# A Discussion of the Papers by John Geanakoplos and by Andrew W. Lo and Jiang Wang

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## 1. INTRODUCTION

At first sight, the two papers in this section seem unrelated. The one by John Geanakoplos is about the role of collateral in explaining liquidity crises and crashes. Andrew Lo and Jiang Wiang's paper is concerned with a theoretical and empirical analysis of trading volume. However, on closer inspection, they have important interrelationships and provide an interesting contrast. They both trace their intellectual roots back to the Arrow–Debreu model, yet they represent two very different approaches to financial economics, both of which are widely used.

The papers investigate deviations from the standard perfect-markets assumption. Frictions are incorporated in a different way, though. In the Geanakoplos paper, the problem is preventing default, and collateral is the way this is achieved. In the Lo and Wang paper, there are asymmetric information and fixed transaction costs. What is more important is that the motivations for trade are quite different. In the Geanakoplos paper, it is differences in beliefs; in the Lo and Wang paper, it is different shocks to nonfinancial income. Both of these assumptions are crucial to the results the authors obtain. They represent quite different traditions.

The Geanakoplos paper is a mainstream general equilibrium paper. In the Arrow–Debreu model, the possibility of differences in preferences is an important component of the model. Because beliefs are embedded in preferences, allowing different beliefs is a standard assumption.

In finance, and in particular in asset pricing, allowing different beliefs is currently viewed as a nonstandard assumption. In explaining trading volume, Lo and Wang briefly mention asymmetric information but do not consider differences in beliefs arising from differences in priors, which is distinct.

This difference in standard assumptions is an interesting phenomenon. Brennan (1989) argues that the reason it took so long from the time Markowitz developed mean-variance analysis to the discovery of the Capital Asset Pricing Model was the boldness of the assumption that everybody has the same beliefs. In the 1960s, the notion that people could have different beliefs was quite acceptable in mainstream papers. Lintner's (1969) widely quoted paper on a



variant of the CAPM with heterogeneous beliefs and Ross' (1976) arbitrage pricing theory provide good examples. However, since then, views appear to have changed. In recent years there have been few asset-pricing papers that adopt this assumption. Harris and Raviv (1993) provided one of these, but it has not been widely imitated. Morris (1995) provides a very nice summary of the arguments in favor of allowing for differences in prior beliefs. In addition, there is some empirical evidence that differences in beliefs are important in practice. Kandel and Person's (1995) results suggest that trading around earnings announcements is due to differences in priors.

Section 2 of this discussion considers John Geanakoplos's paper, and Section 3 considers the paper by Andrew Lo and Jiang Wang. Section 4 gives conclusions.

## 2. THE GEANAKOPLOS PAPER

This paper builds a theory to help understand the liquidity crises and crashes that occurred in fixed income markets in 1994 and in 1998. These were characterized by a price crash in defaultable assets that was not followed by an increase in subsequent defaults. There were spillovers to other markets, margin requirements were raised, and borrowing decreased. The paper builds on the research by Dubey, Geanakoplos, and Shubik (2001), Dubey and Geanakoplos (2001a, 2001b), Geanakoplos (1997), and Geanakoplos and Zame (1998).

The starting point of the model is that the possibility of default necessitates the use of collateral. The natural buyers of an asset, who are the people that value it the most, may have to borrow to acquire it and must post collateral as security for their loans. Collateral is liquid wealth that is in the form of physical assets that can be stored. The liquidity cost of buying an asset is the margin requirement for an asset multiplied by its price. When agents choose their bundle of goods, there are then two constraints. The first is the standard budget constraint that requires that the value of a person's expenditures must not exceed her or his wealth. The second is a liquidity constraint. This requires that the liquidity needed to enable a person to purchase her or his bundle must not exceed her or his liquid wealth.

Incorporating such collateral requirements and liquidity constraints into a general equilibrium analysis, Geanakoplos and Zame (1998) have demonstrated existence and constrained efficiency of equilibrium. The current paper focuses on developing an example to show how these features lead to liquidity crises and crashes. With collateral requirements and heterogeneous beliefs, asset prices depend in an important way on the distribution of wealth. If relatively optimistic buyers are wealthy enough, they will be able to borrow and purchase all of the asset and will be the marginal holders. As a result, its price will be high. If bad news about the asset payoffs arrives, its price can fall for two reasons. The first is because of the fall in expected cash flows. The second is that there is a redistribution of wealth and as a result the marginal holders may no longer

be from the relatively optimistic group. Instead, the marginal holders may now belong to a relatively pessimistic group and the fall in price may be considerably amplified. The volatility that results may lead to an increase in margin requirements, and this can further amplify the change in price if the marginal holder switches to an even more pessimistic group. As a result, small changes in expectations can have a big effect.

The paper is a nice contribution to the literature on financial crises. In many cases, relatively small changes in fundamentals seem to cause large crises. The paper is part of an important and growing literature that explains how this can happen. One strand of this literature uses models with multiple equilibria, in which a crisis is modeled as a switch in equilibrium. The difficulty with this approach is that there are not many good theories of equilibrium selection. An exception is from Morris and Shin (1998), who are able to show in the context of currency crises how a lack of common knowledge can lead to a unique selection of equilibrium. However, Hellwig (2000) has shown that their result depends in an important way on how a lack of common knowledge is introduced. Choosing a different information structure can lead to a different selection of equilibrium.

The alternative to approaches based on multiple equilibria is the use of models in which there is amplification. Examples of such models are given by Kiyotaki and Moore (1997), Chari and Kehoe (1999), and Allen and Gale (2001). The Geanakoplos paper belongs to this strand of the literature. It is a very plausible explanation of the liquidity crises and crashes in the fixed income market that occurred in 1994 and 1998.

One of the important issues the analysis raises is the role of the central bank in providing liquidity. In practice, its actions in providing liquidity through the banking system appear to be crucial in determining asset prices. This aspect is not included in the model here. An important extension would be to do so.

## 3. THE LO AND WANG PAPER

There is a great amount of literature on the theory of asset pricing and on tests of these theories. As the authors point out, by contrast, there is a small literature on the volumes that are traded in financial markets. The paper seeks to change this. The authors start by providing a fairly standard model of dynamic trading. They then use this as the basis of their empirical analysis. The effects of incorporating asymmetric information and fixed transaction costs are also investigated. Finally, they consider technical analysis, as this has always placed considerable emphasis on volume. The paper builds on three of the authors' previous contributions (Lo and Wang, 2000 and Lo, Mamaysky, and Wang, 2000a, 2001b).

The dynamic trading model that is developed has risk-averse investors that maximize expected utility. They bear risk from stochastic asset returns and also from nonfinancial income such as labor income that is positively correlated with stock dividends. The model exhibits four-fund separation. The first two funds are the risk-free asset and the market portfolio. The third is a hedging portfolio that allows investors to hedge against nonfinancial risk. The fourth



is another hedging portfolio that allows investors to hedge against changes in market risks driven by changes in aggregate exposure to nonfinancial risk. It is also shown that the model leads to a dynamic volume-return relationship in which returns accompanied by high volume are more likely to be reversed in the future. This result relies on the assumption of symmetric information. Asymmetric information can reverse it.

Using a volume measure based on turnover, Lo and Wang's empirical work indicates that cross-sectional variation in turnover does seem related to stock-specific characteristics such as risk, size, price, trading costs, and S&P 500 membership. With regard to $K + 1$ fund separation, they demonstrate that the first $K$ principal components of the covariance matrix of turnover should explain most of the time-series variation in turnover, if turnover is driven by a linear $K$-factor model. They find that a one-factor model is a reasonable approximation and a two-factor model captures over 90 percent of the time-series variation in turnover. They also find that the dynamic volume-return relationship suggested by their theoretical model is generally supported by their empirical analysis.

In the theoretical model, investors can trade in the market continuously with no transaction costs. When information flow to the market is continuous in such models, trading volume is infinite. In the empirical analysis it is assumed that trading occurs at finite intervals. When fixed transaction costs are incorporated into the analysis, the level of volume depends critically on their size, as does the illiquidity discount in stock prices. This contrasts with the existing literature, which finds that transaction costs do not have a significant impact on trading volume or illiquidity discounts. It is shown that this version of the model is consistent with empirically plausible trading volumes and illiquidity discounts.

The final part of the paper considers technical analysis. Lo and Wang first develop an algorithm that can identify technical patterns such as "head and shoulders" and various types of "tops" and "bottoms." The effectiveness of the technical analysis is analyzed indirectly by conditioning on the occurrence of a technical pattern and on declining and increasing volume. The conditional and unconditional distributions are compared, and a difference is interpreted as indicating that technical patterns are informative. When they apply these to many stocks over many time periods, Lo and Wang find that certain technical patterns do provide incremental information, especially for NASDAQ stocks. The volume trends also provide incremental information in some cases.

The work described in the paper is a good contribution to the literature on trading volume. It provides a benchmark analysis. One of the most important questions it raises is how much trading volume is due to the types of factors modeled, such as risk sharing and shocks to nonfinancial income. There are many other plausible alternatives that seem at least as likely to be important as any of these factors.

The first is differences in prior beliefs, which play such an important role in the Geanakoplos paper. Casual observations such as the variation in analysts' recommendations suggest that this factor can explain a significant amount of trading. This motivation for trade contrasts with asymmetric information in

that people do not try to deduce informed people's information. They agree to disagree.

Allen (2001) argues that it is not surprising that asset-pricing models based on the assumption that individuals invest their own wealth are unable to explain many asset-pricing anomalies, such as the Internet and technology "bubbles," when in practice institutions own the majority of stocks. A similar argument applies here. The agency issues that arise with delegated portfolio management such as churning are likely to explain a significant proportion of volume. Other important factors include the role of derivative markets and whether they are complements or substitutes and the extent to which markets are effectively arbitraged.

The authors are right to stress the paucity of the asset-quantities literature both in absolute terms and relative to the asset-pricing literature. One would hope that this paper will help to stimulate a larger literature that will identify the relative importance of risk sharing, differences in prior beliefs, institutional investment, and other relevant factors.

## 4. CONCLUDING REMARKS

As the discussion herein has indicated, both of these papers are well worth reading. The fact that they have common intellectual roots in the Arrow–Debreu model but take such a different approach is also revealing. In many areas of financial economics, particularly asset pricing, there is a great deal of rigidity in what is permissible in terms of standard assumptions. When changes such as the move toward behavorial finance do come, they tend to be large. More gradual changes such as considering the effect of differences in beliefs and the role of agency problems should also be considered.

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