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# Market design and the stability of general equilibrium ☆

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**Abstract**

We employ laboratory methods to study the stability of competitive equilibrium in Scarf's economy (Scarf, 1960). Tatonnement theory predicts that prices are globally unstable for this economy, i.e. unless prices start at the competitive equilibrium they oscillate without converging. Anderson et al. (2004) report that in laboratory double auction markets, prices in the Scarf economy do indeed oscillate with no clear sign of convergence. We replicate their experiments and confirm that tatonnement theory predicts the direction of price changes remarkably well. Prices are globally unstable with adverse effects for the economy's efficiency and the equitable distribution of the gains from trade.

We also introduce a novel market mechanism where participants submit demand schedules and prices are computed using Smale's global Newtonian dynamic (Smale, 1976b). If the submitted schedules are competitive – sets of quantities that maximize utility taking prices as given – the resulting outcome is the unique competitive equilibrium of Scarf's economy. In experiments using the schedule market, prices converge quickly to the competitive equilibrium. Besides stabilizing prices, the schedule market is more efficient and results in highly egalitarian outcomes.


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## 1. Introduction

This paper investigates how the design of the market influences price dynamics and trading volumes in Scarf's (1960) economy. In Scarf's economy, the tatonnement model predicts that prices cycle along a closed orbit around the equilibrium without ever converging. In a series of fascinating experiments, Anderson et al. (2004) implemented a version of Scarf's economy in the laboratory to study how prices evolve in the commonly used double auction market. While the double auction is itself a distinctively non-tatonnement institution, Anderson et al. found strong support for the Walrasian tatonnement hypothesis that price dynamics are largely driven by a market's excess demand.[1] Average trade prices in the experiments cycled along a closed orbit around the unique competitive equilibrium with no clear sign of convergence.[2]

A consequence of out of equilibrium price cycling is that an efficient allocation of resources may never be realized. This motivates our market design question: is there a market mechanism that stabilizes prices in Scarf's economy and leads to higher welfare? The main idea behind our proposed solution is to exploit the price-taking behavior that causes instability in the double auction market, as observed by Anderson et al. (2004). Such price-taking behavior has also been observed in other experimental studies, e.g. Friedman and Ostroy (1995).[3] The proposed mechanism is a call market where agents submit demand schedules, which are aggregated to yield an excess demand function.[4] A Newtonian process suggested by Smale (1976b) is then used to find market clearing prices. Whether this schedule market produces desirable outcomes obviously depends on the types of schedules that get submitted. But if every agent submits a competitive schedule, i.e. a set of quantities that are utility maximizing taking prices as given, then the mechanism produces prices and quantities corresponding to the unique competitive equilibrium of the Scarf economy.

We ran two series of experiments. The first series was devoted to replicating Anderson et al.'s (2004) experiments. One of the major strengths of laboratory experimentation for investigating general equilibrium is control, as the Anderson et al. study exemplifies. By inducing carefully selected demand parameters and initial endowments, the experimenters were able to create a

[1] We use *tatonnement model* and *Walrasian hypothesis* interchangeably to refer to a model that predicts prices adjust in proportion to excess demand. We use *tatonnement institution* to refer to a market institution where prices are centrally adjusted according to excess demand and trade only occurs at equilibrium prices. There have been several other experimental tests of the Walrasian hypothesis. Smith (1962) finds some support for it although the "excess rent" hypothesis he introduces does better. Crockett et al. (2011) find support for the Walrasian hypothesis in an experimental study of Gale's (1963) economy.

[2] While the Scarf economy is an idealized example whose conditions are unlikely to be met in practice, this type of disequilibrium behavior is akin to price cycles observed in some important commodity markets, see for example Cashin and McDermott (2002).

[3] A large market is not a necessary condition for price-taking behavior to be optimal, see e.g. Ostroy (1980).

[4] Submitting demand schedules is a common feature of electricity markets, IPOs, and treasury auctions. Furthermore, this procedure is used prior to the start of the New York Stock Exchange to provide the opening prices for the day. Schedule markets are understudied compared to the double auction market, but an early laboratory test is reported by Smith et al. (1982) who consider a single-commodity market for which stability is not an issue. They find that a schedule market produces efficiency levels similar to those observed in the double auction market.