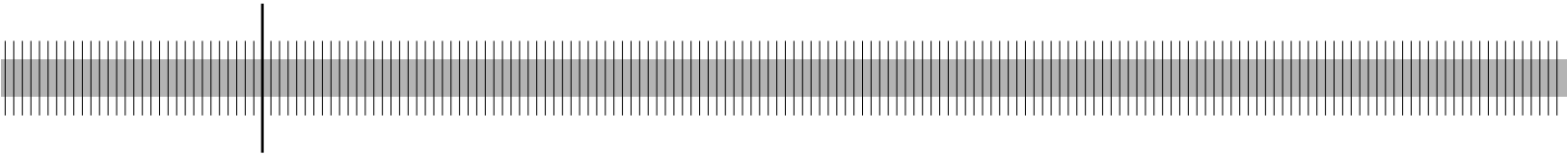# Performance and regulatory effects of non-compliant loans in German synthetic mortgage-backed securities transactions

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Abstract

Over the term of a securitization transaction, the concept of non-compliance allows a securitizing bank to classify a securitized loan as materially non-compliant with certain transaction requirements. Such a loan becomes unqualified for loss allocation. Therefore, non-compliant loans can directly affect transaction performance and the extent of risk transfer achieved with the transaction. The concept of non-compliance is incorporated in many securitizations independent of the underlying assets or structure. In Germany, there are currently no specific regulations regarding this concept. However, a bank can use discretion when classifying a loan as non-compliant and could thus report non-compliant loans strategically. This hypothesis is tested and confirmed based on a unique data set.

Non-technical summary

Non-compliant loans represent securitized loans which do not comply with contractually agreed requirements. As a result, these loans are not effectively protected through the securitization transaction. If the non-compliance cannot be resolved or is not resolved, the credit risk relating to such non-compliant loans is retransferred to the securitizing bank. These non-compliant loans are usually removed from the securitized portfolio. In the following this entire procedure is referred to as the "concept of non-compliance". Basically, independent of the type of risk transfer (true sale or synthetic) or of the securitized asset class, some variation of this concept is incorporated in the transaction documentation of many securitizations.

In the past, the potential effects of non-compliant loans were not regarded to be critical from a regulatory perspective. However, based on the following analysis it is concluded that in some German securitizations there are indications for non-compliant loans having significantly influenced the transaction performance and the extent of risk transfer. For instance, both the overall number and volume of delinquent loans in the portfolio were diminished by a time-weighted average of about 5% per quarter as a result of removing non-compliant delinquent loans. For different reasons the securitizing bank could benefit from such influence. Due to an existing scope of discretion it is therefore conceivable that the concept of non-compliance was used strategically. This could serve the purpose of cost minimization as well as reputation maintenance. In the following, based on different statistical methods, it will be tested which of these objectives might have prevailed. Depending on the actually prevailing objective and the corresponding reporting of non-compliant loans severe regulatory consequences can be derived.

Nichttechnische Zusammenfassung

Non-compliant Loans entsprechen verbrieften Darlehen, die vertraglich vorgegebene Kriterien nicht erfüllen und dadurch nicht wirksam durch eine Verbriefungstransaktion abgesichert sind. Sofern die „Non-compliance" nicht geheilt werden kann oder nicht geheilt wird, fällt das Ausfallrisiko in Bezug auf solche Darlehen zurück auf die verbriefende Bank. In der Regel werden diese Non-compliant Loans aus dem verbrieften Portfolio ausgeschlossen. Insgesamt wird dies im Folgenden als „Non-compliance Mechanismus" bezeichnet. Dieser Mechanismus ist im Grunde unabhängig von der Art des Risikotransfers (true sale oder synthetisch) oder von der Art der verbrieften Forderungen in unterschiedlichen Ausgestaltungen regelmäßig in den Verträgen zu einer Verbriefungstransaktion zu finden.

In der Vergangenheit wurden die möglichen Auswirkungen von Non-compliant Loans aus aufsichtsrechtlicher Perspektive als unbedenklich beurteilt. Im Rahmen der folgenden Analyse wird jedoch festgestellt, dass sich in einzelnen deutschen Verbriefungen Hinweise auf einen signifikanten Einfluss von Non-compliant Loans auf die Transaktionsperformance und auf das Ausmaß des Risikotransfers finden lassen. Im Durchschnitt (zeitgewichtet) wurden beispielsweise die Anzahl und Volumina von rückständigen Krediten im Portfolio um ca. 5% pro Quartal reduziert. Ein solcher Einfluss kann für die verbriefende Bank aus verschiedenen Gründen vorteilhaft sein. Aufgrund bestehender Ermessensspielräume wäre es daher grundsätzlich auch möglich, dass der Non-compliance Mechanismus strategisch genutzt wird. Dies könnte insbesondere dem Zweck der Kostenminimierung sowie der Reputationspflege dienen. Im Folgenden wird anhand verschiedener statistischer Methoden überprüft, welche dieser Zielsetzungen vorliegen könnte. In Abhängigkeit von der tatsächlich vorliegenden Zielsetzung bzw. der entsprechenden Meldung von Non-compliant Loans können gravierende regulatorische Konsequenzen abgeleitet werden.

Contents

Performance and regulatory effects of non-compliant loans in German synthetic mortgage-backed securities transactions*

1 Introduction

Through a synthetic mortgage-backed securities (MBS) transaction, the credit risk of a reference portfolio of mortgage loans is divided into several tranches and transferred to other capital market participants, the protection sellers. Each tranche has a different rank, which determines the priority of payments and losses allocated to it over the term of the transaction (subordination structure). The pay-off for the protection sellers directly depends on the performance of the reference portfolio, the quality and extent of credit enhancements, and, more generally, on transaction performance.

Over the term of the transaction, the securitizing bank can identify a securitized loan to be non-compliant. The credit risk relating to a non-compliant loan is retransferred to the securitizing bank. Depending on their volume and credit quality, non-compliant loans could thus significantly influence the transaction performance and the extent of risk transfer. From a regulatory perspective, such impacts can be critical.

In chapter 2, the concept of non-compliance is explained. On this basis, it is discussed in chapter 3 why a securitizing bank may be motivated to use this concept for strategic purposes. The bank's specific strategy could lead to different regulatory consequences. These are elaborated in chapter 4. In chapter 5, based on a unique data set, the transaction-level performance impact and loan-level performance characteristics of non-compliant loans are examined. The conclusion highlights the key results.

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2 Concept of non-compliance

A securitized reference loan is regarded as being **non-compliant** if it does not meet

(1) the eligibility criteria based on which loans are selected for the securitized portfolio (these criteria also require compliance with the credit and collection policies applicable at the time of the loan origination),

(2) the credit and collection policies including the standard arrears management,

(3) the servicing principles, for example, defining deal-specific permitted loan modifications or

(4) certain transfer provisions, which, for instance, demand the continuous application of the agreed-upon credit and collection policies and servicing principles in case a securitized loan is sold to a third party.[1]

Non-compliance with these contractually agreed, transaction-specific **requirements** can already exist as of the cut-off date (i.e., with regard to the eligibility criteria) and can occur over the term of the securitization transaction (i.e., with regard to the credit and collection policies and servicing principles). In respect of a highly granular portfolio consisting of several thousand loans, it is usually not known with certainty whether and to which extent the securitized portfolio contains non-compliant loans. This greatly depends on transaction-related data and process quality. Based on general market observations, the aggregate amount of non-compliant loans is usually not expected to be significant. However, there are basically two possibilities for a loan to be identified as non-compliant.

First, compliance with the requirements is a condition for loss allocation to the protection sellers. Accordingly, in German synthetic securitizations, the transaction documents often stipulate that after the portfolio cut-off date, a loan's compliance with these requirements must be verified if *a realized loss occurs* with respect to a securitized loan. A **realized loss** is equivalent to the outstanding loan amount plus, depending on the transaction documents, accrued interest and enforcement costs reduced by the available collections (e.g., foreclosure proceeds). The transaction party appointed to perform the verification of losses is the transaction trustee. The trustee function is often performed by an

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[1] See, for example, Prospectus (2006), p. 67 (Clause 10 Trust Agreement) in connection with p. 92 (Clause 7 Reference Pool Provisions). In case the transaction allows for replenishment, there may also be transaction-specific replenishment criteria. However, in the following analysis, replenishment is of minor relevance and is therefore excluded from the discussion. Throughout this work, the individual Prospectus (2006) is only referred to as an example in order to explain the concept of non-compliance as it can also be found in other transactions. The related transaction was not included in the data analysis presented this paper.

accounting firm. The verification procedures are based on actual loan files. If, on this basis, the trustee concludes that a requirement was not met in a material respect, the loan turns out to be non-compliant. The credit risk relating to this non-compliant loan is not effectively transferred and has to be taken back by the securitizing bank (in the following, the **originator** is assumed to also remain the servicer for the securitized portfolio). Accordingly, the realized loss has to be borne by the originator.[2]

If based on the verification procedures the trustee concludes that all requirements were met, the loss does not have to be borne by the originator. In this case, the protection sellers must settle the realized loss. The proceeding for when a "loss occurs" is shown on the left of figure 1.
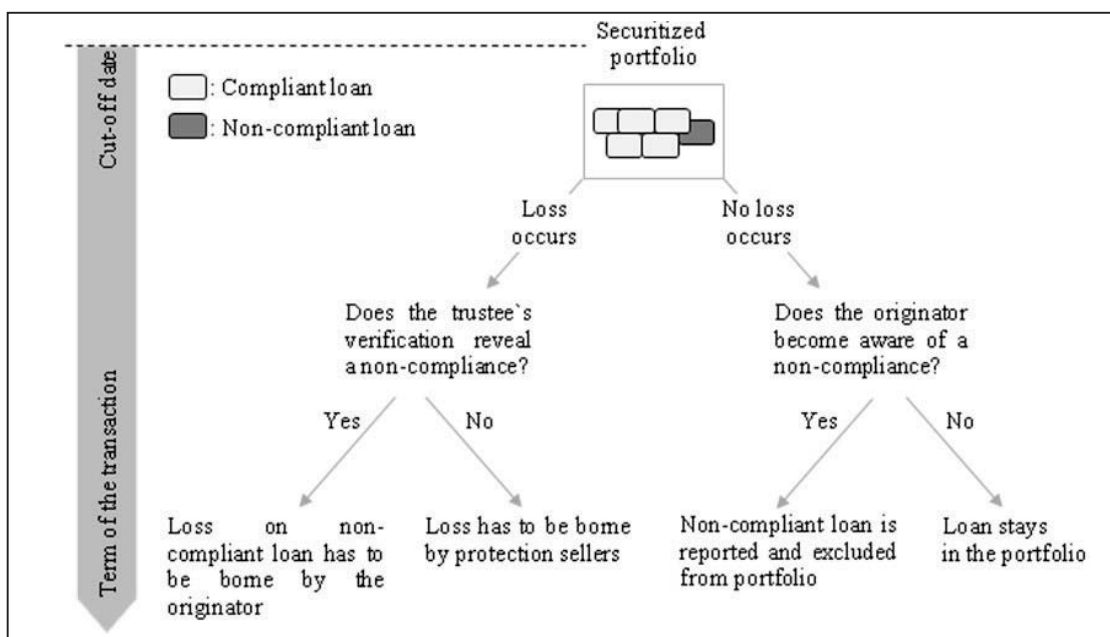
Figure 1: Possibilities for identifying a non-compliant loan.

If *no loss occurs*, a loan's compliance with the above-mentioned requirements will not be verified by the trustee (also see figure 1). Nevertheless, over the term of the transaction, the originator could become aware of a loan's non-compliance and would then have to report this. Instances of minor non-compliance can under specific circumstances be resolved by the securitizing bank so that the relevant loan continues to qualify for loss allocation. However, the credit risk of a loan that the bank identifies to be materially non-compliant is retransferred to the bank. Any non-compliance reason, which the bank determines, and its materiality are only checked by an external party, the trustee, if the bank explicitly requests the trustee for its professional judgment. Therefore, if the bank does not request the trustee's judgment, any loan that the bank reports to be non-compliant and

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[2] See, for instance, Prospectus (2006), p. 35 (Clause 8.1 The Notes) and p. 65 (Clause 8 (2)(a) Trust Agreement).

announces to be removed is excluded from the reference portfolio without specific third-party checks.[3]

The removal of this non-compliant loan will reduce the outstanding balance of the reference portfolio and, accordingly, the protection seller's exposure by the outstanding *nominal* amount of the relevant loan, irrespective of its true credit quality. In addition to this unscheduled portfolio reduction, but basically independent from the occurrence of non-compliant loans, the outstanding portfolio balance will also be reduced by the scheduled repayments which the bank receives from the borrowers relating to the securitized loans. The aggregate effects on the portfolio and the specific effects of a non-compliant loan, which the bank determined and removed from the portfolio, are summarized in figure 2. It is assumed that the portfolio composition is fixed as per the initial cut-off date; that is, after this date, the portfolio is not replenished with new loans.
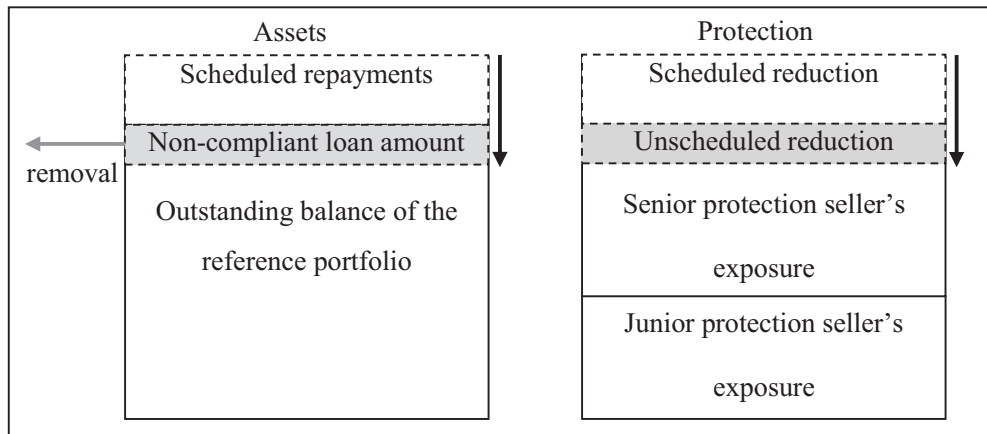
Figure 2: Unscheduled reduction triggered by a non-compliant loan.

The last case shown in figure 1 refers to the possibility that the originator does not become aware of non-compliance. In this case, each loan will continue to be part of the securitized portfolio independent of whether it is actually compliant or non-compliant.

Basically, in identifying and reporting non-compliant loans, the transaction documents provide the originator with some scope of discretion. This refers to the *reason* that is determined to constitute non-compliance, the *timing* for reporting a non-compliant loan, and the *type of loan* that is reported to be non-compliant. For instance, depending on the pursued objective, one bank could accept only strictly material non-compliance reasons to minimize the volume of non-compliant loans. Another bank may also accept less material reasons for removing non-compliant loans. Additionally, over the term of the transaction, a bank could proactively scrutinize selected loans for their compliance. By specifically scrutinizing and removing poorly performing loans, the bank could influence portfolio

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[3] See, for instance, Prospectus (2006), pp. 67 et seq. (Clause 10 Trust Agreement) and pp. 92 et seq. (Clause 9 Reference Pool Provisions).

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quality and the time at which the loans are removed from the portfolio. The analysis is motivated by the resulting possibility for an originator to *strategically* report non-compliant loans.

But why may an originator want to strategically report non-compliant loans and thus take back credit risk? This is assumed to depend on the objective that an originator could pursue over the term of the transaction. The objectives derived to be relevant in this context are cost minimization and reputation maintenance.

3   Potential objectives of the originator

3.1   Cost minimization

First, costs arise from ineffective risk transfer in the case of non-compliant loans. This refers to the fact that following the identification of a non-compliant loan and the associated ineffective risk transfer, the bank must again hold regulatory capital against the affected loan. A loss occurring for such an asset would have to be borne by the bank.

In order to avoid additional costs the bank will generally attempt to keep the volume of non-compliant loans as low as possible. Taking back credit risk will in principle be avoided.

Second, however, a cost-minimizing bank will also consider that each loss realized with regard to a securitized loan will become subject to costly external verification. As a result of the verification, a loss either may be allocable to the protection sellers or, in the case of a non-compliant loan, has to be borne by the originator. In order to avoid costly external verifications revealing non-compliance, the cost-minimizing bank could be motivated to proactively scrutinize loans for their compliance. However, for the purpose of saving costs, the bank will scrutinize only as few loans as possible. Accordingly, the bank is expected to scrutinize only those loans for which realized losses will likely occur and which will thus likely become subject to external verification, that is, defaulted loans.

Per definition, in the case of a **defaulted loan**, a credit event (e.g., failure to pay or bankruptcy) has occurred and has been reported to the trustee. Independent from the occurrence of a credit event, a loan is considered to be a **delinquent loan** if due interest and/or principal payments were not made by the borrower. Therefore, a delinquent loan may not (yet) have reached the status of a defaulted loan. As reasoned above, a cost-minimizing bank is expected to concentrate its compliance checks on lower-quality, defaulted loans.

Defaulted loans that the cost-minimizing bank itself finds to be materially non-compliant, if any, will be removed and thus not be subject to external verification. Controlling for other factors, the removal of defaulted loans improves transaction performance. However, this is only a side effect. Under the logic of cost minimization, the bank will generally use its discretion in determining a non-compliance such that it will only accept strictly material non-compliances. Immaterial non-

compliances are to be resolved. The volume of non-compliant loans will be minimized in order to ultimately maximize ongoing risk transfer to the protection sellers. The potential life cycle of a loan and the expected activities and motivations of a cost-minimizing bank are summarized in figure 3.
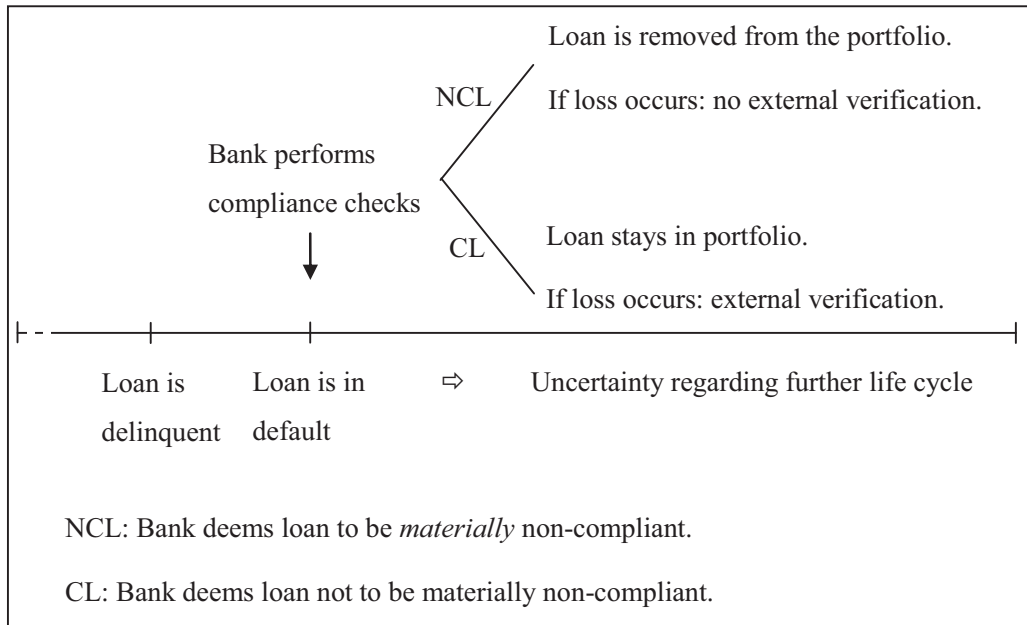
Figure 3: Compliance checks under cost minimization.

3.2 Reputation maintenance

The bank's motivation will be different in case it concentrates on maintaining its reputation for well-performing securitizations. A good reputation can facilitate diversity and reduce costs of future refinancing. For this purpose, the originator could strive to keep the portfolio quality high and the volume of losses allocated to the protection sellers low. A bank pursuing reputation maintenance is expected to be inclined to take back credit risk.

As opposed to the removal of non-compliant loans depicted with respect to cost minimization, under reputation maintenance, as many loans will be reported to be non-compliant as needed to achieve a desired effect on portfolio quality. Accordingly, a reputation-maintaining bank is expected to focus its compliance checks not on only the smallest possible group of defaulted loans but more generally on delinquent loans. For the purpose of removing a specific delinquent loan, a reputation-maintaining bank is also expected to accept less material non-compliance reasons compared to a cost-minimizing bank. This is illustrated in figure 4:

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Figure 4: Compliance checks under reputation maintenance.

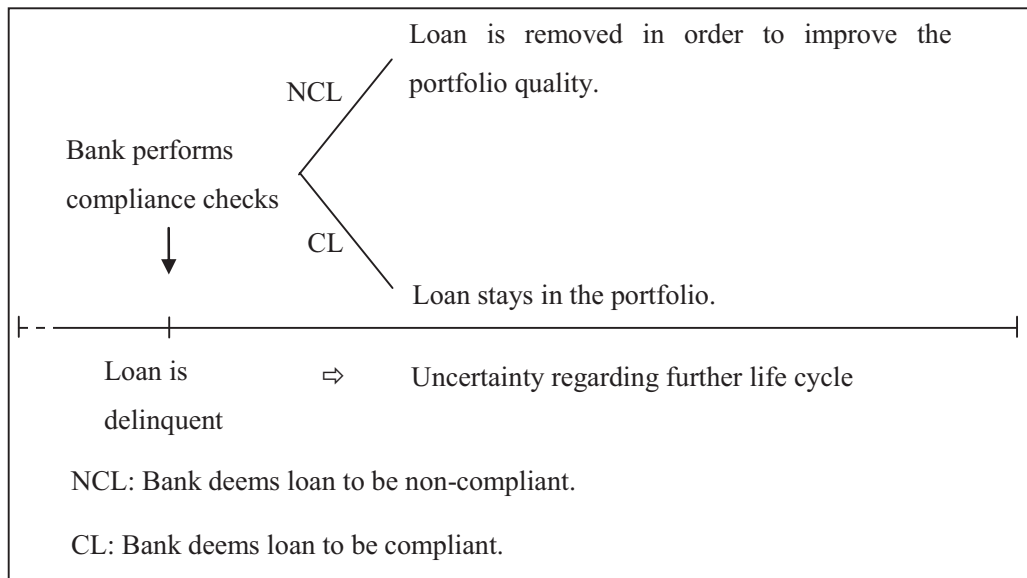As a side effect of strategically removing delinquent loans, loss verification could be less frequent. This could reduce expected costs. However, the removal of delinquent loans is mainly supposed to build up the bank's reputation. The retransfer of credit risk and the associated costs are accepted in light of the higher-ranking goal of maintaining a good reputation.

As depicted in chapter 2, the portfolio is reduced by the nominal non-compliant loan amount. A strategic and significant removal of delinquent loans would thus result in the related risks being taken back by the originator at off-market conditions.[4] As the bank is not contractually obliged to improve the portfolio quality in this way, the strategic removal of poorly performing loans by reporting them as non-compliant would represent a form of implicit support for the securitization transaction.[5] Such conduct is prohibited by regulatory authorities.

For US credit card securitizations, it has been analyzed that implicit support nevertheless exists and that there are incentives for providing such support. Most closely conferrable to this paper, Vermilyea, Webb, and Kish (2008) directly tested for implicit recourse in credit card securitizations. The authors assumed that the specification of losses as credit or fraud losses can be misused as a

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[4] This appears conferrable to the potential misspecification of fraud losses as examined by Vermilyea, Webb, and Kish (2008) regarding US credit card securitizations. Their analysis is further described below.

[5] Confer the Office of the Comptroller of the Currency et al. (2002), pp. 6 et seq. (Example 2). In this source, several actions indicating implicit support were described. The remaining possibilities for managing trust performance were mentioned by Flanagan et al. (2002), p. 3. Referring to implicit recourse provided by incorrectly specifying and excluding loans from a securitized portfolio, see Vermilyea, Webb, and Kish (2008), pp. 1199 et seq.

means to provide implicit recourse and to manipulate transaction performance.[6] Vermilyea, Webb, and Kish (2008) describe fraud as, for example, resulting from unauthorized credit card utilization. Fraudulent receivables are excluded from the securitized portfolio. Fraud losses thus have to be covered by the issuer or originator. Otherwise, losses have to be taken by the protection sellers. The authors analyzed the reporting of fraud losses from banks that securitize and those that do not securitize. They evaluated relevant financial data of the banks as well as performance data based on excess spread relating to individual securitizations. Among other results, the authors find two important elements. First, they conclude that the likelihood of fraud losses being reported by banks securitizing credit card loans is higher than the likelihood of fraud losses being reported by other banks. Second, they find that banks whose securitized credit card portfolios show meager performance tend to report higher fraud losses than banks with well-performing securitization trusts. Their findings indicate the existence of implicit support in the US credit card securitization market.

Higgins and Mason (2004) identified and examined various implicit recourse actions relating to credit card securitizations. Such actions comprised replenishing the securitized portfolio with high-quality loans, selling new loans into the transaction at a discount, increasing credit enhancement, agreeing with investors to waive early amortization triggers or agreeing on a reduction of servicer fees (the servicing is often performed by the originator itself). Higgins and Mason (2004) mentioned that these actions violated the true sale provisions of generally accepted (FASB 140) and regulatory accounting principles. However, none resulted in the derecognition of the securitized loans actually being reversed. Among other aspects, they find that providing recourse on average resulted in improved short- and long-term stock returns of the sponsoring firms. Therefore, providing implicit recourse – although prohibited – was not penalized but rather benefitted the sponsor (i.e., the originator or the company providing other collateral in the securitization).

Gorton and Souleles (2007) discuss a theoretical model referring to the existence of implicit support. They argue that access to off-balance sheet financing via securitization essentially depends on the sponsor's ability to credibly resolve the adverse selection problem toward the investors. In a repeated game setting, this may be achieved if the bank can commit to supporting the transaction when the portfolio quality deteriorates. Due to regulatory and accounting provisions, such a commitment would have to be implicit. If the sponsor does not fulfill its implicit commitment, the investors can penalize the bank by not investing in its future securitizations. Pursuant to Gorton and Souleles (2007), the repeated game setting may thus create an equilibrium with implicit recourse.

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[6] See Vermilyea, Webb, and Kish (2008), p. 1198. Also see Calomiris and Mason (2004), p. 9 who refer to the abuse of removal of accounts provisions (ROAPs)-exceptions in revolving securitizations. Usually, ROAPs shall, for instance, allow flexibility in the workout process or to remove fraud losses.

Tufano (2007) interprets this as an equilibrium, in which the issuer, investor and regulatory authorities willingly do not want to see that the sponsor provides implicit support.

Gorton and Souleles (2007) further stated that implicit support implies that investors in securitizations form expectations about the originators' ability to voluntarily support a securitization beyond contractual obligations.[7] They tested this implication by analyzing whether the spread paid to investors in credit card securitizations also depends on the sponsor's default risk measured by its bond rating. Accounting for different structural features and underlying asset qualities, they conclude that the originator's strength and thus its capability for implicit support significantly influenced the spread.

As a result, implicit support appears to exist although it might also lead to negative effects for the originator. In particular, if implicit support is detected by the regulatory authorities, the originator has to face severe regulatory and accounting sanctions. However, these have so far been rarely applied.

Independent from specific structural features or the securitized asset class, in general, any originator has the ability to provide some form of implicit support. Moreover, any originator could suffer from the adverse effects of a damaged reputation in case the underlying asset performance deteriorated. Therefore, in theory, any bank could be motivated to implicitly support its securitization for the purpose of reputation maintenance.

4 Regulatory effects

Both objectives can lead to an improved transaction performance. This is a side effect under cost minimization but a desired effect under reputation maintenance. Therefore, both objectives and their implementation can have different regulatory effects.

In general, the regulatory authorities[8] allow an originator to release regulatory capital through securitization provided that specific conditions are fulfilled, for example, with respect to a significant and effective risk transfer.[9] If the relevant conditions are met the originator can achieve a regulatory capital release with respect to the securitized portfolio as of the beginning of the transaction. As mentioned above, over the term of the transaction, risk transfer proves to be ineffective for a loan that

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[7] In this context Gorton and Souleles (2007) refer to and follow Gorton and Pennacchi (1989, 1995) and Moody's (1997).

[8] In Germany, the Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht - BaFin) exerts oversight over German banking institutions (see § 6 sec. 1 German Banking Act). The BaFin cooperates with the German Federal Bank (Deutsche Bundesbank; see § 7 German Banking Act).

[9] See § 232 sec. 1 to 4 German Solvency Directive.

is reported to be materially non-compliant. A larger volume and a lower credit quality of non-compliant loans lead to the greater exposure of a bank to a major portion of credit risk. If a non-compliance reason already exists at the cut-off date, the bank is nevertheless able to release regulatory capital with regard to the affected loan for the time from the beginning of the transaction (i.e., as of the cut-off date) until the date of identifying the non-compliant loan. To this extent, the initially recognized risk transfer and release of regulatory capital are not justified.

Under cost minimization, it is expected that the bank strategically checks defaulted loans for their compliance, but generally tries to minimize the volume of removed non-compliant loans. From a regulatory point of view, such a proceeding is not critical, provided that in fact only a negligibly small volume of non-compliant loans has to be reported. The proceeding can become critical, though, if the cost-minimizing bank identifies so many materially non-compliant loans that despite its attempt to minimize their volume, it must remove a large portion of non-compliant defaulted loans. Such a large portion and the resulting ineffective risk transfer question the extent of regulatory capital release recognized for the transaction.

Under reputation maintenance, non-compliant loans would be used for strategic performance improvement. Pursuant to the German Solvency Directive, implicit support refers to off-market credit support that a bank voluntarily provides to a securitization transaction.[10] Such conduct strongly conflicts with the risk transfer requirements to be fulfilled for obtaining the release of regulatory capital. If misconduct in this respect is found, the bank has to treat the securitized exposures as though they were not securitized but risk positions of the bank itself. The resulting additional regulatory capital charges will be accompanied by requirements to disclose the misconduct.[11] These rules apply to both synthetic and true sale, replenishable or non-replenishable securitizations.

The strategic reporting of non-compliant loans for the purpose of reputation maintenance could thus result in the disputing of the overall initially recognized risk transfer. This could severely affect the financial stability of a bank. As an effectively related example, in February 2002, a US banking institution (NextBank) was closed due to its severe undercapitalization.[12] This was caused by, among others, the fact that NextBank had securitized credit card loans with recourse and thus violated

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[10] See § 234 German Solvency Directive. Also confer the Office of the Comptroller of the Currency et al. (2002), pp. 1 and 3.

[11] See § 234 German Solvency Directive.

[12] See the Office of the Comptroller of the Currency (2002) and Flanagan et al. (2002), pp. 1 et seq.

accounting and regulatory risk transfer provisions.[13] The previously derecognized securitized loans had to be re-recognized on the balance sheet. This substantially reduced the regulatory capital ratios.[14]

NextBank had provided recourse by incorrectly specifying delinquent accounts, which were sold into a credit card securitization trust as fraud losses.[15] This form of implicit support appears to be most closely comparable to a potentially strategic reporting of non-compliant loans under the objective of reputation maintenance.

The following analysis will reveal whether the data obtained for five specific transactions indicate that the related originators made strategic use of their discretion in reporting non-compliant loans (chapter 5.1). This will be done by analyzing the transaction-level performance impact of non-compliant loans. The transactions subject to analysis relate to two different originators (3 transactions relate to one bank, 2 transactions to another bank), were closed between 2000 and 2006, represent an overall portfolio volume of about €7 billion and roughly 100,000 loans.[16] Depending on data availability, the information gathered for all of the five transactions together covers about 90 quarterly collection periods. This aggregate number of periods encompasses five time spans, each of which begins in an early transaction phase. In about 60 periods, the two banks reported at least five non-compliant loans per period. In order to avoid distortions, only those 60 periods were examined and included in the analysis. The second step of the analysis will feature, as applicable, the testing of whether the prevailing objective was cost minimization or reputation maintenance (chapter 5.2). This analysis will focus on the performance characteristics of non-compliant loans. Due to higher data requirements, the second analysis can only be performed for two out of the five transactions.

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[13] Other reasons that led to the undercapitalization of NextBank were necessary accounting-related adjustments and the need to increase reserves for possible credit losses. See the Office of the Comptroller of the Currency (2002).

[14] See Calomiris and Mason (2004), p. 11.

[15] Further information can be found at the Office of the Comptroller of the Currency (2002) and FDIC (2003). With regard to fraud losses in US credit card securitizations and the case of NextBank, see Calomiris and Mason (2004), p. 11 and Vermilyea, Webb, and Kish (2008), pp. 1198 et seqq.

[16] To preserve confidentiality, individual transaction data will not be provided or discussed. No individual details or data about originators, transactions or reference loans will be given.

5 Influence on transaction performance

5.1 Transaction-level performance impact of non-compliant loans

The transaction-level performance impact of non-compliant loans will be analyzed based on a null hypothesis (H_0) which is derived from the purely technical non-compliance concept. It assumes that the originator does not make strategic use of its discretion and only reports non-compliances which it coincidentally becomes aware of. Therefore, H_0 states that non-compliant loans did not exert significant influence on the performance of the selected securitizations.

If H_0 has to be rejected, this is assumed to be the result of the originator making strategic use of its discretion with respect to reporting and removing non-compliant loans. In this case, the alternative hypothesis may be correct (H_a: non-compliant loans did exert significant influence on the performance of the selected securitizations).

The transaction data showed that, on average, the overall number of non-compliant loans relative to the total number of loans in the respective portfolios amounted to only 2.2% for each transaction. This percentage is a time-weighted average with the weights being derived from the number of collection periods available for each transaction. The time-weighting reflects the fact that the portfolio balances are of a roughly comparable size, but the collected data series differ in length. The time-weighted average proportion of non-compliant loan amounts relative to the initial portfolio balances was 3.2% and thus a little higher than the numbers-based proportion. However, the proportions indicate that according to numbers and amounts the influence of non-compliant loans was quite small on the basis of initial loan counts and initial portfolio balances.

Nevertheless, even a small proportion of non-compliant loans could influence transaction performance if this proportion contained a high concentration of delinquent and/or defaulted loans. In general, it can be expected that a random number of delinquent and/or defaulted loans turned out to be non-compliant over the term of the transaction. Assuming that H_0 was correct, the proportions of delinquent and/or defaulted non-compliant loans should not be much different from their average proportions in the outstanding portfolios. Therefore, on an aggregated basis, the proportion of delinquent non-compliant loans should not greatly differ from the time-weighted average of 3%. The defaulted loans' share should match approximately 2%. These time-weighted average percentages were calculated on the basis of the median proportions of delinquent and defaulted loans, respectively, determined with regard to each of the five transactions.

For calculating the actual average percentage of *delinquent non-compliant loans*, their number was divided by the overall number of non-compliant loans (*NCL*) reported in a specific collection period t. The time-weighted average was calculated based on these percentages covering each transaction $i=\{1,2,3,4,5\}$. The total number of collection periods considered with respect to

transaction i is denoted as n_i. The same proceedings were performed for non-compliant defaulted loans. As an example, formula (1) shows the calculation for delinquent non-compliant loans.

$$\text{Time−weighted average proportion of delinquent non−compliant loans} = \left(\sum_{i=1}^{5} \sum_{t=1}^{n_i} \frac{\text{aggregate number of delinquent NCL}_{it}}{\text{aggregate number of NCL}_{it}} \right) \div \sum_{i=1}^{5} n_i \qquad (1)$$

The available data showed that the median proportion of delinquent non-compliant loans per quarter amounted to a time-weighted average of 88% based on the total number of non-compliant loans reported in a specific period. For the individual transactions, the median proportions of delinquent non-compliant loans ranged from 79% to 94%.

For the five transactions, the median differences between the proportion of delinquent non-compliant loans and the proportion of delinquent loans in the portfolio were significantly higher than zero (Wilcoxon, one-tailed $p=0.022$).[17]

Overall, the expectation that the proportion of delinquent non-compliant loans does not greatly differ from the proportion of delinquent loans in the portfolio was not corroborated for any of the five transactions. An analysis based on volumes led to the same conclusion.[18]

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[17] This test was based on the median absolute differences by which the proportion of delinquent non-compliant loans [in %] exceeded the proportion of delinquent loans in the portfolio [in %]. The median difference (d) was calculated for each transaction and was tested to be lower than or equal to zero (H$_0$: $d \leq 0$). This hypothesis was rejected based on a significance level of 5%. The results were calculated with SPSS Statistics 17.0. Basically, the test was also supported by a supplementary test that focused on the collection periods of each individual transaction. From an economic point of view, that is, in particular, based on the purely technical background of the non-compliance concept and based on the small portion of non-compliant loans that was observed to be removed, there appears to be no reason why the numbers of performing or delinquent non-compliant loans reported in one quarter, if any, should influence the numbers of performing or delinquent non-compliant loans reported in the next quarter. Analogously, there appears to be no reason for why a difference regarding the proportion of delinquent loans determined for one period should be related to a difference in another period. Therefore, if the null hypothesis was correct, there would be no reason to assume within-sample dependence referring to the gathered quarterly data. However, as the further analysis will show, this assumption may be violated. Therefore, the Wilcoxon test assumption of a randomly drawn sample may be violated. As a result, the power of this supplementary test may be limited. Consequently, the results based on collection period data are only provided for additional indication. Based on this, for all five transactions, H$_0$: $d \leq 0$ was also rejected (Wilcoxon, one-tailed $0.000 \leq p \leq 0.014$). Referring to the nonparametric Wilcoxon signed ranks test, see Siegel (1956), pp. 75 et. seqq.

[18] On an aggregated basis, the volume-based proportion of delinquent non-compliant loans amounted to a time-weighted average of 4%. The available data showed that the median proportion of delinquent non-

In summary, the proportion of delinquent non-compliant loans turned out to be very high. As an indicator for the aggregated effect on transaction performance, both the overall number and volume of delinquent loans in the portfolio were diminished by a time-weighted average of about 5% per quarter as a result of removing non-compliant delinquent loans. With respect to the considered periods, the minimum quarterly reduction of delinquent loan amounts was equal to 0%; the maximum reduction amounted to 29%.

The available data showed that the average number of *defaulted non-compliant loans* per quarter amounted to a time-weighted average of 18% based on the total number of non-compliant loans reported in a specific period. For the individual transactions, though, the median proportions of defaulted non-compliant loans were very different and ranged between 0% and 72%. In particular, transactions 1, 2 and 3 showed a percentage of defaulted non-compliant loans of 0%. In contrast, transactions 4 and 5 revealed median proportions of defaulted non-compliant loans that were 61% on average. Accordingly, only for the latter two transactions was there a major portion of defaulted loans among the total number of non-compliant loans. This explains the fact that for the five transactions, the median differences between the proportion of defaulted non-compliant loans and the proportion of defaulted loans in the portfolio were not found to be significantly higher than zero (Wilcoxon, one-tailed $p=0.343$).[19] However, referring to transactions 4 and 5, the proportion of defaulted loans among the total number of non-compliant loans was on average about 55 percentage points higher than the proportion of defaulted loans contained in the respective portfolio.

As a result, the expectation that the proportion of defaulted non-compliant loans is not much different from the proportion of defaulted loans in the portfolio was not corroborated with respect to

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compliant loans per quarter amounted to a time-weighted average of 89% based on the total volume of non-compliant loans reported in a specific period. For the single transactions, the median proportions of delinquent non-compliant loans ranged from 72% to 96%. For the five transactions, the median differences between the volume-based proportion of delinquent non-compliant loans and the proportion of delinquent loans in the portfolio were significantly higher than zero (significance level of 5%; Wilcoxon, one-tailed $p=0.022$).

[19] This test was based on the median absolute differences by which the proportion of defaulted non-compliant loans [in %] exceeded the proportion of defaulted loans in the portfolio [in %]. The median difference (d) was calculated for each transaction and was tested to be lower than or equal to zero (H_0: $d\leq0$). This hypothesis could not be rejected based on a significance level of 5%. However, relating to transactions 4 and 5, a supplementary test was applied that focused on the collection periods of the two transactions, respectively. Based on this, the hypothesis H_0: $d\leq0$ was rejected with respect to transactions 4 and 5 (Wilcoxon, one-tailed $0.002\leq p\leq0.009$). This indicates that the analyzed differences were significantly higher than zero for these two transactions. For further details on the Wilcoxon test and on the potential limitations of the supplementary test, see the explanations in footnote 17.

transactions 4 and 5. For the other three securitizations, the expectation is regarded to be confirmed. A calculation based on volumes led to the same conclusion.[20]

In summary, the proportion of defaulted non-compliant loans turned out to be high for two transactions. In these cases, the overall number of defaulted loans in the portfolio was reduced by a time-weighted average of 7% per quarter as a result of removing non-compliant loans. The minimum reductions were 0% and 2%; the maximum reductions were 22% and 14%. The defaulted loan volumes per quarter were reduced by on average 8%.

The essential results regarding both delinquent and defaulted non-compliant loans are summarized in the following table:

Analysed data	Results
Proportion of delinquent (defaulted) non-compliant loans based on the total number of non-compliant loans reported in a specific period	88% (61%[21])
Average reduction of the number and volume of delinquent loans per quarter	5%
Average reduction of the number and volume of defaulted loans per quarter	7% and 8%[22]

Table 1: Influence of non-compliant loans.

The large proportions of delinquent and/or defaulted non-compliant loans suggest that the null hypothesis has to be rejected. The results indicate that non-compliant loans did significantly influence the performance of the selected securitizations. Due to the high-risk concentration among the non-

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[20] The volume-based proportion of defaulted loans in the portfolio amounted to a time-weighted average of 2%. The available data showed that the median proportion of defaulted non-compliant loans per quarter amounted to a time-weighted average of 21% based on the total volume of non-compliant loans reported in a specific period. For the single transactions, the corresponding median proportions of defaulted non-compliant loans ranged from 0% to 79%. Transactions 1, 2 and 3 were associated with a percentage of defaulted non-compliant loans of 0%. In contrast, transactions 4 and 5 revealed median proportions of defaulted non-compliant loans of on average 74%. For the five transactions, the median differences between the volume-based proportion of defaulted non-compliant loans and the proportion of delinquent loans in the portfolio were not found to be significantly higher than zero, based on a significance level of 5% (Wilcoxon, one-tailed p=0.343). The median difference was determined for each transaction based on the periods in which at least five non-compliant loans were reported.

[21] This percentage only refers to two transactions.

[22] These percentages only refer to two transactions.

compliant loans, the above-mentioned 3.2% proportion of non-compliant loan amounts relative to the initial portfolio balances appears equivalent to a high-risk tranche effectively retained by the bank. As a result, the 3.2% lose their appraisal of being "small". As argued above, the scope of discretion regarding the reporting and removal of non-compliant loans may actually have been used strategically.

5.2 Loan-level performance characteristics of non-compliant loans

5.2.1 Approach and data

The following analysis will be based on two transactions (in the following referred to as transactions A and B). In the course of the preceding chapter's calculations, transaction A was found to be associated with an extremely low proportion of non-compliant defaulted loans but with an extremely high proportion of non-compliant delinquent loans. As argued above, this result is consistent with the objective of reputation maintenance. Over the term of transaction B, a large portion of non-compliant loans was already defaulted (in total 45%). Based on the discussion above, this is in line with the objective of cost minimization.

Subsequently, it will be further analyzed which objective may respectively have prevailed regarding the two transactions. This will be based on the fact that a large proportion of the defaulted loans were also delinquent. For both transactions, the portfolio proportion of defaulted loans that were also delinquent was approximately 93% (time-weighted average). Therefore, the analysis will solely focus on delinquent loans. For transactions A and B, more than 1,800 and about 500 loans, respectively, were found to be delinquent. Of these, the proportion of delinquent non-compliant loans ranged from 10-25%.[23]

In the following, it will be tested whether, depending on the objective, the delinquent loans actually reported to be non-compliant consistently shared specific loan characteristics. It will be examined whether these loan characteristics influenced the probability for a delinquent loan to be reported as non-compliant or not. This is expected to indicate the prevailing objective based on the following arguments.

A cost-minimizing bank was assumed to scrutinize only a minimum number of loans and to not strategically aim at improving transaction performance. Therefore, apart from the characteristic of being highly delinquent there appear to be no other characteristics that delinquent non-compliant loans should consistently share under the objective of cost minimization. Moreover, the bank was

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[23] To preserve confidentiality, exact information on the portion of delinquent non-compliant loans will not be provided.

expected to keep the volume of non-compliant loans as low as possible. In consequence, even the shared characteristic of being highly delinquent will likely not be a feature that especially distinguishes non-compliant from compliant delinquent loans. Therefore, in the context of cost minimization, loan characteristics are not expected to significantly influence the probability for a delinquent loan to be reported as non-compliant.

This is expected to be different if reputation maintenance was the prevailing objective. In this case, a bank is assumed to be driven by the desire to strategically improve transaction performance. For this purpose, the bank could likely focus on scrutinizing and removing delinquent loans that share specific and, for the purpose of improving transaction performance, favorable loan characteristics. So, under this objective, loan characteristics could significantly influence the probability of non-compliance.

Accordingly, it will be concluded that the objective of reputation maintenance may have prevailed for the examined transaction if, based on the transaction data, it is found that

(1) the loan characteristics altogether influenced the probability for a delinquent loan to be reported as non-compliant and that

(2) the individual characteristics' influence matched the direction of influence expected under the logic of reputation maintenance.

If the overall influence as mentioned in item (1) cannot be found, this will be considered to indicate cost minimization. If, referring to item (2), individual characteristics are not found to influence the probability of non-compliance in the expected way, this has to be evaluated on a case-by-case basis. For the purpose of testing the relationships (1) and (2), loan characteristics will be selected based on data availability and their expected relevance for a reputation-maintaining bank aiming to improve transaction performance.

The analysis will be based on a binary logistic regression. This nonlinearly links the probability of non-compliance to a linear function of independent variables that represent the selected loan characteristics. The binary dependent variable y reflects the event that a delinquent loan was reported to be non-compliant by $y=1$. For cases in which a delinquent loan was not reported to be non-compliant over the observed term of the transaction, this is represented by $y=0$. The probability of non-compliance, that is, the probability for the occurrence of $y=1$, for observation l (=loan) is denoted with $p_l(y=1)$. This probability is assumed to depend on the aggregated influence of the j selected independent variables x_j. A linear combination of x_j results in the unobservable (latent) variable z_l

(also referred to as the "logit") with β_0 and β_j representing the regression coefficients and ε_l denoting the error term. Variable z_l is incorporated in the logistic regression function as shown in formula (2):[24]

$$p_l(y = 1) = \frac{1}{1 + e^{-z_l}} \qquad (2)$$

with
$$z_l = \beta_0 + \sum_{j=1}^{J} \beta_j \times x_{jl} + \varepsilon_l.$$

The characteristics included in the regression as independent variables encompass the maximum relative degree of delinquency, the number of periods for which payments were reported to be delinquent, the seasoning of the transaction, the protected loan amount and the loan-to-value ratio. The variables are discussed regarding their determination, their expected influence on the probability of non-compliance and their level of measurement.

The first variable calculated with respect to both transactions was the maximum relative degree of delinquency (variable name: **Max_degree**). The calculation comprised that for each available period and for each loan the overdue payments proportion was calculated. The overdue payments proportion was approximated by summing up the overdue interest and principal and by dividing these overdue payments by the outstanding loan amount. In the individual transactions, the reporting of payments in arrears deviated with respect to the time and/or amounts in arrears. With respect to this analysis, the data were nevertheless considered to provide an appropriate (conservative) indication.

In order to reveal the *relative* degree of the delinquency of a specific loan in a specific period compared to the overall portfolio quality, the proportion of overdue payments relating to each loan was divided by the average proportion of overdue payments relating to the portfolio in the relevant period. If the resulting ratio was higher than one, the loan was above and otherwise below the average delinquency. Over all available periods, the *maximum* relative degree of delinquency was determined for each loan. This maximum relative degree of delinquency was categorized into two groups.

Group 1 contained all delinquent loans for which the maximum relative degree of delinquency was below or equal to the portfolio-average delinquency (Max_degree=0). Group 2 comprised those cases for which the maximum relative degree of delinquency exceeded the portfolio-average delinquency (Max_degree=1). The grouping is illustrated in figure 5.

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[24] See Ge and Whitmore (2009), pp. 2 et seq. and Backhaus et al. (2008), p. 249.
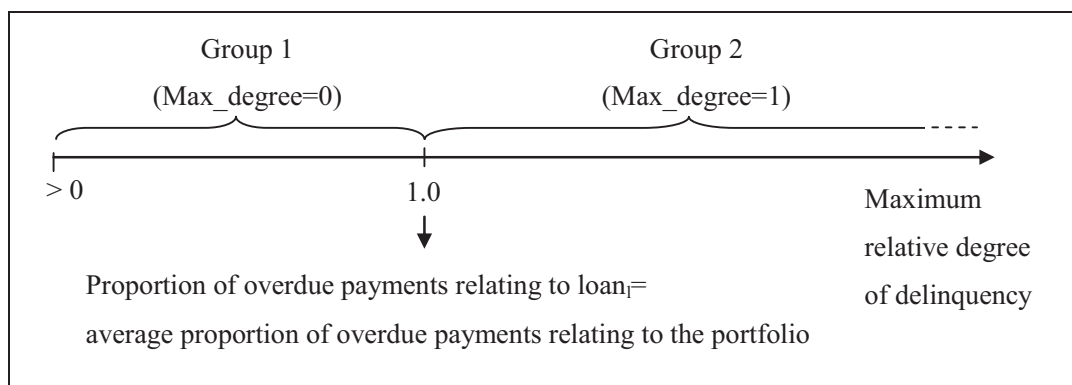
Figure 5: Groups created for the maximum relative degree of delinquency.

The two groups were created to facilitate the identification of the reputation maintenance objective in case it prevailed. More precisely, under the logic of reputation maintenance, it would be more efficient to remove a comparatively highly delinquent loan than to remove only a slightly delinquent loan. Accordingly, it is expected that under reputation maintenance, the odds of being reported as non-compliant are significantly higher for above-average delinquent loans compared to below-average delinquent loans. In the logistic regression Max_degree was incorporated as a dummy variable. The first group (Max_degree=0) served as the reference category.[25]

The number of periods for which payments were reported to be overdue regarding a delinquent loan (variable name: **Periods_delinquent**) was obtained by summing up the number of periods for which payments were reported to be in arrears for a specific loan.

The number of these periods was expected to be a relevant indicator for a loan's default risk. Under reputation maintenance, Periods_delinquent is therefore expected to significantly influence the probability for a delinquent loan to be reported as non-compliant. However, this influence is not expected to be constant for increasing numbers of periods in arrears.

First, the odds of being reported as non-compliant are expected to be significantly *higher* for delinquent loans associated with a larger number of periods in arrears compared with delinquent loans being associated with a smaller number of periods in arrears. Then, at a specific point of time, a delinquent loan may already have been checked for its compliance by the bank but was not found to be non-compliant. Such a loan would remain part of the portfolio and could continue to deteriorate in quality and thus contribute a large number of Periods_delinquent to the analysis. Therefore, going forward from a particular number of periods in arrears, a further increasing number of

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[25] The group 1 loans represent a clearly defined lower-end reference point and were therefore chosen to be the reference category. With regard to the selection of a reference category, see Hardy (1993), p. 10.

Periods_delinquent could even reduce the probability of non-compliance. Accordingly, the above-mentioned effect is expected to decrease in its strength and could potentially even reverse for higher numbers of Periods_delinquent. In the latter case, the odds of being reported as non-compliant would be significantly *lower* for delinquent loans associated with a larger number of periods in arrears compared with delinquent loans associated with a smaller number of periods in arrears. In order to test for these effects, the Periods_delinquent variable was divided into five groups, of which four groups each reflect the length of a collection period (i.e., one quarter). The first group contained all delinquent loans that were reported to be overdue for a time span of up to one quarter. The second group comprised all delinquent loans reported to be overdue for a time span of more than one and up to two quarters. The third group referred to loans reported to be overdue for more than two and up to three quarters. The fourth group was created analogously. The fifth group contained all delinquent loans that were reported to be overdue for a time span of more than four quarters. In the regression, the covariate Periods_delinquent was included as a categorical variable represented by four dummy variables. The first group (Periods_delinquent=1) served as the reference category.

The seasoning of the transaction (variable name: **TA_seasoning**) represents the period within the studied time span of a transaction in which the maximum relative degree of delinquency was observed. For example, if the maximum relative degree of delinquency occurred in the 10th period, the relevant value would be 10.

For a reputation-maintaining bank, the point of time at which the maximum relative degree of delinquency is observed is expected to be relevant for the purpose of controlling portfolio quality over the term of the transaction. An earlier deviation of the portfolio quality from the market's expectations may have more significant negative effects on the bank's reputation. Therefore, supporting the portfolio quality appears to be especially important in the early transaction phase and less so in later stages of the transaction. As a result, the odds of being reported as non-compliant are expected to be lower for delinquent loans whose maximum relative degree of delinquency (Max_degree) was observed at later stages of the transaction compared with those loans whose Max_degree was observed at earlier stages of the transaction. To test this expectation, TA_seasoning was converted into a binary variable. This takes the value of 0 if the Max_degree was observed within the first two years of the transaction and takes the value of 1 otherwise. In the regression, TA_seasoning was incorporated as a dummy variable, with the first group (TA_seasoning=0) being the reference category.

Consistent with the determination of the TA_seasoning, the outstanding protected loan amount (variable name: **Loan_amount**) was obtained for each loan from the specific period in which the Max_degree was observed. For a reputation-maintaining bank, the loan amount at this point of time (as a proxy) is expected to be relevant with regard to improving transaction performance. In particular, the removal of a delinquent loan that at that time is characterized by only a small

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outstanding loan amount would correspondingly result in only a small reduction of the total volume of delinquent loans to be reported in the investor report. For the purpose of improving transaction performance, it would thus be less efficient to scrutinize and remove delinquent loans with small loan amounts. Vice versa, it would be more efficient to scrutinize and remove delinquent loans with a large outstanding amount. Therefore, a higher loan amount is expected to be associated with a higher likelihood for the related loan to be reported as non-compliant. Accordingly, the influence of the Loan_amount variable on the probability of non-compliance is expected to be significant and positive. As a scale variable, the Loan_amount was measured in thousand euros (T€).

The loan-to-value ratio (variable name: **LTV**) is usually calculated by dividing the sum of the relevant loan amount and any equal and prior ranking charges on the mortgaged property by the value of that property as it is defined in the transaction documents.[26] Accordingly, a higher LTV ratio, leads to a lower probability of fully recovering the outstanding loan amount by liquidating the mortgaged property.

The LTV ratio thus represents a measure of risk. As such, the ratio is assumed to be a relevant criterion for a reputation-maintaining bank in the context of improving transaction performance. Specifically, the bank could concentrate on scrutinizing and removing loans associated with a high LTV ratio to take back high-risk loans and to keep less risky loans securitized.[27] Therefore, the odds of being reported as non-compliant are expected to be higher for delinquent loans associated with a high LTV ratio compared to loans associated with a low LTV ratio. For the purpose of testing this relationship the LTV ratio was divided into two groups. The first group (LTV=0) comprised the ratios below or equal to 60% and thus contained the lower-risk loans.[28] The second group (LTV=1) contained all other loans, that is, those with an LTV ratio above 60%, and accordingly represented higher-risk loans. In the model, the LTV ratio was incorporated as a dummy variable, with the first group (LTV=0) serving as the reference category.

5.2.2 Discussion of results

The independent variables were included in the logistic regression based on the forward stepwise procedure as it is offered in SPSS Statistics 17.0 (SPSS). This method selects and deletes covariates for the regression based on their statistical importance. Subsequent to the selection of variables, a test

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[26] For instance, see Prospectus (2006), p. 90 (Clause 6 (vii) Reference Pool Provisions).

[27] This assumption appears to be consistent with the analysis of Ambrose et al. (2005), who find that in a repeated game setting, lenders tend to retain higher-risk loans, whereas loans associated with lower risk are securitized. See Ambrose et al. (2005), p. 117 and referring to the LTV ratio as a risk indicator p. 123.

[28] The 60%-threshold was derived from § 35 sec. 1 sentence 4 No. 1 German Solvency Directive.

for backward elimination is run to remove variables included in the model but whose coefficient did not continue to be statistically significant. As a result of this procedure, all independent variables discussed in the previous section were included in the model regarding transaction A. Only two of the above-mentioned variables (Periods_delinquent and TA_seasoning) were included in the model relating to transaction B.[29]

Referring to the diagnostics performed with respect to the logistic regression, first, for both models it was tested whether the relationship between the latent variable z_l and each of the independent variables was linear (see formula (2) above) or nonlinear in any material respect. To identify nonlinearity, the term $x_j ln(x_j)$ was included in the analysis (Box-Tidwell transformation) and tested for its statistical significance. This method is not sensitive to minor degrees of nonlinearity.[30] With respect to both models the added terms were not significant at the $\alpha=10\%$ level. Therefore, a proof of nonlinearity was not found.

Second, plausible interactions between two of the main independent variables that had been included in the relevant models were examined. This was done by adding the product of two of the main variables to the model.[31] For instance, it appeared reasonable to test whether the maximum relative degree of delinquency (Max_degree) had a different influence on the probability of non-compliance depending on the point of time when the Max_degree had been observed, that is, depending on TA_seasoning. However, with respect to transaction A, no plausible interactions were found to be significant (e.g., $p_{Max\_degree\ x\ TA\_seasoning}$=0.169). Regarding transaction B, the interaction between Periods_delinquent and TA_seasoning was not found to be significant, either. Therefore, for both transactions, only the main effects models will be discussed below.

Third, the main effects models were tested for collinearity based on the tolerance statistic. For obtaining this statistic, a linear regression was run with the dependent and independent variables used in the logistic regression. The tolerance statistic was taken from the output of collinearity diagnostics

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[29] For selecting covariates SPSS applies a score test. The check for backward elimination is based on the likelihood ratio test. Details on the stepwise selection procedure can be found in Hosmer and Lemeshow (2000), pp. 116-128. The probabilities for stepwise were set to 0.05 (=p_{entry}) and 0.1 (=$p_{removal}$). The chosen probabilities were thus quite stringent (see Hosmer and Lemeshow (2000), p. 118 and Menard (2001), p. 64). However, as mentioned, all of the discussed variables were included in the model for transaction A. Referring to transaction B, p_{entry} was set to 0.25 and $p_{removal}$ to 0.3. Nevertheless, for transaction B, only two main variables were incorporated in the model.

[30] See Hosmer and Lemeshow (1989), p. 90 and Menard (2001), pp. 70 et seq.

[31] Details on the test of interactions can be found in Fromm (2005), pp. 28 et seqq., Hosmer and Lemeshow (2000), pp. 98 et seq. and pp. 125-128.

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relating to the linear regression.[32] For transaction A, a sign for serious collinearity was not found (tolerance$_j \geq$0.561). Regarding transaction B, serious collinearity was found with regard to the second category of Periods_delinquent (tolerance$_{Periods_delinquent}$=0.000; apart from this, tolerance$_j \geq$0.645). This implies that the coefficient estimates in the logistic regression model are inefficient but unbiased and suitable for inferences. In the presence of inefficiency, it is harder to reject the hypothesis that the dependent and the independent variables are not associated with each other, even if this hypothesis is false.[33]

Fourth, the data sets subject to logistic regression were examined with respect to zero cells and complete separation. The presence of zero cells was checked on the basis of contingency tables comprising the dependent variable and, respectively, each categorical independent variable. Complete separation was examined on the basis of McFadden's R^2 (see explanation below) as well as on the basis of classification plots.[34] Regarding both transactions, neither zero cells nor indications for complete separation were found.

In the following, the fit of the logistic regression model will be evaluated for transactions A and B. This is done on the basis of the model chi-square, McFadden's R^2, and the Hosmer-Lemeshow test.[35] Each of these statistics was either obtained directly or calculated from the SPSS binary logistic regression output.[36]

The model chi-square statistic indicates the extent by which the independent variables helped to improve the prediction of the dependent variable.[37] It was calculated as the absolute difference

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[32] This procedure was described by Menard (2001), p. 76.

[33] See Menard (2001), pp. 67 and 80.

[34] See Menard (2001), pp. 78-80.

[35] For evaluating the model fit in a logistic regression, Menard (2001) recommends the model chi-square and McFadden's R^2 measures; see Menard (2001), pp. 24, 27 and 41. Referring to all three measures, see also Backhaus et al. (2008), pp. 262-264, 268 et seq.

[36] Outliers were identified and analysed based on Studentized and deviance residuals, the change in the -2 log likelihood statistic of the full model and the difference in the coefficient estimates from the deletion of observation l. See Menard (2001), pp. 80 et seq. and 90 et seq. A deletion of outliers would result in an improved model fit but would require classifying outlier cases as unusual. Most outliers were found with regard to non-compliant loans. As mentioned, the analysis in this chapter will focus on the basic model fit and the direction in which the independent variables influence the probability of non-compliance. The specific amounts of the coefficients are of minor relevance. For this purpose, it is regarded as being more conservative and appropriate to not exclude outliers from the analysis and to accept a lower model fit.

[37] Referring to this test, see Menard (2001), pp. 21-22, 24 and 41; Backhaus et al. (2008), pp. 262 et seq.

between the -2 log likelihood statistic of the initial model, which only includes the intercept and none of the independent variables, and the equivalent statistic of the full model, which, in addition to the intercept, also includes the independent variables. The model chi-square allows testing the null hypothesis that all of the regression coefficients are equal to zero (H_0: $\beta_1=\beta_2=...=\beta_j=0$).

Based on the data available for transaction A, the model chi-square test statistic amounted to 544.580 ($p<0.001$). The test statistic referring to transaction B amounted to 30.701 ($p<0.001$). At a level of significance of 5%, the null hypothesis is therefore rejected with respect to both transactions. It is concluded that respectively all regression coefficients are not equal to zero. Referring to transactions A and B, the independent variables included in the respective model significantly improved the prediction of the probability of non-compliance $p_l(y=1)$.

McFadden's R^2 measures the degree to which the independent variables included in the regression decrease the variation of the initial model. It was calculated by dividing the model chi-square by the -2 log likelihood statistic of the initial model and thus allows comparing different models with each other.[38] For transaction A, the test statistic amounted to 0.305. This suggests that the independent variables resulted in a moderately strong reduction of variation. For transaction B the statistic amounted to only 0.073. Accordingly, with regard to this transaction, no relevant relationship between the dependent and independent variables was indicated.[39]

The Hosmer-Lemeshow test was performed to test the null hypothesis of whether the difference between the observed and predicted values of $y=1$ and $y=0$ is equal to zero (H_0: y_l-classification based on $p_l=0$).[40] The corresponding chi-square test statistic can directly be obtained from the SPSS output and was shown to be 7.924 ($p=0.441$) for the model relating to transaction A. The test statistic for the model relating to transaction B amounted to 3.081 ($p=0.688$). Accordingly, the null hypothesis cannot be rejected. The models relating to transactions A and B appear to fit. Backhaus et al. (2008) further specify with regard to the Hosmer-Lemeshow test, though, that the chi-square statistic should be as small as possible with a level of significance greater than 0.70.[41] In the cases at hand, this is not

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[38] See Menard (2001), pp. 21 and 24 as well as Backhaus et al. (2008), p. 264.

[39] In addition to McFadden's R^2, Nagelkerke's pseudo R^2 statistic was calculated for transactions A (=0.410) and B (=0.078). This also suggested that the model fit was good for transaction A but extremely low for transaction B (see Backhaus et al. (2008), p. 270). However, McFadden's pseudo R^2 is preferred for this analysis due to its favorable properties such as not being sensitive to the proportion of non-compliant loans versus compliant loans (see Menard (2001), p. 27).

[40] See Backhaus et al. (2008), p. 268 as well as Hosmer and Lemeshow (2000), pp. 147 et seqq.

[41] See Backhaus et al. (2008), p. 270.

fulfilled, as 0.441 and 0.688 are lower than 0.70. It is concluded that, based on this test, the model fit is indicated to be not well but acceptable.

In summary, the model chi-square for transaction A was much higher than that for transaction B. This was supported by the McFadden's R^2 statistic, which was acceptable and much higher for transaction A compared to the very low and inacceptable value determined for transaction B. For the purpose of this analysis, the model chi-square and McFadden's R^2 are considered to be the most relevant indicators with regard to the overall model fit. In contrast, the accuracy of classification as indicated by the Hosmer-Lemeshow test is regarded to be less relevant.[42] As an overall result, the goodness of fit is regarded to be acceptable for transaction A but not acceptable for transaction B. Accordingly, regarding transaction B, there appeared to be no sufficiently strong relationship between the overall loan characteristics and the probability of non-compliance. This result may, among others, be driven by the presence of collinearity. Nevertheless, as mentioned above, the model chi-square and McFadden's R^2 relating to transaction B were very weak compared to the results for transaction A. Consistent with what was argued above, the lack of model fit relating to transaction B is therefore considered to indicate cost minimization rather than reputation maintenance. The (preliminary) results are summarized in the following table.

Test statistic	Transaction A	Transaction B
Model chi-square	544.580 ($p<0.001$)	30.701 ($p<0.001$)
McFadden's-R^2	0.305	0.073
Hosmer-Lemeshow test (Chi-square statistic)	7.924 ($p=0.441$)	3.081 ($p=0.688$)
Goodness of fit	Acceptable	Inacceptable
Prevailing objective	(Reputation maintenance?)	Cost minimization

Table 2: Evaluation of the logistic regression models.

The model fit determined with respect to transaction A is regarded to be a primary indicator for reputation maintenance. However, the final conclusion on whether this objective may have prevailed can only be drawn if the individual loan characteristics influenced the probability of non-compliance in the expected manner. The regression output relevant for assessing the individual loan characteristics' impact is provided in the tables below.

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[42] Also confer Menard (2001), p. 37.

			Parameter coding			
		Frequency	(1)	(2)	(3)	(4)
Periods_delinquent	1	> 400	0.000	0.000	0.000	0.000
	2	> 400	1.000	0.000	0.000	0.000
	3	> 400	0.000	1.000	0.000	0.000
	4	> 200	0.000	0.000	1.000	0.000
	5	> 300	0.000	0.000	0.000	1.000
TA_seasoning	0	> 1100	0.000			
	1	> 700	1.000			
LTV	0	Not disclosed	0.000			
	1	Not disclosed	1.000			
Max_degree	0	> 1000	0.000			
	1	> 800	1.000			

Table 3: Coding for the categorical variables.

	β_j	Standard error	Wald statistic	df	Sig.	Exp(β_j) (odds ratio)	95% confidence interval for EXP(β_j)		β_j^*
							Lower	Upper	
Max_degree(1)	1.551	0.167	85.905	1	0.000	4.717	3.398	6.548	0.247
TA_seasoning(1)	-1.403	0.167	70.246	1	0.000	0.246	0.177	0.341	-0.220
LTV(1)	0.700	0.151	21.363	1	0.000	2.013	1.496	2.709	0.107
Loan_amount	0.006	0.002	11.970	1	0.001	1.006	1.003	1.009	0.076
Periods_delinquent			190.021	4	0.000				
Periods_delinquent(1)	1.497	0.360	17.265	1	0.000	4.468	2.205	9.052	0.680
Periods_delinquent(2)	3.044	0.348	76.321	1	0.000	20.990	10.603	41.553	1.382
Periods_delinquent(3)	2.339	0.372	39.615	1	0.000	10.371	5.006	21.486	1.062
Periods_delinquent(4)	0.452	0.398	1.293	1	0.256	1.572	0.721	3.426	0.205
Constant	-4.315	0.345	156.621	1	0.000	0.013			

Table 4: Variables in the logistic regression model (transaction A).

The coding of the categorical variables is displayed in table 3. As an example, the variable Max_degree(1) takes the value of 1 in case an observed loan was determined to be above-average delinquent. Otherwise, Max_degree takes the value of 0.

The statistical significance of the regression coefficients was examined with the Wald statistic. It tests the null hypothesis that an individual regression coefficient equals zero.[43] The Wald statistic and

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[43] See Menard (2001), p. 43 and Backhaus et al. (2008), p. 273.

its statistical significance are included in table 4. For the Periods_delinquent variable consisting of several categories, the Wald statistic is provided for both the overall variable and for each individual related dummy variable.

The data in table 4 indicate that, apart from one case, each regression coefficient was statistically significant at the 5% significance level. The coefficient relating to Periods_delinquent(4) was not significantly different from zero, while the overall variable Periods_delinquent was statistically significant. Thus, each of the loan characteristics contributed to explaining the dependent variable. Their influence will be further examined below. Based on chapter 5.2.1, the influence expected in the context of reputation maintenance will be compared to the influence estimated by the regression.

First, with regard to the **Max_degree** variable, it was expected that the odds of being reported as non-compliant are significantly higher for above-average delinquent loans compared to below-average delinquent loans. The regression coefficient for the Max_degree(1) variable is significantly greater than zero. This indicates that, ceteris paribus, the probability of non-compliance increases if Max_degree(1) is equal to 1, that is, if the relevant loan was determined to be above the average delinquency. The strength of this effect can be estimated on the basis of the odds ratio represented by $Exp(\beta_j)$. As shown in table 4, $Exp(\beta_{Max\_degree(1)})$ is equal to 4.717. Accordingly, the odds of being reported as non-compliant are 4.717 times higher for loans above the average delinquency compared to loans below the average delinquency.[44] This result is consistent with the influence of Max_degree expected under reputation maintenance.

Second, with regard to **Periods_delinquent**, it was expected that the odds of being reported as non-compliant are significantly higher for delinquent loans associated with a larger number of periods in arrears compared with delinquent loans associated with a smaller number of periods in arrears. Moreover, it was expected that this effect will eventually decrease in its strength or potentially even reverse for much larger numbers of periods in arrears. The regression coefficients for the dummy variables Periods_delinquent(1), Periods_delinquent(2) and Periods_delinquent(3) are significantly greater than zero. Accordingly, the odds of being reported as non-compliant are higher for loans that are assigned to one of these three categories compared to loans that are assigned to the reference category. However, the odds ratios relating to Periods_delinquent(1), Periods_delinquent(2) and Periods_delinquent(3) in this order amount to 4.468, 20.990 and 10.371. Therefore, the strength of the influence on the probability of non-compliance first increases but then decreases with respect to the variables representing increasing numbers of periods in arrears. For a loan falling into the largest category of periods in arrears, Periods_delinquent(4), the coefficient was found not to be significantly different from zero. Accordingly, this dummy variable did not significantly influence the probability

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[44] Referring to the way of interpretation, see Hardy (1993), pp. 76 et seq.

of non-compliance. Generally, the relevant regression coefficients were all positive. Therefore, a reversal of the relationship between Periods_delinquent and the probability of non-compliance was not found. Overall, the findings are consistent with the expectations based on the logic of reputation maintenance.

Third, referring to **TA_seasoning**, it was assumed that the odds of being reported as non-compliant will be lower for delinquent loans whose Max_degree was observed at later stages of the transaction compared with loans whose Max_degree was observed at earlier stages. The regression coefficient relating to TA_seasoning(1) is significantly lower than zero. For a loan that was highly delinquent towards the end of the transaction (TA_seasoning(1)=1), the odds of being reported as non-compliant, ceteris paribus, decrease by 75.4% (=1–0.246).[45] This influence is regarded to be consistent with the assumption of reputation maintenance.

Fourth, it was expected that the **Loan_amount** significantly and positively influenced the probability of non-compliance. The estimated coefficient for this variable is significantly greater than zero. Other factors being equal, a loan amount that is higher by one unit increases the odds of being reported as non-compliant by 0.6% (=1.006–1). Therefore, the expectation derived with respect to reputation maintenance is fulfilled.

Last, it was presumed that the odds of being reported as non-compliant are higher for delinquent loans associated with a high **LTV** compared to loans associated with a low LTV. As shown in table 4, the regression coefficient for LTV(1) is significantly greater than zero. The odds ratio indicates that, ceteris paribus, the odds of being reported as non-compliant are 2.013 times higher for delinquent loans associated with an LTV greater than 60% in comparison to loans associated with a lower LTV ratio. This result conforms to what was expected under reputation maintenance.

For the purpose of comparing the relative impacts of the different loan characteristics the standardized logistic regression coefficients were calculated. Following the procedure suggested by Menard (2001), the standardized coefficient β_j^* was determined by dividing the product of the unstandardized coefficient β_j, the standard deviation of the independent variable s_{x_j} and the square root of the coefficient of determination R by the standard deviation of the predicted values of the latent variable $\hat{z}_l$:[46]

$$\beta_j^* = \frac{\beta_j \times s_{x_j} \times R}{\hat{z}_l}$$

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[45] With regard to the method of interpretation, see Menard (2001), p. 56.

[46] See Menard (2001), pp. 52-56.

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The standardized regression coefficients are included in table 4. They suggest that the strongest influence was exerted by the Periods_delinquent variables. For instance, an increase in Periods_delinquent(1) by 1 standard deviation is associated with a 1.382 standard deviation increase in the latent variable z_l. Analogously, an increase in Max_degree(1) by 1 standard deviation was associated with a 0.247 standard deviation increase in z_l. TA _seasoning has a slightly weaker (and reverse) effect: a 1 standard deviation increase is associated with a 0.220 standard deviation decrease in the logit. The weakest relationships were found for the LTV ratio and the loan amount. Therefore, the strongest relationships between the logit and the loan characteristics were found for those characteristics that directly indicate loan performance, that is, Periods_delinquent, Max_degree and TA_seasoning.

In summary, the logistic regression analysis regarding transaction A suggests that all of the selected loan characteristics together significantly influenced the probability for a delinquent loan to be reported as non-compliant. The individual characteristics' influence matched the expectations derived under the logic of reputation maintenance. The results relating to transaction A indicate the prevalence of the objective of reputation maintenance. The findings regarding transaction B point towards cost minimization.

6   Conclusion

The results of the analysis suggest that in some transactions the influence of non-compliant loans goes beyond that of an unsystematically applied removal procedure. Non-compliant loans can significantly influence transaction performance and the extent of the actual risk transfer.[47] The results support the assumption that an originator could report and remove non-compliant loans strategically.

Whether an originator actually pursued a specific objective is difficult to discover. However, an originator should be aware that its reporting pattern could indicate the removal of non-compliant loans to be driven by cost minimization or reputation maintenance. From a regulatory perspective, both objectives and the corresponding removal of non-compliant loans can be critical.

In case the bank pursued cost minimization, it will generally try to minimize the volume of non-compliant loans. From a regulatory point of view, this is not critical, provided that, in fact, only a negligibly small volume of non-compliant loans has to be reported. The proceeding can become critical, though, if the cost-minimizing bank identifies many poorly performing non-compliant loans in the course of its checks so that, despite its attempts to minimize the volume of non-compliant loans,

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[47] In this context, it has to be considered that, based on the available data, it was not possible to determine the actual existing volume of non-compliant loans. It was only possible to analyze those non-compliant loans that were reported. Therefore, the aggregate loan amount affecting the extent of risk transfer is not known.

it has to remove a relatively large amount. The associated ineffective risk transfer questions the extent of regulatory capital release recognized for the transaction. This is particularly true if the identified non-compliance reasons already existed at or shortly after the cut-off date. In this case, the bank was able to release regulatory capital with regard to the non-compliant loans for the time from the beginning of the transaction until the date of identifying the non-compliant loan. To this extent, the initially recognized risk transfer and release of regulatory capital were not justified.

Under the objective of reputation maintenance, non-compliant loans would be (mis)used for strategic performance improvement. This form of implicit support strongly conflicts with the risk transfer requirements to be fulfilled for obtaining regulatory capital release. If implicit support is identified, the originator has to hold regulatory capital against the entire securitized portfolio.

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