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Bank of Japan

Theory on Financial Markets and Central Banks

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(English translation based on the Japanese original)

Introduction

It is a great honor to be invited to the 2017 Spring Annual Meeting of the Japan Society of Monetary Economics.

Today I would like to speak about financial markets. What immediately comes to mind when hearing the term financial markets are stock prices and foreign exchange rates, which are discussed on a daily basis in newspaper articles and news reports, and firms and individual investors are very familiar with the markets. At the same time, however, it can be said that once the discussion touches on the specific structures of transactions and pricing mechanisms, as well as interest rates, securities, and derivatives transactions, topics on financial markets turn out to be increasingly technical and require more expertise.

Over the years, I have been involved with financial markets in various positions. At the Ministry of Finance, I had daily contact with the foreign exchange markets as Japan's foreign exchange authority. At the Asian Development Bank (ADB), it raised funds necessary for development finance by issuing bonds in global financial markets. Currently at the Bank of Japan, I am deeply involved with financial markets as the Bank conducts monetary policy with a mission of ensuring price stability. Specifically, the Bank decides the guideline for market operations at Monetary Policy Meetings, which are held eight times a year, taking account of developments in economic activity and prices as well as financial conditions, with a view to achieving price stability. Based on this guideline, the Bank conducts daily market operations, such as purchases of financial assets including Japanese government bonds (JGBs) in the financial market. Apart from that, the Bank is involved in many facets of financial markets, including enhancing market infrastructures, collecting and releasing market-related data, and operating settlement infrastructure.

Through those experiences, I have always felt that financial markets are a place where theory and reality interact. For example, the pricing mechanisms of stock prices and foreign exchange rates are relatively suited to theoretical analyses, reflecting the characteristics that a great deal of data are continuously produced in financial markets. In fact, all of you here today and those in academia have brought about developments in theory on financial markets and have facilitated a better understanding of the markets. On the other hand,

market prices are determined through the activities of a broad variety of participants such as those with financing needs, fund managers, and policy makers. There are cases where financial markets move in line with theory, but it is not uncommon that they do not. Filling in the divergence between theory and reality might lead to the formation of new theory which enables market participants' behavior to be explained rationally.

In this way, financial markets have continued to develop with theory and practice stimulating each other. Today, bearing this point in mind, I will attempt to provide a bridge between theory and practice, in discussing theory on financial markets and touching on the reality of the markets from the perspective of central banks.

I. Traditional Theory on Financial Markets

I would like to commence by talking about traditional theory on financial markets. Prices in financial markets are determined as a result of a diverse range of participants trading various assets and instruments. Two fundamental theories are widely shared regarding valuation and pricing in financial markets.

Intrinsic Values

First is that prices are formed in the markets based on the intrinsic economic value of assets and instruments that are traded, so they are theoretically explicable. For asset pricing, the present value of expected future cash flow of financial assets is believed to be a starting point. For example, in the stock markets, it is typically considered that "share prices are determined by the present value of the firms' future profits." Long-term interest rates formed in the bond markets are, in principle, considered to be "averages of expected future short-term rates," and theory has been formed where term premiums are taken into account. It is believed that in the foreign exchange markets, the so-called purchasing power parity, with which "fluctuations in foreign exchange rates in the long term reflect differences in inflation rates at home and abroad," provides a reference value.

Nevertheless, actual financial markets are affected by many other factors; therefore, short-term market developments cannot be completely explained based on the theory I have just described, and even taking into account developments during a longer period, the

degree of applicability and explanatory power differ. That being said, I think that the significance of the theory based on intrinsic economic values is recognized as being the foundation or the starting point of valuations and analyses of market prices. Furthermore, if divergences between theoretical value and market prices continue over a long period, analyses on the cause of those divergences are thought to have important meaning in both theory and practice.

Efficient Markets

The second understanding is that prices formed in fair and transparent financial markets do not leave opportunities for arbitrage between instruments and between markets. If a clear arbitrage opportunity is left unexploited, someone is most likely to take advantage of that opportunity to gain profits, thereby bringing about a price correction. Assuming the presence of private economic agents in pursuit of profits, this understanding is quite reasonable.

Of course, this understanding is based on the following strong premises: (1) investors behave rationally, and (2) information that would affect prices becomes available instantly and there is no information disparity in the markets. Therefore, it is not difficult to find cases where this understanding is not applicable in reality. However, I feel that this theory is significant in that it provides the basic perspectives for the functioning of financial markets. Supposing that an arbitrage opportunity is apparently present, the theory would be the basis for discussions on issues such as why that occurred, whether the market is just taking time to adapt and adjust and an autonomous adjustment can be expected, and whether the situation should be artificially corrected by implementing some sort of measures.

II. Mutual Feedback with the Actual Markets

The significance of traditional theory on financial markets is generally accepted not only in academia, but also among many market participants. However, as I have mentioned, there are quite a few phenomena in actual financial markets for which such theory might not provide a satisfactory explanation. It is believed these difficulties are attributable to various factors; three of which I will explain now.

Difficulties in Utilization of Market Data

Practical hurdles are one of the factors that make it difficult for traditional theory to be fully adopted. In relation to asset prices, there often are constraints in utilizing data in practice. Specifically, expected inflation rates and term premiums included in long-term interest rates are not directly observable, even though they are widely accepted concepts. Estimated figures should be seen with a considerable margin as there is no consensus on modeling and formulation.

In addition, there are cases where data availability is a high hurdle in practice. Apart from data that are not observable, which I have just described, there are those that are not collected, those that are regarded as private information and are not for general use, and those that are hidden and therefore their usefulness is not known.

On this point, it should be noted that, against the background of the evolution of information processing technology such as natural language processing, image recognition, and machine learning, as well as improvements in the performance of computers, a trend towards utilizing types of information that was not expected and vast data for investment decisions and market analyses has started to become widespread.[1] It is expected that in the future more information will become available for utilization and will facilitate enhancements in market efficiency, accompanied by initiatives for ensuing privacy and information security.

Anomalies in the Markets

It has been well known that, as long as it can be assumed there are efficient markets that do not leave arbitrage opportunities unexploited and there are rational investors, phenomena referred to as anomalies that are not rationally explainable can be observed in financial markets. Some of them are market development matters: the calendar effect that finds regularity in market developments according to the specific month or the day of the week, and the small-firm effect that indicates a tendency of difference in expected returns by market value. There are also other anomalies that are to a certain extent understandable as

[1] Haruhiko Kuroda (2017), "AI and the Frontiers of Finance," Remarks at the Conference on AI and Financial Services/Financial Markets, Bank of Japan.

investor psychology, such as "investors' expectations tend to be biased by their past experiences" and "investors' risk appetite could vary significantly depending on their performances up to that point." There are some fields where instead of being simply regarded as irrational phenomena, an interdisciplinary approach using, for example, psychology, has led to the creation of new theory, such as behavioral economics.

Changes in Market Structure

Apart from daily price movements in the markets, how to identify structural changes including market infrastructures and to incorporate them into analyses has long been an issue. On this point, from the perspective of a practitioner, I feel that there are fields in which, even with an evident structural change, it is difficult to receive support from a systematic theoretical approach, in part due to the high level of expertise required to correctly recognize the relevant facts.

For example, as trading through electronic platforms has become mainstream, along with the significant decrease in trading through human brokers such as floor and telephone trading, the time required for the execution of each market transaction has shortened dramatically. Under these circumstances, the execution of transactions based on algorithms has become widespread and the weight of high-frequency trading has been increasing in some markets. On the other hand, some institutional investors such as sovereign wealth funds and pension funds, in addition to traditional financial intermediaries and investment trusts, have increased their presence as market participants; as a result, there is a possibility that investment styles have become diversified and the time span for returns has lengthened.

Although there is no question that these structural changes are exerting some sort of effects on pricing mechanisms in the markets, it is not easy to gain a quantitative grasp of the degree of those effects, even if it is possible to give a qualitative explanation. Furthermore, even if the existence of those effects is recognized, there are often diverging views on the degree of their significance including regarding assessments of their sustainability. Be that as it may, such a viewpoint on changes in market structure often serves as important clues for analyzing phenomena that are difficult to explain, such as when prices follow unusual patterns. Moreover, from the perspective of policy makers, it is considered highly important

to foster a better understanding of changes in market structure not only for market analyses in normal times, but also for assessing the situation in times of crises and considering countermeasures.

III. Recent Characteristic Events

I have described three factors behind the clear division between theory on financial markets and reality. Next, I will give two examples related to that gap between theory and reality.

Flash Events

First are so-called flash events, or sharp fluctuations in prices in major markets that occurred in a short period of time in recent years. A few of the widely known flash events that have been observed are the flash events in the U.S. stock markets in May 2010,[2] the U.S. Treasury market in October 2014,[3] and the British pound sterling foreign exchange market in October 2016.[4] These cases share the characteristics where prices or yields plunged and then recovered relatively rapidly in a very short period of time. All of those cases attracted significant interest, mainly as they occurred in major markets that are thought to have considerable liquidity. Although the full breadth of the events with regard to what actually took place has not been uncovered, analyses by staff of related authorities and other organizations suggest that a confluence of factors is likely to explain the events, rather than any single cause. Specifically, it has been pointed out that the reduced presence of traditional financial intermediaries that engage in market making and the increase in machine trading such as algorithmic trading and high-frequency trading could have exacerbated those sharp fluctuations in the markets.

Fortunately, those flash events did not cause a broad impact on global financial markets, which would have led to disruptions in funding by firms and governments and in asset management by investors. However, if similar phenomena occur frequently in major markets, we cannot completely deny the possibility that they would adversely affect

[2] U.S. Commodity Futures Trading Commission and U.S. Securities and Exchange Commission (2010), "Findings regarding the Market Events of May 6, 2010."
[3] U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, and U.S. Commodity Futures Trading Commission (2015), "The U.S. Treasury Market on October 15, 2014."
[4] Bank for International Settlements (2017), "The sterling 'flash event' of 7 October 2016."

financial systems and real economies. Existing theory does not seem to provide a sufficient explanation of how flash events occur; therefore additional research based on broader viewpoints, including on detailed market structures and behavioral patterns of market participants, and theoretical research are awaited.

Effects of Financial Regulations

The second example is the effects of global financial regulatory reforms following the financial crisis. It is necessary to strengthen financial regulations to restrain excess risk taking by financial institutions and investors and the accumulation of financial imbalances, both of which were causes of the financial crisis. However, there is a possibility that, depending on the content of the regulations and the implementation processes, market making and various arbitrage activity by financial institutions would be affected more than expected.

Recently, the introduction of regulatory reform aiming to enhance the soundness of U.S. money market funds (MMFs) brought about a large-scale shift of funds to funds that limit their investments to sovereign assets such as government debts. As a result, it was pointed out that the supply of U.S. dollars to overseas financial institutions -- in which MMFs previously played an active role -- has been constrained, thereby exerting effects on U.S. dollar funding costs. Since the total volume of funds before and after the regulatory reform has not changed, it is possible to claim that such costs will return to their previous levels at some point, as long as arbitrage functions and U.S. dollars can be supplied through other channels. Indeed, some new suppliers of U.S. dollars have started to emerge. However, it seems that it would take a considerable amount of time for both market participants supplying and funding U.S. dollars to adapt to the new environment and change their behavior.

Similarly, in the U.S. money markets, it has been reported that, in view of stronger balance sheet constraints stemming from regulations on leverage ratios and other factors, U.S. banks have become less active in interest rate arbitrage. In this situation, the interest rate on reserves at the Federal Reserve -- which was expected to function as the floor on the federal funds rate upon its introduction -- has changed in nature and now virtually functions as the

ceiling rate, reflecting the money market structures in the United States. Taking into account the actual role of the interest rate on reserves, the Federal Reserve has proceeded with the normalization of monetary policy by providing a new means of absorbing funds, namely reverse repos, which forms a floor on the federal funds rate. Here, new practices have been created to raise interest rates with abundant liquidity in the financial system. This is an example where regulatory and structural factors exerted significant influence on the interest rate formation mechanism in the market and on central bank market operations.

IV. Relationship between Central Banks and the Markets

A. Maintaining and Improving Market Functioning

Mutual feedback between theory on financial markets and reality -- which I have elaborated on -- holds an important meaning for central banks.

With regard to the more practical aspects of business at central banks, monetary policy produces effects as central banks conduct operations through which they influence prices in financial markets, and as this spreads across the markets through arbitrage. Therefore, maintaining and improving market functioning is a very important issue for central banks.

In relation to this point, since September 2016, the Bank has implemented yield curve control, in which it sets the short-term policy interest rate at minus 0.1 percent, and purchases JGBs so that 10-year JGB yields remain at around 0 percent. Under this framework, it can be described that market mechanisms allow the entire yield curve to be consistent with the levels of short- and long-term interest rates indicated as the operating targets in the guideline for market operations. Furthermore, the Bank's Securities Lending Facility -- through which it temporarily provides Japanese government securities (JGSs) it holds depending on market conditions -- is conducted from the perspective of supporting that mechanism in the JGS markets.

Aiming to ensure stability and high functionality in financial markets, the Bank has actively supported initiatives such as (1) the development of market conventions including in the money markets and foreign exchange markets, (2) shortening of the JGB settlement cycle, and (3) the development of a market level business continuity plan. Moreover, the Bank is

committed to enhancing market infrastructures in a broader sense; for example, it has increased the availability of valuable data through collecting market transaction rates and releasing them. Although I will not go into the details today, the Bank administers a robust and convenient settlement system and ensures its stable operation with the same objectives. The Bank will continue to make those steady efforts towards maintaining and improving market functioning.

B. Unconventional Monetary Policy and Financial Markets

The main mechanism of monetary policy conducted by central banks has traditionally been to influence short-term interest rates through their operations including purchases and sales of short-term government bonds, thereby exerting effects on long-term interest rates and prices of other financial assets. Nevertheless, following the global financial crisis, central banks faced with the "zero lower bound" on nominal short-term interest rates implemented policies directly influencing long-term interest rates and various risk premiums under which they conducted purchases of long-term government bonds and riskier assets such as CPs and corporate bonds, in order to respond to the significant deterioration of their economies. This is referred to as "unconventional monetary policy." As a result, the presence of central banks in the markets has become much more significant and their involvement with financial markets has changed.

That "unconventional monetary policy" has been highly effective in ensuring financial market stability and supporting economic activity. At the same time, however, it has given rise to a new issue in analyses of "market prices" formed by incorporating the actions and expectations of various economic bodies, that is, interactions with "the effects of central banks' policies." Further research on this issue is necessary. Moreover, there is a possibility that developments in financial markets would have effects on the sentiment of consumers and businesses as well as on their spending activity, thereby amplifying fluctuations in the real economy. Thus, it is important for macro policy makers to gain an appropriate grasp of the interactions between financial markets and the real economy.

C. Market Intelligence

In this manner, central banks conduct analyses of information produced in financial markets

that are the basis for their policy making and market operations. However, it is not at all easy to understand the causes and background of complex developments in the markets. To this end, it is necessary to carry out multidimensional analyses by, for example, utilizing traditional theories on the intrinsic value of financial assets and the markets' efficiency, as well as findings obtained from new research such as that on pricing mechanisms in the markets under "unconventional monetary policy," and taking into account the views of market participants that actually trade. Furthermore, it is considered necessary to continuously deepen our understanding of market structures such as in terms of systems and regulations, in addition to investors' characteristics and their trading styles, and sharpen our awareness of issues on their potential effects.

Such collection of information and analyses on market developments are referred to as "market intelligence." In this process, exchanging opinions with a diverse range of financial market participants is indispensable. It is certainly possible to enhance our understanding of the essence of financial markets by obtaining the views of as many market participants as possible. As a part of those efforts, the Bank's staff are in contact with a broad range of market participants on various levels, and conduct surveys targeting participants in the money markets and bond markets.

Concluding Remarks

As I have explained, for central banks, financial markets are not only a place to conduct market operations in implementing monetary policy, but also a place to obtain valuable information. In addition, central banks have a significant interest in the sound functioning of the markets, as a condition for the effects of their monetary policies to spread smoothly.

In this context, as the Bank has significantly benefited from developments in theory on financial markets, it has made its own efforts in theoretical research, utilizing findings obtained through practices including the conduct of monetary policy, daily market operations, and analyses. From this unique position, the Bank will continue playing a role of serving as a bridge between theory and practice.

Today's meeting is a great opportunity for discussions among numerous experts from academia and practitioners from financial markets. I would like to close by expressing my

sincere hope that this meeting will generate fruitful discussions, and that further progress in research on financial markets will foster a better understanding of the markets and greatly contribute to the development of the economic society.

Thank you for your attention.