

Kenneth J. Arrow

Knowledge, Belief and the Economic System

Prices, according to one of the fundamental economic assumptions, contain all the information needed by market participants to make decisions. But this hypothesis does not withstand a reality check – a lot of very necessary information is not passed on in the price system. The prices of stocks immediately before the crash of a stock market bubble say very little about their true worth. For a perfect market system markets for all products and for all points in time are needed. These markets do not always exist and sometimes cannot exist – for example markets for products not yet in existence.

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Dear colleagues,

I will make some observations on the topic of Knowledge, Belief and the Economic System. This is somewhat of a Viennese theme, which I guess makes it even more appropriate for this event. It goes back very directly to the earlier versions of the Institute of WIFO in the 1930s and to what I think was then known as the Institut für Konjunkturforschung, which transmuted into the Institut für Wirtschaftsforschung. Of course, one of the hopes of an institute like that was the prediction of economic phenomena – an aim which is still sought after.

Here I should make reference to one phase of my life when I was a weatherman. At that time I had been a graduate student of economics and was aware of the difficulties of economics. I wound up studying for my military service in the United States Army, as a weather forecaster. I thought "well, here we're now going to use natural sciences and get the exactness and the precision of the natural sciences". It turned out that the ability to forecast the weather was in no way better than the ability to forecast economic magnitudes. Even though we are better at forecasting economic phenomena today than we were 70 years ago, it is also true that the ability to make a weather forecast is somewhat better than it was 70 years ago. Yet no great revolution has taken place in either of those fields. We have new statistical methods, we have new theories, but frankly, the record of forecasting business conditions is, shall I say, less than would be desired.

But economics is different from the weather, and this was the point that a Director of the Institut für Konjunkturforschung, Oskar Morgenstern, was making. Not only does public policy require institutes to produce forecasts, but individual businessmen have to produce forecasts as well. When they are making investments, they are forecasting the future – a future environment, in which the investment is to be realised. When you stop building your plant and start producing, how effective are you going to be? Are you going to have a lot of sales, is the price going to be high, etc.?

At the same time one of the determinants of business conditions is of course the extent to which people are investing. Investment – understanding all the qualifications (assumptions) that have to be made for that statement – stimulates business. Furthermore in order to produce with your investment, it may be that businesses need inputs, which hopefully somebody else will produce. So there are many ways in which active investment is dependent on active forecasting. What I do depends on my forecasts, and what other people do depends on their forecasts. In order to forecast, therefore, I should forecast what other people are forecasting. You can see how this spins out into forecasting the forecast of the forecast and so forth, and

this circularity of forecasts was a point that Morgenstern emphasises as a great difficulty. Morgenstern's question therefore, was: how do we get out of this seemingly endless track?

Keynes, writing two years later on, in his "General Theory of Employment, Interest and Money", in 1936, in a brief passage, no more than a paragraph or two, but quoted over and over again, thought about exactly the same issue: he was worried about the determinants of investment and made again the same remarks as Morgenstern had done. He cited as an example, a campaign by an American brewing company. You must remember that at that time we had just had a prohibition of alcoholic beverages for 15 years, and beer was just coming back to market as were the companies that had produced beer 15 or 20 years earlier. In order to get publicity, one of these companies got six models, put their pictures up for you to vote for your preference. You got a prize, like a couple of bottles of beer or something, if your choice was the top choice among the voters. As pointed out by Keynes in this situation it would have been very foolish for people to pick out their best choice. Rather, what they should have done was to pick out what was the other people's preference. But of course you see that cycles in the same way as above – people should guess other people's guesses about the preferences, and so forth.

As an equilibrium theorist I must remark that such a situation does have an equilibrium. This is given if everybody agrees on the same model. In this case all plans and forecasts can be realised. This equilibrium is also stable, in the sense that once it happens, nobody wants to change it. But of course there is the question of how people get to agree, what is the process leading to the equilibrium? Keynes uses these arguments as follows (this and the substantial developments since then are the theme of my lecture): If investments are based on these kinds of mutual expectations, they are bound to be rather unstable. Beliefs can start changing. This has not really been worked out as a fully general model by anybody, including myself, and so it is still research to be encouraged. What it suggests is instability.

Before going into the details of why this instability occurs, let me make some remarks about another Viennese theme, which is a little more widespread in economics. An old thesis of economics, going back to Adam Smith if not even earlier, is that the economy can coordinate disparate and distant parts through the price system: I don't have to know how hard it is for you to produce something I want to buy; all I really care about is what the price of it is. I don't have to go and find out why this is the ruling price; it is enough if I know this is the ruling price. It doesn't make any difference how or why it came about. This proposition, which is in some ways basic to all economists, became especially important and worthy of analysis in the context of the idea of a socialist system.

Ludwig von Mises is famous for arguing that in a socialist system you can't have a price system and if you can't have a price system you can't coordinate, while Friedrich von Hayek in a somewhat milder way drew out this proposition very elaborately: that the price system is a device by which information about things of which you have no direct knowledge is conveyed to you. You don't know any of the details, but you know what the price is and that is all you have to know. If you know all the prices, the price system conveys all of the necessary information. Of course, this concept was picked up also by one school of socialists who said: "well, how are we going to run a socialist system?" and decided, "well, we should use prices". This led to the development of a literature on "market socialism". Some of this goes back to Vilfredo Pareto. He was in no way a socialist, but he had wide intellectual interests and wondered how you would run a socialist system if you had to. His student Enrico Barone wrote the first paper on this question about 1906, in which he argued that you could run a social system by mimicking the capitalist system. You announce prices; if the supply and demand for some commodity were not equal, you would raise or lower the price accordingly. This line of argument was repeated by socialists like Oskar Longe. I must mention, some fundamental work on this was done in the late 1940s by my very good late friend, Leonid Hurwicz, a Polish-American economist who had studied at Ludwig von Mises's Institute for Humane Studies in Geneva just before World War II.

Hayek's proposition was thus used by both as an argument for and against socialism but it emphasised the idea that prices are a conveyor of information. If you notice closely here, there is a little bit of a contradiction to my earlier statements: if prices convey all the information, what difference does it make what my beliefs are? We'll come back to that.

Another Austrian theme is the idea that this coordination really does take place in prices, but that it is disrupted by the process of innovation. You have the economy with production functions, utility functions, etc. (whatever your favourite way of presenting it is) – and you have an equilibrium. Then, somebody comes along with a new product or a cheaper way of making an old product, a product or process innovation. Suddenly the old equilibrium is no longer valid: there is a new commodity that needs to be accommodated somehow, so things get very confused and then you come into equilibrium with the new innovations.

This thesis is due to Josef Schumpeter, who originally wrote on economic developments in the long run situation. But then, in the beginning of the 1920s he began to argue that this was an explanation of business cycles, that each business cycle could be associated with an innovation. There were two very big volumes of Schumpeter on business cycles. The view that a cycle is associated with innovation is not one that's held up very seriously, if one thinks of the Great Recessions of 1929 or 2008 there's no great innovations associated with them. However, I will argue that the presence of innovation has something to do with the failures of coordination.

Let's thus come back to the question of why we need beliefs, why do I have to start forecasting what other people are doing when all I have to do is look at the prices? If you have a system of markets, not just one or two but an interconnected system, such that prices of an output are determined in part by the prices of the inputs, the markets are interrelated and the buyers are choosing among different commodities with the commodities' prices influencing this choice, the need for beliefs arises because the set of markets is not complete. There are many markets that theoretically ought to exist and these markets, since they don't exist, are not conveying information. So it is beliefs about them that are relevant.

What markets would we need to have to have a complete set of markets? There are a lot of problems, I'm not going to go into all of them, but there are two aspects which have been central to theoretical discussion: One is that one would want markets for future goods. If I'm putting up a factory to make steel, I should have a price for steel in the future. If I'm going to build this factory over a period of time, putting in equipment, what I'd really like to do is sell that steel now for delivery 5 years from now. Such markets don't exist. People who have elaborated on this theoretical requirement for full markets over time would be Erik Lindahl in the 1930s and then John R. Hicks, who systematised it in a great book "Value and Capital".

A somewhat parallel reason is that there are after all uncertainties in the world. By looking at the state of one particular economy, I may worry about foreign demand – I don't know what factors are going to affect foreign demand for my products, e.g., how is Country B, that I'm selling to now, going to develop? Maybe they'll develop a domestic capacity; maybe they'll buy from some other country. One can think of lots of reasons, such as demographic shifts, which change things over time, some fairly well predictable, others not. This means that we have to deal with uncertainties. Obviously in this respect natural disasters matter; we can probably put them as secondary factors in a modern economy, although we do have problems with agricultural goods from time to time. We would therefore also want markets for uncertainties. Surely there are insurance markets on which you can buy protection against your house burning down, storm damage, water damage, and others and there is also an increasing number of these natural disasters. So we have some markets for uncertainties, and theoretically you can also imagine a set of securities, which pay off under different constellations of circumstances. I wrote a paper on that many years ago.

Yet there are also many uncertainties that cannot be insured against; these markets are far from complete. One example might be gambling on innovations. If you are in the business of horse-drawn carriages, you'd like insurance against the emer-

gence of automobiles. For various reasons those markets do not necessarily exist. There are also uncertainties concerning new products. A very famous case is that of the pioneer of copying – the Xerox machine. While they were developing their product, they found that the costs of development were a good deal higher than anticipated, so they came up with the idea to sell half of the company to the International Business Machines Corporation to get financing. IBM took this as an interesting idea, it appointed a committee of high-ranking vice-presidents to look into it and decided, "no, it's not a good investment". Passing up this opportunity probably cost the company 5 or 6 billion dollars.

There are many good reasons why such markets do not exist. To take one reason, let us go back to the concept of innovation. Suppose you make manufactured goods, say, automobiles. When you make an investment in plant and equipment, you would like to be able to sell your product for delivery in 5 years' time. You can't really arrange that because neither you nor a potential buyer know what the automobile is going to be like. You can't specify in detail how powerful the engine is, what kind of electrical connections I am going to make. There is continuous innovation at the level of details and also at the "big-scale" level. You can't really specify these, because we know there's going to be innovation, maybe on a large scale, maybe on a small scale, but we don't know what that innovation is. Indeed we cannot even specify what the alternatives are, so we can't really make these contracts and therefore the markets don't exist.

Interestingly enough, we do have future markets in agricultural goods and in minerals, though not for very long periods of time. This is because these homogeneous products offer little scope for innovation: wheat is wheat, and copper is copper, and that's not going to change. In sum there are some limited future markets in minerals or agriculture, but not in manufactured goods. Therefore we see that there are a lot of missing markets.

There are, however, markets for the future of a different kind. These are financial markets. On these markets, I can issue a bond, commit myself to paying interest for a certain number of years, and to redeem the bond at the end. You can also have more sophisticated financial instruments, such as collateral-backed obligations, and common stocks, which provide a method of spreading risk. In this case, you don't have an insurance against any specific risk, but at least common stocks are a way of providing coverage for risks. I'm buying myself into a company, without knowing what's going to happen to that company, but at least it means that they are more people, who are going to bear the risks, so the company can proceed on a more averaged-out basis.

Another possible market that is largely missing is the market for inflation. The ordinary securities are paid in nominal money, so why don't we have a market for the risks of inflation? Such markets, where you essentially bet on the course of inflation, and be insured against inflation have existed. But they have never lasted or developed enough interest. The USA and some other countries do issue bonds payable in real terms, adjustable for the rate of inflation, but they have not been a big success.

Another characteristic of many financial markets is that they have problems with liquidity. If a lot of people want to buy or sell, it turns out you can't sell them, whereas if you sell the same amount over a longer period of time you can. Everyone knows about the role of central banks and the difference between solvency and liquidity, but that's too familiar for me to elaborate on.

In consequence of this discussion beliefs matter a great deal. This does not mean I believe in something with certainty. I'm not saying that something will occur; my belief may be that several things are possible and I assign probabilities to them. Or I recognise that there is uncertainty, but I have a definite sense of belief about the uncertainty. Over the years, we've had a lot of hypotheses, using empirical work, about expectations and beliefs. Some of them are manifested in this year's set of Nobel Laureates. But even these Nobel Laureates are not fully in agreement among themselves, which shows the variety of viewpoints in this matter.

Eugene Fama for example, has argued that the securities market incorporates at any moment the best possible forecasts for its own future. It is an efficient market; it gives the best possible forecasts, and all the information is conveyed in the price.

Robert Shiller, by contrast, has maintained the opposite viewpoint, that the markets are too volatile to be explained by perfect information. After all, it stands to reason that if you look at the average of all common stocks (we have our average – the Dow Jones average, and every other market has its own average), this is an estimate of what the corporate wealth of the USA could be. This is something that shouldn't change very much from day to day. Yet a change of 1 percent is considered as nothing on financial markets. If we think of what is meant by this it is that in one day, whatever happened on the news that day changes your belief by 1 percent of national wealth. This is really an incredibly large amount, and it doesn't really make much sense. This volatility seems to be excessive if your hypothesis is that all the information available is fully reflected in the current price. As a consequence many others such as Lawrence Summers, Andrei Shleifer and the like, have been arguing against the proposition of the efficient markets hypothesis.

A concept which is closely related to beliefs is information. Information is, as one might want to say, an observation which changes beliefs. I may see something in my own business, you might see something by reading the markets, you may pick up things in the public news, you might get private information – there are many sources of information. In particular, information can be bought and sold by spending more money on analysing the data than everybody else has, or by analysing data that I have, if I have some private data, or by spending money on hiring consultants.

So information, on the one hand, is costly to produce, and on the other hand is worth getting, in the sense that you'll revise your beliefs and you believe at least that this will improve your ability to invest in real and in financial terms. But information is a funny commodity, very different from ordinary commodities, and I suspect, though I can't really prove this, that this is partly responsible for the abruptness of changes of what we call the phenomenon of the business cycle. If I sell you steel, you've got the steel, and I don't. If I sell information, I've sold the information and I've got it still. This shows up in the question of credit ratings. Who should pay for credit ratings? Well it should be the purchasers of securities, but that won't work, because once a purchaser has the information, he or she can tell everybody else. The result is that the credit ratings are paid for by the sellers, not by the buyers. That of course creates incentive problems of a very obvious nature.

Another thing about information, aside from the fact that it can be used over and over again, is that it is more valuable to someone if they can use it more often. This leads to specialisation. For example, take medical knowledge. Perhaps I think I'll take care of myself, so I go to medical college for 4 years and develop my knowledge and then can treat myself. The medical problems I will have will be a very small part of the knowledge that a doctor acquires, so I've acquired it very wastefully. If a doctor gets it, he will use that knowledge over and over again, and since the acquisition of knowledge is pretty costly, in terms of time, not to mention money, so it's clear that it pays to have specialists. This applies to all professions.

Also information is more valuable if it's used on a bigger scale, and for more valuable purposes. If I'm a wealthy investor, investing millions of dollars, it pays me to be very well informed because I'm going to use the information on a large scale. The same reasoning applies if I'm thinking of buying a publicly listed security or something like that where I'm interested in the price of the security. To acquire knowledge with a degree of precision will cost me the same if I buy one share as if I buy 5,000 shares. On the other hand, it clearly does not pay the person with one share of stock to gather information because the gains you can get are relatively small. So there is some evidence that richer investors will get a higher rate of return on their investment on average, because they will spend more on information.

Also information is acquired as a result of social contexts that are not motivated by economic considerations. For example, it is true to this day that most jobs are filled by references – somebody already in the company tells a friend that there's a job

opening and recommends him or her. That's true to this day. The word "labour market" is a rather strange concept.

One of the consequences is that people in the same market have different information, and in this case it becomes very difficult to have complete markets. How can I deal with others when I know that they know more than I do or know different things than I do. This is the idea underlying the market for "lemons" that George Akerlof became famous for, and applies to the workings of the health system and also the financial system. If I am dealing with somebody more experienced than I am, and they're selling something, this tells me that maybe I want to be a little more careful, and creates problems for the markets. Asymmetric information is a cause of market failure, but also a consequence of market failure – because markets fail, people develop specialised information, and then their information is asymmetric. From this you get certain phenomena such as moral hazard, and adverse selection, concepts that came from insurance companies, who recognised them long ago, and have now come to be widely accepted in economic analysis.

Let me mention some implications of this for the operations of markets. We have been accustomed to hearing a lot, about how the governments in the USA and elsewhere mess things up. But how do the markets operate when they're not really complete and when beliefs come in? One example of the debate on the interaction between the government and the market is the doctrine of "too big to fail". This is actually a little misleading, because it's not necessarily a question of the size of the company or the bank, it's a question of whether there is a failure, even if there are many banks and they all tend to be highly correlated, that's the more relevant thing. Supposing that it is accepted that the government will take some sort of active measure when there is a big downturn, this means that there is a moral hazard problem, because banks, in their lending, will say, "well, we'll be bailed out if there's a failure, so therefore I'm going to be more generous in my lending, I'll lend on less secure mortgages, I'll lend on the short term" and so forth.

There is a second consequence, which is of course long recognised – bank runs. In the modern form, this is done by investment banks, borrowing on loans used for 24 hours, which are issued to buy securities. Suppose that the short term lenders stop lending (these might be the depositors, who are in effect lending their money to the bank but can withdraw at any time). Supposing they decide to withdraw their money, you might say, "Well what's the problem? The bank bought assets, and it can sell them as needed". The problem of liquidity comes in. It's very difficult to sell large values of assets on short notice, and there are a lot of transaction costs involved.

Let me apply this to a topic concerning the current situation – the effects on markets of the failure of missing markets and the importance of beliefs. Presume the markets have poolers of information. Let me ask empirically, how well do they do? You might say the government policies have been bad. In the USA and UK it is thought that we encouraged home ownership too much, although governments in general, whether right wing or left wing, tend to favour the idea of home ownership. Supposing this is true, consider the private sector. Should they have not reacted, considering they saw the government was undertaking a foolish policy, and thought "aha, they're creating a bubble"? It was of course known that house prices were rising rapidly, it was a subject of comment, people were discussing the fact the housing prices were rising rapidly, and there didn't seem to be any good underlying reason for why house prices were rising at such rates. If the market were operating rationally, they'd say that the government is following a bad policy, and in any case, I see that housing prices are going up and this can't go on and I'm not going to buy mortgage backed securities. These markets are not like the classic bank run situations, the participants are not ignorant investors, they're people who have a lot of money at stake, and are as knowledgeable about markets as anyone is likely to be.

These securities could not be bought by normal people. You needed to have several million dollars before you were allowed to buy these things in the USA. It was both a market that was informed and a market with a lot at stake, and indeed we

know that the biggest investment bank in the world, Lehman Brothers, disappeared as a result of the crash.

An earlier example, which should have given warning and which I'm sure you all know about, was the famous hedge fund, called Long Term Capital Management (LTCM). They had a particular philosophy – they claimed they could find disequilibria. In other words, you find some interest rate here, and there, which really should be connected, and the relation was a little off, so you say, "this is going to snap back into equilibrium, we'll bet on this". Now, the differences were small, so the only way to make money was to invest a lot, and the only way to invest a lot was to borrow most of it. In fact, in the case of LTCM, they roughly borrowed 93 cents for every dollar they invested. It can be argued whether LTCM's strategies were rational or not, they were paying for big stakes, and took a chance of going broke, I don't find much mystery there. The real mystery is why the banks lent to them. The banks were charging higher interest rates than they would have in other lines of business, but they were by no means participating in the gains of LTCM. Otherwise it wouldn't have been profitable for LTCM.

Why were the banks lending? Remember these were big bank. These institutions should have been very capable of understanding the situation, yet they did not anticipate the failure of LTCM. I could go into a lot of explanation why but what it shows is that the market is not so good. Even though it should have all the collective wisdom, as ascribed to it by people such as Hayek, it does not seem to be capable of predicting.

Another example is that of the Greek bonds – why did European banks not take account of the fact that Greece could default? It's true that there was some secrecy and some hiding, but you would think that these banks are smart enough to see through that sort of things.

I really find it interesting that even people who have interests at stake are unable to take account of this. The usual complaint about government decision-maker is that they don't have anything at stake. That's why a price system won't work for socialist states. It's just an administrative statement: adjust prices to cover costs, to meet supply and demand, but what incentives do they have to do it, they are just bureaucrats. But here are people whose money is at stake and yet it turned out they were unable to assess the situation well. I don't have a full answer to the question, but I just want to note that the aggregation of information by market institutions is clearly deficient.

This situation reminds me of a current area of research which has attracted some attention recently, called complex systems. Such systems are often analysed in physics, where we have a lot of complex relationships. A famous example for such a system goes back to my weather forecasting days. People worked out rather simplified models based on sound physics of the weather. Since the post war period these models could in principle be studied by computers, but this was beyond the computational power of the days when I was working in weather forecasting. One meteorologist used such a model to compute a weather forecast. He decided to check it by running the model again. He got entirely different results. When checking it, he found that when they were entering the data again, they made a very small error in one entry. This small mistake changed the solution of the system completely. In other words, the system was chaotic, which in technical terms means instability or that relatively small variations can produce very large changes. The argument is now how could you forecast the weather (or the economy), when a small variation in inputs completely changes the results, or in other words results will not be a continuous function of the inputs (i.e. of the observed data in the initial period).

Another area of research where such chaotic complex systems play an important role is in ecological studies. I have had a lot of contact with ecologists in the recent years. I find that their recommendations seem to be in clash with what economists think. One of the points they keep on stressing is modularity – you want to break up a system into parts and not have the parts connected. The economists say you want to connect as much as possible – in terms of foreign trade, the most classical view of economists is obviously that foreign trade should be free. One of the arguments is

that if there is a failure of crop here and abundance of crop somewhere else, it gives us some kind of insurance. The goods will go where they are most wanted, according to the price system. So it is an efficient allocation to have the goods flow freely. The ecologists, although I am not following them, give the example of the power system – failure tends to be contagious. I don't fully understand why by the way, but I accept the fact. Because the demand gets shifted, a plant closes down when the demand exceeds the supply, so the result is that you reduce the supply.

The way I like to think about it is that ecologists are thinking of fire, whereas economists are thinking of water. With fire, if you really want to prevent a fire, you create fire lanes. So, if one part of the forest gets on fire, it doesn't spread to the other part. On the other hand if it is water, you probably don't want to have barriers, because then the water rise will be a couple of inches deep. If you start blocking it, then when it breaks you have floods. In the example with fire you can really see that you want to have fire breaks and break up the system.

The question therefore is whether a complex system, which we see in the examples of the economic crisis above and that is certainly not fully articulated here, is in some kind the victim of a contagion effect. Of course in any way of describing a recession – even classically, long before the modern period, would have statements of the form that, if prices fall here, then they are going to fall there. There are many different stories for completing the analysis of what is happening. If there is deflation the debts become more expensive; that is an old theory of why recession happens. The difference in this story is that if something happens it creates more problems, rather than things equilibrating, while the standard self-adjusting economic principle is based on the idea that things happen to compensate other things from happening. But we see pretty clearly that in many cases the collapse of expectations and shifts in beliefs which I have been stressing, are part of such a story of complex systems.

In such a complex system we are not going to be able to predict the consequences of various actions very well. This includes the consequences of government policies, which raises the issue of how governments can deal with the complexity. One possible answer is that although we really can't tell what is going to happen in the economic system we seem to have very simple rules of what to do if it breaks down. Usually this solution is associated with easy money policies. In the case of a breakdown if things go wrong in the economy, then we cut interest rates and have easy money. One extreme version is the idea of Milton Friedman, according to which you should have a policy which is completely independent of the economic conditions. We should just keep on raising the nominal rate of money at a fixed rate, regardless of economic circumstances. Other thinkers such as Alan Greenspan, former chairman of the Federal Reserve in the USA, or my colleague John Taylor, have fairly simple rules for reaction. According to Taylor you have to worry about inflation and you have to worry about unemployment, so you raise the interest rate if there is inflation, you lower it if there is unemployment and if there is both you use a mixture of the two.

Greenspan has formalised this idea after the bursting of the so called "dot com" bubble of the early 2000s. Everyone thought that the policies followed then were a great success, since we did not go into a great recession. I have heard Greenspan lecture once on the theme, that you can't burst a bubble, because you don't know whether a bubble is a bubble. In the case of what was happening from the end of the 1995 until 2000, there was a rise in stock prices, and there was the question whether this was a bubble. In a sense you can't tell, but if the bubble collapses then we know what to do. He pointed this out before the collapse of 2008.

By contrast, the 2008 story did not seem to be met with any similar success. This may simply be due to the different size of the shock. In other words, we cannot count on a mop-up policy. It probably does work if the disturbances are not too big to begin with but it turns out that we have not eliminated the possibility of large disturbances.

Another thing policy can do is to take preventative measures – the equivalent of fire breaks – whenever there is the potential of instability to try to prevent that from happening and to try to make regulations to prevent it. In earlier times we did this

with regards to the stock market of 1929, when you could buy and sell on a margin, which was 5 percent. You could buy a 100 dollars' worth of stock for 5 dollars and borrow the remaining 95 dollars from the stock broker. As a consequence when the price went under 5 percent you were under water, you would have to start paying and would have problems. After the crisis of 1929 the margin became 50 percent as a result of a New Deal reform. This doesn't mean that this regulation prevented the stock market from collapse, but it did make it less likely that stock market collapse affected the rest of the economy.

Speaking broadly therefore, what you want to do is reduce leverage. If you have leverage you want to reduce it. One implication of this is higher capital requirements for banks, and I mean much higher, including investment banks. This is a position which has recently been taken by Anat Admati and Martin Hellwig in their new book. This sounds like it will greatly reduce the profits of banks and will reduce presumably the supply of credit or business, so that there are a lot of violent objections to this suggestion. Yet, I should point out that very serious economists in the past have gone as far as to advocate 100 percent reserve requirement for banking, (i.e., that you keep 100 percent reserves). Irving Fisher, who I consider one of the greatest economists of all time, certainly the greatest American economist, was arguing for 100 percent capital requirements for banks. He could see the instabilities. I would not go quite as far as he did, but the risks of bank lending (defaults and so on) should be borne on the first instance by the shareholders, and it should be a long time before this risk starts affecting the depositors. I think this is extremely important.

Another interesting thing is that many securities exchanges do not constitute proper markets. The stock market is a market, there is a price, even though there is some difference in the buying price and selling price, but there is a price, everybody knows the price, the transactions are required to take place, they are regulated. The same thing applies to future commodities markets. Mortgage backed securities, however, are not a market in that sense – there is no single price for them, everyone has been negotiating special arrangements in this market, so that the idea of prices and regulations was subverted by the fact that there were no simple prices.

An extreme version of this was the case of credit default swaps, where an agent would give an insurance against a decline in the price of a security. (By the way, the person who is buying this credit might have not had any of those stocks at all, and might have been just speculating. An ordinary insurance has the requirement that you have an insurable interest. You can't insure a house if the risks of storm damage are very high. You can decide to bet on the occurrence of a storm, but you can't insure your house for more than it is worth. But in credit default swaps, the buyers may be just gambling.

The second thing with ordinary insurance is that the state requires you to set up reserves. For credit default swaps no such reserves were required.

What is more, one couldn't compete over the price because every credit default swap was a negotiated arrangement and no one knew what the price was. The idea that the price is revealing information to other market participants therefore was not valid because there were no prices. Furthermore, nobody knew what the traded volume was. It was a surprise when it turned out that these were many trillions of dollars in credit default swaps. And we ended up bailing out the biggest lender, the biggest swap dealer, the biggest guarantor.

It seems to be that all these things require margin requirements and marketisation. Mortgage-backed securities and similar arrangements should have been put on markets, so that they become standardised and one could make comparisons based on prices and the known volume of transaction. Some things therefore could also be achieved by having prices as a source of information and by improving the workings of these markets.

Thank you for your attention!