
**POLISH ACADEMY OF SCIENCES
SYSTEMS RESEARCH INSTITUTE**

**THE INTERNATIONAL
ECONOMIC COOPERATION**
THEORETICAL FOUNDATIONS

STANISŁAW PIASECKI



**POLISH ACADEMY OF SCIENCES
SYSTEMS RESEARCH INSTITUTE**

**THE INTERNATIONAL
ECONOMIC COOPERATION**

THEORETICAL FOUNDATIONS

STANISŁAW PIASECKI

Warszawa 1992

PREFACE

The main difference between the work here presented and the other studies related to the same, generally speaking, domain, consists in the fact that considerations contained in this book indicate the possibility of resolving questions concerning the choice of the subject and establishment of profitability of international trade and cooperation in conditions when:

- * prices on the internal market do not correspond to social costs,

- * there is lack of conviction as to correctness of exchange rates,

- * prices in international trade are subject to manipulations, resulting from definite interests of some countries, or they simply cannot follow the development of world production system.

As can easily be noticed these are just the conditions in which currently the international trade and cooperation system is being shaped. These particular conditions result, for instance, from governmental subsidies oriented at individual commodities or groups of commodities (e.g. food products), from existing custom tax barriers and from an extremely quick pace of technological progress in the techniques of production.

INTRODUCTION

The problem of international exchange was presented for the first time in precise mathematical terms by Wassily Leontief in his paper entitled "Factor Proportions and the Structure of American Trade", published in *Review of Economics and Statistics* (1956, vol. 38, no. 4).

The first mathematical approach to the problem presented in Poland, was of international industrial cooperation formulated in the Doctoral dissertation of Andrzej Ameljańczyk (Military Technical Academy, 1975), supervised by this author.

Earlier, a similar formulation of the problem of international trade exchange had been forwarded in the Doctoral dissertation of J.Kotyński (Main School of Planning and Statistics, Warsaw, 1968).

If we distinguish the specific problem of international economic cooperation within the broader domain of international trade exchange then the first monograph devoted entirely to economic cooperation is the book in Polish by S.Piasecki, J.Hołuniec and A.Ameljańczyk, entitled "International economic cooperation - Modelling and Optimization" (PWN, Warsaw-Lódź, 1982).

The assumption of complementarity of goods, characteristic for the problem of cooperation, was first introduced by D.Graham in 1923 in his paper "The Theory of International Values Examined" (*Quarterly Journal of Economics*, vol. 38, no.1).

The present publication contains the original results of studies conducted during the years 1982-1985, being a continuation of work started a dozen years before.

Models of international cooperation considered there (see Chapters 1 to 3) were much simpler than in the ones presented here. Still, they are, alas, only theoretical models, which cannot be practically applied in economic activity.

Notwithstanding this situation, the models give certain possibilities with respect to applications. I am convinced that

further in-depth studies in and broadening of the theory presented here will make out of it in the future a perfect instrument for economic practice. I think that conclusions resulting from it may contribute to quicker reequilibration of the international economic system, which has been put so much off the equilibrium by the existing debts.

Against the background of existing numerous publications dealing with international trade and cooperation, as well as international specialization, the theory here presented does not require acceptance of the commonly up to date adopted assumption concerning economic equilibria within the cooperating countries, and, furthermore, this theory has much greater practical potential than the previous theories, in which it has been necessary to assume existence of economic equilibrium prices for comparing profitability of trade.

Since the theory presented in this book is independent of existence of prices, it can also be used in determination of the price structure of goods included in the trade, profitable for the partners in such an international trade deal. Thus, the structure determined ("terms of trade") guarantees stimulation of international cooperation and improvement of international specialization.

On the other hand, the theory can also be used in deciding whether the structure of prices actually existing in the international market is enhancing or, to the contrary, hindering, the development of trade, whether it does not lead to an unsound development of some of the partners at the expense of the other ones. It is not difficult to realize that the theory presented, and especially its results, concern one of the essential economic problems of present time.

The theory has, indeed, its weak points as well. A number of technical simplifying assumptions put aside (their number shall be decreasing as the theory develops), there is one fundamental assumption. It says that every participant of cooperation relation (of international trade) tries to produce the maximum of necessary goods of a given structure, entering the group

considered.

When these ones are consumption goods, we are dealing with the situation, when every partner (every national economy) participating in international exchange, is geared towards maximization of the living standard of own population, given a consumption structure characteristic for this population.

When, however, these are not consumption goods, but, e.g. semi-products, then this corresponds to the situation in which every participant-producer tries to maximize own production, this production determining the structure of demand for semi-products encompassed by cooperation. From this point of view the theory presented may get applied beyond the domain of international cooperation.

Technical simplifications adopted in the book result from the wish of possibly clear and understandable presentation of the theory. Thus, wanting to show graphically the mechanism of cooperation and to illustrate the results of the theory, the present author emphasizes in the book bilateral cooperation encompassing only two kinds or groups of commodities. Analysis of the thus simplified problem is contained in first seven chapters of the book.

The eighth chapter is in a way a generalization of considerations presented in the previous chapters so as to account for the case of multilateral cooperation, involving multiple goods. This chapter may constitute a separate whole - a summary of the contents of the book.

Thus, consequently, the problem arises of the manner in which one should establish the "fair" price structure \hat{w} or the "fair" division of the net product obtained, ε , into the parts β^k . Solution to this problem is described in ***.

9. FINAL REMARKS

The present publication shows the methods of determination of the most advantageous specialization in the domain of international exchange and production in such a way as to possibly increase the consumption level ("standard of living") of every partner of exchange.

The specialization mentioned is being determined irrespective of current internal prices of economies participating in exchange and of the international market prices, basing merely upon the characteristics of the industrial potential at hand.

We are therefore obtaining the capacity of establishing a stable international economic cooperation notwithstanding the speculative price fluctuations. The structure of the thus determined cooperation shall be undergoing modifications along with the changes of productive potentials of participants.

The cooperation established in this manner may happen to be identical with the one determined on the basis of analysis of international prices (just as it is being done presently) under the condition that these will be the prices of economic equilibrium, which are not the subject of speculation, and that the changes of these prices, brought about by the changes of production potentials would not be delayed with regard to the industrial development of the participants.

We can deduce from the theory presented a conclusion going in the opposite direction as well. Thus, if we know how to determine the optimum cooperation for participants having various internal currencies, then we can choose the international prices (expressed

in terms of currency of one of the participants, or in any other) and the exchange rates of the currencies of participants in such a way as to induce the countries which are directed by these values in seeking the balancing of own foreign trade to form the optimum cooperation.

The problem of determination of currency exchange rates is the key problem of cooperation and international exchange. The theory here presented may be used for that purpose, although the methods of determination of the exchange rates were not presented here, the only element demonstrated being the ratio of prices for a concrete set of commodities subject to exchange. The author expresses his hope of being able, in the future, of considering the question of determination of currency exchange rates, which can be made use of both for controlling the international trade and for forecasting of directions of its change.

The latter manner of making use of the theory has a very partial, but directly utilitarian nature.

Let us now pass over to more concrete conclusions - how to make use of the theory in the actual practice of controlling the international trade. We shall demonstrate this on the example of trading of two goods between two participants.

Thus, namely, in the present publication (in the first seven chapters of it) the manner was given of determining the most advantageous:

- * pair of commodities (exported and imported one) which are to become the object of trade or cooperative exchange,

- * structure and magnitude of trade of the pair of commodities, and, in relation to that - the structure and magnitude of own production, as well as the limitations set upon this exchange, resulting from the existing price structure,

- * structure and magnitude of production of the pair of commodities for both cooperating sides and the structure and magnitude of cooperative exchange connected with it, together with the condition on the price structure, allowing for establishment of such a cooperation.

These questions are being considered in the situation when in the framework of every economic organization there exists a possibility of producing both commodities, that is - in the situation, in which the choice as to which of the commodities should be exported and which should be imported, is significant.

Simultaneously, this choice cannot be made on the basis of existing price relations and currency exchange rates, for their economic correctness is doubtful.

It is assumed, also, that production capacities with regard to both commodities are linearly constrained by the productive potential owned, while, simultaneously, the demands of both partners for these commodities are unlimited, given the consumption requirements (demand), which is known.

The case when the capacities of producing goods are limited nonlinearly and when the consumption structure changes depending upon its magnitude was considered in the book mentioned in the introduction, but only for the situation when $b_{12} = b_{21} = 0$.

Since the choice of the most advantageous (optimal) exchange strategy takes place without the requirement of knowledge of existing prices, then the method given makes it possible to state whether the existing price structure allows to achieve the financial balancing of such an exchange. In case when balancing of exchange is not possible the method allows to determine the boundaries within which the price structure ("terms of trade") could change, so as to ensure that the exchange between two sides which is the most advantageous for both of them, be also financially balanced. The method gives therefore an objective basis for concluding dilateral agreements (trade and cooperative ones), in which price relations are established each time in the process of trade negotiations.

It is also not difficult to notice that in the case of current world situation, when internal and international prices are not resulting from an economic equilibrium lasting over a long period of time (with no governmental subsidies nor custom tax barriers), there can not exist currency rates independent of the kinds of

commodities exchanged. This leads directly to the conclusion that international exchange must be conducted under surveillance, usually in the form of granting export-import licenses.

Thus, the ideal model of international exchange (and the international specialization), based upon the uniform currency exchange rates might be valid in conditions of global price equilibrium (concerning both internal and international markets) and abolition of all governmental subsidies and tax barriers.

Until that time we must be prepared for existence and spread of clearing-type bilateral agreements with negotiated prices, as well as for tolerating the import and export licences.

In conclusion of our considerations we shall present an exemplary way of applying the theory presented for selective construction and development of advantageous cooperative connections.

The manner of applying the theory for this purpose is shown in the form of an ALGORITHM of proceeding, which can be carried out by appropriate units of administration.

The ALGORITHM:

1. Select a pair of commodities (call them no.1 and no.2), whose exchange has not been analysed until now, and which are of interest for you in terms of exchange, for you might expect that such an exchange could be advantageous for you. In case when analysis was performed for all pairs already, terminate the procedure of searching for the advantageous cooperation solutions.

2. Check whether for the selected pair of commodities there exist the conditions of free trade in the international market.

If "yes" - propose their production and exchange applying Theorem 1 and then return to point 1. of the Algorithm.

If "no" - then look for the partner of cooperation by carrying out point 3. of the Algorithm.

BIBLIOGRAPHY

1. Aganbegyan, A., Bagrinovski, K., Granberg, A.: Modele matematyczne w planowaniu gospodarczym (mathematical models in economic planning, in Polish). PWE, Warszawa 1974.
2. Ameljańczyk, A.: Niefinansowy model sterowania współpracą międzynarodową (A non-financial model of controlling the international cooperation, in Polish). *Organizacja i Kierowanie*, No. 3/1976.
3. Ameljańczyk, A., Hołubiec, J., Piasecki, S.: Optimisation of international economic cooperation. *Ricerche Economiche*, no.1, 1978.
4. Ameljańczyk, A., Hołubiec, J.: Optimal international economic cooperation and solution of a multi-person cooperative game. *Ricerche Economiche*, no.1/2, 1981.
5. Ameljańczyk, A.: Multicriterial optimisation of international economic cooperation. Vth International Conference on Systems Science, Wrocław (Poland), 1978. *Prace Naukowe ICT Politechniki Wrocławskiej*, no.39, 1978.
6. Ameljańczyk, A., Hołubiec, J.: Modelling of international cooperation in energy by multiperson cooperative game. *Proc. of the First International Conference on Applied Modelling and Simulation*, AMSE, Lyon, 1981 (vol.V).
7. Ameljańczyk, A., Hołubiec, J.: Compromise solution of multiperson cooperative game and its application to international energy consumption. *Large Scale systems, Theory and Applications*. Pergamon Press, London, 1983.
8. Ameljańczyk, A., Hołubiec, J.: The influence of political conditions on the international economic cooperation. *Proc. of SWISS Workshop: Supplemental Ways for Improving International Stability*. Pergamon Press, Oxford, 1984.
9. Ameljańczyk, A., Hołubiec, J.: Modelling of economic cooperation among blocks of countries with different politico-economic objectives. *9th World Congress of IFAC*. Pergamon Press (IFAC Proc. Series, no.6), Oxford 1985.

10. Aumann, R.J.: Existence of competitive equilibria in markets with a continuum of traders. *Econometrica*, 34/1966.
11. Bondareva, O.N.: O teoretiko-igrovykh model'akh v ekonomik'e (On game theoretical models in economics, in Russian). *Izd. Leningradskogo Universiteta*, Leningrad 1974.
12. Czerwiński, Z.: Problematyka planowania cen w ujęciu matematycznym (The problem of price planning in the mathematical perspective, in Polish). PTPN PAN, Poznań 1963.
13. Czerwiński, Z.: Podstawowe problemy konstrukcji racjonalnego systemu cen. *Poznańskie Roczniki Ekonomiczne*. Poznań 1969.
14. Debreu, G.: Economies with a finite set of equilibria. *Econometrica*, 38, 1970.
15. Debreu, G., Scarf, H.: A limit theorem on the core of an economy. *Internat. Econ. Rev.*, 4, no.3, 1963.
16. Gale, D.: On optimal development in a multi-sector economy. *Review of Economic Studies*, 34/1, no.97, 1976.
17. Gale, D.: *The Theory of Linear Economic Models*. McGraw-Hill, New York 1960.
18. Gale, D.: On optimal development in a multi-sector economy. *Rev. Econ. Studies*, 34, no.1, 1967.
19. Georgesen-Roegen, N.: Some properties of a generalized Leontief model. *Activity Analysis of Production and Allocation*, T.C.Koopmans, ed., New York 1951.
20. Gambarelli, G., Hołubiec, J.: Modelling and optimization of international economic cooperation via fuzzy mathematical programming and cooperative games. *Control and Cybernetics*, no.4, 1988
21. Graham, D.: The theory of international values examined. *Quarterly Journal of Economics*, 38, no.1.
22. Hahn, F., Matthews, R.C.O.: The theory of economic growth. A survey. *Economic Journal*, 74, 1964.
23. Hołubiec, J., Piasecki, S.: La collaborazione economica internazionale e la uniformità dei prezzi internazionali (International economic cooperation and the uniformity of

international prices, in Italian). *Rivista di Politica Economica*, no. 12, 1978.

24. Holubiec, J.: Modelling of the International Economic Cooperation. *System Theory and Mathematical Economics*. Pitagora Ed., Bologna, 1986.

25. Intriligator, M.: *Mathematical Optimization and Economic Theory*. Prentice Hall, New York 1971.

26. Kemeny, J.G., Morgenstern, O., Thompson, G.L.: A generalization of the von Neumann model of an expanding economy. *Econometrica*, 24, no. 2, 1956.

27. Kotyński, J.: *Teoria wymiany międzynarodowej a programowanie liniowe*. PWE, Warszawa 1970.

28. Kulikowski, R., ed.: *Modelowanie systemowe społeczno gospodarczego rozwoju kraju (Systems modelling of the socioeconomic development of a country, in Polish)*. PWN, Warszawa 1979.

29. Leontief, W.: Factor proportion and the structure of American trade. Further theoretical and empirical analysis. *Review of Economics and Statistics*, 38, no. 4.

30. Leontief, W.: *Structure of American economy 1919-1929* Cambridge-Massachusetts, Harvard Univ. Press 1941.

31. Leontief, W., Carter A.P., Petri P.A.: *The Future of the World Economy*. New York 1977, Oxford Univ. Press.

32. Luce R.D., Reiffa H.: *Games and Decisions*.

Wiley and Sons, New York 1957.

33. Maciejewski, W.: *Algorytmy optymalizacji struktury handlu zagranicznego i kursów kierunkowych (Algorithms of optimization of the structure of foreign trade and the directional rates, in Polish)*. *Zastosowanie metod matematycznych do analizy ekonomicznej*. ZBKS HZ, Warszawa, 1968.

34. Maciejewski, W.: *Ekonometryczne modele wymiany międzynarodowej (Econometric models of international trade, in Polish)*. PWN, Warszawa 1981.

35. Mycielski, J., Trzeciakowski, W.: *Critères du choix des investissements rapidement rentables (Criteria of choice of quick*

repayment investments, in French). *Economies and Societies*, no.1, 1970.

36. Mycielski, J., Rey, K., Trzeciakowski, W.: *Decomposition and Optimization of Short-Run Planning in a Planned Economy* (T. Barna, ed.). London 1963.

37. Nash, J.F.: Equilibrium points in n -person games. *Proc. Nat. Acad. Sciences, USA*, 36, 1950.

38. von Neumann, J., Morgenstern, O.: *Theory of Games and Economic Behaviour*. Princeton 1974.

39. Nikaido, H.: *Convex Structures and Economic Theory*. Academic Press, New York - London 1968.

40. Pawłowski, Z.: *Ekonometria (Econometrics, in Polish)* PWN, Warszawa 1978 (fifth edition).

41. Piasecki, St., Ameljańczyk, A.: A control of international economic cooperation. IVth International Conference on Systems Science, Wrocław, Poland, 1977. *Prace Naukowe ICT Politechniki Wrocławskiej*, no.47, 1977.

42. Piasecki, St., Hołubiec, J.: Sterowanie wymianą gospodarczą (Controlling the economic exchange, in Polish) *Prace IBS PAN*, no.32, Warszawa 1979.

43. Piasecki, St., Hołubiec, J.: Wieloletnia koordynacja międzynarodowego rozwoju gospodarczego (Multiannual coordination of the international economic development, in Polish). *Prace IBS PAN*, no.52, Warszawa 1980.

44. Piasecki, St., Hołubiec J.: International economic cooperation and the uniform international prices (in Polish). *Prace IBS PAN Nr 52*, Warszawa 1980.

45. Piasecki, St., Hołubiec, J.: Pewne zagadnienie międzynarodowej współpracy gospodarczej (On a certain problem in international economic cooperation, in Polish). *Prace IBS PAN*, no.77, 1981.

46. Piasecki, St., Hołubiec, J., Ameljańczyk, A.: Międzynarodowa kooperacja gospodarcza (The International Economic Cooperation, in Polish). PWN, Łódź - Warszawa 1982.

47. Piasecki S.: *Model of Socio-Economic National Development*

(in polish). Prace IBS PAN, No 164 Warszawa 1988.

48. Piaszczyński, W.: Matematyczne modele teorii handlu międzynarodowego (Mathematical Models of the Theory of International Trade, in Polish). PWE, Warszawa 1974.

49. Rosati, D.: Polityka eksportowa. PWE, Warszawa 1990.

50. Rosenmüller, J.: Kooperative Spiele und Market (Cooperative Games and Market, in German). Springer Verlag, Berlin - Heidelberg - New York 1971.

51. Roth, A.E.: Subsolutions and supercore of cooperative games. *Mathematics of Operations Research*, vol.1, no.1, 1976.

52. Shapley, L.S., Shubik, M.: On market games. *J.Economic Theory* 1, no.1, 1969.

53. Shubik, M.: Edgeworth market games. *Annals of Math. Studies*, vol.IV, no.40, 1959.

54. Solow, R.M.: A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 70, 1956.

55. Shagalov, G.L.: Problemy optimalnogo planirovaniya vneshe-ekonomicheskikh svyazey (Problems of optimum planning of external economic relations, in Russian). Izd. Moskva 1973

56. Trzeciakowski, W.: Modele pośredniego kierowania gospodarką planową w sterowaniu handlem zagranicznym (Models of indirect management of a planned economy in the control of foreign trade, in Polish). PWE, Warszawa 1975.

57. Tsukui, J.: Turnpike theorem in a generalized dynamic input-output system. *Econometrica*, 34, no.2, 1966.

58. Uzawa, H.: Optimal growth in a two-sector model of capital accumulation. *Review of Economic Studies*, 31, 1964.

For order and other information, please write to:

**Systems Research Institute, Polish Academy of Sciences
ul. Newelska 6, 01-447 Warsaw, Poland
Fax: +4822/37 27 72**

ISBN 83-90-00412-5-1