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# Evaluating the Stock Market

Bharat Trehan

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Since the 1980s, U.S. stock markets have soared, and stock prices now are at levels that were unimaginable before the boom started. There has been no shortage of speculation about the reasons for this performance. Some claim this performance is an irrational “bubble,” built on false hopes and thin evidence, that will collapse under the weight of reality. Others claim that the high prices may be justified by the explosion in information technology that has transformed the way firms do business and enhanced the prospects for strong productivity growth.

The unusual behavior of the stock market is a concern to monetary policymakers for a variety of reasons; for instance, growing stock market wealth can lead to an increase in consumption demand that exceeds the economy’s productive capacity. In view of these concerns, the Federal Reserve Bank of San Francisco and the Stanford Institute for Economic Policy Research held a workshop on April 21, 2000, to discuss five papers on the stock market. This *Economic Letter* summarizes and discusses those papers.

### Overview

How can we explain recent stock market valuations? Heaton and Lucas set up an economic model to answer this question. They find that no single explanation is adequate; instead, one needs to assume that several changes, such as increases in portfolio diversification and market participation, occurred roughly at the same time to increase the demand for stocks. Hall’s paper turns the question around: If stocks are reasonably valued, what are the markets telling us? His answer is that markets are telling us that there has been a huge increase in the quantity of organizational capital (such as intellectual property) over this period. The two papers coauthored by Jovanovic also try to extract information about the economy from the behavior of the market, but they focus on what the market can tell us about

technology shocks. A key conclusion is that the arrival of new (information-processing) technology is responsible for both the decline in the stock market in the mid-1970s and the stock market boom since the early 1980s. Zeira's paper suggests that while an increase in productivity (induced by information technology) could well be behind the recent boom in the stock market, the stock market is still capable of overshooting its long-run value and then returning to this value with a crash. This "boom and bust" sequence occurs because markets tend to overestimate the extent of the productivity change while it is going on and then are surprised when it ends. Overall, the papers at the conference suggest that changes in technology as well as in market participation have played a role in the market run-up in recent years, but that it is hard to determine exactly how much of the increase is attributable to them.

## Explaining stock prices

Heaton and Lucas point out that despite the surprising strength of the stock market, we do not have the evidence to state definitively that stock prices have reached levels that cannot be rationalized. We must therefore proceed by trying to determine whether the changes in fundamentals required to explain the observed change in stock prices appear reasonable.

In a simple model of the stock market, the price of a stock depends upon the present value of discounted future dividends. Thus, the price of a stock can change (a) either because the rate of expected dividend growth changes (b) or because the rate at which future dividends are discounted changes. Heaton and Lucas estimate that real earnings (which help determine dividend growth) have grown at a rate of 1.4% a year over the past century, while the real annual return on a broad-based U.S. stock index has averaged 7.3%. They calculate that the level of stock prices at the end of their sample period (1998) can be justified if one is willing to postulate that the growth rate of earnings has risen to 2.4%, while the required real rate of return has fallen to 6.6%.

To determine whether changes of this magnitude can be the result of plausible changes in economic variables, they present some exercises from a numerical model of the economy. They consider variables that can be classified under three broad headings: changes in stock market participation patterns, changes in consumer preferences, and changes in earnings growth. They find that while no single variable explains the large change in stock prices, assuming simultaneous changes in all three classes of variables does. Specifically, the model "works" if one is willing to assume that investors now have longer horizons (because of increased life expectancy), that participation in the stock market has risen from 50% to 80%, and that the dividend process is less volatile and, importantly, less skewed, so that it is less likely to expose investors to extremely large losses. The authors interpret their assumption about the less risky dividend process as reflecting one of the benefits of diversification, which reinforces their conclusion that the growth in mutual funds is a significant factor in the recent performance of the market.

## What the stock market may be telling us

Hall wants to establish that changes in the stock market value of the firm largely reflect changes in the *quantity* of its capital and not its price. To do so, he must find a way to decompose the market value of the firm's capital (which can be observed in the stock market) into the quantity of capital and its price. Note that one cannot directly observe either the quantity of this capital or its purchase by the firm. Though physical capital can be observed, much of organizational capital consists of unobservables, such as ideas and the quality of employees.

Deducing the quantity of capital from the total value requires some assumptions. Hall's assumptions about the absence of monopoly and the speed at which the capital stock adjusts to its desired level help him find a close correlation between changes in the value of capital and in its quantity in the data. The recent run-up in the stock market can then be interpreted as an increase in the amount of organizational capital in the economy.

The main conclusions from Hall's analysis of stock market data are that the 1950s and 1960s were a period of high capital accumulation and high productivity, as were the 1980s and the 1990s. In addition, he finds that a substantial fraction of the capital stock was destroyed in 1973 and 1974. Hall also presents some results for capital productivity growth, which depend upon the assumption one makes about the speed at which the capital stock adjusts. If firms are assumed to complete 50% of the required adjustment in one year, then the productivity of capital (over 1945 to 1998) is estimated to have increased by 18.3% per year, while if the speed of adjustment is 6% per year, then the rate of productivity growth is estimated to be 15.6%.

Hall's paper provides an interesting way of looking at the recent movements in the market. However, as DeLong points out in his discussion, the paper replaces one puzzle with another. Instead of having to explain why prices are so volatile, we now have to explain why productivity is so volatile: Hall's estimates of productivity range from 8% in 1960s, to 2% in 1970s, to 17% in 1990s; over the last five years, his estimate of annual productivity growth has averaged 24%!

### **Technology shocks and the stock market**

The papers by Hobijn and Jovanovic and by Jovanovic and Rousseau are concerned with the effect of technology shocks on the stock market. The key idea underlying these papers is that a major technical innovation lowers the value of existing firms, causing a reduction in the value of the stock market that will persist until shares in the new firms that can use the new technology make their way to the market.

In the first paper this hypothesis is used to explain both the decline in the stock market in the early 1970s and its rise since the mid-1980s. According to the authors, new technology<sup>1</sup> or information about new technology<sup>2</sup> arrived in 1973 (more loosely, over the 1968<sup>2</sup>1974 period). The key event was the invention of the microprocessor; prior to this, computers were too expensive and cumbersome for most businesses. Such revolutions favor new firms for a number of reasons. For one thing, old firms have old capital (both physical and human), whose value will be diminished by the technological change. Established firms are more likely to resist change as well; and they may not have the skills needed to adopt new technology. As a consequence, the introduction of new technology would cause the value of existing firms to fall. New firms cannot immediately compensate for the resulting decline in the stock market, because they will not be in a position to issue tradable securities. Only after these firms have done IPOs will the value of the new technology be reflected in the market.

The authors then present different kinds of evidence in support of their hypothesis. For instance, they show that most of the increase in stock market capitalization relative to GDP since 1985 represents an increase in the value of new firms. Firms that were already in existence in 1972 lost about half their value (relative to GDP) in the early 1970s and never fully recovered.

The paper by Jovanovic and Rousseau presents a further development of these ideas. Using a data set that spans 1895-1995, the authors examine how changes in the value of a firm are related to changes in the economy's technology. The two big technological changes they focus on are the spread of electricity around the turn of the century and the explosion in information technology in our own era. They find some notable parallels between the two episodes. For instance, the ratio of market capitalization to GDP dropped after the introduction of electric power just as it did prior to the widespread adoption of computers. However, the market recovered with a longer lag in the first case because it was harder for new firms to enter at that time (since markets were not as developed). Similarly, the recovery period (around the early 1920s) was marked by an unusually large number of new firms entering the stock market, just what has happened in the current boom.

### **Information and the stock market**

Zeira's paper provides another link between technological change and stock market fluctuations, one that involves learning by stock market participants. To understand his argument, assume that there is some

sort of technological breakthrough that will lead to an increase in the level of productivity and profits; however, no one knows by exactly how much. In the simplest framework, one can imagine individuals observing an increase in dividends paid by the firm and then trying to estimate how long this growth will persist. Recall that an (unexpected) increase in dividends causes stock prices to go up; thus, the longer that dividends are expected to grow, the more prices will be bid up. Uncertainty about the length of this period (which is equivalent to uncertainty about how much dividends will increase) is the key element in Zeira's argument. One way to think of this uncertainty is to imagine that different people have different beliefs about the length of this period. Most of the time, when dividends stop growing, some people will be disappointed, and will immediately reduce their estimate of the value of the stock. Consequently, stock prices will come crashing down.

Technological change is not the only possible trigger for booms and crashes in this model. Zeira points out that one can get a similar boom and bust sequence following financial liberalization, when the number of participants in the market (and therefore the demand for stocks) goes up, but no one knows the extent of the increase. Thus, the basic requirement is that there be some fundamental change in the economy, the duration or extent of which is unknown in advance. Stock prices move around (sometimes violently) as people learn about this change.

Zeira's model has some interesting features and implications. Note first that the increase in prices begins in response to an improvement in fundamentals. One fact that is consistent with this hypothesis is that post-crash prices often remain above levels that prevailed before the boom. This would be hard to explain if manias and panics were the key reason for swings in the stock market. An interesting implication of this model is that an economy may experience more booms and crashes during periods of rapid technical progress than it does during periods of moderate growth.

Bharat Trehan  
Research Officer

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## Conference papers

The papers and comments are available in pdf format at [/economic-research/conferences/000421/index.html](http://economic-research/conferences/000421/index.html)

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