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A Representation of International Trade Exchanges through Neural Networks

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National economies' trade exchanges may possibly be represented and explored through the notional system of neural networks. Within the framework of this representation, national economies constitute neurons, the relations between national economies constitute synapsis and the whole constitutes an artificial neural network.

Every national economy as an artificial neuron produces in every moment or time-period a specific set of commodities in specific quantities, using a part or the whole amount of fixed capital and available labour as well as the imported commodities from other national economies. In which quantities, however, does it produce these commodities? It produces the specific quantities that are estimated to satisfy total demand (=intermediate inputs + up-used fixed capital + domestic consumption and investment + exports). Its output towards other national economies is considered as its exports. Its inputs coming from other national economies are considered as its imports.

In every national economy, feedbacks are observed («autosynapsis»). A share of consumption goods, produced but not exported by the national economy, are used to support employees and thus labour. Besides, capital goods, produced but not exported by the national economy, replace a part of the perished fixed capital and the rest is used to increase fixed capital. In addition, incomes produced by the national economy, namely wages and profits, are used as follows: on the one hand, wages cater for consumption demand, supposing for simplicity reasons that salaried employees do not save up, while profits cater for consumption and investment demand. The conception of the national economy and not of every individual sector of the economy as an artificial neural network is based on these feedbacks.

In our analysis, we suppose that every national economy transforms its inputs to outputs in a linear way. Thus, as far as its product activity is con-

cerned, it can be represented by a linear –not necessarily a square– system of production.

If the relationships between national economies are represented as synapsis between neurons, then which ones are the "signals" that every neuron, that is every national economy, sends to and receives from other neurons? These signals are the potential exports and the potential imports of the economy – both of them are considered as physical concepts represented as vectors. How are these signals weighted? The prices of the particular commodities expressed in the national economy's currency are regarded as "weights". Suppose that there is one currency in the international trade exchanges, for instance the dollar. Then, the price of every particular commodity expressed in the national economy's currency is equal to the product between the commodity price in dollars and the parity between the dollar and the national currency. Thus, the weights of signals are two: the price in national currency and the parity between the national currency and dollar. This applies for both the imported as well as the exported commodities. For simplicity reasons, we suppose that there is no arbitrage or that if there is any, it is considered to be negligible.

When does a national economy import a commodity in the desired quantity, and from which particular economy does it import it? It will import the commodity when other national economies produce it cheaper compared to the particular economy (in cif prices) and it will import it by the economy that produces it most cheaply. Thus, for every potential imported product there is a "threshold price". In this sense, there are as many "threshold prices" as the number of the world-wide produced commodities. When the commodity price is lower than the "threshold price", then the signal is "set off", that means that the commodity is imported. In the known neural networks, there is only a single sort of "weights". Additionally, in these same networks, since the weighted signals are summed up to a single signal, there is only one signal, and thus, only one "threshold price". In this case, on the contrary, there are many weighted signals and therefore the same number of threshold prices.

Thus, every neuron (=national economy) "learns", to the degree that it takes into account both the changes in national currencies expressed in commodity prices as well as the changes in parities. And it learns that separately for every commodity.

The above model pledges for two things:

- It is an application of the theory of artificial neural networks in the economy and
- Through this application, the specific theory is expanded.

Observations as far as point (a) is concerned:

Through the previously mentioned application it will be possible to obtain:

1st: A complete and accurate recording of the trade relationships between national economies – which is related to the constitution of National Accounts and the like.

2nd : The accurate answer in questions as:

- How much will the inflation rate change, if the parity changes at a specific rate?
- How much will the inflation rate change, if the price of a particular imported commodity changes, for instance petroleum?

Observations as far as point (b) is concerned:

Since this point does not directly affect the economic science, but the one of the artificial neural networks, we would like to mention the following: The application of the above model in the economy could be the outset of an important expansion of the theory of artificial neural networks. Firstly, due to the multiple feedbacks («autosynapsis») of the model, secondly, due to the fact that the "weights" are functions of two independent variables, the price in national currency and the parity between the dollar and the national currency and thirdly, due to the fact that for every neuron we have not only one but multiple "signals" and not only one but many "threshold prices".

The research of the above mentioned issue is twofold; there is the part of the theoretical exploration and the part of the application. The latter part consists of two parts as well; the first part consists of the construction of a numerical artificial neural network model with a specific number of neurons (=national economies), and the second part represents, based on statistical data, the trade exchanges of a certain national economy, and thus it will constitute the empirical study of a neuron.