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# Temi di Discussione

(Working Papers)

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by Valerio Vacca

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*The views expressed in the articles are those of the authors and do not involve the responsibility of the Bank.*

# AN UNEXPECTED CRISIS?
# LOOKING AT PRICING EFFECTIVENESS OF DIFFERENT BANKS

By Valerio Vacca*

**Abstract**

This paper shows how credit quality transition matrices of loans to Italian firms changed during a cyclical downturn (2008-09), compared with a previous time of growth (2006-07). Once transition matrices were linked to interest rates, banks appear to have been remarkably able at calibrating required risk premiums to actual idiosyncratic risk, both during expansion and recession. However, the uncertainty generated by the crisis accentuated the unexpected component of credit worsening, thus lowering pricing effectiveness. The main finding is that larger banking groups were more affected by the sudden deterioration of credit quality than smaller ones, as far as ability to price risk is concerned. The bank-size effect can be tackled through an efficient use of hard or soft information: both rating users and decentralized banks showed an above-average ability in calibrating rates to risk during the crisis; banks with a stronger relationship with borrowers smoothed the risk-price curve in normal times.

**JEL classification:** G21, G01, E43, E32.

**Keywords:** banking, crisis, credit migration, credit risk pricing.

**Contents**



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# 1 Introduction[1]

This paper addresses the question of which banks were more affected by the sudden deterioration of credit quality during the crisis, as far as their ability to correctly price risk is concerned. In order to answer this question, I apply to the Italian credit market a tool drawn from credit risk analysis, the transition matrix, and use the recent crisis as a natural experiment to gauge pricing effectiveness. The steps are as follows.

For the first time, credit quality transition matrices for bank loans to Italian firms are computed; they are referred to two distinct periods, namely a 'before the crisis' (2006-07) and a 'crisis' period (2008-09).

Second, the paper employs well-established risk pricing models, stating that (bank) interest rates should incorporate a risk premium, or spread, based upon the transition matrix estimated ex ante by the price setter (Jarrow et al, 1997).

Finally, the focus is on the correspondence between the realised transitions and the rates charged by banks to firms. A weaker correspondence signals that the actual riskiness of debtors has been assessed ex ante with lower accuracy. We can therefore detect for which banks the credit deterioration had a larger unexpected component by looking at modifications in the link between interest rates and transitions, before and after the crisis.

The main finding of the paper is that the discriminatory power of spreads was unambiguously weakened by the crisis, with significant divergence among banks of different type. The *unexpected* component of the credit worsening entailed a decline of the risk-related spread, compared with that applied before the crisis; the decline was larger for top five banking groups than for other banks. Looking beyond the mere size effect, the slower reaction of larger banks to the turmoil was probably rooted into organisational complexity, hampering an efficient use of information, of both hard and soft nature. Banks which resorted to formal rating systems benefited from a systematic use of hard information. Highly decentralised banks also display stronger capability to calibrate rates to risk in a downturn, thanks to their aptitude to collect non-codified information about firms. Banks with a stronger relationship to borrowers (their main banks) build a steeper risk-adjusted curve in normal times, but make it milder than other banks in hard times.

[1] The views expressed in this article are those of the author and do not necessarily reflect those of the Bank of Italy. The author would like to thank Giorgio Albareto, Paolo Angelini, Marcello Bofondi, Luisa Carpinelli, Giovanni Ferri, Nikola Tarashev and an anonymous referee for insightful comments. The usual disclaimer applies.

Other contributions are the following. 'Expansion' and 'recession matrices' are clearly different, and this finding provides us with a concrete measure of the increase in uncertainty faced by banks. I further document that banks have been able to calibrate interest rates to the actual riskiness of Italian obligors, based upon their location within the matrix. This finding holds true during the crisis, in spite of greater uncertainty.

The paper proceeds as follows. Section 2 summarizes the debate on transition matrices and on pricing effectiveness of different banks. Section 3 elaborates matrices for bank loans to Italian firms based on an extensive set of individual data and comments on modifications intervened with the crisis. Section 4 deals with the pricing of loans feeding the matrix, while section 5 performs a descriptive and an econometric analysis of spreads with a view to isolating the unexpected component of the realised credit portfolio deterioration. Section 6 concludes.

# 2 Background

Two strands of literature are relevant to the present analysis. First, the crisis is used as a natural experiment and its effects are explored on credit quality migrations and on ability of banks in foretelling these migrations. Second, the core question deals with the nature of banks which were more affected in their capacity to forecast this evolution.

## *2.1 The effect of a crisis on credit quality migrations*

Rating systems and matrices of obligors' transition between ratings are the first building block of credit risk models (Lowe, 2002). The transition matrix characterises the frequency or probability with which debtors within a portfolio shift across different credit qualities over a given time horizon.[2]

Several studies have shown that these probabilities can be affected by the current regime of the economy or by cross-section factors, such as the size, sector or location of the obligors (Altman and Kao, 1992a, 1992b, Altman, 1998, Nickell et al, 2000, Bangia et al, 2002, Lando and Skodeberg, 2002). In particular, the impact of the business cycle suggests hypothesizing time non-homogeneity, therefore distinguishing between "expansion matrices" and "recession matrices". The correct estimation of these conditional matrices is relevant, and can modify the assessment of

[2] From a theoretical point of view, it is usually assumed the evolution in the credit situation to be governed by a Markov process. Let x($t$) be the state vector, defined as a row-vector which characterise the probability distribution of the quality of credit (e.g. extended to a given company) at time $t$; then the Markov process governing the evolution of the state vector is such that x($k+1$) = x($k$)P, where P is the transition matrix which defines the passage of the state vector from a period to the subsequent.

the amount of capital that financial institutions should post against their credit risk (Jafry and Schuermann, 2004, Panetta et al, 2009a). Allowing for conditional migration frequencies leads to a measure of the increase in uncertainty, driven by an upsurge in unexpected losses for banks during a recession: to tackle higher unexpected losses, a larger capital buffer is required (Valencia, 2010). Recognising the cyclical nature of uncertainty facing banks, in turn, helps explaining leverage cycles in the banking sector, where assets-to-capital ratios change in connection with economic phases (Estrella, 2004). Time-dependent patterns in matrices are at the roots of procyclicality of the credit assessment systems, and might reflect real and financial imbalances which naturally build up in expansions, sowing the seeds of future contractions (Borio et al, 2001).

Bangia et al, 2002, estimate how much the required economic capital is altered on the grounds of the cycle-corrected transition frequencies. Estimates of the Value at Risk (VaR) of a credit portfolio can change in a nontrivial way (25 to 30 per cent) if the matrix is computed under time non-homogeneity. Kashyap and Stein, 2004, show that capital requirements referred to a portfolio of credits can change following the cycle, the size of these changes depending on the method used to assess credit risk. Some credit risk assessment models explicitly assume that both transition probabilities and their correlations evolve over time (Nickell et al, 2000, Otani et al, 2009).

For banks, the importance of a correct estimation of credit migration matrices also stems from the fact that interest rates should be consistent with the estimated transitions of debtors, according to risk pricing models (Jarrow et al, 1997).

Although beyond the reach of this paper, there are general reasons to explore the changing link between interest rates and transition matrices. The link allows to compare two hypotheses about the nature of credit and economic cycles: according to a predictability view, cycle would follow a partly predictable pattern, and the credit risk measure within interest rates would therefore grow before recessions; on the other hand, a random walk view maintains the irregular component of the cycle is predominant, making prediction difficult, and therefore measured risk would basically reflect current economic conditions (Pederzoli and Torricelli, 2005, Kwark, 2002, Gertler et al, 1991). Moreover, the spread charged to risky customers might be driven by a *credit spread puzzle* (Amato and Remolona, 2003; Cremers et al, 2005, Collin-Dufresne et al, 2010): spreads are usually found to be high with respect to historical default rates. The puzzle suggests that rates incorporate an insurance premium against *jump-to-default risk*, the risk that the quality of underlying debt experiences sudden systematic evolutions. In positive junctures banks would apply a spread

including this insurance premium; as jump-risk realizes, i.e. in economic downturns, interest rates appear to be low compared with previous (expansion) spreads.

*2.2 The pricing effectiveness of different banks*

A specific research interest, of microeconomic nature, is the core question of this paper. It addresses the characteristics of the banks for which the link between rates and actual debtors' riskiness has been blurred to a greater extent, owing to the crisis. I will investigate this issue having regard to two dimensions: the bank size and the use of different types of information (hard and soft information).

The first feature which could influence banks' ability to correctly price risk is size. On one hand, the portfolio of a small bank features a higher correlation in defaults, as is less diversified at a geographical, industry and firm-size level. Correlation tends to further grow during a sudden cyclical downturn (Andersen et al, 2000) and this might put at a disadvantage limited portfolios, with high idiosyncratic and local contagion risk (Giesecke and Weber, 2004).

On the other hand, the advantage of large portfolios shrinks and in the end evaporates when correlations between defaults rise to a significant degree (Amato and Remolona, 2005). Risk management systems tend to under-rate both the increase in correlations, and the credit portfolio size which is needed to effectively diversify risk away. At times of a severe regime change, credit pricing in outsized portfolios might result *ex post* more inefficient, as it relied on lower-than-realised default correlations. Hence, the surprise effect measured from rates would be larger for larger banks. Furthermore, larger banks which in recent years extended their business might suffer the winner's curse of entrants into new markets, which lowers their pricing effectiveness (Shaffer, 1997, Bofondi and Gobbi, 2004, Gobbi and Lotti, 2004, Hauswald and Marquez, 2006).

Recent research has shown that, beyond bank size, organisational arrangements or adoption of lending technologies could affect the credit process (see Albareto et al, 2008 for a comprehensive survey). Pricing effectiveness of larger banks in times of turmoil could benefit from a more efficient use of hard information (Panetta et al, 2009b) or instead be weakened by organisational features, e.g. the greater distance between decision hubs and local customers.

It is worth trying to look into the "black box" of the bank size, in order to disentangle the specific contribution of such factors to price effectiveness. First, the effects of the adoption of rating systems on the cost of credit are ambiguous (Berger et al, 2002). The use of quantitative methods

could allow banks to broaden credit availability to risky businesses (marginal borrowers). The overall portfolio riskiness would not necessarily rise, however, if idiosyncratic risk of single debtors is identified with higher accuracy. Neither a clear-cut hypothesis is possible with respect to average rates. Rates could end up being unable to account for ex post losses, e.g. if the bank mainly uses ratings to grant credit, rather than to price it. In general, strong reliance on hard information, which is necessarily lagged (e.g. for balance-sheet data), and lower reliance on soft information might jeopardize timely identification of credit cycle changes (Berger et al, 2005).

Against this background, organisational arrangements might provide incentives to the bank structure for collecting relevant information. In particular, broader delegation to loan officers would foster their willingness to gather and process non-transmittable soft information, which in turn might affect the effectiveness of credit pricing (Stein, 2002).

Finally, the intensity of bank-borrower relationship is also relevant, in that it allows for information accumulation, and hence more accurate pricing. At the same time, stronger relationships also give room for strategic pricing from the part of the bank: relying on a strong and long-lasting relationship, a bank might find convenient to smooth interest rates with respect to the (change of) borrower's riskiness (Machauer and Weber, 1998, Petersen and Rajan, 1995). This could lead to weaker correspondence between rates and riskiness, especially in turmoil.

Pricing accuracy might also have a geographical dimension. Recent entry of banks into highly contestable markets amplifies the mobility of market shares in some areas. This again might lead to Shaffer's, 1997, winner's curse, which materialize for banks expanding their market shares, and granting credit to (sub)marginal borrowers when entering new, contestable markets.

## 3 *Step 1*: Transition matrices of bank loans to Italian firms

The crisis which set off in 2007 and intensified in 2008 resulted in a deterioration of credit quality for Italian banks, which was not homogeneous across banking groups of different dimensions (Table a1).

In order to thoroughly appreciate the path of deterioration of bank loans to Italian firms, firm-level data in the Italian Credit Register database (*Centrale dei Rischi*, CR) allow filling a matrix of the frequencies with which bank loans shift through different states of impairment. The sample covers all the bank-firm relationships in the database, about 3 million observations. The frequencies are based on *conditional transition matrices*, i.e. referred to two biennial periods, 2006-07

and 2008-09 (Bangia et al, 2002). The adopted method implements a cohort approach, the most common in matrix computation (see methodological appendix).[3]

**Table 1**

Transition matrix between situations of impairment for loans to Italian firms (1)

*(period 31 December 2007 – 2009 and 2005 – 2007; percentage frequencies)*

| State of the loan at the initial date of the reference period | State of the loan at the final date of the reference period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fully regular | Overdraft | Past-due <180 dd | Past-due >180 dd | Sub standard | Non- performing | Loss | *N. loans (000)* |
| | a. "Recession" matrix (December 2007 ➔ December 2009) | | | | | | | |
| Fully regular | **79.5** | **14.2** | **1.4** | **1.2** | **2.1** | **1.4** | **0.2** | *962.4* |
| Overdraft | **43.1** | **35.3** | **3.4** | **3.3** | **8.0** | **6.0** | **0.9** | *267.4* |
| Past-due <180 dd | **32.7** | **25.0** | 5.8 | **6.8** | **16.0** | **12.4** | **1.4** | *20.5* |
| Past-due >180 dd | 30.1 | **19.7** | **4.2** | **10.9** | **19.5** | **14.2** | **1.3** | *19.6* |
| Sub standard | **7.4** | **6.5** | 1.2 | **1.6** | **41.3** | **37.5** | **4.4** | *24.6* |
| Non- performing | **0.1** | | | | **0.1** | **94.7** | **5.1** | *256.0* |
| Loss | | | | | | **10.4** | **89.6** | *82.1* |
| | b. "Expansion" matrix (December 2005 ➔ December 2007) | | | | | | | |
| Fully regular | 81.1 | 15.1 | 1.1 | 1.0 | 0.8 | 0.8 | 0.1 | *847.4* |
| Overdraft | 47.0 | 38.5 | 2.9 | 2.9 | 3.8 | 4.0 | 0.8 | *249.6* |
| Past-due <180 dd | 35.5 | 31.5 | 5.6 | 7.7 | 8.7 | 9.3 | 1.6 | *20.8* |
| Past-due >180 dd | 30.6 | 25.2 | 4.7 | 12.3 | 12.4 | 12.6 | 2.2 | *24.9* |
| Sub standard | 8.1 | 7.9 | 1.2 | 1.7 | 31.6 | 41.0 | 8.4 | *22.6* |
| Non- performing | | | | | | 88.1 | 11.8 | *271.9* |
| Loss | | | | | | 1.0 | 99.0 | *74.7* |

Source: Central Credit Register. See methodological appendix.

(1) Entries in the matrix represent the percentage frequencies at which bank-firm relationships, recorded in the state shown in the first column at the start of the reference period, moved towards the situation shown in the subsequent columns at the end of the following 24 months. Frequencies are reported as percentage of the number of the bank-firm relationships in the sample belonging to the relevant initial state; they sum up to 1 by row. Values below 0,1 are not reported. Entries In bold for 2007-09 matrix are statistically different from the corresponding entry in the 2005-07 matrix (at 1 per cent confidence level). To perform these tests, I calculate t-statistics equal to the difference between corresponding entries in the first sample (2007 to 2009) and the second sample (2005 to 2007) transition probabilities divided by standard errors for the first sample estimate. The calculation is therefore conditional on the first sample probabilities. Standard errors are calculated under the simplifying assumption that rating transitions are temporally and cross-sectionally independent (Nickell et al, 2000).

Table 1 presents transition matrix for bank loans to Italian firms.[4] The distinction between expansion and recession matrices seems to emerge unambiguously. In fact, the bold figures in the 2008-09 matrix highlight entries which are statistically different from corresponding entries in 2006-07 matrix (at 1 per cent level).[5] While frequencies in these matrices refer to number of bank-

[3] Lando and Skodeberg, 2002. The cohort approach is flawed by statistical limitations, in that it usually takes into account the debtors' situation at the start and the end of period, disregarding transitions to other states during the period; moreover, statistical issues such as (right) censoring and (left) truncation are overlooked. This entails a misalignment in transition estimates compared to sounder statistical methods, based upon survival analysis (e.g. duration or hazard rate approach). However, misalignment among different methods does not seem to be systematic, since within the same portfolio over- and under-estimations can simultaneously be found for different classes, without monotonic pattern. Cyclical phases are not the only determinant of transition matrices. Transition matrices can be separately estimated for different firm sizes, industries or location (see fig. a2 to a5 for matrices based on subsamples of firms). Nickell et al, 2000 fits an ordered probit model, finding that business cycle is the most important factor to be accounted for.

[4] Matrix frequencies should in principle be monotonically decreasing moving away from diagonal. Violations of monotonicity are however often found, and might depend, apart from noise in employed data, on the effect of infra-period transitions within the relevant horizon, i.e. over a shorter period than the reference horizon for the estimation of the final transition (Bangia et al, 2002).

[5] This matrix translates what is generally understood to be the firms' rating (its probability of default, PD) into credit quality as defined according to CR paradigm. Future research would usefully compare the average rating of firms belonging to different matrix cells, in order to check for correspondence between alternative definitions of credit quality.

firm relationships, matrices referred to amount of bank credit exhibit very similar patterns (Table a6).[6]

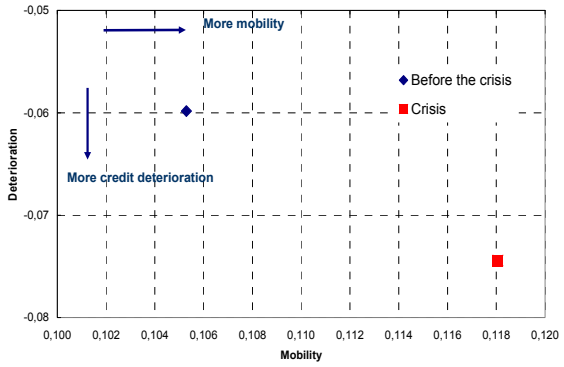
Matrices can be compared through summary indicators (see Appendix 1). A mobility index documents the speed of changes in credit quality, whereas a deterioration index shows how much of this mobility is due to credit worsening. Fig. 1, panel a, shows that credit quality mobility increased by about 12 per cent; this figure provides us with a quantitative estimate of the degree of uncertainty facing the traditional banking business as a consequence of the crisis inception. At the same time, deterioration switched from -6.0 to -7.4 per cent.

**Figure 1**

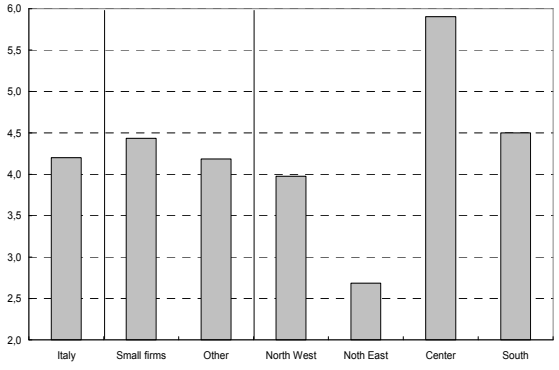
Mobility, deterioration and distance in expansion and recession matrices

*(indicator values)*

a) Mobility and deterioration in credit quality (1)




b) Distance between "expansion" and "recession transition matrices" (2)




Source: Central Credit Register. See the methodological appendix.
(1) The x-axis is a mobility index. The y-axis is a credit quality deterioration/improvement index, which ranges from +1 (maximum improvement) to -1 (maximum deterioration). See the methodological appendix. – (2) Euclidean distance $L^2$ between two matrices $P_a$ and $P_b$ is the square of the sum of the quadratic differences between each entry in matrix $P_a$ and the corresponding entry in $P_b$, divided by $N^2$ (Jafry and Schuermann, 2004).

It is possible to account for changes in non-diagonal entries through distance metrics. Figure 1, panel b, displays distance metrics between recession and expansion matrices. The distance is found to range from 2.5 to 6, depending on the specific matrix. Transitions are more affected by business cycles for small firms, which hence, according to this evidence, seem to have been hit by the downturn in a stronger way (Hancock and Wilcox, 1998). The matrices are also quite different across country areas, with major changes for Centre-Southern companies. In these regions credit growth has been stronger during the crisis, and the overall impact of the crisis has been partly diluted only by the larger share of (public) service sector (Banca d'Italia, 2009).

[6] A main departure of credit amount-based matrices from headcount-based matrices refers to transitions from/to overdraft. This is due to the relative diffusion of minor overdraft situations, and to the stricter definition of overdraft loans used in amount-based matrices. See the methodological appendix.

The rapid worsening of loans portfolio did not affect all banks to the same extent (Figure a1). Banks belonging to the top five groups experienced an above-the-average jump in credit mobility. The effect of using formal rating or scoring systems is ambiguous:[7] portfolios of banks using ratings to assess small business creditworthiness experienced a minor spike in uncertainty, whereas this does not hold true for the use of ratings for non-small and medium enterprises (non-SMEs). Finally, the systematic use of qualitative information in credit decisions helps taming swings at downturns, and strong reliance on collateral tends to magnify it.

## 4 *Step 2*: Effective loan pricing by banks

According to credit risk models, credit pricing should mirror the expected transition matrix. Banks should calibrate risk premiums charged to customers to the ex ante likelihood that the relationship move to a (different) impairment situation.[8] As a consequence, the transition matrix allows gauging to what extent Italian banks have correctly applied this risk management principle. If riskiness has been correctly estimated, interest rates to customers belonging to different entries in transition matrices should display a monotonic upward slope on each row. The steeper this curve, the stronger will appear the discriminatory capacity of banks at setting rates: in fact, a steeper interest rate curve on the ex post matrix suggests that the probabilities of credit worsening estimated ex ante (and incorporated in rates) closely mirrored the realised transitions.

The Bank of Italy's Taxia survey, which covers a large sample of credits included in the CR database (see Appendix 1), allows looking at correspondence between credit transitions and pricing. Table 2 presents average rates charged at the initial reference date (December 2007 and December 2005, respectively) on customers belonging to the entries of the transition matrix. In other words, Table 2 fills *ex ante* rates into the *ex post* matrix.

First, it is noticeable that rates distribution complies – to a large extent – with the implications of the risk models on correct credit pricing process. In particular, the first row of the matrix, concerning loans fully regular at the starting date, displays a clear upward slope in connection with the outcome of the credit relationship in a two-year time. For instance, in December 2007 fully regular loans to companies which would have stayed regular in the subsequent 24 months paid an

[7] The Bank of Italy carried out a survey at a very large sample of Italian banks, asking questions about organisational features of the bank, like use of credit rating / scoring systems, importance of qualitative information or collateral in extending credit, etc. The survey was carried out in two waves, in 2007 and 2010. For details, see Albareto et al, 2008.

[8] Crouhy et al, 2000. According to Jarrow et al, 1997, risk premia should be proportional to the probability that corporate credit evolves towards the worst state (the "absorption" state), starting from the situation at reference date.

average 7.11 per cent. At the same time, fully regular loans set to deteriorate to substandard paid 8.37 per cent, those heading to non perform paid 9.01, and future losses paid 9.11 (with a spread of 126bp, 190bp and 200bp in the order). The same pattern can be observed on end-2005 rates.

**Table 2**

Interest rates to firms, according to transition of firms between situations of (non)impairment (1)

*(period 31 December 2007 – 2009 and 31 December 2005 – 2007; percentage rates)*

| State of the loan at the initial date of the reference period | State of the loan at the final date of the reference period | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fully regular | Overdraft | Past-due <180 dd | Past-due >180 dd | Sub standard | Non- performing | Loss |
| | a. Interest rates referred to "Recession" matrix (December 2007 ➔ December 2009) | | | | | | |
| Fully regular | 7.11 | 7.69 | 7.52 | 7.76 | 8.37 | 9.01 | 9.11 |
| Overdraft | 7.81 | 8.03 | 8.48 | 8.55 | 9.12 | 9.89 | 10.25 |
| Past-due <180 dd | 8.19 | 8.44 | 8.66 | 8.38 | 9.45 | 9.98 | 10.82 |
| Past-due >180 dd | 7.73 | 8.53 | 8.49 | 7.54 | 9.20 | 9.64 | 11.08 |
| Sub standard | 9.27 | 10.47 | 10.25 | 9.86 | 9.20 | 10.20 | 10.17 |
| Non- performing | | | | | 5.97 | 12.17 | 12.70 |
| Loss | | | | | | 13.65 | 13.65 |
| | b. Interest rates referred to "Expansion" matrix (December 2005 ➔ December 2007) | | | | | | |
| Fully regular | 5.95 | 6.59 | 6.42 | 6.59 | 7.92 | 8.08 | 8.61 |
| Overdraft | 6.91 | 7.19 | 7.43 | 7.52 | 7.73 | 9.41 | 9.33 |
| Past-due <180 dd | 6.66 | 8.24 | 7.74 | 7.38 | 8.61 | 10.23 | 10.21 |
| Past-due >180 dd | 7.14 | 7.36 | 6.91 | 7.30 | 8.54 | 10.25 | 9.90 |
| Sub standard | 7.49 | 8.43 | 6.09 | 8.49 | 8.54 | 9.64 | 9.68 |
| Non- performing | 8.80 | 16.20 | | | 12.88 | 12.95 | 11.06 |
| Loss | | | | | 5.99 | 5.37 | |

Source: Central Credit Register. See methodological appendix.
(1) Entries in the matrix represent the average interest rates on short-term credit, charged by banks at the start of the relevant reference period to Italian firms that, from the state shown in the first column at the beginning of the reference period, would have moved towards the situation shown in the subsequent columns at the end of the following 24 months.

For loans which had already deteriorated before the start of the reference period the curve does not always display a clear positive slope (Figure a2). This confirms that where probabilities of default and correlations are higher, estimating parameters for an appropriate assessment of credit risk is subject to higher uncertainty (Tarashev, 2009).

Table 2 shows the ability of banks in discriminating among obligors with different perspective riskiness, in spite of a similar initial situation, thus confirming the banks' forward-looking approach (Magri and Pico, 2010). However, it is interesting to see to what extent this capacity was modified by the recent economic downturn. Figure 2 compares end-2005 to end-2007 curve of spreads, and suggests that banks have been actually surprised by the rapid deterioration of financial situation of firms. Smaller spreads in each row for end-2007 rates (i.e. a flatter risk-adjusted curve) epitomize the surprise effect triggered by a crisis whose progress has been largely unforeseen, both in intensity and speed.[9] The discriminatory power of the banks has been reduced not

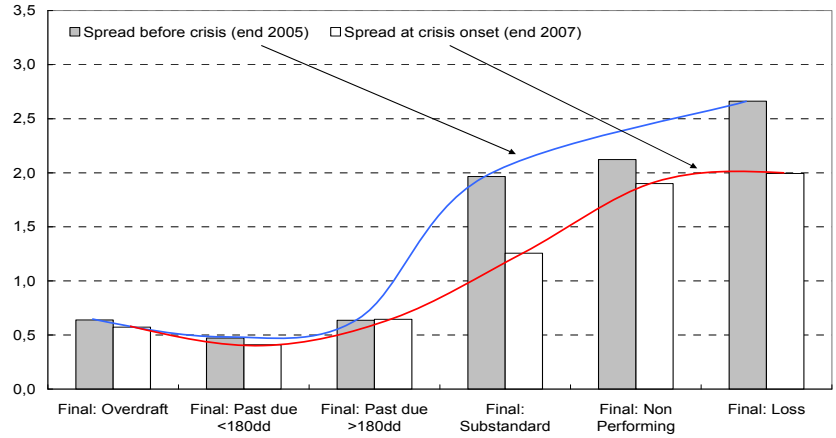
[9] The actual unexpected component could be deemed even larger, taking into account the higher general level of rates at end 2007 with respect to end 2005. Moreover, the unanticipated component due to recorded deteriorations or unex-

only with respect to loans which were fully regular at the start of the reference period, but also for those which were already impaired at the moment of their pricing (Figure a2).

**Figure 2**

Discriminatory capacity of interest rates, before and after crisis (1)

*(percentage rates)*




Source: Central Credit Register. See methodological appendix.
(1) Spread between (a) average interest rates charged at the end of reference year to firms which would have shifted from "fully regular" situation to the state shown on the x-axis within the subsequent 24 months, and (b) average interest rate to firms which would have stayed in the "fully regular" situation over the same period. The blue and red curves are graphical proxies.

# 5 *Step 3*: Different banks and the unexpected component of the crisis

## *5.1 Measuring unexpected credit worsening through spreads: a descriptive analysis*

The lower spread charged to risky customers at end 2007 as compared with end 2005 suggests that banks had correctly anticipated the deterioration of only a part of these loans, possibly as a consequence of an increase in information asymmetry between lenders and borrows (Dell'Ariccia and Marquez, 2004). By comparing rates to debtors in the different cells of the matrix we can quantify the surprise effect which hit banks at the onset of crisis.

Spread at end 2007 for risky customers can be decomposed into a benchmark spread and an unexpected component, related to the crisis, according to a straightforward methodology (see Appendix 1). In the decomposition end-2005 spread is assumed as a *benchmark* or normal-times price gap that banks require to marginal borrowers. The reduction in spreads in the crisis period, i.e. the vertical distance between curves in Figure 2, gauges the unexpected component of the cyclical deterioration: risky obligors are assumed to pay, at end 2007, a spread below the 2005 benchmark *if* banks failed, more than usual, to spot loans set to worsen in the subsequent two years. The lower

pected losses on credits could be under-estimated in light of the tendency to under-report losses which is sometimes found in phases of banking system fragility (Stever and Wilcox, 2007).

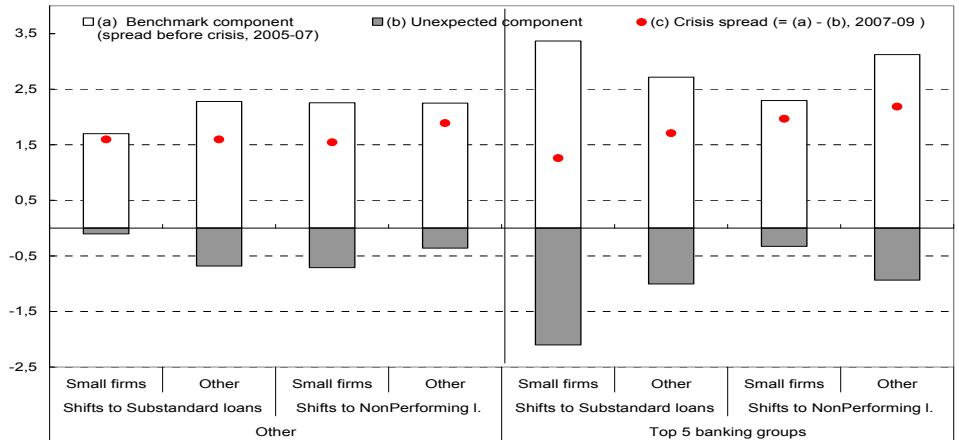
the absolute value of the unexpected component, the more stable the ability of banks to locate credit risk.

The result of this decomposition is shown in Figure 3. The unexpected component of credit quality deterioration (the darker bar in the charts) was not homogeneous if one pays attention at different types of banks (or firms). Different findings for subsamples of loans are important. Subsamples that experienced the largest unexpected worsening might have suffered a flight-to-safety from banks: i.e., where we find larger surprises, we could expect a more severe subsequent tightening from the part of banks, during the credit crunch period.

**Figure 3**

Unexpected component in interest rates during crisis, by size of bank (1)

*(percentage points)*




Source: Central Credit Register. See methodological appendix.

(1) The benchmark component is the spread, recorded at end 2005, between (a) average rates required to "fully regular" obligors which would have turned substandard or non-performing within the following 24 months, and (b) average rates required to "fully regular" obligors which would have stayed regular within the following 24 months. The Crisis spread is the same spread computed at end 2007. The unexpected component is the difference between the two spreads.

Unexpected component was unambiguously larger for banks belonging to top five Italian groups (Figure 3). Overall, spreads applied to future substandard loans shrank by 1.3 per cent during the crisis, compared with the pre-crisis period (-0.6 per cent for smaller banks). For non performing loans, the predictive power of rates was reduced by 0.9 per cent for big groups (-0.3 for smaller banks). The difference is especially striking for credit lines set to produce substandard loans at smaller firms, i.e. where the size asymmetry is larger between large banking groups and customers. This seems to corroborate the hypothesis pointing to a worse impact of economic downturn on large and fast growing portfolios, and on more complex institutions.

*5.2 Econometric analysis*

*5.2.1 The model*

The main aim of the econometric analysis is to disentangle bank categories for which risk-spreads were more affected by the crisis in their capacity to spot the actual riskiness of loans, i.e. their possible transition to different impairment states. The baseline equation is:

$$s_{i,b,t} = f(Tr_{i,b,t},\ X_b,\ Z_i,\ Crisis,\ \lfloor Tr_{i,b,t} * X_b * Crisis \rfloor,\ \lfloor Tr_{i,b,t} * Z_i * Crisis \rfloor) \quad [1]$$

In [1], the dependent variable, $s_{i,b,t}$ is the rate applied by bank *b* to firm *i* at time *t* (*t* assumes two values, the crisis and the period before the crisis). The rate is expressed as a spread with respect to the average rate applied to non-impaired debtors that would maintain the situation at the end of the relevant period. $Tr_{i,b,t}$ are dummies for each possible transition between states of impairment for debtor *i* towards bank *b* in period *t* to *t+24 months* (the benchmark case being for debtors being regular at both the start and at the end of the relevant period). $X_b$ and $Z_i$ are controls for bank and firm features, in the order. Some of these features are interacted with both the transition and the crisis dummies, between brackets in [1]. These interactions are a major focus of the analysis, in order to detect crisis-related changes in the relationship between *ex post* transitions and *ex ante* rates, i.e. to detect a possible weakening in the correct risk-price association. The bank features which are controlled for are size and proxies for the aptitude of banks to gather and employ hard or soft information. The firm features are size, industrial and institutional sector, the incorporation technique (e.g. limited company), the regional location, the length of the firm's credit history, the availability of some form of collateral and the initial situation of the credit line. Tables a7-a12 report the results for different specifications based on the general form of the [1].

*5.2.2 Pricing effectiveness and the crisis*

In Table a7 the basic relationship is first estimated separately for the period before and after the crisis, using the turmoil as a natural experiment to appraise pricing effectiveness at banks. The fit of the regressions shows that the banks (i) do comply with the pricing rules suggested by the theoretical credit risk models, and (ii) are able to foresee the future evolution of the quality of debtors. Without imposing any restriction on estimation, it is noticeable that the coefficients of the transi-

tion dummies follow a regular pattern, namely an upward slope across the matrix rows, often with non overlapping confidence intervals (Figure 4). Statistical tests (not reported) establish that coefficients in the first row are different (larger) from the previous cell coefficients, at 1 per cent level.

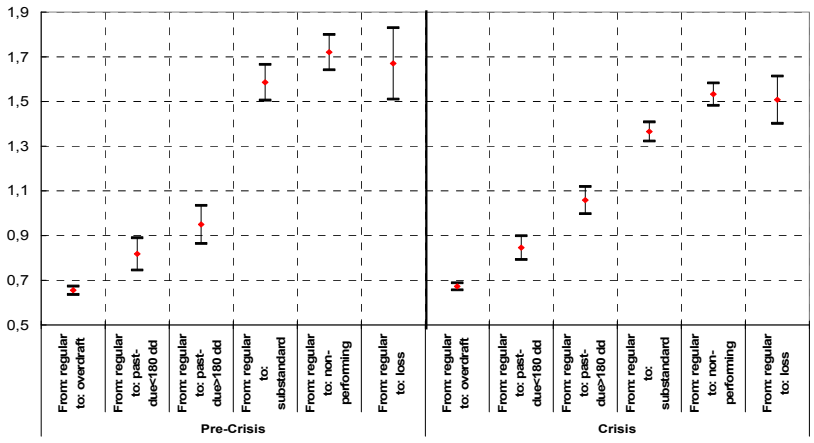
In other words, econometric estimates unambiguously confirm the hypothesis of the credit risk models. Credits which are already in a non-regular situation at the moment of the pricing also command a premium, regardless of their final destination: coefficients for the initial credit situations are positive and increasing. This is the effect of greater uncertainty surrounding unstable situations, which is also reflected in less significant coefficients in lower rows of the matrices (Tarashev, 2009). Finally, spreads are decreasing in firm size and if the credit line is assisted by collateral.

The previous remarks hold both before and during the crisis, confirming that banks largely maintained their pricing ability during the turmoil as well. However, some differences are remarkable. First, during the crisis the fit of the estimation decreases, pointing to a weaker explanatory power of the credit transitions with respect to the interest rate applied. Second, the slope of the coefficient for worse transitions is milder during the crisis, again suggesting that banks were less sharp at calibrating rates to actual debtors' riskiness.

**Figure 4**

Estimated risk related interest rates spread, before and after the crisis (1)

*(percentage points)*




Source: Central Credit Register. See methodological appendix.
(1) Estimated coefficients for transition of credits from regular to impaired situations. Each coefficient gauges the spread of regular credits shifted to impaired situations, with respect to the average rate applied to credit lines which were regular at both the beginning and the end of the relevant period. Estimation periods are end 2005 to end 2007 (before the crisis), end 2007 to end 2009 (crisis). Vertical lines denote 5 per cent confidence intervals for estimated parameters.

*5.2.3 Major banks versus other banks*

Regression in Table a8 basically estimates the [1], the pivotal specification of this exercise, based on the whole sample. A dummy variable singles out banks belonging to top five banking groups, and is interacted with the crisis indicator. The pricing accuracy of banks was reduced by the crisis across the board (with an average risk spread reduction of -13 basis points). However, the accuracy of larger banking groups was lessened by far more: the interaction between the dummy for top five banking groups and the crisis has a coefficient of about -66 basis points, suggesting that bigger banks experienced a large *additional* decrease in pricing accuracy. Noticeably, the risk-related spread charged by major groups is apparently higher across the whole period (the top five groups coefficient, without interaction with the crisis, is positive). In my view, this further confirms that major banks were unable to foretell the upcoming downturn, although their prices are more selective in non-crisis times.

With the aim to shed light on the determinants of the larger unexpected component of credit deterioration for some banks, beyond bank group size, I will now try to disentangle the effect of the aptitude of banks to gather and employ information, of both hard and soft nature. In order to do so, additional regressions consider credit transitions interacted with a set of variables proxying bank features which could affect ability in pricing risk, namely (i) the use of rating models, (ii) the span of delegation allowed to loan officer, and (iii) the intensity of the bank-firm relationship. The following sections comment the results of these specifications (Table a9).

*5.2.4 Gathering and using information: the adoption of rating models by banks*

In the first column in Table a9 a dummy identifies banks which had already implemented quantitative rating models in 2007, i.e. before the crisis. The information is retrieved from the Bank of Italy survey on a large sample of banks (see Appendix 1). The estimates suggest that rating-users do not show superior ability to price-discriminate for risk, in normal times. However, in crisis times, banks using rating models show a lower decrease in the slope of their risk-adjusted interest rate curve (the coefficient of the interaction for use of ratings and crisis is positive).

Albareto et al, 2008, find that some banks do not use rating models for pricing, but mainly for screening or monitoring borrowers. Therefore, Table a9, column 2, looks at banks which state that their rating models are ‘important’ or ‘fundamental’ (also) in credit pricing. These banks do not display superior pricing effectiveness in normal times, but are less affected by the crisis surprise

than other banks. These findings apparently suggest that the crisis did not completely blur the informational improvements stemming from a more intense usage of hard information (see Panetta et al, 2009b).

*5.2.5 Gathering and using information: the delegation to loan officers*

Organisational diseconomies of scale can be tackled by banks through the span of autonomy allowed to managers directly involved in the relationship with customers (Benvenuti et al, 2010). The Bank of Italy survey allows gauging this delegation breadth, through an indicator of relative manager's autonomy, i.e. the ratio between (a) the maximum amount of credit a loan officer can grant and (b) the maximum amount the bank's CEO can grant. In column 3 of Table a9, a dummy variable is equal to 1 if the scope of delegated powers at the lending bank – measured as above – is above the median value of the sample.

The results suggest that the span of delegation in normal times does not improve effective pricing of credit. However, when a crisis impends, highly decentralised banks seem to be less surprised by upcoming deterioration of their loans, as their risk-adjusted interest rate curve stays more upward-sloping. The finding strengthens the relevance of the soft information argument, since more empowered loan officers should be, in principle, more prone to gather non-codified information.

*5.2.6 Gathering and using information: the intensity of bank-borrower relationship*

The last column in Table a9 takes into account the strength of the bank-borrower relationship, through the prominent role of a bank among the lenders. The "main bank" dummy takes value 1 where the bank extends the largest (or single) loan to the borrower, according to the dataset. The main bank benefits from a stronger relationship to the firm, and in principle is in a better position to acquire (soft) information about the intrinsic value of the entrepreneurial project. This would enhance ability to calibrate rates to the actual riskiness, also in turmoil. However, often a stronger relationship means a longer one, which could lead to interest rate smoothing along the life of the relationship, thus softening the reaction of rates to a changing credit situation of the borrower.

The results of the estimations shed light on these contrasting views. The dummy for the main bank is negative, which supports the idea that main lenders tend to smooth interest rates across the debtor's riskiness (Machauer and Weber, 1998). Consistently, when faced by a sudden turmoil, the decrease in the risk-related slope for main lenders is smaller, implying that the unexpected

component of the credit deterioration is mitigated by the superior information provided by a stronger role of the bank among the firm's lenders.

Overall, looking beyond the size effect, the role of both hard and soft information clearly emerges during the crisis from the analysis of organisational features and lending technologies (Table 3). Ratings helped better calibrate rates to risk, especially if they are explicitly employed in the pricing process. Highly decentralised banks have been more effective at shielding themselves from credit quality surprises, possibly thanks to their skills in collecting non-codified information. A stronger bank-borrower relationship led to milder risk-related interest rates curve in normal times, while making the risk curve steeper in a downturn. The larger unexpected credit deterioration at larger groups is confirmed when ability in using information is accounted for. It therefore seems to be rooted into organisational complexity, hampering an efficient use of gathered information.

**Table 3**

Main results of the econometric analysis

| | Slope of the risk-adjusted interest rate curve (1) | |
|---|---|---|
| | In normal times | During the crisis |
| Larger banking groups | Higher | Lower |
| Beyond bank size: | | |
| - Use of rating models | … | Higher |
| - Use of ratings for pricing | … | Higher |
| - High delegation (decentralisation) | … | Higher |
| - Main bank | Lower | Higher |

Source: Econometric analysis. See figures in the appendix.
(1) Slope of the risk adjusted interest rate curve for the relevant category of bank, with respect to the average bank, according to econometric estimates reported in figures in the appendix. Only statistically significant coefficients are reported.

*5.2.7 Additional findings: smaller and larger firms, regional differences*

The results above do not seem to depend on the customer firm type. In Table a10, columns 1 and 2, the behaviour of interest rates for SMEs and non-SMEs are separately investigated. The pattern of the risk-related interest rate curve is appreciably different among firms of different size (Figure 5). Bank rates for smaller firms (SMEs) feature higher spreads according to their matrix-related riskiness. Spreads applied to SMEs are also more dispersed around their mean value; this

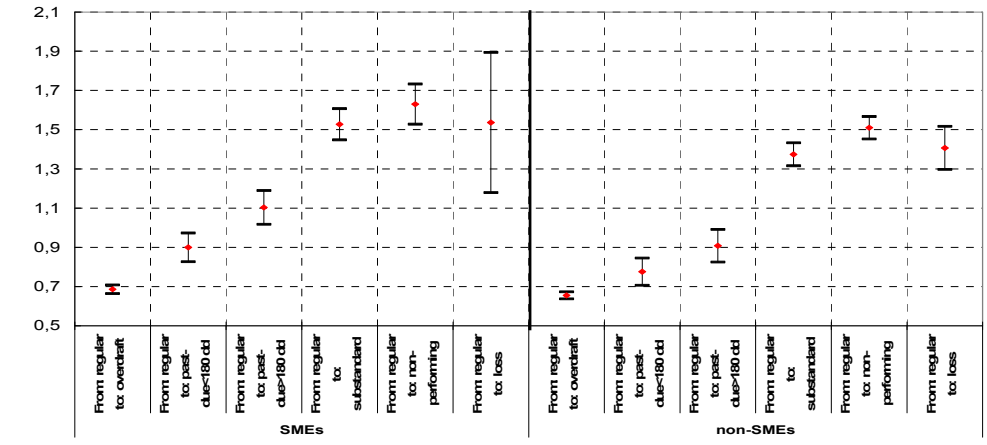
is presumably the effect of greater opaqueness at small firms (Benvenuti et al, 2010). However, the surprise effect of the crisis was basically the same for larger and for smaller firms and the additional unexpected component of the worsening for the largest banking groups was almost the same.

Table a11 finally looks at the effect of regional location of firms. Basis regional coefficients suggest that, in general, the pricing accuracy of banks is larger in northern regions. At the same time, I find that the crisis came as a major surprise mainly in the northern regions: interacting regional location with crisis provides negative and significant coefficients for several northern regions. By contrast, transitions of central and southern firms to worse credit situations were less of a surprise to banks.

**Figure 5**

Estimated risk related spreads for smaller and other firms (1)

*(percentage points)*




Source: Central Credit Register. See methodological appendix.
(1) Estimated coefficients for transition of credits from regular to impaired situations. Each coefficient gauges the spread of regular credits shifted to impaired situations, with respect to the average rate applied to credit lines which were regular at both the beginning and the end of the relevant period. Estimation periods are end 2005 to end 2007, end 2007 to end 2009. Vertical lines denote 5 per cent confidence intervals for estimated parameters.

*5.2.8 Alternative explanations and robustness checks*

In order to check for the robustness of main findings, some alternative econometric exercises on the baseline specification are run (Table a12).

First, an alternative explanation of the spread reduction during the crisis is investigated. A milder curve during the crisis could stem not only from credit quality surprises, but also from other sources: during the crisis, some banks could have adopted heavier under-reporting of credit impairment than other banks. In order to check the under-reporting hypothesis, the impairment situation of each credit relationship has been re-defined according to the worst credit classification of

the debtor at the reference date. In other words, each bank-firm relationship is assigned to the worst recorded status, regardless of which classification has been reported by the lending bank. This procedure should iron out possible under reporting of impairment from the part of some banks, at least for borrowers with multiple bank relationships.

Then, the same regressions were run using as dependent variable interest rates, instead of spreads (the dependent variable in the baseline specification are spreads towards the average rate for benchmark situation, i.e. the average rate charged to loans fully regular at both the start and the end of the period). The estimation was run excluding fixed effects for banks, and allowing for clustering of standard errors by firm, wherever a given firm accounts for multiple observations. Spreads outside the 5$^{th}$ and the 95$^{th}$ percentile were excluded, instead of only those beyond 1$^{st}$ and 99$^{th}$ percentile. Further, some controls were omitted, like guaranteed credits or banks' institutional category, which are present in the baseline specifications, and might overlap with other dimensions of interest. Finally, estimations were run with a set of refinements to the base-line definitions: impairment status was defined having regard to credit amount classified in each impairment status, which entails a stricter definition of overdrafts (see methodological appendix), and alternative reference periods were used, i.e. two 30-month period, June 2008 to December 2010 (crisis), vs. December 2005 to June 2008.

All these extensions, apart from an expected decrease in the overall fitting of the estimation, basically yield the same results for relevant parameters.

# 6 Conclusions

This paper addresses the question of which banks were more affected by the sudden deterioration of credit quality during the crisis, as far as their ability to correctly price risk is concerned. In order to answer this question, it starts from computing the credit quality transition matrices of bank loans to Italian firms, for the first time to my knowledge.

As a preliminary contribution, I document that matrices have changed, in a significant way, between expansion and recession. Distance metrics provide a concrete yardstick of this increase in uncertainty faced by banks in their traditional business, owing to cyclical downturn. Second, banks have been remarkably able to calibrate spreads to the realised credit quality, as measured by the transition matrix. The discriminatory power of spreads remains unquestionable during the crisis, in spite of greater uncertainty.

However, the key result is that the crisis made the risk-related curve of rates applied to firms noticeably flatter, as uncertainty diluted banks' capacity to detect ex ante risky credit. The *unexpected* component of the credit worsening is sizeable, and depends on the type of bank extending credit. Unexpected downturn was more serious for top five Italian groups, suggesting that pricing effectiveness of banks is strongly affected by organisational features, e.g. their governance complexity. Interestingly, larger banks are more capable, in general, to tailor ex ante spreads to actual riskiness of their debtors. In other words, the blurring of their spread structure was the specific outcome of the surprise effect from a rapid unfavourable evolution.

Looking beyond bank's size, the more efficient use of hard information (quantitative rating models) improved the pricing performance during the downturn. The geographical or functional distance between decision hubs and local customers might have weakened the ability of some banks to spot the upcoming credit worsening just before the turmoil, and in fact decentralised banks suffered less of a surprise. The role of bank-borrower relationship is two-faceted: a stronger relationship with their borrowers led reference banks (the *main* banks) to smooth the interest rates-risk relationship in normal times, which also stayed more stable in the downturn.

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# Appendix 1: Data and methodology

### 1. Data

*Computing the matrices from Italian credit register (CR) data.* – Against the background of a conventional 12-month horizon for transition matrices, a 24-month period captures the specific dynamics of loan worsening in two stages, that can be labelled as a pre-crisis (or expansion) and a crisis (or recession) situation.
In the matrix, single, non-negative entries sum up to 1 by row (right stochastic matrix). The diagonal represents the frequency of keeping the initial state; off-diagonal entries represent the frequency of transition from one state to another, with worsening on the right of the diagonal. The basic assumption behind the cohort approach is that, for a given sample, the probability of a transition from rating $i$ to $j$, is a constant parameter, $p_{ij}$: for a given initial state, transitions to different possible future states follow a constant parameter, temporally independent process. Estimation can then be performed by taking the fraction of occasions in the sample on which an obligor starts the year in state $i$ and ends it in $j$ (Nickell et al, 2000).
At the initial date of each reference period (i.e. end 2005, end 2007) a static pool of loans is defined, which are tracked until the end of the relevant period. Transition matrices are computed from the cash credit lines from banks to firms recorded in the CR. Loans larger than 75,000 euro are recorded (30,000 euro from 1 January 2009). All the bank-firm relationships are included with actual credit usage above zero at both (i) the start of the reference period (end 2005, end 2007), and (ii) the end of the reference period (end 2007, end 2009). The state of the loan is observed at the start/end of period, disregarding the state of the loan at intermediate dates within this period. This entails that a certain number of bank-firm relationships are lost between the start and the end of each period, and therefore do not enter the matrix computation. A bank-firm relationship might be cancelled within a 24 month period due to (i) repayment; (ii) amount reduction below the CR threshold; (iii) transition to loss and subsequent write-off. With regards to involved credit quantities, the weight of the non recorded loans can be estimated at about 18.0% of total initial credit in the two 24-month periods. Cancellations due to write-off (i.e. situation (iii) above) could cause underestimation of the actual credit worsening. However, this portion should be minor, due to the fact that before write-off a credit is usually recorded in the non-performing category, where the average stay is 54 months. In the reported matrices, loans classified in categories like "securitised", "debt restructuring", "other", etc, have been overlooked, because in these cases it is unclear how to rank the degree of impairment, with respect to other states.

*Matrices on the number of positions (bank-firm relationships).* – Frequencies are such that $f_{ij} = n_{ij} / n_i$, i.e. the frequency in each cell describing the transition from state $i$ to state $j$ is equal to the number of observations which displayed this migration at the end of the period, divided by the number of observations in the state $i$ at the start of the period. When a credit line is simultaneously classified in different states of impairment, the worst impairment state has been deemed relevant. This approach could affect in particular the "overdraft" classification, which refers to specific credit lines, rather than to the overall bank-firm relationship: a given bank-firm relationship is classified as overdraft even if only a minor share of credit belongs to this state of impairment. In order to check for these possible distortions, estimations on credit amount-based matrices use a finer definition of overdraft credit (see below).

*Matrices on the amount of granted and used credit.* – Frequencies have also been calculated having regard to loan amounts, attaching a size-weighted importance to each position. The total credit used within the bank-firm relationship at reference date is assigned to the worst reported state of impairment, provided that the amount of credit recorded in the relevant state of impairment is at least 10 per cent of the total used credit (30 per cent for overdraft). Frequencies in the table refer to the used credit amount at the initial reference date of each period.

*Matrices on the number of positions vs. credit amounts.* – The base-line analysis in the paper refers to matrices calculated on number of positions. Mobility and improvement/deterioration patterns are similar for matrices based on *numbers* of bank-firm relationships and on *quantities* of credit, suggesting that no relevant differences would emerge from using the latter in the descriptive or econometric analysis. The following table reports the mobility index and the improvement/deterioration indexes for the two estimation methods of the transition matrices:

Comparison between mobility and deterioration indexes,
matrices based on number of bank-firm relationships *Vs.* based on quantity of credit (1)

| | Matrices based on numbers | | Matrices based on quantities | |
|---|---|---|---|---|
| | 2005-2007 | 2007-2009 | 2005-2007 | 2007-2009 |
| Mobility index | 10.5 | 11.8 | 9.1 | 13.0 |
| Deterioration/improvement | -0.57 | -0.63 | -0.41 | -0.75 |

(1) Indexes are calculated collapsing fully regular loans with overdraft loans. See methodological appendix about the method to calculate the indexes.

*Definition of Absorbing states.* – Absorbing states are those credit situations from where an improvement should be unfeasible. In a typical transition matrix, this is the *default* situation. In the CR classification, absorbing state should be in principle the *loss* state. (Please note that the *non-performing* state also entails virtual no reversion, since it is defined as credit "…towards debtors in an insolvency state (although non judicially certified) or in substantially comparable situations": see Bank of Italy, Annual report). In fact, CR data base records some reversions from the loss state, i.e. bank-firm relationships which are recorded as loss at *t* and in a non-loss situation at *t+1*. These case could emerge due to (i) erroneous classifications of the firm situation (at *t* or *t+1*); (ii) mergers among banks (e.g. bank *a*, recording debtor *i* as loss at *t* is merged into bank *b* at *t+1*, and bank *b* might not record debtor *i* as loss at *t+1*, due to previous relationship with the same debtor: since at each reference date the worst situation is accounted for, debtor *i* would mark an "improvement from loss" after the merger). The improvements from loss are purely erroneous or fictitious, and hence there is no signal from their change between periods. The impact of these unusual transitions is negligible to the paper's purpose: (i) they account for about 0.3% of the recorded bank-firm relationships in both the relevant periods; (ii) none of these "reverted" situations is used into the econometric estimation.

*Survey statistics on interest rates.* – Interest rates are retrieved from banks' survey reports to the Bank of Italy, which cover over 200 bank, and a large part of loans to firms (dataset Taxia). Here below is the coverage of the interest rate survey, with respect to the CR data base:

Average coverage of interest rate data on CR-recorded loans (1)
*(percentage values)*

| | Period December 2005 – December 2007 | Period December 2007 – December 2009 |
|---|---|---|
| Overall | 43.6 | 43.8 |
| *Top 5 groups* | *48.2* | *49.7* |
| *Small-Medium Firms (SMEs)* | *37.5* | *37.8* |
| *Other firms* | *49.1* | *49.2* |

(1) Percentage of bank-firm relationships for which interest rates on short-term bank credit are recorded in Taxia data base, at the initial data of the reference period (December 2005, December 2007), with respect to the corresponding number of bank-firm relationships recorded in the CR data base, and used for the computation of the transition matrix.

Rates are calculated as the weighted average of simple rates, disregarding fees and commissions. Outlier rates are excluded (below 1st and 99th percentile). In order to compute averages for end-2005 (end-2007) rates, debtors are classified according to their transition from end-2005 to end-2007 (from end-2007 to end-2009). Small businesses, or SMEs, are defined as firms below 20 employed units.

*Survey on organisational features.* – Organisational and lending technologies variables are retrieved from the Bank of Italy survey carried out in early 2007 and early 2010 (Albareto et al, 2008).

**2. Mobility, deterioration and distance indexes for matrices**

A mobility index, based upon eigenvalues of a $N \times N$ matrix, is $Mp(P) = (1/N - 1)*(N - tr(P))$, where $P$ is the matrix and $tr(...)$ denotes the trace of the matrix (Jafry and Schuermann, 2004; Shorrocks, 1978).[10] Weighing frequencies on each row with the corresponding marginal frequency amounts to computing mo-

[10] Mobility indexes basically carry out a subtraction from a transition matrix of an *identity*, which corresponds to a static outcome, where no subject changes its state between the start and the end of the reference period. The subtraction allows to disentangle the exclusively dynamic part of the original matrix, which reflects its dimension in terms of implicit mobility.

bility index on number of positions, rather than on relative frequencies. With respect to tables in the text, mobility indexes account for some transitions which are not displayed (to "restructured loans"), because their ranking in terms of degree of deterioration is not univocally defined. Furthermore, slight deteriorations (overdraft) are collapsed with fully regular loans into an "almost regular loans" category, since small overdrafts are rather common in Italian bank-firm relationships.

The deterioration/improvement index ranges from 1 (maximum improvement) to -1 (maximum deterioration), and is calculated as follows:

*(Improvement – Deterioration) / (Improvement + Deterioration + Stability)*

where *Improvement* = $\Sigma_{i>j}\ (n_{ij})$, *Deterioration* = $\Sigma_{i<j}\ (n_{ij})$ and *Stability* = $\Sigma_{i=j}\ (n_{ij})$.

Usual distance metrics between two matrices, $P_A$ and $P_B$, are labelled $L^1$ or $L^2$. $L^1$ equates the average absolute difference between corresponding elements of the matrices. The $L^2$ distance metric averages root-mean-square differences:

$L^1(P_A, P_B) = \sum\sum|P_{A,i,j} - P_{B,i,j}|$

$L^2(P_A, P_B) = \sqrt{\ (\sum\sum(P_{A,i,j} - P_{B,i,j})^2\ )} / N^2$

**3. Descriptive analysis. Decomposing the spreads in the matrix into a benchmark and an unexpected component**

Spread at end 2007 for risky customers can be decomposed into a "benchmark" spread and an unexpected component, crisis-related. Assume that, *ex ante*, rates applied by banks to obligors are broadly consistent with Jarrow et al, 1997:

$$r_i^* = r_{reg}^* + s_i^* \qquad [a1]$$

Where $r^*_{reg}$ is the rate applied to obligors which are expected to be regular at the end of the relevant horizon, and $s^*_i > 0$ is the spread which accounts for the likelihood of risky debtors to shift to the $i^{th}$ class of impairment by the end of the period. Banks can not perfectly forecast the actual worsening of each obligor. Therefore, averaging these ex ante rates according to the realised transitions, as in Table 2, what we expect to find is an ex post average of rates. If we assume there are two periods, a benchmark (*bm*) and a crisis (*cr*) period, then the average rates will be, in the benchmark period (tildes denote averages):[11]

$$\tilde{r}_{i,b} = r_{reg}^* w_{u,i,bm} + (r_{reg}^* + s_i^*)(1 - w_{u,i,bm}) \qquad [a2.a]$$

Where $w_{u,i,bm}$ is the share of unexpected impairments, i.e. obligors that we find in the $i^{th}$ cell of impairment of the matrix, but were not detected as risky ex ante, and therefore were erroneously charged a rate $r^*_{reg}$ ($0 \le w_{u,i,bm} \le 1$). The complement ($1 - w_{u,i,bm}$) is the share of expected, correctly priced impairments. By the same token, in the crisis period:

$$\tilde{r}_{i,c} = r_{reg}^* w_{u,i,cr} + (r_{reg}^* + s_i^*)(1 - w_{u,i,cr}) \qquad [a2.b]$$

The two ex post spreads, with respect to the base-rates in [a1], will be:

$$\tilde{s}_{i,bm} = r_{reg}^* w_{u,i,bm} + r_{reg}^* - r_{reg}^* w_{u,i,bm} + s_i^* - s_i^* w_{u,i,bm} - r_{reg}^* = +s_i^* - s_i^* w_{u,i,bm} \qquad [a3.a]$$

$$\tilde{s}_{i,cr} = r_{reg}^* w_{u,i,cr} + r_{reg}^* - r_{reg}^* w_{u,i,cr} + s_i^* - s_i^* w_{u,i,cr} - r_{reg}^* = +s_i^* - s_i^* w_{u,i,cr} \qquad [a3.b]$$

The difference between the ex post spreads in the two periods, $\tilde{s}_{i,cr} - \tilde{s}_{i,bm}$, will be:

[11] Without loss of generality, I assume that there are just one class of impairment and the same ex ante rates in the two periods.

$$\widetilde{s}_{i,cr} - s_{i,bm} = s_i^* - s_i^* w_{u,i,cr} - s_i^* + s_i^* w_{u,i,bm} = s_i^* (w_{u,i,bm} - w_{u,i,cr}) \quad [a4]$$

We can define the additional unexpected share of impairments, due to the crisis, $\Delta w_{u,i,cr}$, such that $w_{u,i,cr} = w_{u,i,bm} + \Delta w_{u,i,cr}$. Then, the ex post spread in the 'crisis' matrix can be decomposed as follows:

$$\widetilde{s}_{i,cr} = \widetilde{s}_{i,bm} + s_i^* (w_{u,i,bm} - w_{u,i,cr}) = \widetilde{s}_{i,bm} + s_i^* (w_{u,i,bm} - w_{u,i,bm} - \Delta w_{u,i,cr}) = \widetilde{s}_{i,bm} - s_i^* \Delta w_{u,i,cr} \quad [a5]$$

The [a5] states that the spread in the crisis matrix is given by the spread in the 'benchmark' matrix, minus an *unexpected* component, which is proportional to the *additional* surprises in impairments due to the crisis. If $\Delta w_{u,i,cr}>0$ (i.e., there is a positive amount of surprises entirely due to the crisis), then the second component will lessen the crisis-spread.

**4. Econometric analysis. Variables description**

*Dependent variable: spread.* – This is the difference between the short-term interest rate applied to any given bank-firm relationship in the sample, and the average interest rate applied at the same date to fully regular loans, which remained fully regular after 24 months, within the same region as the relevant firm.

*Transitions.* – Dummy variables, = 1 if the bank-firm relationship has recorded the relevant shift among different credit impairments in the 24 months following the date the interest rate is recorded. Each dummy corresponds to a given cell of the transition matrix (49 dummies, e.g. 'From fully regular to fully regular', 'From fully regular to overdraft', etc.).

*Credit initial situation.* – Dummy variables, = 1 if the bank-firm relationship starts the reference period in a given state of impairment (7 dummies, 'Fully regular', 'Overdraft', 'Past-due < 180 dd', 'Past-due > 180 dd', 'Substandard', 'Non performing', 'Loss').

*Crisis.* Dummy variable, = 1 for period 2007-09 (interest rates recorded at end 2007, transitions recorded from end 2007 to end 2009).

*Top Five banking groups.* – Dummy variable, =1 if the bank belongs to the biggest 5 Italian banking groups.

*Firm size.* – Logarithm, or square, of the size of bank credit recorded in the Taxia dataset, proxied by the computational numbers for interest rates charged by all banks to the relevant firm at the relevant date.

*SMEs.* – Dummy variable, =1 for firms with a workforce < 20 units.

*Collateral.* – Dummy variables, =1 if the bank-firm relationship is assisted by collateral at the start or at the end of the relevant period (2 dummies).

*Firm's credit history length.* – Dummy variables, = 1 if the firm has been recorded for the first time into the Italian Credit Register in the relevant year (13 dummies, <1995, 1996 to 2007).

*Firm's institutional sector.* – Dummy variables, = 1 if the firm belongs to the relevant institutional sector (16 dummies, e.g: 'operational firms', 'holdings', 'pool of firms', etc.).

*Firm's industry.* – Dummy variables, = 1 if the firm operates into the relevant sector (192 dummies).

*Firm's region.* – Dummy variables, = 1 if the firm is located in the relevant Italian region (20 dummies).

*Firm's incorporation technique.* – Dummy variables, = 1 if the firm is incorporated according to the relevant scheme (5 dummies, e.g. 'limited company with equity capital', 'limited company', etc.).

*Bank's category.* – Dummy variables, = 1 if the bank belongs to the relevant institutional-dimensional group (3 dummies, 'Big, major and medium-sized banks', 'Small banks, not mutual (Bcc)', 'Small, mutual banks (Bcc)').

*Banks using rating models, using rating model for pricing, with high delegation* . – Dummy variables, = 1 if banks, according to the Banca d'Italia survey (Albareto et al, 2008), used rating models for firms in 2007, or used rating models for pricing, or had a above-the-median relative delegation to Loan Officer (amount of credit that the Loan Officer could grant to firms with respect to the amount of credit that the CEO could grant).

*Main bank.* – Dummy variable, = 1 if the bank extended the major amount of credit to the relevant firm at the initial date of the relevant period.

# Appendix 2: Tables and Figures

**Table a1**

Italian banking groups: Credit quality (1)
*(shares of total credit to customers; percentage values)*

| ITEMS | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| | | | Total banking groups (2) | | |
| Fully regular (a) | 93.8 | 94.9 | 95.4 | 93.5 | 90.9 |
| Impaired (b) | 6.2 | 5.1 | 4.6 | 6.5 | 9.1 |
| *- past-due and overdraft* | *0.7* | *0.4* | *0.4* | *0.5* | *0.8* |
| *- restructured* | *0.2* | *0.3* | *0.1* | *0.2* | *0.6* |
| *- sub standard* | *1.9* | *1.1* | *1.1* | *2.0* | *3.0* |
| *- non performing* | *3.4* | *3.2* | *3.0* | *3.8* | *4.7* |
| **Total credit to customers (a+b)** | **100** | **100** | **100** | **100** | **100** |
| | | | Major banking groups (3) | | |
| Fully regular (a) | 93.5 | 94.9 | 95.2 | 93.2 | 90.1 |
| Impaired (b) | 6.5 | 5.1 | 4.8 | 6.8 | 9.9 |
| *- past-due and overdraft* | *0.7* | *0.4* | *0.3* | *0.5* | *0.7* |
| *- restructured* | *0.1* | *0.4* | *0.2* | *0.2* | *0.7* |
| *- sub standard* | *2.2* | *1.1* | *1.1* | *2.1* | *3.3* |
| *- non performing* | *3.5* | *3.3* | *3.2* | *4.1* | *5.2* |
| **Total credit to customers (a+b)** | **100** | **100** | **100** | **100** | **100** |

Source: Bank of Italy, Annual report.

(1) Data retrieved from supervisory statistical reports. They are not perfectly comparable to Credit Register (CR) data reported in other tables. – (2) Italian groups which are subsidiaries of foreign banks are included. – (3) Top five groups as regards total assets as at the end of the reference year.

**Table a2**

## Transition matrix (North-West) (1)

*(period 31 December 2007 – 2009 and 2005 – 2007; percentage frequencies)*

| State of the loan at the initial date of the reference period | State of the loan at the final date of the reference period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fully regular | Overdraft | Past-due <180 dd | Past-due >180 dd | Sub standard | Non- performing | Loss | *N. loans (000)* |
| a. "Recession" matrix (December 2007 ➔ December 2009) | | | | | | | | |
| Fully regular | 80.1 | 14.1 | 1.2 | 0.9 | 2.0 | 1.4 | 0.3 | **322.9** |
| Overdraft | 43.6 | 36.0 | 3.2 | 2.5 | 7.6 | 6.0 | 1.1 | **87.0** |
| Past-due <180 dd | 32.1 | 25.9 | 5.0 | 6.0 | 15.1 | 13.9 | 2.0 | **5.8** |
| Past-due >180 dd | 31.4 | 20.6 | 4.4 | 10.6 | 17.0 | 14.7 | 1.3 | **4.9** |
| Sub standard | 7.5 | 6.3 | 1.1 | 1.3 | 38.3 | 40.1 | 5.4 | **6.5** |
| Non- performing | 0.1 | | | | | 94.0 | 5.9 | **62.1** |
| Loss | | | | | | 14.0 | 86.0 | **15.1** |
| b. "Expansion" matrix (December 2005 ➔ December 2007) | | | | | | | | |
| Fully regular | 82.1 | 14.6 | 0.9 | 0.8 | 0.7 | 0.7 | 0.1 | **295.6** |
| Overdraft | 48.3 | 38.8 | 2.6 | 2.4 | 3.3 | 3.7 | 0.9 | **78.6** |
| Past-due <180 dd | 36.1 | 33.0 | 5.0 | 6.5 | 8.0 | 9.6 | 1.7 | **5.8** |
| Past-due >180 dd | 32.6 | 26.8 | 4.6 | 11.2 | 10.5 | 12.6 | 1.7 | **6.4** |
| Sub standard | 8.3 | 8.5 | 0.9 | 1.3 | 27.5 | 44.0 | 9.5 | **5.4** |
| Non- performing | | | | | | 90.7 | 9.1 | **62.6** |
| Loss | | | | | | 1.7 | 98.3 | **12.6** |

Source: Central Credit Register. See methodological appendix.

(1) Entries in the matrix represent the percentage frequencies at which bank-firm relationships, recorded in the state shown in the first column at the start of the reference period, moved towards the situation shown in the subsequent columns at the end of the following 24 months. Frequencies are reported as percentage of the number of the bank-firm relationships in the sample belonging to the relevant initial state; they sum up to 1 by row. Values below 0,1 are not reported.

**Table a3**

## Transition matrix (North-East) (1)

*(period 31 December 2007 – 2009 and 2005 – 2007; percentage frequencies)*

| State of the loan at the initial date of the reference period | State of the loan at the final date of the reference period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fully regular | Overdraft | Past-due <180 dd | Past-due >180 dd | Sub standard | Non- performing | Loss | *N. loans (000)* |
| a. "Recession" matrix (December 2007 ➔ December 2009) | | | | | | | | |
| Fully regular | 81.7 | 12.8 | 1.2 | 0.9 | 1.7 | 1.3 | 0.3 | **294.5** |
| Overdraft | 46.1 | 33.7 | 3.2 | 2.7 | 7.3 | 5.9 | 1.1 | **75.1** |
| Past-due <180 dd | 34.9 | 24.7 | 5.9 | 6.1 | 14.9 | 12.1 | 1.4 | **5.7** |
| Past-due >180 dd | 32.0 | 19.0 | 4.6 | 10.1 | 18.3 | 14.9 | 1.1 | **4.6** |
| Sub standard | 1 | 8.2 | 1.4 | 1.5 | 39.3 | 35.1 | 4.6 | **6.5** |
| Non- performing | 0.1 | 0.1 | | | 0.1 | 94.5 | 5.3 | **40.9** |
| Loss | | | | | | 6.5 | 93.5 | **13.0** |
| b. "Expansion" matrix (December 2005 ➔ December 2007) | | | | | | | | |
| Fully regular | 82.2 | 14.4 | 1.0 | 0.8 | 0.7 | 0.7 | 0.2 | **264.5** |
| Overdraft | 47.4 | 38.8 | 2.9 | 2.5 | 3.8 | 3.8 | 0.8 | **68.1** |
| Past-due <180 dd | 36.1 | 32.6 | 5.5 | 6.9 | 9.1 | 8.4 | 1.5 | **5.5** |
| Past-due >180 dd | 31.1 | 27.2 | 5.0 | 11.9 | 12.2 | 10.8 | 1.8 | **5.4** |
| Sub standard | 10.3 | 10.5 | 1.5 | 1.5 | 33.9 | 35.1 | 7.0 | **5.7** |
| Non- performing | | | | | | 84.4 | 15.5 | **40.3** |
| Loss | | | | | | 1.1 | 98.8 | **10.1** |

Source: Central Credit Register. See methodological appendix.

(1) Entries in the matrix represent the percentage frequencies at which bank-firm relationships, recorded in the state shown in the first column at the start of the reference period, moved towards the situation shown in the subsequent columns at the end of the following 24 months. Frequencies are reported as percentage of the number of the bank-firm relationships in the sample belonging to the relevant initial state; they sum up to 1 by row. Values below 0,1 are not reported.

**Table a4**

## Transition matrix (Center) (1)

*(period 31 December 2007 – 2009 and 2005 – 2007; percentage frequencies)*

| State of the loan at the initial date of the reference period | State of the loan at the final date of the reference period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fully regular | Overdraft | Past-due <180 dd | Past-due >180 dd | Sub standard | Non- performing | Loss | *N. loans (000)* |
| | a. "Recession" matrix (December 2007 ➔ December 2009) | | | | | | | |
| Fully regular | 77.1 | 15.6 | 1.7 | 1.7 | 2.2 | 1.5 | 0.2 | **196.3** |
| Overdraft | 40.6 | 36.3 | 3.8 | 4.4 | 8.1 | 6.1 | 0.8 | **61.6** |
| Past-due <180 dd | 32.0 | 25.7 | 6.7 | 8.1 | 15.6 | 10.7 | 1.1 | **5.1** |
| Past-due >180 dd | 28.3 | 20.9 | 4.3 | 12.7 | 2 | 12.8 | 1.1 | **5.3** |
| Sub standard | 6.6 | 6.9 | 1.3 | 2.0 | 42.6 | 36.5 | 4.2 | **5.9** |
| Non- performing | 0.1 | | | | 0.1 | 93.7 | 6.1 | **57.1** |
| Loss | | | | | | 9.6 | 90.4 | **26.2** |
| | b. "Expansion" matrix (December 2005 ➔ December 2007) | | | | | | | |
| Fully regular | 79.4 | 16.2 | 1.3 | 1.3 | 0.9 | 0.8 | 0.1 | **161.0** |
| Overdraft | 47.2 | 38.1 | 3.0 | 3.2 | 3.7 | 3.9 | 0.8 | **61.6** |
| Past-due <180 dd | 35.5 | 32.4 | 5.9 | 8.9 | 7.5 | 8.1 | 1.8 | **5.6** |
| Past-due >180 dd | 29.7 | 25.4 | 5.4 | 13.4 | 12.4 | 11.1 | 2.6 | **7.4** |
| Sub standard | 7.2 | 7.0 | 1.3 | 1.9 | 33.4 | 39.5 | 9.7 | **5.9** |
| Non- performing | | | | | | 83.0 | 17.0 | **62.5** |
| Loss | | | | | | 0.6 | 99.4 | **25.6** |

Source: Central Credit Register. See methodological appendix.

(1) Entries in the matrix represent the percentage frequencies at which bank-firm relationships, recorded in the state shown in the first column at the start of the reference period, moved towards the situation shown in the subsequent columns at the end of the following 24 months. Frequencies are reported as percentage of the number of the bank-firm relationships in the sample belonging to the relevant initial state; they sum up to 1 by row. Values below 0,1 are not reported.

**Table a5**

## Transition matrix (South) (1)

*(period 31 December 2007 – 2009 and 2005 – 2007; percentage frequencies)*

| State of the loan at the initial date of the reference period | State of the loan at the final date of the reference period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fully regular | Overdraft | Past-due <180 dd | Past-due >180 dd | Sub standard | Non- performing | Loss | *N. loans (000)* |
| | a. "Recession" matrix (December 2007 ➔ December 2009) | | | | | | | |
| Fully regular | 77.0 | 15.3 | 1.6 | 1.7 | 2.8 | 1.4 | 0.1 | **148.7** |
| Overdraft | 40.4 | 35.4 | 3.5 | 4.3 | 9.7 | 6.2 | 0.6 | **43.7** |
| Past-due <180 dd | 31.5 | 23.0 | 5.6 | 7.1 | 19.2 | 12.7 | 1.0 | **4.0** |
| Past-due >180 dd | 29.1 | 18.3 | 3.6 | 1 | 22.8 | 14.5 | 1.6 | **4.8** |
| Sub standard | 5.3 | 4.4 | 1.1 | 1.6 | 45.8 | 38.4 | 3.3 | **5.6** |
| Non- performing | | | | | | 95.9 | 4.0 | **95.9** |
| Loss | | | | | | 10.9 | 89.0 | **27.8** |
| | b. "Expansion" matrix (December 2005 ➔ December 2007) | | | | | | | |
| Fully regular | 78.3 | 16.3 | 1.4 | 1.7 | 1.2 | 1.0 | 0.1 | **126.3** |
| Overdraft | 43.3 | 38.4 | 3.1 | 4.2 | 5.0 | 5.3 | 0.7 | **41.3** |
| Past-due <180 dd | 33.7 | 26.6 | 6.4 | 8.9 | 10.8 | 12.0 | 1.5 | **4.0** |
| Past-due >180 dd | 28.9 | 21.1 | 3.5 | 12.6 | 14.9 | 16.4 | 2.5 | **5.6** |
| Sub standard | 6.7 | 5.7 | 1.1 | 2.2 | 31.4 | 45.6 | 7.4 | **5.6** |
| Non- performing | | | | | | 91.0 | 8.9 | **106.5** |
| Loss | | | | | | 0.9 | 99.0 | **26.3** |

Source: Central Credit Register. See methodological appendix.

(1) Entries in the matrix represent the percentage frequencies at which bank-firm relationships, recorded in the state shown in the first column at the start of the reference period, moved towards the situation shown in the subsequent columns at the end of the following 24 months. Frequencies are reported as percentage of the number of the bank-firm relationships in the sample belonging to the relevant initial state; they sum up to 1 by row. Values below 0,1 are not reported.

**Table a6**

## Transition matrix (Credit amounts) (1)

*(period 31 December 2007 – 2009 and 2005 – 2007; percentage frequencies)*

| State of the loan at the initial date of the reference period | State of the loan at the final date of the reference period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fully regular | Overdraft | Past-due <180 dd | Past-due >180 dd | Sub stan-dard | Non- per-forming | Loss | *Amount of loans (Eur mn)* |
| | a. "Recession" matrix (December 2007 ➔ December 2009) | | | | | | | |
| Fully regular | 89.3 | 1.1 | 1.6 | 1.8 | 3.9 | 2.0 | 0.4 | 610,629.6 |
| Overdraft | 78.6 | 4.0 | 1.9 | 2.1 | 6.5 | 4.1 | 2.8 | 6,027.6 |
| Past-due <180 dd | 57.8 | 1.1 | 5.4 | 5.8 | 16.7 | 12.4 | 0.7 | 7,342.3 |
| Past-due >180 dd | 55.8 | 0.6 | 2.7 | 9.1 | 19.4 | 11.8 | 0.6 | 7,702.3 |
| Sub standard | 14.1 | 0.3 | 0.8 | 1.2 | 40.7 | 39.2 | 3.7 | 9,571.5 |
| Non- performing | 0.2 | 0.0 | 0.0 | 0.0 | 0.1 | 93.8 | 5.8 | 17,935.2 |
| Loss | 0.3 | 0.0 | | | 1.4 | 3.6 | 94.7 | 4,248.1 |
| | b. "Expansion" matrix (December 2005 ➔ December 2007) | | | | | | | |
| Fully regular | 93.7 | 1.3 | 1.2 | 1.3 | 1.4 | 1.0 | 0.2 | 492,580.3 |
| Overdraft | 83.2 | 7.3 | 1.3 | 2.0 | 2.7 | 2.9 | 0.5 | 5,953.6 |
| Past-due <180 dd | 70.7 | 1.1 | 5.3 | 7.3 | 7.9 | 6.9 | 0.8 | 7,396.7 |
| Past-due >180 dd | 61.3 | 1.0 | 3.8 | 12.3 | 12.5 | 8.7 | 0.5 | 10,036.6 |
| Sub standard | 16.4 | 0.3 | 1.0 | 1.6 | 40.0 | 36.0 | 4.7 | 9,319.1 |
| Non- performing | 0.3 | 0.1 | 0.0 | 0.0 | 0.2 | 92.1 | 7.2 | 19,161.7 |
| Loss | 0.4 | 0.0 | | 0.0 | 0.0 | 8.6 | 90.9 | 8,222.2 |

Source: Central Credit Register. See methodological appendix.

(1) Entries in the matrix represent the percentage frequencies at which the credit amounts referred to each bank-firm relationship, recorded in the state shown in the first column at the start of the reference period, moved towards the situation shown in the subsequent columns at the end of the following 24 months. Frequencies are reported as percentage of the number of the bank-firm relationships in the sample belonging to the relevant initial state; they sum up to 1 by row. Values below 0,1 are not reported.

**Table a7**

## The impact of the crisis on credit risk pricing (1)

*dependent variable: interest rate spread towards regular loans at both the start and the end of the relevant period*

| | [1] Before the crisis (2005-07) | | | | | | | [2] During the crisis (2007-09) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transitions: (2) | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
| 1. from regular loans | | **0.66** | **0.82** | **0.95** | **1.59** | **1.72** | **1.67** | | **0.67** | **0.85** | **1.06** | **1.37** | **1.53** | **1.51** |
| 2. from overdraft | 0.35 | 0.88 | 1.01 | 1.16 | 1.68 | 1.85 | 1.93 | **-1.53** | **-0.99** | **-0.82** | **-0.70** | **-0.38** | **-0.17** | |
| 3. from past-due <180dd | **-0.71** | -0.12 | | -0.02 | **0.64** | **0.79** | **0.84** | **-1.57** | **-1.10** | **-1.06** | **-0.93** | **-0.48** | -0.28 | |
| 4. from past-due >180dd | **-0.57** | 0.01 | | 0.07 | **0.84** | **1.07** | **1.34** | **-0.73** | **-0.24** | | -0.09 | **0.46** | **0.68** | **0.95** |
| 5. from substandard | **-0.39** | -0.03 | -0.08 | | -0.18 | 0.19 | 0.24 | **-0.39** | -0.09 | | 0.04 | -0.15 | 0.21 | 0.32 |
| 6. from non performing | | | | | | | 0.66 | | | | | | **5.73** | |
| Credit initial situation: | | | | | | | | | | | | | | |
| 2. overdraft | | 0.591 | | | | | | | 2.482 | *** | | | | |
| 3. past-due <180dd | | 1.883 | *** | | | | | | 2.820 | *** | | | | |
| 4. past-due >180dd | | 1.850 | *** | | | | | | 1.961 | *** | | | | |
| 5. substandard | | 2.523 | *** | | | | | | 2.408 | *** | | | | |
| 6. non performing | | 1.954 | *** | | | | | | | | | | | |
| Top five banking groups | | 0.411 | | | | | | | -1.353 | *** | | | | |
| Firm size (log) | | -0.192 | *** | | | | | | -0.055 | *** | | | | |
| Firm size (squared) | | -0.002 | *** | | | | | | -0.008 | *** | | | | |
| Non-SMEs | | 0.084 | | | | | | | 0.103 | | | | | |
| Collateral - start period | | -0.047 | *** | | | | | | -0.020 | | | | | |
| - end period | | -0.063 | *** | | | | | | -0.043 | *** | | | | |
| Firm credit history length | | Y | | | | | | | Y | | | | | |
| Firm institutional sector | | Y | | | | | | | Y | | | | | |
| Firm industry | | Y | | | | | | | Y | | | | | |
| Firm region | | Y | | | | | | | Y | | | | | |
| Firm incorporation technique | | Y | | | | | | | Y | | | | | |
| Bank's category | | Y | | | | | | | Y | | | | | |
| Bank's fixed effects | | Y | | | | | | | Y | | | | | |
| Constant | | 6.533 | *** | | | | | | 4.499 | *** | | | | |
| N. observations | | 596,717 | | | | | | | 682,246 | | | | | |
| Adj. R-squared | | 0.29 | | | | | | | 0.27 | | | | | |

Source: estimation of regressions based on equation [1] in the text.
(1) * = significant at 10 percent; ** = significant at 5 percent; *** = significant at 1 percent. Missing values mean that the estimation is not possible for the relevant parameter. Interest rates outside 1st or 99th percentile are dropped. – (2) The reported coefficients refer to the spread of loans shifting from situation in the first column to situations in the subsequent columns, labelled as follows: 1. regular 2. overdraft, 3. past-due <180 dd, 4. past-due >180 dd, 5. substandard, 6. non performing, 7. loss. Figures in bold denote parameters statistically significant at least at 1 or 5 per cent level.

**Table a8**

## The impact of the crisis on credit risk pricing: top five groups (1)

*dependent variable: interest rate spread towards regular loans at both the start and the end of the relevant period*

| Transitions, basis spread: (2) | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
|---|---|---|---|---|---|---|---|
| 1. from regular loans | | **0.67** | **0.82** | **0.99** | **1.43** | **1.56** | **1.44** |
| 2. from overdraft | **-1.47** | **-0.94** | **-0.79** | **-0.66** | **-0.23** | -0.05 | |
| 3. from past-due <180dd | **-0.58** | -0.06 | | 0.05 | **0.61** | **0.81** | **0.88** |
| 4. from past-due >180dd | 0.73 | 1.28 | 1.33 | 1.32 | 2.01 | 2.21 | 2.53 |
| 5. from substandard | 1.40 | 1.81 | 1.85 | 1.92 | 1.70 | 2.01 | 2.00 |
| 6. from non performing | | | | | | | 0.23 |
| | | | | | | | |
| Unexpected worsening for top five groups: (2) (3) | | | | | | | |
| 1. from regular loans | | 0.04 | 0.07 | **0.19** | -0.03 | 0.08 | **0.40** |
| 2. from overdraft | **-0.04** | **0.06** | 0.08 | **0.22** | **-0.10** | -0.04 | 0.30 |
| 3. from past-due <180dd | -0.09 | 0.00 | 0.24 | 0.21 | -0.03 | -0.05 | 0.47 |
| 4. from past-due >180dd | -0.05 | -0.06 | 0.22 | **0.41** | -0.06 | 0.03 | 0.06 |
| 5. from substandard | -0.01 | **-0.33** | -0.45 | -0.54 | **-0.32** | **-0.17** | **0.29** |
| 6. from non performing | | | | | | **3.49** | |

| | | |
|---|---|---|
| Credit initial situation: | | |
| 2. overdraft | 2.42 | *** |
| 3. past-due <180dd | 1.79 | *** |
| 4. past-due >180dd | 0.54 | |
| 5. substandard | 0.67 | |
| 6. non performing | 2.20 | *** |
| | | |
| Top five banking groups | 0.396 | *** |
| Crisis | -0.133 | *** |
| Top five banking groups * Crisis | -0.658 | *** |
| Firm size (log) | -0.127 | *** |
| Firm size (squared) | -0.005 | *** |
| Non-SMEs | 0.162 | *** |
| Non-SMEs * Crisis | -0.052 | *** |
| Collateral - start period | -0.039 | *** |
| - end period | -0.038 | *** |
| | | |
| Firm credit history length | Y | |
| Firm institutional sector | Y | |
| Firm industry | Y | |
| Firm region | Y | |
| Firm incorporation technique | Y | |
| Bank's category | Y | |
| Bank's fixed effects | Y | |
| | | |
| Constant | 5.598 | *** |
| | | |
| N. observations | 1,278,963 | |
| Adj. R-squared | 0.27 | |

Source: estimation of regressions based on equation [1] in the text.
(1) * = significant at 10 percent; ** = significant at 5 percent; *** = significant at 1 percent. Missing values mean that the estimation is not possible for the relevant parameter. Interest rates outside 1st or 99th percentile are dropped. – (2) The reported coefficients refer to the spread of loans shifting from situation in the first column to situations in the subsequent columns, labelled as follows: 1. regular 2. overdraft, 3. past-due <180 dd, 4. past-due >180 dd, 5. substandard, 6. non performing, 7. loss. Figures in bold denote parameters statistically significant at least at 1 or 5 per cent level. – (3) The coefficients estimate the interaction of the transition dummies * top five groups * Crisis, and gauge the differential unexpected component of the credit worsening, as reflected in credit risk pricing efficiency, for top five groups.

**Table a9**

## The impact of the crisis on credit risk pricing: beyond the size-effect (1)

*dependent variable: interest rate spread towards regular loans at both the start and the end of the relevant period*

| | [1] Use of rating | | [2] Use rating for pricing | | [3] Delegation to l.officer | | [4] Main bank | |
|---|---|---|---|---|---|---|---|---|
| Credit transitions | Y | | Y | | Y | | Y | |
| Transitions*Bank feature*Crisis | Y | | Y | | Y | | Y | |
| Credit initial situation: | | | | | | | | |
| 2. overdraft | 2.490 | *** | 2.515 | *** | 1.845 | *** | 2.476 | *** |
| 3. past-due <180dd | 1.894 | *** | 1.834 | *** | 2.800 | *** | 1.882 | *** |
| 4. past-due >180dd | 0.523 | | 0.519 | | 3.086 | *** | 0.532 | |
| 5. substandard | 0.894 | | 0.858 | | 2.495 | *** | 0.891 | |
| 6. non performing | 2.212 | *** | 2.190 | *** | 4.001 | *** | 3.949 | *** |
| Top five banking groups | 0.406 | *** | 0.368 | *** | 0.394 | *** | 0.389 | *** |
| Crisis | -0.221 | *** | -0.151 | *** | -0.067 | *** | -0.203 | *** |
| Top five banking groups * Crisis | -0.667 | *** | -0.647 | *** | -0.733 | *** | -0.637 | *** |
| Use of rating models | 0.015 | | | | | | | |
| Use of rating models * Crisis | 0.111 | *** | | | | | | |
| Use of ratings for pricing | | | 0.002 | | | | | |
| Use of ratings for pricing *Crisis | | | 0.188 | *** | | | | |
| High delegation to Loan Officer | | | | | -0.351 | | | |
| High delegation to L.O. * Crisis | | | | | 0.058 | *** | | |
| Main bank | | | | | | | -0.491 | *** |
| Main bank * Crisis | | | | | | | 0.079 | *** |
| Firm size (log) | -0.127 | *** | -0.127 | *** | -0.110 | *** | -0.071 | *** |
| Firm size (squared) | -0.005 | *** | -0.005 | *** | -0.006 | *** | -0.008 | *** |
| Non-SMEs | 0.162 | ** | 0.162 | ** | 0.117 | * | 0.129 | ** |
| Non-SMEs * Crisis | -0.051 | *** | -0.056 | *** | -0.054 | *** | -0.022 | *** |
| Collateral - start period | -0.039 | *** | -0.040 | *** | -0.034 | ** | -0.028 | ** |
| - end period | -0.038 | *** | -0.037 | *** | -0.049 | *** | -0.032 | ** |
| Firm credit history length | Y | | Y | | Y | | Y | |
| Firm institutional sector | Y | | Y | | Y | | Y | |
| Firm industry | Y | | Y | | Y | | Y | |
| Firm region | Y | | Y | | Y | | Y | |
| Firm incorporation technique | Y | | Y | | Y | | Y | |
| Bank's category | Y | | Y | | Y | | Y | |
| Bank's fixed effects | Y | | Y | | Y | | Y | |
| Constant | 5.579 | *** | 5.607 | *** | 4.755 | | 5.738 | *** |
| N. observations | 1,278,963 | | 1,278,963 | | 1,111,357 | | 1,278,963 | |
| Adj. R-squared | 0.27 | | 0.27 | | 0.27 | | 0.27 | |

Source: estimation of regressions based on equation [1] in the text.
(1) * = significant at 10 percent; ** = significant at 5 percent; *** = significant at 1 percent. Missing values mean that the estimation is not possible for the relevant parameter. Interest rates outside 1st or 99th percentile are dropped.

**Table a10**

**The impact of the crisis on credit risk pricing: Small and Medium Enterprises (SMEs) and non-SMEs** (1)
*dependent variable: interest rate spread towards regular loans at both the start and the end of the relevant period*

| | [1] Small and Medium Enterprises (SMEs) | | | | | | | [2] Non-Small and Medium Enterprises | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transitions: (2) | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
| 1. from regular loans | | **0.69** | **0.90** | **1.10** | **1.53** | **1.63** | **1.54** | | **0.66** | **0.78** | **0.91** | **1.37** | **1.51** | 1.41 |
| 2. from overdraft | **-1.27** | **-0.75** | **-0.59** | **-0.45** | -0.06 | 0.04 | | 0.06 | 0.61 | 0.73 | 0.85 | 1.32 | 1.53 | 1.57 |
| 3. from past-due <180dd | **-1.38** | **-0.93** | **-0.92** | **-0.89** | -0.47 | -0.33 | | **-1.58** | **-1.01** | **-0.87** | **-0.83** | -0.12 | 0.08 | |
| 4. from past-due >180dd | **-1.84** | **-1.33** | **-1.24** | **-1.26** | **-0.74** | **-0.70** | | **-1.81** | **-1.24** | **-1.24** | **-1.25** | **-0.38** | -0.02 | |
| 5. from substandard | **-0.50** | -0.21 | | -0.16 | -0.21 | -0.02 | -0.10 | **-0.83** | -0.26 | -0.53 | | **-0.52** | -0.09 | -0.13 |
| 6. from non performing | | | | | | | 2.40 | | | | | | **2.05** | |
| Unexpected worsening for top five groups: (2) (3) | | | | | | | | | | | | | | |
| 1. from regular loans | | 0.02 | -0.04 | **0.21** | **-0.15** | 0.12 | **0.81** | | **0.05** | 0.12 | **0.20** | 0.03 | 0.10 | **0.36** |
| 2. from overdraft | 0.03 | 0.02 | 0.10 | 0.15 | **-0.20** | 0.03 | **0.48** | **-0.07** | **0.08** | 0.07 | **0.27** | -0.05 | -0.07 | **0.25** |
| 3. from past-due <180dd | -0.04 | -0.06 | 0.16 | **0.49** | -0.08 | 0.00 | 0.16 | -0.10 | 0.04 | 0.24 | 0.02 | -0.04 | -0.12 | 0.51 |
| 4. from past-due >180dd | 0.06 | -0.11 | 0.03 | **0.47** | -0.19 | 0.06 | -0.66 | -0.14 | -0.06 | 0.33 | 0.30 | 0.00 | -0.07 | 0.20 |
| 5. from substandard | -0.31 | **-0.43** | **-0.89** | -0.25 | **-0.49** | **-0.40** | 0.44 | 0.31 | -0.24 | 0.19 | -1.02 | **-0.21** | -0.05 | 0.25 |
| 6. from non performing | | | | | | | | | | | | | **3.60** | |
| Credit initial situation: | | | | | | | | | | | | | | |
| 2. overdraft | | 2.275 | *** | | | | | | 0.854 | | | | | |
| 3. past-due <180dd | | 2.794 | *** | | | | | | 2.646 | *** | | | | |
| 4. past-due >180dd | | 3.310 | *** | | | | | | 2.953 | *** | | | | |
| 5. substandard | | 2.666 | *** | | | | | | 2.829 | *** | | | | |
| 6. non performing | | | | | | | | | | | | | | |
| Top five banking groups | | 0.349 | *** | | | | | | 0.414 | *** | | | | |
| Crisis | | -0.157 | *** | | | | | | -0.169 | *** | | | | |
| Top five banking groups*Crisis | | -0.589 | *** | | | | | | -0.693 | *** | | | | |
| Firm size (log) | | -0.077 | *** | | | | | | 0.001 | | | | | |
| Firm size (squared) | | -0.009 | *** | | | | | | -0.009 | *** | | | | |
| Collateral - start period | | -0.009 | | | | | | | -0.066 | | | | | |
| - end period | | -0.052 | *** | | | | | | -0.017 | *** | | | | |
| Firm credit history length | | Y | | | | | | | Y | | | | | |
| Firm institutional sector | | Y | | | | | | | Y | | | | | |
| Firm industry | | Y | | | | | | | Y | | | | | |
| Firm region | | Y | | | | | | | Y | | | | | |
| Firm incorporation technique | | Y | | | | | | | Y | | | | | |
| Bank's category | | Y | | | | | | | Y | | | | | |
| Bank's fixed effects | | Y | | | | | | | Y | | | | | |
| Constant | | 5.273 | *** | | | | | | 3.232 | **** | | | | |
| N. observations | | 495,523 | | | | | | | 783,440 | | | | | |
| Adj. R-squared | | 0.30 | | | | | | | 0.25 | | | | | |

Source: estimation of regressions based on equation [1] in the text.
(1) * = significant at 10 percent; ** = significant at 5 percent; *** = significant at 1 percent. Missing values mean that the estimation is not possible for the relevant parameter. Interest rates outside 1st or 99th percentile are dropped. – (2) The reported coefficients refer to the spread of loans shifting from situation in the first column to situations in the subsequent columns, labelled as follows: 1. regular 2. overdraft, 3. past-due <180 dd, 4. past-due >180 dd, 5. substandard, 6. non performing, 7. loss. Figures in bold denote parameters statistically significant at least at 1 or 5 per cent level l. – (3) The coefficients estimate the interaction of the transition dummies * banks within the top five groups * Crisis, and gauge the differential unexpected component of the credit worsening, as reflected in credit risk pricing efficiency, for banks within the top five groups.

**Table a11**

## The impact of the crisis on credit risk pricing: regional effects (1)

*dependent variable: interest rate spread towards regular loans at both the start and the end of the relevant period*

| | (a) Overall effects | | | | | | | (b) Regional effects | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transitions, basis spread: (2) | 1. | 2. | 3. | 4. | 5. | 6. | 7. | | Basis values | | Crisis change | |
| 1. from regular loans | | **0.68** | **0.83** | **1.02** | **1.41** | **1.60** | **1.59** | | | | | |
| 2. from overdraft | **-1.58** | **-1.02** | **-0.88** | **-0.73** | **-0.37** | **-0.15** | | - Piemonte | *(Base)* | | *(Base)* | |
| 3. from past-due <180dd | **-0.63** | -0.09 | | 0.03 | **0.55** | **0.77** | **0.97** | - Valle d'Aosta | -1,291 | *** | -0,215 | ** |
| 4. from past-due >180dd | **0.77** | **1.33** | **1.40** | **1.42** | **2.03** | **2.26** | **2.64** | - Lombardia | -0,579 | *** | 0,024 | |
| 5. from substandard | 1.47 | 1.83 | 1.82 | 1.93 | 1.67 | 2.06 | 2.17 | - Liguria | 0,469 | *** | -0,187 | *** |
| 6. from non performing | | | | | | | -1.58 | - Trentino-AA | 0,569 | *** | -0,305 | *** |
| | | | | | | | | - Veneto | 0,287 | *** | -0,123 | *** |
| Credit initial situation: | | | | | | | | - Friuli VG | 0.205 | *** | 0.042 | |
| 2. overdraft | | 2.520 | *** | | | | | - Emilia-R | -0.337 | *** | 0.097 | *** |
| 3. past-due <180dd | | 1.835 | *** | | | | | - Toscana | -0.307 | *** | 0.125 | *** |
| 4. past-due >180dd | | 0.512 | *** | | | | | - Umbria | -0.630 | *** | 0.417 | *** |
| 5. substandard | | 0.605 | | | | | | - Marche | -0.620 | *** | 0.180 | *** |
| 6. non performing | | 3.847 | *** | | | | | - Lazio | 0.233 | *** | -0.074 | *** |
| | | | | | | | | - Abruzzo | -0.833 | *** | 0.375 | *** |
| Top five banking groups | | -0.018 | * | | | | | - Molise | -0.549 | *** | 0.399 | *** |
| Crisis | | -0.400 | *** | | | | | - Campania | -0.576 | *** | 0.245 | *** |
| Firm size (log) | | -0.130 | *** | | | | | - Puglia | -1.076 | *** | 0.569 | *** |
| Firm size (squared) | | -0.005 | *** | | | | | - Basilicata | -0.085 | | -0.025 | |
| Non-SMEs | | 0.162 | ** | | | | | - Calabria | -1.067 | *** | 0.690 | *** |
| Non-SMEs * Crisis | | -0.061 | *** | | | | | - Sicilia | -0.622 | *** | 0.142 | *** |
| Collateral - start period | | -0.040 | *** | | | | | - Sardegna | -0.865 | *** | 0.736 | *** |
| - end period | | -0.039 | *** | | | | | | | | | |
| Firm credit history length | | Y | | | | | | | | | | |
| Firm institutional sector | | Y | | | | | | | | | | |
| Firm industry | | Y | | | | | | | | | | |
| Firm region | | Y | (see panel (b) ) | | | | | | | | | |
| Firm incorporation technique | | Y | | | | | | | | | | |
| Bank's category | | Y | | | | | | | | | | |
| Bank's fixed effects | | Y | | | | | | | | | | |
| Constant | | 5.678 | *** | | | | | | | | | |
| N. observations | | 1,278,963 | | | | | | | | | | |
| Adj. R-squared | | 0.27 | | | | | | | | | | |

Source: estimation of regressions based on equation [1] in the text.
(1) * = significant at 10 percent; ** = significant at 5 percent; *** = significant at 1 percent. Missing values mean that the estimation is not possible for the relevant parameter. Interest rates outside 1st or 99th percentile are dropped. – (2) The reported coefficients refer to the spread of loans shifting from situation in the first column to situations in the subsequent columns, labelled as follows: 1. regular 2. overdraft, 3. past-due <180 dd, 4. past-due >180 dd, 5. substandard, 6. non performing, 7. loss. Figures in bold denote parameters statistically significant at least at 1 or 5 per cent level.

**Table a12**

## The impact of the crisis on credit risk pricing: robustness checks (1)

*dependent variable: interest rate or spread towards regular loans at both the start and the end of the relevant period*

| | Robustness check (a) | | Robustness check (b) | | Robustness check (c) | | Robustness check (d) | |
|---|---|---|---|---|---|---|---|---|
| Credit transitions | Y | | Y | | Y | | Y | |
| Credit transitions*Topfive*Crisis | Y | | Y | | Y | | Y | |
| Credit initial situation: | | | | | | | | |
| 2. overdraft | 2.417 | *** | 2.543 | *** | 2.424 | *** | 0.771 | *** |
| 3. past-due <180dd | 1.790 | *** | 1.874 | *** | 1.807 | *** | 2.415 | *** |
| 4. past-due >180dd | 0.539 | | 0.489 | | 0.621 | | 1.678 | *** |
| 5. substandard | 0.706 | *** | 0.766 | *** | 0.763 | *** | 2.316 | *** |
| 6. non performing | 2.204 | *** | 1.178 | *** | 2.191 | *** | 1.839 | *** |
| Top five banking groups | 0.407 | *** | 0.752 | *** | 0.403 | *** | 0.098 | *** |
| Crisis | -0.125 | *** | -0.293 | *** | 1.043 | *** | -0.499 | *** |
| Top five banking groups*Crisis | -0.667 | *** | -0.194 | *** | -0.717 | *** | -0.338 | *** |
| Firm size (log) | -0.127 | *** | -0.128 | *** | -0.129 | *** | -0.120 | *** |
| Firm size (squared) | -0.005 | *** | -0.005 | *** | -0.005 | *** | -0.004 | *** |
| Non-SMEs | 0.162 | *** | 0.265 | *** | 0.176 | *** | 0.179 | *** |
| Non-SMEs * Crisis | -0.052 | *** | -0.100 | *** | -0.074 | *** | -0.125 | *** |
| Collateral - start period | -0.039 | *** | -0.043 | *** | -0.042 | *** | -0.027 | ** |
| - end period | -0.038 | *** | -0.047 | *** | -0.037 | *** | -0.052 | *** |
| Firm credit history length | Y | | Y | | Y | | Y | |
| Firm institutional sector | Y | | Y | | Y | | Y | |
| Firm industry | Y | | Y | | Y | | Y | |
| Firm region | Y | | Y | | Y | | Y | |
| Firm incorporation technique | Y | | Y | | Y | | Y | |
| Bank's category | NO | | NO | | Y | | Y | |
| Bank's fixed effects | Y | | NO | | Y | | Y | |
| Constant | 5.589 | *** | 4.595 | *** | 11.713 | *** | 5.571 | *** |
| N. observations | 1,278,963 | | 1,278,963 | | 1,278,963 | | 1,186,593 | |
| Adj. R-squared | 0.27 | | 0.21 | | 0.24 | | 0.26 | |

Source: estimation of regressions based on equation [1] in the text.

(1) * = significant at 10 percent; ** = significant at 5 percent; *** = significant at 1 percent. Missing values mean that the estimation is not possible for the relevant parameter. Each column refers to a different modification of the baseline specification in equation [1]: Column (a) = bank's category excluded; (b) = bank's category excluded and non fixed effect for banks; (c) dependent variable = interest rates, not spread towards the benchmark case (i.e. the average rate to firms whose loans were in regular situations both at the start and at the end of the relevant period; (d) = excluded outlier observations with spreads beyond 5$^{th}$ and 95$^{th}$ percentile. Estimates for coefficient of the transition matrices and the same coefficients interacted with the crisis variable are omitted.

**Table a12 (continued)**

**The impact of the crisis on credit risk pricing: robustness checks** (1)

*dependent variable: interest rate or spread towards regular loans at both the start and the end of the relevant period*

| | Robustness check (e) | | Robustness check (f) | |
|---|---|---|---|---|
| Credit transitions | Y | | Y | |
| Credit transitions*Topfive*Crisis | Y | | Y | |
| | | | | |
| Credit initial situation: | | | | |
| 2. overdraft | 1.405 | *** | 0.484 | *** |
| 3. past-due <180dd | -0.331 | | 0.456 | *** |
| 4. past-due >180dd | 1.156 | *** | 0.597 | *** |
| 5. substandard | 1.994 | *** | 0.192 | *** |
| 6. non performing | 1.241 | | -0.121 | |
| | | | | |
| Top five banking groups | -0.599 | *** | 0.421 | *** |
| Crisis | -0.017 | ** | -0.217 | *** |
| Top five banking groups*Crisis | -0.337 | *** | -0.655 | *** |
| Firm size (log) | 0.299 | *** | -0.027 | *** |
| Firm size (squared) | -0.013 | *** | -0.010 | *** |
| Non-SMEs | 0.046 | | 0.124 | * |
| Non-SMEs * Crisis | 0.005 | | -0.026 | *** |
| Collateral - start period | -0.065 | *** | -0.032 | *** |
| - end period | N | | -0.038 | *** |
| | | | | |
| Firm credit history length | Y | | Y | |
| Firm institutional sector | Y | | Y | |
| Firm industry | Y | | Y | |
| Firm region | Y | | Y | |
| Firm incorporation technique | Y | | Y | |
| Bank's category | Y | | Y | |
| Bank's fixed effects | Y | | Y | |
| | | | | |
| Constant | 0.342 | | 5.184 | *** |
| | | | | |
| N. observations | 1,161,899 | | 1,278,963 | |
| Adj. R-squared | 0.16 | | 0.28 | |

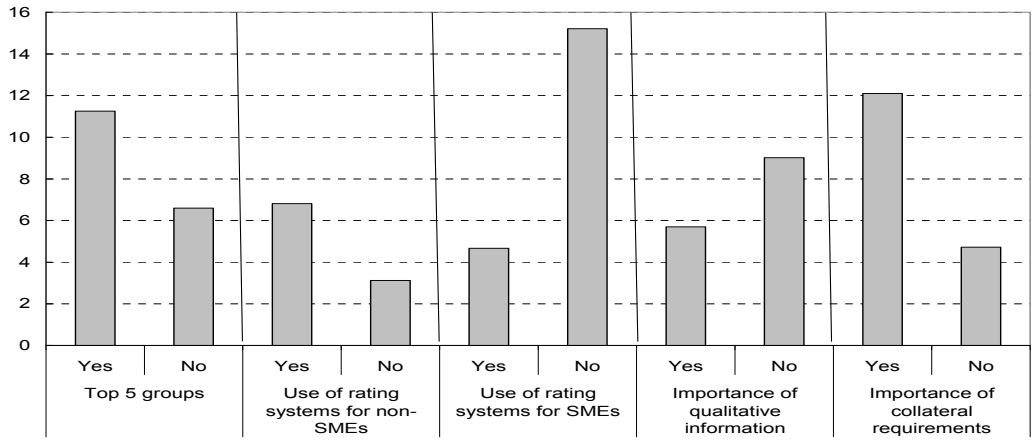
Source: estimation of regressions based on equation [1] in the text.

(1) * = significant at 10 percent; ** = significant at 5 percent; *** = significant at 1 percent. Missing values mean that the estimation is not possible for the relevant parameter. Each column refers to a different modification of the baseline specification in equation [1]: Column (e) = impairment situations for each bank-firm relationship are defined according to the quantities of credit in each situation at the reference date (see Appendix 1, *Data and methodology*). Reference period are Dec 2005-Jun 2008 (non-crisis), Jun 2008-Dec 2010 (crisis). (f) = the impairment situation is defined having regard to the worst recorded classification of the debtor in the CR database at the reference date, regardless of which bank had provided the worst classification.

**Figure a1**

Distance between expansion and recession matrices, by type of bank (1)

*(indicator values)*



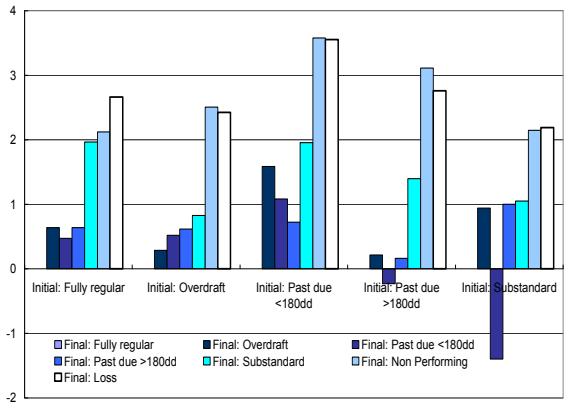

Source: Central Credit Register. See the methodological appendix.
(1) Euclidean distance $L^2$ between two matrices $P_a$ and $P_b$ is the square of the sum of the quadratic differences between each entry in matrix $P_a$ and the corresponding entry in $P_b$, divided by $N^2$ (Jafry and Schuermann, 2004). Apart from bank size, banks are classified according to a survey run by the Bank of Italy at 2007 and 2010.

**Figure a2**

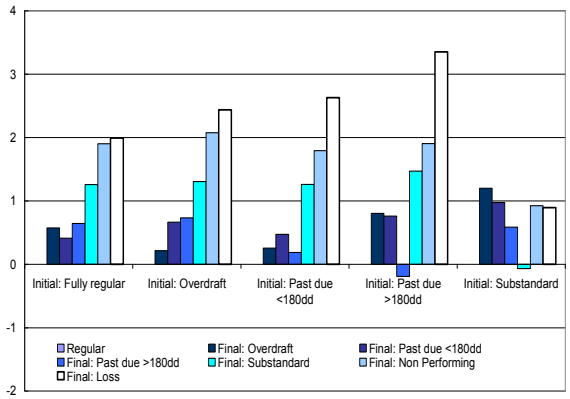
Interest rate spread with respect to evolution of credit quality, before and after crisis (1)

*(percentage values)*

a) Pre-crisis (end 2005)




b) Crisis (end 2007)

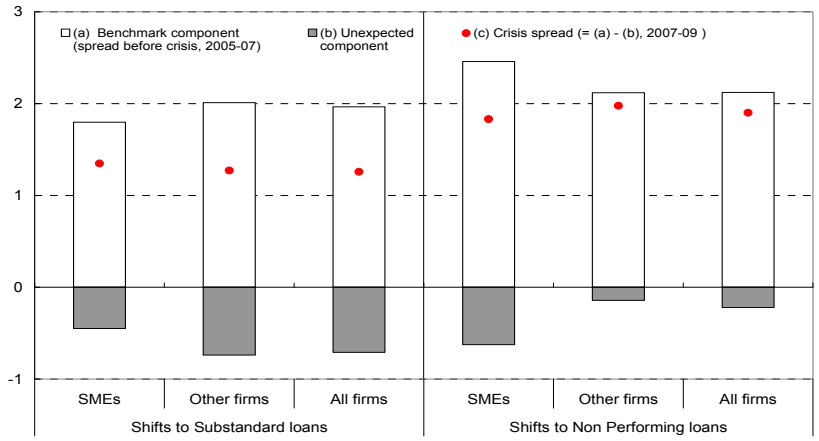



Source: Central Credit Register. See methodological appendix.
(1) Spread between (a) average interest rates at end of year (2005, 2007) on fully regular loans to firms that would have moved towards the state reported on the legend in the subsequent 24 months, and (b) average interest rates at the same time on loans that, starting from the situation reported on x-axis, would have moved to a fully regular situation in the subsequent 24 months.

**Figure a3**

## Unexpected component in interest rates during the crisis (1)

*(percentage points)*



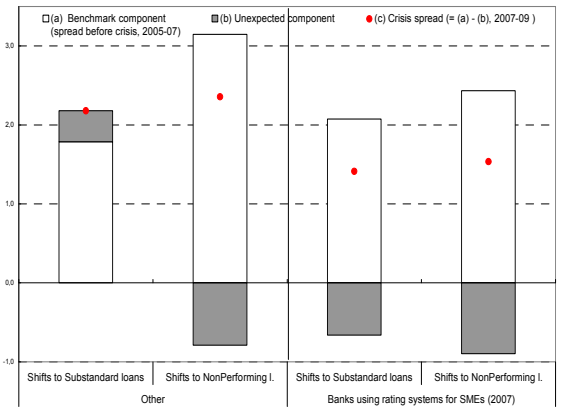

Source: Central Credit Register. See methodological appendix.
(1) The benchmark component is the spread, recorded at end 2005, between (a) average rates required to "fully regular" obligors which would have turned substandard or non-performing within the following 24 months, and (b) average rates required to "fully regular" obligors which would have stayed regular within the following 24 months. The Crisis spread is the same spread computed at end 2007. The unexpected component is the difference between the two spreads.

**Figure a4**

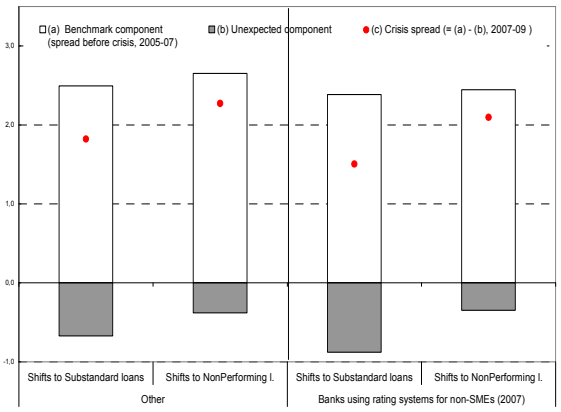
## Unexpected component in interest rates during the crisis, for banks using ratings or not (1)

*(percentage points)*

a) Loans to SMEs




b) Loans to non-SMEs




Source: Central Credit Register. See methodological appendix.
(1) The benchmark component is the spread, recorded at end 2005, between (a) average rates required to "fully regular" obligors which would have turned substandard or non-performing within the following 24 months, and (b) average rates required to "fully regular" obligors which would have stayed regular within the following 24 months. The Crisis spread is the same spread computed at end 2007. The unexpected component is the difference between the two spreads.

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