

Forges, Françoise

Working Paper

The ex ante incentive compatible core in exchange economies with and without indivisibilities

CESifo Working Paper, No. 1686

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Forges, Françoise (2006) : The ex ante incentive compatible core in exchange economies with and without indivisibilities, CESifo Working Paper, No. 1686, Center for Economic Studies and ifo Institute (CESifo), Munich

This Version is available at:

<https://hdl.handle.net/10419/19150>

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 EX ANTE INCENTIVE COMPATIBLE CORE IN EXCHANGE ECONOMIES WITH AND WITHOUT INDIVISIBILITIES

FRANÇOISE FORGES

CESIFO WORKING PAPER NO. 1686
CATEGORY 9: INDUSTRIAL ORGANISATION
MARCH 2006

An electronic version of the paper may be downloaded

- *from the SSRN website:* www.SSRN.com
- *from the CESifo website:* www.CESifo-group.de

THE EX ANTE INCENTIVE COMPATIBLE CORE IN EXCHANGE ECONOMIES WITH AND WITHOUT INDIVISIBILITIES

Abstract

The ex ante incentive compatible core of an exchange economy with private information is the (standard) core of a socially designed characteristic function, which expresses the fact that coalitions allocate goods by means of random incentive compatible mechanisms. We first survey some results in the case of perfectly divisible goods. Examples then show that the ex ante incentive compatible core can be empty, even if utility functions are quasi-linear. If, in addition to quasi-linearity, further assumptions are made (like independent private values), the non-emptiness of the core follows nevertheless from d'Aspremont and Gérard-Varet's construction of incentive compatible, *ex post* efficient mechanisms. We also introduce a private information version of Shapley and Scarf's economies with indivisible goods, and prove that the ex ante incentive compatible core is always non-empty in this framework.

JEL Code: C78, C71, D82.

Keywords: core, incentive compatible mechanism, indivisible goods, private information.

Françoise Forges
CEREMADE
University of Paris-Dauphine
Place du Maréchal de Lattre de Tassigny
75775 Paris Cedex 16
France
francoise.forges@dauphine.fr

January 2003 (revised December 2005)

Paper prepared for the conference in the memory of Louis-André Gérard-Varet "Strategic Interactions in Industrial and Social Organizations", CORE, January 24-25, 2003. I wish to thank E. Minelli for numerous helpful discussions and H. Stahn for comments.

1 Introduction

In most collective decision problems, agents have private information on parameters entering their own utility functions as well as the others'. There is often a preliminary stage, the *ex ante* stage, at which agents do not know their precise information yet but share a common prior probability distribution on possible type profiles. At the later *interim* stage, agents learn their own types and consequently update their probability distribution over the others' types.

An *ex ante* stage typically happens when decisions are made up by representative institutions such as States. Consider for instance the application of the "precautionary principle" to public health issues. A mechanism is typically designed at the *ex ante* stage, before individuals privately know their own state of health, and implemented at the *interim* stage (e.g., by requiring a test from the individuals). As another example, consider those States like Norway, Switzerland, etc. which are not members of the European Union but are "associated" to it. When they decide whether to participate in a particular E.U. program of scientific cooperation and how much to invest in case they participate, they do not know precisely what the quality of the applicants (laboratories, students, etc. including the national ones) will be but only have statistical data.

If an *ex ante* stage is available and binding agreements are feasible, as is assumed in classical cooperative game theory, the agents commit themselves in advance to a mechanism (i.e., a collective strategy to select decisions as functions of the agents' types), and implement this mechanism at the *interim* stage. Since types constitute private information at this *interim* stage, one must impose incentive constraints in order to guarantee that truthful revelation be a Nash equilibrium in the game induced by the mechanism. By the well-known *revelation principle*, Bayesian incentive compatible mechanisms suffice to describe any Nash equilibrium of any non-cooperative game that the agents could design in order to exchange information and make collective decisions. There is obviously no reason to forbid mixed strategies in these general non-cooperative games so that one also has to consider *random* mechanisms - namely, lotteries selecting collective decisions as functions of the agents' reported types.

If the underlying environment does not involve externalities, e.g., if it consists of an exchange economy with private information, incentive compatible mechanisms can be chosen not only by the group as a whole, but

also by coalitions of agents. At least coalitions can pose a threat. A natural stability requirement (in addition to Pareto efficiency) is then that the grand coalition's incentive compatible mechanism be not blocked by any smaller coalition, i.e., that no subgroup can design an incentive compatible mechanism yielding a higher expected utility to all its members. This amounts to saying that the grand coalition's mechanism is in the *core* of a suitably defined characteristic function. We refer to this core as the “*ex ante* incentive compatible core”. In the public health example, mechanisms through which all the participants stay together make good sense, because of potential insurance effects. Natural coalitions might emerge at the *ex ante* stage: for instance, individuals who are unlikely to be infected by the underlying disease might not accept to cooperate. Solutions in the *ex ante* incentive compatible core take all these threats into account, while favoring information revelation by means of appropriate compensation schemes.

In the sequel, we focus on the *ex ante* incentive compatible core of an exchange economy with private information. In section 3, we first survey some results in standard Walrasian economies (i.e., with perfectly divisible goods and non-transferable utility). An example in Forges, Mertens and Vohra [14] shows that in that model, the *ex ante* incentive compatible core can be empty. However, Forges and Minelli [15] establish a positive result when no good is initially owned by two different agents and utility functions are additively separable across goods.

We introduce particular N.T.U. economies with *indivisible* goods which extend Shapley and Scarf [30]’s model to incomplete information. Every agent initially owns at most one indivisible item, e.g., a house, and possibly some money. Every agent has preferences over all items, which depend on the available information, but can only make use of a single item. These economies are not a strict particular case of Forges and Minelli’s ones but are close to them. We give here a direct proof of the non-emptiness of the *ex ante* incentive compatible core in this model. We first show that we can, without loss of generality, restrict ourselves to “straightforward” mechanisms, whose outcomes are, for every agent, the probability of getting any given item, together with an expected amount of money. We then rely on Scarf [29]’s theorem.

In section 4, we turn to exchange economies in which unlimited monetary transfers are allowed and utility functions are quasi-linear. As in the N.T.U. case, Forges, Mertens and Vohra [14] provide an example of an economy with perfectly divisible goods in which the *ex ante* incentive compatible core is

empty. The example is shown to be robust but features a fully informed agent and common values. As first shown by d'Aspremont and Gérard-Varet (see [4] and [5]), if *interim* monetary transfers are possible, appropriate assumptions on the prior beliefs and/or the utility functions (e.g., independent private values) make first best solutions achievable in a Bayesian incentive compatible way. By relying on this result, one can establish the non-emptiness of the *ex ante* incentive compatible core in several classes of T.U. exchange economies.

We also consider unlimited monetary transfers in the economies with indivisible goods introduced in section 3. The resulting model is then an extension of Shapley and Shubik's [31] assignment game. Though not needed for the non-emptiness result, transfers still play an important role in this model, by making it possible to achieve first best allocations. This is illustrated by means of a detailed example.

Section 5 concludes with further observations on *interim* solution concepts.

2 Basic definitions

An *exchange economy with private information* consists of

- a set of agents $N = \{1, \dots, n\}$
- l goods (each of which is either perfectly divisible or indivisible)
- for every agent $i \in N$: a finite set of types T_i , a consumption set $C_i \subseteq \mathbb{R}_+^l$, an initial endowment $e_i \in C_i$ and a von Neumann-Morgenstern utility function $u_i : T \times C_i \rightarrow \mathbb{R}$, where $T = \prod_{i \in N} T_i$. $u_i(t, \cdot)$ is assumed to be continuous and increasing for every $t \in T$.
- a probability distribution q over T , such that without loss of generality, $q(t_i) > 0$ for every $t_i \in T_i$.

Notice that consumption sets and initial endowments are independent of private information.

We assume that at the *ex ante* stage, i.e., before the agents are informed of their types, each subset of agents (or coalition) $S \subseteq N$, $S \neq \emptyset$, can decide on a mechanism μ_S , which will only be implemented at the *interim* stage (i.e., when every agent knows his type) if S has formed.

Let X_S be the set of feasible allocations:

$$X_S = \left\{ x \in \prod_{i \in S} C_i : \sum_{i \in S} x_i \leq \sum_{i \in S} e_i \right\} \quad (1)$$

and let $\Delta(X_S)$ be the set of all probability distributions over X_S . A (random¹, feasible) *mechanism* for S is a mapping $\mu_S : T \rightarrow \Delta(X_S)$ such that μ_S is measurable w.r.t. $T_S = \prod_{i \in S} T_i$, namely $\mu_S(t) = \mu_S(t')$ for every $t, t' \in T : t_S = t'_S$.

As usual, the interpretation is that every member of S has to tell his type t_i to the mechanism, which selects a feasible allocation in X_S as a function of the *reported* types. In order to define incentive compatibility, assume that agent $i \in S$, of type t_i , pretends that his type is t'_i possibly different from t_i . His expected utility from μ_S is then

$$U_i(\mu_S | t_i, t'_i) = \sum_{t_{-i}} q(t_{-i} | t_i) \int_{X_S} u_i(t_i, t_{-i}, x_i) d\mu_S(x | t'_i, t_{-i}) \quad (2)$$

Let us denote as $U_i(\mu_S | t_i)$ the (*interim*) expected utility of agent i when he truthfully reports his type to μ_S , namely

$$U_i(\mu_S | t_i) = U_i(\mu_S | t_i, t_i)$$

μ_S is *incentive compatible* (I.C.) if

$$U_i(\mu_S | t_i) \geq U_i(\mu_S | t_i, t'_i) \quad \text{for every } i \in S, t_i, t'_i \in T_i \quad (3)$$

Finally, $U_i(\mu_S)$ denotes the *ex ante* expected utility of agent $i \in S$, that is

$$U_i(\mu_S) = \sum_{t_i} q(t_i) U_i(\mu_S | t_i)$$

We associate the following (N.T.U.) characteristic function with the economy²:

$$V^*(S) = \{v \in \mathbb{R}^n : \exists \text{ an I.C. mechanism } \mu_S \text{ s.t. } U_i(\mu_S) \geq v_i \quad \forall i \in S\}$$

¹We allow for lotteries and free disposal. As shown in [16] and [14], both assumptions can be helpful in the presence of incentive constraints. Lotteries may already play a role under complete information (see, e.g., [1], [7], [8], [18], [21]).

²As in [20], “*” reminds of incentive compatibility.

V^* is well-behaved: for every S , $V^*(S)$ is closed, convex (thanks to random mechanisms) and comprehensive. The *ex ante incentive compatible core* of the economy is defined as the (standard) core $C(V^*)$ of V^* , namely as the set of all vector payoffs $v \in V^*(N)$ that cannot be blocked by any coalition (i.e., there does not exist S and $w \in V^*(S)$ such that $w_i > v_i$ for every $i \in S$).

3 N.T.U. economies

3.1 Perfectly divisible goods

We capture perfectly divisible goods by setting $C_i = \mathbb{R}_+^l$ for every $i \in N$ and denote the corresponding economy as $\mathcal{E}_{div} = \{N, (T_i, u_i, e_i)_{i \in N}, q\}$. In this context, Forges, Mertens and Vohra's counterexample (see [14], section 6) demonstrates that there is no hope for a general result on the non-emptiness of $C(V^*)$. Nevertheless, by focusing on utility functions that are additively separable across goods, i.e., such that

$$u_i(t, x_i) = \sum_{r=1}^l u_i^r(t, x_i^r) \quad \forall i \in N, t \in T, x_i \in \mathbb{R}_+^l$$

for some continuous, increasing functions $u_i^r(t, \cdot) : \mathbb{R}_+ \rightarrow \mathbb{R}$, Forges and Minelli [15] established the following

Proposition 1 *If in \mathcal{E}_{div} no good is initially owned by two different agents (i.e., $e_i^r > 0 \Rightarrow e_j^r = 0$ for every $i, j \in N, r = 1, \dots, l$) and utility functions are additively separable across goods, the ex ante incentive compatible core is non-empty.*

Linear utility functions are obviously additively separable across goods. Furthermore, starting with arbitrary initial endowments, we can rename the goods according to their initial owner (i.e., good r initially owned by agent i becomes good ri) and re-express the utility functions in terms of the new goods. These utility functions are still linear. Hence

Corollary 1 *If in \mathcal{E}_{div} utility functions are linear, the ex ante incentive compatible core is non-empty.*

Obviously the corollary still holds with deterministic mechanisms $\mu_S : T \rightarrow X_S$; this result was identified by many authors (see [16]). Random mechanisms are however crucial in proposition 1.

3.2 Indivisible goods

Let us turn to a particular case of the economies introduced in section 2. We set $l = k + 1$ and $K = \{1, \dots, k\}$; goods in K are indivisible items (e.g., houses) while good l is perfectly divisible (e.g., money). We assume $k \leq n$. Agent i 's consumption set is $C_i = \{0, 1\}^k \times \mathbb{R}_+$. His initial endowment $e_i \in C_i$ satisfies: $e_i^r = 1$ if $r = i \in K$, $e_i^r = 0$ if $r \in K$ but $r \neq i$, $e_i^l \geq 0$. In other words, there are k different, indivisible items; every agent $k \in K$ initially owns exactly one item; all agents may own some money.

We will focus on particular utility functions, which express that every agent only cares for a single item and that his favorite item depends on the n -tuple of types t . Let $w_i^r(t) \geq 0$ be real numbers representing the utility of item r to agent i when the types are t . We set, for $x_i \in C_i$,

$$u_i(t, x_i) = \max_{r \in K} \{w_i^r(t) I[x_i^r = 1]\} + x_i^l \quad (4)$$

where I denotes the indicator function. Observe that these utility functions are *not* additively separable across goods (except for money). We denote the economy just described as $\mathcal{E}_{ind} = \{N, K, (T_i, w_i^r(\cdot))_{i \in N, r \in K, q}\}$.

According to (1),

$$X_S = \left\{ x = ([x_i^r]_{1 \leq i \leq n, 1 \leq r \leq k}, (x_i^l)_{1 \leq i \leq n}) \in \{0, 1\}^{n \times k} \times \mathbb{R}_+ : \begin{array}{l} \sum_{i=1}^n x_i^r \leq 1 \quad r = 1, \dots, k \\ \sum_{i=1}^n x_i^l \leq \sum_{i=1}^n e_i^l \end{array} \right\} \quad (5)$$

A feasible allocation x thus consists of an $n \times k$ matrix $[x_i^r]$, each entry of which is 0 or 1, and an allocation of the divisible good. $x_i^r = 1$ if item r is allocated to agent i , $x_i^r = 0$ otherwise. Since there is exactly one item r in the economy, there is at most one "1" in every column r . However, at this point, several items may be allocated to the same agent.

Leaving aside incomplete information, the previous model is more general than Shapley and Scarf [30]'s one, because it possibly involves a perfectly divisible good (in [30], $e_i^l = 0$ for every i), but less general than Quinzii [28]'s one, where the utility functions are not necessarily separable in money.

The specific form of the economy \mathcal{E}_{ind} allows for a very tractable characterization of I.C. mechanisms, which are originally defined as in section 2. For simplicity, we focus on the grand coalition N . We first introduce a particular class of mechanisms, which we call *straightforward*; then we show that, without loss of generality, one can focus on straightforward mechanisms.

A straightforward mechanism associates with every $t \in T$ an $n \times k$ substochastic matrix $\pi(t)$ and a deterministic allocation $m(t)$ of the divisible good l .

The first condition means that the entries of $\pi(t)$ are non-negative and that the sum of the entries in each row and each column is less than one³. More precisely, the feasibility conditions for a straightforward mechanism (π, m) are

$$\begin{aligned}
\pi_i^r(t) &\geq 0, \quad m_i(t) \geq 0 \quad i = 1, \dots, n, \quad r = 1, \dots, k \\
\sum_{i=1}^n \pi_i^r(t) &\leq 1 \quad r = 1, \dots, k \\
\sum_{r=1}^k \pi_i^r(t) &\leq 1 \quad i = 1, \dots, n \\
\sum_{i=1}^n m_i(t) &\leq \sum_{i=1}^n e_i^l
\end{aligned} \tag{6}$$

These inequalities are interpreted as follows: if t is the n -tuple of reported types, then agent i obtains item r with probability $\pi_i^r(t)$ and the amount $m_i(t)$ of the divisible good. The total probability of allocating item r to some agent is less than 1, and the total probability that agent i gets some item is also less than 1. By (a variant of) the Birkhoff-von Neumann theorem, any substochastic matrix is a convex combination of $n \times k$ matrices whose entries are 0 or 1, with at most one “1” in every *row* and every *column*⁴. As a consequence, every straightforward mechanism can indeed be viewed as a random, feasible mechanism in the sense of section 2, i.e., as a probability distribution over the set X_S of feasible allocations defined in (5). In addition, straightforward mechanisms never allocate two items to the same agent.

Straightforward mechanisms can also be interpreted as time-sharing schemes: $\pi_i^r(t)$ is the fraction of time during which agent i uses item r . The feasibility conditions state that no agent can use two items at the same time and that no item can be used by two agents at the same time. This interpretation allows to recover perfectly divisible goods. However, thanks to the Birkhoff-von Neumann theorem, we do not have to rely on it.

Expected utilities from a straightforward mechanism (π, m) are easily

³A “bi-stochastic” matrix corresponds to the case where these sums are exactly equal to one.

⁴See [8] for a recent application.

computed:

$$U_i(\pi, m|t_i, t'_i) = \sum_{t_{-i}} q(t_{-i}|t_i) \left\{ \sum_{r=1}^k \pi_i^r(t'_i, t_{-i}) w_i^r(t_i, t_{-i}) + m_i(t'_i, t_{-i}) \right\}$$

Incentive compatibility of (π, m) can thus be derived as in (3).

Lemma 1 *Let $\mu : T \rightarrow \Delta(X_N)$ be a (random, feasible) I.C. mechanism for the grand coalition in \mathcal{E}_{ind} . There exists an I.C. straightforward mechanism (π, m) which achieves the same interim expected utilities as μ .*

Proof: By substituting utility functions u_i from (4) into (2), we get

$$\begin{aligned} U_i(\mu|t_i, t'_i) &= \sum_{t_{-i}} q(t_{-i}|t_i) \left\{ \int_{X_S} \max_{r \in K} \{w_i^r(t) I[x_i^r = 1]\} d\mu(x|t'_i, t_{-i}) \right\} \\ &\quad + \sum_{t_{-i}} q(t_{-i}|t_i) \int_{X_S} x_i^l d\mu(x|t'_i, t_{-i}) \end{aligned} \quad (7)$$

Let us set

$$m_i(t) = \int_{X_S} x_i^l d\mu(x|t)$$

Defined in this way, m satisfies the feasibility conditions for a straightforward mechanism. Once we replace the second term in (7) as a function of m , the still relevant part of $\mu(\cdot|t)$, which appears in the first term of (7), is a probability distribution over finitely many $n \times k$ matrices $[x_i^r]$ satisfying the feasibility constraints in (5). Assume that for some t , there exists a matrix $[x_i^r]$, which we still denote as x , such that $\mu(x|t) > 0$ and with several “1” in row i . This means that, when t is reported, agent i gets several items with positive probability. Let r^* be (one of) agent i ’s favorite item(s) at t (i.e., such that $w_i^{r^*}(t) = \max_{r \in K: x_i^r=1} w_i^r(t)$). Modify the matrix by setting $x_i^{r^*} = 1$, $x_i^r = 0$ for $r \neq r^*$ (we thus first alter the support of $\mu(\cdot|t)$ and then, if necessary, adjust the probability values). The change does not affect agents $j \neq i$ (we only considered row i), nor the expected utility of agent i at $t = (t_i, t_{-i})$. Furthermore, it may only *lower* the expected utility of agent i at (t'_i, t_{-i}) , since we have disposed of some items which did not matter for t_i but could matter for t'_i . Hence, incentive compatibility is still fulfilled. By repeating this construction, we are left with an I.C. mechanism, which we

still denote as μ , selecting $n \times k$ matrices with at most one “1” in every row and in every column. (7) can be rewritten as

$$U_i(\mu|t_i, t'_i) = \sum_{t_{-i}} q(t_{-i}|t_i) \left\{ \sum_x \sum_{r=1}^k w_i^r(t_i, t_{-i}) I[x_i^r = 1] \mu(x|t'_i, t_{-i}) \right\} \\ + \sum_{t_{-i}} q(t_{-i}|t_i) m_i(t'_i, t_{-i})$$

We can now set

$$\pi_i^r(t) = \sum_x I[x_i^r = 1] \mu(x|t)$$

(π, m) , as constructed above, defines an I.C. straightforward mechanism equivalent to μ . Q.E.D.

An analog to the previous lemma holds for every coalition S , so that the characteristic function V^* associated with \mathcal{E}_{ind} is fully determined by I.C. straightforward mechanisms. Upon being measurable w.r.t. T_S , a straightforward mechanism (π_S, m_S) for coalition S will satisfy feasibility constraints similar to (6), by setting

$$\pi_{S,i}^r(t) = m_{S,i}(t) = 0 \quad \text{if } i \notin S \text{ or } r \notin K_S$$

where $K_S = \{r \in K : \exists i \in S \text{ s.t. } e_i^r = 1\}$ is the set of items initially owned by members of S . Equivalently, conditions (6) hold with “ $i \in S$ ” and “ $r \in K_S$ ” instead of “ $i \in N$ ” and “ $r \in K$ ”, respectively.

We will establish the following extension of Shapley and Scarf [30]’s result:

Proposition 2 *The ex ante incentive compatible core of \mathcal{E}_{ind} is non-empty.*

As in [30] and [28], the proof applies Scarf [29]’s theorem. We thus have to check that the game V^* induced by \mathcal{E}_{ind} is balanced, i.e., that $\cap_{S \in \mathcal{S}} V^*(S) \subseteq V^*(N)$ for every balanced family of coalitions⁵. This is an immediate consequence of the following lemma:

Lemma 2 *Let \mathcal{S} be a balanced family of coalitions with associated weights λ_S , $S \in \mathcal{S}$, and let (π_S, m_S) be a (straightforward) I.C. mechanism for S , $S \in \mathcal{S}$. Then $(\pi, m) = \sum_{S \in \mathcal{S}} \lambda_S (\pi_S, m_S)$ is a (straightforward) I.C. mechanism for N .*

⁵Recall that a family \mathcal{S} of coalitions is balanced if there are weights λ_S , $S \in \mathcal{S}$, such that $\sum_{S \in \mathcal{S}, i \in S} \lambda_S = 1$ for every $i \in N$.

Proof of the lemma: Let us for instance check that $\sum_{i \in N} \pi_{ir}(t) \leq 1$. The left hand side is

$$\begin{aligned} \sum_{i \in N} \sum_{S \in \mathcal{S}} \lambda_S \pi_{S,i}^r(t) &= \sum_{i \in N} \sum_{S \in \mathcal{S}: i \in S, r \in K_S} \lambda_S \pi_{S,i}^r(t) = \sum_{S \in \mathcal{S}: r \in K_S} \lambda_S \sum_{i \in S} \pi_{S,i}^r(t) \\ &\leq \sum_{S \in \mathcal{S}: r \in K_S} \lambda_S = \sum_{S \in \mathcal{S}: a(r) \in S} \lambda_S = 1 \end{aligned}$$

where $a(r)$ denotes the initial owner of item r . The other feasibility conditions are similar. The incentive compatibility conditions are linear inequalities and thus hold for (π, m) , which is a linear combination of the (π_S, m_S) . Q.E.D.

The mechanism (π, m) in the statement of lemma 2 is not, as such, a convex combination of the (π_S, m_S) , $S \in \mathcal{S}$. Hence its feasibility had to be checked. As in the proof of proposition 1 (see [15]), the previous reasoning uses the fact that each good can be identified with the agent who initially owns it. However, in [15], the grand coalition's mechanism constructed from the balanced family's mechanisms allocates the different goods *independently* of each other, which would *not* give rise to a feasible (straightforward) mechanism in the present model.

Clearly, the linearity of *interim* expected utilities $U_i(\pi, m | t_i, t'_i)$ as a function of mechanisms is extremely helpful in proposition 2 but this is not the only key to the result. As soon as *random* mechanisms are allowed, *interim* expected utilities *become* linear in the mechanism but this does not ensure the non-emptiness of the *ex ante* I.C. core, as shown in [14]. If economies with random mechanisms are naively interpreted as linear, the exact feasibility condition imposed on mechanisms in section 2 is weakened to expected feasibility (see [15] and [16], section 4.3.2). In the economies with indivisible goods considered above, expected and exact feasibility are basically equivalent, thanks to the von Neumann-Birkhoff theorem. To apply this result, we needed to concentrate on straightforward mechanisms, and for this, we used the particular form of utility functions in (4). Whether proposition 2 holds in more general models, like the ones considered in [28] or [6], is an open question.

4 T.U. economies

Let us assume, in the basic model of section 2, that good $l = k + 1$ is perfectly divisible (let us refer to it as money) and that utility functions are quasi-linear

with respect to money, i.e.,

$$u_i(t, x_i) = w_i(t, x_i^1, \dots, x_i^k) + x_i^l \quad i \in N, t \in T \quad (8)$$

where $w_i(t, \cdot)$ is continuous and increasing for every $i \in I$ and $t \in T$. Let us further assume that individual allocations in money need not be bounded below or above: $C_i = \mathbb{R}_+^k \times \mathbb{R}$ (resp., $C_i = \{0, 1\}^k \times \mathbb{R}$) if goods are perfectly divisible (resp., indivisible). Feasibility obviously requires that the aggregate allocation in money does not exceed the total initial endowment in that good. We may thus as well assume that $e_i^l = 0$ for every $i \in N$. For reasons that will be clear below, we denote the underlying economy as \mathcal{E}_{TU} (we need not distinguish perfectly divisible goods from indivisible ones).

X_S can be defined exactly as in (1):

$$X_S = \left\{ x \in \prod_{i \in S} C_i : \sum_{i \in S} x_i^r \leq \sum_{i \in S} e_i^r \quad r = 1, \dots, k, \quad \sum_{i \in S} x_i^l \leq 0 \right\}$$

According to the definition of section 2, a mechanism μ_S for coalition S is described by probability distributions over X_S for every type profile t . However, since the utility functions are quasi-linear, the incentive compatibility constraints only depend on the conditional expected monetary transfers. Hence we can restrict ourselves without loss of generality to *deterministic* money transfers and describe μ_S as (ξ_S, m_S) , where ξ_S selects feasible allocations of goods $r = 1, \dots, k$ and $m_S : T \rightarrow \mathbb{R}^N$ selects feasible money transfers, namely $\sum_{i \in S} m_{S,i}(t) \leq 0$.

Furthermore, type independent monetary transfers are obviously incentive compatible, so that the characteristic function V^* defined in section 2 reduces to the following T.U. characteristic function:

$$v^*(S) = \max_{(\xi_S, m_S) \text{ I.C.}} \sum_{i \in S} U_i(\xi_S, m_S)$$

The *ex ante* incentive compatible core simplifies into the set $C(v^*)$ of all vector payoffs $v \in \mathbb{R}^N$ such that $\sum_{i \in N} v_i \leq v^*(N)$ and, for every S , $\sum_{i \in S} v_i \geq v^*(S)$.

For comparison, we also define the characteristic function v which prevails in the absence of incentive constraints. In this case, free disposal of money cannot be useful. Moreover, if the utility functions are concave, lotteries are

not necessary either. Hence v takes the simple form:

$$v(S) = \max_{\xi_S \text{ deterministic}} \sum_{i \in S} \sum_{t \in T} q(t) u_i(t, \xi_{S,i}(t))$$

By the complete information results (see [19] for perfectly divisible goods and [31] for indivisible goods), $C(v)$ is not empty. If $v^*(N) = v(N)$, namely if incentive compatibility constraints do not matter in the grand coalition, $C(v) \subseteq C(v^*)$, so that the *ex ante* incentive compatible core is also non-empty.

Starting with d'Aspremont and Gérard-Varet ([4], [5]), a number of papers (e.g., [2], [3], [9], [10], [22]) have identified conditions on the beliefs q and/or the utility functions $w_i(t, x_i^1, \dots, x_i^k)$ which guarantee that the grand coalition N can achieve first best allocations by means of an incentive compatible mechanism with budget balanced transfers⁶, which implies that $v^*(N) = v(N)$. Hence these conditions also ensure the non-emptiness of $C(v^*)$. We illustrate this kind of result with two particular simple sets of sufficient conditions (see [14] for further details and other results making use of the same reasoning).

Proposition 3 *If in \mathcal{E}_{TV} the beliefs are independent (i.e., $q(t) = \prod_{i \in N} q(t_i)$ for every t) and values are private (i.e., $w_i(t, (x_i^r)_{1 \leq r \leq k}) = w_i(t_i, (x_i^r)_{1 \leq r \leq k})$ for every $i, t, (x_i^r)_{1 \leq r \leq k}$), the ex ante incentive compatible core is non-empty.*

The next proposition is established in [22]. Let us denote as $q_{i,i+1}(\cdot | t_i)$ agent i 's conditional probability distribution (induced by q) over T_{i+1} given t_i , where $i + 1$ is understood *mod. n*.

Proposition 4 *If in \mathcal{E}_{TV} the beliefs satisfy*

$$q_{i,i+1}(\cdot | t_i) \neq q_{i,i+1}(\cdot | s_i) \quad \forall i, \forall t_i, s_i, t_i \neq s_i,$$

the ex ante incentive compatible core is non-empty.

The previous analysis applies in economies with perfectly divisible goods as well as in the T.U. version of the economies with indivisible goods that we considered in section 3.2. However, monetary transfers do not play any essential role to make the core non-empty in the latter case, since it was

⁶Namely, (ξ, m) such that $\sum_{i \in N} m_i(t) = 0$.

already non-empty with non-transferable utilities. More precisely, proposition 2 holds in the T.U. case, and the proof of the analog of lemma 2 can be simplified by relying on the Bondareva-Shapley theorem instead of Scarf [29]’s (see [13]). Although unlimited monetary transfers are not necessary for the non-emptiness of the core, they are nevertheless useful to achieve first best solutions in the *ex ante* incentive compatible core. This is illustrated in the next example.

Example

Let us assume that $n = 4$ and $k = 2$. Agents 1 and 2, who can be viewed as sellers, both own an item, say, a house, and know, at the *interim* stage, whether the quality of their own house is high or low: $T_1 = \{h_1, l_1\}$, $T_2 = \{h_2, l_2\}$. The probability distribution over the sellers’ types is $q(h_1, h_2) = q(l_1, l_2) = \frac{3}{8}$, $q(h_1, l_2) = q(l_1, h_2) = \frac{1}{8}$. Agents 3 and 4, the potential buyers, have no private information. The reservation price of the sellers is p_h (resp., p_l) for a high (resp., low) quality house. In other words, the utility from selling his house is $-p_h$ (resp., $-p_l$) for a high (resp., low) type seller. The reservation prices of the buyers are u_h and u_l respectively, i.e., acquiring a high (resp., low) quality house yields utility u_h (resp., u_l) to each buyer. We assume that $u_l < p_l < p_h < u_h$ and that $\frac{1}{2}(u_l + u_h) < \frac{1}{2}(p_l + p_h)$ (e.g., 0, 9, 12, 20) and that the utility of any agent is 0 when no sale takes place.⁷

Since the buyers are not submitted to incentive constraints, we will, without loss of generality, focus on transfers summing up to 0 throughout the example.

Let us first consider a seller-buyer coalition $\{i, j\}$, $i \in \{1, 2\}$, $j \in \{3, 4\}$. The seller has then two equiprobable types, which we denote as h and l . We face a simple, discrete version of Myerson [25]’s “lemon problem”. A mechanism for a seller-buyer coalition consists of the probability of trade π_h (resp., π_l) when the seller reports type h (resp., l) and the corresponding expected transfers m_h , m_l from the buyer to the seller (note that the transfers include the sale price as well as possible fees). By eliminating the transfers from the incentive constraints (see, e.g., [22] or [25]), the optimization problem of a

⁷For a concrete example, think of the termites invading some regions of France. The qualities of houses in the same neighborhood are highly correlated. We assume that mechanisms are designed before the sellers know the quality of their houses, which is consistent with the fact that quality is only checked in case of potential transactions.

seller-buyer coalition $\{i, j\}$, $i \in \{1, 2\}$, $j \in \{3, 4\}$ is

$$v^*(\{i, j\}) = \max\left[\frac{1}{2}\pi_h(u_h - p_h) + \frac{1}{2}\pi_l(u_l - p_l)\right] \quad s.t. \quad 0 \leq \pi_h \leq \pi_l \leq 1$$

so that, under our assumptions,

$$v^*(\{i, j\}) = 0 \quad i \in \{1, 2\}, j \in \{3, 4\}$$

Let us set $g_h = u_h - p_h > 0$. Observe that, in absence of incentive constraints, $v(\{i, j\}) = \frac{1}{2}g_h$. Trade is indeed beneficial in state h , but the incentive compatibility conditions prevent revelation of information from the seller.

Let us turn to the grand coalition $N = \{1, 2, 3, 4\}$. First best efficiency requires to sell the high quality houses, and only those, at every state of nature. Hence,

$$v(N) = g_h$$

We will construct an incentive compatible mechanism achieving g_h as sum of expected payoffs, so that

$$v^*(N) = g_h$$

As observed above, this implies that $C(v) \subseteq C(v^*)$ and provides a simple procedure to construct expected payoffs in the *ex ante* incentive compatible core.⁸

Consider a mechanism in which only high quality houses are sold, namely

$$\begin{aligned} \pi(h_1, h_2) &= \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} & \pi(h_1, l_2) &= \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix} \\ \pi(l_1, h_2) &= \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix} & \pi(l_1, l_2) &= \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} \end{aligned}$$

The sum of expected payoffs from π is g_h . Obviously, π is not incentive compatible, but one can construct transfers m such that (π, m) is incentive compatible. For instance, the transfers m_1 to the first seller must satisfy

$$\begin{aligned} -p_h + \frac{3}{4}m_1(h_1, h_2) + \frac{1}{4}m_1(h_1, l_2) &\geq \frac{3}{4}m_1(l_1, h_2) + \frac{1}{4}m_1(l_1, l_2) \\ \frac{1}{4}m_1(l_1, h_2) + \frac{3}{4}m_1(l_1, l_2) &\geq -p_l + \frac{1}{4}m_1(h_1, h_2) + \frac{3}{4}m_1(h_1, l_2) \end{aligned}$$

⁸The procedure can be applied to a large class of mechanisms (see, e.g., [2], [3], [4], [5], [9], [10], [22]).

A possible solution is

$$\begin{aligned} m_1(h_1, h_2) &= \frac{3p_h - p_l}{2} + \frac{g_h}{4} & m_1(h_1, l_2) &= \frac{3p_l - p_h}{2} + \frac{g_h}{4} \\ m_1(l_1, h_2) &= \frac{g_h}{4} & m_1(l_1, l_2) &= \frac{g_h}{4} \end{aligned}$$

The transfers m_2 to the second seller can be chosen in a similar way. In order to balance the transfers, one can simply set $m_3 = -m_1$, $m_4 = -m_2$. The mechanism (π, m) thus associates buyer 3 (resp., 4) with seller 1 (resp., 2) but sale only takes place if the seller's house is of high quality. (π, m) yields the expected payoff $\frac{g_h}{4}$ to each trader. The mechanism reflects that sale prices are influenced by the presence of low quality items; the transfers in the low state should be interpreted as a fee that the potential buyers pay to get information and avoid a bad decision. Many other mechanisms achieving ex post efficiency can be constructed. In particular, as in [10], it is possible to design the transfers in such a way that the mechanism is *interim* individually rational for the sellers, who fully extract the surplus⁹.

Let us end the analysis of the example by showing that the expected payoff from (π, m) , namely, $(\frac{g_h}{4}, \frac{g_h}{4}, \frac{g_h}{4}, \frac{g_h}{4})$, belongs to $C(v^*)$. We have evaluated $v(\{i, j\})$, $i \in \{1, 2\}$, $j \in \{3, 4\}$ and $v(N)$. To complete the description of v , we compute that

$$\begin{aligned} v(\{i, 3, 4\}) &= \frac{g_h}{2} & i &= 1, 2 \\ v(\{1, 2, j\}) &= \frac{5g_h}{8} & j &= 3, 4 \end{aligned}$$

Hence, $(\frac{g_h}{4}, \frac{g_h}{4}, \frac{g_h}{4}, \frac{g_h}{4}) \in C(v)$. It follows from our previous remarks that $(\frac{g_h}{4}, \frac{g_h}{4}, \frac{g_h}{4}, \frac{g_h}{4}) \in C(v^*)$. The same reasoning applies to $(\frac{g_h}{2}, \frac{g_h}{2}, 0, 0)$.

This example shows that it may be better for the agents (in the sense of generating a higher sum of expected payoffs) to stay together at the *ex ante* stage in order to exchange information *within the grand coalition*. For instance, this enables the agents to exploit the possible correlation between types and to achieve first best efficiency through full revelation.

⁹Adding (resp., subtracting) $\frac{g_h}{4}$ to (resp., from) all previous transfers gives the surplus to the sellers (resp., buyers). All these mechanisms, including the latter, are interim individually rational for the sellers. Another mechanism with the same properties is

$$\begin{aligned} m_1(h_1, h_2) &= \frac{3u_h - p_l}{2} & m_1(h_1, l_2) &= \frac{3p_l - u_h}{2} \\ m_1(l_1, h_2) &= \frac{3g_h}{2} & m_1(l_1, l_2) &= \frac{-g_h}{2} \end{aligned}$$

5 Concluding remarks

In this paper, we have focused on the *ex ante* incentive compatible core, which is defined without any ambiguity, as the classical core of a well-behaved characteristic function. As pointed out by Myerson (see, e.g., [23], [24], [26], [27]), it might be that no *ex ante* stage is available. In many examples, coalitions do form at the *interim* stage. The main issue then is that the negotiation over mechanisms already conveys information on the agents' types, so that a completely different approach is needed. This problem is still widely open (see [11], [12], [26] [27] for a discussion of the issues and possible solutions; [16] surveys most available results).

The previous difficulties disappear if coalitions *form* at the *interim* stage, but cannot exchange information at that stage. This approach was followed by Wilson [33] and Vohra [32] in order to define the *coarse core* and the *incentive compatible coarse core*, respectively. The latter solution concept assumes that coalitions S use incentive compatible mechanisms μ_S as in this paper. But coalition S can block proposals from the grand coalition at the *interim* stage, namely as soon as it is common knowledge in S , at that stage, that some incentive compatible mechanism improves the expected payoffs of all members of S (i.e., there exists an incentive compatible mechanism yielding a higher payoff to *all types* in T_S that are common knowledge in S). As a consequence, mechanisms in the incentive compatible coarse core are *interim* individually rational (see, e.g., [9], [10]) and *interim* incentive efficient (in the sense of Holmström and Myerson [20]).

The incentive compatible coarse core is empty in Forges, Mertens and Vohra [14]'s example, both in the T.U. and the N.T.U. case. It is non-empty in exchange economies with linear utility functions or with divisible goods as in section 3.2: both corollary 1 and proposition 2 apply to the incentive compatible coarse core (see Forges [13] for a detailed proof of the result in the case of T.U. economies with indivisible goods). This might let us hope that the incentive compatible coarse core behaves in the same way as the *ex ante* incentive compatible core. However, nothing of the kind is clear for the results which depend on unlimited monetary transfers, as propositions 3, 4 and 5. Even the basic T.U. structure of the model disappears at the *interim* stage (see [16] and [14] for further comments).

References

- [1] Abdulkadiroglu, A. and T. Sönmez (1988), “Random serial dictatorship and the core from random endowments in house allocation problems”, *Econometrica* 66, 689-701.
- [2] d’Aspremont, C., J. Crémer and L.-A. Gérard-Varet (1990), “Incentives and the existence of Pareto-optimal revelation mechanisms”, *Journal of Economic Theory* 51, 233-254.
- [3] d’Aspremont, C., J. Crémer and L.-A. Gérard-Varet (2002), “Correlation, independence and Bayesian incentives”, mimeo.
- [4] d’Aspremont, C. and L.-A. Gérard-Varet (1979), “Incentives and incomplete information”, *Journal of Public Economics* 11, 25-45.
- [5] d’Aspremont, C. and L.-A. Gérard-Varet (1982), “Bayesian incentive compatible beliefs”, *Journal of Mathematical Economics* 10, 83-103.
- [6] Alkan, A. and D. Gale (1990), “The core of the matching game”, *Games and Economic Behavior* 2, 203-212.
- [7] Bogomolnaia, A. and H. Moulin (2001), “A new solution to the random assignment problem”, *Journal of Economic Theory* 100, 295-328.
- [8] Bogomolnaia, A. and H. Moulin (2002), “A simple random assignment problem with a unique solution”, *Economic Theory* 19, 623-635.
- [9] Crémer, J. and R. McLean (1985), “Optimal selling strategies under uncertainty for a discriminating monopolist when demands are interdependent”, *Econometrica* 53, 345-361.
- [10] Crémer, J. and R. McLean (1988), “Full extraction of the surplus in Bayesian and dominant strategy auctions”, *Econometrica* 56, 1247-1257.
- [11] de Clippel, Geoffroy and E. Minelli (2004), “Two-person bargaining with verifiable types”, *Journal of Mathematical Economics* 40, 799-813.
- [12] Dutta, B. and R. Vohra (2003), “Incomplete information, credibility, and the core”, Working Paper 2003-21, Department of Economics, Brown University.

- [13] Forges, F. (2004), “The ex ante incentive compatible core of the assignment game”, *Mathematical Social Sciences* 47, 135-151.
- [14] Forges, F., J.-F. Mertens and R. Vohra (2002), “The ex ante incentive compatible core in the absence of wealth effects”, *Econometrica* 70, 1865-1892.
- [15] Forges, F. and E. Minelli (2001), “A note on the incentive compatible core”, *Journal of Economic Theory* 98, 179-188.
- [16] Forges, F., E. Minelli and R. Vohra (2002), “Incentives and the core of an exchange economy: a survey”, *Journal of Mathematical Economics* 38, 1-41.
- [17] Gale, D. (1960), *The Theory of Linear Economic Models*, McGraw-Hill.
- [18] Garrat, R. and C.-Z. Qin (1996), “Cores and competitive equilibria with indivisibilities and lotteries”, *Journal of Economic Theory* 68, 531-543.
- [19] Hildenbrand, W. and A. Kirman (1988), *Equilibrium Analysis: Variations on Themes by Edgeworth and Walras*, North Holland.
- [20] Holmström, B. and R. Myerson (1983), “Efficient and durable decision rules with incomplete information”, *Econometrica* 51, 1799-1819.
- [21] Hylland, A. and R. Zeckhauser (1979), “The efficient allocation of individuals to positions”, *Journal of Political Economy* 91, 293-313.
- [22] Johnson, S., J. Pratt and R. Zeckhauser (1990), “Efficiency despite mutually payoff-relevant private information: the finite case”, *Econometrica* 58, 873-900.
- [23] Myerson, R. (1983), “Mechanism design by an informed principal”, *Econometrica* 51, 1767-1797.
- [24] Myerson, R. (1984), “Cooperative games with incomplete information”, *International Journal of Game Theory* 13, 69-96.
- [25] Myerson, R. (1985), “Analysis of two bargaining problems with incomplete information”, in A. Roth (ed), *Game-Theoretic Models of Bargaining*, Cambridge University Press, Chapter 7, 115-147.

- [26] Myerson, R. (1995), “Sustainable matching plans with adverse selection”, *Games and Economic Behavior* 9, 35-65.
- [27] Myerson, R. (2002), “Virtual utility and the core for games with incomplete information”, research notes, mimeo.
- [28] Quinzii, M (1984), “Core and competitive equilibria with indivisibilities”, *International Journal of Game Theory* 13, 41-60.
- [29] Scarf, H. (1967), “The core of an n-person game”, *Econometrica* 35, 50-69.
- [30] Shapley, L. and H. Scarf (1974), “On cores and indivisibility”, *Journal of Mathematical Economics* 1, 23-37.
- [31] Shapley, L. and M. Shubik (1972), “The assignment game I: the core”, *International Journal of Game Theory* 1, 111-130.
- [32] Vohra, R. (1999), “Incomplete information, incentive compatibility and the core”, *Journal of Economic Theory* 86, 123-147.
- [33] Wilson, R. (1978), “Information, efficiency and the core of an economy”, *Econometrica* 46, 807-816.

CESifo Working Paper Series

(for full list see www.cesifo-group.de)

- 1625 Sam Bucovetsky and Andreas Haufler, Tax Competition when Firms Choose their Organizational Form: Should Tax Loopholes for Multinationals be Closed?, December 2005
- 1626 Silke Uebelmesser, To go or not to go: Emigration from Germany, December 2005
- 1627 Geir Haakon Bjertnæs, Income Taxation, Tuition Subsidies, and Choice of Occupation: Implications for Production Efficiency, December 2005
- 1628 Justina A. V. Fischer, Do Institutions of Direct Democracy Tame the Leviathan? Swiss Evidence on the Structure of Expenditure for Public Education, December 2005
- 1629 Torberg Falch and Bjarne Strøm, Wage Bargaining and Political Strength in the Public Sector, December 2005
- 1630 Hartmut Egger, Peter Egger, Josef Falkinger and Volker Grossmann, International Capital Market Integration, Educational Choice and Economic Growth, December 2005
- 1631 Alexander Haupt, The Evolution of Public Spending on Higher Education in a Democracy, December 2005
- 1632 Alessandro Cigno, The Political Economy of Intergenerational Cooperation, December 2005
- 1633 Michiel Evers, Ruud A. de Mooij and Daniel J. van Vuuren, What Explains the Variation in Estimates of Labour Supply Elasticities?, December 2005
- 1634 Matthias Wrede, Health Values, Preference Inconsistency, and Insurance Demand, December 2005
- 1635 Hans Jarle Kind, Marko Koethenbuerger and Guttorm Schjelderup, Do Consumers Buy Less of a Taxed Good?, December 2005
- 1636 Michael McBride and Stergios Skaperdas, Explaining Conflict in Low-Income Countries: Incomplete Contracting in the Shadow of the Future, December 2005
- 1637 Alfons J. Weichenrieder and Oliver Busch, Artificial Time Inconsistency as a Remedy for the Race to the Bottom, December 2005
- 1638 Aleksander Berentsen and Christopher Waller, Optimal Stabilization Policy with Flexible Prices, December 2005
- 1639 Panu Poutvaara and Mikael Priks, Violent Groups and Police Tactics: Should Tear Gas Make Crime Preventers Cry?, December 2005

- 1640 Yin-Wong Cheung and Kon S. Lai, A Reappraisal of the Border Effect on Relative Price Volatility, January 2006
- 1641 Stefan Bach, Giacomo Corneo and Viktor Steiner, Top Incomes and Top Taxes in Germany, January 2006
- 1642 Johann K. Brunner and Susanne Pech, Optimum Taxation of Life Annuities, January 2006
- 1643 Naércio Aquino Menezes Filho, Marc-Andreas Muendler and Garey Ramey, The Structure of Worker Compensation in Brazil, with a Comparison to France and the United States, January 2006
- 1644 Konstantinos Angelopoulos, Apostolis Philippopoulos and Vangelis Vassilatos, Rent-Seeking Competition from State Cooffers: A Calibrated DSGE Model of the Euro Area, January 2006
- 1645 Burkhard Heer and Bernd Suessmuth, The Savings-Inflation Puzzle, January 2006
- 1646 J. Stephen Ferris, Soo-Bin Park and Stanley L. Winer, Political Competition and Convergence to Fundamentals: With Application to the Political Business Cycle and the Size of Government, January 2006
- 1647 Yu-Fu Chen, Michael Funke and Kadri Männasoo, Extracting Leading Indicators of Bank Fragility from Market Prices – Estonia Focus, January 2006
- 1648 Panu Poutvaara, On Human Capital Formation with Exit Options: Comment and New Results, January 2006
- 1649 Anders Forslund, Nils Gottfries and Andreas Westermarck, Real and Nominal Wage Adjustment in Open Economies, January 2006
- 1650 M. Hashem Pesaran, Davide Pettenuzzo and Allan G. Timmermann, Learning, Structural Instability and Present Value Calculations, January 2006
- 1651 Markku Lanne and Helmut Luetkepohl, Structural Vector Autoregressions with Nonnormal Residuals, January 2006
- 1652 Helge Berger, Jakob de Haan and Jan-Egbert Sturm, Does Money Matter in the ECB Strategy? New Evidence Based on ECB Communication, January 2006
- 1653 Axel Dreher and Friedrich Schneider, Corruption and the Shadow Economy: An Empirical Analysis, January 2006
- 1654 Stefan Brandauer and Florian Englmaier, A Model of Strategic Delegation in Contests between Groups, January 2006
- 1655 Jan Zápál and Ondřej Schneider, What are their Words Worth? Political Plans and Economic Pains of Fiscal Consolidations in New EU Member States, January 2006

- 1656 Thiess Buettner, Sebastian Hauptmeier and Robert Schwager, Efficient Revenue Sharing and Upper Level Governments: Theory and Application to Germany, January 2006
- 1657 Daniel Haile, Abdolkarim Sadrieh and Harrie A. A. Verbon, Cross-Racial Envy and Underinvestment in South Africa, February 2006
- 1658 Frode Meland and Odd Rune Straume, Outsourcing in Contests, February 2006
- 1659 M. Hashem Pesaran and Ron Smith, Macroeconometric Modelling with a Global Perspective, February 2006
- 1660 Alexander F. Wagner and Friedrich Schneider, Satisfaction with Democracy and the Environment in Western Europe – a Panel Analysis, February 2006
- 1661 Ben J. Heijdra and Jenny E. Ligthart, Fiscal Policy, Monopolistic Competition, and Finite Lives, February 2006
- 1662 Ludger Woessmann, Public-Private Partnership and Schooling Outcomes across Countries, February 2006
- 1663 Topi Miettinen and Panu Poutvaara, Political Parties and Network Formation, February 2006
- 1664 Alessandro Cigno and Annalisa Luporini, Optimal Policy Towards Families with Different Amounts of Social Capital, in the Presence of Asymmetric Information and Stochastic Fertility, February 2006
- 1665 Samuel Muehlemann and Stefan C. Wolter, Regional Effects on Employer Provided Training: Evidence from Apprenticeship Training in Switzerland, February 2006
- 1666 Laszlo Goerke, Bureaucratic Corruption and Profit Tax Evasion, February 2006
- 1667 Ivo J. M. Arnold and Jan J. G. Lemmen, Inflation Expectations and Inflation Uncertainty in the Eurozone: Evidence from Survey Data, February 2006
- 1668 Hans Gersbach and Hans Haller, Voice and Bargaining Power, February 2006
- 1669 Françoise Forges and Frédéric Koessler, Long Persuasion Games, February 2006
- 1670 Florian Englmaier and Markus Reisinger, Information, Coordination, and the Industrialization of Countries, February 2006
- 1671 Hendrik Hakenes and Andreas Irmen, Something out of Nothing? Neoclassical Growth and the ‘Trivial’ Steady State, February 2006
- 1672 Torsten Persson and Guido Tabellini, Democracy and Development: The Devil in the Details, February 2006

- 1673 Michael Rauber and Heinrich W. Ursprung, Evaluation of Researchers: A Life Cycle Analysis of German Academic Economists, February 2006
- 1674 Ernesto Reuben and Frans van Winden, Reciprocity and Emotions when Reciprocators Know each other, February 2006
- 1675 Assar Lindbeck and Mats Persson, A Model of Income Insurance and Social Norms, February 2006
- 1676 Horst Raff, Michael Ryan and Frank Staehler, Asset Ownership and Foreign-Market Entry, February 2006
- 1677 Miguel Portela, Rob Alessie and Coen Teulings, Measurement Error in Education and Growth Regressions, February 2006
- 1678 Andreas Haufler, Alexander Klemm and Guttorm Schjelderup, Globalisation and the Mix of Wage and Profit Taxes, February 2006
- 1679 Kurt R. Brekke and Lars Sørsgard, Public versus Private Health Care in a National Health Service, March 2006
- 1680 Dominik Grafenhofer, Christian Jaag, Christian Keuschnigg and Mirela Keuschnigg, Probabilistic Aging, March 2006
- 1681 Wladimir Raymond, Pierre Mohnen, Franz Palm and Sybrand Schim van der Loeff, Persistence of Innovation in Dutch Manufacturing: Is it Spurious?, March 2006
- 1682 Andrea Colciago, V. Anton Muscatelli, Tiziano Ropele and Patrizio Tirelli, The Role of Fiscal Policy in a Monetary Union: Are National Automatic Stabilizers Effective?, March 2006
- 1683 Mario Jametti and Thomas von Ungern-Sternberg, Risk Selection in Natural Disaster Insurance – the Case of France, March 2006
- 1684 Ken Sennewald and Klaus Waelde, “Itô’s Lemma“ and the Bellman Equation for Poisson Processes: An Applied View, March 2006
- 1685 Ernesto Reuben and Frans van Winden, Negative Reciprocity and the Interaction of Emotions and Fairness Norms, March 2006
- 1686 Françoise Forges, the Ex Ante Incentive Compatible Core in Exchange Economies with and without Indivisibilities, March 2006