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„Is it possible that an LLR contributes to the overcoming of a crisis?”

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At this point, I would like to thank Professor Borrmann for his support and fast reply to my questions.

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ABS	asset-backed securities
AG	Aktiengesellschaft
BAWAG P.S.K.	Bank für Arbeit und Wirtschaft und Österreichische Postsparkasse AG
CDO	collateralized debt obligation
EBA	European Banking Authority
EU	European Union
FIMBAG	Finanzmarktbeteiligung Aktiengesellschaft des Bundes
FinStaG	Finanzmarktstabilitätsgesetz
GSA	Geldservice Austria
IAS	International Accounting Standards
IFRS	International Financial Reporting Standards
ILLR	international lender of last resort
IMF	International Monetary Fund
LLR	lender of last resort
NINJA	no income, no job and assets
OeBFA	Österreichische Bundesfinanzierungsagentur
OeBS	Oesterreichische Banknoten- und Sicherheitsdruck GmbH
ÖIAG	Österreichische Industrieholding AG
OeNB	Oesterreichische Nationalbank
OMO	open market operations
RZB	Raiffeisen Zentralbank Österreich AG
SIV	structured investment vehicle
VB	Volksbank

1 Introduction

Uncertainty and mistrust are the keywords of the latest economic crisis.

In 2007, the first effects of a long-lasting false financial policy became noticeable due to the insolvency of two hedge funds of Bear Stearns. However, at that time the real collapse was still imminent. It was the bankruptcy of Lehman Brothers in September 2008, which involved several countries as well as banks around the world in trouble [102].

From now on, the Austrian financial sector has been dominated by uncertainty. It was unsecure whether Austrian banks were hit by the crisis starting from America, how many banks were hit and to which extent. Furthermore, depositors started to worry about the safety of their deposits. However, the upcoming uncertainty concerning the above-mentioned circumstances was not the only problem. It was also difficult to choose the right answer to the worsened situation of the Austrian financial sector, which indeed depicted a problem.

In former times, banks got into financial difficulties as well. There is much literature concerning the proper response to such a case. An institution which grants an illiquid bank a loan is referred to as a “lender of last resort”. The beginnings of this term date back to the eighteenth century. Until now, several papers and research works dealing with this topic have been published. One reason for sure is the importance and topicality, which has always accompanied this issue.

The Austrian government issued two laws in order to combat the financial crisis. On the one hand, the “Interbankmarktstärkungsgesetz” allowed the foundation of “Österreichische Clearingbank AG”. Its main task was borrowing money from banks on its own behalf and lending this money to other banks.

On the other hand, the “Finanzmarktstabilitätsgesetz” enabled the foundation of the “FIMBAG (Finanzmarktbeteiligung Aktiengesellschaft des Bundes)”, which was the trustee of the government. The FIMBAG’s main task was granting troubled banks a loan, which was carried out by the supply of so-called Partizipationskapital.

This master thesis consists of three parts. The first part provides a summary of the concepts published by those economists who covered the topic first of all. Next, the most important questions are dealt with. It is examined which institution usually serves as an LLR and whether there is a need for one at all. The different possibilities how an LLR is able to accommodate troubled banks with money as well as the conditions which have to be fulfilled by these banks are shown. It is considered if there are monetary systems which demand different tasks from an LLR, or systems which do not require an LLR at all. A huge difficulty in connection with the LLR function is the moral hazard problem. It occurs as the LLR compensates for a loss, which the managers of the bank have caused. Finally, the adequacy of an international LLR is analyzed.

The second part of the thesis presents the model of the economist Rafael Repullo. Initially, the diverse variables are set and the model's framework, like the fact that three dates are considered, is explained. Next, three different situations are analyzed. First, it is assumed that there exists an LLR, which does not charge a penalty rate. Second, there is no LLR and the bank has to overcome a liquidity shortage by itself. Third, it is supposed that an LLR exists, but it charges a penalty rate in return for its lending.

Repullo examines the value of the most important variables in all three cases. Thereby, he answers crucial questions. Is there a situation which encourages a bank to invest riskier than in another situation? Does the bank's composition of assets depend on the existence of an LLR? How about its liabilities?

Finally, Repullo's model provides a result, which contradicts the statement of many economists.

The third part deals with the economic crisis and the aforementioned responses of the Austrian government to it.

Five Austrian banks needed support in the form of money. However, this support was not granted without any consideration, which is also cited in this chapter. Next, it is

tried to verify some of Repullo's assertions on the basis of the behavior and the characteristics of those Austrian banks which were assisted.

The Austrian government saved each bank suffering from the latest crisis, but this was not always the case. There are banks which have been forsaken in the recent past for example the Trigon Bank AG. It is analyzed why these banks have not been supported in contrast to the banks suffering from the current financial crisis.

Finally, the results of the assistance are investigated. Have the distressed banks recovered? How about the economy as a whole? Do the consequences of supporting the banks predominate? Or was a greater disaster averted?

2 Definition of an LLR

2.1 First literature describing the term “lender of last resort”

Sir Francis Baring is the first author who can be associated with the term “lender of last resort”. He published the book “Observations on the Establishment of the Bank of England” in 1797. Therein, he calls the Bank of England a “dernier resort”, meaning that it provides liquidity in periods of crisis for other banks [19, p. 12].

Shortly after, the economists Henry Thornton and Walter Bagehot developed the first extensive concepts relating to the terminology. Both are Englishmen [26, p. 334] and, like Baring, they refer to the Bank of England as a lender of last resort. It had indeed functioned as such during the 19th century because of many crises at that time [75].

Of course, both are influenced by the economic situation in England at the time of developing their concepts. First, England had a policy of bimetallism, which is defined as a currency system comprising two metals serving as legal tender. In 1816, this period ended and England introduced the “gold standard”. Therefore, gold was the only metal functioning as legal tender [57, pp. 789-791].

The Bank of England was founded in 1694. In its year of foundation, the bank started to issue its own bank notes [89], which were an accepted currency. In 1821, the Bank of England was re-enlisted to swap bank notes into gold at a fixed price, whenever there was demand for it. Another important step was the Bank Charter Act in 1844. According to it, the Bank got the sole power to issue bank notes in England and in Wales. In Scotland, the issue of notes conducted by other banks still existed, but they had to hold “Bank of England notes” as backup. The Bank Charter Act also determined that the Bank of England was not allowed to issue notes without a consequent increase in gold reserves [75] except for the amount of 14 million £ [92]. The uncovered amount increased to 18.4 million £ until 1913. Thereby, the banknotes were partly covered by the gold reserves [10, p. 700]. In 1931, England abandoned the gold standard [24, p. 74].

2.1.1 Summary of Henry Thornton's concept

Henry Thornton's remarks relating to this topic are collected in his book "An Enquiry into the Nature and Effects of the Paper Credit of Great Britain". He was a banker and monetary economist, who published his book in 1802 [26, pp. 334-335]. Henry Thornton deals with the topic extensively, underlines the most important characteristics of a lender of last resort and addresses the moral hazard problem.

Finally, Thornton specifies three distinctive features of a lender of last resort using the example of the Bank of England. According to Thornton, first, the Bank is the owner of the central gold reserve and, as already mentioned, it issues its own bank notes. Due to the circumstance that the Bank of England has the sole power to provide other banks with these "Bank of England notes" and the exclusive control over them, Thornton classifies it as a lender of last resort [25, p. 8].

Second, the Bank of England's task to keep the central gold reserve leads to further responsibilities, which constitute another feature of a lender of last resort according to Thornton. One of these responsibilities is that the Bank has to make sure that enough reserves are available at any moment and without loss of time. Beyond that, it has to protect the resources against too intensive internal or external drains [25, pp. 8-9].

Internal drains occur within a country. The start of a panic may simply be initiated by the rumor that a bank has financial difficulties. Depositors begin to worry about their deposits and a bank run likely takes place. Subsequently, they start to switch their "unsafe" country bank notes into gold or Bank of England notes, which are considered to be safe. Gold and notes issued by the Bank of England are called "high-powered money" [25, pp. 8-9]. In general, high-powered money is defined as the sum of circulating cash and bank reserves, whereas bank reserves consist of vault cash and deposits of commercial banks at the central bank [1, pp. 100, 197].

According to Thornton, the increased demand for this high-powered money leads to an internal drain of the reserves [25, p. 11]. Nevertheless, the demand is not only higher because of depositors who want to switch their country bank notes into high-powered money. It also increases due to the country banks which strive to raise their

reserves of gold and Bank of England notes, since they want to dispel doubts about financial difficulties. Besides, they also need more reserves to overcome the bank run. Thornton suggests that, in order to get over internal drains, the Bank of England should quickly raise the issue of bank notes and the granting of loans. According to him, this is the best solution to calm the public [25, p. 12].

By contrast, external drains do not only happen within the country. Thornton distinguishes between temporary and persistent external drains. He relates a temporary external drain with a trade deficit, which means that the imports of the country outweigh its exports, for example due to a crop failure. As a consequence, the country has to pay more money than it earns by exporting goods. This causes an external drain of the gold reserves as per Thornton. Normally, the Bank keeps enough gold reserves to overcome such a crisis. Nevertheless, if one shock after another takes place (for example three consecutive crop failures), Thornton suggests that the Bank of England should react with an expansionary policy. This means that it should temporarily raise the issue of bank notes. Thereby, the trade deficit will be tackled and the development of a persistent drain is avoided [25, p. 10].

However, increasing the issue of bank notes can also have the opposite effect. Instead of overcoming the temporary external drain, an overissue causes a persistent one. The increased amount of money leads to inflation, which results in higher prices. As a consequence, exports continue sinking, as the prices are no longer competitive. At the same time, imports tend to rise and thus the trade deficit becomes larger. Now, Thornton proposes that the Bank of England should respond to it with a policy of monetary contraction. On the one hand, it could adapt the inflated prices to the prices abroad. On the other hand, the Bank could foster the demand for money, which will increase the selling and diminish the purchasing of the public. Finally, a policy of monetary contraction will boost exports, curb imports and thus, remove the trade deficit as well as the drain of reserves [25, p. 10].

Third, Thornton declares that a lender of last resort differs from other banks because of its duties. A typical bank is only responsible for its customers and its stockholders. In contrast to that, a lender of last resort has also public responsibilities meaning it is responsible for the whole economy. It has to retain the purchasing power and support

the financial system of an economy. This difference becomes mainly visible during a crisis. In times of distress, a typical bank reduces its lending, while a lender of last resort has to increase its note issue and its lending [25, p. 9].

Apart from defining the above-mentioned characteristics of an LLR, Thornton also specifies the main task of it. According to him, the LLR is primarily responsible for the protection of the money supply [25, p. 11]. On the one side, it should ensure that the amount of increase of the money supply is similar to the long-term rate of growth of output. On the other side, it may be necessary to protect the amount of money against short-term declines [25, p. 10].

As stated above, these declines are often induced by a bank run, because it reduces the assets of a country bank as well as its ability to grant loans. Finally, it leads to a drain of gold and Bank of England notes [25, pp. 8-9]. Thornton declares that this drain poses a huger threat to the economy than the credit crisis caused by the bank run. The reason is that the ability to lend originates from money and not vice versa. Without money, loans cannot be allowed and thus, the level of output will decrease. Thereby, the unemployment will rise [25, p. 11]. As aforementioned, Thornton suggests increasing the issue of notes and with it, the lending of money [25, p. 12].

Referring to the third attribute of an LLR, namely the responsibility for the whole economy, he also notes that the LLR should primarily focus on “the general interests” and not on the interests of an individual bank. According to him, this view also solves the moral hazard problem. Money should not be lent to banks which have taken excessive risks, which are characterized by mismanagement [25, pp. 10-11] or do not offer good collateral [22, p. 7]. Thereby, it does not matter how large the bank is. This strategy is in everyone’s interest, because the failure of inefficient banks distributes the resources to efficient ones and hence improves the resource allocation [25, p. 11].

Nevertheless, Thornton suggests that, even if a bank has acted imprudently the LLR should intervene in the event of contagion effects. This means that one bank run leads to other bank runs as well and thus the whole economy is harmed. In such a case, the Bank of England should provide the market with more liquidity [25, p. 11].

2.1.2 Summary of Walter Bagehot's concept

Walter Bagehot also contributed a lot to today's understanding of a lender of last resort. He was the editor of "The Economist" and an economic historian [26, p. 334]. In 1873, he published the book "Lombard Street" and he promoted many views of Thornton. As aforementioned, Bagehot also used the example of the Bank of England and like Thornton, he emphasized the special characteristics of it (for example the fact that it is the owner of the central gold reserve). He also believed that these characteristics would result in the expectation of aid in times of crisis [25, p. 12].

Bagehot differentiates between internal and external drains, too, but his remarks are a little bit diverse compared to those of Thornton. According to him, the best solution to get over an internal drain is to approve loans generously. This opinion is also shared by Thornton. However, in the case of an external drain, he suggests that the best response of the Bank of England is to raise its lending rate. Thereby, foreign gold is more attractive than domestic gold and the reserves of the Bank of England are saved [25, p. 12].

It is important to overcome the external drain, as a persistent one enhances the probability of the occurrence of an internal drain as well. If both drains appear, the Bank of England should link both above-mentioned strategies. From this it follows that it should approve very large loans, provided that it receives a very high rate of interest. Summarized, Bagehot suggests that the Bank of England should "lend freely at a high rate". This statement of Bagehot is famous and often characterized as Bagehot's rule [25, p. 12].

The following assertions of Bagehot are also closely related to those of Thornton. Similarly, Bagehot states that the LLR should mainly focus on the general interests instead of the interests of an individual bank. Thereby, he also underlines that the LLR should concentrate more on macroeconomic matters and less on microeconomic affairs [25, p. 12]. A bank should not be granted a loan if its liquidity shortage arises from mismanagement and recklessness. It is also not the LLR's task to avert the appearance of triggers which cause the failure of unsound banks. This also holds for important and large banks. Bagehot agrees with Thornton that the LLR

should only intervene if the failure of an unsound bank has negative effects on sound banks or on the whole economy. In this case, he also proposes that the LLR should provide the market with more liquidity. Therefore, both do not suggest rescuing an unsound bank. They think that supporting the market is more efficient than saving a failed bank [25, p. 13].

Although Bagehot promoted many views of Thornton, he also developed some new assertions and extended some of Thornton's statements.

First, he states that an LLR should indicate that it will approve loans in periods of crisis. The reason is that this announcement may prevent future crises [25, p. 13].

Second, he notes that the lender of last resort should charge a penalty rate in return for its lending. Bagehot associates four major advantages with this strategy. On the one hand, it ensures that the credits are quickly repaid after the crisis because of the disadvantageous terms of loan. Thereby, the additional issue of bank notes, which was necessary to cope with the crisis, is revoked as well as the short-term increase of inflation. On the other hand, it avoids that overcautious persons or institutions ask for gold at the beginning of the crisis and hence diminish the reserves [25, pp. 13-14]. Furthermore, a penalty rate protects the domestic reserves since foreign capital becomes more attractive. This implies that the export of domestic gold is averted and the import of foreign short-term capital is stimulated. It diminishes the purchasing of the public, which leads to lower prices and thus exports are boosted and imports are curbed. Finally, the balance of trade is enhanced [25, p. 13].

The fourth advantage mentioned by Bagehot is that a penalty rate constitutes a test regarding the soundness of a potential debtor. The reason is that the disadvantageous terms of loan provided by the LLR induce banks to look for other sources of capital before turning to the Bank of England. If it is not possible for these banks to obtain capital elsewhere, this may be a sign of their missing creditworthiness [25, p. 14].

After Bagehot's recommendations that the LLR should announce its willingness to lend and that it should introduce a penalty rate, he advises that the LLR should

accommodate everyone with money, as long as its collateral is good. This advice is also given by Thornton. However, Bagehot extends this statement and assumes that the type of collateral does not matter. The Bank of England should only keep in mind the quality [25, pp. 12-16], but it should also accept a lower quality than without the presence of a crisis [18, p. 27].

2.1.3 Conclusion

In summary, Thornton and Bagehot emphasize that an LLR should primarily focus on the general interests and thus on macroeconomic matters. Both think that the protection of the money supply is more important than saving individual banks. They also agree on the fact that a distressed bank should not be granted a loan, if its liquidity shortage accrues from mismanagement and excessive risk-taking propensity. Thereby, the size of the distressed bank does not matter [25, pp. 13, 16].
Compared to Thornton, Bagehot also developed some new assertions and he covered the topic even more precisely. He suggests that the lender of last resort should announce that it will grant loans in times of crisis. The reason is that this measure removes uncertainty and may prevent future crises [25, p. 13]. Furthermore, he notes that loans should only be approved on condition that the borrower's collateral is of good quality [25, p. 14]. Bagehot promotes the introduction of a penalty rate in return for the LLR's lending [25, p. 13]. The circumstance that Thornton does not suggest charging a penalty rate may be traced back to the fact that an increase of the interest rate above 5 % was forbidden in his days [22, p. 7].

2.2 Statements of other economists

Apart from Henry Thornton and Walter Bagehot, other economists also provided some useful concepts in connection with the topic. Different views were developed and important questions, which had not been posed by Thornton and Bagehot, arose.

2.2.1 Definition of the term “lender of last resort” and the tasks of an LLR

Thornton and Bagehot refer to the Bank of England as an LLR. It is the central bank of the UK [75]. Separate from the two authors, most economists think of a central bank in the context of the question which institution should serve as an LLR.

Goodfriend and King (1988) identify two major tasks, which are passed on the central banks in the United States. The first task is the control of the amount of high-powered money. As mentioned above, high-powered money is defined as the sum of circulating cash and bank reserves. Bank reserves consist of vault cash and deposits of commercial banks at the central bank. The amount of money influences the price level and the production. The importance of this task is also emphasized by Thornton and Bagehot. The second task implies accommodating commercial banks with money, which involves granting a loan in times of crisis or just on demand in an economic stable situation [20, p. 19].

The question arises whether both above-mentioned tasks of a central bank are also LLR actions. Some economists solely define the LLR function as the accommodation of a loan during a crisis in order to meet the increased demand for capital [20, p. 36] or to overcome a bank run [7, p. 18]. This also holds true for Goodhart. According to him, one should only speak about an LLR if an individual bank is assisted with money [20, p. 36]. These emergency interventions are short-term and defensive actions, whereas the central bank’s task of controlling the amount of money is a long-term assignment [33, p. 170]. By contrast, Goodfriend and King do not think, that it is necessary to distinguish between actions in order to control the amount of money and actions in order to raise the money supply due to an increased demand [20, p. 36].

They differentiate between monetary and banking policy. If the central bank carries out monetary policy, it changes the sum of high-powered money, respectively monetary policy is defined as the control of the amount of high-powered money. In contrast, banking policy either alters the structure of the bank’s assets without a change in the balance sheet total or it comprises regulatory actions and monitoring performed by the central bank. Goodfriend and King refer to the second task of the LLR as banking policy as well [20, pp. 3-4, 8].

2.2.2 The reasons which speak for the existence of an LLR

There is a need for an LLR, which can be ascribed to two attributes of the most common monetary systems. First, the central bank is the sole institution which can issue bank notes. Second, banks are allowed to have deposits. Their cash holdings only have to account for a certain percentage, which means that the total amount of deposits of a bank is not readily available. This policy is called fractional reserve banking. Both attributes foster a dependence on the central bank in times of crisis [27, p. 276].

Another approach, which explains the need for an LLR, refers to two problems, which may cause a crisis. One problem is the presence of information asymmetry. As a consequence, depositors do not know the level of risk, which the bank has chosen for its investments. If they feel concerned about the recovery of their deposits, a bank run likely takes place. Thus, the bank has to change its long-term assets into cash in order to satisfy demand and it incurs losses. Furthermore, the interbank market may fail due to information asymmetry and the bank is not able to borrow from other banks. Possible reasons for a failure of the interbank market are listed below. In summary, bank runs and the inability to borrow from other banks may lead to the insolvency of a sound bank [18, pp. 28-31].

The second argument for the existence of an LLR refers to the effects on the market, which the insolvency of a bank implicates. Over time, a relationship between a bank and its debtors emerges. Freixas et al. (2002) call this circumstance “relationship banking”, because the bank learns more and more about borrowers. If the bank fails, the information is lost. Mainly households and small companies suffer from it, as it may be difficult for them to find new lenders in a little while [18, p. 32].

The failure of a bank also exacerbates the situation for other banks, if they have lent money to it. Finally, a run on one bank may trigger a run on another bank as well. This phenomenon is called “contagion” and has already been mentioned by Thornton. Freixas et al. differentiate between “information-based contagion” and “pure panic contagion”. In the case of information-based contagion, depositors withdraw their money whenever they think that their bank has invested in similar assets as the bank which experienced the initial run. By contrast, pure panic

contagion causes bank runs regardless of whether the banks have invested in similar assets or not. Studies showed that information-based contagion is much more likely to appear than contagion effects caused by pure panic [18, pp. 33-35].

2.2.3 The different possibilities of providing capital

As mentioned before, Goodfriend and King (1988) identify two major tasks of a central bank. It has to control the amount of high-powered money and accommodate commercial banks with money on demand [20, p. 19]. They differentiate between monetary and banking policy. Monetary policy leads to a change of the amount of high-powered money, whereas banking policy does not cause a change [20, p. 4].

There are different possibilities how a central bank can provide capital. First, it can grant a loan to individual banks if required, which is called “discount-window lending”. The central bank has two possibilities to raise the credit amount and therefore, we distinguish between unsterilized and sterilized discount-window lending. Unsterilized discount-window lending increases the amount of high-powered money and therefore belongs partly to monetary policy. By contrast, sterilized discount-window lending does not affect the sum of high-powered money. The central bank raises the credit amount by selling an equal amount of securities in the open market. Goodfriend and King allocate it to banking policy [20, p. 11].

Second, the LLR can favor open market operations [20, pp. 5, 11]. This means that liquidity is not provided to an individual bank, but to the interbank market, which will allocate money to banks suffering from a liquidity shortage. The only constraint is that these banks have to be considered as solvent, since in an efficient interbank market insolvent banks will not receive money [18, pp. 30, 35-36]. Thus, if there is an increased demand for money, the central bank just buys securities which are available in the open market and thereby provides money as well as gratifies the higher demand. As a consequence, it avoids that the price level falls. By contrast, if the central bank sells securities, it reduces the amount of money and the price level declines [49, p. 162]. The extent of effects on the price level induced by open market operations is much discussed in the literature. Open market operations belong to monetary policy [20, p. 11].

Goodfriend and King conclude that open market operations should be utilized for the execution of monetary policy meaning the control of the amount of high-powered money. Thus, unsterilized discount-window lending, which also affects the money supply, is not necessary [20, p. 11].

Afterwards, they examine whether sterilized discount-window lending is beneficial. Sterilized discount-window lending is similar to the granting of credit by private lenders. If a bank asks for credit, the central bank should monitor the borrower and charge its price depending on the risk of its loan [20, p. 12].

In case banks ask for emergency lending in times of crisis, the central bank is faced with many problems. Perhaps it has to approve a loan to insolvent banks as well, provided that they are big and the political pressure of saving them is large. Besides, it may be difficult to distinguish between illiquid but solvent and insolvent banks due to incomplete information. As a consequence, private lenders will charge a higher rate than when compared to the case of complete information in order to offset losses incurred because of insolvent banks. Thus, solvent banks will pay a higher and insolvent banks will pay a lower rate in case of incomplete information. However, if the central bank also pursues this strategy, it will mainly attract weak banks [20, p. 14].

The central bank can solve this problem by monitoring banks and figuring out the good ones. However, this leads to monitoring costs. Private lenders also partly supervise their debtors and there is no evidence that the central bank is better than them in carrying out this task [20, p. 14].

All in all, Goodfriend and King find it difficult to recommend using sterilized discount-window lending and thereby banking policy in case a bank applies for a loan in times of crisis or in stable times. They highlight that private lenders may be efficient enough to carry out this task [20, p. 15].

Next, Goodfriend and King examine whether banking policy is necessary in the event of large economic crises. All in all it can be said that, even in this case they argue in favor of open market operations and hence they prefer monetary policy. They only

mention one advantage related to banking policy. Accommodating individual banks with money avoids bankruptcies and saves the costs associated with them. Nevertheless, the benefits of monetary policy outweigh this benefit. On the one hand, open market operations induce no monitoring costs. On the other hand, they do not encourage excessive risk-taking and therefore lead to moral hazard [20, pp. 19-20].

As aforementioned, if the central bank deploys open market operations, the interbank market will allocate money to banks suffering from a liquidity shortage, unless they are not classified as credible. However, this assumption does not always prove true. Sometimes, the interbank market does not function properly and thus the money is not allocated to solvent banks. Freixas et al. (2002) list three reasons for a failure in their paper “Lender of Last Resort: A Review of the Literature” [18, pp. 30, 35-36].

They assume that information asymmetry underlies the three reasons for a failure. First, the market is upset because of incomplete information and banks cannot feel certain about the soundness of an individual bank. A study shows that, if the central bank carries out a test and thereby tries to find out the future performance of a bank, its results will be more correct than the results of market assessments. The only condition is that the test is up-to-date. Otherwise market assessments provide the better information. As a result, the market may misjudge the soundness of a bank and it is necessary that the central bank or the lender of last resort intervenes [18, pp. 30-31].

The second cause of a malfunction is the increased wariness of the interbank market if a crisis occurs. The liquidity shortage may be too large and thus it is not possible for an individual bank to lend money to all illiquid banks. As a consequence, losses harm the lender to a greater extent and it may be more efficient if the central bank accommodates illiquid banks with money. It has more financial resources, is able to grant more illiquid banks a loan and therefore it suffers less from losses due to diversification [18, p. 31].

Third, banks may not lend money to illiquid banks, because they fear that they will not be approved a loan in case they become illiquid. Finally, a self-fulfilling prophecy takes place. Again, this case requires a central bank respectively an LLR which either

accommodates illiquid banks with money or assures potential lenders of obtaining capital in the case of a liquidity shortage [18, p. 31].

2.2.4 The recipients of capital

Bagehot proposes that the central bank should only grant a loan on condition that the borrower's collateral is of high quality, which, in his opinion means that the bank is solvent [25, pp. 12-16]. Goodhart (1999) criticizes this suggestion (other opinions see chapter "The Moral Hazard Problem"). According to him, the quality of the collateral does not give information about the capital value of the bank. In general, the central bank is not able to decide on the basis of short-dated whether a bank is solvent or not. As a consequence, it is not possible to distinguish between illiquidity and insolvency [21, p. 343]. Nevertheless, whenever a bank applies for a loan at the central bank, it is a sign that the bank may not be solvent. Otherwise, it would have obtained liquidity from other banks, which constitute its first contact point. The reason is that, in many countries, the provision of capital by the central bank implies a loss of reputation. In addition, banks do not prefer borrowing from the central bank in case it charges a penalty rate, and thus the market conditions are more favorable [21, pp. 344-345].

Goodhart thinks that Bagehot only insist on a good quality concerning the borrower's collateral, because he wants to diminish the risk of loss for the central bank. In former times, central banks were private institutions, but nowadays they are public ones. Therefore, he declares that these days, it does not matter whether the central bank becomes insolvent or not, because finally the government is responsible for the central bank's liabilities and decides who pays for the deficits [21, pp. 346-348]. In most cases, the taxpayer is the one who bears the burden at last. Nevertheless, it is controversial, whether the taxpayers should be the only ones faced with the losses. If a bank has lent money to another bank, which then proves unsound, it may be efficient to involve the lender in the deficits. The reason is that, in such a case, the creditor charges a different interest rate, which indeed mirrors that the risk and the distribution of capital is not sophisticated. Another argument for involving the lender in the losses is that it would be unfair if the whole burden falls on the taxpayers. An argument against it refers to the fact that banks are more vulnerable in case a crisis

occurs and thus a contribution towards expenses undermines them in addition [21, pp. 352-356].

2.2.5 Changes under different monetary systems

As aforementioned, Thornton and Bagehot relate to England, which was an open economy with a gold standard in former times. Humphrey and Keleher also refer to the concepts of Thornton and Bagehot, but they criticize that the LLR function was not explained for different monetary systems. Therefore, they make up for this point and distinguish between a closed and a small open economy. The open economy has either introduced fixed exchange rates or flexible ones [27, pp. 278-282].

The difference between a closed and an open economy is that the closed economy does not import or export goods, it does not buy shares or bonds from abroad or sells them abroad and its inhabitants are not allowed to work outside their country. As a consequence, it does not have any relationships with other countries. By contrast, open economies interact with other countries and hence are the opposite of closed economies [105]. A small open economy is defined as an economy which cannot directly influence the world prices. They are set by the large open economies [55, p. 25].

An example of a fixed exchange rate system is the Bretton Woods System, which was enacted in Bretton Woods in 1944. Thereby, the major currencies were tied to the dollar, which means that the exchange rate between them and the dollar was fixed. The dollar was the anchor currency, because the United States were the economic leader at that time. In those countries which had adopted the Bretton Woods System, the central banks were responsible for the preservation of the exchange ratio. This means that they had to sell their currency and increase their amount of dollars in order to decrease their currency’s value, if it was too high. Contrary to that they had to buy their currency and thereby raise its value, provided that its value was too low [70].

Another feature of the Bretton Woods System was that the dollar was convertible into gold and the exchange rate between the dollar and gold was fixed as well. In 1971, the Bretton Woods System was repealed [70].

A country that has introduced a flexible or floating exchange rate system permits its currency to fluctuate and thus change dependent on the development of other currencies. However, even in this case, central banks often intervene and try to influence the exchange rate of their currency [70].

Humphrey and Keleher (1984) start their analysis assuming that a small open economy which has introduced fixed exchange rates or a gold standard exists [27, p. 278].

In a system with fixed exchange rates, the primary target of the central bank is securing the exchange ratio and, in the case of a gold standard, the convertibility into gold. Therefore, the increase of the amount of money should be proportional to the increase of the international reserves, respectively the gold reserves. Furthermore, the central bank has to protect the reserves against drains, which occur for example due to an increased demand for the reserves induced by banks suffering from bank runs, or due to a trade deficit. The proposed solutions for the drains equal those suggested by Bagehot. In order to ensure that the primary target of maintaining the convertibility is achieved, the central bank should not shrink from lending money to individual banks. The policy under which a central bank grants individual banks a loan is, as already mentioned, called discount-window lending [27, pp. 279-280].

Afterwards, the LLR function is explained for a small open economy which has adopted flexible exchange rates and a closed economy. Under these circumstances, it is no longer necessary to secure the exchange ratio or the convertibility into gold. Therefore, the primary target of the central bank is controlling the money supply and safeguarding stability. It has to prohibit that credit crises induced by bank runs turn into monetary crises. In contrast to the case of a fixed exchange rate system, the LLR should supply liquidity in times of crisis through open market operations (OMO) now.
Thus, the authors suggest different methods of handling a crisis situation in distinct monetary systems. However, they conclude that regardless of the system, the interaction of the LLR in a crisis does not contradict the primary target of it [27, pp. 280-282].

2.2.6 Systems which do not require an LLR

Bordo (1990) examines the question of whether other solutions than the provision of capital by the central bank are possible to overcome crises. He investigates if there are systems, which do not require an LLR [7, p. 25].

In Scotland, a central bank did not exist for many years. The country's strategy was "free banking". Under this system, it was easy to set up a bank and its shareholders were fully liable for it. The issue of notes was unrestricted and they could be changed into coins. Few banks failed and the system proved to be efficient in view of monetary stability. Depositors did not withdraw their money, since they felt safe due to the full liability of the shareholders. Furthermore, fractional reserve banking did not exist and banks were allowed to engage in several business segments. Nevertheless, in case of a severe liquidity shortage, the Bank of England would have intervened as an LLR. Of course, the system has its drawbacks, since some policies, as for instance the full liability of the bank's shareholders, are not enforceable any longer [7, p. 25].

Apart from mentioning Scotland as an example, which once pursued the strategy "free banking", Bordo considers the question of whether this strategy removes the need for an LLR ultimately. He points to the literature dealing with this topic and concludes that such a system does not necessitate an LLR, since panics do not occur. According to him, panics are only ascribed to limitations like the restricted issue of notes and the interdiction of statewide branches. If banks are allowed to engage in several business segments, they are able to diversify their risk [7, pp. 21-22].

Another country which has overcome several crises without a central bank is Canada. However, in contrast to Scotland, fractional reserve banking existed there. Crises were managed with the help of the Canadian Bankers Association [7, pp. 25]. It was founded in 1891 at the recommendation of the government and bankers. They wished for a formal banking organization [78]. In order to cope with financial difficulties, the Canadian Bankers Association fostered the amalgamation of troubled and sound banks in times of crisis and it provided a reserve fund in the case of an ultimate bank failure. Besides, the banks made sure that their reserves were more or less available on demand. Therefore, they invested them in short-dated assets and

were able to raise money whenever the circumstances required it. Twice the reserves turned out to be not enough and the government had to intervene.

Finally, the Finance Act created a fixed possibility for banks to borrow money in case of a shortage. It was adopted in 1914 and enabled the Treasury Board to accommodate troubled banks with money if necessary. Henceforth, an institution was entrusted with the LLR function in Canada [7, pp. 25-26].

2.2.7 The moral hazard problem

Moral hazard arises when the LLR compensates for a loss, which the managers of the bank have caused. In contrast, the responsible managers are not penalized.
There are many authors who think that the moral hazard problem is too serious. They agree that open market operations should be applied in order to control the money supply, but they negate that individual banks should be saved from insolvency. Moreover, they believe that open market operations are also sufficient to deal with systemic crises [23, pp. 352-353].

Goodhart (1999) also takes into consideration whether the moral hazard problem is compounded, if depositors are insured. The reason is that insured depositors do not face the risk of losing their money and thus they do not supervise the bank. He concludes that insuring deposits up to a certain amount is better than not insuring them, as small depositors are not able to supervise their bank efficiently anyway. However, the insurance should not cover all deposits. In such a case, the depositors would search for the bank that offers the highest interest rates and thereby which had the highest risk.

In order to avoid moral hazard, Goodhart argues that the responsible managers should not be fully protected against the consequences of their misbehavior [21, pp. 354-356].

Freixas et al. (2002) refer to Bagehot's suggestion that central banks should charge a penalty rate and list the disadvantages of it. First, a penalty rate may compound the financial difficulties of the troubled bank. Second, if the depositors get to know that their bank has applied for a loan at a high rate, it may increase the probability of a

bank run. Third, a penalty rate raises the repayment sum and perhaps it encourages the managers of the bank to undertake riskier investments in order to offset losses [18, p. 40].

Freixas et al. criticize Bagehot's proposal that the central bank should lend money only if the borrower's collateral is of good quality and the borrower is thus not insolvent. Apart from the effects on the market caused by the failure of a bank (see chapter "The reasons, which speak for the existence of an LLR"), they assume that it is more efficient to rescue an insolvent bank [18, p. 40]. There are many other papers as well which contain the statement that insolvent banks should not be abandoned. Central banks should especially save them if they are large. It is argued that the failure of a large bank endangers the economy as a whole. This phenomenon is named the "Too-big-to-fail"- problem [36, p. 2].

In order to reduce the moral hazard problem, they suggest using "constructive ambiguity" and thereby, the creation of uncertainty. It should be uncertain whether a troubled bank is approved a loan as well as when and under which conditions it is granted one. If insecurity regarding the provision of money in times of crisis should be created, the central bank may have to conceal the lending to a bank. However, the authors also consider Bagehot's view and state that in the case of an already erupted crisis, the announcement of the LLR's supporting measures may reassure the public [18, pp. 40-41].

Furthermore, they suggest to penalize bank managers, provided that they have acted carelessly in order to lessen the moral hazard problem. This statement reflects Goodhart's opinion [18, p. 42].

They also support the opinion of Goodfriend and King and think that, if the market or other banks accommodate troubled banks with money, the moral hazard problem is mitigated. As mentioned before, the interbank market may not function properly. In such a case, the authors propose that the central bank should intervene and improve the coordination. Otherwise, the more competition between banks exists, the less willing are sound banks to assist a failed bank [18, pp. 42-44].

2.2.8 An international LLR

There are also considerations whether the tasks of an LLR should be conferred to an international institution. The facility which seems to be convenient for it is the International Monetary Fund (IMF). Many economists argue that the IMF cannot act as an ILLR, because it does not have the possibility of issuing bank notes. Besides, an ILLR even complicates the situation, since there are more institutions and people involved than in the national case of lending [22, pp. 20-22].

However, Stanley Fischer, who was the First Deputy Managing Director of the IMF until 2001 [94], states that there is a need for an ILLR. He particularly points to the instance of an external crisis. In such a case, a country faces an increased demand for foreign exchange, which cannot be met by a domestic central bank [17, p. 94]. Goodhart and Illing also recognize that there is a need for an institution with access to reserves of foreign exchange if a shortage occurs [22, p. 20].

Furthermore, the IMF has already acted as an ILLR in the past. Fischer also refers to the argument that it cannot issue bank notes and thus is actually unable to function as an LLR. First, the IMF has access to resources and beyond that it has the possibility of creating reserves according to the Articles of Agreement. Therefore, it can serve as a crisis lender. Second, the IMF has already induced negotiations in past crises, and thereby it has acted as a crisis manager. Both functions are essential in order to overcome a crisis. However, further improvements are still necessary for example the involvement of private lenders in times of crisis should be improved. Thereby it is possible to mitigate the moral hazard problem [17, pp. 87-88, 96-97, 102].

2.3 Conclusion

There is much literature dealing with the term “lender of last resort”. Different economists provide different opinions and as a result, various definitions of the term as well as diverse suggestions of how an LLR should act exist. The basic statements originate from Henry Thornton and Walter Bagehot. They were largely in complete agreement, although Bagehot covered the topic more precisely.

First, the term LLR as well as its tasks are defined by Goodfriend and King and Goodhart. It is conspicuously that most of the economists refer to a central bank as an LLR. The reason may be that the majority of them determine the LLR's primary objective as the granting of credit to a distressed bank in times of crisis.

Next, the causes which speak for the existence of an LLR are mentioned. One reason is the dependence on the central bank due to the restricted issue of notes.

There are different possibilities of providing capital. The LLR can grant a loan to an individual bank. This policy is called "discount-window lending". Another possibility is the provision of capital to the interbank market. If this strategy is applied, the LLR makes use of open market operations. Goodfriend and King recommend the use of open market operations for the control of the amount of high-powered money. Furthermore, they also suggest the application of this method in case distressed banks ask for a loan. However, open market operations may not transport money to the illiquid banks because of information asymmetry.

Economists are also divided over the recipients of capital. While Bagehot claims that only solvent banks should be granted a loan, Freixas et al. think that it may be efficient to support insolvent banks as well.

The question arises whether an economy which pursues the strategy "free banking" also needs an LLR. In such a system, the issue of notes is not restricted and banks are allowed to engage in several business segments. Therefore, panics do not occur. Much discussed is the moral hazard problem induced by the existence of an LLR. There are several suggestions of solving it. One possibility is the use of "constructive ambiguity". This means that banks should be uncertain about the LLR's willingness to lend and about its conditions.

Besides the focus on national central banks as an LLR, there are also considerations whether the IMF should function as an international LLR. A disadvantage of it is the increased complexity as more institutions are involved.

3 Repullo's model[1]

The significance of Repullo's model lies in his statement that the existence of a lender of last resort does not encourage a bank to take more risk. With this assumption, he contradicts the statements of many economists.

3.1 Model with an LLR

3.1.1 General information about the model

On the one hand, he assumes that the bank can invest in a risky and illiquid asset, on the other hand it can invest in a secure and perfectly liquid asset. With the variable λ he shows the proportion of the bank's capital invested in the safe asset. As a consequence, $1-\lambda$ shows the proportion invested in the risky and illiquid asset. Repullo supposes that the investment in the safe asset does not lead to any revenue, whereas the bank's investment in the risky asset yields the return R.

The return R is either high (R_1) or low (R_0). For R_1 holds $R_1 = R(p)$ with probability p, for R_0 holds $R_0 = 0$ with probability $1-p$, and p belongs to $[0,1]$. The higher the probability p is, the higher is the likelihood that the bank obtains the high return and the "safer" is the illiquid asset. Otherwise, $R(p)$ is decreasing in p, which means that a higher value of p leads to a lower expected return $R(p)$. Thus, the riskier the investment is, the higher is $R(p)$ in the case of success, but the lower is the probability that this case will occur.

Repullo further assumes that $R(1) \geq 1$. This equation shows that even if the bank chooses the lowest level of risk, its return in the case of success does not fall below 1 (the amount of money invested), which equals the investment in the safe asset. Therefore, investing money in the risky asset will pay off.

The liability side of the bank's balance sheet consists of equity and deposits. Repullo uses the variable k to show the bank's equity capital, whereas $1-k$ reflects the

[1] The following section is based on [59] **Repullo, Rafael** (2005), Liquidity, Risk-Taking, and the Lender of Last Resort, International Journal of Central Banking, Vol. 1, Nr. **2**, pp. 47-80.

amount of deposits. The equity capital is provided by bankers, who expect a rate of return $\delta \geq 0$ in reward of their investment. It has to fulfill the constraint $k \geq \kappa(1-\lambda)$ with $\kappa \in (0,1)$. Hence, the bank has to achieve a minimum capital requirement depending only on the amount of money the bank has invested in the risky asset. The variable κ represents the share of the risky asset, which has to be supported with equity capital. It does not relate to the level of risk chosen by the bank.

Furthermore, Repullo assumes that depositors do not get interest because their deposits are insured and therefore safe.

The model considers the dates $t = 0, 1, 2$. At $t = 0$, the bank chooses the level of risk p, the amount invested in the safe asset λ (and as a result, the amount invested in the risky asset $1-\lambda$) and its equity capital k. However, the bank will only raise as much equity capital as required. Depositors pay their money into an account.

At $t = 1$, a part of the deposits is suddenly withdrawn and depending on the amount, the bank may need the help of an LLR. Since the risky asset is illiquid, the bank cannot trade it on the secondary market. It can only use its investment in the safe asset λ as a liquidity buffer.

At $t = 2$, the bank gets the return R of the risky asset and, in the case of R_1, it is able to pay back the loan, if it received one from the LLR at $t = 1$.

For the withdrawal at $t = 1$, Repullo uses the variable v. At $t = 0$, there are no inferences about the extent of the withdrawal possible and thus, v is a continuous random variable with the distribution function $F(v)$ and for this holds $v \in [0,1]$. At $t = 1$, the amount $v(1-k)$ of the deposits is withdrawn. Now, there are two possible cases. If $v(1-k) \leq \lambda$, the bank does not need a loan from the LLR. It is able to pay depositors by selling the needed amount of its liquid asset.

Yet, if $v(1-k) > \lambda$, the bank faces a liquidity shortage. In order to continue operating, it needs a loan in the amount of $v(1-k) - \lambda$ from the LLR. If the LLR does not accommodate the bank with a loan, it is liquidated at $t = 1$. However, the

sole consequence is that the bank has to stop operating in this case. The liquidation does not lead to any costs for the bank because of the assumption of limited liability.

3.1.2 The signal s and its quality

The decision of the LLR whether it should approve the loan or not depends on the one hand on the costs and earnings resulting from lending to the bank. On the other hand, it is subject to the expenses arising from a bank failure.

In order to determine the costs resulting from lending, it is crucial to know if the illiquid investment of the bank leads to a return at $t = 2$ or not, because in the case of R_0 the bank won’t be able to pay back the loan. However, the LLR does not monitor the bank’s selection of p and hence, the level of risk taken by the bank, respectively the probability of the high return. Nevertheless, it observes a signal s and for s holds $s \in \{s_0, s_1\}$. It describes if the return of the bank’s risky asset will be high (R_1) or low (R_0), whereat s_1 is the good signal meaning that it is more likely that the bank obtains the high return at $t = 2$ as though s_0 (the bad signal) is observed by the LLR. However, this condition only holds if the supervisory signal s is of good quality and therefore informative.

The quality of the signal is shown by the variable q and Repullo assumes that for q holds $\Pr(s_0|R_0) = \Pr(s_1|R_1) = q \in [\frac{1}{2}, 1]$. This means that the probability that the bad signal s_0 is observed if the low return is obtained by the bank is equal to the probability that the good signal s_1 is observed in the case of a high return for the bank. If $q = \Pr(s_1|R_1)$, then $1 - q = \Pr(s_0|R_1)$, which shows the probability that the bad signal s_0 is observed by the LLR, while the high return R_1 is obtained by the bank.

Finally, it is possible to calculate $\Pr(R_1|s_1)$ and $\Pr(R_1|s_0)$, which show the probability that the high return will be obtained (and thus the bank will be able to pay back the loan), if the good signal or the bad signal is observed.

According to Bayes’ law (when there is a certain quantity of mutually exclusive events):

$$\Pr(A_i|B) = \frac{\Pr(B|A_i)\times\Pr(A_i)}{\Pr(B)}$$

with:

$$\Pr(\mathrm{B}) = \sum_{\mathrm{j}=1}^{\mathrm{N}} \Pr(\mathrm{A_j} \cap \mathrm{B}) = \sum_{\mathrm{j}=1}^{\mathrm{N}} \Pr(\mathrm{B}|\mathrm{A_j}) \times \Pr(\mathrm{A_j})$$

The above formula shows the probability that event A_i occurs if event B has taken place ($\Pr(A_i|B)$). The probability of event B ($\Pr(B)$) results from the law of total probability, meaning that it considers the joint probability of each event A_j and of event B in the case of exhaustive and mutually exclusive events.

Taking account of Bayes’ law and the law of total probability, $\Pr(R_1|s_1)$ and $\Pr(R_1|s_0)$ are made up of:

$$\Pr(R_1|s_1) = \frac{\Pr(S_1|R_1)\times\Pr(R_1)}{\Pr(s_1)} = \frac{q\times p}{q\times p+(1-q)\times(1-p)}$$

with:

$$\Pr(\mathrm{s_1}) = \sum_{\mathrm{j}=1}^{\mathrm{N}} \Pr(\mathrm{s_1}|\mathrm{R_j}) \times \Pr(\mathrm{R_j}) = \Pr(\mathrm{s_1}|\mathrm{R_1}) \times \Pr(\mathrm{R_1}) + \Pr(\mathrm{s_1}|\mathrm{R_0}) \times \Pr(\mathrm{R_0})$$

$$\Pr(\mathrm{R_1}|\mathrm{s_0}) = \frac{\Pr(\mathrm{S_0}|\mathrm{R_1})\times\Pr(\mathrm{R_1})}{\Pr(s_0)} = \frac{(1-\mathrm{q})\times\mathrm{p}}{(1-\mathrm{q})\times\mathrm{p}+\mathrm{q}\times(1-\mathrm{p})}$$

with:

$$\Pr(\mathrm{s_0}) = \sum_{\mathrm{j}=1}^{\mathrm{N}} \Pr(\mathrm{s_0}|\mathrm{R_j}) \times \Pr(\mathrm{R_j}) = \Pr(\mathrm{s_0}|\mathrm{R_1}) \times \Pr(\mathrm{R_1}) + \Pr(\mathrm{s_0}|\mathrm{R_0}) \times \Pr(\mathrm{R_0})$$

It is already mentioned above that the likelihood of the high return ($\Pr(R_1)$) is p and as a consequence, the probability of the low return ($\Pr(R_0)$) is $1-p$.

As previously mentioned, Repullo assumes that $q \in [\frac{1}{2}, 1]$. If $q = \frac{1}{2}$, then $\Pr(R_1|s_1) = \Pr(R_1|s_0) = p$ and thus, the signal is of bad quality and uninformative, because there is no difference between the good and the bad signal. It is not more preferable for the bank if the LLR observes s_1 instead of s_0 in order to obtain a loan.

Proof:

$$\Pr(R_1|s_1) = \frac{\frac{1}{2}\times p}{\frac{1}{2}\times p+(1-\frac{1}{2})\times(1-p)} = \frac{\frac{1}{2}\times p}{\frac{1}{2}\times p+\frac{1}{2}-\frac{1}{2}\times p} = \frac{1}{2}\times p\times 2 = p$$

$$\Pr(\mathrm{R}_1|\mathrm{s}_0) = \frac{(1-\frac{1}{2})\times \mathrm{p}}{(1-\frac{1}{2})\times \mathrm{p}+\frac{1}{2}\times(1-\mathrm{p})} = \frac{\frac{1}{2}\times \mathrm{p}}{\frac{1}{2}\times \mathrm{p}+\frac{1}{2}-\frac{1}{2}\times \mathrm{p}} = \frac{1}{2}\times \mathrm{p}\times 2 = \mathrm{p}$$

If $q = 1$, then $\Pr(R_1|s_1) = 1$ and $\Pr(R_1|s_0) = 0$ and hence, the signal is perfectly informative. It is sure that the high return will be obtained by the bank if the good signal is observed, and it is certain that the bank will get the low return if the LLR observes the bad signal. In this case, the LLR will only lend money to the bank, if s_1 is monitored.

Proof:

$$\Pr(R_1|s_1) = \frac{1\times p}{1\times p+(1-1)\times(1-p)} = \frac{p}{p} = 1$$

$$\Pr(\mathrm{R}_1|\mathrm{s}_0) = \frac{(1-1)\times \mathrm{p}}{(1-1)\times \mathrm{p}+1\times(1-\mathrm{p})} = \frac{0}{1-\mathrm{p}} = 0$$

Apart from these extreme cases, where $q = \frac{1}{2}$ or $q = 1$ holds $\Pr(R_1|s_0) < p < \Pr(R_1|s_1)$ for $p < 1$ and $q > \frac{1}{2}$. As a consequence, the LLR is more willing to approve a loan, if it observes the good signal s_1, which reflects a higher probability that the high return will be obtained at $t = 2$ compared to s_0. Finally, the signal is not verifiable, because the information gathered through bank investigations consists of many subjective elements.

Next to the signal s, the LLR also observes the amount invested in the safe asset λ, the bank’s equity capital k and the extent of the withdrawal by depositors v.

The more the bank has invested in the safe and liquid asset, the more money can be used as a liquidity buffer and the less money is needed from the LLR. If the bank’s equity capital is higher, its deposits $1 - k$ are lower. Therefore, the liquidity shock $v(1 - k)$ is also smaller. The more depositors withdraw their money at $t = 1$, the greater is the liquidity shock and thus, the more money is needed from the LLR. Repullo first examines the case where the LLR does not charge a penalty rate, which

means that at $t = 1$, it pays the outstanding withdrawals $v(1-k) - \lambda$ and at $t = 2$, it only receives the amount which it has paid.

As mentioned above, the LLR also cares about the costs arising from a bank failure (social cost), which are denoted by c. These costs occur for example due to the closing of the failed bank, the loss of the bank's customer relations, contagion effects and the repayment of all deposits.

3.1.3 Objective function of the LLR

The reason why the LLR makes its decision conditional on the costs and earnings resulting from lending and on the costs arising from a bank failure may be that the reward of its officials depends on the profit or loss achieved. In order to develop the objective function of the LLR, it is necessary to consider the two possible situations. If the LLR grants a loan in the amount of $v(1-k) - \lambda$ after observing the signal s, it will get it back at $t = 2$ with the probability $\Pr(R_1|s)$. However, with the probability $\Pr(R_0|s)$ the bank will receive the low return at $t = 2$ and therefore will not be able to repay the credit. In this case, the LLR further incurs the social cost c. If the lender of last resort does not grant a loan, the bank will definitely fail and the LLR will have to bear the social cost c.

Now, the LLR will support the bank, if the following condition is fulfilled:

$$-[v(1-k) - \lambda + c]\Pr(R_0|s) \geq -c$$

This means that the expected payoff, if the LLR supports the bank, has to be higher or at least equal compared to the payoff achieved, if the LLR does not support the bank. The payoff in the case of supporting the bank is zero, providing that the bank gets the high return at $t = 2$. If the bank gets the low return and hence a bank failure takes place, the payoff consists of the loss of the LLR's loan and the cost of the bank failure c. The above condition can be transformed due to the circumstance that $\Pr(R_0|s) = 1 - \Pr(R_1|s)$:

$$\begin{aligned} -v(1-k)\Pr(R_0|s) + \lambda\Pr(R_0|s) - c\Pr(R_0|s) &\geq -c \\ -\mathrm{v}(1-\mathrm{k})\Pr(\mathrm{R_0}|\mathrm{s}) + \lambda\Pr(\mathrm{R_0}|\mathrm{s}) &\geq -\mathrm{c} + \mathrm{c}\Pr(\mathrm{R_0}|\mathrm{s}) \\ -\mathrm{v}(1-\mathrm{k})\Pr(\mathrm{R_0}|\mathrm{s}) + \lambda\Pr(\mathrm{R_0}|\mathrm{s}) &\geq -\mathrm{c}(1-\Pr(\mathrm{R_0}|\mathrm{s})) \end{aligned}$$

$$
\begin{aligned}
-\mathrm{v}(1-\mathrm{k})\,\Pr(\mathrm{R}_0|\mathrm{s}) + \lambda\Pr(\mathrm{R}_0|\mathrm{s}) &\geq -\mathrm{c}\left(1-\left(1-\Pr(\mathrm{R}_1|\mathrm{s})\right)\right)\\
\Pr(\mathrm{R}_0|\mathrm{s})(-\mathrm{v}(1-\mathrm{k})+\lambda) &\geq -\mathrm{c}\Pr(\mathrm{R}_1|\mathrm{s})\\
-\mathrm{v}(1-\mathrm{k})+\lambda &\geq \frac{-\mathrm{c}\Pr(\mathrm{R}_1|\mathrm{s})}{\Pr(\mathrm{R}_0|\mathrm{s})}\\
-\mathrm{v} &\geq \frac{\frac{-\mathrm{c}\Pr(\mathrm{R}_1|\mathrm{s})}{\Pr(\mathrm{R}_0|\mathrm{s})}-\lambda}{1-\mathrm{k}}\\
\mathrm{v} &\leq \frac{\frac{\mathrm{c}\Pr(\mathrm{R}_1|\mathrm{s})}{\Pr(\mathrm{R}_0|\mathrm{s})}+\lambda}{1-\mathrm{k}}
\end{aligned}
$$

Having the information about the signal s, its quality q, the amount invested in the safe asset λ, the bank’s equity capital k, the extent of the withdrawal v and the social cost c, it is possible to create two parameters, which influence the LLR’s decision on supporting or not supporting the bank. In order to develop the parameters, the aforementioned probabilities $\Pr(R_1|s_1)$ and $\Pr(R_1|s_0)$ as well as the probabilities $\Pr(R_0|s_1)$ and $\Pr(R_0|s_0)$ are inserted in the inequation above. If the LLR observes the good signal s_1, $\Pr(R_1|s_1)$ and $\Pr(R_0|s_1)$ are used:

$$
\begin{aligned}
\Pr(R_1|s_1) &= \frac{\Pr(s_1|R_1)\times\Pr(R_1)}{\Pr(s_1)} = \frac{q\times p}{q\times p+(1-q)\times(1-p)}\\
\Pr(\mathrm{R}_0|\mathrm{s}_1) &= \frac{\Pr(\mathrm{s}_1|\mathrm{R}_0)\times\Pr(\mathrm{R}_0)}{\Pr(\mathrm{s}_1)} = \frac{(1-\mathrm{q})\times(1-\mathrm{p})}{\mathrm{q}\times\mathrm{p}+(1-\mathrm{q})\times(1-\mathrm{p})}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{v} &\leq \frac{\frac{\mathrm{c}\Pr(\mathrm{R}_1|\mathrm{s}_1)}{\Pr(\mathrm{R}_0|\mathrm{s}_1)}+\lambda}{1-\mathrm{k}}\\
\mathrm{v} &\leq \frac{\frac{\mathrm{c}\times\mathrm{q}\times\mathrm{p}}{\mathrm{q}\times\mathrm{p}+(1-\mathrm{q})\times(1-\mathrm{p})}\times\frac{\mathrm{q}\times\mathrm{p}+(1-\mathrm{q})\times(1-\mathrm{p})}{(1-\mathrm{q})\times(1-\mathrm{p})}+\lambda}{1-\mathrm{k}}\\
\mathrm{v} &\leq \frac{\frac{\mathrm{c}\times\mathrm{q}\times\mathrm{p}}{(1-\mathrm{q})\times(1-\mathrm{p})}+\lambda}{1-\mathrm{k}}\\
\mathrm{v} &\leq \frac{\mathrm{v}_1+\lambda}{1-\mathrm{k}}\\
v(1-k)-\lambda &\leq v_1
\end{aligned}
$$

From this it follows that, if the LLR observes the good signal s_1, it will support the bank provided that its loan respectively the liquidity shortfall of the bank $v(1-k)-\lambda$ is below or at least equal compared to the critical value v_1.

If the LLR monitors the bad signal s_0, $\Pr(R_1|s_0)$ and $\Pr(R_0|s_0)$ have to be inserted in the inequation above:

$$\Pr(R_1|s_0) = \frac{\Pr(s_0|R_1)\times\Pr(R_1)}{\Pr(s_0)} = \frac{(1-q)\times p}{(1-q)\times p+q\times(1-p)}$$

$$\Pr(R_0|s_0) = \frac{\Pr(s_0|R_0)\times\Pr(R_0)}{\Pr(s_0)} = \frac{q\times(1-p)}{(1-q)\times p+q\times(1-p)}$$

$$v \leq \frac{\frac{c\Pr(R_1|s_0)}{\Pr(R_0|s_0)}+\lambda}{1-k}$$

$$v \leq \frac{\frac{c\times(1-q)\times p}{(1-q)\times p+q\times(1-p)}\times\frac{(1-q)\times p+q\times(1-p)}{q\times(1-p)}+\lambda}{1-k}$$

$$v \leq \frac{\frac{c\times(1-q)\times p}{q\times(1-p)}+\lambda}{1-k}$$

$$v \leq \frac{v_0+\lambda}{1-k}$$

$$v(1-k)-\lambda \leq v_0$$

Thus, if the lender of last resort observes the bad signal s_0, it will grant the bank a loan on condition that the loan respectively the liquidity shortfall of the bank is below or equal to the critical value v_0.

Repullo shows that for v_1 and for v_0 holds true:

$$\frac{v_1}{\left(\frac{q}{1-q}\right)^2} = v_0$$

$$\frac{\mathrm{c}\times\mathrm{q}\times\mathrm{p}}{(1-\mathrm{q})\times(1-\mathrm{p})}\times\frac{(1-\mathrm{q})^2}{\mathrm{q}^2} = 0$$

$$\frac{c\times p\times(1-q)}{(1-p)\times q} = v_0$$

As a consequence, $v_1 > v_0$ if $q > \frac{1}{2}$, which means that the signal s is of good quality and informative. Therefore, the LLR is more willing to provide money whenever it observes the good signal s_1. It is less prepared to lend when it monitors the bad signal s_0.

The formulas of v_1 and v_0 show that the critical values will increase, if the social cost c rises. It is comprehensible that the incentive for the LLR to grant a loan is better, if a bank failure causes higher costs. The formulas also reflect the previously mentioned relationship between the signal s and its quality q. The more informative the signal is, the more willing is the LLR to lend money to the bank, if the good signal is observed and hence, the higher is v_1. Vice versa, a more informative signal decreases the readiness of the LLR to grant credit and therefore v_0. The higher $\Pr(R_1)$ and thus p is, the higher are v_1 and v_0. However, as aforementioned, the LLR is not able to monitor the bank's selection of p, which implies that v_1 and v_0 are dependent on the equilibrium value of p (p^*). The calculation of p^* will be explained below.

The LLR's willingness to lend money also increases if the bank has invested a higher amount of money in the safe asset λ. This results from the role of the safe asset as a liquidity buffer. The bank has a better chance to obtain a loan if its equity capital k is higher, because then its deposits $1-k$ are lower and the size of the liquidity shock $v(1-k)$ is also smaller.

In summary, Repullo assumes that the LLR cares about the costs and earnings accompanied by its lending and the costs arising from a bank failure. Its readiness to lend depends on the signal observed (s_1 or s_0) and the critical values v_1 and v_0, which evolve from the information available for the LLR. It is not possible to verify the signal, because bank investigations lead to subjective information. Therefore, Repullo supposes that a socially optimal decision will not be made.

3.1.4 Objective function of the bank

Compared to the LLR, the bank also worries about its costs and revenues. It wants to maximize its final payoff. The bank either continues operating or it fails. In two cases, the bank collapses. First, it is liquidated if it does not receive a loan from the LLR in the case of a liquidity shortage at $t=1$. Second, the bank fails if it cannot pay back the loan granted by the LLR, because the return of its risky asset is low at $t=2$. In both cases, the bank's payoff equals zero because of limited liability.

However, if the bank withstands the withdrawal of its deposits as well as the following liquidity shortage with the help of the LLR and obtains the high return, it will receive $(1-\lambda)R(p)-(1-v)(1-k)-[v(1-k)-\lambda]$ at $t=2$. $1-\lambda$ reflects the proportion invested in the risky asset, which yields the high return $R(p)$. Next, the bank pays the outstanding deposits, whereas $1-v$ is the share of the total deposits $1-k$, which has not been withdrawn at $t=1$. As already mentioned, depositors do not get interest because they do not bear any risk. Finally, $v(1-k)-\lambda$ equals the loan obtained by the bank at $t=1$. At $t=2$, the LLR only recovers the amount paid in this case.

It is possible to further facilitate the above formula:

$$R_1=(1-\lambda)R(p)-(1-v)(1-k)-[v(1-k)-\lambda]$$
$$R_1=R(p)-\lambda R(p)-(1-k-v+vk)-(v-vk-\lambda)$$
$$R_1=R(p)-\lambda R(p)-1+k+v-vk-v+vk+\lambda$$
$$R_1=R(p)-\lambda R(p)-1+k+\lambda$$
$$R_1=(1-\lambda)(R(p)-1)+k$$

As aforementioned, the bank only does not fail, if it obtains the high return R_1 and if the LLR grants a loan. The LLR will accommodate the bank with a loan, provided that it observes the good signal s_1 and for the liquidity shock holds $v\leq\frac{v_1+\lambda}{1-k}$ or on condition that it monitors the bad signal s_0 and the withdrawal satisfies $v\leq\frac{v_0+\lambda}{1-k}$.

Thus, it is necessary to compute the following probabilities:

$$Pr\left(R_1, s_1, and\ v\leq\frac{v_1+\lambda}{1-k}\right)=pqF\left(\frac{v_1+\lambda}{1-k}\right)$$
$$Pr\left(R_1, s_0, and\ v\leq\frac{v_0+\lambda}{1-k}\right)=p(1-q)F\left(\frac{v_0+\lambda}{1-k}\right)$$

Finally, the bankers who provide the bank’s equity capital k get a rate of return $\delta\geq 0$ in reward of their investment. Therefore, $(1+\delta)k$ has to be deducted from the bank’s payoff.

All in all, the objective function of the bank is:

$$U_B = p\left[qF\left(\frac{v_1+\lambda}{1-k}\right)+(1-q)F\left(\frac{v_0+\lambda}{1-k}\right)\right]\times[(1-\lambda)(R(p)-1)+k]-(1+\ \delta)k$$

3.1.5 Nash equilibrium

Now, a Nash equilibrium is calculated. This means that both the bank and the LLR choose a strategy which maximizes the payoff for each. Both have no incentive to change their strategy, because then they would be worse off [90].

Thus, the bank selects the level of risk p^*, its equity capital k^*, the amount invested in the safe asset λ^* and the LLR selects v_1^* and v_0^* such that (p^*, k^*, λ^*) maximizes

$$p\left[qF\left(\frac{v_1^*+\lambda}{1-k}\right)+(1-q)F\left(\frac{v_0^*+\lambda}{1-k}\right)\right]\times[(1-\lambda)(R(p)-1)+k]-(1+\ \delta)k$$

dependent on the minimum capital requirement $k \geq \kappa(1-\lambda)$, and

$$v_1^* = \frac{c\times q\times p^*}{(1-q)\times(1-p^*)}\ and\ v_0^* = \frac{c\times(1-q)\times p^*}{q\times(1-p^*)}.$$

As noted above, the LLR is not able to monitor the bank’s actual choice of p, which implies that v_1 and v_0 are only dependent on the equilibrium value p^*. Therefore, the coefficient $\left[qF\left(\frac{v_1^*+\lambda}{1-k}\right)+(1-q)F\left(\frac{v_0^*+\lambda}{1-k}\right)\right]$ can be excluded. The objective function of the bank becomes $p[(1-\lambda)(R(p)-1)+k]$, which means that the bank wants to maximize the probability of the high return p multiplied by the high return $[(1-\lambda)(R(p)-1)+k]$.

Repullo assumes that, in order to obtain the level of risk, it is necessary to solve the subsequent equation. In the first-best case, it is a question of the following equation:

$$R(\hat{p})+\hat{p}R'(\hat{p})=0$$

The outcome is the first-best $\hat{p}$, which is the optimal level of risk for the bank. Now, the equation has to be adapted to the current conditions, since the bank will not choose the first-best $\hat{p}$ as its equilibrium value of risk:

$$\mathrm{R}(\mathrm{p}^*)\ = (1-\lambda^*)(\mathrm{R}(\mathrm{p}^*)-1)+\mathrm{k}^*$$
$$R'(p^*) = (1-\lambda^*)(R'(p^*))$$

Therefore, it turns into:

$$\begin{aligned}(1-\lambda^*)[R(p^*)-1]+k^*+p^*(1-\lambda^*)R'(p^*) &= 0\\ (1-\lambda^*)[R(p^*)-1]+p^*R'(p^*) &= -k^*\\ R(p^*)-1+p^*R'(p^*) &= \tfrac{-k^*}{(1-\lambda^*)}\\ R(p^*)+p^*R'(p^*) &= 1-\tfrac{k^*}{(1-\lambda^*)}\end{aligned}$$

As aforementioned, Repullo further assumes that the bank will only raise as much equity capital as required. Thus, for the bank’s capital holds $k^* = \kappa(1-\lambda^*)$. Now, the equation becomes:

$$R(p^*)+p^*R'(p^*) = 1-\tfrac{\kappa(1-\lambda^*)}{(1-\lambda^*)}$$

$$R(p^*)+p^*R'(p^*) = 1-\kappa$$

From this it follows that the equilibrium value p^* increases if the minimum capital requirement increases. This fact is explained due to the capital-at-risk effect. Accordingly, the higher the bank’s equity capital is, the higher are the losses of the bankers if the bank obtains the low return R_0 at $t = 2$.

Nevertheless, compared to the first-best case the bank still selects too much risk. This circumstance relates to the risk-shifting effect, which occurs whenever part of the capital originates from creditors. In this case the creditors are the depositors.

3.2 Model without an LLR

3.2.1 Objective function of the bank

After presenting his general model, Repullo proves that the existence of an LLR does not increase the level of risk chosen by the bank. In order to develop the objective function of the bank under these circumstances, it is necessary to note that for the critical values hold $v_1 = v_o = 0$. Now, the bank only has the amount invested in the safe asset at its disposal to overcome the liquidity shortage. Thus, the bank does not fail only if $v(1-k) \leq \lambda$. The probability for this instance is $F\left(\frac{\lambda}{1-k}\right)$. As before, the second condition that the bank continues operating is the receipt of the high return R_1

at $t = 2$. Again, the high return equals $(1 - \lambda)(R(p) - 1) + k$ and it is obtained with probability p.

The objective function of the bank is now:

$$U_B = pF\left(\frac{\lambda}{1-k}\right) \times [(1 - \lambda)(R(p) - 1) + k] - (1 + \delta)k$$

Once more, the equation needed to calculate the bank's equilibrium value p^* is:

$$R(p^*) + p^* R'(p^*) = 1 - \kappa$$

Thus, Repullo's model shows that the existence of an LLR does not affect the risk chosen by the bank at $t = 0$, since the equilibrium value p^* is always calculated with the same equation. Nevertheless, it has an influence on the amount invested in the safe asset and thus on the bank's equity capital.

3.2.2 Calculation

By way of illustration, the effects of the existence of an LLR on the investment in the safe asset and on the bank's capital are shown numerical. For the following variables hold $\kappa = \delta = c = 0.10, q = 0.60$, the bank's high return $R(p)$ equals $3 - 2p^2$ and $F(v) = v^\eta$, whereas $\eta = 0.25$.

The bank's equilibrium value of risk is calculated as follows:

$$\begin{aligned} R(p^*) + p^* R'(p^*) &= 1 - \kappa \\ 3 - 2p^{*2} + p^* \times (-4p^*) &= 1 - 0.10 \\ 3 - 2p^{*2} - 4p^{*2} &= 0.90 \\ -6p^{*2} &= -2.10 \\ p^* &= \sqrt{0.35} = 0.5916 \end{aligned}$$

Thus, regardless of the existence of an LLR, the level of risk chosen by the bank is 0.5916. Now it is possible to compute the critical values v_1^* and v_0^*, which determine the LLR's decision on granting the loan or not.

The critical values v_1^* and v_0^* are:

$$\mathrm{v}_1^* = \frac{\mathrm{c}\times\mathrm{q}\times\mathrm{p}^*}{(1-\mathrm{q})\times(1-\mathrm{p}^*)} = \frac{0.10\times0.60\times0.5916}{(1-0.60)\times(1-0.5916)} = 0.2173$$

$$\mathrm{v}_0^* = \frac{\mathrm{c}\times(1-\mathrm{q})\times\mathrm{p}^*}{\mathrm{q}\times(1-\mathrm{p}^*)} = \frac{0.10\times(1-0.60)\times0.5916}{0.60\times(1-0.5916)} = 0.0966$$

As already mentioned, $v_1^* > v_0^*$ whenever the signal s is informative. The LLR is more willing to grant the loan, if it observes the good signal s_1 as though it monitors the bad signal s_0. In order to calculate the amount invested in the safe asset λ, the formula $k = \kappa(1-\lambda)$ is inserted in the bank's objective function and the function is derived with respect to λ.

The bank's amount invested in the safe asset λ, if an LLR exists, is:

$$U_B = p^*\left[qF\left(\frac{v_1^*+\lambda^*}{1-\kappa(1-\lambda^*)}\right) + (1-q)F\left(\frac{v_0^*+\lambda^*}{1-\kappa(1-\lambda^*)}\right)\right]$$
$$\times\left[(1-\lambda^*)(\mathrm{R}(\mathrm{p}^*)-1) + \kappa(1-\lambda^*)\right] - (1+\delta)\times\kappa(1-\lambda^*)$$

$$\mathrm{U_B} = 0.5916\left[0.60\left(\frac{0.2173+\lambda^*}{1-0.10(1-\lambda^*)}\right)^{0.25} + (1-0.60)\left(\frac{0.0966+\lambda^*}{1-0.10(1-\lambda^*)}\right)^{0.25}\right]$$
$$\times\left[(1-\lambda^*)(3-0.70-1) + 0.10(1-\lambda^*)\right] - (1+0.10)\times0.10(1-\lambda^*)$$

$$\frac{\mathrm{dU_B}}{\mathrm{d}\lambda^*} = -0.8837\left(\frac{\lambda^*+0.2173}{\lambda^*+9}\right)^{0.25} - \frac{1.9404(\lambda^*-1)}{(\lambda^*+9)^2\times\left(\frac{\lambda^*+0.2173}{\lambda^*+9}\right)^{0.75}} - 0.5891\left(\frac{\lambda^*+0.0966}{\lambda^*+9}\right)^{0.25}$$

$$0 = -\frac{1.3114(\lambda^*-1)}{(\lambda^*+9)^2\times\left(\frac{\lambda^*+0.0966}{\lambda^*+9}\right)^{0.75}} + 0.11$$

$$\lambda^* = 0.1060$$

As a consequence, the amount invested in the risky asset accounts for 0.8940, respectively $89.40\,\%$. However, the bank invests more in the safe and liquid asset in the case of no LLR.

If no LLR exists, the bank invests in the safe asset λ:

$$U_B = p^*F\left(\frac{\lambda^*}{1-\kappa(1-\lambda^*)}\right)\times\left[(1-\lambda^*)(R(p^*)-1) + \kappa(1-\lambda^*)\right]$$

$$-(1+\ \delta)\times\kappa(1-\lambda^*)$$

$$U_B = 0.5916\left(\frac{\lambda^*}{1-0.10(1-\lambda^*)}\right)^{0.25}\times[(1-\lambda^*)(3-0.70-1)+0.10(1-\lambda^*)]$$
$$-(1+0.10)\times 0.10(1-\lambda^*)$$

$$\frac{dU_B}{d\lambda^*} = -1.4729\left(\frac{\lambda^*}{\lambda^*+9}\right)^{0.25}-\frac{3.3139(\lambda^*-1)}{(\lambda^*+9)^2\times\left(\frac{\lambda^*}{\lambda^*+9}\right)^{0.75}}+0.11$$

$$\lambda^* = 0.2308$$

Therefore, the bank increases its investment in the safe asset by $12{,}48\,\%$ in the absence of an LLR. This is a corollary due to the fact that in the absence of an LLR, the bank has to overcome the liquidity shortage by the safe asset as its liquidity buffer. The amount invested in the safe asset λ^* also influences the bank’s equity capital k^*, since $k^* = \kappa(1-\lambda^*)$.

Thus, the bank’s capital in the case of the existence of an LLR amounts to:

$$k^* = \kappa(1-\lambda^*) = 0.10(1-0.1060) = 0.0894$$

If there is no LLR, the amount of the bank’s equity capital is:

$$k^* = \kappa(1-\lambda^*) = 0.10(1-0.2308) = 0.0769$$

As a result a higher liquidity buffer, which occurs in the case of no LLR, leads to a lower amount of equity capital and vice versa to a higher amount of deposits. It is also possible to compute the likelihood that the bank’s investment in the safe asset is sufficient to cope with the withdrawal of deposits.

If there is an LLR, the probability that the bank gets over the liquidity shortage without the help of the LLR is:

$$F\left(\frac{\lambda^*}{1-k^*}\right) = \left(\frac{0.1060}{1-0.0894}\right)^{0.25} = 0.5842 = 58.42\,\%$$

The likelihood that the bank manages the liquidity shortage in the absence of an LLR is:

$$F\left(\frac{\lambda^*}{1-k^*}\right) = \left(\frac{0.2308}{1-0.0769}\right)^{0.25} = 0.7072 = 70.72\ \%$$

Hence, the likelihood that the bank’s investment in the safe asset is sufficient to cope with the withdrawal of deposits, is larger in the case of no LLR. This is consistent with the fact that the bank increases its liquidity buffer if there is no LLR at its disposal at $t = 1$. The larger the liquidity buffer is, the greater is the amount available to repay depositors at $t = 1$. Next, it is possible to calculate the probability that the bank gets the high return at $t = 2$ and the amount of the high return.

In the case of the presence of an LLR, the probability of the high return and its expected amount are the following:

$$\Pr(R_1) = p^*\left[qF\left(\frac{v_1^*+\lambda^*}{1-k^*}\right) + (1-q)F\left(\frac{v_0^*+\lambda^*}{1-k^*}\right)\right]$$

$$\Pr(R_1) = 0.5916\left[0.60\left(\frac{0.2173+0.1060}{1-0.0894}\right)^{0.25} + (1-0.60)\left(\frac{0.0966+0.1060}{1-0.0894}\right)^{0.25}\right]$$

$$\Pr(R_1) = 0.4365$$

$$U_B = p^*\left[qF\left(\frac{v_1^*+\lambda^*}{1-k^*}\right) + (1-q)F\left(\frac{v_0^*+\lambda^*}{1-k^*}\right)\right] \times [(1-\lambda^*)(R(p)-1) + k^*] - (1+\ \delta)k^*$$

$$U_B = 0.4365 \times [(1-0.1060)(3-0.7-1) + 0.0894] - (1+0.10)0.0894$$

$$U_B = 0.4480$$

If there is no LLR, the likelihood of the high return and its expected amount are:

$$\Pr(R_1) = \mathrm{p}^*\mathrm{F}\left(\frac{\lambda^*}{1-\mathrm{k}^*}\right)$$

$$\Pr(R_1) = 0.5916\left(\frac{0.2308}{1-0.0769}\right)^{0.25}$$

$$\Pr(R_1) = 0.4184$$

$$\mathrm{U_B} = \mathrm{p}^*\mathrm{F}\left(\frac{\lambda^*}{1-\mathrm{k}^*}\right) \times [(1-\lambda^*)(\mathrm{R(p)}-1) + \mathrm{k}^*] - (1+\ \delta)\mathrm{k}^*$$

$$\mathrm{U_B} = 0.4184 \times [(1-0.2308)(3-0.7-1) + 0.0769] - (1+0.10)0.0769$$

$$U_B = 0.3659$$

Both, the probability of the high return and the expected amount of the high return are higher if there is an LLR. The reason is that the bank invests more in the risky asset $1 - \lambda^*$ compared to the case where an LLR does not exist. The investment in the risky asset yields a higher return than investing in the safe asset.

In summary, the most important results are that the presence of an LLR does not encourage the bank to raise the level of its risk chosen. However, it reduces the amount invested in the safe asset and thus it increases the bank’s equity capital. The presence of an LLR also increases the probability of the high return and the expected amount of it, since the bank invests less money in the safe asset.

3.3 Model with an LLR and a penalty rate

Now, Repullo extends his model. He assumes that an LLR exists, but it charges a penalty rate as compensation for granting a loan. The penalty rate is denoted by the variable r, it is exogenously defined and thus not set by the LLR and for it holds $r > 0$. If $v(1-k) \leq \lambda$, there are no changes in comparison to the remarks aforementioned. The bank is able to overcome the liquidity shortage by itself and does not need the LLR. However, if $v(1-k) > \lambda$, the bank will apply for a credit. Now, the model slightly changes. On the one hand, the new assumption concerning the penalty rate influences the readiness of the LLR to grant a loan. On the other hand, it affects the bank’s objective function.

3.3.1 Objective function of the LLR

As determined in the model above, the LLR’s decision on lending depends on the costs and earnings resulting from it and on the costs arising from a bank failure. Either the LLR approves the loan at $t = 1$ and recovers the money at $t = 2$, or it does not approve it, respectively, it does not get its money back at $t = 2$. First, the LLR monitors the signal s. If it convinces the LLR to accommodate the loan, it will get the money back at $t = 2$ with the probability $\Pr(R_1|s)$. Thus, in this case, the LLR recovers the loan in the amount of $v(1-k) - \lambda$ and it receives the penalty rate

amounting to $r[v(1-k)-\lambda]$. However, with probability $\Pr(R_0|s)$ the LLR will not get its money back. It will lose its loan and it will incur the social cost c. If the signal s does not convince the LLR to grant a loan, the bank will have to be liquidated at $t=1$ and the LLR will definitely bear the social cost c.

Thus, the LLR will approve the loan, if the following condition is fulfilled:

$$r[v(1-k)-\lambda]\Pr(R_1|s)-[v(1-k)-\lambda+c]\Pr(R_0|s)\geq -c$$

Therefore, the LLR's expected payoff, if it grants the loan, has to be higher or at least equal compared to the payoff achieved, if it does not support the bank. The payoff in the case of lending consists of the penalty rate obtained on condition that the bank is successful at $t=2$. However, the payoff contains the loss of the credit approved as well as the cost of the bank failure, provided that the bank finally gets the low return.
As before, the critical values v_1 and v_0, which influence the LLR's decision on lending, have to be determined. Therefore, it is necessary to reshape the above condition:

$$\begin{aligned}
-c &\leq r[v(1-k)-\lambda]\Pr(R_1|s)-[v(1-k)-\lambda]\Pr(R_0|s)-c\Pr(R_0|s)\\
-c(1-\Pr(R_0|s)) &\leq -[v(1-k)-\lambda]\times\left(-r\Pr(R_1|s)+\Pr(R_0|s)\right)\\
\frac{-c\left(1-\left(1-\Pr(R_1|s)\right)\right)}{\Pr(R_0|s)-r\Pr(R_1|s)} &\leq (-v(1-k)+\lambda)\\
\frac{-c\Pr(R_1|s)}{\Pr(R_0|s)-r\Pr(R_1|s)} &\leq (-v(1-k)+\lambda)\\
\frac{\frac{-c\Pr(R_1|s)}{\Pr(R_0|s)-r\Pr(R_1|s)}-\lambda}{1-k} &\leq -v\\
\frac{\frac{c\Pr(R_1|s)}{\Pr(R_0|s)-r\Pr(R_1|s)}+\lambda}{1-k} &\geq v
\end{aligned}$$

On the one hand, if the lender of last resort observes the good signal s_1, it will support the bank, provided that:

$$v\leq\frac{\frac{cPr(R_1|s_1)}{Pr(R_0|s_1)-rPr(R_1|s_1)}+\lambda}{1-k}$$

$$v\leq\frac{\frac{\frac{c\times q\times p}{q\times p+(1-q)\times(1-p)}}{\frac{(1-q)\times(1-p)}{q\times p+(1-q)\times(1-p)}-\frac{r\times q\times p}{q\times p+(1-q)\times(1-p)}}+\lambda}{1-k}$$

$$v \leq \frac{\frac{c \times q \times p}{q \times p + (1-q) \times (1-p)} \times \frac{q \times p + (1-q) \times (1-p)}{(1-q) \times (1-p) - r \times q \times p} + \lambda}{1-k}$$

$$v \leq \frac{\frac{c \times q \times p}{(1-q) \times (1-p) - r \times q \times p} + \lambda}{1-k}$$

$$v \leq \frac{v_1 + \lambda}{1-k}$$

On the other hand, if the LLR monitors the bad signal s_0, it will grant a loan in the case of:

$$v \leq \frac{\frac{cPr(R_1|s_0)}{Pr(R_0|s_0) - rPr(R_1|s_0)} + \lambda}{1-k}$$

$$v \leq \frac{\frac{\frac{c \times (1-q) \times p}{(1-q) \times p + q \times (1-p)}}{\frac{q \times (1-p)}{(1-q) \times p + q \times (1-p)} - \frac{r \times (1-q) \times p}{(1-q) \times p + q \times (1-p)}} + \lambda}{1-k}$$

$$v \leq \frac{\frac{c \times (1-q) \times p}{(1-q) \times p + q \times (1-p)} \times \frac{(1-q) \times p + q \times (1-p)}{q \times (1-p) - r \times (1-q) \times p} + \lambda}{1-k}$$

$$v \leq \frac{\frac{c \times (1-q) \times p}{q \times (1-p) - r \times (1-q) \times p} + \lambda}{1-k}$$

$$v \leq \frac{v_0 + \lambda}{1-k}$$

Again, $v_1 > v_0$ if $q > \frac{1}{2}$, which means that whenever the signal s is qualitative, the LLR prefers to lend money, when it observes the good signal s_1 than the bad signal s_0.

The formulas of v_1 and v_0 show that the critical values will increase if the penalty rate r rises. This relationship is comprehensible, since a higher penalty rate increases the expected payoff for the LLR.

3.3.2 Objective function of the bank

The bank’s objective function also changes due to the implementation of a penalty rate. Its return in case of success (R_1) equals $(1-\lambda)R(p)-(1-v)(1-k)-(1+r)[v(1-k)-\lambda]$ at $t=2$. Partly new is the last piece $(1+r)[v(1-k)-\lambda]$, which shows that, in contrast to the previous model, it is not enough if the bank only repays its loan. In the case of the high return, it has to repay the loan and it has to pay the penalty rate.

It is possible to further facilitate the formula of the high return:

$$R_1 = (1-\lambda)R(p)-(1-v)(1-k)-(1+r)[v(1-k)-\lambda]$$
$$R_1 = R(p)-\lambda R(p)-(1-k-v+vk)-(v-vk-\lambda+rv-rvk-r\lambda)$$
$$R_1 = R(p)-\lambda R(p)-1+k+v-vk-v+vk+\lambda-r[v(1-k)-\lambda]$$
$$R_1 = R(p)-\lambda R(p)-1+k+\lambda-\ r[v(1-k)-\lambda]$$
$$R_1 = (1-\lambda)(R(p)-1)+k-\ r[v(1-k)-\lambda]$$

As noted above, the bank only applies for a credit, provided that $v(1-k)>\lambda$. Also aforementioned, if the good signal occurs, the LLR will only grant a loan on condition that $v \leq \frac{v_1+\lambda}{1-k}$. Thus, in the case of the appearance of the good signal, the bank borrows money, respectively the LLR lends money whenever for the withdrawal v holds:

$$\frac{\lambda}{1-k} < v \leq \frac{v_1+\lambda}{1-k}$$

The additional expected costs for the bank are:

$$r\left[\int_{\frac{\lambda}{1-k}}^{\frac{v_1+\lambda}{1-k}} [v(1-k)-\lambda]dF(v)\right] Pr(s_1|R_1)$$

The formula shows that the penalty rate depends on the amount of the loan as well as on the likelihood of occurrence of the good signal if the high return is obtained.

$\Pr(s_1|R_0)$ is not relevant, as the bank is not able to pay a penalty rate if it receives the low return. The area between $\frac{\lambda}{1-k}$ and $\frac{v_1+\lambda}{1-k}$ reflects the section, where the LLR accommodates the bank with a loan and hence, charges the penalty rate.

Assuming that the LLR observes the bad signal, it will lend money to the bank, given that $v \leq \frac{v_0+\lambda}{1-k}$.

Now, the bank applies for a loan, respectively the LLR approves it only if:

$$\frac{\lambda}{1-k} < v \leq \frac{v_0+\lambda}{1-k}$$

The expected amount of the penalty rate is:

$$r\left[\int_{\frac{\lambda}{1-k}}^{\frac{v_0+\lambda}{1-k}} [v(1-k)-\lambda]dF(v)\right] Pr(s_0|R_1)$$

Therefore, the adapted objective function of the bank is:

$$U_B = p\left[qF\left(\frac{v_1+\lambda}{1-k}\right) + (1-q)F\left(\frac{v_0+\lambda}{1-k}\right)\right] \times [(1-\lambda)(R(p)-1)+k] - (1+\ \delta)k -$$
$$r \times p \times \left[q \times \int_{\frac{\lambda}{1-k}}^{\frac{v_1+\lambda}{1-k}} [v(1-k)-\lambda]dF(v) + (1-q) \times \int_{\frac{\lambda}{1-k}}^{\frac{v_0+\lambda}{1-k}} [v(1-k)-\lambda]dF(v)\right]$$

In this case the equilibrium level of risk (p^*) depends on the penalty rate r and it is less compared to the case with no penalty rate. The reason is that a penalty rate declines the expected payoff for the bank. Thus, the bank attempts to offset the loss by increasing the risk and, thereby, its expected return in the case of success. As shown in the model without a penalty rate, the lower $\Pr(R_1)$ and thus p^* is, the lower are the critical values v_1^* and v_0^*. However, the penalty rate represents a source of revenue for the LLR. This positive effect outweighs the decrease in v_1^* and v_0^* caused by the decline of p^*. As a consequence, the critical values are higher than before. The rise of the LLR’s readiness to lend decreases the bank’s investment in the safe asset λ^* and as a result, the bank’s equity capital k^* is higher.

3.4 Conclusion

In summary, a comparison of the model with an LLR, the model without an LLR and the model with a penalty rate shows that the existence of an LLR does not influence the level of risk chosen by the bank. In contrast, the presence of a penalty rate decreases p^* and thus increases the risk chosen. At this point, Repullo’s model contradicts Bagehot’s statements.

The investment in the safe asset λ^* is high in the model without an LLR because in this case the bank has to overcome the liquidity shortage v by itself. The bank invests less in the safe asset, if there is an LLR and its investment further decreases, provided that the LLR’s readiness to lend increases.

The bank’s equity capital k^* increases if the investment in the safe asset declines due to the relationship $k^* = \kappa(1 - \lambda^*)$. A rise of the bank’s capital leads to a decrease in deposits $(1 - k^*)$.

The LLR is more willing to grant a loan in the case of a penalty rate, since it raises the expected payoff for the LLR. However, the implementation of a penalty rate diminishes the expected payoff for the bank.

4 Analysis of the last economic crisis

4.1 Emergence of the crisis

One trigger of the latest crisis was the policy of low interest rates, which was pursued by the Fed for many years. It reduced the federal funds rate due to the bursting of the dot-com bubble in 2000 and the terrorist attack on September 11, 2001. Finally, in July 2003, the federal funds rate amounted to 1%, which had been the lowest level for 50 years [35, pp. 19 – 20].

As a result, money was available at a low price and banks increased their lending. Unfortunately, the requirements for obtaining a loan were relaxed and so-called subprime loans were approved. Therefore, the amount of granted mortgage loans increased. However, after a while the creditors further loosened the requirements and even “NINJA” loans were allowed. The term “NINJA” stands for “no income, no job and assets”. As a result of the relaxed requirements, the real estate market boomed and the prices of properties increased by 86% between the beginning of 2000 and the ending of 2006. People with nearly no money at their disposal were offered a loan with a very low interest rate for the first two years. Afterwards, the creditors planned a sharp increase of the interest rates, which was not considered as a problem for the debtors due to the assumed further increase of the real estate prices. In order to pay the higher interest, the homeowners could refinance with a higher mortgage loan [35, pp. 19 – 20].

Besides, the banks did not keep the loans. They founded “SIVs” (structured investment vehicles) [35, pp. 19 – 20] and transferred the loans to them [60, p. 19]. In general, SIVs try to finance debts through the issue of commercial papers. The advantage is that the debts do not appear in the banks’ balance sheets, but in the balance sheets of the SIVs [8, p. 48]. Before the financial crisis, the SIVs invested in so-called “CDOs” (collateralized debt obligations), that is, they appeared as CDOs [60, p. 19]. CDOs are defined as a bunch of loans for instance mortgage loans. The advantage of bundling loans is a risk reduction. If many loans are pooled, it is possible to refinance them in the form of bonds [110]. CDOs belong to the group of “ABS” (asset-backed securities), which means that the basis of the commercial

papers are assets or accounts receivable. In other words, the purchasers of the commercial papers (for instance bonds) have a payment claim, which is backed by accounts receivable. A bundle of loans was taken and divided into different tranches. There were three types of tranches and they were referred to as the “Equity Tranche”, the “Mezzanine Tranche” and the “Senior Tranche”. The Equity Tranche offered the highest interest rate, but the underlying risk was also higher than compared to the other tranches. In contrast, the Senior Tranche was the safest of the tranches and its loans were primarily served. It received a triple-A rating [61, pp. 45-46]. As a consequence, many banks engaged in this investment opportunity [35, pp. 22, 26].

However, over time the debtors could not pay their interest any longer. They tried to sell their houses in order to clear debts. The problem was that nobody wanted to purchase them, since the potential buyers were aware of the fact that the debtors had to sell the houses and therefore, they waited for lower prices [35, pp. 22, 26].

Finally, the bubble burst in 2007. The trigger was the announcement of the investment bank Bear Stearns that two of its hedge funds are insolvent. The crisis did not only affect American banks. It had an impact on many European banks as well as on other markets, like the automobile industry. Below follows an analysis of the effects of the crisis on the Austrian banking sector [35, pp. 22, 26].

4.2 The crisis in Austria and its Bank Aid Package

In Austria, two laws were issued in order to combat the financial crisis. On the one hand, the “Interbankmarktstärkungsgesetz” was introduced. Its purpose was the strengthening of the trust in the interbank market [35, p. 40]. First, the losses of several banks diminished the liquidity available in the market. Second, banks did not confide each other any longer, since they were afraid of further losses [35, p. 22].

Based on the Interbankmarktstärkungsgesetz, “Österreichische Clearingbank AG” was founded by some Austrian banks in 2008 [72]. It borrowed money from banks on its own behalf and lent this money to other banks, [35, pp. 40-41] whereby this process was carried out by means of auctions. The institute transacted short-term

business and therefore tried to improve the equalization of liquidity in the money market. Additionally, the Austrian government assumed liability for these short-term loans in the amount of four billion euros. Altogether, Clearingbank AG conducted 310 auctions, which led to an allocation of 22.5 billion euros and 1.5 billion dollars. Finally, the liability of the Austrian government was not required and Clearingbank AG stopped working at the end of February in 2011 [72]. The introduction of the Interbankmarktstärkungsgesetz and Clearingbank AG shows that the Austrian government attached importance to the functioning of the interbank market. It was aware of the fact that in times of crisis the interbank market may not operate properly due to information asymmetry, and thereby solvent banks are not granted a loan. The fact that this case really occurred, confirms the statements expressed in the literature, which assume that incomplete information may deter banks from lending to other banks [18, pp. 28-31].

On the other hand, the “Finanzmarktstabilitätsgesetz” was issued. Based on this law, the “FIMBAG (Finanzmarktbeteiligung Aktiengesellschaft des Bundes)” was founded in 2008. In contrast to Clearingbank AG, it remains unlimited and is in the ownership of “Österreichische Industrieholding AG (ÖIAG)”. The FIMBAG’s task is the support of the government, if it executes measures according to the Finanzmarktstabilitätsgesetz. Therefore, it is the trustee of the government [88]. The measures include, for example, the assumption of liability for debts of troubled banks and insurance companies, the granting of credit and the acquisition of company shares [69, § 2 (1)]. In any case, the granting of credit was carried out by the supply of so-called Partizipationskapital [88].

On June 18, 2013 the trust assets involve “Partizipationskapital” with a face value of approximately 4 billion euros as well as common stocks of “Kommunalkredit Austria AG” and “KA Finanz AG” [88]. Previously, Kommunalkredit Austria AG and KA Finanz AG were not two independent banks. The division was a consequence of the restructuring of the former Kommunalkredit Austria AG. Nowadays, KA Finanz AG is responsible for the non-strategic business such as the transaction in securities, whereas Kommunalkredit Austria AG carries out the strategic business including for example the support of communes [97, p. 1].

As aforementioned, there are two possibilities how an LLR can provide capital. On the one hand, it can grant a loan to individual banks, which is called discount-window lending. Thereby we distinguish between unsterilized and sterilized discount-window lending. On the other hand, the LLR can provide liquidity to the interbank market as a whole, which means that it makes use of open market operations [20, pp. 5, 11] [18, pp. 30, 35-36]. The provision of Partizipationskapital reminds more of the first possibility, since individual banks were supported. Is it possible to match the supply of Partizipationskapital to unsterilized or sterilized lending, respectively?

Unsterilized discount-window lending takes place if the amount of high-powered money increases. By contrast, sterilized discount-window lending does not affect the sum of high-powered money and the central bank raises the credit amount by selling securities [20, p. 11]. In order to answer the above question, it is necessary to know from where the money which was lent to the banks originated. The Austrian government respectively “Österreichische Bundesfinanzierungsagentur (OeBFA)” raised money by the issue of bonds in 2008 [104]. In Austria, OeBFA is responsible for the debt management as well as the cash management of the Republic. Its target is securing solvency [103]. After the government did not need all funds procured in 2008, it increased its deposits at banks. In 2009, more Austrian commercial banks required support in the form of Partizipationskapital and, again, money was raised by the issue of bonds and money market papers. Once again, more money was mobilized than needed, and, therefore, the Austrian government further increased its deposits at banks [104]. All in all, it seems that in the case of Austria sterilized discount-window lending was applied.

The provision of Partizipationskapital increases a bank’s core capital. If the Austrian government accommodates a bank with it, the bank has to pay a dividend. According to the pre-defined conditions, the requested dividend has to be adequate. Therefore, it amounts to 9.3% per year. This percentage reduces to 8% per year in case the bank repays 110% of the face value or its increase in capital originates from private investors in the minimum amount of 30%. Thereby, the bank has to notice that the original shareholders should represent only a third of the private investors. Furthermore, the requested dividend rises if the bank does not pay the capital back before the expiration of the fifth year after the payment. The dividend increases by

0.5% in the sixth and in the seventh year, it further increases by 0.75% in the eighth year and, finally, it rises by 1% annually from the ninth year on [88].

Additional requirements which have to be fulfilled by debtors are, for example, the increase of lending to Austrian companies and citizens, the preservation of jobs and the securing of a sustainable management [88].

However, banks did not have to provide collateral. The suggestion that the lender of last resort should only grant a loan on condition that the borrower's collateral is of good quality has already been mentioned by Bagehot (1873). Bagehot also proposes that an LLR should charge a penalty rate in return for its lending. The dividend which has to be paid by banks can be regarded as a penalty rate [25, pp. 12-16].

The following tables show the original amount of Partizipationskapital, which was provided by the Austrian government to the individual banks:

Name of bank	Hypo Alpe-Adria	RZB	Volksbanken AG
Year of lending	2008	2009	2009
Amount of Partizipationskapital	900 million euros	1,750 million euros	1,000 million euros

Table 1.1: Provision of Partizipationskapital, Part 1

Name of bank	Erste Bank	BAWAG-PSK
Year of lending	2009	2009
Amount of Partizipationskapital	1,224 million euros	550 million euros

Table 1.2: Provision of Partizipationskapital, Part 2

Source: Data in Table 1.1 and Table 1.2 originate from [41] **Oesterreichische Industrieholding AG** (2010), Geschäftsbericht 2009.

As already mentioned, the literature focuses mainly on a central bank in the context of the question which institution should serve as an LLR. However, in the Austrian case, it seems that the government assumed this duty by means of institutions, e.g., the FIMBAG which were especially founded for it.

Nevertheless, there exists a central bank in Austria, which is named the "Oesterreichische Nationalbank". It is responsible for the execution of the monetary

policy as well as its communication, and it monitors the stability of the economy. The Oesterreichische Nationalbank is part of the European System of Central Banks, which is constituted of the national central banks of all EU member states and the European Central Bank [104].

Furthermore, it belongs to the Eurosystem. This system involves the central banks of the countries which have adopted the euro and the European Central Bank. One of the characteristics of the Eurosystem is a consistent monetary policy among the member states. Its primary target is the securing of price stability [104].

The Oesterreichische Nationalbank's tasks related to the monetary policy mainly include its operational execution, the management of monetary reserves and the issue of bank notes. It states that monetary policy is executed by means of open market operations. Monetary reserves have to be maintained by all banks because of minimum capital requirements. As aforementioned, the bank also monitors the stability of the economy, which implies that it is up to date concerning the condition of the financial institutions and the financial markets. It collaborates with the banking supervision and conducts on-site inspections at banks in order to have current information [104].

The tasks of the Oesterreichische Nationalbank are consistent with the duties which have already been ascribed to central banks by Goodfriend and King (1988). On the one hand, the bank is responsible for the execution of the monetary policy. This task resembles the responsibility for the amount of high-powered money, which is mentioned by Goodfriend and King. On the other hand, the bank monitors the stability of the economy. Additionally, it acts as a lender of last resort in some cases. In 2006, it supported, for example, BAWAG-PSK. The assistance of BAWAG shows that the Oesterreichische Nationalbank acknowledges the LLR function. It is even obliged to assist troubled banks according to law [104]. This responsibility of a central bank is also stated by Goodfriend and King [20, p. 19].

As aforementioned, the Oesterreichische Nationalbank uses open market operations in order to execute monetary policy. However, in the case of BAWAG, it did not make use of open market operations. It provided the bank with liquidity in exchange for

securities [104]. As aforementioned, the provision of Partizipationskapital during the latest economic crisis equals sterilized discount-window lending. Open market operations were also not applied. Goodfriend and King recommend open market operations in all cases, because they induce no monitoring costs and do not encourage excessive risk-taking [20, pp. 19-20].

At first sight, it seems strange that the government and not the Oesterreichische Nationalbank played the major role during the last economic crisis. Although most economists think of a central bank as an LLR, it does not need to be the case. Bordo states, for example, that the LLR function can also be executed by other authorities [7, p. 27].

Despite the question, which institution should serve as an LLR, it seems more important that there is at least one institution which feels responsible for this task. In Austria, two circumstances are fulfilled. First, the Oesterreichische Nationalbank is, together with its subsidiaries “Münze Österreich AG”, “Oesterreichische Banknoten- und Sicherheitsdruck GmbH (OeBS)“ and „Geldservice Austria (GSA)”, the sole institution, which can issue bank notes. The OeNB is the sole owner of Münze Österreich AG as well as OeBS and it is the majority owner of GSA [104]. Second, the Austrian banks are allowed to have deposits. These two attributes are the reasons which necessitate an LLR according to an approach found in the literature [27, p. 276].

4.3 Linking with Repullo’s model[1]

The Austrian case illustrates an example of a bailout. On the one hand, it reminds of Repullo’s model with an LLR, which charges a penalty rate. Otherwise, it is not possible to calculate his model one-to-one. One problem is that Repullo assumes that some depositors withdraw their money before the LLR’s support. In further consequence, the extent of the withdrawal v affects several formulas. Since the above-mentioned banks did not experience a bank run, it is not possible to determine the variable v.

[1] All references to Repullo’s model are based on [59] **Repullo, Rafael** (2005), Liquidity, Risk-Taking, and the Lender of Last Resort, International Journal of Central Banking, Vol. 1, Nr. **2**, pp. 47-80.

Difficulties also arise concerning the determination of the signal s and its quality q, which are observed by the LLR. There is only one sign which shows that the FIMBAG supposed that all banks are overall sound institutions. It is allowed to charge a dividend in the amount of 10% per year, if it grants a distressed bank a loan [88]. The annual financial statements of the diverse banks indicate the conditions which go along with the receipt of the Partizipationskapital and none of the institutions mention a dividend amounting to 10% in the first year. They either pay 9.3% or 8%, which depends on the aforementioned circumstances [3, p. 15], [12, p. 124], [28, p. 171], [51, p. 180], [45, p. 102].

Nevertheless, it is possible to verify some of Repullo's assertions. First, he claims that the presence of a penalty rate increases the risk chosen by the bank. Second, Repullo states that the LLR's willingness to lend rises because of the penalty rate and, therefore, the bank invests less in the safe asset λ. As a consequence, its equity capital k increases due to the relationship $k = \kappa(1 - \lambda)$ and its deposits decline.

These two assertions are now examined using the example of the Austrian banks. However, the following analysis differs from Repullo's model. Repullo investigates the level of risk chosen by the bank and the amount invested in the safe asset at $t = 0$. This means that he uses a date before the LLR accommodated a bank with money. By contrast, the following analysis examines whether banks increased their level of risk and decreased their investment in the safe asset after the receipt of LLR support.

Does this difference matter? The underlying reason for the bank's riskier investments is the attempt of increasing its expected return in case of success in order to offset its losses incurred due to the penalty rate. A penalty rate increases the LLR's willingness to grant a loan and, therefore, the bank invests less in the safe asset.

Although there are differences between Repullo's model and this analysis, the question arises why the aforementioned assertions should not also hold in this case. One cannot preclude that the banks tried to offset their losses by increasing their level of risk afterwards. Additionally, it is possible that they felt safe after the receipt of the first support and, as a consequence, they reduced their safe investment.

4.3.1 Examination of the level of risk

There are some hints in a bank's balance sheet, which allow inferences about its selected risk. One example is the calculation of a bank's regulatory capital. Its amount depends on the "risk-weighted assets". They are computed by determining the risk for each amount receivable. Thereby, the outstanding accounts, which are considered as relatively safe, usually obtain a percentage less than 100%, whereas the accounts receivable, which are regarded as unsafe, get a percentage above 100%. Finally, each amount receivable and its corresponding percentage depending on the risk are multiplied and the total sum represents the risk-weighted assets [58, pp. 26-28].

There are two approaches in order to determine the percentages. Banks can either adopt the standardized approach or the internal ratings-based approach, whereby in the latter case they can choose between the foundation and an advanced approach. The main difference is that the standardized approach includes the usage of external ratings conducted by recognized rating agencies. They allocate a certain credit risk to each debtor subject to the category to which he belongs. By contrast, the internal ratings-based approaches are, as its name implies, based on internal ratings [58, pp. 26-28] and more complex. The distinction between the foundation and the advanced internal ratings-based approach is that the latter is even more complicated, because the bank has to estimate not only the probability of default, but, for instance, also the amount of the bad debt [67, pp. 19-20].

However, the advantage of using a more complex approach is that the bank is able to calculate its credit risk more accurately. As a result, it can diminish the risk-weighted assets and, in further consequence, its regulatory capital, since the provisions of Basel II dictate that the regulatory capital has to account for at least 8% of the risk-weighted assets [9, pp. 9-11].

Another variable which allows inferences about a bank's chosen risk is the risk provisioning. It occurs in the balance sheet as well as in the profit and loss statement. The risk provisioning published in the balance sheet comprises the amount of allowances for financial credit transactions. In the profit and loss statement, it consists of allocations to and releases of allowances for financial and off-balance-

sheet credit transactions as well as write-offs of receivables and subsequent payments of depreciated receivables [11, pp. 83-84]. The main difference between the risk provisioning and the regulatory capital is that the regulatory capital should protect against unexpected losses. By contrast, the risk provisioning should safeguard the banks against expected losses [23, p. 1279], [68, p. 11].

Referring to Repullo's statement that the presence of a penalty rate increases the risk chosen by the bank, it can be concluded that, after the receipt of the "Partizipationskapital", the risk-weighted assets and the risk provisioning of the banks must have risen. This argumentation is a consequence of the fact that higher risks imply higher risk-weighted assets and, finally, a higher regulatory capital [58, p. 27]. Moreover, it is unlikely that the risk provisioning does not rise provided that the bank invests riskier. Certainly, it catches more clients, who indeed become insolvent and face financial difficulties in the future.

Repullo's assertion is verified by means of the annual financial statements published by the five banks which received Partizipationskapital. Therefore the risk-weighted assets and the amount of the risk provisioning are examined as from the year 2007 until the year 2012.

The following table shows the performance of the risk-weighted assets in the above-mentioned period (in thousands of euros, year of receiving the Partizipationskapital is highlighted):

Name of bank	Year	Amount of risk-weighted assets
BAWAG-PSK	2007	24,900,000
	2008	20,837,500
	2009	19,737,500
	2010	21,425,000
	2011	20,512,500
	2012	18,787,500
Erste Bank	2007	95,091,000
	2008	103,663,000
	2009	106,383,000
	2010	103,950,000
	2011	97,630,000
	2012	90,434,000

Name of bank	Year	Amount of risk-weighted assets
Hypo Alpe-Adria	2007	28,246,620
	2008	32,831,625
	2009	27,907,900
	2010	24,611,100
	2011	23,111,000
	2012	21,323,500
RZB	2007	83,090,533
	2008	89,040,288
	2009	74,989,688
	2010	79,995,940
	2011	81,416,287
	2012	72,197,895
Volksbanken AG	2007	38,502,339
	2008	33,262,990
	2009	27,255,125
	2010	25,453,573
	2011	22,946,850
	2012	13,443,438

Table 2: Risk-weighted assets of supported banks

Sources: see below Table 3

The following table shows the performance of the risk provisioning from 2007 to 2012 (in thousands of euros, year of receiving the Partizipationskapital is highlighted):

Name of bank	Year	Amount of risk provisioning
BAWAG-PSK	2007	746,000
	2008	707,000
	2009	852,000
	2010	755,000
	2011	693,000
	2012	666,000
Erste Bank	2007	3,296,453
	2008	3,782,793
	2009	4,954,291
	2010	6,119,058
	2011	7,027,331
	2012	7,643,724

Name of bank	Year	Amount of risk provisioning
Hypo Alpe-Adria	2007	705,266
	2008	1,086,231
	2009	2,447,700
	2010	3,202,700
	2011	3,103,100
	2012	3,073,200
RZB	2007	1,452,505
	2008	2,304,143
	2009	4,176,589
	2010	4,786,675
	2011	5,110,458
	2012	5,715,230
Volksbanken AG	2007	500,761
	2008	496,563
	2009	1,233,691
	2010	1,522,532
	2011	945,744
	2012	1,067,045

Table 3: Risk provisioning of supported banks

Sources: Data in Table 2 and Table 3 originate from the annual financial statements from the respective banks of the years 2009 until 2013: [2] – [6] **BAWAG P.S.K.**, Konzern-Geschäftsbericht, [11], [13] – [16] **Erste Group Bank AG**, Konzernabschluss, [28] – [32] **Hypo Alpe-Adria-Bank AG**, Konzern-Geschäftsbericht, [50] – [54] **Raiffeisen Zentralbank Österreich Aktiengesellschaft**, Geschäftsbericht, [44] – [48] **Oesterreichische Volksbanken-Aktiengesellschaft**, Konzernbericht.

The following line charts provide a graphic representation of the performance of the risk-weighted assets and the risk provisioning (the amount in 2007 is used as base value and depicts 100%):

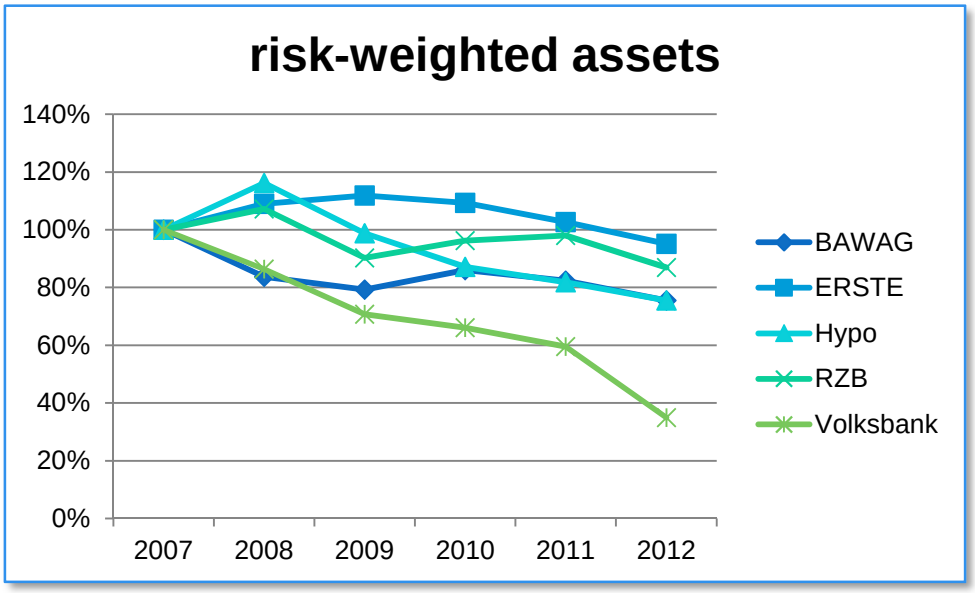

Figure 1: Development of the risk-weighted assets

Source: The figure refers to Table 2.

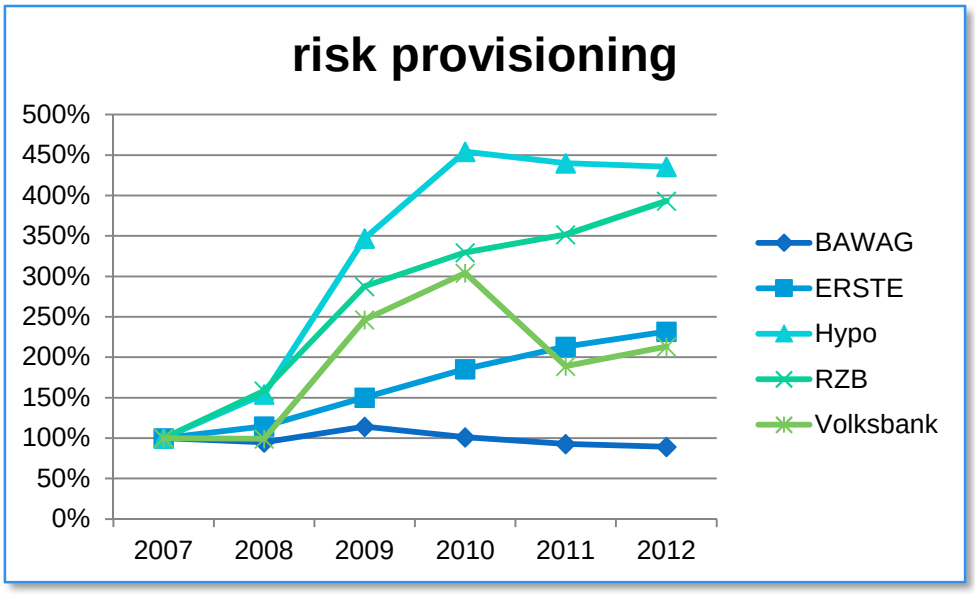

Figure 2: Development of the risk provisioning

Source: The figure refers to Table 3.

In all cases, the risk-weighted assets of the concerned banks decreased over time and in 2012, they even reached the lowest level in the period investigated.

Considering the date of lending, there are only two banks with risen risk-weighted assets in the year after the receipt of Partizipationskapital. These banks are BAWAG-PSK and RZB, whereby in the case of RZB, the risk-weighted assets further increased in the following year, which was the year 2011. Is there a connection between the granting of credit and the short-term increase in risk-weighted assets in the event of these two banks?

RZB provides a compilation which shows the exact composition of the risk-weighted assets. From this, it follows that the increase in 2010 is mainly reduced to a higher risk in the asset classes “companies” and “retail customers (including small and medium-sized business)” [52, p. 206]. In 2011, the segment “companies” is especially responsible for the risen risk-weighted assets [53, p. 189]. However, the bank did not continue enhancing its risky investments.

RZB provides an explanation why there was a sharp decline in 2012. It argues that the reason is a new regulation of the European Banking Authority (EBA). The EBA is an institution of the EU. Its target is the securing of an effective regulation of the European banking sector [87]. According to its new regulation all system-relevant banks had to increase their core capital until it reached a quota of 9% calculated after the new prescription. This regulation should be fulfilled until the end of June 2012 [54, p. 169]. In Austria, Erste Bank, RZB and Volksbanken AG undertook to accomplish the new quota [90].

RZB argues that the decrease in risk-weighted assets was one of the necessary measures in order to increase its core capital [106]. Similarly, Erste Bank ascribes its raise of core capital to its reduction of risk-weighted assets. It states that the reduction was enabled by diminishing its non-core business activities [86]. Although BAWAG-PSK was not obliged to reach a quota of 9% in terms of the core capital calculated after EBA, it states that it reduced its risk-weighted assets in order to improve this rate [76].

Beside the new regulation concerning the core capital, the FIMBAG put pressure on the banks to secure a sustainable management. This requirement involves the reduction respectively abandonment of risky business activities [88].

In conclusion, the analysis shows no correlation between the development of risk-weighted assets and the LLR's support.

The investment decision of banks depends on many factors. Even if, the payment of a penalty rate influences a bank to invest riskier, other factors encourage it to act risk-averse. In the case of a stronger influence of these factors, a bank will finally reduce its risk chosen. As a result, the risk-weighted assets will decrease without showing the extent of the impact of the particular factors.

In contrast to the risk-weighted assets, each bank experienced an increase in risk provisioning except for BAWAG-PSK. The amount of its risk provisioning was lower in 2012 than in 2007. In all remaining cases, the rise constituted even more than 200% at the end of the period investigated. Hypo Alpe-Adria achieved the highest rise amounting to 436%. It is followed by RZB, which experienced an increase of 393% compared to the year 2007.

In case of Erste Bank and RZB, the risk provisioning has constantly grown over time. However, the annual financial statements of the other banks do not show a constant development. Volksbank AG, for example, experienced a huge increase in risk provisioning in 2009 and 2010, whereas in 2011 it showed a sharp decline compared to the year 2010. Is the fact that nearly each bank experienced an increase in risk provisioning until the end of 2012 an indication of riskier investments?

As aforementioned, the crisis, which broke out in 2007, was characterized by debtors who could not repay their loans. This circumstance could have required higher allowances, which cause a higher risk provisioning. Volksbank AG argues, for example, that the economic crisis was the trigger of the huge rise in risk provisioning in 2009 [45, p. 23]. According to it, the crisis worsened the financial situation for many companies and provoked liquidity shortages [45, p. 35].

Summarized, neither the analysis of the risk-weighted assets nor the examination of the risk provisioning support the thesis that the banks increased their level of risk after the receipt of Partizipationskapital.

As already mentioned, a bank's investment decision depends on many factors. The development of the risk-weighted assets shows that the banks' wish to offset their losses incurred by the payment of the dividends did not induce them to invest riskier. Besides, the increase of the risk provisioning is traced back to the tense financial situation of many debtors during the crisis. Over time, more and more loans turned out to be unrecoverable, which explains the ongoing rise of the risk provisioning.

Next, the amounts of risk-weighted assets and the risk provisioning published by Bank Austria and Oberbank are examined in order to improve the significance of the investigation. Both banks have not asked for Partizipationskapital, which is the relevant difference in the context of this analysis.

The following table shows the performance of risk-weighted assets from 2007 to 2012 (in thousands of euros):

Name of bank	Year	Amount of risk-weighted assets
Bank Austria	2007	117,993,000
	2008	133,239,000
	2009	114,386,000
	2010	127,906,000
	2011	125,153,000
	2012	130,067,000
Oberbank	2008	9,965,439
	2009	9,965,722
	2010	9,791,920
	2011	10,139,781
	2012	10,476,930

Table 4: Risk-weighted assets of not supported banks

Sources: see below Table 5

The banks reported the following risk provisioning in the above-mentioned period (in thousands of euros):

Name of bank	Year	Amount of risk provisioning
Bank Austria	2007	3,728,000
	2008	3,938,000
	2009	5,790,000
	2010	6,997,000
	2011	7,762,000
	2012	6,877,000
Oberbank	2008	216,518
	2009	248,981
	2010	312,585
	2011	350,289
	2012	368,825

Table 5: Risk provisioning of not supported banks

Sources: Data in Table 4 and Table 5 originate from the annual financial statements from the respective banks of the years 2009 until 2013: [62] – [66] **UniCredit Bank Austria AG**, Geschäftsbericht, [37] – [40] **Oberbank AG**, Geschäftsbericht.

Interestingly, the development of Bank Austria's and Oberbank's risk-weighted assets is in contrast to the other banks. While the other banks reported a decrease over time, Bank Austria's and Oberbank's risk-weighted assets do not decline from year to year. All of the banks which received Partizipationskapital reached the lowest level of risk-weighted assets in 2012, which was the end of the period investigated. By contrast, Bank Austria and Oberbank showed a higher value in 2012 than in 2007.

Concerning the risk provisioning, Bank Austria as well as Oberbank present a similar development like the majority of the other banks. Their risk provisioning also went up. In 2012, Bank Austria's rise constituted 184%, Oberbank's risk provisioning increased by 170% (the amount in 2007 is used as base value and depicts 100%). Do these facts prove that both banks increased their risky investments in contrast to the supported banks? Were they able to do so, because the strict regulations of the FIMBAG were not valid for them?

First, the question arises whether Bank Austria and Oberbank had an incentive to raise their risk. Both banks did not have to offset losses incurred due to a penalty

rate. Nevertheless, they also suffered from the economic crisis. Bank Austria's annual surplus in 2007 was 2,360 million euros, whereas, in 2008, it was only 1,283 million euros [62, p. 122]. The bank explains the decline with extensive provisions and value adjustments [62, p. 94]. In 2011, the annual surplus even decreased to 258 million euros [65, p. 92]. Oberbank's annual surplus was 105.5 million euros in 2008 and 77.3 million euros in 2009 [37, p. 76].

Thus, Bank Austria and Oberbank published a downward movement of their annual surplus over the years. Nevertheless, this development need not be the reason for an increased risk-taking and a subsequent rise of risk-weighted assets. As aforementioned, the investment decision of banks is too complex in order to draw such conclusions. Besides, Bank Austria's and Oberbank's increase of risk provisioning can be ascribed to the worse financial situation of debtors like in the case of the other banks.

4.3.2 Examination of the amount of equity capital

As aforementioned, Repullo also claims that, in case an LLR exists and charges a penalty rate, the bank diminishes its investment in the safe asset λ, since it feels safer concerning the receipt of LLR support. The decrease in λ increases the bank's equity capital k.

Does a connection between an increase in equity capital and a decline of the investment in the safe asset still exist nowadays? Assuming that a bank invests more money in risky assets than in safe assets raises the amount of its risk-weighted assets. Risen risk-weighted assets lead to an increase in a bank's regulatory capital, since it has to account for at least 8% of them [9, pp. 9-11].

As a result, Repullo's assertion still holds these days. However, the regulatory capital does not only depend on the risk-weighted assets. The market and the operational risk also influence it [104]. Additionally, there is a distinction between the equity capital published in the bank's balance sheet and the regulatory capital. Furthermore, a bank has to report its allowable equity capital, which depicts another variable

related to its equity capital. A surplus of equity capital emerges, if the allowable capital exceeds the regulatory capital [11, p. 148].

This analysis focuses on the amount of allowable equity capital, because it is easier to observe than the level of the investment in the safe asset. It is not concentrated on the equity capital published in the bank's balance sheet. The allowable capital represents the amount which can be used for the fulfillment of the minimum capital requirement. Therefore, it may be a more precise indication of the actual equity base.

The following table shows the performance of the allowable equity capital and the development of the surplus of equity capital. It is examined whether the five banks which received Partizipationskapital experienced an increase in capital from 2007 to 2012 (in thousands of euros, year of receiving the Partizipationskapital is highlighted):

Name of bank	Year	Amount of allowable equity capital	Amount of surplus of equity capital
BAWAG-PSK	2007	2,934,000	906,000
	2008	2,180,000	327,000
	2009	2,829,000	1,033,000
	2010	2,797,000	821,000
	2011	2,785,000	928,000
	2012	2,819,000	1,170,000
Erste Bank	2007	11,114,000	2,345,000
	2008	11,758,000	2,160,000
	2009	15,772,000	5,861,000
	2010	16,220,000	6,633,000
	2011	16,415,000	7,293,000
	2012	16,311,000	7,885,000
Hypo Alpe-Adria	2007	2,872,218	576,588
	2008	4,173,243	1,376,443
	2009	2,999,800	574,100
	2010	2,777,500	610,100
	2011	2,498,700	449,800
	2012	3,057,100	1,173,900

Name of bank	Year	Amount of allowable equity capital	Amount of surplus of equity capital
RZB	2007	10,297,064	2,806,039
	2008	10,801,195	2,296,618
	2009	12,308,247	4,792,338
	2010	12,531,527	4,565,714
	2011	12,724,500	4,742,006
	2012	12,667,432	5,702,221
Volksbanken AG	2007	4,257,831	1,119,572
	2008	3,423,646	606,463
	2009	3,682,461	1,321,397
	2010	3,562,994	1,332,533
	2011	3,326,092	1,225,107
	2012	2,467,494	1,209,884

Table 6: Information about equity capital of supported banks

Sources: Data in Table 6 originate from the annual financial statements from the respective banks of the years 2009 until 2013: [2] – [6] **BAWAG P.S.K.**, Konzern-Geschäftsbericht, [11], [13] – [16] **Erste Group Bank AG**, Konzernabschluss, [28] – [32] **Hypo Alpe-Adria-Bank AG**, Konzern-Geschäftsbericht, [50] – [54] **Raiffeisen Zentralbank Österreich Aktiengesellschaft**, Geschäftsbericht, [44] – [48] **Oesterreichische Volksbanken-Aktiengesellschaft**, Konzernbericht.

The following line charts provide a graphic representation of the performance of the allowable equity capital and the surplus of equity capital (the amount in 2007 is used as base value and depicts 100%):

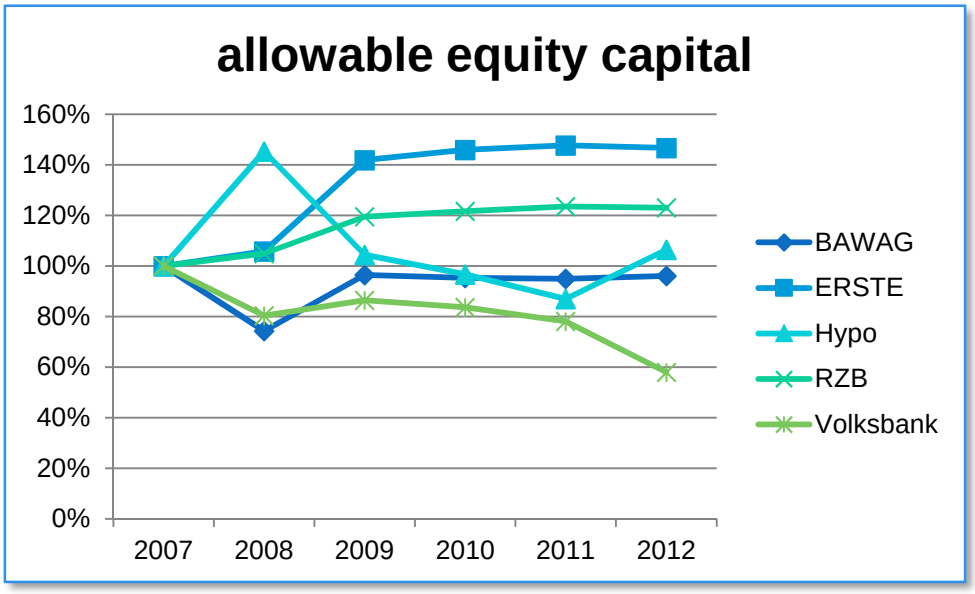

Figure 3: Development of the allowable equity capital

Source: The figure refers to Table 6.

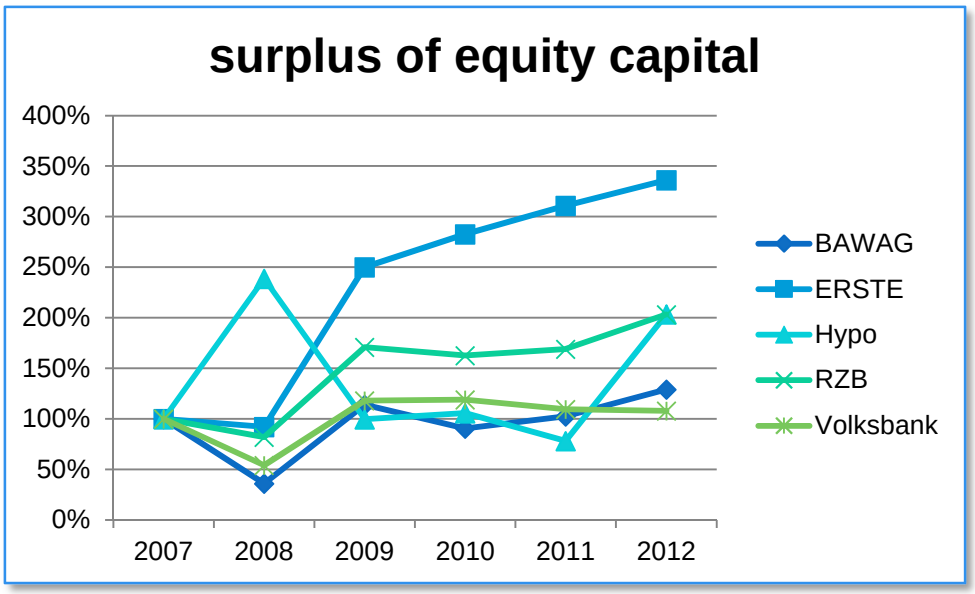

Figure 4: Development of the surplus of equity capital

Source: The figure refers to Table 6.

The analysis shows that the majority of banks reported a higher allowable equity capital in the year 2012 than in 2007. From 2007 to 2008, Hypo's equity capital increased by 145%. The bank argued that the rise was ascribed to the receipt of Partizipationskapital and an increase in capital [28, p. 22]. As above-mentioned, the provision of Partizipationskapital by the government increases a bank's core capital and, therefore, the argumentation is comprehensible.

Another change which is eye-catching is the rise of Erste Bank's allowable equity capital in 2009. According to its annual report, the growth was a consequence of the issue of new shares and, like in the case of Hypo, the Partizipationskapital contributed to the increase [12, p. 2]. All banks published a higher allowable equity capital in the year of receiving the Partizipationskapital.

The following table compares the amount of Partizipationskapital received by each bank and the subsequent increase in its allowable equity capital (in thousands of euros):

Name of bank	Year	Amount of Partizipationskapital	Increase in allowable equity capital
BAWAG-PSK	2009	550,000	649,000
Erste Bank	2009	1,224,000	4,014,000
Hypo Alpe-Adria	2008	900,000	1,301,000
RZB	2009	1,750,000	1,507,000
Volksbanken AG	2009	1,000,000	259,000

Table 7: Information about the increase in allowable equity capital of supported banks

Sources: Data in Table 7 originate from [41] **Oesterreichische Industrieholding AG** (2010), Geschäftsbericht 2009 and the annual financial statements from the respective banks: [3] **BAWAG P.S.K.**, Konzern-Geschäftsbericht 2009, [13] **Erste Group Bank AG**, Konzernabschluss 2009, [28] **Hypo Alpe-Adria-Bank AG**, Konzern-Geschäftsbericht 2008, [51] **Raiffeisen Zentralbank Österreich Aktiengesellschaft**, Geschäftsbericht 2009, [45] **Oesterreichische Volksbanken-Aktiengesellschaft**, Konzernbericht 2009.

The table shows that in case of BAWAG, Erste Bank and Hypo, the increase in allowable equity capital exceeded the amount of Partizipationskapital.

It may be relevant to focus on the surplus of equity capital as well. As already mentioned, regulatory capital depends on legal regulations. Thus, if regulatory capital rises, the bank has increased its investments in riskier assets. Perhaps, the bank raises allowable capital in case it has to augment its regulatory capital. An increase of its capital is anyhow best apparent if the surplus of equity capital goes up independently of the performance of its regulatory and allowable capital.

The figures show that each bank has a higher surplus at the end of 2012 than at the end of 2007. Again, it is comprehensible that, in the year of the receipt of the Partizipationskapital, banks published a higher surplus compared to the previous years.

Next, the amounts of the allowable equity capital as well as the surpluses of equity capital published by the Bank Austria and the Oberbank are examined. As aforementioned, both banks did not receive Partizipationskapital.

The following table shows the above-mentioned figures from 2007 to 2012 (in thousands of euros):

Name of bank	Year	Amount of allowable equity capital	Amount of surplus of equity capital
Bank Austria	2007	13,165,000	3,726,000
	2008	12,251,000	1,592,000
	2009	12,496,000	3,345,000
	2010	15,520,000	5,288,000
	2011	15,878,000	5,863,000
	2012	16,194,000	5,789,000
Oberbank	2008	1,286,080	436,469
	2009	1,534,337	679,539
	2010	1,635,099	789,775
	2011	1,673,128	798,011
	2012	1,762,486	857,897

Table 8: Information about equity capital of not supported banks

Sources: Data in Table 8 originate from the annual financial statements from the respective banks of the years 2009 until 2013: [62] – [66] **UniCredit Bank Austria AG**, Geschäftsbericht, [37] – [40] **Oberbank AG**, Geschäftsbericht.

Both of the banks published a higher equity capital and a higher surplus of capital in 2012 than in 2007. Bank Austria states that its huge rise of equity capital in 2010 is a precautionary measure for the bank's further growth and for the upcoming tightening of the regulatory capital requirements [64, p.11].

The same explanations are found in the annual financial statements of Oberbank. In 2009, the bank stated that its raised equity capital is used in order to enable a business expansion [37, p. 10]. Additionally, in 2012, the bank declared that the regulatory capital requirements demanded because of Basel III are already fulfilled. As a consequence, it will not be necessary that the bank restricts its granting of credit in order to increase its equity capital [40, p. 7].

In conclusion, Repullo's second assertion is also not confirmed. He states that a bank feels safer in case an LLR exists and charges a penalty rate. As a consequence, the bank invests less in the safe asset λ and due to the relationship $k = \kappa(1 - \lambda)$, the bank's equity capital increases.

The above analysis shows that the majority of banks published an increase in allowable equity capital and a rise of the surplus of equity capital over time. However, part of the increase is traced back to the provision of Partizipationskapital, since it raises a bank's core capital. This reason is even mentioned in the annual financial statements of Hypo and Erste Bank.

New and stricter regulations also contributed to the rise of equity capital, which is shown in the financial statements of the supported banks as well as in the financial statements of Bank Austria and Oberbank.

4.4 Differences between supported and forsaken banks

Next, the question appears why the Austrian government saved each bank suffering from the latest economic crisis. Apart from the assistance with Partizipationskapital, it provided other measures as well. In 2009, it assumed for example all shares of Hypo Alpe-Adria, [29, p. 129] and this was not the first case. The takeover of shares of Kommunalkredit Austria AG was already concluded at the beginning of January 2009 [41, p. 22].

Compared to the past, it was not always the case that each bank was supported in Austria. Some of the most recent bank failures were for example the failure of Trigon Bank AG in 2001, the opening of bankruptcy in the case of Diskont Bank AG in 1998 and the bankruptcy of Riegerbank AG in 1998 [107].

As already mentioned, there are different opinions expressed in the literature regarding the support of individual banks, which got into financial difficulties. Thornton (1802) and Bagehot (1873) state that a distressed bank should not be granted a loan if its liquidity shortage accrues from mismanagement and excessive risk-taking propensity. Both argue that the size of the distressed bank does not matter [25, p. 13].

By contrast, Freixas et al. (2002) criticize this opinion. They assume that it is more efficient to rescue an insolvent bank in any case. Together with other authors, they emphasize that distressed banks should especially be saved, if they are large. The

reason is that the failure of a large bank endangers the economy as a whole. This phenomenon is named the “Too-big-to-fail”- problem [18, p. 40] [36, p. 2]. Repullo supposes that an LLR always takes into account the costs and earnings resulting from lending to a bank as well as the costs arising from a bank failure. He does not consider the size of a bank or whether mismanagement led to the failure.

Did the Austrian government not save the above-mentioned banks, because they acted imprudently? In order to answer this question, it is necessary to detect the reasons which caused the insolvency of the banks.

Trigon Bank AG got into financial difficulties due to the payments of high interest rates [99]. Furthermore, it had lent money to insecure debtors, which resulted in high depreciations [101]. The insolvencies of Diskont Bank AG and Riegerbank AG are closely interconnected, as mutual receivables existed [112]. Particularly, the bankruptcy of Riegerbank AG caused a huge scandal since its chief executive officer made off with depositor’s money. Additionally, the balance sheets of the bank were counterfeited and sugar-coated [79]. They published assets which did not exist in reality. In fact, the bank was insolvent [74].

Since Trigon Bank accommodated insecure debtors with money, part of its losses accrued from excessive risk-taking. In any case, one can speak of mismanagement in connection with Riegerbank. Therefore, the argumentation that the Austrian government did not support these banks because of misconduct is comprehensible. However, compared to the latest crisis, the question arises whether all of the distressed banks which received assistance had been led exemplary before. It speaks for the banks that part of the bad loans even received a triple-A rating [61, pp. 45-46] and one could argue that the banks were deceived and did not act imprudently. Furthermore, the question arises, if mismanagement was the only reason which induced the Austrian government to forsake the above-mentioned banks. Certainly, the size of the banks also influenced the government’s decision of offering no support.

An optimal figure in order to appreciate the size of a bank is the balance sheet total. The following table shows the total assets of Riegerbank AG, Diskont Bank AG and

Trigon Bank AG as well as the balance sheet total of the banks, which were supported during the last economic crisis (in thousands of euros, year of receiving the support is used, except for Riegerbank, Diskont Bank and Trigon Bank):

Name of bank	Year	Balance sheet total
Riegerbank AG	1997	43,604
Diskont Bank AG	1997	91,568
Trigon Bank AG	1999	113,079
Kommunalkredit Austria AG	2008	37,456,647
Hypo Alpe-Adria	2008	43,336,051
BAWAG-PSK	2009	41,225,000
Erste Bank	2009	201,513,476
RZB	2009	147,938,248
Volksbanken AG	2009	49,145,593

Table 9: Balance sheet total of forsaken and not forsaken banks

Sources: Data in Table 9 originate from the annual financial statements from the respective banks respectively other sources: [56, p. 15], [113], [73], [34, p. 18] **Kommunalkredit Austria AG**, Geschäftsbericht 2008, [28, p. 93] **Hypo Alpe-Adria-Bank AG**, Konzern-Geschäftsbericht 2008, [3, p. 49] **BAWAG P.S.K.**, Konzern-Geschäftsbericht 2009, [13, p. 88] **Erste Group Bank AG**, Konzernabschluss 2009, [51, p. 122] **Raiffeisen Zentralbank Österreich Aktiengesellschaft**, Geschäftsbericht 2009, [45, p. 99] **Oesterreichische Volksbanken-Aktiengesellschaft**, Konzernbericht 2009.

In case of Riegerbank AG and Diskont Bank AG the balance sheet total of the year before the bank went bankrupt is shown. Trigon Bank AG failed in 2001, but the amount of the total assets shown is the value of 1999. Nevertheless, this value is enough in order to determine that all three banks which were not supported by the Austrian government were much smaller than the other banks.

Another hint concerning the size of a bank is the number of employees. The following table shows the number of employees of Riegerbank AG, Diskont Bank AG, Trigon Bank AG and the above-mentioned supported banks (year of receiving the support is used, except for Riegerbank, Diskont Bank and Trigon Bank):

Name of bank	Year	Number of employees
Riegerbank AG	1996	29
Diskont Bank AG	1997	38
Trigon Bank AG	2000	24

Name of bank	Year	Number of employees
Kommunalkredit Austria AG	2008	314
Hypo Alpe-Adria	2008	8,114
BAWAG-PSK	2009	4,954
Erste Bank	2009	51,799
RZB	2009	59,800
Volksbanken AG	2009	3,666

Table 10: Number of employees of forsaken and not forsaken banks

Sources: Data in Table 10 originate from the annual financial statements from the respective banks respectively other sources: [56, p. 15], [56, p. 47], [110], [34, p. 76] **Kommunalkredit Austria AG**, Geschäftsbericht 2008, [28, p. u1] **Hypo Alpe-Adria-Bank AG**, Konzern-Geschäftsbericht 2008, [3, p. 1] **BAWAG P.S.K.**, Konzern-Geschäftsbericht 2009, [13, p. 109] **Erste Group Bank AG**, Konzernabschluss 2009, [51, p. 2] **Raiffeisen Zentralbank Österreich Aktiengesellschaft**, Geschäftsbericht 2009, [45, p. 1] **Oesterreichische Volksbanken-Aktiengesellschaft**, Konzernbericht 2009.

The number of employees confirms the impression that all banks which were supported during the latest economic crisis are much larger than the forsaken banks. Therefore, one can argue that Riegerbank, Diskont Bank and Trigon Bank were not saved because they were characterized by mismanagement as well as excessive risk-taking and because they were small banks.

It is difficult to verify Repullo's assertion that an LLR makes its decision conditional on the costs and earnings resulting from lending. There are many variables which are complicated to determine exactly. Complex is, for example, the specification of the numerical values of the signal s and its quality q. Both parameters influence the LLR's decision.

Another problem is the determination of the numerical value of the social cost c, which represents the expense arising from a bank failure. These expenses arise from the costs of closing a bank, the loss of the bank's customer relations, contagion effects and the repayment of all deposits. Although it is not possible to set a numerical value of the social cost c, it is obvious that these costs have to be higher if a bank is larger. A larger bank has more customers and hence more deposits. As a consequence, more customer relations are lost provided that a large bank fails and

so on. Finally, it is not feasible to preclude Repullo's thesis that an LLR cares about the costs arising from a bank failure and that it was just not efficient to save the banks.

In summary, there are many reasons imaginable, which induced the Austrian government to forsake Trigon Bank AG, Diskont Bank AG and Riegerbank AG. Certainly, the government was not only influenced by the above-mentioned factors. The expected future development of a bank after the receipt of LLR support or the amount of money which would be necessary for favorable future prospects played for sure a role. However, the facts that the forsaken banks were characterized by mismanagement and a smaller size than for example Erste Bank influenced the government certainly. Additionally, saving the banks was not as efficient as in the case of the assisted banks.

4.5 Effects of the support on the banks and on the whole economy

Another point which is worth considering is the question whether the support of the troubled banks seems ultimately to be the right decision. Thornton (1802) and Bagehot (1873) emphasize that an LLR should primarily focus on the general interests and not on the interests of an individual bank [25, p. 10-12]. Of course, forsaking of a bank does not only have consequences for the bank itself, but also for the whole state and, in most cases, for other states as well. Nevertheless, the analysis starts with the examination whether the support has helped the individual banks.

First, it is investigated if the banks were able to increase their annual surpluses, which is partly a sign of a sound institution.

The following table shows the annual surpluses after tax and before minority interest from 2007 to 2012 (in thousands of euros, year of receiving the Partizipationskapital is highlighted):

Name of bank	Year	Annual surplus
BAWAG-PSK	2007	- 464,700
	2008	- 714,800
	2009	165,100
	2010	136,600
	2011	120,800
	2012	136,300
Erste Bank	2007	1,549,954
	2008	1,038,602
	2009	976,629
	2010	1,043,310
	2011	- 562,568
	2012	631,010
Hypo Alpe-Adria	2007	- 70,337
	2008	- 518,254
	2009	- 1,550,600
	2010	- 1,079,000
	2011	69,300
	2012	3,000
RZB	2007	1,190,075
	2008	431,978
	2009	570,623
	2010	1,168,244
	2011	728,465
	2012	630,888
Volksbanken AG	2007	345,910
	2008	- 210,869
	2009	- 1,115,606
	2010	- 1,368,000
	2011	- 1,059,764
	2012	440,131

Table 11: Annual surplus of supported banks

Sources: see below Table 12

Another indication of the condition of a bank is its number of employees. A reduction in staff mostly comes along with decreased revenues or a downturn. As aforementioned, the banks did only receive Partizipationskapital on condition that

they preserve the jobs. Therefore, they were actually not allowed to lay off employees and a reduction can only occur, if they did not hire new personnel whenever someone retired.

The following table shows the number of employees from 2007 to 2012 (year of receiving the Partizipationskapital is highlighted):

Name of bank	Year	Number of employees
BAWAG-PSK	2007	6,626
	2008	5,351
	2009	4,954
	2010	4,812
	2011	4,038
	2012	4,003
Erste Bank	2007	52,352
	2008	53,847
	2009	51,799
	2010	50,386
	2011	50,167
	2012	49,537
Hypo Alpe-Adria	2007	7,542
	2008	8,114
	2009	7,546
	2010	7,624
	2011	7,690
	2012	6,576
RZB	2007	61,351
	2008	66,651
	2009	59,800
	2010	60,356
	2011	59,836
	2012	60,694
Volksbanken AG	2007	8,055
	2008	8,255
	2009	3,666
	2010	3,540
	2011	2,038
	2012	1,912

Table 12: Number of employees of supported banks

Sources: Data in Table 11 and Table 12 originate from the annual financial statements from the respective banks of the years 2009 until 2013: [2] – [6] **BAWAG P.S.K.**, Konzern-

Geschäftsbericht, [11], [13] – [16] **Erste Group Bank AG**, Konzernabschluss, [28] – [32] **Hypo Alpe-Adria-Bank AG**, Konzern-Geschäftsbericht, [50] – [54] **Raiffeisen Zentralbank Österreich Aktiengesellschaft**, Geschäftsbericht, [44] – [48] **Oesterreichische Volksbanken-Aktiengesellschaft**, Konzernbericht.

The following line charts provide a graphic representation of the performance of the annual surplus and the number of employees (annual surplus: in millions of euros and in contrast to the other line charts not expressed as a percentage, number of employees: the amount in 2007 is used as base value and depicts 100%):

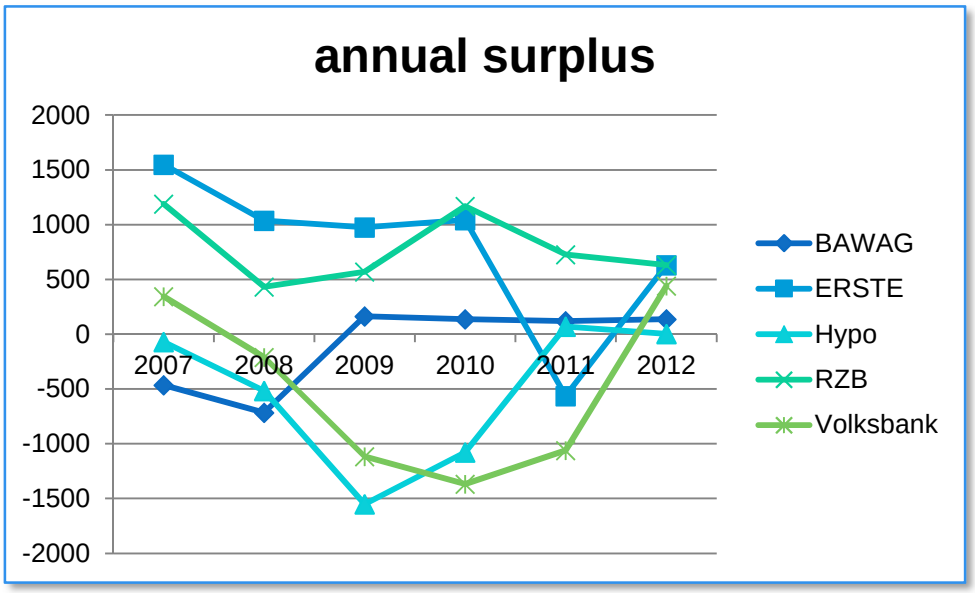

Figure 5: Development of the annual surplus

Source: The figure refers to Table 11.

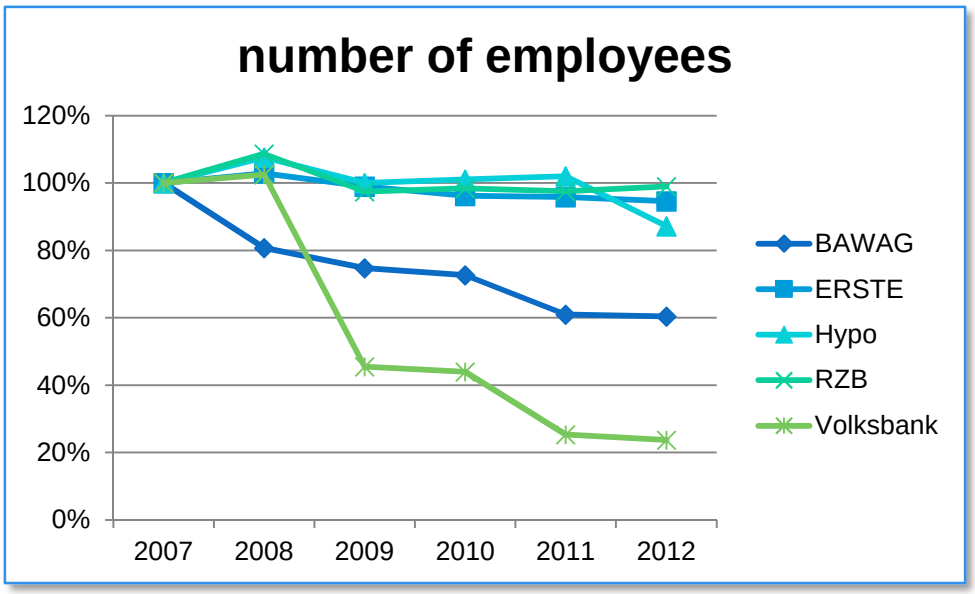

Figure 6: Development of the number of employees

Source: The figure refers to Table 12.

The analysis of the development of the annual surplus does not show a consistent course for all examined banks. In case of BAWAG-PSK, Erste Bank and Volksbanken AG, the annual surplus was higher in 2012 than in 2007. By contrast, Hypo Alpe-Adria and RZB reported a lower amount in 2012. Nevertheless, the analysis shows that all banks suffered from the economic crisis, since all of them underwent profit collapses. However, the time of their greatest loss is different. While BAWAG's and RZB's annual surplus reached the low point in 2008, Volksbank reported its biggest loss in 2010. Any bank except for RZB also revealed a negative value at least once in the period investigated.

Hypo Alpe-Adria and Volksbanken AG registered the hugest losses. Their loss exceeded 1 billion euros. Therefore, these two banks suffered most from the crisis taking into account the annual surplus.

The decline of Erste Bank's annual surplus in 2011 is also eye-catching. The bank argues that this decline was caused by one-time items, which included amortizations of goodwill in Hungary and Romania as well as losses resulting from an investment portfolio [15, pp. 95, 105].

Finally, none of the supported banks except for BAWAG showed an immediate improvement of its annual surplus after the receipt of Partizipationskapital. Otherwise, none of them reported a huge loss in 2012. Certainly, the recovery is a protracted process and as a consequence, rapid improvements are not possible. Additionally, the whole extent of the crisis becomes visible over time. Without the support of the government, the figures would be even worse most likely.

The analysis of the number of employees over the years shows more consistent results than the development of the annual surplus. Without exception the banks had more employees in 2007 than at the end of the period investigated. Like before, the figure shows that the economic crisis impacted each bank. Volksbanken AG reported the largest reduction in staff. In 2012, its number of employees had decreased by 76% compared to the year 2007. The second largest reduction was noted at BAWAG-PSK. In 2012, it employed 40% less employees than in 2007.

A decline in the number of employees of more than 50% is published by Volksbanken AG in 2009. However, part of the reduction is the result of the exclusion of the disposal group in 2010 (number of employees in 2009 has been adjusted afterwards in order to obtain a better comparability) [46, p. 2]. A disposal group according to IFRS 5 is defined as a unit of assets and liabilities, which should be sold as a whole [77]. In case of Volksbanken AG, “VB Linz+Mühlviertel” depicted the disposal group [46, p. 37]. Furthermore, part of the huge decline can be traced back to the adaption because of IAS 8 in 2011. IAS 8 requires that a change of the accounting policies must involve an adjustment of the figures of the previous periods [47, p. 69].

In case of BAWAG, the reduction in staff in 2011 is partly the consequence of the sale of the company Stiefelkönig [5, p. 1]. Thereby, the bank’s investment portfolio changed [5, p. 34].

Despite all of the above-mentioned factors, it seems that all banks did not have enough resources in order to hire new personnel, whenever someone retired.

In summary, none of the banks increased or kept their number of employees. However, all of the employees would have become unemployed in case of a bank failure and thus, the provision of Partizipationskapital has saved jobs certainly.

Next, it is analyzed whether the assistance of the troubled banks was the right decision with regard to the Austrian economy. Therefore, it is relevant if the banks will repay the Partizipationskapital.

BAWAG-PSK is the first bank which started with the repayment. In 2013, it refunded 50 million euros. The fact that the bank has to pay a higher amount in return for the capital from the sixth year on (that is 2014) seems to be the main reason for the repayment of the first tranche [80]. As aforementioned, the requested dividend increases by 0.5% in the sixth year after the receipt of Partizipationskapital.

Furthermore, Erste Bank plans to repay the whole amount of its Partizipationskapital in the third quarter of 2013. It also argues that the increase of the costs has been the decisive factor. Besides, the banks will not be allowed to allocate the Partizipationskapital to the core capital in future due to new regulatory requirements. Erste Bank also cites this circumstance as one reason [85].

By contrast, RZB has not decided on the time of its repayment yet. It is also uncertain whether the bank will pay back the whole amount at a single blow or whether it will divide the sum into parts [71].

In case of Hypo and Volksbanken AG, the Austrian government incurred depreciations on the Partizipationskapital. Volksbanken AG received 1,000 million euros in 2009. At the end of 2012, FIMBAG reported that the outstanding amount accounts for 300 million euros, which shows that the government faced a depreciation of 700 million euros [43, p. 34], [100]. Hypo received 900 million euros in 2008. However, in 2011, the amount of Partizipationskapital accounted for 275 million euros [42, p. 36], since the general assembly decided on a capital reduction in order to compensate the loss of 2010 [95], [98].

Furthermore, both banks never paid interest [108]. Thus, the question arises if the support of Hypo and Volksbanken AG really paid off.

As already mentioned, the government assumed all shares of Hypo in 2009. This incident took place after the bank had already obtained support in the form of Partizipationskapital in 2008. In 2013, there are still no positive headlines about the bank. It was planned that the Austrian government will provide another 700 million euros in this year. Finally, this sum is already needed for the creation of the semi-annual financial statements, since the bank expects a loss amounting to more than 970 million euros. Thereby, the loss will even exceed half of the bank's nominal capital [93]. The latest recovery plan includes the sale of the Austrian as well as the Southeast European subsidiary. Furthermore, the government already considers whether it should establish a bad bank or not. The purpose of such a bank is the taking over of Hypo's bad loans [82].

Should the government have let Hypo fail? Saving the bank has already cost approximately 3 billion euros [93]. In 2013, the Oesterreichische Nationalbank has compiled an internal document concerning the further possibilities. It states that an immediate liquidation of the bank would cause costs amounting to 16 billion euros, whereby the state would have to bear 14 billion euros. Moreover, the Nationalbank adverts to the risk that an immediate liquidation promotes the emergence of a bank run [81].

In 2009, experts have already quoted several reasons which speak for the rescue of Hypo apart from the costs. They criticize that Austria has no ideal insolvency law and that a processing of the liquidation would have lasted for many years. Furthermore, they state that a bankruptcy of Hypo would also have led to an insolvency of its subsidiaries in Southeastern Europe. The consequences for this region would have been enormous, since there is no deposit insurance.

A bankruptcy would have also had a negative impact on the labor market. In Austria alone, 1600 employees would have lost their job. As a consequence, high costs would have originated just because of the unemployment benefit, which the state would have had to pay. Furthermore, costs would have been caused due to the

insolvency of the state Carinthia. This insolvency would have been unavoidable, after Carinthia had assumed a deficiency guarantee in the amount of 19 billion euros in case Hypo fails. As a result, Austria's deficit would have increased to 7%. Thereby, the country would have faced a loss of reputation and higher financing costs. Besides, economists assume that the influence of Austria on Southeastern Europe would have been weakened.

Volksbanken AG which is, as aforementioned, the second bank with huge losses, has also not attracted attention with positive news. Beside the provision of Partizipationskapital in 2009, further measures were necessary in order to save the bank. Therefore, the Austrian government allocated another 250 million euros and became a co-owner of the bank. In addition, the government provided a guarantee amounting to 100 million euros.

Although the saving of Volksbanken AG cost more money than initially thought, the government still defends its measures. According to it, the use of the deposit insurance as well as liabilities arising in case the bank fails would have caused costs in the amount of 13 billion euros.

Taking into account the development of annual surplus and the development of the number of employees, supporting the banks has helped them to improve these figures certainly. Without the assistance of the government and in case of bank failures, all employees would have lost their jobs.

Concerning the effects on the whole economy, different opinions exist whether the government should have let especially Hypo fail. It is difficult to make a point in this case.

4.6 Conclusion

In summary, the recent economic crisis was caused by the policy of low interest rates in America. It had far-reaching effects on the Austrian banks as well. However, the Austrian government acted promptly and issued the "Interbankmarktstärkungsgesetz" and the "Finanzmarktstabilitätsgesetz". The latter law enabled the government with

the assistance of FIMBAG to accommodate troubled banks with Partizipationskapital. Finally, BAWAG-PSK, Erste Bank, Hypo Alpe-Adria, RZB and Volksbanken AG made use of this measure.

The above analysis continues with an investigation of two of Repullo's statements. First, it is examined whether the penalty rate charged in return for the Partizipationskapital encourages a bank to invest riskier. Second, the analysis deals with the question, if the increased LLR's willingness to support distressed banks diminishes a bank's investment in the safe asset. Such a decrease comes along with a rise of equity capital. Finally, both assertions cannot be confirmed.

Next, it is analyzed why the government supported all of the distressed banks. Different reasons are imaginable. On the one hand, the Too-big-to-fail- problem is present in this case. Otherwise, a failure of the supported banks would have implied high social costs c.

At the end, it is investigated if the support had positive effects on the banks respectively the Austrian economy. Hypo and Volksbanken AG are the worst affected banks at first sight. Their saving cost more than originally assumed. Nevertheless, the government defends its decision even in case of these two banks.

5 Conclusion

Many economists have dealt with questions arising in connection with the LLR function, and different opinions have evolved. One main topic is the moral hazard problem, which emerges from the fact that it is not the bank managers who are held responsible for a loss.

The first extensive concepts were published by the British economists Henry Thornton and Walter Bagehot in the nineteenth century. Both thought that an individual bank should not be saved if its liquidity shortage accrues from mismanagement. Thereby, the size of the bank does not matter. Yet, negative effects on sound banks or on the whole economy due to the failure of such a bank should not be ignored. The LLR should intervene and provide the market with more liquidity. By means of this behavior, they thought that the LLR can mitigate the moral hazard problem.

There are other authors as well who share the opinion of Henry Thornton and Walter Bagehot. These economists advocate the use of open market operations instead of saving an individual bank. Open market operations can actually be compared with the aforementioned provision of liquidity for the market. In detail, this means that liquidity is provided to the interbank market, which will allocate money to banks suffering from the liquidity shortage. Nevertheless, other banks with a surplus of liquidity will not accommodate insolvent banks with money.

However, there are also economists who disagree with Thornton and Bagehot. Freixas, Giannini, Hoggarth and Soussa for example argue that it is more efficient to rescue an insolvent bank. First, the failure of a bank causes a loss of the relations to its debtors. Second, it endangers other banks, which have lent money to the bank or which experience a bank run caused by the run on the failed bank. Many economists also contradict Thornton's and Bagehot's statement that the size of an insolvent bank does not matter. They refer to the "Too-big-to-fail"- problem, which means that the collapse of a large bank endangers the whole economy.

Rafael Repullo shows with his model the lender of last resort's motivations, which determine his decision on the granting of credit. First, the LLR cares about the costs and earnings resulting from lending to the bank. Therefore, he examines the value of the signal s and its quality q, which allow inferences about the return of the bank's risky investment. He also investigates the bank's investment in the safe asset λ as well as its equity capital k. The higher both variables are, the less risky it is to support the bank. Finally, the LLR cares about the extent of the withdrawal by depositors v.

Second, the LLR's decision to lend or not to lend depends on the costs caused by a bank failure. At this point, Repullo agrees with Freixas, Giannini, Hoggarth and Soussa who consider the loss of the bank's customer relations and contagion effects.

Thus, Repullo presents assumptions, which contradict the opinion of some economists partly. He also disagrees with Bagehot concerning the utility of a penalty rate. Bagehot stated that the LLR should charge a penalty rate because it fosters the quick repayment of the loan and avoids that overcautious institutions apply for a credit. Furthermore, it protects the domestic reserves, since foreign capital becomes more attractive and it allows inferences about the solvency of a potential borrower.

By contrast, Repullo proved with his model that the presence of a penalty rate encourages a bank to invest riskier. The reason is that the bank wants to offset the loss with a higher expected return in case of success.

However, Freixas, Giannini, Hoggarth and Soussa also criticize Bagehot's suggestion of charging a penalty rate. They argue that a penalty rate aggravates the bank's financial position and increases the likelihood of a bank run. Like Thornton, they advert to the probability that a bank wants to offset its losses if it faces a penalty rate.

Finally, the measures taken by the Austrian government in order to combat the financial crisis are analyzed. Although many economists advise against the support of individual banks, the Austrian government accommodated five banks with Partizipationskapital. These banks are BAWAG-PSK, Erste Bank, Hypo Alpe-Adria, RZB and Volksbanken AG. However, these banks had to pay a dividend in return for the Partizipationskapital.

The situation can be compared with Repullo's model of an LLR, which demands a penalty rate. As a result, two of his findings are investigated, using the example of the supported Austrian banks.

Repullo's first statement is that a bank faced with a penalty rate invests riskier than another bank. In order to verify this assertion, the development of the risk-weighted assets and the risk provisioning of the supported banks is investigated.

The examination shows that each of the supported banks confronts an increase in risk provisioning, whereas the risk-weighted assets have decreased in all cases. It seems consistent that the increase in risk provisioning is a result of more troubled debtors, who were again one consequence of the crisis. This assumption is also confirmed by the contrary development of the risk-weighted assets, since an increased willingness to take risks have also to be visible there in all likelihood. Finally, Repullo's assertion is not confirmed. Investing with a higher risk would have been complicated due to a new minimum capital requirement of the EBA and the stricter supervision of the supported banks by the FIMBAG.

The second statement of Repullo claims that in case an LLR exists and charges a penalty rate, the bank increases its equity capital. This assertion is examined by the amounts of allowable equity capital and the amounts of surplus of equity capital published by the banks over time.

The majority of banks reported a higher allowable equity capital and all banks showed a higher surplus at the end of the period investigated. However, it has to be considered that the provision of Partizipationskapital increased the bank's equity capital as well as the banks had to prepare for the imminent stricter regulations of Basel III. Therefore, Repullo's second assertion is also not confirmed.

Finally, the question arises whether supporting all of the troubled banks was the right decision. It had not always been the case that each bank suffering from a liquidity shortage was saved in Austria. This also holds for the last economic crisis. In 2008, the forsaking of Lehman Brothers caused a sensation and worsened the economic situation around the world.

There is always a microeconomic and a macroeconomic perspective. Maybe the provision of capital did not have the desired outcome concerning a bank.

Nevertheless, it is possible that it was the right decision with regard to the whole economy. In Austria, the development of the annual surplus and the number of employees do not really show a strong improvement after the banks had received Partizipationskapital. However, the Austrian government defends its course. It states that the failure of the banks would have cost even more.

In any case, it is a controversial topic whether banks should be saved or not. The fear that banks act too recklessly, provided that they feel certain about the credit accommodation in times of crisis, exists.

Finally, it is possible to find reasons for and arguments against the supporting of distressed banks. The first reason, which speaks for the assistance refers to the fact that insolvencies often cost more than rescues. Second, the insolvency of one bank may ruin other banks as well. A reasonable compromise is the charging of a penalty rate or a profit participation of the government, since such measures diminish the costs for it. Besides, a good solution depicts the approach that banks pay for their own rescue and the burden is not born by the taxpayers alone. In Austria, the government is trying to implement it. It has decided that all banks should pay higher taxes in order to finance the rescue of Volksbanken AG [83].

Nevertheless, there are arguments against the assistance of banks as well. A good example that the decision of not accommodating banks with money does not have to destroy the whole economy is Iceland. The country did not grant loans during the latest economic crisis and let banks fail. Surprisingly, it got fast over the crisis. According to the economist Philipp Bagus, troubled banks should not be saved. He states that this is better, since they will fail anyway because they are not competitive enough [84].

It is difficult to decide whether a bank should be saved or not and it seems that there is no universally valid solution. Perhaps, the best strategy is the evaluation in individual cases.

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Appendix

Abstract in English

This master thesis deals with the term „lender of last resort”. Normally, it is referred to a central bank as an LLR. It is expected that a central bank supports distressed banks in times of crisis. A mathematical model is presented in addition to an extensive analysis of the literature addressing this topic. The model shows whether the existence of an LLR increases a bank’s willingness to take risks. Finally, the economic crisis, which came up in 2007, is used as an example. The validity of the theoretical statements of diverse economists as well as the validity of the model’s implications is verified.

Abstract in German

Diese Masterarbeit beschäftigt sich mit dem Begriff „Lender of Last Resort“. Als Kreditgeber der letzten Instanz bezeichnet man in der Regel die Zentralbank eines Landes. Man erwartet von ihr, dass sie notleidende Banken in einer Krise finanziell unterstützt. Neben einer umfangreichen Analyse der Literatur zu diesem Thema wird ein mathematisches Modell vorgestellt. Dieses Modell geht der Frage nach, ob die Existenz eines LLRs die Risikofreude der Banken steigert. Abschließend wird die Wirtschaftskrise, die im Jahr 2007 ausgebrochen ist, als Beispiel herangezogen. Anhand dieser Krise wird die Gültigkeit der theoretischen Aussagen diverser Wirtschaftswissenschaftler und der Schlussfolgerungen des Modells überprüft.

Curriculum vitae

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Study and education

since March 2011	University of Vienna Faculty of Business, Economics and Statistics master course: „international business administration“ focus on controlling, international management
2008 – 2011:	University of Vienna Faculty of Business, Economics and Statistics bachelor course: „business administration“ focus on management, business law first bachelor thesis: „Marketingumfeld und Konsumentenverhalten der Wiener Linien“ second bachelor thesis: „Einfluss der Liquiditätskrise auf den österreichischen Bankensektor“
2003 – 2008:	commercial highschool inTulln focus on controlling matriculation project: „MLP doubles your money easily“
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Special knowledge

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Previous work experience

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