

2 A SAM as a Walrasian Equilibrium Framework

In this part of the present work, we are going to present different macroeconomic aspects of a SAM in the context of further macroeconomic models to be presented and estimated. It is useful to remind readers about Walrasian general equilibrium features of a SAM. This will increase understanding of its construction and improve interpretation of its post-estimation outputs. This point of interpreting outputs will appear with more acuity in the coming sections when, at the end of the estimation process by the maximum entropy principle, we have to interpret parameters of the estimated model. Though in the next chapter on the computable general equilibrium model we will examine the philosophical underpinnings of the SAM in terms of economic theory, we must immediately be aware that both the input-output table and the SAM were conceived as practical applications of the general equilibrium theory earlier introduced by Walras, one of initiators of the Australian school of thought. Brown & Stone (1962) has provided a definition of Walrasian hypotheses as follows:

H1. *Observed market demand is the sum of consumers' demands derived from utility maximization subject to budget constraints at observed market prices.*

H2. *There exists an observable (locally) unique equilibrium price system such that the observable market demand is equal to the observable market supply in every market.*

H3. *The observed equilibrium price system is a (locally) stable equilibrium of trial-and-error price adjustment.*

The first hypothesis fixes the prerequisites under which Walrasian equilibrium is feasible. The second and third hypotheses specify quantitative relations which lead to equilibrium. Equilibrium in the economic flows results in the conservation of both product and value (Liossatos, 2004).

Additionally, the three conditions of *market clearance*, *zero profit*, and *income balance* are employed by CGE modellers to solve simultaneously for the set of prices and the allocation of goods and factors that support general equilibrium. In terms of circular flows in economy, each row total of each economic sector is equal to a corresponding column total, and in that way a general equilibrium of macroeconomic aggregates is ensured.

Research contributions in this area are, to our knowledge, very limited. In their pioneering work, Duncan & Smith (Duncan, 1999; Liossatos, 2004) found that Walrasian equilibrium is not guaranteed by a free market existence. Without implausibly strong restrictions on the production sets and preferences (for example, that the production sets do not exhibit increasing returns to scale, a pervasive feature of real tech-

nologies), the demand and supply correspondences may be empty for some prices and may be discontinuous, so that no equilibrium price system can be found.

The question of the existence and stability of a Walrasian equilibrium encounters mathematical difficulties and paradoxes. In particular, the question of finding a robust stability in equilibrium prices has remained elusive, and the issue of the existence of Walrasian equilibrium has been settled only by introducing into the argument powerful abstract mathematical principles, which have no real economic foundation (see, e.g., Duncan & Smith, 2009). Taking the above into account, one may think that Walrasian equilibrium, at least on empirical grounds, is a kind of approximation of the Pareto efficiency benchmark.

Using the maximum entropy principle, the above authors (Duncan, 1999; Liossatos, 2004) have recently tried to prove the existence, the uniqueness, and the stability of the Pareto optimum.

The starting hypothesis is to consider *"a set of feasible market transactions as typically large, that is, once the number of types, the number of traders of each type, and the number of points in the offer sets become moderately large. Furthermore, there are many different ways of assigning traders to transactions in their offer sets that clear (or approximately clear) the market. The principle of voluntary market exchange in and of itself is not sufficient to determine the market transaction. Thus, entropy equilibrium is a short-run, temporary equilibrium model of market exchange which replaces the Walrasian picture of the market in equilibrium as a budget hyper plane defined by equilibrium relative prices with a scalar field of transaction probabilities."* (Brown & Shannon, 1997).

Under these conditions and following the same authors, entropy prices clear the market by distributing agents over their offer sets, rather than moving agents to optimal commodity bundles in their consumption sets, and thus effectively "convexify" the economy. Furthermore, the fact that different traders experience different transaction prices implies that random statistical equilibrium does not exhaust all the potential Pareto-improving transactions in the economy. Thus, such a statistical equilibrium approximates, but does not achieve, Pareto-efficiency. The statistical equilibrium in this market fails to achieve Pareto-efficiency because some potentially mutually advantageous transactions fail to be executed, and there is dispersion in actual transactions prices.

To achieve the Pareto optimum, the pioneering work of Foley (1994) has attempted to endogenize the offer sets of economic actors in a rational expectation framework:

"If we imagine a given agent repeatedly entering a market in statistical equilibrium, it is tempting to suppose that she will alter her offer set in order to optimize her market outcome given the probabilities that govern transactions in the market equilibrium. This idea gives rise to the concept of endogenous offer sets."

According to the same author, the present state of research should be that we rigorously establish that Walrasian equilibrium is the asymptotic outcome of a process in which endogenous offer sets adapt to statistical equilibrium entropy prices, and where the chances to transact in any period become numerous. Walrasian equilibrium is not unique, whereas statistical equilibrium for given offer sets of traders should be unique. The adaptation process sketched out here allows offer sets to change over time, giving rise to a dynamic process which may have multiple equilibria, each corresponding to a Walrasian equilibrium in markets with multiple Walrasian equilibria.

We argue that the problem should be placed in the context of non-additive statistics, suggesting that agent behaviours are time or space dependent. In fact, the above Gibbs-Shannon entropy related price suggests an ergodic system in which agent actions are disconnected from long-run memory of past market events and/or confluent—space related—information from surrounding markets. Then, system complexity describing market transactions should lead to non-extensive entropy related prices. Further research is needed to understand to what extent macroeconomic equilibrium and thermodynamic equilibrium are comparable in the context of non-ergodic real world systems.

To conclude, there is no assurance that the balanced post-entropy social accounting matrix is achieving (or approximating) the Pareto Optimum. As stated above, some probabilistic distributions of price entropy may be meaningless or not optimal in the convex space of all possible transactions—not even the voluntarily contracted ones.

More investigation is required to better appreciate, among other possibilities, the new approach of endogenizing dynamic offer sets, as suggested above. For the time being, entropy econometrics as presented in the coming sections seems to be the best approach to resolve such ill-behaved inverse problems.