MECHANISMS, MULTI-LATERAL INCENTIVE COMPATIBILITY, AND THE CORE

by

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I. Introduction

The concept of group, or multi-lateral incentive compatibility, has recently found many uses both in pure theory (Hammond, 1983) and in applications to public finance (Hammond, 1983), financial structure, and banking (Jacklin 1988, Haubrich and King 1988, Haubrich 1988). The work applying this concept has used techniques centering on the ability of groups or coalitions to change the allocation of goods across agents. This concentration on allocations, as opposed to mechanisms, raises some questions about the validity of the procedure. Basically, resource allocation within coalitions must be subject to the same incentive constraints that bind the social planner. The coalitions considered in the literature on multilateral incentive compatibility may not respect that constraint. The theory has little content if it gives coalitions a magical ability to induce true preference revelation. Harris and Townsend (1981) have shown that the (individually) incentive compatible efficient allocations are core allocations. How could coalitions somehow improve upon (block) the core? At the very least the problem remains of how to relate the results of Hammond to the mechanism-theory literature stemming from Harris and Townsend (1981) and Myerson (1979).

This paper attempts to cast multi-lateral incentive compatibility in a standard mechanism theory framework in order to resolve these questions. Some basic assumptions about mechanisms must be modified, but group incentive compatibility can be rationalized in a mechanism theoretic framework. The analysis in turns sheds light on the nature of mechanisms, particularly their sequential nature: questions of observability, the resolution of uncertainty, and the ability of coalitions to make members consume bundles, come to the forefront. Similar questions have led Holmstrom and Myerson (1983) and

Crawford (1985) to investigate "durable" decision rules, and we pursue the connection between the concepts in Section III.

The main difference between individual and group incentive compatibility, and thus between their mechanisms, is that group incentive compatibility considers that agents may exchange goods after an allocation has been received. Standard mechanism theory assumes that agents consume the bundle delivered by the mechanism. This paper postulates a 2-stage mechanism game, where agents play a mechanism game <u>again</u>, after the first game has yielded them an allocation of goods. This allows agents the option of trading, dealing, or making side payments with the original allocation. In particular, a person may misrepresent his or her type, not because the bundle gained by lying is better <u>per se</u>, but because exchanges will make the final allocation preferable.

The remainder of the paper expands upon these themes. Section II introduces the basic concepts and notation used in the rest of the paper, and follows Harris and Townsend quite closely. Section III discusses the importance of the core mechanisms, and proves the main result of the paper. Finally, section IV provides examples showing the difference between core mechanisms of the sort considered in this paper, and the sort used by Harris and Townsend and Myerson.

II. Basic Concepts and Notation

Since the purpose of this paper is to derive the benefits of recasting multi-lateral incentive compatibility in a mechanism theoretical framework, we adhere closely to the notation of Harris and Townsend (1981). Likewise, we adopt the concepts of environment, mechanism and perfect Bayesian Nash equilibrium. This section sets forth the notation and basic conventions used in the paper. Parts that re-iterate harris and Townsend will be kept brief;

more emphasis will fall on the extensions needed to implement group incentive compatibility.

Environments

The economic environment consists of a continuum $T \subset \mathbb{R}$ of agents and a collection of production sets associated with coalitions of agents. This number of agents differs from Harris and Townsend, who use a finite number of agents. The continuum is what Hammond uses in his seminal work on multi-lateral incentive compatibility (1983); it also rules out many trivial demand revelation schemes. Agents have a common consumption set $C \subset \mathbb{R}^{\ell}_{+1}$, $\ell \geq 2$. Agents may be identified by their endowments, their preferences, and their initial information.

Endowments and preferences depend on a vector θ of parameters. $N = \{1, 2, \ldots n\}$ is the set of parameter indices, while $\Theta_S \subset \mathbb{R}$, Θ_S finite, denote the set of possible values of the S^{th} parameter θ_S. Let $\Theta = X_{S \in N} \Theta_S$ be the (product) parameter space with typical value θ, where $\theta = (\theta_1, \theta_2, \theta_3 \ldots \theta_n)$. Assume that *ex ante* all agents are identical, getting distinguished only after the resolution of Θ.

Each agent a observes some realized values of the parameter $N_a \subset N$. That is, each actor sees some θ_S's. Some parameter values may be seen only by particular agents, others by groups, still others by the entire population. What person a observes is $\Theta^a = X_{S \in N_a} \Theta_S$, with typical element θ^a. Each agent has a utility function, depending in some part on taste shocks, U_a: $C \times \Theta^T \to \mathbb{R}$ where Θ^T are the taste shock components of Θ^a.

For those parameters not observed, each agent has beliefs which take the form of a non-degenerate prior distribution over those parameters. The prior $\rho_a(\xi|\theta^a)$ identifies the agent's belief that the true value of $\Theta = \xi$ when person a observes θ^a. Notice that if $\xi^a \neq \theta^a$, $\rho_a(\xi|\theta^a) = 0$, and assume that $\rho_a(\xi|\theta^a) > 0$ for all ξ such that $\xi^a = \theta^a$.

Since the major theme of this paper concerns coalitions, it is crucial to define the allocations achievable by coalitions. Any subset A of agents T can consume in a non-empty set $\lambda(A) \subset C^A$. A typical element of $\lambda(A)$ delivers a consumption bundle to each $a \in A$. Thus, λ maps coalitions (sets of agents) to feasible allocations. Following Harris and Townsend, we call this the <u>technology</u>.

The total milieu of these various elements is the <u>environment</u>, a vector $E = [T, \ell, N, (N_a), \Theta, \lambda, U_T, \rho_T, \theta]$ where T denotes the set of agents, ℓ the number of goods, N the parameter index, N_a the parameters observed by each agent a, Θ the random variable of parameters, λ the technology, U_T the utility function, ρ_T the priors, and finally, θ the actual realized parameter values. Often we focus on a sub-environment E_A for coalition A.

<u>Mechanisms</u>

A <u>mechanism</u> sets forth a set of rules which specify an extensive form game played by the agents. The elements of this mechanism involve τ, the number of stages in the game, the total set of potential signals in S, and the set of feasible signals for agent a at stage t is S_{at}. Each S_{at} is a correspondence associating a subset of the signal space with each sequence of past signals. Finally, there is a payoff function F which determines the final allocation in $\lambda(A)$ as a function of the sequence of signals s_A^τ.

Invoking the revelation principle, which reduces the messages to 1-stage truthful reporting of parameter values, allows us to characterize, and thus refer to mechanisms, by the payoff function F. This often proves convenient.

The framework so far has scarcely deviated from that of Harris and Townsend: now we introduce the extension that allows multi-lateral incentive compatibility. After the agents play a mechanism game and receive the final allotments, another mechanism game starts, taking as environment the allocation determined by the first mechanism. This added game relaxes the assumption that agents must consume the allotment given by F, yet it constrains any trading, dealing, or side payments to occur via the well defined mechanism game. The payoff structure of standard mechanisms prevented agents from misreporting their parameters by making the truthful payoff the most desireable: now that payoff must also dominate allocations resulting from trading and side-payments. An agent may prefer to mis-report in the first round to better his chances in the second, even though cheating in the first round by itself would not make sense. Intuitively, the 2-stage mechanism describes a world where transfers between agents are unobservable.

Any coalition $B \subset A \subset T$ has a technology for the second stage of $\mu(B)$. As before, it suffices to distinguish between second stage mechanisms (M_B) by the payoff function G: $\lambda(A|B) \to \mu(B)$. The notation $A|B$ means "A restricted to B." Strictly speaking, that must wait for the revelation principle; formally, G: $S_B^{\tau} \to \mu(B)$.

Equilibrium

An equilibrium concept associates strategies (here signals or messages) with environments and games. We follow Harris and Townsend in adopting the perfect Bayesian Equilibrium. This specifies a strategy and a posterior distribution for each agent. Given actor a's priors on others' strategies, a picks a message as a best response to those strategies. Actor a rationally updates his subjective distribution conditional on the messages received from all other agents. For more details, consult Harris and Townsend (1981) or Harsanyi (1967-68).

The sequential nature of the game considered here adds some complexity to the problem, but the basic notion of equilibrium remains the same. Given the strategies of other agents (which now contain a time element) any actor maximizes his own expected utility. An equilibrium occurs when this holds for all agents. In this, as in all else, we follow Harris and Townsend as closely as possible.

III. Preferences over Mechanisms and Core Efficiency

The agents who comprise society wish to select a mechanism that is "best" in some sense. Again, following the short but rich tradition of mechanism theory, this paper centers attention on core mechanisms. The core, though not without its flaws, is appealling on both positive and normative grounds. Since no group can improve upon a point in the core, no group has an incentive to produce a different point. Thus the core appears a natural outcome as well as exhibiting efficiency properties.

Even with core efficiency as an objective, preferences over mechanisms are not yet well-defined: they depend on the time of the preference relative to the resolution of uncertainty. Hölmström and Myerson distinguish three stages: *ex ante*, before individuals have received any private information; *interim*, when each agent knows its own, but not others' private information, and *ex post*, when the information is common knowledge. Most work, arising from free-rider and principal-agent analysis, has used interim efficiency. This paper, however, stresses *ex ante* efficiency. This emphasis results from the previous use of multi-lateral incentive compatibility on problems of banking and insurance, where agents protect themselves from adverse realizations of type, i.e., lifetime wealth, time preference, or other attribute. Though for any particular game the change in criteria may be important, formally the difference is small. As Harris and Townsend, who use interim efficiency, note: "An alternative formulation would be to suppose that preferences over mechanisms are expressed prior to the revelation of θ^a to agent a, but that the mechanism must be 'played out' (as before) subsequent to this revelation."

To make the notion of core more precise, take a set of agents A, a corresponding environment E_A, and a mechanism M_A and define the expected utility of agent $a \in A$ as

$$W_a[M_a] = \int_{\xi \in \Theta} U_a\{c_a[M_A, \xi], \xi\} e_a(\xi) d\xi$$

or the (ex ante) expected utility of the allocation determined by the mechanism. A coalition $B \subset A$ can <u>improve upon</u> (Shapley 1973) a mechanism M_A if there exists a mechanism M_B' so that $W_b[M_B'] \geq W_s[M_A]$ for every $b \in B$, with strict inequality for some $b \in B$. A mechanism M_A^* for A is a <u>core mechanism</u> if no coalition B can improve upon M_A^*.

This section now examines some basic properties of core mechanisms of the sort considered in this paper. It starts out with the revelation principle. Then, several propositions explore the basis of multi-lateral incentive compatibility. The first shows that precommitment can reduce this mechanism to the sort considered by Harris and Townsend, and thus when multi-lateral incentive compatibility may be ignored in favor of plain incentive compatibility. The next shows why it is sufficient to consider only 2 stage (as opposed to 3, 4, or n-stage) mechanisms to capture MIC. The following section provides examples of the power of MIC.

First, though, we must justify

Proposition 1: The Revelation Principle holds for the 2-stage mechanism game.

Two different arguments justify using the Revelation Principle. The first notes that for any game form, if a solution concept is private and based on outcomes, then it satisfies the revelation principle (see Green 1985). This implies that the Bayesian-Nash equilibrium used here satisfies the revelation principle. Following Green (1985), Reiter (1977) and Laffont and Maskin (1982), we define a Game Form Γ as a function from strategies to payoffs. A solution concept maps game forms and economies to strategies ($\Gamma \times E \rightarrow S$). Again following standard usage, we say a solution concept respects privacy if a player's action depends only on his type and the game form, not on the actual types of other players. Thus both the Dominant Strategy and Bayesian-Nash equilibrium concepts preserve privacy, but a Nash equilibrium does not. If the mapping to strategies depends on the payoffs to strategies in a non-trivial way, we say the solution concept depends on outcomes. Since the stage mechanism game fits the very general notion of game form, and since the Bayesian-Nash solution concept preserves privacy and depends on outcomes, the Revelation Principle holds.

Alternatively, one may apply the revelation principle to each stage of the mechanism separately. A backward induction argument would then extend the analysis to the entire mechanism. More concretely, we know from Myerson (1979) that the revelation principle holds for the second stage. Now apply the resulting allocation function (G) to payoffs on messages in the first stage, and the same (standard) proof works again.

Invoking the revelation principle considerably simplifies the problem. The first application will be to show conditions under which the 2-stage mechanism considered in this paper reduces to a 1-stage mechanism considered by Harris, Townsend, Myerson, Hölmström, et al. It is the central proposition of this paper, as it highlights the difference in mechanisms needed to consider group and individual incentive compatibility.

Recall that the function F associates allocations with agents in the first stage of the mechanism, and that the function G does similarly in the second stage. This background lets us state

Proposition 2: Let M_A be a core mechanism. If the corresponding second-stage function G can be chosen *ex ante*, then the final allocation (of the 2-stage process) can be obtained from a 1-stage core mechanism.

In other words, if agents could choose G when they choose F, G would be superfluous. Note that this does not make the weak claim that it is *possible* to specify a G that doesn't matter (say, the identity, so $G \circ F = F$) but rather that agents will willingly choose (in the core sense) such an allocation function. First, though, a preliminary lemma, analogous to Harris and Townsend's Theorem 3.

Lemma: For a one stage mechanism, if $\tilde{c}_A$ is an allocation resulting from a core mechanism, $\tilde{c}_A$ is a core allocation. The converse also holds.

Proof of lemma: If $\tilde{c}_A$ is an (*ex ante*) core allocation, it satisfies the incentive compatibility constraints and thus is the outcome of some (not necessarily core) mechanism, i.e.,

$$\tilde{c}_A(\theta_A) = c_A[M_A] \ .$$

Then M_A is a core mechanism for the environment E_A^O. Why? Suppose not. Then there exists a coalition $B \subset A$ and a mechanism M_B' for B such that

$$W_b[M_B'] \geq W_b[M_A]$$

for all $b \in B$ with at least 1 strict inequality. Now let $\tilde{x}_B = c_B[M_B']$, then define

$$U_b(\tilde{c}_b) = W_b[M_A]$$

$$U_b(\tilde{x}_b) = W_b[M_B']$$

so that the U's denote expected utility of allocations, as W's denote expected utility of mechanisms. Since M_B' improves upon M_A, for some b, $W_b[M_B'] > W_b[M_A]$, thus $U_b(\tilde{x}_b) > U_b(\tilde{c}_b)$. This last inequality contradicts c_A being a core allocation, so M_A is a core mechanism.

Q.E.D.

Notice that except for judging allocations and mechanisms <u>ex ante</u>, this proof copies Harris and Townsend exactly. A similar proof by contradiction will establish proposition 2.

Proof of proposition 2: Let $\tilde{c}_A$ be an <u>ex ante</u> core allocation. By the above lemma, it is the result of a core 1-stage mechanism. Suppose this allocation can be improved upon by a (<u>ex ante</u>) coalition B that specifies a 2-stage mechanism function $G \circ F$. But if B improves upon $\tilde{c}_A$ (and the corresponding M_A and F), $\tilde{c}_A$ was not in the core to begin with, since B does better with the allocation resulting from $G \circ F$. This contradiction establishes the result.

Q.E.D.

An alternative proof shows that $G \circ F$ is both resource feasible and incentive compatible, so that the function $G \circ F$ is one of the functions considered by agents when they decide upon the mechanism. Hence the chosen function must be preferable to $G \circ F$. This captures the intuition exactly. When <u>ex ante</u>, agents and coalitions consider mechanisms, any allocation they can specify in two steps, F and G, can be specified in one, $H = G \circ F$. This depends on the ability to pre-specify the second stage mechanism G, and force agents to stick with it. Otherwise, after the resolution of the uncertainty and the first stage allocations, agents will have different preferences and endowments and may prefer a different mechanism in the second stage. Without pre-commitment, a time-inconsistency problem arises (see Kydland and Prescott, 1979). One example of this is a labor contract. In some circumstances, an optimal risk shifting contract results in some layoffs. At some wage below their marginal product, the workers would willingly work, but this *ex post* recontracting, if allowed, would ruin the risk shifting of the original contract (see Grossman and Hart, 1981).

One interpretation of pre-committing G is that the social planner can observe trades or consumption. Then the mechanism can guarantee that agents consume their allocation. This assumption underlies most mechanism theory, and is why they need only consider individual incentive constraints. When trades and consumption are hidden, then multi-lateral incentive constraints become necessary, as agents may then misrepresent themselves with an eye for later exchange.

The next proposition shows that we can restrict attention to a 2-stage mechanism.

Proposition 3: If G(B) is a direct core mechanism for coalition B, extending the game to allow any further mechanism will not change the final allocation.

In other words, if a third stage is added to the mechanism game, with allocation function H_1 then for any coalition $C \subset B$, $H(C) = G(B|C)$, modulo-uniqueness, of course. Intuitively, since there is no more information revealed for H than for G, the third stage just reshuffles allocations in a way that could have been done in the second stage, had agents desired it. The proof makes this point more formally. The proof uses core allocations, but Harris-Townsend theorem 3 translates these into core mechanisms.

Proof of proposition 3: If a coalition C can improve upon its share of the allocation $\tilde{x}_B$ with $\tilde{y}_C$, then $U_c(\tilde{y}_C) \geq U_c(\tilde{x}_c)$ with at least one strict inequality. However, $\tilde{y}_C$ was feasible for C before. Change the function G(B) defined on B to G(B) on B - C and set G(B) = H(C) on C. That is, for all $c \subset C$, change $\tilde{x}_c$ to $\tilde{y}_c$. But $\tilde{y}_C$ can't improve upon $\tilde{x}_C$, since $\tilde{x}_C$ is in the core.

Q.E.D.

Proposition 3 means that we can restrict attention to 2-stage mechanisms.

Holmstrom and Myerson (1983) also examine these problems of efficiency, the timing of decision rules relative to the resolution of uncertainty, and the desire to re-contract. They introduce the concept of a durable decision rule, one which individuals would never unanimously vote to change. For example, after agents have learned their types but before the planner hands out the goods, people may realize that, given the actual distribution of types, a different decision rule would make everybody better off. This points out both the similarities and differences with multi-lateral incentive compatibility. Durability too depends on an additional stage of the mechanism game, and the final allocation can change as a result of the final vote. Still, after that vote the goods are handed out and agents must consume the bundle they receive. The additional stage required for multi-lateral incentive compatibility, though, allows agents to "vote with their feet" and rearrange consumption after the allocation has occurred.

Another concept introduced by Holmstrom and Myerson relates the two ideas. A rule is uniformly incentive compatible, if no agent would lie about his type even if he knew the types of others, provided the others tell the truth. In the voting game this implies durability. In the 2-stage game, it implies multi-lateral incentive compatibility, since it prevents agents from misrepresenting their type in order to trade with others. Multi-lateral incentive compatibility thus has a similar flavor to durability, but has the advantage of being decentralized. Something less than a unanimous vote can upset the allocation: two agents trading in their backyard is enough. Thus, if we consider mechanisms as arising through some evolutionary process or an invisible hand, multi-lateral incentive compatibility represents a superior refinement.

IV. Examples

It is tempting to generalize proposition 2 in either of two ways, both of which are wrong. One way would claim that G will never change the core allocation of the original 1-stage mechanism. The other way suggests that G would always change the results of F. In this section, we present a simple yet rigorous example showing the first claim false. We note here that the second claim is false if the initial economy corresponds to the classical Arrow-Debreu world.

The example presented below represents a simplification of recent information based banking theories (see Diamond and Dybvig, 1983, Haubrich and King, 1983). It motivates a simple need for insurance against agent type. For greater detail on the justification, solution, and interpretation of this sort of simple model, see Haubrich (1984) or Jacklin (1986).

In this example, all agents start out *ex ante* identical. They are then subject to a random shock, which they wish to insure against. This uncertainty takes the form of an additive shock to tastes: an individual's utility will be $u(c_0 \pm\theta, c_1)$. In the beginning, agents do not know whether they get a boost or a drag in good 1. A formally identical way to model this would use endowment uncertainty; we forgo that opportunity in order to conform to the preference-based uncertainty of the mechanism theory literature.

The equivalence of core allocations and core mechanisms allows easy characterizations of the direct core mechanism. It is the mechanism that supports the solution to the programming problem:

I. $$\max EU(\cdot, \cdot)$$

s.t. 1. resource constraints
2. incentive compatibility constraints.

One way of picturing this situation is shown in figure 1. that depicts the situation with _ex ante_ identical homothetic indifference curves subject to an additive shift in preferences. Point E represents the endowment point, while point UO denotes the unconstrained optimum; the point of full insurance, reachable if all information were public. Point CE depicts the _ex post_ competitive equilibrium--the result if agents made no _ex ante_ agreements and engaged in trade after the resolution of uncertainty. The _ex post_ competitive equilibrium satisfies incentive compatibility, but _ex ante_ arrangement can provide much more insurance. Point A denotes the solution to problem I, the core allocation, the point that maximizes the expected utility of agents before the type shock (though generally it need not lie on the contract curve). Point B denotes the allocation an agent receives when he lies about his type. Point A lies on an indifference curve at least as high as point B by incentive compatibility.

Thus, point A represents, as the solution to problem I, the core mechanism among 1-stage mechanisms for this environment. We next show what sort of difference moving to a 2-stage mechanism, and the multi-lateral incentive compatibility, makes for the solution.

Point A, for example, is not multi-lateral incentive compatible. Consider the following strategy by an agent with a positive draw ($+\theta$, thus "lucky"). In stage 1, the agent misrepresents his type, ending up at point B. In stage 2, he correctly reveals (per the revelation principle) his allocation as B, and trades with those who told the truth. The resulting allocation, along the line segment joining A and B is preferred to A or B. Put another way, given that an agent has received allocation B, the core mechanism for the second stage results in an allocation along $\overline{AB}$. Thus, point A is not a core allocation for the 2-stage mechanism, or, what amounts to the same thing, A is not multi-lateral incentive compatible.

Noting that the above strategy depended on $\overline{AB}$ cutting above the indifference curve through A, and further noting that $\overline{AB}$ always passes through E, consideration of trades between the lucky, the unlucky, and both shows that the only point satisfying multi-lateral incentive compatibility is CE. That is, for this environment, <u>the only multi-lateral incentive compatible point is the</u> ex post <u>competitive equilibrium</u>.

The core of a 1-stage mechanism for this environment is A. The core of a 2-stage mechanism is CE. For explicit proofs, more intuition, arbitrage interpretations and so on, for this particular environment, see Haubrich (1984). The basic reference on multi-lateral incentive compatibility is, of course, Hammond (1983).

BIBLIOGRAPHY

Crawford, V. P., "Efficient and Durable Decision Rules: A Reformulation," Econometrica 53.4, 1985.

Green, Edward J., "The Fed Lectures on Game Theory, Mechanism Design, and Auctions," unpublished 1985.

Grossman, Sanford J. and Oliver Hart, "Implicit Contracts, Moral Hazard and Unemployment," AER Papers and Proceedings 71, May 1981.

Hammond, Peter, "Multilateral Incentive Compatibility in Continuum Economies," IMSSS Technical Report No. 435, Nov. 1983.

Harris, Milton and Robert M. Townsend, "Resource Allocation under Asymmetric Information," Econometrica, Vol. 49, No. 1, January 1981.

Harsanyi, John C., "Games with Incomplete Information Played by 'Bayesian' Players (Parts I-III)," Management Science 14, 1967-68.

Haubrich, Joseph G., "Optimal Financial Structure in Exchange Economies," International Economic Review, Forthcoming, 1988.

Haubrich, Joseph G. and Robert G. King, "Banking and Insurance," Journal of Monetary Economics, Forthcoming, 1988.

Holmstrom, Bengt and Roger B. Myerson, "Efficient and Durable Decision Rules with Incomplete Information," Econometrica, Vol. 51, No. 6, November 1983.

Jacklin, Charles, "Demand Deposits, Trading Restrictions, and Risk Sharing," in Contractual Arrangements for Intertemporal Trade, E. Prescott and N. Wallace, eds., University of Minnesota Press, 1988.

Kydland, Finn and Edward C. Prescott, "Rules Rather than Discretion: The Inconsistency of Optimal Plans," Journal of Political Economy 85.3, 1977.

Laffont, Jean-Jacque and Eric Maskin, "The Theory of Incentives: An Overview," Chapter 2 in Advances in Economic Theory, W. Hildenbrand, ed., Cambridge University Press, New York, 1982.

Myerson, Roger B., "Incentive Compatibility and the Bargaining Problem," Econometrica, Vol. 47, No. 1, January 1979.

Reiter, Stanley, "Information and Performance in the (New)^2 Welfare Economics," American Economic Review 67.1, February 1977.

Shapley, Lloyd, "Let's Block 'Block,'" Econometrica 41, 1973.

AN EXAMPLE OF MULTI-LATERAL INCENTIVE COMPATIBILITY

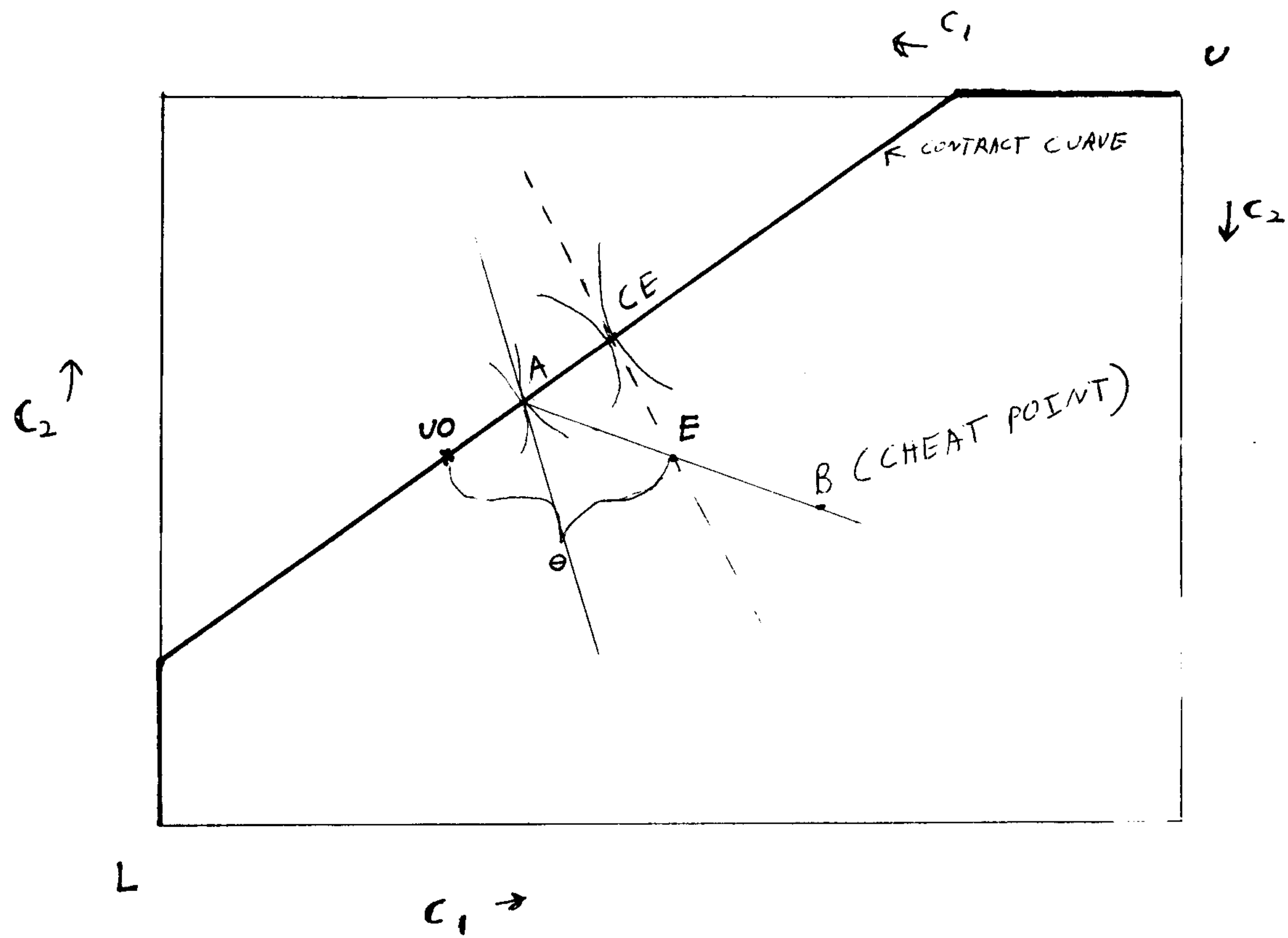

FIGURE 1.