Chapter 44

MULTIPLE MARKET SYSTEMS AND THE CLASSICAL PRINCIPLES OF PRICE DYNAMICS IN GENERAL EQUILIBRIUM

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The study of the multiple equation structure of general equilibrium models seems to naturally motivate four questions:

Can markets ever find a zero (an equilibrium) of a complex system?

Will it always happen?

Can markets find all of the zeros?

If so, how does it happen?

The answer to the first question is clearly yes. A mountain of data dealing with multiple market processes (Forsythe, Palfrey, and Plott, 1982, 1984; Plott, 1988, 2001; Plott and Sunder, 1988; Williams et al., 2000), derived demand (Goodfellow and Plott, 1990), finance (Asparouhova, Bossaerts, and Plott, 2003; Bossaerts, Kleinman, and Plott, 2001; Bossaerts and Plott, 2002, 2004; Bossaerts, Plott, and Zame, 2001), international trade (Noussair, Plott, and Riezman, 1995), international finance (Noussair, Plott, and Riezman, 1997), and macro economics (Lian and Plott, 1998) demonstrate that markets can sometimes find zeros. The answer to the third question is "no" as given by experiments on stability of markets. Markets will not find the unstable equilibria, only the stable ones.

Fundamental issues posed by the second and fourth questions remain and between these two questions there is a clear scientific priority. The conditions under which markets will equilibrate, and therefore the frequency with which equilibration might be expected, depend on the nature of the process of equilibration and the underlying principles of dynamics. So, in order to answer the second question we need an answer to the fourth question, which will provide the tools needed to find the cases in which convergence is not expected to take place. Thus, in a sense, the last question is the most basic of them all and the subject of this note is the steps taken toward an answer.

Scarf (1960), especially as extended by Hirota (1981), created an important platform from which to launch the study by producing an example demonstrating that if the price adjustment process is the classical tatonnement mechanism then the theoretical answer to the second question is "no." Theoretically, it is not the case that markets will necessarily equilibrate even when the equilibrium is a unique, interior equilibrium. In his example prices always orbit around the equilibrium and thus never converge. That platform thus provides the starting point of the research. For the parameters of his example, either the markets will not equilibrate, as predicted by theory, or the basic principle of dynamics he employed is substantially wrong. The Scarf example is ideal for a study of classical dynamics because in that situation the theory makes striking and unexpected predictions.

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Table 1
Parameters for scarf environment experiments

Case	Type	Preferences	Initial endowments		
			X	Y	X
Convergence to equilibrium	I	$40\min\{y/20, z/400\}$	10	0	0
	II	$40\min\{x/10, z/400\}$	0	20	0
	III	$40\min\{x/10, y/20\}$	0	0	400
Counter clockwise orbit	I	$40\min\{y/20, z/400\}$	0	20	0
	II	$40\min\{x/10, z/400\}$	0	0	400
	III	$40\min\{x/10, y/20\}$	10	0	0
Clockwise orbit	I	$40\min\{y/20, z/400\}$	0	0	400
	II	$40\min\{x/10, z/400\}$	10	0	0
	III	$40\min\{x/10, y/20\}$	0	20	0

Anderson et al. (2003) focus directly on the issue by finding extensions of the environment in which the classical theory of dynamics predicts a clockwise orbit under one set of initial endowments, a counterclockwise orbit under another set of initial endowments and convergence to the unique interior equilibrium under a third set of endowments. Thus, according to theory the experimenter can change the direction of a price orbit or cause the markets to converge by simply changing the initial endowments alone, without preference, institution or procedural changes. That experiment is exactly the one performed.

The example is a three commodity general equilibrium, $\{x, y, z\}$, in which one of the commodity, $\{z\}$, serves as money. All trades are made in terms of the money. Agents have preferences that are perfect complement between two of the commodities and have no preferences for the third. Three types of preferences exist in the economy and are illustrated in Figure 1 and in Table 1. Type I person has preference for y and z while getting no utility at all for x. Specifically Type I has the utility function (and it is the one used in the experiments) $U(y, z) = 40\min\{y/20, z/400\}$. Type II gets utility from x and z and receives no utility from y with the utility function $U(x, z) = 40\min\{x/10, z/400\}$. Type III gets utility from only x and y, having utility function $U(x, y) = 40\min\{1/10, y/20\}$. These are the actual incentives used each period with the units denoted in cents.

Table 1 organizes the parameters in terms of predictions. As shown, convergence to the equilibrium is predicted if each agent is endowed with units of the commodity that the individual does not want. If each individual is endowed with one of the commodities that the individual wants the prediction is an orbit in a particular direction (say clockwise). The predicted direction of the orbit is reversed (counter clockwise) if all individuals are endowed with the other commodity that they do not want.

Anderson et al. (2003) discovered that the market prices have all of the major features predicted by the classical model. Furthermore, they discovered that the features exist

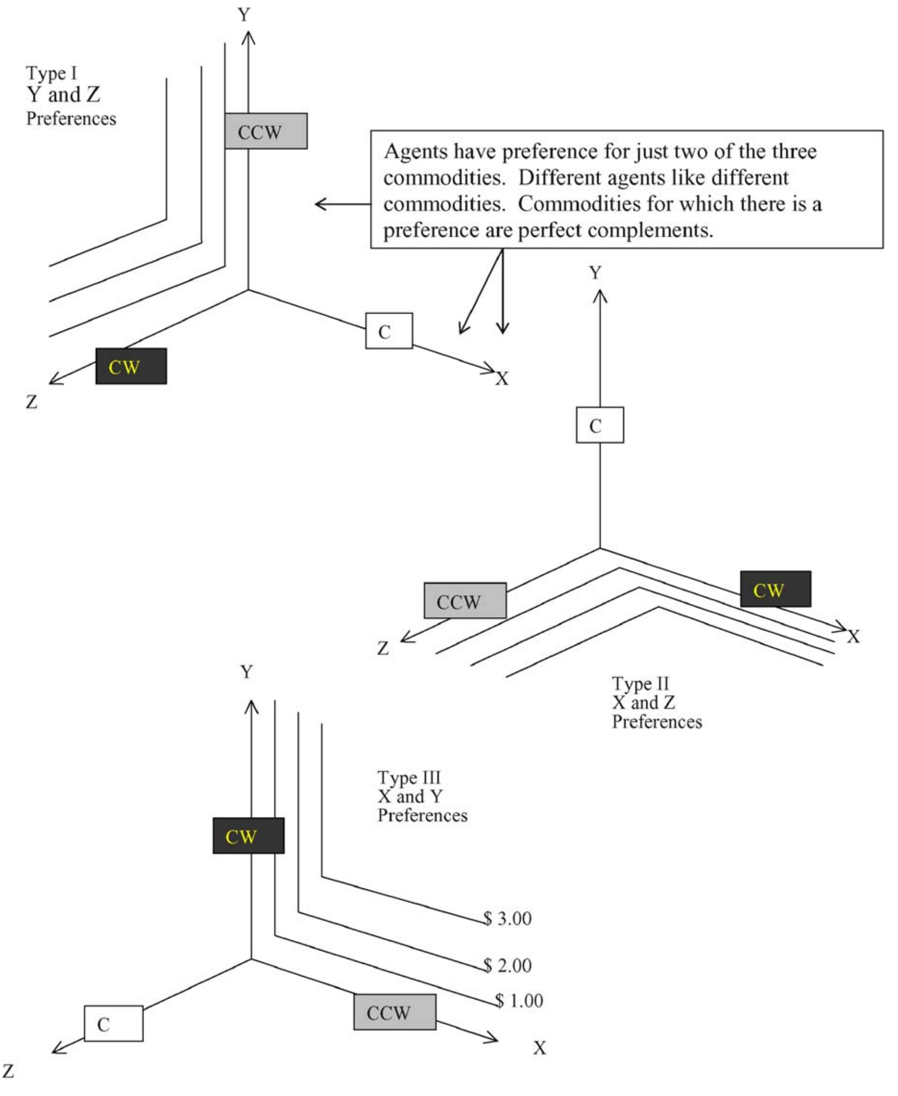


Figure 1. The three types of preferences in the scarf environment.

in markets organized as multiple unit double auctions. That is, while the theoretical markets studied by Scarf (1960) were constructed under tatonnement properties, with one price in the market and no trades at disequilibria the real, experimental markets studied by Anderson et al. (2003) did not. The experimental markets were organized as multiple unit double auctions so markets were populated by many prices and essentially no trades took place at equilibrium. Thus, the theoretical properties exhibit an amazing

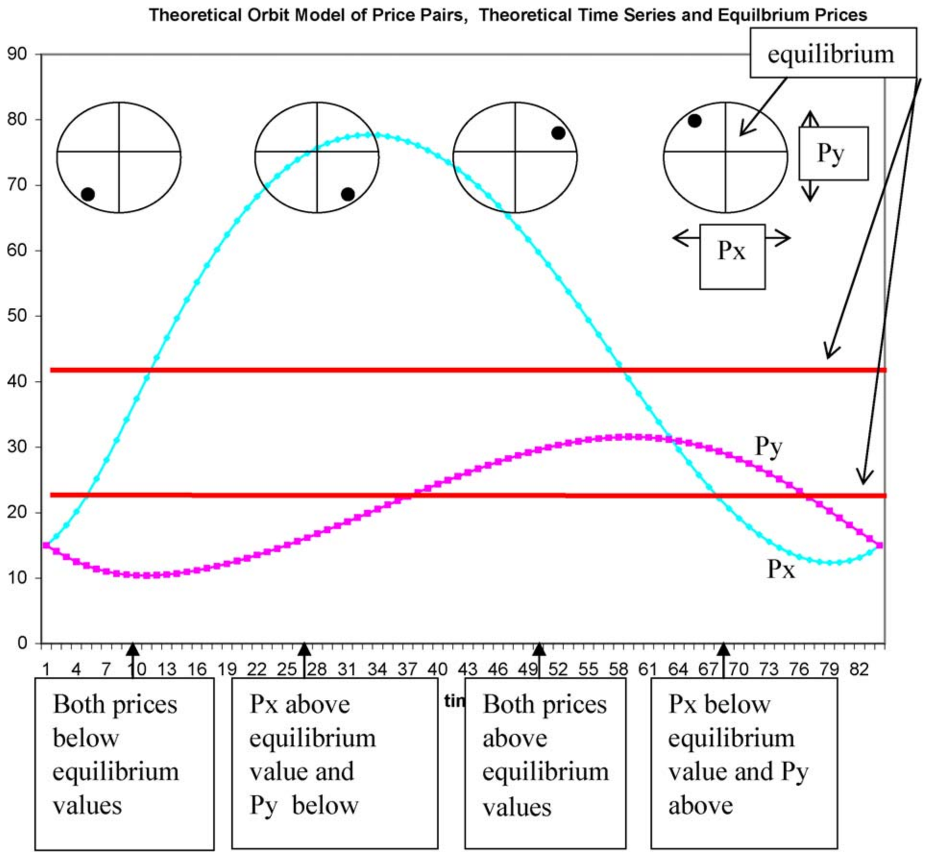


Figure 2. The circles at the top of the figure illustrate the position of the pair of prices relative to the equilibrium. The circle represents the theoretical orbit around the equilibrium. Horizontal and vertical lines partition space so angle to point representing price location indicates price movement directions. In first circle both prices are below equilibrium levels.

robustness in the face of market environments that could have impacts on the price discovery process.

The experiments reported here tests the robustness of the Anderson et al. (2003) result by employing a multiple unit double auction with an open book. Since the environment is one of strong complements the contracts reflect a preference for contingent contracts. A person does not want to transact in market A without assurance that of a transaction in market B. Since the open book allows market depths to be observed such coordination is easier. The issue is whether the open book form of market organization would remove the cycles and facilitate convergence. The markets studied in Anderson et al. (2003) had no order book and thus had limited possibility of planning.

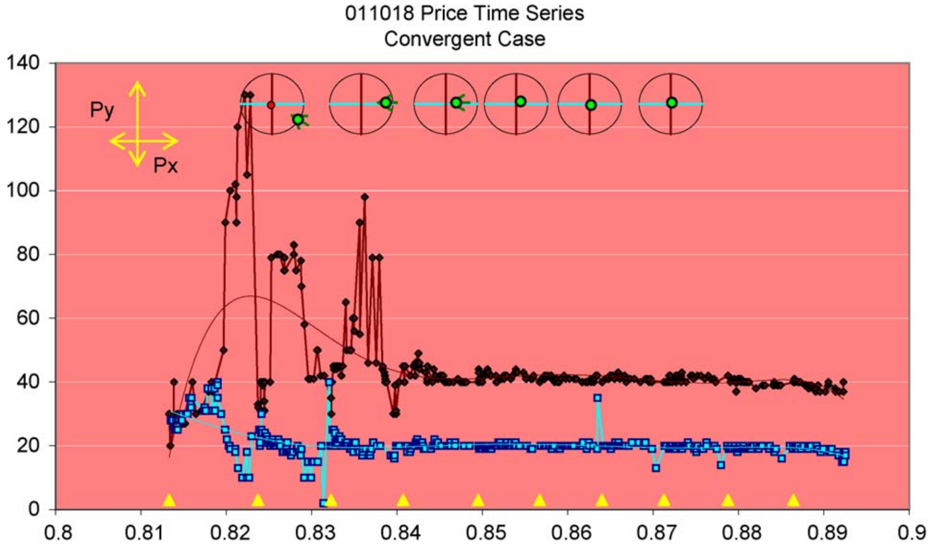


Figure 3.

The basic result reported here is that the open book makes no difference. The Anderson et al. (2003) results replicate. The predictions of the classical dynamic theory are illustrated in Figure 2. The bottom panel illustrates the price cycles as they would appear in a time representation, a time domain. The top of the figure illustrates the relationship between the predictions in the price pairs domain positioned over the relevant area in the time domain. Basically, these are two, related ways of representing a cycle.

Representative data are contained in Figures 3, 4 and 5. The data produced by an experiment in which convergence is predicted are contained in Figure 3. The equilibrium prices for X and Y are 40 and 20 respectively and as can be observed the data tightly converge to the predicted price pair. While this is only two markets the behavior here is not far from what is observed in the much more complex economies reported in the referenced materials. Figure 4 contains data from an economy where the classical dynamics predicts a counter clockwise cycle. As can be seen the data move in the predicted direction. The results of an experiment in which a clockwise cycle is predicted are represented in Figure 5. The data are moving in the clockwise direction as predicted.

Overall, the contrast among Figures 3, 4 and 5 are dramatic. When the classical dynamic model predicts convergence, that is what happens. When the classical model predicts counter clockwise cycles the data move in a counter clockwise direction. When the model predicts a clockwise orbit the data move in the clockwise direction predicted.

The results of these experiments move the science toward an answer to question four. From this step the presumption should be that markets are governed by the classical Walrasian dynamic. The rate of adjustment of the price in a market is directly related to the magnitude of its own excess demand. Of course, there are many other variables

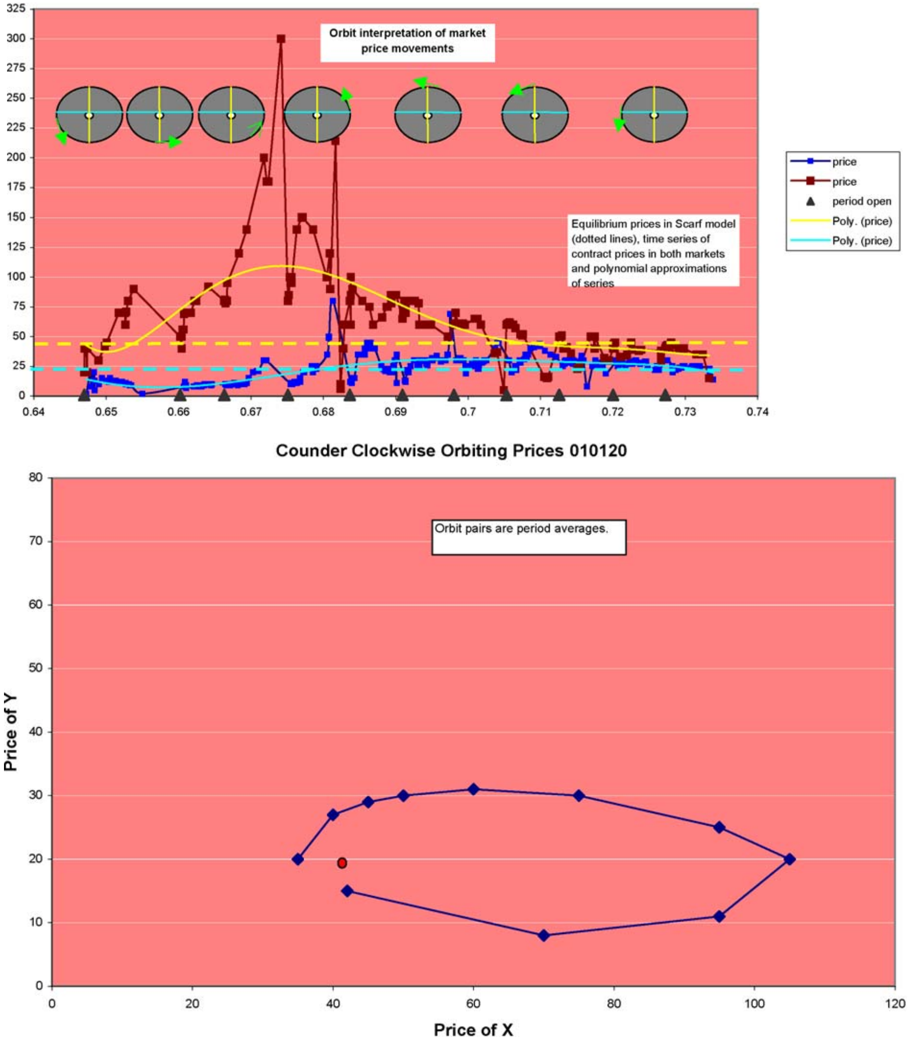
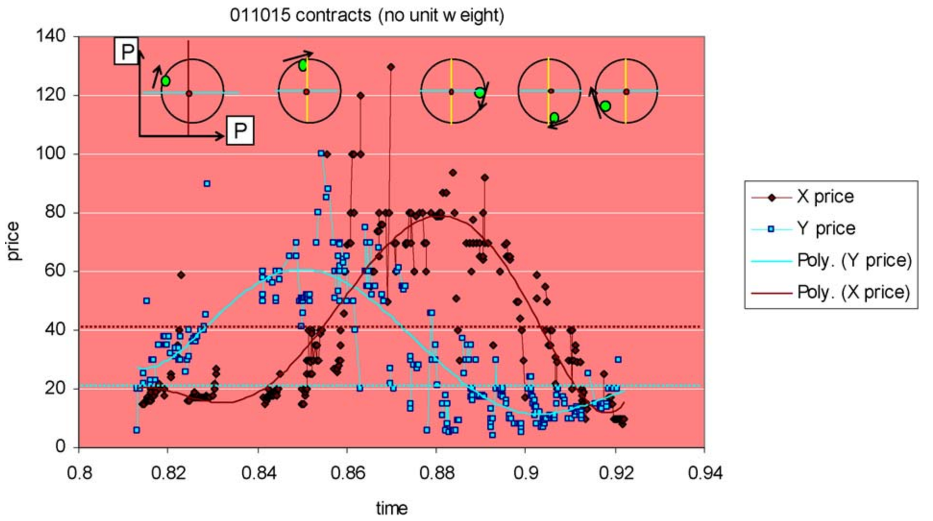


Figure 4.

that can enter into this equation but for now it is the place to start. The experiments demonstrate that it is not the case that markets will always find the equilibrium and the reason is because the market dynamics can fail to lead it there. To this basic conclusion there is a corollary and that is that the classical model of tatonnement, in which disequilibrium trades do not take place, can be used as an approximation of what to expect in the complex world of continuous, double auction markets in which disequilibrium trades do take place.



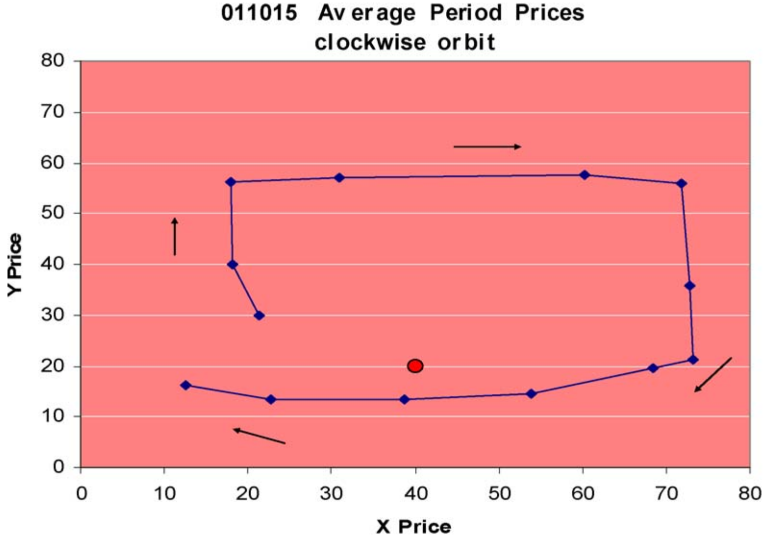


Figure 5.

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