Introduction

The financial crisis, which originated in 2007 with the subprime mortgage *affaire* and continued in Europe with the turbulence of the Euro, is one of the most important events of this new century. This is not only due to its material effects (the greatest default in the history of the United States, the most serious recession in the recent history of developed countries, the crisis of the European institutions), but above all due to the profound changes it has provoked on a cultural, social, and political level. The debate around ideas in finance, economics, and politics has changed significantly.

Ten years after the financial crisis, with this book I will try to evaluate the legacy of those events.

If we go back to the debate that followed the Lehman Brothers default, we discover that the possibility for states to intervene to save the banks led to a rather surprising alliance: the most convinced supporters of the positive role of the market (and of the negative role of public intervention) rejoiced at the decision to let Lehman fail, and on the other side, the representatives of antagonist movements more or less followed the same line. For example, representatives of the "Occupy London" movement, which occupied the square in front of St. Paul's Cathedral in 2011 as a sign of protest against the City, expressed their intention not to pay for banking crises. Proponents of pure capitalism and anti-finance radicals agreed for once!

This is not the only surprising de facto alliance. Faced with the flop of the international financial system, an easy and necessary loophole seemed to be that of a recourse to ethics; an assessment shared by moral authorities, such as Pope Benedict XVI and the Archbishop of Canterbury, and

by representatives of the financial system such as the governor of the Bank of England.*

If opposites meet, the events must be truly disruptive. In my analysis I want to start from the "easy" appeal to ethics, which too often becomes a travelling companion for the most extreme positions and populist campaigns that see the bailout of a bank as a favour to bankers rather than to depositors and companies that need credit.

In my experience, I have dealt with this issue in at least two different roles. First, as a finance professor who bears the responsibility of introducing students to the world of finance. I tell them that finance is a neutral technique and that individual conscience must be a watchdog in their professional experience, but the temptation to limit finance back to a technique that, like nuclear energy, is neither good nor bad in itself, has always struck me as not fully sincere. It is too easy to say that the value of finance depends on how we use it.

There is no doubt that finance is a technique that must be accompanied by a capacity of discernment and an ethical foundation established by people. These attitudes certainly provide a good service in general, but to me, a generic reference to the conscience of a person or to a generic "common good" has never seemed to be an adequate guide for those who must make everyday decisions in the world of finance. I have developed this conviction in my experience as an independent director of finance companies. Surely there are financial operators who have abdicated this responsibility while looking for easy gains, but "to separate the wheat from the chaff" is not always easy. There are plenty of directors of companies who, faced with unprecedented scandals, simply claimed that they did not have enough information to understand what was happening. How credible is this position and how much did they simply not want to see reality? It is not easy to answer. Even if a person has integrity and works conscientiously, an appeal to ethics is likely to be of little help. Just to give some examples: what is the fair fee for managing funds? What is the fair price in a transaction outside an organized market? What risks can an intermediary afford? How proper is it to insert and cancel orders suddenly on the market with the aim of influencing the trend?

While these are questions that often do not produce precise answers from a technical point of view, an ethical evaluation is even more difficult,

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* Pope Benedict XVI (2009), *Caritas in Veritate*; Mark Carney (2014), I*nclusive Capitalism. Creating a Sense of the Systemic*, London, 27 May.

as it requires a clear identification of the values and rights of the people involved. These features are as foggy, or even more foggy, than the answers that the technique seeks to provide.

The call to ethics is therefore not very helpful; my belief is that the financial crisis has shown that the problem with finance is much subtler and more complex. In the case of nuclear energy, the terms of the problem from a technical point of view, and the values at stake, are well-defined. Evaluation from an ethical point of view can be very complex, but the terms of the question are well-posed. For example, the choice to use nuclear energy for civilian use requires comparing the cost savings in producing energy with the consequences of a possible accident and those related to the disposal of nuclear waste in the future.

Finance cannot be addressed in these terms. Of course we can reduce the whole debate to how much a CEO should earn compared to a bank teller, but if we follow this perspective we will not get very far because the proper functioning of the financial system is much more complex. The point is that the financial crisis has clearly shown that there is good finance and bad finance; the former is well-designed while the latter is not. It is good or bad technical methods, rather than human greed, that make finance good or bad. This is the point that I will try to investigate in this book. I believe that the misuse of some important cornerstones of finance theory (demonstrated in many books), the lobbying action of the financial industry and the myopia/powerlessness of the regulatory/political authorities, have ended up producing a badly constructed finance that has not been able to keep the promise to be useful to society. This is the theme that I will try to address in this work.

It is difficult to introduce ethics and moral considerations in finance. As an example, consider the meeting between Georgia Hale (Melissa Leo) of Standard&Poor's and hedge fund manager Mark Baum (Steve Carell) in the film *The Big Short*. Baum is questioning the ratings of structured products that are obviously not aligned with fundamentals. Hale defends herself by arguing that Baum is a hypocrite because his argument is due to his short position on structured products linked to subprime mortgages. Baum takes the blow but counterattacks saying that the fact that he is betting against the markets "doesn't make him wrong".

The book aims precisely to investigate what is "right" and "wrong", to build a financial system that is sound and useful (for society), disentangling this perspective from an ethical point of view.

It is difficult to discern what is "right" from what is "fair". The two things are not always aligned. The end of the film shows this point clearly: having bet against structured products, Mark Baum has the possibility to make a huge amount of money by closing the position. Finally, he accepts it, but he also says that in doing so they will be like all the others. This difficult decision makes the limits of ethics in finance explicit: Baum was acting correctly, but he was making money by betting against the market and the economy as a whole. Was this ethical? It is difficult to say, and maybe his reaction after the collapse renders the difficulty of the choice: he becomes gracious and never says "I told you so" to anyone.

What I propose to do is to reflect on the mechanisms behind what happened. The aim is not so much to identify the culprits but to investigate the root causes of the crisis, to evaluate its legacy and to identify possible solutions, including the technological Fintech revolution.

My analysis will focus on four themes: commoditization of risk, industrialization of finance, deregulation, and ineffectiveness of institutions.

To make the journey easier, I will start from the two phases of the crisis: that of subprime mortgages in United States, and that of banks and the Euro in Europe. Chapter 1 is dedicated to investigating the origin of the crisis in the United States. I will focus on three aspects that will assist us in our analysis: subprime mortgages, their securitization, and the functioning of the markets during the crisis, when liquidity evaporated overnight. Then, I will deal with the Euro crisis, its connection with the subprime mortgage crisis, and the ineffectiveness of European institutions and supervisory authorities in ensuring the stability of financial intermediaries and banks.

The subsequent chapters will go to the heart of the analysis of the four themes that I believe have been brought to the fore by the financial crisis.

In Chapter 3, I will go deeply into the nature of the ultimate object traded on financial markets: risk. Risk deals with two dimensions: the probability with which an event could occur in the future, and the damage associated with that event. It is not easy to provide a definition of risk, in part because it has a multifaceted nature. As a matter of fact, we do not refer to a fact but to something that could happen in the future, whose effects are unfortunately only observed too late (after the uncertainty has been resolved). Its perception by people is strongly influenced by ex post evaluations. Basically, addressing risk requires making assessments and choices today, but the effects will only be felt tomorrow; a difficult situa-

tion to face, also because a uniform ex ante measurement of risk does not exist. The true origin of the financial crisis is ultimately to be found in the assumption used in modern financial theory and industry that treats risk as a measurable entity and thus as a commodity with objective characteristics that can be traded in the market and regulated.

In Chapters 4 and 5, I will analyse how the improper commoditization of risk has had a significant impact on the proper functioning of intermediaries and financial markets. An object such as risk, which is difficult to define and evaluate, makes managing a financial company very complex. The classic goal of "maximizing profit" does not fit financial companies well either because of intrinsic limits on large companies, or because of the peculiarities of their activities. Starting from the examples offered by the financial crisis, I will focus in particular on three issues: governance, business models, and non-traditional banking.

The financial crisis showed all the limits of the functioning of the markets, that were unable to fulfil their aims: to define an appropriate price for the assets obtained from the securitization of subprime mortgages, to provide the most basic liquidity and transparency requirements in the case of derivatives, and to punish non-virtuous companies and provide sufficient protection to savers. The financial markets did not work properly, and the "Invisible Hand" suggested by Adam Smith did not reveal itself.

Finally, in Chapter 6, I will focus on the limits of action by institutions: monetary policy, regulatory and supervisory authorities, and state intervention. The issue is controversial, but it is time to conduct an assessment by determining what worked and what did not.

According to the Governor of the Bank of England, Mark Carney, "finance has to be trusted... A sense of self must be accompanied by a sense of the systemic", and it can also be said that "For markets to sustain their legitimacy, they need to be not only effective but also fair...". Not to be outdone, Pope Benedict XVI wrote: "Without internal forms of solidarity and mutual trust, the market cannot completely fulfil its proper economic function. And today it is this trust which has ceased to exist, and the loss of trust is a grave loss". This is the challenge that must be seized without slipping into abstract principles that do not represent a workable perspective. The point is to understand how much room there is to build good finance. In Chapter 7, I will try to identify the legacy of the financial crisis for a wide range of actors: politicians, moral authorities, economists, technical operators, regulators, and bankers.

At the end of the crisis, what we could consider God's true punishment for finance, suddenly showed up: the Fintech revolution. Fintech presents some characteristics that have fuelled the imagination of those who were critical of the financial system, often belonging to the two extremes that merged during the crisis. The new technologies applied in finance could lead to a disintermediation of classic actors with bitcoins that could replace the Euro, Amazon, or decentralized platforms (like blockchain) that could allow for money transfers at a lower cost than banks offer. Big data and machine learning could allow for more effective advisory activity and financial products closer to customer needs. Fintech has a vague anarchist flavour, and is synonymous with the democratization and personalization of finance, two interesting features after the financial crisis.

Will Fintech be the solution to all problems? Probably not, but it will be part of the future by opening up very interesting perspectives. The financial world as we knew it before the crisis with the centrality of the banks, is undergoing profound changes. Nothing will be the same as before; we must try to glimpse the future having learned the lessons of the financial crisis. This is what I will try to do.

1 The Origin of the Crisis in the U.S.

Let's start with an episode already discussed beyond measure. While visiting the prestigious London School of Economics, in November 2008 the Queen of England posed a direct question to the English academic world: "Why did nobody notice it?"[1] The sentence appears innocent for its candour and leniency, almost harmless. Yet it is not innocent at all; the Queen was not referring to a pickpocket on the street, but to the deepest financial crisis since that of 1929, which we can now say, will definitely mark the history of this young century.

Orthodox economists replied with a piqued defence claiming that one of the implications of Financial Market Theory is precisely the unpredictability of markets, and thus the impossibility of predicting the outbreak of a crisis. Markets are "efficient" because they are unpredictable.[2]

The argument goes more or less as follows: the market is populated by rational people who are interested in taking advantage of every investment opportunity that allows them to make money. If there were a way to predict the trend of financial markets (with good reliability), and the outbreak of a crisis, a person could make money by exploiting this possibility. His trades in the market on the basis of the information would change the price of the securities, thus cancelling this potential advantage, at least in part. As a matter of fact, if a person were convinced a stock is overvalued,

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[1] Andrew Perce (2008), «The Queen Asks Why no One Saw the Credit Crunch Coming», *Telegraph-online edition,* 5 November.

[2] Eugene Fama (1970), «Efficient Capital Markets: A Review of Theory and Empirical Work», *The Journal of Finance*, 25: 383-417.

then he would sell it in a massive way (even short if he is allowed to) contributing to reducing its price and thus dampening a possible bubble.

Markets are said to be characterized by internal rebalancing forces, a feature that has led many observers to attribute them an anthropomorphic nature, claiming that they are "rational". Since any piece of information about the future value of a security will be used by rational people to get rich, prices will tend to move as a result of market trades in the direction indicated by the information, dampening a possible (upward or downward) trend. Market prices incorporate the information available in the market, and this makes future prices unpredictable, or "efficient" according to the theory of finance. It is not a coincidence that in finance one refers to a "random walk" in order to describe the dynamics of the price of a security. This theory is confirmed by the empirical evidence showing that it is very difficult to build a profitable investment strategy based on information available on the market. It is said that it is very difficult to "beat" the market.

In assuming this position, economists have shown that they have not grasped the Queen's challenge, and the risk is that with this approach, they certify their own irrelevance. Faced with an unprecedented crisis, it cannot be said that the failure to predict the crisis confirms a theory whose main message is the unpredictability of markets and crises. If this were the case, then the question would become: what is the relevance of financial theory? As a matter of fact, the relevance of a theory is assessed by its ability to predict and govern phenomena. A defensive position like the one described above induces people to laugh in front of the innocence of the Queen's question.

Claiming that the failure to foresee the financial crisis confirms a theory according to which it is impossible to predict the future is fully legitimate, but it could also be the case that a crisis represents a considerable breakdown of the pillars on which the theory itself is based. Even the magnitude makes a difference: daily market movements are mostly smooth, while a financial crisis implies a larger movement. While the failure to predict a small, day-by-day variation can be consistent with the efficient markets theory, it is more difficult to agree with this position in the case of a significant and repeated downward market movement.

Some economists have counterattacked by arguing that financial bubbles cannot be identified, that crises cannot be predicted, and that ultimately a crisis is a rare event which entails positive implications, fuelling the Schumpeterian process of creative destruction. According to this in-

terpretation, all in all, crises involve a very limited cost compared to the advantages that the development of the market economy brings with it, and therefore the approach was that it was better to deal with the aftermath of bubbles in stock markets and housing markets than to try to prevent them.[3] It is very difficult to fully assess this claim. A welfare-based analysis of financial crises for the economy as a whole is far from being feasible. The risk is that this thesis can be encapsulated in the tautological consideration that the market economy (as well as democracy) is the best of all possible worlds. This position may contain some elements of truth, but that does not help us prevent and manage financial crises.

Economists (and regulators) have had much to say on the origin and management of the crisis; I will return to them at the end of the book. To understand the financial crisis, I want to start from its origin: subprime mortgages and the famous toxic securities, securitization of subprime mortgages and asset-backed securities. For the time being, I will limit myself as much as possible to presenting some facts, leaving the interpretations to the following chapters.

1. The origin of the crisis: subprime mortgages

The origin of the financial crisis does not lie in complicated derivative contracts, but rather the simplest and most common of financial contracts: mortgages allowing American families to purchase homes.

By now the story has been widely investigated, so I can concentrate on the salient features.[4] This event gives us a good starting point for our analysis, because it reminds us of something we should never forget: when a transaction takes place in a market, there are always those who buy and those who sell. It is therefore necessary to understand the reasons that led people to conduct a transaction. Identifying the reason for a market transaction as the irrationality of traders, disinformation they had, or bad faith

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[3] Tim Besley and Peter Hennessy (2009), *Letter to the Queen*, British Academy.

[4] Gary Gorton (2010), *Slapped by the Invisible Hand*, Oxford University Press; Benjamin Keys, Tomasz Piskorski, Amit Seru and Vikrant Vig (2013), «Mortgage Financing in the Housing Boom and Bust», in Edward Glaeser and Todd Sinai editors (2013), *Housing and the financial crisis*, NBER books; Christopher Mayer, Karen Pence and Shane Sherlund (2009), «The Rise in Mortgage Defaults», *Journal of Economic Perspectives*, 23: 27-50.

seems to be a hasty answer, which risks not recognizing the truth, and above all, does not help us adequately prepare a response for the future.

In this case we have banks, brokers, and intermediaries who originated mortgages for the purchase of houses by people whose characteristics did not bode well for their ability to repay the loans. Why did these financial operators offer mortgages to these people, and why did the people accept them?

The answer has at least three ingredients: income distribution in U.S. society, low interest rates, and mortgage securitization.

Understanding the phenomenon requires us to broaden the horizon of our analysis, by looking at the U.S. society. In the background, we have the growth of inequality in developed economies.[5] One figure makes the phenomenon very clear: take the 10% of the U.S. population with higher income and the 10% with lower income. In 1975, the first group had an income equal to three times that of the latter, while in 2005 the ratio had risen to five times as much.

Faced with the growth of inequality, the recourse to debt provided an "easy" way out for American families. They borrowed to buy their homes and to sustain a level of consumption that was no longer guaranteed by their income. The phenomenon is common to all developed countries, but it is particularly significant in the United States: from 2002 to 2007, the level of debt of U.S. households doubled, and the ratio of debt to income grew by 50%. The connection with the growth of inequality in U.S. society is shown by the fact that less reliable people, those with a low level of creditworthiness (low FICO credit scoring), were the main protagonists of the phenomenon: the debt-to-income ratio doubled among the 20% of population with the lowest credit scores. The less reliable people in terms of credit quality were also the protagonists during the financial crisis: those who belonged to the 40% of the population with the lowest level of creditworthiness were responsible for 70% of the mortgages that were not honoured after 2007.[6]

In-depth studies on the U.S. economy have confirmed this interpretation: the areas of the United States characterized by high growth of mort-

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[5] Raghuram Rajan (2010), *Fault Lines*, Princeton University Press.

[6] Atif Mian and Amir Sufi (2015), *Household Debt and Defaults from 2000 to 2010: Facts from Credit Bureau Data*, working paper; Manuel Adelino, Antoinette Schoar and Felipe Severino (2016), «Loan Originations and Defaults in the Mortgage Crisis: The Role of the Middle Classs», *Review of Financial Studies, 29*: 1635-1670.

gages in the 2000s were also characterized by a relative (and in some cases even absolute) decrease in the income of the population. This negative relationship is an absolutely new phenomenon; indeed, in the 90s the relationship was positive.[7]

This interpretation, which links inequality and the growth of debt in the U.S. population, has for a long time not been accepted by policymakers and academics, who have considered the growth of debt to be quite natural, even at the level of the economy as a whole (a current account imbalance with foreign countries) as a response to the growth of productivity connected to new technologies.

Monetary policy accompanied the growth of debt in the U.S. by guaranteeing a very long period of low interest rates. Short-term interest rates in the money market were significantly lower than the rates that would have been derived from the application of the Taylor rule, which was the reference point for monetary policy at the turn of the new millennium. In particular, monetary tightening should have taken place at the end of 2001, but instead came only in 2004[8]. The reason for the Fed's loose monetary policy is to be found in the fact that despite the growth of the economy, inflation did not rear its head and unemployment did not decrease. The loose monetary policy also influenced long-term bonds (between 2000 and 2005, the rate of ten-year U.S. government bonds fell by almost 2%) and the average rate of a fixed-rate standard mortgage contract (which fell from 8.2 to 6.1%). In the same period, property prices doubled. According to some estimates, the prolonged season of low interest rates may have accounted for about 30% of the rise in property prices in the new millennium by fuelling the demand for mortgages.[9]

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[7] Atif Mian and Amir Sufi (2009), «The Consequences of Mortgage Credit Expansion. Evidence from the U.S. Mortgage Default Crisis», *The Quarterly Journal of Economics, 124*: 1449-1496; Atif Mian and Amir Sufi (2010), «The Great Recession: Lessons from Macroeconomic Data», *The American Economic Review, 100*: 51-56.

[8] John Taylor (2012), «Monetary Policy Rules Work and Discretion Does Not: A Tale of Two Eras», *Journal of Money Credit and Banking*, 44: 1017-1032.

[9] Charles Himmelberg, Christopher Mayer, and Todd Sinai (2005), «Assessing High House Prices: Bubbles, Fundamentals and Misperceptions», *Journal of Economic Perspectives*, 19: 67–92; Edward L. Glaeser, Joshua D. Gottlieb, Joseph Gyourko (2013), «Can Cheap Credit Explain the Housing Boom?», in *Housing and the Financial Crisis*, Edward Glaeser and Todd Sinai, editors, University of Chicago Press: 301-359; Charles Bean, Matthias Paustian, Adrian Penalver and Tim Taylor (2010), *Monetary Policy After the Fall*, Jackson Hole, August.

According to critics, the Fed abandoned the rules of strict monetary policy it had up to that point, to take a discretionary approach that had serious consequences (the real estate bubble and then the financial crisis). Opinions about the relevance of an accommodative monetary policy in creating the conditions for the financial crisis are discordant. For example, the chairman of the Fed at the time, Alan Greenspan, argued that it was not short-term interest rates (controlled by the Fed) that "caused" the crisis, since long-term interest rates (not controlled by the Fed) had been excessively low because of excess global savings (global saving glut).[10] Ben Bernanke, who succeeded Greenspan as chairman of the Fed, argued that the period of low interest rates at the beginning of the new millennium did not actually deviate significantly from Taylor's rule.[11] For sure, the monetary tightening in 2004 was the trigger of the crisis: from June 2004 to June 2006, the LIBOR rate (the interest rate at which banks exchange liquidity among themselves) increased by 3.5% and the rate of a standard subprime mortgage rose from 8% to 11.5%. The increase in mortgage rates led to an increase in delinquency of borrowers who held adjustable rate mortgages (ARM).

The securitization of mortgages, to which I will return in the next section, contributed significantly to the boom in the real estate market (with a 60% increase in the decade before the crisis) and thus to fuelling the bubble and creating the conditions for the crisis. A study that distinguishes among different regions in the United States highlighted a coincidence that is not so strange: regions characterized by a strong increase of subprime mortgages, i.e. to people who did not have a high credit rating, also experienced a high rate of securitized mortgages and a sharp rise in property prices in the early 2000s; after 2007, those same regions were characterized by a significant increase in mortgage defaults and a marked decline in property prices.[12]

It seems that in the 2000s, the value of the properties negatively correlated with the income of the population - while in the previous century

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[10] Alan Greenspan (2009), «The Fed did not Cause the Housing Bubble», *Wall Street Journal*, 11 March; Alan Greenspan (2010), *The Crisis*, Brookings Papers on Economic Activity.

[11] Ben Bernanke (2010), *Monetary Policy and the Housing Bubble,* Speech at the American Economic Association Meeting.

[12] Amir Mian and Atif Sufi (2009), «The Consequences of Mortgage Credit Expansion. Evidence from The U.S. Mortgage Default Crisis», *The Quarterly Journal of Economics*, 124: 1449-1496.

the correlation was positive - and positively correlated with the share of securitized mortgages. Moreover, in the regions of the U.S. with a low increase in income and a high share of securitized mortgages, we observed other phenomena: a significant decrease in the rate of rejection by banks in granting mortgages, an increase of the borrower's debt-to-income ratio, and a reduction in the spread between the rate for subprime mortgages and that for prime mortgages. These phenomena suggest that the conditions for originating mortgages were "softened" to favour families contracting a mortgage. This was facilitated by the securitization of mortgages. The bill for this "drugged" market arrived all at once in 2007, with a very high proportion of mortgage defaults.

This picture shows us how the boom in the real estate market and the subsequent crisis are closely linked to two phenomena: the increase in subprime mortgages, and their securitization. The phenomena were mutually reinforcing: thanks to securitization, an increase in mortgages (in particular subprime mortgages) led to an increase in the demand for houses, which translated into an increase in their value. Such a price increase in turn led people to refinance the mortgage and/or to borrow even more as the property provided as collateral had a higher value.[13]

In order to better understand the phenomenon, I start by tracing an outline of the "subprime mortgages phenomenon".

Subprime mortgages (and Alt-A mortgages that have less extreme characteristics) were mortgages granted to people that did not meet the credit standards usually adopted by banks (prime or jumbo mortgages): low credit rating, and therefore high probability of default (the median FICO credit scoring indicator was less than 620), late payments in the last two years, bankruptcy in the last five years, mortgage/earnings ratio above 50%, and high loan to value of the property, that could even exceed 90%. There are many anecdotes about the fact that the banks pushed to provide credit to so-called NINJA (no income, no job and no assets), or to people who were not able to provide material evidence of their income: about 1/3 of subprime mortgages, and an even higher percentage in the case of Alt-A loans, were missing part of the proper documentation.

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[13] Amir Mian and Atif Sufi (2009), «The Consequences of Mortgage Credit Expansion. Evidence from the U.S. Mortgage Default Crisis», *The Quarterly Journal of Economics*, 124: 1449-1496; Giovanni Favara and Jean Imbs (2014), «Credit Supply and the Prices of Housing», *The American Economic Review*, 105: 985-992.

The subprime and Alt-A mortgage segment became significant in the 2000s: subprime and Alt-A mortgages granted in 2000 accounted for only 12% of the total ($125 bn, 6% subprime), by 2006 the share had risen to 34% ($1,000 bn, 20% subprime). The growth was impressive: in the 2000s (before the crisis), as the total amount of good quality mortgages (prime and jumbo) doubled, subprime mortgages rose by 800%. In terms of stock, subprime mortgages in 2006 represented 15% of total mortgages (28% including Alt-A) which amounted to $10 trillion (70% of U.S. GDP). Note that the debt market in the U.S. as a whole amounted to $18 trillion.[14]

The subprime and Alt-A mortgages were obviously riskier than the prime and jumbo mortgages. One figure represents the point well: the delinquency rate on subprime mortgages (a delay of more than ninety days in payments or foreclosure) was above 10% for all of the 2000s, and in 2007, it reached the level of 17%. The same figure for prime mortgages has never moved from 3%. Similar differences can be seen for foreclosures. 50% of the subprime mortgages originated in 2007 went into default within five years. The delinquency rate was high in the case of mortgages with a high loan to value, mortgages with incomplete documentation, and those with low credit quality.[15]

The subprime mortgage contracts were different from prime mortgages that were offered to households whose characteristics were more reassuring. Considering a thirty-year contract, 2/28 subprime mortgages (a contract quite common for subprime mortgages) typically had these features.[16]

- Unlike prime contracts, which were mostly fixed rate (FRM), the 2/28 subprime mortgages were hybrid with a relatively low fixed rate (teaser rate) for the first two years and a variable rate (ARM) over the next twenty-eight years with a very high rate spread over the benchmark rate (e.g. the LIBOR rate). The rate of a mortgage taken out in 2006 could go from 8% to 11% after two years.
- The fees to repay the mortgage before its natural maturity (prepayment) were very high, and were present in about 75% of the

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[14] International Monetary Fund (2008), *Global Financial Stability Report*.

[15] United States Government Accountability Office (2010), *Nonprime Mortgages. Analysis of Loan Performance, Factors Associated with Defaults, and Data Sources*.

[16] Gary Gorton (2010), *Slapped by the Invisible Hand*, Oxford University Press.

> subprime mortgages, while prime mortgages typically did not foresee any fees of this type. The penalty lasted at least until the date on which the mortgage shifted to a variable rate.

Contracts of this type (fixed rate for the first years and then a variable rate in the following years) represented 70% of the subprime mortgages issued between 2000 and 2007. For example, in 2006, 53% of subprime mortgages were designed as indicated above, while the share of prime mortgages was 14%.[17]

These contracts turned out to be a hellish trap. A 2/28 mortgage often forced the borrower to refinance the loan after two years, as he could not afford the mortgage instalments with a variable rate. The new conditions could entail an increase of the instalments by as much as 30-50%. The gap grew significantly after interest rates increased in mid-2004. If, in the meantime, the value of property had grown, then the refinancing could take place at more favourable conditions than the original ones, and therefore the borrower could obtain a prime instead of a subprime mortgage. In this case, the value of the collateral had increased and therefore the loan to value had decreased and the deal had become less risky for the bank. On the other hand, if the value of the property had decreased, in many cases default on the mortgage was the only outcome. Not surprisingly, at the end of 2009, these hybrid mortgages also had a far greater percentage of delinquency (48%) than fixed-rate mortgages (21%).

Only under these conditions could it be worthwhile for banks to grant a loan to people who offered limited guarantees of honouring their commitment. It was a risky business for the banks. In order to make it appealing, two measures were necessary: to make the early renegotiation of the loan by the borrower (prepayment) very expensive; and to enter into short-term contracts. The first goal was achieved by introducing high fees for early prepayment of the mortgage (before the switch to the floating rate), so that the borrower could not take advantage of a possible drop in interest rates or an increase in the value of the properties in order to reduce the exposure (extracting equity) or increase it; the presence of high early prepayment fees obliged the borrower to "passively" suffer any increase in the value of the property that was the collateral for the mortgage. The second

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[17] Geetesh Bhardwaj and Rajdeep Sengupta (2012), «Subprime Mortgage Design», *Journal of Banking and Finance*, 36: 503-1519.

goal was achieved by entering into contracts that provided for a change to the floating rate and a possible renegotiation within one or two years. This way the mortgage was a short-term contract because it would be reconsidered in two years with the bank having all the cards in its hand, because it was not easy for the household to afford the new instalment. This is how the banks limited the risk of the contract.

Therefore, subprime mortgages were short-term risky loan contracts. In fact, if the value of real estate grew, then the borrower would re-contract the mortgage every two/three years trying to exploit the improvement of the conditions that the bank offered him. If the value of real estate decreased, then in many cases the default was a judgement call. The borrower was thus attracted into a succession of refinancing/new mortgages. Not surprisingly, 60% of mortgage contracts in the 2000s were nothing more than refinancing of existing mortgages.

It should be noted that the increase in home prices only partially resulted in greater solidity of the borrower, and therefore in more favourable conditions for him: in the 2000s, around 50% of subprime refincancings involved some equity extraction and 30% of the increase in home prices translated into new debt for American families. Households used the property as a sort of "piggy bank": as the value of the house increased, they obtained more credit to finance their consumption habits.[18]

Financial engineering placed no constraints on offering mortgage contracts that could attract people eager to buy a home or in need of a loan to support their consumption. Under some contracts, in the early years the borrower only repaid the interest on the principal (or even just a part of it) while the repayment of the principal was put off to subsequent years. This type of contract came to represent over 30% of subprime and Alt-A mortgages at the outbreak of the crisis. In other cases, the mortgage could last thirty years but the amortization plan actually lasted much longer, with the repayment of the residual value of the mortgage at the end of the thirty years. Subprime mortgages also had much higher fees than prime mortgages at the time of signing.

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[18] Atif Mian and Amir Sufi (2011), «House Prices, Home Equity-Based Borrowing, and the U.S. Household Leverage Crisis», *The American Economic Review*, 101: 2132-2156.

2. And securitizations…

Mortgages were only the first step in the financial debt industry. The second was represented by securitization.

The banks kept only a part of the mortgages on their books. Most of them were securitized. Mortgage securitization consists of two distinct operations: pooling and tranching. The mortgages, and thus the cash flow linked to them, are passed to an off-balance sheet company (special investment vehicle, SIV) that is perfectly isolated with respect to the bank that originated them. In particular, the company is not affected by the default of the bank. Each securitization transaction involves thousands of mortgages. The pooling of a large number of positions makes it possible to exploit the diversification principle which I will discuss in Chapter 3, and therefore to reduce the risk. The company finances the purchase of mortgages by issuing RMBS (Residential Mortgage Backed Securities) with a different degree of subordination (seniority). The coupons and the principal of the RMBS are paid through the proceeds from mortgage repayments.

Tranching refers to how mortgage repayments are assigned to the remuneration of the various tranches. If the households do not honour their commitments, then the bonds are impacted in succession according to their seniority. The super senior bonds are impacted last, the junior ones first. Between junior and senior tranches, there are mezzanine tranches. The first tranches to be called into question to absorb losses are called equity tranches. These tranches are typically held by the bank that originated the mortgages. So in doing this, the bank takes the first losses that may occur and to some extent signals its degree of confidence in the transaction. Thanks to the tranching, apart from the default of a very large number of positions, senior tranches are protected from any losses and can therefore be considered almost riskless. The risk is also mitigated due to overcollateralization: the amount of mortgages transferred to the SIV is larger than the amount of RMBS issued by the vehicle.

The tranching system and overcollateralization allowed the SIV to issue low-risk bonds. In a typical securitization, tranches with a AAA rating (with a very low probability of default) represented 80% of the issue, the mezzanine tranche with a AA, A, or BBB+ rating could reach 20%, and the equity tranche could represent between 5 and 10% of the issue. In the early 2000s, the complexity of securitization grew significantly: if in 2001 the average number of tranches per securitization was 8, in 2006 it had reached 23.

The share of securitized mortgages grew over time. At the outbreak of the crisis, only 30% of total mortgages were held by intermediaries that had originated mortgages. RMBS represented the world's largest fixed-income market, with a nominal value of $5,700 bn. In the 2000s, the issuance of RMBS was more than twice that of corporate bonds, and the rate of securitization of housing loans went from 30% in 1995 to 80% in 2006. In 2005 and 2006, subprime mortgage origination peaked at $1.2 bn and 80% were securitized. As of the outbreak of the crisis, RMBS based on subprime and Alt-A mortgages totalled around 25% of all RMBS.

Thanks to securitization, the banks, which had taken considerable risks in granting loans to people who had limited capability to honour their commitments, found a way to get rid of them by transferring the risk to the market.

RMBS did not represent the end of the story. The mezzanine tranches typically provided the raw material for a further securitization step, giving rise to a Collateralized Debt Obligation (CDO). A CDO is a SIV that purchases bonds and issues medium/long-term securities (tranches) for financing its investment. The bonds purchased included RMBS, and in particular the mezzanine tranches of the securitization of subprime mortgages (with a rating lower than AAA). The coupons paid by the asset pool that represented the collateral of the issue (the securities in which the CDO was invested) allowed the redemption of the nominal value, and the payment of the coupons of the securities issued by the CDO. The process could be reiterated with a CDO that invested in other CDOs. In this case we refer to a CDO^2 (CDO square), which mostly invested in mezzanine and junior tranches of CDO.

Unlike securitization, building a CDO or CDO^2 from mortgage securitization does not bring any gains in terms of risk diversification. As I will show in more detail in Chapter 3, the securitization of mortgages plays two important roles. First, it allows banks to transfer to the market a risk that would otherwise be entirely on their books, and therefore, would not be diversifiable. In addition, by investing in RMBS, non-bank operators can take on exposure to property/credit risk, which they could otherwise not easily do. Both these functions play a positive role under the hypothesis that sharing/diversification of risks brings a benefit to the economy as a whole.

These reasons do not justify the structuring of a CDO and a CDO^2, which rest on risks already traded on the market. The main reason for building CDOs was the fact that the mezzanine tranches of the securiti-

zations provided an attractive yield compared to other securities with the same rating. The yield mismatch was due to the fact that the market assigned greater risks to these securities than other securities with the same rating, and to the presence of an illiquidity premium because these tranches were not traded in a significant market; being difficult to trade these securities, their holders demanded an extra return. Illiquidity meant that those companies structuring CDOs became the natural buyers of these securities. These features allowed CDOs (and CDO^2s) to deliver a high coupon compared to other securities, with the same rating. They were thus very attractive to many banks, including some European commercial banks.

These securities were built taking advantage of market imperfections, which saw securities with the same rating deliver different coupons. In technical terms we refer to arbitrage opportunity (rating arbitrage).

The degree of complexity going from a CDO to a CDO^2 was significant. If we consider a CDO^2 with the characteristics typically observed in the market at the time of the outbreak of the crisis, we see that it contained 150 bonds, and each bond involved a 150-page contract. Therefore, the evaluation of the risk/definition of the price of these securities made it necessary to read about 22,500 pages.[19]

Even in the case of CDOs, the size of the market was significant. In the two-year period 2006/2007, over $500 bn in CDOs were issued per year, of which over $100 bn referred to mezzanine tranches of RMBS based on subprime mortgages. The amount of CDOs issued tripled from 2004 to 2006. According to some estimates, CDO issues that referred to securitization of subprime and Alt-A mortgages accounted for 80% of total CDO issues that involved RMBS.[20] At some point, the raw material (RMBS) became too scarce to satisfy the demand for CDOs. To address the market request, synthetic CDOs were built using CDS referring to ABS. In this way, there were no restrictions on the possibility to build credit-linked structured products.

RMBS, CDOs and CDO^2s (Asset-backed Securities, ABS), or "structured securities" as a whole, were assessed by rating agencies. At the time of the outbreak of the crisis, about 60% of structured securities had a AAA rating (37,000 securities with a notional value of about $5,000 bn) compared to

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[19] Andrew Haldane (2009), *Rethinking the Financial Network, Speech at the Financial Student Association*, Amsterdam.

[20] UBS (2007), *Mortgage and ABS CDO Losses*.

the fact that the companies issuing bonds with a AAA rating were less than 1%. At the same time, and certainly not by chance, the fees that the main rating agencies received for their evaluation of structured securities came to surpass the revenues obtained from the valuation of the bonds issued by the companies: in 2006, ABS represented 44% of revenues for Moody's, while the valuation of bonds issued by companies represented only 32%.

The work of the rating agencies was not impeccable: in 2007-2008, 36,000 structured products assessed by Moody's were downgraded; 2/3 of those downgrades involved products linked to mortgages, 40% concerned CDOs, and 1/3 concerned products with a AAA rating.[21] Approximately 70% of the CDOs that underwent a downgrade had subprime mortgages as their underlying asset. As of 30 June 2009, 90% of CDOs related to subprime mortgages, which had been issued between 2005 and 2007 and originally had a AAA rating, underwent downgrades, 80% of which ended up with a rating below investment grade.[22]

Although it is difficult to estimate, the overall losses related to ABS for the banking, insurance and government agencies in the United States between the second quarter of 2007 and the second quarter of 2009 amounted to approximately $1,000 bn. A similar figure was present for the debt market as whole until 2008: banks (650), insurance companies (200) hedge funds and others (130).[23]

3. Contagion: liquidity evaporates overnight

The quote by Chuck Prince, Citi's CEO of the time, is well-known, "when the music ends, in terms of liquidity, things will be complicated. But as long as there is music, you have to get up and dance. We are still dancing".[24]

The financial crisis showed that markets, which seemed to be very solid, suddenly collapsed. Liquidity, interpreted as the presence in the market

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[21] Efraim Benmelech and Jennifer Dlugosz (2010), «The Credit Rating Crisis», *NBER Macroeconomics Annual*, 24: 161-208.

[22] Lawrence White (2010), «Markets: the Credit Rating Agencies», *Journal of Economic Perspectives*, 24: 211-226.

[23] International Monetary Fund (2008), *Global Financial Stability Report*.

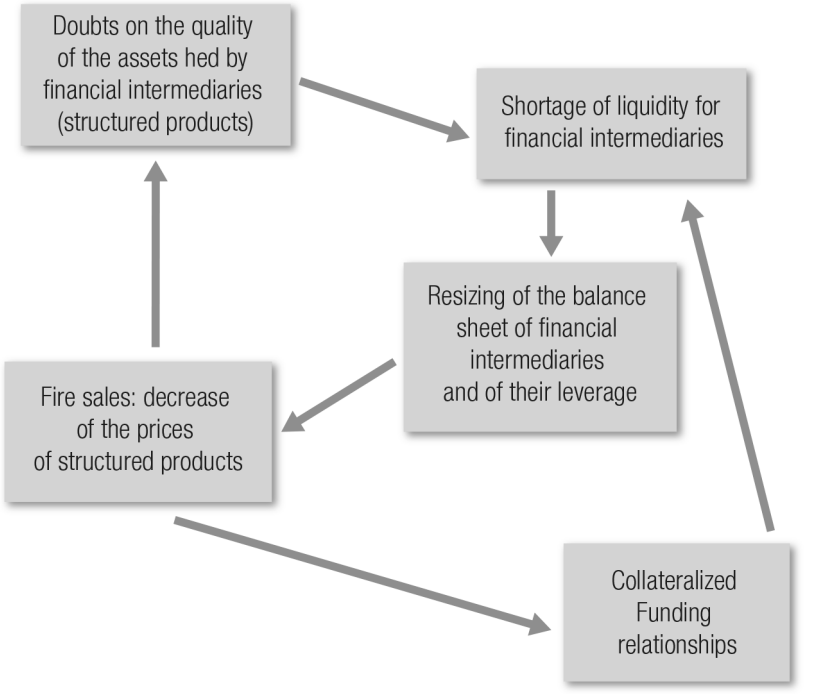
[24] Michiyo Nakamoto and David Wighton (2007), «Citigroup Chief Stays Bullish on Buyouts», *Financial Times*, 7 July.

of players ready to buy an asset or to provide liquidity to an intermediary, disappeared overnight. According to Greenspan "the evaporation of the global supply of short-term credits within hours or days of the Lehman failure is, I believe, without historical precedent".[25]

Financial markets collapsed for two reasons that reinforced each other: the high leverage of some investment and retail banks, associated with short-term/market funding rather than with households through deposits, and the dubious quality of structured products held by financial intermediaries.

The engine of the crisis can be represented by a spiral described through the block diagram represented in Diagram 1. The lack of confidence in the quality of assets kept many market players from providing liquidity to

Diagram 1 Spiral of Debt



[25] Alan Greenspan (2010), *The Crisis*, Brookings Papers on Economic Activity.

financial intermediaries. In the absence of liquidity, the most exposed intermediaries in terms of leverage with funding on the market rather than through retail deposits, were forced to sell off their assets at rapidly deteriorating market conditions (fire sales). The decrease in the price of assets strengthened doubts about the quality of the securities and the soundness of banks. This spiral led to a succession of banking crises.

The crisis marked a turning point in the political debate over the management of a crisis involving large banks. In fact, before the crisis, there were basically two options on the table: rescue by another bank, or nationalization (bailout). During the financial crisis, two other options were explored: bail-in, and default. In both cases, bank shareholders and bondholders suffer financial losses. The default of large banks in the U.S. strengthened the negative spiral leading to contagion on the market.

The absolute protagonist of the crisis was credit (and counterparty) risk with the possible default of a market player. To understand what happened, it is useful to trace the development of the crisis in the United States.

Let us start with the collapse of the asset-backed commercial paper market (ABCP, August-December 2007). At the time of the outbreak of the crisis, some U.S. banks had a very high level of leverage (debt+capital divided by capital) and/or held RMBS (subprime and not) and CDOs through SIVs. These vehicles invested in medium/long-term securities financing their position on the market by issuing short/medium-term securities, including commercial papers collateralized by ABS (ABCPs) with an average maturity of ninety days. The underlying assets of these securities were represented by securities held in their portfolio, including AAA tranches of CDOs linked to subprime mortgages. Exposure to these securities was quite considerable: according to some estimates, these vehicles ended up holding 18% of RMBS linked to subprime mortgages, and about half of the ABCPs had subprime mortgages as underlying assets[26]. These vehicles were provided with a more or less explicit credit line from the sponsoring bank that guaranteed the ABCP repayment at par; if the vehicle did not honour its commitments, then the bank would take over. This guarantee allowed SIVs to enjoy a high rating for their bonds as the risk was very limited.

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[26] Gary Gorton (2010), *Slapped by the Invisible Hand*, Oxford University Press.

The SIV proposed the classic model of credit intermediation characterized by a mismatch of maturities between assets and liabilities and the sponsor bank as a guarantee. The differences were that the assets consisted mainly of investments in ABS and that the liabilities were mostly represented by bonds (ABCPs) or collateralized funding (REPOs); the bank's guarantee on issued bonds replaced the public deposit guarantee in order to prevent a "run".

The ABCP market grew significantly in parallel with the boom of the real estate and securitization markets: in 2004, the market size was $650 bn, and in July 2007 it reached $1.3 trillion.

The balance sheet of these vehicles provoked strong distrust towards them during the crisis, causing a collapse of the ABCP market. The distrust concerned both the quality of the structured securities held in the portfolio, and the guarantee by the sponsor bank that did not appear to be carved in stone. The crash was notable: in ten days in August 2007, the market decreased by $200 bn, and by the end of December by over $400 bn. By the end of 2010, the ABCP market had dropped to one-third of the peak reached at the outbreak of the crisis.

The turning point in this crisis is an episode that in retrospect may seem of little significance, but which changed the course of the crisis: the decision on 9 August 2007 by BNP Paribas to freeze the outflows of its investment funds since it was impossible to evaluate the ABS linked to subprime mortgages held in the portfolio. This decision led to the collapse of the market, as the overnight ABCP spread went from 10 basis points to 150 points in a single day.

The SIV underwent what is called a "bank run" on the ABCP market. The run was unconventional because the protagonists were not depositors, as in the case of a bank, but institutional investors who refused to buy ABCP. By the end of December 2007, 40% of the plans to issue new ABCP were blocked because it was impossible to find subscribers, and thus to proceed with the issue of the securities.[27] At the same time, precisely because of the distrust among investors, ABCP maturity decreased drastically: after August 2007, the ratio between issues of ABCP with a

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[27] Daniel Covitz, Nellie Liang and Gustavo Suarez (2009), «The Evolution of a Financial Crisis: Panic in the Asset-Backed Commercial Paper Market», *The Journal of Finance*, 68: 815-848.

maturity less than twenty days and issues of ABCP with longer maturity doubled (from 2 to 4).[28]

Commercial papers became risky from the outset of the crisis because of the emergence of counterparty risk, i.e. the risk that the counterparty of a financial transaction (loan or derivative contract) would be unable to meet its commitments. This risk is well described by the spread between the three-month LIBOR rate and the three-month Overnight Index Swap (OIS) rate. The three-month LIBOR rate represents the rate at which banks exchange money with a three-month maturity; the three-month OIS rate is an indicator of what the market expects the average overnight rate to be over the next three months. The three-month LIBOR rate incorporates the risk that the counterparty to whom I provide liquidity may be unable to deliver it within three months (counterparty risk), while the OIS rate is not affected by counterparty risk as it is the rate I expect to obtain by providing liquidity day by day (overnight) over the next three months. The overnight loan is in fact almost immune to default by the counterparty, and therefore the OIS rate is not affected by counterparty risk and is a good proxy for the expected interest rate. Therefore, the difference between the two rates measures what is not provided by the expectations on future interest rates, a difference that represents the premium for the risk of default by the counterparty over a three-month horizon.

The crisis revealed a counterparty risk premium that was not previously priced by the market regarding liquidity exchanges among financial intermediaries: in August 2007, the spread between the two rates jumped from 10 basis points to 100 basis points. Since then, that change has become structural. In August 2007, American Home Mortgage Investment Corp declared bankruptcy.

In order to depict the financial crisis, it is worthwhile to refer to two particularly important cases: Bear Stearns and American International Group (AIG), see Box 1 and 2, repsectively.[29]

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[28] Gary Gorton, Andrew Metrick and Lei Xie (2014), «The Flight from Maturity», *NBER working paper* nr.2027.

[29] William Ryback (2009), *Case Study on Bear Stearns*, working paper; Bryan Burrough (2008), «Bringing Down Bear Stearns», *Vanity Fair*, June; Roddy Boyd (2008), «The Last Days of Bear Stearns», *Fortune*, March; William Sjostrom (2009), «The AIG Bailout», *Washington and Lee Law Review*, 66: 943-991; Catherine Donnelly and Paul Embrechts (2010), *The Devil is the Tails: Actuarial Mathematics and*

Box 1 Bear Stearns

In 2007, Bear Stearns was the seventh-largest U.S. investment bank, with a leverage of 36. The bank held on its books derivatives for a notional value of $13,000 bn, and assets of almost $400 bn, of which $28 bn were level III assets (assets that are not traded in a market and therefore are evaluated through a model). About $200 bn of the securities held by the bank were linked to subprime mortgages. That level of exposure compared to capital of $11 bn. The position was much more unbalanced than that of Lehman Brothers, which held $85 bn in securities linked to subprime loans, four times its capital, with a leverage of 31. The bank was therefore heavily exposed to illiquid securities and in particular to ABS related to subprime mortgages.

The crisis in the real estate market hit the bank, forcing it to inject $3.2 bn in June 2007 into its hedge fund that was exposed to securities linked to subprime mortgages. The bank tried in vain to get liquidity from Merrill Lynch and JPMorgan for another fund. In July, both funds defaulted due to the worsening of the crisis on the ABS market linked to subprime mortgages. During the following months, there were many rumors about the fact that the bank was in serious difficulty. At the beginning of March 2008, the bank's liquidity provision was $18 bn, while in the course of a few days during the week of March 10, a series of intermediaries withdrew liquidity in various forms:

- March 6: a European bank did not renew a $0.5 bn credit line and threatened to do the same for another $2 bn;
- March 11: it was a Dutch bank's turn not to renew a credit line. Some hedge funds, which provided liquidity to the bank, or were counterparties in derivative contracts, interrupted their relationships. Bear Stearns witnessed an avalanche of novation requests (transfers of derivatives positions from one counterparty to another) for derivative contracts from counterparties at Deutsche Bank, Credit Suisse and Goldman Sachs. These banks began to put in place enhanced authorization processes for these deals in order to control credit risk. The news became public. Late in the day a hedge fund asked Goldman Sachs to be a counterparty in a transaction that would have required an increase in its exposure to Bear Stearns, and Goldman only accepted the transaction the next day. The delay (leaked to the media) was incorrectly interpreted as a refusal, contributing to increasing tensions;
- March 12: counterparties in the REPO market (repurchase agreements in which Bear Stearns receives liquidity for a fixed period of time providing assets as collateral) started to withdraw. Liquidity reserves reached $15 bn;
- March 13: a hedge fund withdrew $5 bn in one day. In the afternoon, the bank realized that the next day it would not be able to renew $30 bn of REPO contracts, creating a shortfall of $15 bn. In a single week the bank had squandered all its liquidity;
- March 16: JPMorgan bought the bank for $2 (then increased to $10) per share with $30 bn of liquidity support from the Federal Reserve Bank of New York. In March 2007, the stock was valued $150.

Box 2 AIG

AIG suffered significant losses from the securities lending business and CDS business. In 2008, AIG lost approximately $21 bn from securities lending in which AIG loaned out assets and invested the proceeds in risky assets (including ABS backed by subprime mortgages). According to AIG's financial statements, in 2007 its financial arm sold credit default swaps (CDS) for a notional amount of €527 bn. By selling a CDS contract written on a company, AIG agreed to reimburse a fixed amount of money to the counterparty who underwrote the CDS in the event that the company defaulted. To secure this contingent reimbursement, the counterparty agreed to pay a fee to AIG. AIG had sold CDSs written on corporate loans and on prime residential mortgages ($379 bn notional), CDS written on corporate debt/collateralized loans obbligations ($70 bn), and CDSs written on multisector CDOs ($78 bn notional); about 50% of these securities (a notional amount of $40 bn) were linked to subprime mortgages. At the time the CDS was signed all the underlying securities had AAA ratings. A large part of these contracts were bought by banks (including European ones) which, through a CDS, insured against the risk associated with subprime mortgages, a hedge that made it possible to make the capital requirements on the ABS held in their balance sheets less stringent.

CDS are traded outside regulated markets (over the counter, OTC). According to the Credit Support Annex, that regulates OTC transactions, a trade requires a form of collateralization, that is to say, the company that sells the contract undertakes to post on a bilateral account with the counterparty an amount of funds equal to the market value (fair value) of the contract. Collateralization requires the seller to transfer money to the counterparty who signs the contract not only in the case of a "bankruptcy" of the underlying security (credit payment) but also in the event that the underlying security (RMBS or CDO) suffers a loss in the notional amount of the underlying assets (floating payment). As a result, as the subprime mortgage crisis worsened, the amount of liquidity posted by AIG as a CDS seller increased. Technically, we refer to this as a ''margin call''. In order to meet the liquidity requirements linked to the fair value of CDSs written on CDOs related to subprime mortgages, AIG suffered a huge drainage of liquidity: $3 bn posted as collateral on 31 December 2007, $7.5 bn in March 2008, $13 bn in June 2008, and $32 bn in September 2008. In addition to this, in September counterparties interrupted securities lending activities with AIG, causing a drainage of an additional $24 bn of liquidity. The company was not able to face the liquidity shortage since a significant portion of its assets were linked to subprime mortgages.

The company suffered what is called a ''margin run'' that brought it to the brink of bankruptcy, requiring a rescue by the Federal Reserve Bank of New York through a liquidity injection of $85 bn (September 16), then extended to $180 bn. The company was brought to its knees by the collateral request for derivatives transactions and securities lending. On the day of its rescue, AIG was short of $11 bn with CDS counterparties; this is considered one of the key reasons for the decision to rescue AIG. The total losses of the company in 2008 amounted to $100 bn. One year later, the overall estimate of the losses rose to $145 bn.

The first bank collapsed due to the disappearance of liquidity on the REPO and interbank market, and the decision of many institutional clients not to use the bank for its prime brokerage business (trade execution, settlement, record keeping, financing). AIG collapsed because of its securities lending activity and margin provisions on the OTC derivatives markets. In February 2008, AIG, the largest insurance company in the world, announced over six billion dollars in profits for 2007, and its share price was worth 50 dollars. Seven months later the company was bankrupt.

The approach of the U.S. government to assisting financial intermediaries during the crisis was not linear. Bear Stearns was rescued with the help of a white knight (JPMorgan) in March 2008; the two agencies Fannie Mae and Freddie Mac were nationalized in September 2008; on 15 September, Lehman Brothers was left to fail when the Fed and the U.S. government decided not to support the rescue plan by Barclays (the bank was short $4.5 bn faced with daily REPO funding of $200 bn); and on 16 September, on the other hand, AIG was saved with a massive injection of liquidity. These are the most famous cases but they are not the only ones. On 25 September, it was Washington Mutual's turn (the sixth largest bank in the country) to be rescued by the FDIC and then have its banking business sold to JPMorgan for $2 bn, while the remaining part was declared bankrupt. A similar fate awaited Wachovia (the seventh largest bank in the country); on 29 September, the bank would be bought by Wells Fargo.

If until the rescue of Bear Stearns, Fed Chairman Ben Bernanke assessed that the problems in the subprime mortgage market were under control[30], the contagion/panic induced by the Lehman default and the rescue of AIG led the authorities to act decisively on three fronts: monetary policy, use of public resources, and supervisory activities. In Chapter 6, I will try to provide an assessment of the effectiveness of the measures taken by the supervisory authorities and of monetary policy; here I limit myself to listing the main measures.

In the diagram on the debt spiral we can identify the two root causes that fuelled the contagion: lack of confidence in counterparties (coun-

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the Subprime Mortgage Crisis, working paper; Robert McDonald and Anna Paulson (2015), «AIG in Hindisight», *Journal of Economic Perspectives*, 29: 81-106; René Stulz (2010), «Credit Default Swaps and the Credit Crisis», *Journal of Economic Perspectives*, 24: 73-92.

[30] Ben Bernanke (2008), *The Economic Outlook, Before the Joint Economic Committee*, U.S. Congress.

terparty risk), and lack of liquidity. As shown by the LIBOR-OIS spread, in the summer of 2007 counterparty risk showed up in the interbank market.[31] These two interpretative keys can explain why the intervention by the authorities was not always linear. The authorities had to help the market understand what the bad apples were (counterparty risk), and at the same time provide liquidity to the market to prevent collapse.

The crisis in the ABCP market in 2007 did not affect only the United States; the international interbank market suffered a heavy backlash as well. For the first time in history, on 12 December, 2007, the central banks of the United States, the Eurozone, Great Britain, Switzerland and Canada sponsored a joint intervention to provide liquidity on the interbank market. In December 2007, the Fed launched the Term Auction Facility (TAF) program to provide liquidity to dealers.

On 19 September 2008, the U.S. government launched the Troubled Asset Relief Program (TARP) with the aim of buying illiquid ABS having mortgages as their underlying assets from financial institutions in the secondary market for $700 bn. The effect was disruptive because the program made the gravity of the situation explicit to the market, and because it was difficult to implement the program. If the default of Lehman Brothers resulted in an increase in the LIBOR-OIS spread of 18 basis points, the TARP announcement had an effect of 60 basis points. In September, the Fed introduced swap lines with the main central banks to absorb any liquidity problems.

On 24 October, the TARP was redefined, allowing funds to be used to recapitalize banks in trouble buying preferred stocks (Capital Purchase Program). In November (although the program became fully operative in March 2009) the Fed launched a three/five-year liquidity assistance program (term asset-backed securities loan facility, TALF) to purchase ABS having mortgages as their underlying ($200 bn). In the same period, the Fed extended the liquidity assistance to operators who bought ABCP from money market funds, thus helping the latter to satisfy the outflows that followed the Lehman bankruptcy ($150 bn). The Treasury provided a guar-

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[31] John Taylor and John Williams (2009), «A Black Swan in the Money Market», *The American Economic Journal: Macroeconomics*, 1: 58-83; Paolo Angelini, Andrea Nobili and Maria Cristina Picillo (2009), «The Interbank Market After August 2007: What Has Changed and Why?», Banca d'Italia, *Temi di discussione* nr. 731.

antee on deposits of money market funds which held a huge amount of Lehman bonds and experienced significant redemptions in September 2008.[32] The FDIC provided a guarantee on the issue of bonds by banks. In February 2009, TARP evolved into the Public-Private Investment Program (PPIP), which expanded its capacity to $1 trillion. Through a number of interventions, in autumn 2008, the U.S. government committed 50% of GDP to rescuing the financial system, mostly guaranteeing the liabilities of banks.

Starting in December 2008, the Fed launched a program to purchase mortgage-backed securities for a value of $1,450 bn (Quantitative Easing I) and subsequently a program to purchase $300 bn of government bonds (Quantitative Easing II). These operations led to an expansion of the Fed balance sheet, which peaked in June 2010 with $2,100 bn invested in ABS, government bonds and bank bonds.

In December 2008 and March 2009, the Fed explicitly stated that interest rates would remain close to zero for a long time.[33] In February 2009, the Fed published the results of the first stress tests of American banks.

4. Summing up

- Debt growth helped U.S. households cope with loss of purchasing power.
- Subprime mortgage contracts were very risky; their economic rationale for banks was sound only in a situation of a booming real estate market.
- The securitization of subprime mortgages favoured the expansion of leverage since the banks were only intermediaries between the borrower and the market that bought the structured securities. Therefore the market, rather than the banks, came to be exposed to mortgage contracts.
- Rating agencies systematically overestimated the creditworthiness of structured securities.

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[32] Lawrence Schmidt, Allan Timmermann, and Russ Wermers (2016), «Runs on Money Market Mutual Funds», *The American Economic Review*, 106: 2625-2657.

[33] Brett Fawley and Christopher Neely (2013), *Four Stories of Quantitive Easing*, Federal Reserve Bank of St. Louis, working paper: 51-88.

- The banking crisis resulted mainly from three factors: the large size of bank balance sheets compared to capital (high level of leverage), exposure of banks to dubious quality assets, and short-term funding by banks on the market rather than from retail savers.
- Once structured securities appeared to be of dubious quality, the market no longer gave liquidity to banks, not trusting their balance sheets and creating the conditions for their liquidity crisis, which was amplified by the high degree of leverage.
- U.S. authorities acted in three directions: monetary policy, use of public resources, and supervisory activities.
- Credit and counterparty risk are the absolute protagonists of the subprime mortgage crisis: the risk that the borrower will not repay the loan, the risk of default of ABS, and the risk of default of the banks and of the SIVs.
- In the midst of the crisis it was difficult to distinguish, and therefore to combat with policy actions, the risk of insolvency and the lack of liquidity on the market.