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**Conference Paper — Digitized Version**

## Comment on "Dynamico: A multilevel programming model of world trade and development" by Antonio M. Costa

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*Suggested Citation:* Snower, Dennis J. (1983) : Comment on "Dynamico: A multilevel programming model of world trade and development" by Antonio M. Costa, In: Bert G. Hickman (Ed.): Global international economic models: Selected papers from an IIASA conference, ISBN 0-444-86718-X, North-Holland, Amsterdam, pp. 276-279

This Version is available at:

<https://hdl.handle.net/10419/3702>

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COMMENTS\*

Dr. Costa's paper really concerns much more than a normative analysis of trade and development in the 1980s. It deals with production interdependencies with and among ten comprehensive regions of the world, with opportunity costs of production activities and monetary flows, with excess supplies in worldwide factor markets, with foreign exchange and resource constraints on economic growth, and with socially desirable choices of production technologies. Even this list of topics is only a sample. They are all treated in a coherent analytical framework: the global model DYNAMICO.

Dr. Costa maintains that, at bare minimum, the model provides an empirical means for exploring the production possibility frontier of the world economy. It is certainly a rather refined means. Intersectoral production relations are not simply specified in terms of fixed input–output coefficients whereby each sector uses a single technology; instead, each sectoral output can be produced by various technologies, the choice of which is determined through efficiency criteria. Yet such an appraisal of the model involves an obvious and inexcusable understatement. The truly extraordinary feature of DYNAMICO is its normative framework. Through it, the global welfare effects of regional economic activities can be assessed empirically and thus one may inquire whether a particular region is overpaid or underpaid for the productive and extractive services it provides. In other words, interregional externalities are evaluated and these may be used to appraise the desirability not only of trade and development of underdeveloped regions, but also of monetary flows and of growth of developed regions.

In addition to an empirical specification of the productive structure of various regions, a global social welfare function provides another basic building block of DYNAMICO. Dr. Costa does not argue in favor of any particular social welfare function. He presents several alternatives (the maximization of world GNP, the minimization of the income gap between rich and poor nations, and the maximization of the discounted value of regional consumption) and chooses one (the first) to exemplify his empirical results. In this context, he presents some interesting conclusions. For example (p. 273), "Of the ten regions covered by the model, North America, Japan and Oceania, Latin America, the petroleum-exporting and the Asian countries are estimated to contribute to the GWP to an extent that is greater than their own GNP." Again (p. 275), "The case of Western and

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Eastern Europe is just the opposite: since they enjoy comparative advantage in, specialize in, and trade manufactures which are in excess supply, the contribution of these two regions to the world product is smaller than their GNP."

Aside from this issue of externalities, the model provides a novel approach to the possibility of unemployment and excess capacity under globally optimal conditions. Unlike the neoclassical macroeconomic models, the demands for and supplies of capital and labor services are not necessarily responsive to factor price changes in DYNAMICO. Instead, factor demands are derived demands (viz., derived from sectoral outputs) and factor supplies are given by technological (such as depreciation) and demographic considerations. Global optimality is defined with reference to sectoral outputs, not inputs; thus, unemployment and excess capacity may occur even after the global optimum has been attained. This possibility has not commonly been analyzed in normative macroeconomic models thus far. Of course, institutional and sociological constraints — not to be found in neoclassical macro models — are responsible for the economies' inability to take advantage of the gains from trade which unemployment and excess capacity imply; but given that such constraints exist, the resulting second-best optima are certainly worth exploring.

The normative nature of the model is brought into sharpest relief in the "master program," in which a global objective function (e.g., a weighted average of regional GNPs) is maximized subject to three constraints: (i) that a weighted average of regional trade balances sum to zero, (ii) that a weighted average of regional capital payment flows sum to zero, and (iii) that the weights computed for the commodities and regions all sum to unity. The model provides no mechanism whereby excess product demands and excess capital demands always collapse to zero on world markets. In fact, the model tells a story in which such a mechanism is manifestly excluded. The decomposition method, whereby the model is solved, does not guarantee that there exists a set of prices (suitably augmented by taxes and subsidies derived from the master program) which can induce the regional programs to generate the global optimum. The globally optimal solution is specified as a convex combination of solution sets from a sequence of iterations of the regional programs. No single iteration of the regional programs may yield the global optimum, since the worldwide constraints of the master program do not enter the regional programs. Hence, the global optimum may not lie on the boundary of the feasible regional production sets and no price system can induce the regions to produce in the interior of these sets.

In short, the globally optimal solution must be *imposed* on the regions through the explicit decree of a benevolent dictator; it cannot, in general, be found through a price system. The model is normative; its descriptive counterpart is conspicuously absent.

All that are relevant for the derivation of the real economic variables in the optimal solution are the global welfare function and the various constraints on production and capital payments as well as the above-mentioned market-clearing conditions. The objective functions of the regional programs — which would clearly be important in a descriptive account of global economic relations — are entirely irrelevant for this purpose. A transformation of a regional objective function from, say, minimization of production cost to maximization of personal consumption has no effect on the globally optimal real economic variables. However, it does affect the opportunity costs of regional economic activities. Insofar as these opportunity costs — i.e., the terms of trade for goods and services, the implicit interest rates on outstanding capital balances, and the resource costs of running

the economic activity of each region at the unit level – are significant results of the model, the formulation of regional objective functions is significant as well.

But how important are these opportunity costs really in the formulation of global economic policy? It must be recalled that the opportunity costs are computed *at* the global optimum; moreover, at this global optimum, the worldwide market for goods and services and the worldwide market for capital payment flows both clear. Now, these two market-clearing conditions do not necessarily hold in practice. When they do not, the opportunity costs of regional economic activities may differ from the opportunity costs computed through the model. If the world economy faces non market-clearing conditions, the levying of taxes and subsidies prescribed by the model may not be desirable.

Besides, it has already been noted above that there may be *no* set of taxes and subsidies which can induce the regions – subject simply to their regional constraints – to produce the socially optimal set of goods and services. *Any* set of opportunity costs may provide an insufficient description of optimal policy measures.

Lastly, it may be well to recall that the opportunity costs depend on the specification of the regional objective functions. If the opportunity costs are to have any chance of yielding policy implications, then the regional objective functions of the model must be equivalent to the objective functions which these regions actually optimize. But what are these functions? How can they be determined? Or, more fundamentally, do such functions exist? Do regions or countries try to maximize anything? These are sticky questions indeed; yet they cannot be avoided if we are to attach any policy meaning to the opportunity costs gleaned from DYNAMICO.

Hence, it is not clear whether the author is justified in stating (p. 259) that “Among the most striking features of the model are the ways it addresses region-specific development priorities and the indications it provides . . . as to the costs and benefits of [their] interaction.” Some very basic and difficult questions must be answered before the usefulness of DYNAMICO in this area is beyond doubt.

The dynamic linkages among optimal solutions of the global model give rise to another serious difficulty in determining the policy implications of the model. These dynamic linkages enter in the form of resource endowments (the greater the amount of a resource used in the present period, the smaller the amount left over for the next period), foreign exchange reserves (the more of these reserves that are used to purchase foreign goods and services now, the fewer are available to purchase foreign goods and services in the future), and so on. Since resources and foreign exchange are not in unlimited supply, the intertemporal externalities generated in using them now may be quite important. For petroleum supplies, for example, these externalities are certainly important. In this case, the marginal social value of petroleum consumption should be set equal to the marginal cost of extraction *plus* the marginal user cost of petroleum (the latter embodying the intertemporal externality). Yet intertemporal externalities cannot be taken into account in a one-period model. An intertemporal global optimization program would be necessary for this purpose.

Since DYNAMICO is not intertemporal in this sense, it cannot describe the globally optimal economic activities in the longer run. The optimal set of economic activities period by period is not, in general, equivalent to the optimal set of economic activities for a conglomerate of these periods. The solutions of the model are optimal only if the global

policy-maker's horizon is rather short, namely one year. Yet it is rather questionable that the common uses for a model such as DYNAMICO require such a short horizon. There appears to be no way of circumventing this difficulty other than making DYNAMICO dynamic. Restrictions on computational capacity may imply that the model may have to be aggregated before variables of different time subscripts can be accommodated. If so, it may be a price worth paying.

All in all, DYNAMICO is an impressive attempt to incorporate many of the world's most pressing macroeconomic issues within a single, logically coherent, analytical framework. Like all ambitious attempts in the early stages of creation, the model gives rise to a number of fundamental and challenging problems. Their solution would be important not only for DYNAMICO, but for vast areas of macroeconomics as well.