Chapter 14

TATONNEMENT

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The concept of tatonnement evolved to embody a methodology for determining price – a "price discovery process" – without disequilibrium trades taking place. It has been viewed as an auctioneer calling out prices, observing behavior and calling out new prices in response to the behavior. The process is imagined as continuing until an equilibrium is reached. For "well behaved" economic environments, such systems can function effectively. However, the behavioral principles that operate within such mechanisms are not those imagined by those who introduced the concept as a theoretical tool, and as a result, the tatonnement mechanisms are not generally reliable. That is, the tatonnement mechanism is not reliable as a market discovery tool in single or multiple markets.

Two different forms of tatonnement adjustment processes have been tested in the literature. The classical model holds that prices adjust proportionally to excess demand. That is, it is a process drawn from the model

$$\mathrm{d}P/\mathrm{d}t = \alpha\big[D(P) - S(P)\big].$$

In the practical world of an experiment the time variable is discrete so the model becomes $P_{t+1} - P_t = \alpha[D(P_t) - S(P_t)]$, where t is a "round" in which agents submit demands and supplies contingent on the price announced. Of course the demand and supply functions are not observed by the mechanism. Only the quantities X_t^D and X_t^S are observed, where these quantities are the buy orders and sell orders that are tendered in response to the price announced. These quantities replace the functions in the formula. The stopping rule, unless an alternative convention is adopted, is where the buy and sell orders are equal.

The second tatonnement method of price discovery was first introduced and tested by Plott and George (1992) and is based on the "secant" algorithm for finding the zeros of an equation. It is based on the Newton model

$$\mathrm{d}P/\mathrm{d}t = \big[1/\big(D'(P) - S'(P)\big)\big]\big(D(P) - S(P)\big).$$

Again, the practical world of an experiment requires an operational interpretation of the system, which was:

$$P_{t+1} = P_t + \big|\big[(P_t - -P_{t-1})/(X_t - X_{t-1})\big]\big|X_t \quad \text{if } X_t \neq X_{t-1} \quad \text{and}$$
$$P_{t+1} = P_t + (P_t - P_{t-1}) \quad \text{if } X_t = X_{t-1},$$

where X_t is the difference between buy and sell orders in response to the announced price. Notice that the absolute value imposed in the formula follows Walras's fundamental principle that the direction of price change is dictated by the sign of the excess

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demand. Of course, in the unstable case that is exactly what does not happen so because of this feature of the mechanism the mechanism itself would seem to be inconsistent with the underlying forces at work.

Both mechanisms have performed successfully as price discovery mechanisms in cases in which only a single market existed and that market the demand and supplies were essentially linear, leading smoothly to a unique equilibrium. By contrast, when a single market environment has a slightly more complex structure or when multiple markets are involved the tatonnement mechanism either operates inefficiently or does not work at all in the sense that it does not converge.

When multiple markets are involved two problems exist. The first is "cheap talk" in the sense that agents are not bound to the quantities they express at a price unless the system happens to terminate at that moment. They also know that the price announced in the next period is influenced by the price this period. The resulting pattern of responses does not necessarily lead the process to an efficient equilibration. The second problem is related to coordination. Agents might coordinate themselves and tender responses that might get the adjustment process in one market to be close to a termination configuration but then the second market is typically nowhere near termination. When attention is diverted to the second market the first market will move in a manner that signals non-termination. Experiments ended with subjects frustrated and never achieving a trade.

The basic problem with tatonnement is illustrated in Figure 1. The demand and supply configuration is the classical "swastika" design first studied by Smith, in which the demand curve is perfectly inelastic and cuts the supply where the latter is perfectly elastic. It a technical sense there is no classical competitive equilibrium in this environment because at no price does the quantity demanded exactly equal the quantity supplied in the absence of some sort of selection mechanism that picks the supply units to be allocated to the demanders when the price announced is the competitive equilibrium. At the competitive equilibrium price of 195, there are 16 units demanded and 35 units offered as supply. Since the suppliers make zero profit at that price they are indifferent, according to theory, and submit a supply correspondence as shown in Figure 1. It is well-established that when the exchange mechanism is the oral double auction or the multiple unit double auction, the market will converge to the competitive equilibrium and the allocation will be one hundred percent efficient.

Data from the application of the tatonnement (the secant method that was shown to work in Plott and George, 1992), are contained in the figure. Notice first that the allocations were not necessarily efficient. The volumes are often above the 16 units of the competitive equilibrium. Demanders are seen buying units that had no value for them. That is, units with zero redemption value were purchased. Second, the prices need not be at the competitive equilibrium level. In two cases, the prices are above 300. Third, cases exist in which the mechanism terminated without demand equaling supply. The iterations stopped due to the algorithm reaching its maximum precision for an iteration.

Why does this happen? When the system stops because the quantity expressed as demand equaled the quantity expressed as supply it is because demanders were willing to buy more than they wanted and suppliers were compromising on the quantities they

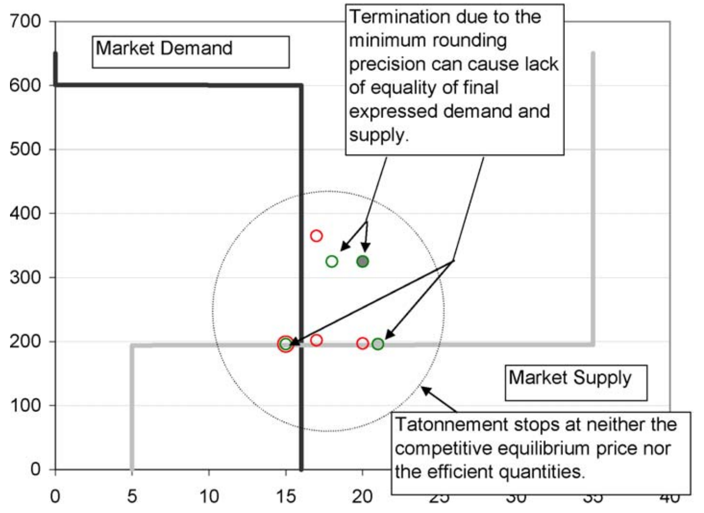

Figure 1.

wanted to sell. The agents were modifying their requests in the light of what they really wanted in order to get the mechanism to stop iterating. Agents realized that the system was using much resource time in iterations and in the interest of acquiring some gains from the exchange, as opposed to continuous iteration terminating with no trade, they compromised in a negotiating fashion. Thus, when the system did terminate, it was due to a process of negotiation that ended in an inefficient allocation. This feature is exacerbated when many markets are involved. The "negotiations" and "compromises" are attempted but in a multiple market system they are not successfully coordinated. The iterations continue without termination until the system is arbitrarily stopped and no exchanges take place.

Reference

Plott, R. Charles, George, Glen (1992). "Marshallian vs Walrasian stability in an experimental market". The Economic Journal 102, 437–460.