International Coffee Agreement: Incomplete Membership and Instability of the Cooperative Game

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Abstract

Bargaining in international agreement is often analyzed through the dominant noncooperative game theory perspective. Unlike previous works, this paper uses the cooperative game theory framework to study the evolution of the international coffee agreement over time. The analysis reveals that the agreement adjusts to changes in its environment, but ultimately fails because of its incomplete membership and conflicting members' objectives. The failure of the quota system was the result of an institutional change following disequilibrium in utility allocation. Incomplete membership, unclear and ambiguous objectives caused the coalition to be unstable and led to a parallel market. Allocations inside the core became dominated, and some members found it more profitable to operate outside the core. Any future agreement based on quotas that will attempt to raise prices above the equilibrium market prices will encourage new producers to enter the market, and nonmember producers to increase their production.

Introduction

Fluctuations in the prices of agricultural commodities cause sharp variations in the export earnings of many developing nations. This generates instability in domestic income, handicaps economic planning and damages prospects for growth (Balassa, 1971). A common solution to commodity price fluctuations has been the formation of international multilateral commodity agreements like the International Coffee Agreement (ICA) signed in 1940. Earlier study found that imperfect competition would lead to greater price stability, which explains why countries set up commodity agreements (Newbery, 1984). Palfrey and Rosenthal (1994) added that in a case of coordination and cooperation, repetition leads to greater cooperation, the magnitude of which depends on the ability of players to monitor each other's strategy and on the environmental parameters. Many adjustments have been operated to the first agreement until the ICA reached the total liberalization stage in the early 1990s.

Several authors have analyzed the intergovernmental commodity agreements either from the standpoint of their impact on government policies or their closeness to cartel theory (Newberry, 1984; Tsou et al., 1944; Swerling, 1963; Mikesell, 1963; Haley, 1846; Haberger & Wall, 1984). These studies have focused on the evaluation of its impact on trade and export revenue stability for the member countries. They have studied the effect of ICA on prices, price stability, volume traded, and revenue. However, none of them have considered the formation and the evolution of ICA in the light of the coalitional game theory.

This paper attempts to analyze the evolution of the ICA as a cooperative game. The ICA could be thought of as a coalition with a transferable utility characteristic function. The analysis hypothesizes that the evolution of the agreement resulted each time from a change in rules of the game between traders. It was modified repeatedly to adapt to market conditions.

I. Notes on the International Coffee Agreements (ICA).

Mikesell (1963) divides the individual commodity agreements into three categories: (1) those based on limiting market supply by means of export quotas in order to maintain price at or near the desired level, (2) those employing multilateral long-term contracts, and (3) those which rely upon an international buffer stock to maintain prices within a given range by means of purchase and sales from the buffer stock. The ICA was part of the first category.

The ICA evolved from the Inter-American Coffee Agreement (IACA), which was signed long before the guidelines for the operations of the intergovernmental commodity agreements were drafted for the abortive Havana Charter for an International Trade Organization in 1947[1].

I.1. The Inter-American Coffee Agreement

The first Agreement was the Inter-American Coffee Agreement (IACA), signed in 1940 between the United States and fourteen Latin-American coffee-producing countries to lessen the burden imposed by the loss of European market to Latin American producers (Tsou & Black, 1944). The central feature of the IACA was a system of export quotas, for which basic schedules were agreed upon after negotiation and compromise. Its avowed objective was to assure terms of trade equitable for both producers and consumers by adjusting the supply to the demand (Mikesell, 1963). Producers would restrict the quantity supplied and consumers would agree to pay a negotiated price.

The coffee-exporting countries were interested in having these export quotas fixed so that cutthroat competition would be prevented, and American coffee prices would rise to profitable levels. The United States, in effect, indicated its willingness to facilitate such rise in the interest of inter-American solidarity (Davis, 1946). Haley (1946) argued that processors in consuming countries might have been more interested in price stabilization, as they probably had considerable sums invested in inventories. The United States had the power to increase her quota in excess of 5 percent per year at a time. From the standpoint of the United States, the underlying political objective of the agreement was to prevent the complete economic collapse of the Latin American members. For this reason, no criteria of fairness or statement of specific price objectives were made public.[2]

The Inter-American Coffee Agreement was reviewed yearly on a standby basis until September 1948. When the demand increased more than the supply in late 1948, the Latin American Producers opposed the continuation of the agreement and applied extensive production strategies in an attempt to benefit from the subsequent increase in prices. By 1947, coffee prices decreased and it became more evident that national control efforts could no longer stabilize the market. The Latin American producing countries

[1] Refer to Haley, B. F. (1946) for more details about these guidelines.
[2] Davis, S.J. (1946) explains that the IACA was mostly a foreign aid tool; for that reason its economic objectives were unclear.

founded the Latin American Coffee Agreement for the purpose of restricting exports. The agreement was negotiated on a yearly basis. In 1959, the principal African producers joined the schemes. The ICA was later signed.

I.2. The International Coffee Agreement (ICA)

In 1962, fifty-eight producing and consuming countries negotiated a new agreement to replace the 1959 agreement. The International Coffee Agreement (ICA), which ran from 1963 to 1973, was a long-term agreement, unlike the former short-term agreement that involved other producers and consumers. The inclusion of consumers in the 1962 agreement was necessary to strengthen the pact.

Table 1
International Coffee Agreement: Membership and Distribution of Votes in 1962

34 Exporting Members	Votes	21 Importing members	Votes
Brazil	346	Argentina	-
Burundi	8	Australia	11
Colombia	122	Austria	12
Congo (Leopoldville)	19	Belgium	33
Costa Rica	24	Canada	42
Cuba	9	Denmark	29
Dominican Republic	13	Federal Republic of Germany	120
Ecuador	16	Finland	25
El Salvador	33	France	118
Ethiopia	28	Japan	13
Ghana	6	Luxembourg	6
Guatemala	31	Netherlands	40
India	12	New Zealand	7
Indonesia	38	Norway	20
Mexico	34	Spain	20
Nicaragua	13	Sweden	47
Nigeria*	-	Switzerland***	-
OAMCAF**	89	Tunisia	-
Panama	6	United Kingdom	39
Peru	16	United States	400
Portugal	48	USSR	18
Rwanda	8		
Sierra Leone	6		
Tanzania	13		
Trinidad & Tobago	6		
Uganda	42		
Venezuela	14		
Total	**1000**	**Total**	**1000**

Source: Senate Committee on Finance, Coffee (Senate Report No. 53. Washington D.C.: 89th Congress 1st Session), P. 11.

*Nigeria, an exporting member, and Argentina and Tunisia, as importing members, have lost their votes for nonpayment of dues.

**OAMCAF members are Cameroon, Central African Republic, Congo (Brazzaville), Dahomey, Gabon, Ivory Coast, Madagascar, and Togo.

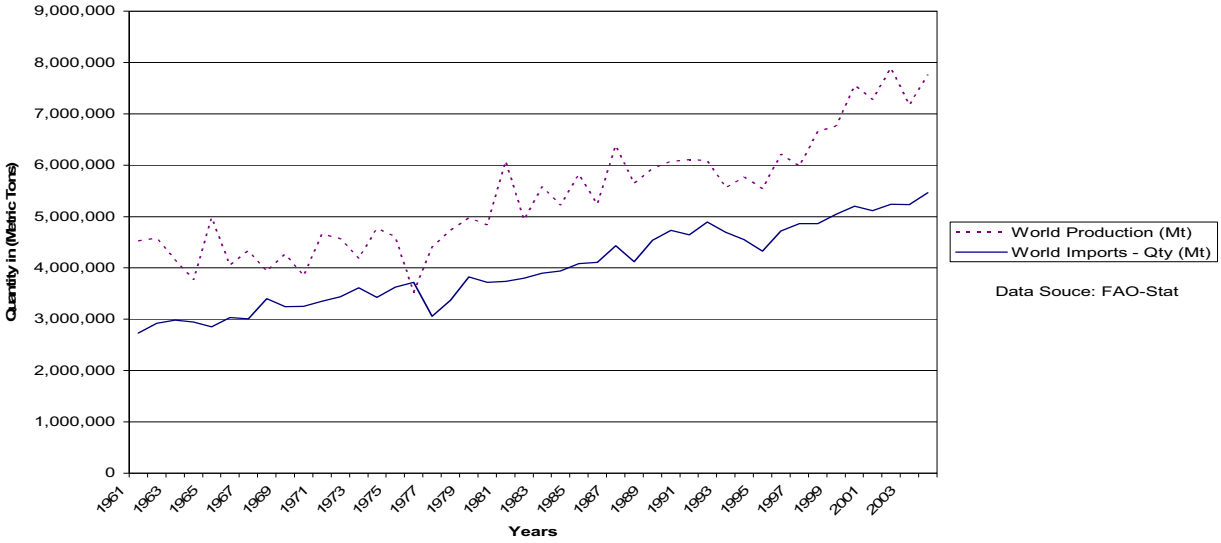
***Switzerland had just joined the Agreement.

The International Coffee Organization (ICO) supervised the ICA, whose objectives seemed different for importing and exporting members. For the exporters, the agreement attempted to assist in increasing the purchasing power of exporting countries. In 1962 ICA, the statement of objective reads: "To achieve a reasonable balance between supply and demand on a basis which will assure adequate supplies of coffee to consumers and markets for coffee to producers at equitable prices, and which will bring about long-term equilibrium between production and consumption" (Mikesell, 1963, p.68). It appears that members mutually agreed to: (1) stabilize prices by increasing consumption, (2) achieve a long-term equilibrium between production and consumption, and (3) assure adequate supply to consumers and markets to producers at equitable prices. Members intended to keep the world supply as small as possible while trying to maximize their own share, without making any effort to curtail production. Those were rather contradictory statements of objectives for exporters when entering into negotiations according to Mikesell (1963).

The objectives of the importing countries were less clear. Important consumers like the United States envisioned the main goal of the agreement as one of simply halting the drastic downward trend in prices, and ameliorating the terms of trade (Jones, 1967). Thus, the participation of importers in the agreement has been explained primarily in political terms. Policymakers in major coffee-importing countries seem to have assumed that this mechanism could achieve larger amounts of foreign aid than formal legislation (Bohman, 1996).

Bohman (1996) described, in a model, the functioning of the ICA as follows: A target range for prices (weighted average of different types of coffee) was established and a global export quota fixed to meet the desired price. Exporting countries received a percentage of the total exports quota, and exports to the member market were constrained so as not to exceed the quota amount. The model assumes the quota amount is exogenous, reflecting the ICA operations until 1987. The ICA rules were modified to make quota changes partially dependent on exports and stocks. This was done in response to the demand of some important producers like Brazil, which accumulated large stocks to satisfy its quota constraint. Changes in the quota were small and quota shares also responded slightly to lobbying within the International Coffee Organization (ICO).

Figure 1: World coffee Supply and Demand (1961-2004)



Mikesell (1963) predicted that a free market price outside the member market would emerge and create two-price system, and the low nonmember price market would in turn discourage production. A secondary or nonmember market existed alongside the member market because some coffee-importing countries elected not to join the ICA. Member exporters were allowed to sell to nonmember importers, but only at the same price that prevailed in the member market, or with a large price discount whenever ICA quotas were in effect. Neither the exporting countries nor the nonmember had any incentive to restrict such sales. Consequently, the imposition of the global quota caused prices in the member market to rise above the free trade price, and prices in the nonmember market to fall below that level. Coffee exporters thus faced two distinct markets: one with high prices constrained by quotas, and the other unconstrained with low prices.

The ICA failed in 1989, as the cost of maintaining excess stocks and excess production capacity became unsustainable. Also, dissatisfaction among importing members stemmed from the lower prices paid by nonmember countries. The quota system was abandoned on July 4, 1989. Free market was established, and the agreement is now a mere statement of good intentions from members.

II. Analysis of the ICA using a Cooperative Game Framework

The ICA could be classified in the category of cooperative game, different from noncooperative game in that it allows binding agreements (Friedman' 1986, p.148). Other differences cited are (a) the fairness of outcomes, (b) the naturalness of outcomes, (c) the scope for players to make active choices, and (d) the levels on which players can interact. Talking of the fairness of outcomes, which is a debatable concept, the outcome of the ICA can be considered fair for each party as long as they are all happy with it. If producers and consumers (whose interests naturally diverge) can come together and reach an agreement, the outcome of the agreement should be fair for each of them. Otherwise, they would leave the coalition.

The naturalness of outcomes is defined as how reasonable it is to expect a particular solution or equilibrium to be realized in practice. Again, it seems that the outcomes are "natural" based on the fact that if producers and consumers have diverging interests, reaching binding agreements can only lead to a natural outcome since the parties cannot do otherwise than behave in accord with the achieved equilibrium. The equilibrium to be reached here, which is the core of the game, is roughly the main objective of the agreement: to stabilize the price of coffee. Regardless of the motivations of parties in the game, they all agreed upon this objective.

The scope for players to make active choices is captured in this game in form of the Shapley value (sum of the marginal contributions). In fact the quotas allowed to the parties are contributions of individual members to the solution of the game. The level on which players interact is high. Members are free to form subgroups.

The ICA could have been viewed as two-people's game, as two original groups were formed, one made of producers (exporters) and the other of consumers (importers). However, incomplete membership rules out this alternative. Within the original groups, others were formed[3] (producers of Arabica coffee, producers of Robusta coffee, OAMCAF, Latin-American producers, Asian producers etc.). These subgroups could be thought of as engaged in as many subgames. Each member of those subgroups negotiates to maximize its utility or quota, while trying to minimize its competitor's. They all have to come out with a single strategy in the bigger game, which would have resulted in Nash equilibrium in the event of a noncooperative game. The solution to this Nash equilibrium would have been the pair of outcome (Price, Quantity).

II. 1. The Characteristic Function

Having defined the ICA as a cooperative game, we should say it is a coalition with a transferable characteristic function. In fact, it satisfies the definition of coalition set by Friedman (1986). He defines a coalition as a subset of players that is able to make a binding agreement. The transferable utility characteristic function of a game having the set of N is defined a scalar valued function, $v(K) \in R$ with each $K \subset N$, where $v(K)$ is the maximum payoff to members of the coalition K that the coalition can guarantee to itself. This simply means that the coalition can achieve a certain amount of utility that it can freely divide among its members in a mutually agreeable fashion. In our case the total amount of utility is divided in form quota allocated to each member.

The characteristic function contains both α and β characteristic functions. The α-characteristic function exists here in the sense that each player or group of players (either exporters or importers) seek to guarantee itself or themselves certain payoffs through quotas (sale or purchasing) while others act to minimize it. The β-characteristic function is related to the fact that the other members of the coalition decide on the quota to be allocated to a particular exporter or importer.

The characteristic functions are based on this key assumption:

If $u^K \in R^K$ can be achieved by the coalition K, then K can achieve any u'^K satisfying

[3] See Table 1 for the list of coffee producers.

(1) $\sum_{i \in K} u'_i \leq \sum_{i \in K} u_i$ where u^K is that utility of the coalition K

It is assumed that coalitions can achieve at least as much as the sum of what their members can achieve. This is the superadditivity condition, which is defined in terms of any partition of a subset. That is

(2) $K \cap L = \varnothing$, then $v(K \cup L) \geq v(K) + v(L)$, where K and L are subsets of N.

The characteristic function of a game, also called coalitional form, is given by $\Gamma = (N, v)$, and is characterized by player N and the characteristic function v.

II. 2. The Core

The core is a solution concept for coalitional games that requires that no set of players be able to break away and take a joint action that makes all of them better off (Osborne & Rubinstein, 1994). Friedman defines the core of the game $\Gamma = (N, v)$ as the set of undominated imputations. An imputation x is in the core if $\sum_{i \in K} x_i \geq v(K)$ for all coalitions K. Every game with a transferable utility characteristic function has a nonempty core. A nonempty core of the game $\Gamma = (N, v)$ is the solution of the linear programming problem, whose form is:

(3) Minimize $\sum_{i \in N} x_i$

(4) Subject to $\sum_{i \in K} x_i \geq v(K)$ for all $K \in N, K \neq N$

The core of this particular game is the main objective upon which all the members agree. The main objectives of the ICA were to match the world coffee supply and demand in order to stabilize its price, provide stable and reasonable profits for producing countries, and stabilize prices for consuming countries (Tilley & Indahsari, 1996). The equilibrium achieved through this objective is undominated. The quotas are the solution of a linear programming model, whose constraints are derived from the objectives of the agreements.

(5) Maximize $\sum_{i \in N} x_i$

Subject to the targeted level of quantity supplied.

If the target price is set at a certain level, given the level of the world coffee demand, the quantity supplied corresponding to the target price could be determined easily. This quantity is then divided among exporters in proportion with their current stocks and level of production.

The coalition would be stable if no imputation in the core is dominated by another imputation in the core, or if the imputations in the core are not dominated by any other imputation outside the core. That is:

(6) $\sum_{i \in K} x_i \leq v(K)$

We could say the epsilon-core (ε-core), which consists of imputations that are within epsilon of being in the core, existed in the ICA, through the secondary or nonmember market, made of countries that elected not to joint the ICA. The fact the prices were higher in the member market was an incentive for members to target their sales only to member-importers, and probably justified, to some extent, the retention of stock by some major exporters and the battle for the adjustment of the quotas allocation.

If the core becomes unstable, imputations within the core might become dominated by those outside. This will cause members to leave the coalition, and it will ultimately be ruled out, which introduces the concept of the bargaining set of the game.

II. 3. The Bargaining Set

The bargaining set consists of individually rational payoff configurations for which every objection can be met with a counter objection (Friedman, 1986). If a group of dissident members tried to convince few others to go along with them, it should be possible for another group to offer a better plan to attract the entire dissidents with them. This allows objections and counter objections to cancel each other out and leave the coalition as a stable set. The set is stable if an allocation in the core is not undominated inside and/or outside the core. If any allocation inside the core is dominated, some members will find it more profitable to operate outside the core and quit the coalition.

III. The Evolution of the ICA

The ICA relied upon quotas as the main instrument through which it achieved its aims. Total annual quotas were established on the basis of estimated world import requirements for the coming year. The basic quotas were reviewed each year, and they were subject to revision by a distributed two-thirds majority vote. Each year's requirements were estimated and export quotas were assigned to members on the same relative basis as their percentage share of the basic export quota. Several provisions were included in the text of the agreement to allow for adjustment of quotas during the year when conditions seem to necessitate such actions. Members were always looking to improve on their actual allocation of quotas. They were involved in a kind of repeated game where they always tried to rule out the current equilibrium.

Attempts to improve the current quotas have been reflected in the negotiations between Latin American and African producers. Schotter (1986) points out that if players in a game are rational, they would be willing to constrain their strategy sets only as long as such a constriction of their freedom improves their expected payoff. Improving the payoffs was not always possible, given the nature of the commodity, which is subject to the deterioration of the terms of trade. This was the reason of the disagreement that caused the abandonment of the quota system in 1989. Members would stay in the coalition only if the payoff they got from it was greater than the one they got individually. Some important members (i.e. the U.S.) no longer had the political motivation to support the coalition. The end of the Cold War, marked by the collapse of Berlin Wall, ironically did also mark the end of the ICA (Fritsch, 2002). Moreover, the failure of the quotas to be adjusted caused the allocations within the core to be dominated. The core became unstable and the coalition was ultimately ruled out.

In 1989, importing countries were frustrated by the difference between the coalition price and the free market price. Bohman shows that the average member market price of Indonesian Coffee for the period 1981-1988 was 109 cents per pound, while the average nonmember market price for the same period was 56 cents per pound. Moreover, many authors including Harberger and Wall (1984, p.634) argued that instruments for promoting economic development, such as the ICA, amount to an extremely cumbersome method of transferring income from consumers to producers.

Those methods entail considerable economic waste through the probable decisions by arbitrary high prices, and through the probable necessity of production restrictions and surplus disposal. They hence suggest that it would be economically far more rational to provide income transfers directly from the rich to the poor countries. Swerling (1963) warned that more complications would arise due the fact that coffee, as a commodity, is less homogeneous, and price differentials between Arabica and Robusta could be distorted by regulations.

Table 2
Basic Export Quotas (60-kilogram Bags, 1962-65)

Exporter	Quota
Brazil	18,000,000
Columbia	6,011,280
Costa Rica	950,000
Cuba	200,000
Dominican Republic	425,000
Ecuador	552,000
El Salvador	1,429,500
Guatemala	1,344,500
Haiti	420,000
Honduras	285,000
Mexico	1,509,000
Nicaragua	419,000
Panama	26,000
Peru	580,000
Venezuela	475,000
Cameroon	762,795
Central African Republic	150,000
Congo (Brazzaville)	11,000
Dahomey (Benin)	37,224
Gabon	18,000
Ivory Coast	2,324,278
Malgasy Republic	828,828
Togo	170,000
Kenya	516,835
Uganda	1,887,737
Tanganyika (Tanzania)	435,458
Portugal	2,188,737
Congo (Leopoldville)	700,000
Ethiopia	850,000
India	360,000
Indonesia	1,176,000
Nigeria	18,000
Rwanda and Burundi	340,000
Sierra Leone	65,000
Trinidad	44,000
Yemen	77,000
Grand Total	**45,587,172**

Source: Jones, R. J. (1967). *An Evaluation of the 1962 International Coffee Agreement*

Exporting countries like Brazil, Indonesia and Ivory Cost had been experiencing growing stocks. These producers favored a review of the quota system that would increase their shares while others, who benefited from the initial quota allocation (Colombia for instance), wanted the same old system to continue. Mikesell (1963) warned that the existence of such growing stocks would ultimately pose a treat to the agreement. The payoff from the coalition for the members with growing production, given the low quotas was eventually dominated by the payoff they would have received if they were allowed to sell some of their coffee to the nonmember market.

Members of the coalition, not having been able to improve upon their initial allocations, ruled it out and opted for the free market. This is a typical case of an induced institutional change. According to Ruttan and Hayami (1984), institutions that have been efficient at generating growth in the past may, over time, come to direct their efforts primarily to protecting the vested interests of some of their members. They do this by maintaining the status quo, and consequently become obstacles to further economic development. The growing disequilibria in resource allocation created opportunities for members to organize actions to bring about institutional change. It turned out that producing countries were concerned not just with stabilizing the prices of their commodities, but with raising them (Newbery, 1984).

In order to sustain the price on the international market some producing countries have been trying to form a new ICA (ICCO, 2000), in which leading coffee producing countries would adopt a quota system. There is no indication whether consuming countries will participate in this agreement. If importers were part of the new agreement, complete membership will be required for the new coalition to be stable. This condition implies the impossibility for a potential nonmember market. A two-person's game will then appear attractive in this situation, consumers and producers forming two blocks.

In the absence of consuming countries, a cooperative subgame between producing countries, in a form of a cartel, could be considered. The cartel would be subject to instability as potential players will come into market as free riders. A price floor on the market would encourage investment and production by those not bound by the cartel. The last alternative would be a noncooperative game between producers and consumers acting strategically, whose result would be a traditional Nash Equilibrium.

IV. Summary and Conclusions

The International Coffee Agreement was a strategy to stabilize the price of coffee and the revenue of producers. This paper analyzed the ICA using the game theory framework. The ICA could be classified in the category of cooperative games or coalitions, which are different from noncooperative games in that they allow binding agreements. The coalition had a transferable utility characteristic function and a core. The characteristic function represented the value of the coalition to its members, and contained both α and β characteristics functions. There was an ε-core containing players within epsilon of reaching the core.

However, unclear and ambiguous objectives added to incomplete membership contributed to the instability of the coalition. Importers considered the agreement to be a foreign aid tool, while exporters seemed to view it as a cartel agreement. The incomplete membership, characterized by the existence of a nonmember market with a higher payoff, caused the core to become unstable, and ultimately destabilized the ICA. Some high

volume producing countries elected not to join to coalition, which undermined the value of the coalition.

The paper shows that the game evolves according to theory of the evolution of rules. The failure of the quotas system in 1989 was the result of an institutional change (change in the rules of the game), following a disequilibrium in utility allocation. Members, who have not been able to improve on their initial allocations, had no other choice than to rule it out and opt for free market. It appears that Mikesell's prediction of a two-price system did emerge, but the low nonmember market price did not discourage production.

The analysis suggests that an agreement in a market between two groups with conflicting goals will only be stable if all the elements of the two groups are included in the coalition. Incomplete memberships will lead to a parallel market whose utility could potentially dominate the coalition's utility. Any future agreement based on quotas that will attempt to raise prices above the equilibrium market prices will encourage new producers to enter the market, and nonmember producers to increase their production.

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Appendix A

ICA: Original Agreement Objectives (Source: International Coffee Organization)

- To achieve a reasonable balance between supply and demand on a basis which will assure adequate supplies of coffee to consumers and markets for coffee to producers at equitable prices, and which will bring about long-term equilibrium between production and consumption;
- To alleviate the serious hardship caused by burdensome surpluses and excessive fluctuations in the prices of coffee to the detriment of the interests of both producers and consumers;
- To contribute to the development of productive resources and to the promotion and maintenance of employment and income in the Member countries, thereby helping to bring about fair wages, higher living standards, and better working conditions;
- To assist in increasing the purchasing power of coffee-exporting countries by keeping prices at equitable levels and by increasing consumption;
- To encourage the consumption of coffee by every possible means;

In general, in recognition of the relationship of the trade in coffee to the economic stability of markets for industrial products, to further international cooperation in connection with world coffee problems.