optimal (i.e. optimal for workers) if $\mu_W \geq_W \mu$, whenever μ is any stable matching for G .

3. Some Preliminary Lemmas:

Lemma 1: Let μ and $\bar{\mu}$ be stable matchings for a two-sided matching problem G .

Let $f \in F$ and $\mu(f) = w \in W$. If, $\mu(f) \succ_f \bar{\mu}(f)$, then $\bar{\mu}(w) \succ_w \mu(w)$. Conversely, if $\bar{\mu}(w) = \bar{f}$ and $\bar{\mu}(w) \succ_w \mu(w)$, then $\mu(\bar{f}) \succ_{\bar{f}} \bar{\mu}(\bar{f})$.

Proof : Suppose $\mu, \bar{\mu}, f$ and w are as above. If $w = \mu(f) \succ_f \bar{\mu}(f)$, then $\bar{\mu}(w) \neq f$.

Thus stability of $\bar{\mu}$ requires, $\bar{\mu}(w) \succ_w f = \mu(w)$. Conversely, if $\bar{f} = \bar{\mu}(w) \succ_w \mu(w)$, then since $\mu(\bar{f}) \neq w$, stability of μ requires that $\mu(\bar{f}) \succ_{\bar{f}} w = \bar{\mu}(\bar{f})$. Q.E.D.

The following lemma extends one due to Knuth (1976):

Lemma 2 : Let G be a two-sided matching problem, for which $\bar{\mu}$ is a stable matching. Suppose that μ is a matching such that $\bar{\mu} \geq_F \mu$. If there does not exist $f \in F$, such that $(f, \bar{\mu}(f))$ block μ , then $\mu \geq_W \bar{\mu}$.

Proof : Towards a contradiction suppose that $f = \bar{\mu}(w) \succ_w \mu(w)$, for some $w \in W$.

Since $(f, \bar{\mu}(f)) = (f, w)$ does not block μ , and since $\mu(f) \neq w$, it must be the case that $\mu(f) \succ_f w = \bar{\mu}(f)$. This contradicts the hypothesis $\bar{\mu} \geq_F \mu$, and proves the lemma. Q.E.D.

Hence, if in Lemma 2, μ is a stable matching, then, $\bar{\mu} \geq_F \mu$ if and only if

$\mu \geq_W \bar{\mu}$. This is precisely the result in Knuth (1976), which Lemma 2 extends.

4. The Gale-Shapley Theorem and its consequences:

We begin this section by presenting the seminal theorem due to Gale and Shapley (1962). In an appendix to this paper we provide the procedure (Deferred Acceptance Procedure With Firms Making Offers) used to prove the theorem, since the same argument is required in the proofs of several theorems that follow.

Theorem 1 (Gale and Shapley (1962)) : Every two-sided matching problem admits an F-optimal and a W-optimal stable matching.

As a consequence of Lemma 2 and Theorem 1 we obtain the following result:

Corollary of Lemma 2 : Let G be a two-sided matching problem and suppose μ is an unstable matching, such that $\mu_F >_F \mu$. If there does not exist a pair $(f, \mu_F(f))$ which blocks μ , then there exists $f \in F$ and $w \in W$, such that $\mu_F(f) >_f \mu(f)$ and $f >_w \mu(w)$.

Proof : Suppose that there does not exist a pair $(f, \mu_F(f))$ which blocks μ . Thus, there does not exist a pair $(\mu_F(w), w)$ which blocks μ . Thus, $f = \mu_F(w) >_w \mu(w)$ implies $\mu(f) >_f w = \mu_F(f)$. This contradicts $\mu_F >_F \mu$. Thus, $\mu \geq_W \mu_F$. Since μ is unstable there exists a pair (f, w) which blocks μ . Thus, $w >_f \mu(f)$ and $f >_w \mu(w)$. If $\mu_F(f) \geq_f w$, then we are done. Hence suppose $w >_f \mu_F(f)$. Since μ_F is stable, $\mu_F(w) >_w f$. Thus $\mu_F(w) >_w \mu(w)$. This contradicts, $\mu \geq_W \mu_F$. Thus there exists $f \in F$ and $w \in W$, such that $\mu_F(f) >_f \mu(f)$ and $f >_w \mu(w)$. Q.E.D.

Another direct consequence of a combination of Lemma 2 and the deferred acceptance procedure with firms making offers is the following theorem due to Gale and Sotomayor (1985 a,b).

Theorem 2 (Gale and Sotomayor (1985 a,b)) : Let $G = \langle F, W, (R_x)_{x \in F \cup W} \rangle$ and $G' = \langle F, W', (R'_x)_{x \in X} \rangle$, where $W \subset W'$, $X = F \cup W'$ and $R_x = R'_x \upharpoonright F \cup W$ for all $x \in F \cup W$.

Let μ_F and μ_W be the F – optimal and W – optimal stable matchings for G . Let μ'_F and μ'_W be the F – optimal and W – optimal stable matchings for G' . Then,
(i) $\mu_F \geq_W \mu'_F$, $\mu_W \geq_W \mu'_W$; (ii) $\mu'_W \geq_F \mu_W$, $\mu'_F \geq_F \mu_F$.

Proof : By the symmetry of the F- optimal stable matching and the W- optimal stable matchings and Lemma 2 it is enough to prove the following:

(a) Let $G = \langle F, W, (R_x)_{x \in F \cup W} \rangle$ and $G' = \langle F, W', (R'_x)_{x \in X} \rangle$, where $W \subset W'$, $X = F \cup W'$ and $R_x = R'_x \upharpoonright F \cup W$ for all $x \in F \cup W$. Let μ_F be the F – optimal for G and let μ'_F be the F – optimal stable matchings for G' . Then, $\mu'_F \geq_F \mu_F$.

(b) Let $G = \langle F, W, (R_x)_{x \in F \cup W} \rangle$ and $G' = \langle F', W, (R'_x)_{x \in X} \rangle$, where $F \subset F'$, $X = F' \cup W$ and $R_x = R'_x \upharpoonright F \cup W$ for all $x \in F \cup W$. Let μ_F be the F – optimal for G and let μ'_F be the F – optimal stable matchings for G' . Then, $\mu_F \geq_F \mu'_F$.

Let us first prove (a). Suppose that at the first step of the deferred acceptance procedure for G' , a firm f is rejected by a worker $w = \mu_F(f)$. Since, worker w , proceeds up his ranking during the procedure, w rejects f in favor of some other firm f' . This follows from the fact that the set of firms acceptable to w is non-empty. Since, f' made the offer to w at the very first step, f' ranks w first and hence above, $\mu_F(f')$. This contradicts the stability of μ_F .

Suppose that up to a certain stage in the deferred acceptance procedure for G' , no firm f is rejected by a worker $w = \mu_F(f)$. Suppose that at the next stage of the procedure for G' , a firm f is rejected by a worker $w = \mu_F(f)$ in favor of another firm f' . Thus, w prefers f' to f . By the induction hypothesis, f' has not been rejected by $\mu_F(f')$ up to the stage, where it makes the offer to w in the deferred acceptance procedure for G' . Since, f' moves one rank down at a time in the procedure, $w \geq_{f'} \mu_F(f')$. Since $w \neq \mu_F(f')$, $w >_{f'} \mu_F(f')$, contradicting the stability of μ_F . Thus, even at this stage of the deferred acceptance procedure for G' , no firm f is rejected by a worker $w = \mu_F(f)$. Since the procedure terminates in a finite number of steps, it must be the case that $\mu'_F \geq_F \mu_F$.

Now let us prove (b). For a stage k of the deferred acceptance procedure for G and $w \in W$, let $F^k(w) = \{f \in F / f \text{ makes an offer to } w\}$. For a stage k of the deferred acceptance procedure for G' and $w \in W$, let $H^k(w) = \{f \in F' / f \text{ makes an offer to } w\}$. Clearly, $F^1(w) \subset H^1(w)$ for all $w \in W$. Further, for all $w \in W$, any firm who is rejected from $F^1(w)$ is also rejected from $H^1(w)$. Suppose that up to a stage K of the two procedures: $[\bigcup_{k=1}^K F^k(w) \subset \bigcup_{k=1}^K H^k(w) \text{ for all } w \in W]$ and $[\text{for all } w \in W,$

any firm who is rejected from $\bigcup_{k=1}^K F^k(w)$ by w at a stage $k \leq K$, is also rejected

from $\bigcup_{k=1}^K H^k(w)$ by w at the same stage or earlier]. Suppose firm f makes an offer to worker w at stage $K+1$ in the deferred acceptance procedure for G . In that case there must have been a worker w' , such that $f \in F^k(w')$ for some $k < K+1$ and f was rejected by w' from $\bigcup_{k=1}^K F^k(w')$ at stage K . Thus, $f \in \bigcup_{k=1}^K F^k(w')$, and f was rejected

by w' from $\bigcup_{k=1}^K F^k(w')$ at stage K . By the induction hypothesis, $f \in \bigcup_{k=1}^K H^k(w')$,

and f was rejected by w' from $\bigcup_{k=1}^K H^k(w')$ at stage K or earlier. Since each firm

moves down its list of acceptable workers one rank at a time in the deferred acceptance procedure, the fact that f makes an offer to w after being rejected by w' in the procedure for G , implies that it would be doing the same in the procedure

for G' . Thus, $\bigcup_{k=1}^{K+1} F^k(w) \subset \bigcup_{k=1}^{K+1} H^k(w)$. Further, any firm who is rejected from $\bigcup_{k=1}^{K+1} F^k(w)$ at stage $K+1$, will also be rejected from $\bigcup_{k=1}^{K+1} H^k(w)$ at stage $K+1$, unless it has already been rejected at an earlier stage. Thus, even up to stage $K+1$ of the two procedures, $[\bigcup_{k=1}^{K+1} F^k(w) \subset \bigcup_{k=1}^{K+1} H^k(w)$ for all $w \in W]$ and [for all $w \in W$, any firm who is rejected from $\bigcup_{k=1}^{K+1} F^k(w)$ by w at a stage $k \leq K+1$, is also rejected from $\bigcup_{k=1}^{K+1} H^k(w)$ by w at the same stage or earlier]. Since each firm moves down its list of acceptable workers one rank at a time in the deferred acceptance procedure, it follows that $\mu_F \geq_F \mu'_F$. Q.E.D.

5. The Roth and Sotomayor theorem:

Theorem 3 (Roth and Sotomayor (1990)): Let $G = \langle F, W, (R_x)_{x \in F \cup W} \rangle$ and $G' = \langle F, W', (R'_x)_{x \in X} \rangle$, where $W' = W \cup \{w_0\}$, $w_0 \notin W$, $X = F \cup W'$ and $R_x = R'_x \upharpoonright F \cup W$ for all $x \in F \cup W$. Let μ^* be the F - optimal stable matching for G and let μ^{**} the W - optimal stable matching for G' . If w_0 is not single under μ^{**} , then given any stable matching μ for G and μ' for G' there exists a non-empty subset S of firms, such that $\mu' >_S \mu$ and $\mu >_{W^*} \mu'$, where $W^* = W \cap \mu^*(S)$.

Proof: We prove by induction on the cardinality of W that there exists a non-empty subset S of firms, such that $\mu^{**} >_S \mu^*$ and $\mu^* >_{W^*} \mu^{**}$, where $W^* = W \cap \mu^*(S)$.

Let $\mu^{**}(w_0) = f_0$. Suppose $\#W = 1$. Let $W = \{w\}$.

- (a) If w is single under μ^* , then $\mu^*(f) = f$ for all $f \in F$. Let $S = \{f_0\}$. Thus, $\mu^{**} >_S \mu^*$. Since, $W^* = \emptyset$, $\mu >_{W^*} \mu^{**}$ holds vacuously.
- (b) If $\mu^*(w) = f \neq f_0$, then $\mu^*(f_0) = f_0$. Let $S = \{f_0\}$. Thus, $\mu^{**} >_S \mu^*$. Since, $W^* = \emptyset$, $\mu^* >_{W^*} \mu^{**}$ holds vacuously.
- (c) If $\mu^*(w) = f_0$, then for all $f \in F \setminus \{f_0\}$, $w >_f$ implies $f_0 >_w f$ by the stability of μ^* and the fact that $W = \{w\}$. Further $f_0 >_w w$. If f_0 prefers w to w_0 then the pair (f_0, w_0) would block μ^{**} contradicting its stability. Thus, f_0 prefers w_0 to w .

Let $S = \{f_0\}$. Thus, $\mu^{**} >_S \mu^*$ and $\mu^* >_{W^*} \mu^{**}$, where $W^* = \{w\}$.

Hence the required assertion is true for $\#W = 1$.

Suppose the required assertion is true for $\#W = 1, \dots, k$ and now let $\#W = k+1$. If $\mu^*(f_0) = f_0$, then by letting $S = \{f_0\}$, the required assertion is easily seen to hold.

Hence suppose $\mu^*(f_0) = w_1 \in W$. Thus, w_1 prefers f_0 to remaining single.

Case 1: $\mu^{**}(w_1) = w_1$.

If f_0 prefers w_1 to w_0 , then the pair (f_0, w_1) would block μ^{**} , contradicting its stability. Thus f_0 prefers w_0 to w_1 . Let $S = \{f_0\}$. Thus, $\mu^{**} >_S \mu^*$ and $\mu^* >_{W^*} \mu^{**}$, where $W^* = \{w_1\}$.

Case 2: $\mu^{**}(w_1) = f_1 \in F$.

Let $Z' = X \setminus \{w_1\}$ and $Z = Z' \setminus \{w_0\}$. Let $G_1 = \langle F, W \setminus \{w_1\}, (Q'_x)_{x \in Z'} \rangle$, $G_2 = \langle F, W \setminus \{w_0, w_1\}, (Q_x)_{x \in Z} \rangle$, where for all $x \in Z'$, $Q'_x = R'_x|Z'$ and for all $x \in Z$, $Q_x = R_x|Z$. Let μ be the F-optimal stable matching for G_2 and μ' be the W-optimal stable matching for G_1 .

By the induction hypothesis there exists a non-empty subset S of F , such that $\mu' >_S \mu$ and $\mu(w) >_w \mu'(w)$ for all $w \in (W \setminus \{w_1\}) \cap \mu(S)$.

By Theorem 2, $\mu^{**} \geq_F \mu'$, $\mu \geq_F \mu^*$.

Now, $\mu^{**} \geq_F \mu'$, $\mu' >_S \mu$ and $\mu \geq_F \mu^*$ implies $\mu^{**} >_S \mu^*$.

By Lemma 2, $\mu^* >_{W^*} \mu^{**}$.

It now follows by a standard induction argument that for all cardinalities of W , there exists a non-empty subset S of firms, such that $\mu^{**} >_S \mu^*$ and $\mu^* >_{W^*} \mu^{**}$, where $W^* = W \cap \mu^*(S)$.

Further $\mu^* \geq_F \mu$ and $\mu^{**} \geq_{W'} \mu'$.

By Lemma 2, $\mu' \geq_F \mu^{**}$ and $\mu \geq_W \mu^*$. Hence, $\mu' \geq_F \mu^{**}$, $\mu^{**} >_S \mu^*$ and $\mu^* \geq_F \mu$ implies $\mu' >_S \mu$. Similarly, $\mu \geq_W \mu^*$, $\mu^* >_{W^*} \mu^{**}$ and $\mu^{**} \geq_{W'} \mu'$ implies $\mu >_{W^*} \mu'$.

This proves the theorem. Q.E.D.

References :

1. D. Gale and L. Shapley (1962) : “ College Admissions and the stability of Marriage”, American Mathematical Monthly, Volume 69, pages 9 – 15.
2. D. Gale and M. Sotomayor (1985 a) : “ Some Remarks on the Stable Matching Problem”, Discrete Applied Mathematics, Volume 11, pages 223 – 232.
3. D. Gale and M. Sotomayor (1985 b) : “ Ms. Machiavelli and the stable matching problem”, American Mathematical Monthly, Volume 92, pages 261-268.
4. D. Knuth (1976) : “Marriages Stables”, Montreal : Les Presses de l'Universite de Montreal.
5. H. Moulin (1995) : “ Cooperative Microeconomics: A game-theoretic introduction”, Princeton Univ. Press.
6. A. Roth (2001) : "Introduction to the Theory of Two Sided Matching", unpublished lecture note, Harvard University.
7. A. Roth and M. Sotomayor (1990) : “ Two – Sided Matching: A Study in Game Theoretic Modeling and Analysis”, Econometric Society Monograph No : 18, Cambridge University Press.

8. E. Wolfstetter (2001) : “ Topics in Microeconomics: Industrial Organization, Auctions and Incentives”, Cambridge University Press.

Appendix

Deferred Acceptance Procedure With Firms Making Offers (Gale and Shapley (1962)): To start each firm makes an offer to its favorite worker, i.e. to its first worker on its list of acceptable workers. Each worker rejects the offer of any firm who is unacceptable to him, and each worker who receives one or more acceptable offers, rejects all but his most preferred of these. Any firm whose offer is not rejected at this point is kept “pending”.

At any step any firm whose offer was rejected at the previous step, makes an offer to its next choice (i.e., to its most preferred acceptable worker, among those who have not rejected its offer), so long as there remains an acceptable worker to whom it has not yet made an offer. If at any step of the procedure, a firm has already made offers to, and been rejected by all workers it finds acceptable, then it makes no further offers. Each worker receiving offers rejects any from unacceptable firms, and also rejects all but his most preferred among the group consisting of the new offers together with any firm that he may have kept pending from the previous step.

The algorithm stops after any step in which no firm is rejected. At this point, every firm is either kept pending by some worker or has been rejected by every worker on its list of acceptable workers. The matching that is defined now, associates to each firm the worker who has kept him pending, if there be any. Further, workers who did not receive any offers at all and firms who have been rejected by all the workers on their list of acceptable workers, remain single. In the above procedure, each firm, proceeds down its list of acceptable workers, and each worker proceeds up his list of acceptable firms.

Let us call this matching μ_F .

Note : It follows from the deferred acceptance procedure that a worker who is not employed, either has a empty set of admissible firms or is ranked below the F-optimal stable matching allocation of every firm. The latter, in particular implies that the concerned worker is unacceptable to any firm who in spite of being acceptable to the worker, does not employ any worker in the F-optimal stable matching.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Paper Series

Our Note di Lavoro are available on the Internet at the following addresses:

<http://www.feem.it/Feem/Pub/Publications/WPapers/default.html>

<http://www.ssrn.com/link/feem.html>

NOTE DI LAVORO PUBLISHED IN 2003

PRIV	1.2003	<i>Gabriella CHIESA and Giovanna NICODANO: <u>Privatization and Financial Market Development: Theoretical Issues</u></i>
PRIV	2.2003	<i>Ibolya SCHINDELE: <u>Theory of Privatization in Eastern Europe: Literature Review</u></i>
PRIV	3.2003	<i>Wietze LISE, Claudia KEMFERT and Richard S.J. TOL: <u>Strategic Action in the Liberalised German Electricity Market</u></i>
CLIM	4.2003	<i>Laura MARSILIANI and Thomas I. RENSTRÖM: <u>Environmental Policy and Capital Movements: The Role of Government Commitment</u></i>
KNOW	5.2003	<i>Reyer GERLAGH: <u>Induced Technological Change under Technological Competition</u></i>
ETA	6.2003	<i>Efrem CASTELNUOVO: <u>Squeezing the Interest Rate Smoothing Weight with a Hybrid Expectations Model</u></i>
SIEV	7.2003	<i>Anna ALBERINI, Alberto LONGO, Stefania TONIN, Francesco TROMBETTA and Margherita TURVANI: <u>The Role of Liability, Regulation and Economic Incentives in Brownfield Remediation and Redevelopment: Evidence from Surveys of Developers</u></i>
NRM	8.2003	<i>Elissaios PAPYRAKIS and Reyner GERLAGH: <u>Natural Resources: A Blessing or a Curse?</u></i>
CLIM	9.2003	<i>A. CAPARRÓS, J.-C. PEREAU and T. TAZDAÏT: <u>North-South Climate Change Negotiations: a Sequential Game with Asymmetric Information</u></i>
KNOW	10.2003	<i>Giorgio BRUNELLO and Daniele CHECCHI: <u>School Quality and Family Background in Italy</u></i>
CLIM	11.2003	<i>Efrem CASTELNUOVO and Marzio GALEOTTI: <u>Learning By Doing vs Learning By Researching in a Model of Climate Change Policy Analysis</u></i>
KNOW	12.2003	<i>Carole MAIGNAN, Gianmarco OTTAVIANO and Dino PINELLI (eds.): <u>Economic Growth, Innovation, Cultural Diversity: What are we all talking about? A critical survey of the state-of-the-art</u></i>
KNOW	13.2003	<i>Carole MAIGNAN, Gianmarco OTTAVIANO, Dino PINELLI and Francesco RULLANI (lix): <u>Bio-Ecological Diversity vs. Socio-Economic Diversity. A Comparison of Existing Measures</u></i>
KNOW	14.2003	<i>Maddy JANSSENS and Chris STEYAERT (lix): <u>Theories of Diversity within Organisation Studies: Debates and Future Trajectories</u></i>
KNOW	15.2003	<i>Tuzin BAYCAN LEVENT, Enno MASUREL and Peter NIJKAMP (lix): <u>Diversity in Entrepreneurship: Ethnic and Female Roles in Urban Economic Life</u></i>
KNOW	16.2003	<i>Alexandra BITUSIKOVA (lix): <u>Post-Communist City on its Way from Grey to Colourful: The Case Study from Slovakia</u></i>
KNOW	17.2003	<i>Billy E. VAUGHN and Katarina MLEKOV (lix): <u>A Stage Model of Developing an Inclusive Community</u></i>
KNOW	18.2003	<i>Selma van LONDEN and Arie de RUIJTER (lix): <u>Managing Diversity in a Globalizing World</u></i>
Coalition	19.2003	<i>Sergio CURRARINI: <u>On the Stability of Hierarchies in Games with Externalities</u></i>
Theory	20.2003	<i>Giacomo CALZOLARI and Alessandro PAVAN (lx): <u>Monopoly with Resale</u></i>
Network	21.2003	<i>Claudio MEZZETTI (lx): <u>Auction Design with Interdependent Valuations: The Generalized Revelation Principle, Efficiency, Full Surplus Extraction and Information Acquisition</u></i>
PRIV	22.2003	<i>Marco LiCalzi and Alessandro PAVAN (lx): <u>Tilting the Supply Schedule to Enhance Competition in Uniform-Price Auctions</u></i>
PRIV	23.2003	<i>David ETTINGER (lx): <u>Bidding among Friends and Enemies</u></i>
PRIV	24.2003	<i>Hannu VARTIAINEN (lx): <u>Auction Design without Commitment</u></i>
PRIV	25.2003	<i>Matti KELOHARJU, Kjell G. NYBORG and Kristian RYDQVIST (lx): <u>Strategic Behavior and Underpricing in Uniform Price Auctions: Evidence from Finnish Treasury Auctions</u></i>
PRIV	26.2003	<i>Christine A. PARLOUR and Uday RAJAN (lx): <u>Rationing in IPOs</u></i>
PRIV	27.2003	<i>Kjell G. NYBORG and Ilya A. STREBULAIEV (lx): <u>Multiple Unit Auctions and Short Squeezes</u></i>
PRIV	28.2003	<i>Anders LUNANDER and Jan-Eric NILSSON (lx): <u>Taking the Lab to the Field: Experimental Tests of Alternative Mechanisms to Procure Multiple Contracts</u></i>
PRIV	29.2003	<i>TangaMcDANIEL and Karsten NEUHOFF (lx): <u>Use of Long-term Auctions for Network Investment</u></i>
PRIV	30.2003	<i>Emiel MAASLAND and Sander ONDERSTAL (lx): <u>Auctions with Financial Externalities</u></i>
ETA	31.2003	<i>Michael FINUS and Bianca RUNDSHAGEN: <u>A Non-cooperative Foundation of Core-Stability in Positive Externality NTU-Coalition Games</u></i>
KNOW	32.2003	<i>Michele MORETTO: <u>Competition and Irreversible Investments under Uncertainty</u></i>
PRIV	33.2003	<i>Philippe QUIRION: <u>Relative Quotas: Correct Answer to Uncertainty or Case of Regulatory Capture?</u></i>
KNOW	34.2003	<i>Giuseppe MEDA, Claudio PIGA and Donald SIEGEL: <u>On the Relationship between R&D and Productivity: A Treatment Effect Analysis</u></i>
ETA	35.2003	<i>Alessandra DEL BOCA, Marzio GALEOTTI and Paola ROTA: <u>Non-convexities in the Adjustment of Different Capital Inputs: A Firm-level Investigation</u></i>

GG	36.2003	<i>Matthieu GLACHANT</i> : <u>Voluntary Agreements under Endogenous Legislative Threats</u>
PRIV	37.2003	<i>Narjess BOUBAKRI, Jean-Claude COSSET and Omrane GUEDHAMI</i> : <u>Postprivatization Corporate Governance: the Role of Ownership Structure and Investor Protection</u>
CLIM	38.2003	<i>Rolf GOLOMBEK and Michael HOEL</i> : <u>Climate Policy under Technology Spillovers</u>
KNOW	39.2003	<i>Slim BEN YOUSSEF</i> : <u>Transboundary Pollution, R&D Spillovers and International Trade</u>
CTN	40.2003	<i>Carlo CARRARO and Carmen MARCHIORI</i> : <u>Endogenous Strategic Issue Linkage in International Negotiations</u>
KNOW	41.2003	<i>Sonia OREFFICE</i> : <u>Abortion and Female Power in the Household: Evidence from Labor Supply</u>
KNOW	42.2003	<i>Timo GOESCHL and Timothy SWANSON</i> : <u>On Biology and Technology: The Economics of Managing Biotechnologies</u>
ETA	43.2003	<i>Giorgio Busetti and Matteo MANERA</i> : <u>STAR-GARCH Models for Stock Market Interactions in the Pacific Basin Region, Japan and US</u>
CLIM	44.2003	<i>Katrin MILLOCK and Céline NAUGES</i> : <u>The French Tax on Air Pollution: Some Preliminary Results on its Effectiveness</u>
PRIV	45.2003	<i>Bernardo BORTOLOTTI and Paolo PINOTTI</i> : <u>The Political Economy of Privatization</u>
SIEV	46.2003	<i>Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH</i> : <u>Burn or Bury? A Social Cost Comparison of Final Waste Disposal Methods</u>
ETA	47.2003	<i>Jens HORBACH</i> : <u>Employment and Innovations in the Environmental Sector: Determinants and Econometrical Results for Germany</u>
CLIM	48.2003	<i>Lori SNYDER, Nolan MILLER and Robert STAVINS</i> : <u>The Effects of Environmental Regulation on Technology Diffusion: The Case of Chlorine Manufacturing</u>
CLIM	49.2003	<i>Lori SNYDER, Robert STAVINS and Alexander F. WAGNER</i> : <u>Private Options to Use Public Goods. Exploiting Revealed Preferences to Estimate Environmental Benefits</u>
CTN	50.2003	<i>László Á. KÓCZY and Luc LAUWERS (Ixi)</i> : <u>The Minimal Dominant Set is a Non-Empty Core-Extension</u>
CTN	51.2003	<i>Matthew O. JACKSON (Ixi)</i> : <u>Allocation Rules for Network Games</u>
CTN	52.2003	<i>Ana MAULEON and Vincent VANNETELBOSCH (Ixi)</i> : <u>Farsightedness and Cautiousness in Coalition Formation</u>
CTN	53.2003	<i>Fernando VEGA-REDONDO (Ixi)</i> : <u>Building Up Social Capital in a Changing World: a network approach</u>
CTN	54.2003	<i>Matthew HAAG and Roger LAGUNOFF (Ixi)</i> : <u>On the Size and Structure of Group Cooperation</u>
CTN	55.2003	<i>Taiji FURUSAWA and Hideo KONISHI (Ixi)</i> : <u>Free Trade Networks</u>
CTN	56.2003	<i>Halis Murat YILDIZ (Ixi)</i> : <u>National Versus International Mergers and Trade Liberalization</u>
CTN	57.2003	<i>Santiago RUBIO and Alistair ULPH (Ixi)</i> : <u>An Infinite-Horizon Model of Dynamic Membership of International Environmental Agreements</u>
KNOW	58.2003	<i>Carole Maignan, Dino PINELLI and Gianmarco I.P. OTTAVIANO</i> : <u>ICT, Clusters and Regional Cohesion: A Summary of Theoretical and Empirical Research</u>
KNOW	59.2003	<i>Giorgio BELLETTINI and Gianmarco I.P. OTTAVIANO</i> : <u>Special Interests and Technological Change</u>
ETA	60.2003	<i>Ronnie SCHÖB</i> : <u>The Double Dividend Hypothesis of Environmental Taxes: A Survey</u>
CLIM	61.2003	<i>Michael FINUS, Ekko van Ierland and Robert DELLINK</i> : <u>Stability of Climate Coalitions in a Cartel Formation Game</u>
GG	62.2003	<i>Michael FINUS and Bianca RUNDSHAGEN</i> : <u>How the Rules of Coalition Formation Affect Stability of International Environmental Agreements</u>
SIEV	63.2003	<i>Alberto PETRUCCI</i> : <u>Taxing Land Rent in an Open Economy</u>
CLIM	64.2003	<i>Joseph E. ALDY, Scott BARRETT and Robert N. STAVINS</i> : <u>Thirteen Plus One: A Comparison of Global Climate Policy Architectures</u>
SIEV	65.2003	<i>Edi DEFRANCESCO</i> : <u>The Beginning of Organic Fish Farming in Italy</u>
SIEV	66.2003	<i>Klaus CONRAD</i> : <u>Price Competition and Product Differentiation when Consumers Care for the Environment</u>
SIEV	67.2003	<i>Paulo A.L.D. NUNES, Luca ROSSETTO, Arianne DE BLAEIJ</i> : <u>Monetary Value Assessment of Clam Fishing Management Practices in the Venice Lagoon: Results from a Stated Choice Exercise</u>
CLIM	68.2003	<i>ZhongXiang ZHANG</i> : <u>Open Trade with the U.S. Without Compromising Canada's Ability to Comply with its Kyoto Target</u>
KNOW	69.2003	<i>David FRANTZ (Ixi)</i> : <u>Lorenzo Market between Diversity and Mutation</u>
KNOW	70.2003	<i>Ercole SORI (Ixi)</i> : <u>Mapping Diversity in Social History</u>
KNOW	71.2003	<i>Ljiljana DERU SIMIC (Ixi)</i> : <u>What is Specific about Art/Cultural Projects?</u>
KNOW	72.2003	<i>Natalya V. TARANOVA (Ixi)</i> : <u>The Role of the City in Fostering Intergroup Communication in a Multicultural Environment: Saint-Petersburg's Case</u>
KNOW	73.2003	<i>Kristine CRANE (Ixi)</i> : <u>The City as an Arena for the Expression of Multiple Identities in the Age of Globalisation and Migration</u>
KNOW	74.2003	<i>Kazuma MATOBA (Ixi)</i> : <u>Glocal Dialogue- Transformation through Transcultural Communication</u>
KNOW	75.2003	<i>Catarina REIS OLIVEIRA (Ixi)</i> : <u>Immigrants' Entrepreneurial Opportunities: The Case of the Chinese in Portugal</u>
KNOW	76.2003	<i>Sandra WALLMAN (Ixi)</i> : <u>The Diversity of Diversity - towards a typology of urban systems</u>
KNOW	77.2003	<i>Richard PEARCE (Ixi)</i> : <u>A Biologist's View of Individual Cultural Identity for the Study of Cities</u>
KNOW	78.2003	<i>Vincent MERK (Ixi)</i> : <u>Communication Across Cultures: from Cultural Awareness to Reconciliation of the Dilemmas</u>
KNOW	79.2003	<i>Giorgio BELLETTINI, Carlotta BERTI CERONI and Gianmarco I.P. OTTAVIANO</i> : <u>Child Labor and Resistance to Change</u>
ETA	80.2003	<i>Michele MORETTO, Paolo M. PANTEGHINI and Carlo SCARPA</i> : <u>Investment Size and Firm's Value under Profit Sharing Regulation</u>

ITEM	81.2003	<i>Alessandro LANZA, Matteo MANERA and Massimo GIOVANNINI: <u>Oil and Product Dynamics in International Petroleum Markets</u></i>
CLIM	82.2003	<i>Y. Hossein FARZIN and Jinhua ZHAO: <u>Pollution Abatement Investment When Firms Lobby Against Environmental Regulation</u></i>
CLIM	83.2003	<i>Giuseppe DI VITA: <u>Is the Discount Rate Relevant in Explaining the Environmental Kuznets Curve?</u></i>
CLIM	84.2003	<i>Reyer GERLAGH and Wietze LISE: <u>Induced Technological Change Under Carbon Taxes</u></i>
NRM	85.2003	<i>Rinaldo BRAU, Alessandro LANZA and Francesco PIGLIARU: <u>How Fast are the Tourism Countries Growing? The cross-country evidence</u></i>
KNOW	86.2003	<i>Elena BELLINI, Gianmarco I.P. OTTAVIANO and Dino PINELLI: <u>The ICT Revolution: opportunities and risks for the Mezzogiorno</u></i>
SIEV	87.2003	<i>Lucas BRETSCGHER and Sjak SMULDERS: <u>Sustainability and Substitution of Exhaustible Natural Resources. How resource prices affect long-term R&D investments</u></i>
CLIM	88.2003	<i>Johan EYCKMANS and Michael FINUS: <u>New Roads to International Environmental Agreements: The Case of Global Warming</u></i>
CLIM	89.2003	<i>Marzio GALEOTTI: <u>Economic Development and Environmental Protection</u></i>
CLIM	90.2003	<i>Marzio GALEOTTI: <u>Environment and Economic Growth: Is Technical Change the Key to Decoupling?</u></i>
CLIM	91.2003	<i>Marzio GALEOTTI and Barbara BUCHNER: <u>Climate Policy and Economic Growth in Developing Countries</u></i>
ITEM	92.2003	<i>A. MARKANDYA, A. GOLUB and E. STRUKOVA: <u>The Influence of Climate Change Considerations on Energy Policy: The Case of Russia</u></i>
ETA	93.2003	<i>Andrea BELTRATTI: <u>Socially Responsible Investment in General Equilibrium</u></i>
CTN	94.2003	<i>Parkash CHANDER: <u>The γ-Core and Coalition Formation</u></i>
ITEM	95.2003	<i>Matteo MANERA and Angelo MARZULLO: <u>Modelling the Load Curve of Aggregate Electricity Consumption Using Principal Components</u></i>
ITEM	96.2003	<i>Alessandro LANZA, Matteo MANERA, Margherita GRASSO and Massimo GIOVANNINI: <u>Long-run Models of Oil Stock Prices</u></i>
CTN	97.2003	<i>Steven J. BRAMS, Michael A. JONES, and D. Marc KILGOUR: <u>Forming Stable Coalitions: The Process Matters</u></i>
KNOW	98.2003	<i>John CROWLEY, Marie-Cecile NAVES (Ixiix): <u>Anti-Racist Policies in France. From Ideological and Historical Schemes to Socio-Political Realities</u></i>
KNOW	99.2003	<i>Richard THOMPSON FORD (Ixiii): <u>Cultural Rights and Civic Virtue</u></i>
KNOW	100.2003	<i>Alaknanda PATEL (Ixiii): <u>Cultural Diversity and Conflict in Multicultural Cities</u></i>
KNOW	101.2003	<i>David MAY (Ixiii): <u>The Struggle of Becoming Established in a Deprived Inner-City Neighbourhood</u></i>
KNOW	102.2003	<i>Sébastien ARCAND, Danielle JUTEAU, Sirma BILGE, and Francine LEMIRE (Ixiii) : <u>Municipal Reform on the Island of Montreal: Tensions Between Two Majority Groups in a Multicultural City</u></i>
CLIM	103.2003	<i>Barbara BUCHNER and Carlo CARRARO: <u>China and the Evolution of the Present Climate Regime</u></i>
CLIM	104.2003	<i>Barbara BUCHNER and Carlo CARRARO: <u>Emissions Trading Regimes and Incentives to Participate in International Climate Agreements</u></i>
CLIM	105.2003	<i>Anil MARKANDYA and Dirk T.G. RÜBBELKE: <u>Ancillary Benefits of Climate Policy</u></i>
NRM	106.2003	<i>Anne Sophie CRÉPIN (Ixiv): <u>Management Challenges for Multiple-Species Boreal Forests</u></i>
NRM	107.2003	<i>Anne Sophie CRÉPIN (Ixiv): <u>Threshold Effects in Coral Reef Fisheries</u></i>
SIEV	108.2003	<i>Sara ANIYAR (Ixiv): <u>Estimating the Value of Oil Capital in a Small Open Economy: The Venezuela's Example</u></i>
SIEV	109.2003	<i>Kenneth ARROW, Partha DASGUPTA and Karl-Göran MÄLER(Ixiv): <u>Evaluating Projects and Assessing Sustainable Development in Imperfect Economies</u></i>
NRM	110.2003	<i>Anastasios XEPAPADEAS and Catarina ROSETA-PALMA(Ixiv): <u>Instabilities and Robust Control in Fisheries</u></i>
NRM	111.2003	<i>Charles PERRINGS and Brian WALKER (Ixiv): <u>Conservation and Optimal Use of Rangelands</u></i>
ETA	112.2003	<i>Jack GOODY (Ixiv): <u>Globalisation, Population and Ecology</u></i>
CTN	113.2003	<i>Carlo CARRARO, Carmen MARCHIORI and Sonia OREFFICE: <u>Endogenous Minimum Participation in International Environmental Treaties</u></i>
CTN	114.2003	<i>Guillaume HAERINGER and Myrna WOODERS: <u>Decentralized Job Matching</u></i>
CTN	115.2003	<i>Hideo KONISHI and M. Utku UNVER: <u>Credible Group Stability in Multi-Partner Matching Problems</u></i>
CTN	116.2003	<i>Somdeb LAHIRI: <u>Stable Matchings for the Room-Mates Problem</u></i>
CTN	117.2003	<i>Somdeb LAHIRI: <u>Stable Matchings for a Generalized Marriage Problem</u></i>
CTN	118.2003	<i>Marita LAUKKANEN: <u>Transboundary Fisheries Management under Implementation Uncertainty</u></i>
CTN	119.2003	<i>Edward CARTWRIGHT and Myrna WOODERS: <u>Social Conformity and Bounded Rationality in Arbitrary Games with Incomplete Information: Some First Results</u></i>
CTN	120.2003	<i>Gianluigi VERNASCA: <u>Dynamic Price Competition with Price Adjustment Costs and Product Differentiation</u></i>
CTN	121.2003	<i>Myrna WOODERS, Edward CARTWRIGHT and Reinhard SELTEN: <u>Social Conformity in Games with Many Players</u></i>
CTN	122.2003	<i>Edward CARTWRIGHT and Myrna WOODERS: <u>On Equilibrium in Pure Strategies in Games with Many Players</u></i>
CTN	123.2003	<i>Edward CARTWRIGHT and Myrna WOODERS: <u>Conformity and Bounded Rationality in Games with Many Players</u></i>
1000		Carlo CARRARO, Alessandro LANZA and Valeria PAPPONETTI: <u>One Thousand Working Papers</u>

NOTE DI LAVORO PUBLISHED IN 2004

IEM	1.2004	<i>Anil MARKANDYA, Suzette PEDROSO and Alexander GOLUB:</i> <u>Empirical Analysis of National Income and So2 Emissions in Selected European Countries</u>
ETA	2.2004	<i>Masahisa FUJITA and Shlomo WEBER:</i> <u>Strategic Immigration Policies and Welfare in Heterogeneous Countries</u>
PRA	3.2004	<i>Adolfo DI CARLUCCIO, Giovanni FERRI, Cecilia FRALE and Ottavio RICCHI:</i> <u>Do Privatizations Boost Household Shareholding? Evidence from Italy</u>
ETA	4.2004	<i>Victor GINSBURGH and Shlomo WEBER:</i> <u>Languages Disenfranchisement in the European Union</u>
ETA	5.2004	<i>Romano PIRAS:</i> <u>Growth, Congestion of Public Goods, and Second-Best Optimal Policy</u>
CCMP	6.2004	<i>Herman R.J. VOLLEBERGH:</i> <u>Lessons from the Polder: Is Dutch CO2-Taxation Optimal</u>
PRA	7.2004	<i>Sandro BRUSCO, Giuseppe LOPOMO and S. VISWANATHAN (lxv):</i> <u>Merger Mechanisms</u>
PRA	8.2004	<i>Wolfgang AUSENNEGG, Pegaret PICHLER and Alex STOMPER (lxv):</i> <u>IPO Pricing with Bookbuilding, and a When-Issued Market</u>
PRA	9.2004	<i>Pegaret PICHLER and Alex STOMPER (lxv):</i> <u>Primary Market Design: Direct Mechanisms and Markets</u>
PRA	10.2004	<i>Florian ENGLMAIER, Pablo GUILLEN, Loreto LLORENTE, Sander ONDERSTAL and Rupert SAUSGRUBER (lxv):</i> <u>The Chopstick Auction: A Study of the Exposure Problem in Multi-Unit Auctions</u>
PRA	11.2004	<i>Bjarne BRENDSTRUP and Harry J. PAARSCH (lxv):</i> <u>Nonparametric Identification and Estimation of Multi-Unit, Sequential, Oral, Ascending-Price Auctions With Asymmetric Bidders</u>
PRA	12.2004	<i>Ohad KADAN (lxv):</i> <u>Equilibrium in the Two Player, k-Double Auction with Affiliated Private Values</u>
PRA	13.2004	<i>Maarten C.W. JANSSEN (lxv):</i> <u>Auctions as Coordination Devices</u>
PRA	14.2004	<i>Gadi FIBICH, Arie GAVIOUS and Aner SELA (lxv):</i> <u>All-Pay Auctions with Weakly Risk-Averse Buyers</u>
PRA	15.2004	<i>Orly SADE, Charles SCHNITZLEIN and Jaime F. ZENDER (lxv):</i> <u>Competition and Cooperation in Divisible Good Auctions: An Experimental Examination</u>
PRA	16.2004	<i>Marta STRYSZOWSKA (lxv):</i> <u>Late and Multiple Bidding in Competing Second Price Internet Auctions</u>
CCMP	17.2004	<i>Slim Ben YOUSSEF:</i> <u>R&D in Cleaner Technology and International Trade</u>
NRM	18.2004	<i>Angelo ANTOCI, Simone BORGHESI and Paolo RUSSU (lxvi):</i> <u>Biodiversity and Economic Growth: Stabilization Versus Preservation of the Ecological Dynamics</u>
SIEV	19.2004	<i>Anna ALBERINI, Paolo ROSATO, Alberto LONGO and Valentina ZANATTA:</i> <u>Information and Willingness to Pay in a Contingent Valuation Study: The Value of S. Erasmo in the Lagoon of Venice</u>
NRM	20.2004	<i>Guido CANDELA and Roberto CELLINI (lxvii):</i> <u>Investment in Tourism Market: A Dynamic Model of Differentiated Oligopoly</u>
NRM	21.2004	<i>Jacqueline M. HAMILTON (lxvii):</i> <u>Climate and the Destination Choice of German Tourists</u>
NRM	22.2004	<i>Javier Rey-MAQUIEIRA PALMER, Javier LOZANO IBÁÑEZ and Carlos Mario GÓMEZ GÓMEZ (lxvii):</i> <u>Land, Environmental Externalities and Tourism Development</u>
NRM	23.2004	<i>Pius ODUNGA and Henk FOLMER (lxvii):</i> <u>Profiling Tourists for Balanced Utilization of Tourism-Based Resources in Kenya</u>
NRM	24.2004	<i>Jean-Jacques NOWAK, Mondher SAHLI and Pasquale M. SGRO (lxvii):</i> <u>Tourism, Trade and Domestic Welfare</u>
NRM	25.2004	<i>Riaz SHAREEF (lxvii):</i> <u>Country Risk Ratings of Small Island Tourism Economies</u>
NRM	26.2004	<i>Juan Luis EUGENIO-MARTÍN, Noelia MARTÍN MORALES and Riccardo SCARPA (lxvii):</i> <u>Tourism and Economic Growth in Latin American Countries: A Panel Data Approach</u>
NRM	27.2004	<i>Raúl Hernández MARTÍN (lxvii):</i> <u>Impact of Tourism Consumption on GDP. The Role of Imports</u>
CSRM	28.2004	<i>Nicoletta FERRO:</i> <u>Cross-Country Ethical Dilemmas in Business: A Descriptive Framework</u>
NRM	29.2004	<i>Marian WEBER (lxvi):</i> <u>Assessing the Effectiveness of Tradable Landuse Rights for Biodiversity Conservation: an Application to Canada's Boreal Mixedwood Forest</u>
NRM	30.2004	<i>Trond BJØRNDAL, Phoebe KOUNDOURI and Sean PASCOE (lxvi):</i> <u>Output Substitution in Multi-Species Trawl Fisheries: Implications for Quota Setting</u>
CCMP	31.2004	<i>Marzio GALEOTTI, Alessandra GORIA, Paolo MOMBRINI and Evi SPANTIDAKI:</i> <u>Weather Impacts on Natural, Social and Economic Systems (WISE) Part I: Sectoral Analysis of Climate Impacts in Italy</u>
CCMP	32.2004	<i>Marzio GALEOTTI, Alessandra GORIA, Paolo MOMBRINI and Evi SPANTIDAKI:</i> <u>Weather Impacts on Natural, Social and Economic Systems (WISE) Part II: Individual Perception of Climate Extremes in Italy</u>
CTN	33.2004	<i>Wilson PEREZ:</i> <u>Divide and Conquer: Noisy Communication in Networks, Power, and Wealth Distribution</u>
KTHC	34.2004	<i>Gianmarco I.P. OTTAVIANO and Giovanni PERI (lxviii):</i> <u>The Economic Value of Cultural Diversity: Evidence from US Cities</u>
KTHC	35.2004	<i>Linda CHAIB (lxviii):</i> <u>Immigration and Local Urban Participatory Democracy: A Boston-Paris Comparison</u>
KTHC	36.2004	<i>Franca ECKERT COEN and Claudio ROSSI (lxviii):</i> <u>Foreigners, Immigrants, Host Cities: The Policies of Multi-Ethnicity in Rome. Reading Governance in a Local Context</u>
KTHC	37.2004	<i>Kristine CRANE (lxviii):</i> <u>Governing Migration: Immigrant Groups' Strategies in Three Italian Cities – Rome, Naples and Bari</u>
KTHC	38.2004	<i>Kiflemariam HAMDE (lxviii):</i> <u>Mind in Africa, Body in Europe: The Struggle for Maintaining and Transforming Cultural Identity - A Note from the Experience of Eritrean Immigrants in Stockholm</u>
ETA	39.2004	<i>Alberto CAVALIERE:</i> <u>Price Competition with Information Disparities in a Vertically Differentiated Duopoly</u>
PRA	40.2004	<i>Andrea BIGANO and Stef PROOST:</i> <u>The Opening of the European Electricity Market and Environmental Policy: Does the Degree of Competition Matter?</u>
CCMP	41.2004	<i>Micheal FINUS (lxix):</i> <u>International Cooperation to Resolve International Pollution Problems</u>

KTHC	42.2004	<i>Francesco CRESPI</i> : <u>Notes on the Determinants of Innovation: A Multi-Perspective Analysis</u>
CTN	43.2004	<i>Sergio CURRARINI and Marco MARINI</i> : <u>Coalition Formation in Games without Synergies</u>
CTN	44.2004	<i>Marc ESCRIHUELA-VILLAR</i> : <u>Cartel Sustainability and Cartel Stability</u>
NRM	45.2004	<i>Sebastian BERVOETS and Nicolas GRAVEL</i> (lxvi): <u>Appraising Diversity with an Ordinal Notion of Similarity: An Axiomatic Approach</u>
NRM	46.2004	<i>Signe ANTHON and Bo JELLES MARK THORSEN</i> (lxvi): <u>Optimal Afforestation Contracts with Asymmetric Information on Private Environmental Benefits</u>
NRM	47.2004	<i>John MBURU</i> (lxvi): <u>Wildlife Conservation and Management in Kenya: Towards a Co-management Approach</u>
NRM	48.2004	<i>Ekin BIROL, Ágnes GYOVAI and Melinda SMALE</i> (lxvi): <u>Using a Choice Experiment to Value Agricultural Biodiversity on Hungarian Small Farms: Agri-Environmental Policies in a Transitional Economy</u>
CCMP	49.2004	<i>Gernot KLEPPER and Sonja PETERSON</i> : <u>The EU Emissions Trading Scheme. Allowance Prices, Trade Flows, Competitiveness Effects</u>
GG	50.2004	<i>Scott BARRETT and Michael HOEL</i> : <u>Optimal Disease Eradication</u>
CTN	51.2004	<i>Dinko DIMITROV, Peter BORM, Ruud HENDRICKX and Shao CHIN SUNG</i> : <u>Simple Priorities and Core Stability in Hedonic Games</u>
SIEV	52.2004	<i>Francesco RICCI</i> : <u>Channels of Transmission of Environmental Policy to Economic Growth: A Survey of the Theory</u>
SIEV	53.2004	<i>Anna ALBERINI, Maureen CROPPER, Alan KRUPNICK and Nathalie B. SIMON</i> : <u>Willingness to Pay for Mortality Risk Reductions: Does Latency Matter?</u>
NRM	54.2004	<i>Ingo BRÄUER and Rainer MARGGRAF</i> (lxvi): <u>Valuation of Ecosystem Services Provided by Biodiversity Conservation: An Integrated Hydrological and Economic Model to Value the Enhanced Nitrogen Retention in Renaturated Streams</u>
NRM	55.2004	<i>Timo GOESCHL and Tun LIN</i> (lxvi): <u>Biodiversity Conservation on Private Lands: Information Problems and Regulatory Choices</u>
NRM	56.2004	<i>Tom DEDEURWAERDERE</i> (lxvi): <u>Bioprospection: From the Economics of Contracts to Reflexive Governance</u>
CCMP	57.2004	<i>Katrin REHDANZ and David MADDISON</i> : <u>The Amenity Value of Climate to German Households</u>
CCMP	58.2004	<i>Koen SMEKENS and Bob VAN DER ZWAAN</i> : <u>Environmental Externalities of Geological Carbon Sequestration Effects on Energy Scenarios</u>
NRM	59.2004	<i>Valentina BOSETTI, Mariaester CASSINELLI and Alessandro LANZA</i> (lxvii): <u>Using Data Envelopment Analysis to Evaluate Environmentally Conscious Tourism Management</u>
NRM	60.2004	<i>Timo GOESCHL and Danilo CAMARGO IGLIORI</i> (lxvi): <u>Property Rights Conservation and Development: An Analysis of Extractive Reserves in the Brazilian Amazon</u>
CCMP	61.2004	<i>Barbara BUCHNER and Carlo CARRARO</i> : <u>Economic and Environmental Effectiveness of a Technology-based Climate Protocol</u>
NRM	62.2004	<i>Elissaios PAPYRAKIS and Reyner GERLAGH</i> : <u>Resource-Abundance and Economic Growth in the U.S.</u>
NRM	63.2004	<i>Györgyi BELA, Györgyi PATAKI, Melinda SMALE and Mariann HAJDÚ</i> (lxvi): <u>Conserving Crop Genetic Resources on Smallholder Farms in Hungary: Institutional Analysis</u>
NRM	64.2004	<i>E.C.M. RUIJGROK and E.E.M. NILLESEN</i> (lxvi): <u>The Socio-Economic Value of Natural Riverbanks in the Netherlands</u>
NRM	65.2004	<i>E.C.M. RUIJGROK</i> (lxvi): <u>Reducing Acidification: The Benefits of Increased Nature Quality. Investigating the Possibilities of the Contingent Valuation Method</u>
ETA	66.2004	<i>Giannis VARDAS and Anastasios XEPAPADEAS</i> : <u>Uncertainty Aversion, Robust Control and Asset Holdings</u>
GG	67.2004	<i>Anastasios XEPAPADEAS and Constadina PASSA</i> : <u>Participation in and Compliance with Public Voluntary Environmental Programs: An Evolutionary Approach</u>
GG	68.2004	<i>Michael FINUS</i> : <u>Modesty Pays: Sometimes!</u>
NRM	69.2004	<i>Trond BJØRNDAL and Ana BRASÃO</i> : <u>The Northern Atlantic Bluefin Tuna Fisheries: Management and Policy Implications</u>
CTN	70.2004	<i>Alejandro CAPARRÓS, Abdelhakim HAMMOUDI and Tarik TAZDAÏT</i> : <u>On Coalition Formation with Heterogeneous Agents</u>
IEM	71.2004	<i>Massimo GIOVANNINI, Margherita GRASSO, Alessandro LANZA and Matteo MANERA</i> : <u>Conditional Correlations in the Returns on Oil Companies Stock Prices and Their Determinants</u>
IEM	72.2004	<i>Alessandro LANZA, Matteo MANERA and Michael MCALEER</i> : <u>Modelling Dynamic Conditional Correlations in WTI Oil Forward and Futures Returns</u>
SIEV	73.2004	<i>Margarita GENIUS and Elisabetta STRAZZERA</i> : <u>The Copula Approach to Sample Selection Modelling: An Application to the Recreational Value of Forests</u>
CCMP	74.2004	<i>Rob DELLINK and Ekko van IERLAND</i> : <u>Pollution Abatement in the Netherlands: A Dynamic Applied General Equilibrium Assessment</u>
ETA	75.2004	<i>Rosella LEVAGGI and Michele MORETTO</i> : <u>Investment in Hospital Care Technology under Different Purchasing Rules: A Real Option Approach</u>
CTN	76.2004	<i>Salvador BARBERÀ and Matthew O. JACKSON</i> (lxx): <u>On the Weights of Nations: Assigning Voting Weights in a Heterogeneous Union</u>
CTN	77.2004	<i>Àlex ARENAS, Antonio CABRALES, Albert DÍAZ-GUILERA, Roger GUIMERA and Fernando VEGA-REDONDO</i> (lxx): <u>Optimal Information Transmission in Organizations: Search and Congestion</u>
CTN	78.2004	<i>Francis BLOCH and Armando GOMES</i> (lxx): <u>Contracting with Externalities and Outside Options</u>

CTN	79.2004	<i>Rabah AMIR, Effrosyni DIAMANTOUDI and Licun XUE (lxx): <u>Merger Performance under Uncertain Efficiency Gains</u></i>
CTN	80.2004	<i>Francis BLOCH and Matthew O. JACKSON (lxx): <u>The Formation of Networks with Transfers among Players</u></i>
CTN	81.2004	<i>Daniel DIERMEIER, Hülya ERASLAN and Antonio MERLO (lxx): <u>Bicameralism and Government Formation</u></i>
CTN	82.2004	<i>Rod GARRATT, James E. PARCO, Cheng-ZHONG QIN and Amnon RAPOPORT (lxx): <u>Potential Maximization and Coalition Government Formation</u></i>
CTN	83.2004	<i>Kfir ELIAZ, Debraj RAY and Ronny RAZIN (lxx): <u>Group Decision-Making in the Shadow of Disagreement</u></i>
CTN	84.2004	<i>Sanjeev GOYAL, Marco van der LEIJ and José Luis MORAGA-GONZÁLEZ (lxx): <u>Economics: An Emerging Small World?</u></i>
CTN	85.2004	<i>Edward CARTWRIGHT (lxx): <u>Learning to Play Approximate Nash Equilibria in Games with Many Players</u></i>
IEM	86.2004	<i>Finn R. FØRSUND and Michael HOEL: <u>Properties of a Non-Competitive Electricity Market Dominated by Hydroelectric Power</u></i>
KTHC	87.2004	<i>Elissaios PAPYRAKIS and Reyer GERLAGH: <u>Natural Resources, Investment and Long-Term Income</u></i>
CCMP	88.2004	<i>Marzio GALEOTTI and Claudia KEMFERT: <u>Interactions between Climate and Trade Policies: A Survey</u></i>
IEM	89.2004	<i>A. MARKANDYA, S. PEDROSO and D. STREIMIKIENE: <u>Energy Efficiency in Transition Economies: Is There Convergence Towards the EU Average?</u></i>
GG	90.2004	<i>Rolf GOLOMBEK and Michael HOEL: <u>Climate Agreements and Technology Policy</u></i>
PRA	91.2004	<i>Sergei IZMALKOV (lxx): <u>Multi-Unit Open Ascending Price Efficient Auction</u></i>
KTHC	92.2004	<i>Gianmarco I.P. OTTAVIANO and Giovanni PERI: <u>Cities and Cultures</u></i>
KTHC	93.2004	<i>Massimo DEL GATTO: <u>Agglomeration, Integration, and Territorial Authority Scale in a System of Trading Cities. Centralisation versus devolution</u></i>
CCMP	94.2004	<i>Pierre-André JOUVET, Philippe MICHEL and Gilles ROTILLON: <u>Equilibrium with a Market of Permits</u></i>
CCMP	95.2004	<i>Bob van der ZWAAN and Reyer GERLAGH: <u>Climate Uncertainty and the Necessity to Transform Global Energy Supply</u></i>
CCMP	96.2004	<i>Francesco BOSELLO, Marco LAZZARIN, Roberto ROSON and Richard S.J. TOL: <u>Economy-Wide Estimates of the Implications of Climate Change: Sea Level Rise</u></i>
CTN	97.2004	<i>Gustavo BERGANTIÑOS and Juan J. VIDAL-PUGA: <u>Defining Rules in Cost Spanning Tree Problems Through the Canonical Form</u></i>
CTN	98.2004	<i>Siddhartha BANDYOPADHYAY and Mandar OAK: <u>Party Formation and Coalitional Bargaining in a Model of Proportional Representation</u></i>
GG	99.2004	<i>Hans-Peter WEIKARD, Michael FINUS and Juan-Carlos ALTAMIRANO-CABRERA: <u>The Impact of Surplus Sharing on the Stability of International Climate Agreements</u></i>
SIEV	100.2004	<i>Chiara M. TRAVISI and Peter NIJKAMP: <u>Willingness to Pay for Agricultural Environmental Safety: Evidence from a Survey of Milan, Italy, Residents</u></i>
SIEV	101.2004	<i>Chiara M. TRAVISI, Raymond J. G. M. FLORAX and Peter NIJKAMP: <u>A Meta-Analysis of the Willingness to Pay for Reductions in Pesticide Risk Exposure</u></i>
NRM	102.2004	<i>Valentina BOSETTI and David TOMBERLIN: <u>Real Options Analysis of Fishing Fleet Dynamics: A Test</u></i>
CCMP	103.2004	<i>Alessandra GORIA e Gretel GAMBARELLI: <u>Economic Evaluation of Climate Change Impacts and Adaptability in Italy</u></i>
PRA	104.2004	<i>Massimo FLORIO and Mara GRASSEN: <u>The Missing Shock: The Macroeconomic Impact of British Privatisation</u></i>
PRA	105.2004	<i>John BENNETT, Saul ESTRIN, James MAW and Giovanni URGÀ: <u>Privatisation Methods and Economic Growth in Transition Economies</u></i>
PRA	106.2004	<i>Kira BÖRNER: <u>The Political Economy of Privatization: Why Do Governments Want Reforms?</u></i>
PRA	107.2004	<i>Pehr-Johan NORBÄCK and Lars PERSSON: <u>Privatization and Restructuring in Concentrated Markets</u></i>
SIEV	108.2004	<i>Angela GRANZOTTO, Fabio PRANOVI, Simone LIBRALATO, Patrizia TORRICELLI and Danilo MAINARDI: <u>Comparison between Artisanal Fishery and Manila Clam Harvesting in the Venice Lagoon by Using Ecosystem Indicators: An Ecological Economics Perspective</u></i>
CTN	109.2004	<i>Somdeb LAHIRI: <u>The Cooperative Theory of Two Sided Matching Problems: A Re-examination of Some Results</u></i>

- (lix) This paper was presented at the ENGIME Workshop on “Mapping Diversity”, Leuven, May 16-17, 2002
- (lx) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by the Fondazione Eni Enrico Mattei, Milan, September 26-28, 2002
- (lxi) This paper was presented at the Eighth Meeting of the Coalition Theory Network organised by the GREQAM, Aix-en-Provence, France, January 24-25, 2003
- (lxii) This paper was presented at the ENGIME Workshop on “Communication across Cultures in Multicultural Cities”, The Hague, November 7-8, 2002
- (lxiii) This paper was presented at the ENGIME Workshop on “Social dynamics and conflicts in multicultural cities”, Milan, March 20-21, 2003
- (lxiv) This paper was presented at the International Conference on “Theoretical Topics in Ecological Economics”, organised by the Abdus Salam International Centre for Theoretical Physics - ICTP, the Beijer International Institute of Ecological Economics, and Fondazione Eni Enrico Mattei – FEEM Trieste, February 10-21, 2003
- (lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003
- (lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL), Venice, August 28-29, 2003
- (lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003
- (lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003
- (lxix) This paper was presented at the Fourth EEP Plenary Workshop and EEP Conference “The Future of Climate Policy”, Cagliari, Italy, 27-28 March 2003
- (lxx) This paper was presented at the 9th Coalition Theory Workshop on "Collective Decisions and Institutional Design" organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004

2003 SERIES

CLIM	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
GG	<i>Global Governance</i> (Editor: Carlo Carraro)
SIEV	<i>Sustainability Indicators and Environmental Valuation</i> (Editor: Anna Alberini)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
KNOW	<i>Knowledge, Technology, Human Capital</i> (Editor: Gianmarco Ottaviano)
IEM	<i>International Energy Markets</i> (Editor: Anil Markandya)
CSRM	<i>Corporate Social Responsibility and Management</i> (Editor: Sabina Ratti)
PRIV	<i>Privatisation, Regulation, Antitrust</i> (Editor: Bernardo Bortolotti)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)
CTN	<i>Coalition Theory Network</i>

2004 SERIES

CCMP	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
GG	<i>Global Governance</i> (Editor: Carlo Carraro)
SIEV	<i>Sustainability Indicators and Environmental Valuation</i> (Editor: Anna Alberini)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
KTHC	<i>Knowledge, Technology, Human Capital</i> (Editor: Gianmarco Ottaviano)
IEM	<i>International Energy Markets</i> (Editor: Anil Markandya)
CSRM	<i>Corporate Social Responsibility and Management</i> (Editor: Sabina Ratti)
PRA	<i>Privatisation, Regulation, Antitrust</i> (Editor: Bernardo Bortolotti)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)
CTN	<i>Coalition Theory Network</i>