BANK LOAN-LOSS PROVISIONING, Methodology and Application*

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Abstract

A fair level of provisions on bad and doubtful loans is an essential input in mark-to-market accounting, and in the calculation of bank profitability, capital and solvency. Surprisingly, recent micro studies on loan loss-given-default have not been exploited to derive provisioning schedules. Two methodologies to calculate a fair level of loan-loss provisions, at the time of default and after the default date, are developed in the paper. To illustrate, the methodology is applied to a private data set of non-performing loans. The estimated dynamic provisioning schedule is then compared to a regulatory schedule imposed by a central bank.

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Introduction

Fair provisioning on bad and doubtful loans is of great importance for investors and bank regulators. Consider the merits of Basel II, the revised capital accord that would much better capture the actual risks taken by banks (Basel Committee, 2004). It is quite evident that this accord will not have much relevance if the measurement of bank capital is not satisfactory. A key input in the measurement of bank capital is the amount of loan-loss provisions[1] on bad and doubtful loans. Well-known cases of significant under-provisioning in recent history include the French Credit Lyonnais in 1993, Thailand in 1997, Japan in late 1990's (Genay, 1998), and, more recently, China. A fair level of loan-loss provisions is needed to measure bank profitability, capital, and solvency.

As bank loans are, by their economic nature, private, there is not much market-based information to assess their current value in many countries, so that loan-loss provisions must often be estimated. Loan-loss provisioning is directly related to estimates of loan loss-given default (LGD). A literature on LGD on bank loans is developing but, surprisingly, it has not been exploited to address, at the micro level, the issue of provisioning at the time of default, and after the default date. As the likelihood of being repaid diminishes as time elapses after the default date, a dynamic schedule of provisioning is needed. In this study, we build on a recent LGD paper (Dermine-de Carvalho, 2005a) to develop a methodology to evaluate a fair level of provisions, at a time of default and after the default date. To illustrate, the methodology is applied to a private data set of non-performing loans. The estimated dynamic provisioning schedule is then compared to a regulatory schedule imposed by a central bank.

The banking literature has studied loan loss provisioning from several perspectives, such as impact on stock returns or contagion effects, but, to the best of our knowledge, no academic study has developed a normative methodology to estimate, at a micro level, the adequate level of loan loss provision at the time of default and over time. The contribution of the paper is to apply mortality analysis and multivariate statistics to dynamic provisioning on impaired loans. This allows to compare an empirical estimate

[1]Note that European terminology is being used. Loan-loss provisions represent the expected losses on a portfolio of impaired loans. They constitute a contra-account, which is deducted from the value of gross loans in a balance sheet. Provisions are referred to as 'loan-loss allowance' or 'loan-loss reserves' in US bank accounts.

of provisioning schedule to a regulatory schedule enforced by a central bank.

The paper is structured as follows. The literature on bank loan-loss provisioning is reviewed in Section 1 of the paper. The mortality-based approach to analyzing fair provisioning on bad and doubtful loans is discussed in Section 2. In Section 3, the database on individual loan-losses is presented. Empirical univariate estimates of dynamic provisioning are presented in Section 4, and these estimates are compared to those imposed by a central bank. Finally, a multivariate statistics approach to loan-loss provisioning is developed in Section 5. Section 6 concludes the paper.

1 Review of the Literature on Loan Loss Provisioning

The accounting and finance literatures have analyzed four main provisioning issues related to private information held by banks on loans, one of the fundamental characteristic which explains the economic role of banks (Diamond, 1984): the extent of earnings and capital smoothing, the impact of reported provisions on a bank's stock returns, the systemic impact on the banking industry of disclosure on loan provisions by one bank, and the time lag between credit growth and loan losses[2]. This paper addresses a different issue. It provides a micro-based methodology to calculate fair provisions on bad and doubtful loans.

A series of papers have analyzed the extent of earnings and capital smoothing through a pro-cyclical loan-loss provisioning, with high provisions in good times and lower provisions in bad times. For instance, Laeven and Majnoni (2003), Hasan and Wall (2004), and Bikker and Metzemakers (2005) report empirical evidence throughout the world consistent with the earnings smoothing hypothesis[3]. Similar studies, documenting managerial discretion in loan-loss provisioning, include Wahlen (1994), Wetmore and Brick (1994), Collins et al. (1995), Beattie et al. (1995), Soares de Pinho (1996), Kim and Kross (1998), and Ahmed, Takeda and Thomas (1999)[4].

[2] See the survey on loan-loss accounting by Wall and Koch (2000).

[3] A theoretical argument for earnings smoothing can be found in Degeorge et al. (1999).

[4] Related papers on bank earnings management include Barth et al. (1990) who document income smoothing through the realization of capital gains and losses, Scholes et al. (1990), and Beatty et al. (1995) who analyze the realization of capital gains and losses

A second stream of the literature has analyzed the impact of reported provisions on bank stock returns[5]. Musumeci and Sinkey (1990) and Elliott et al. (1991) report that unexpected provisions on international LDC loans had a positive impact on stock returns. Wahlen (1994) generalized the previous results in reporting that unexpected provisions have a positive impact on bank stock returns. This, at first counter-intuitive, result is interpreted as a signal that future earnings will be good, allowing the build-up of provisions by bank managers.

A third stream of the loan-loss reserve literature has analyzed the signalling impact of loan-loss reserves announcements on the stock returns of the announcing bank and that of other institutions (for instance, Grammatikos and Saunders, 1990, and Docking et al., 1997).

Finally, and fourth, Jimenez and Saurina (2005) have analysed the timelag between loan growth and loan losses, calling for the build up of ex ante provisions on performing loans during periods of economic expansion.

This paper addresses a different issue: how to measure loan-loss provisions on non- performing loans. It seeks to answer questions raised by Berger et al. (1989 and 1991) who, in their critical review of market value accounting, suggest that value adjustment for credit risk should be based on a loan-loss reserve on nonperforming loans.

Two approaches will be used to analyze loan-loss provisioning, a univariate mortality-based approach, and a multivariate statistical analysis of the determinants of recovery.

2 Loan-Loss Provisioning, a Mortality-based Approach

To calculate provisions, we shall, in a first step, analyze recovery on bad and doubtful loans. Having access to the history of cash flows on loans after default, we can study the time distribution of recovery. With reference to the studies by Altman (1989), Altman and Suggit (2000), and Dermine and

in the context of tax planning and capital management, and Galai et al. (2003) who analyze, in a theoretical model, the timing of realized capital gains on real assets (such as buildings).

[5] Refined in Liu et al. (1997), the analysis shows that the positive effect is observed with banks with relatively low regulatory capital.

Neto de Carvalho (2005a), we apply the mortality approach. It examines the percentage of a bad and doubtful loan, which is recovered t months after the default date. This methodology is appropriate because the population sample is changing over time. For some default loans, we have a long recovery history (66 months), while for more recent loans in default, we have an incomplete history of recovery.

For an individual loan i in default, we define four concepts[6], t denoting the number of months after the initial default date 0:

$MRR_{i,t}$ = Marginal Recovery Rate in month t

= Cash flow$_i$ paid at end of month t / Loan$_i$ outstanding at end of month t

$PULB_{i,t}$ = Percentage Unpaid Loan Balance at the end of month t = 1 – $MRR_{i,t}$

The Cumulative Recovery Rate evaluated from the default date 0 until infinity, $CRR_{i,0,\infty}$, and the Loan Loss Provision, $LLP_{i,0}$, are equal to:

$$CRR_{i,0,\infty} = \text{Cumulative Recovery Rate, } \infty \text{ months after the default} = 1 - \prod_{t=1}^{\infty} PULB_{i,t}$$

$$LLP_{i,0} = \text{Loan-loss provisions} = 1 - CRR_{i,0,\infty}$$

The Cumulative Recovery Rate on a loan balance outstanding at time 0 represents the proportion of the initial defaulted loan that has been repaid (in present value terms).

For sake of presentation, the loan-loss provision was calculated on a loan balance outstanding at the default date, 0. In a more general dynamic provisions setting, the provision can be calculated on a loan balance outstanding at any date n after the default date. For instance, one can compute the cumulative recovery on loan balances outstanding 4 or 13 months after the

[6] A numerical example is provided in Dermine and Neto de Carvalho (2005b).

default date. This information will allow calculating dynamic provisions on the remaining loan balance, several months after the default date.

Having computed the cumulative recovery rate on individual loans, one can compute an arithmetic average cumulative recovery rate for the sample of loans. Alternatively, one can compute a principal-weighted average recovery rate that will take into account the size of each loan. This is defined as follows:

$SMRR_t$ = Sample (weighted) Marginal Recovery Rate at end of month t

$$= \sum_{i=1}^{m} Cash\ flow\ received_{i,t} \Big/ \sum_{i=1}^{m} Loan\ outstanding_{i,t}\ ,$$

where i stands for each of the m loan balances outstanding in the sample, t months after default.

$SPULB_t$ = Sample (weighted) Percentage Unpaid Loan Balance at end of month t

$$= 1 - SMRR_t$$

$SCRR_\infty$ = Sample (weighted) Cumulative Recovery Rate, an infinite number of months after the default

$$= \left(1 - \prod_{t=1}^{\infty} SPULB_t\right).$$

A comparison of the Sample (weighted) Cumulative Recovery Rate with the average of recovery rates on individual loans will be indicative of a size effect.

3 Bank Loan-losses, Database and Measurement Issues

To illustrate, the mortality-based approach to provisioning will be applied to real bank data. The database was provided by the largest private bank in Portugal, Banco Comercial Português (BCP). It consists of 374 defaults cases on loans to small and medium size companies[7], evenly spread over the period June 1995 to December 2000. The use of data from a specific bank is a limitation. But, given the absence of publicly available data on cash flow recovery on distressed bank loans in Portugal, it is a step in our understanding of both the level and dynamics of fair provisions.

As a complete description of the data is available in Dermine and Neto de Carvalho (2005a), limited information is provided in this paper. The available information in the database includes the industry classification, the interest rate charged on the loan, the history of the loan after a default has been identified, the type of collateral or guarantees, the internal rating attributed by the bank, the age of the firm, and the length of relationship with the bank[8]. In Table 1 (panel A), the various forms of guarantees, or collateral, are reported. These include:

- Personal guarantee
- Real estate collateral
- Physical collateral (inventories)
- Financial collateral (bank deposits, bonds or shares).

In 35.6% of the cases, there is no guarantee or collateral. Personal guarantees, which are used in 58.3% of the cases, refers to written promises made by the guarantor (often the owner or the firm's director) that allows the bank to collect the debt against the personal assets pledged by the guarantor. Collateral is used in 15.0% of the cases[9].

[7]The data gathered for this study do not include any reference to the identity of the clients or any other information which, according to Portuguese banking law, cannot be disclosed.

[8]The database used in this study did not exist in the appropriate format. The bank provided help to identify all these variables, and to recover the data located in various databases. The history of each loan, after a default had occurred, has been carefully analyzed.

[9]Jimenez and Saurina (2002) also observe, in the case of Spain, that a very large proportion of bank loans are not collaterized. Franks et al. (2004) argue that differences

Panel B of Table 1 shows the age of the firm, and the number of years of relationship with the bank. Companies have, on average, a life of 17 years, with extremes going from 6 months to 121 years. The average relationship with the bank is six years[10].

Table 2 reports the concentration of default cases in different business sectors and the use of guarantee/collateral across these sectors. Fifteen business sectors have been created, with reference to the European Union's NACE economic activity codes. Further aggregation, used in the econometric tests, leads to four activity sectors: real sector (activities with well-identified real assets, such as land, mines or real estate property, which could be used for security), manufacturing, trade and services. Default cases are observed in all business sectors, with a concentration in construction (13% of default cases), wholesale and retail trade (44%) and services (10%). The relative use of personal guarantee or collateral seems to be uniformly spread across the four aggregated activity sectors.

Any empirical study of credit risk and loan provisioning raises two measurement issues. Which criterion should be used to define the time of the default event? Which method should be used to measure the recovery rate on a defaulted transaction?

The criterion used for the classification of a loan in the 'default' category is critical for a study on provisions, as a different classification would lead to different results. Three 'default' definitions are used in the literature:

i) A loan is classified as 'doubtful' as soon as "full payment appears to be questionable on the basis of the available information".

ii) A loan is classified as 'in distress' as soon as a payment (interest and/or principal) has been missed.

iii) A loan is classified as 'default' when a formal restructuring process or bankruptcy procedure is started.

In this study, because of data availability, we adopt the second definition, that is, a loan is classified as 'in default' as soon as a payment is missed. For information, the reporting to the Central Bank of Portugal takes place after thirty days, if the loan remains unpaid or unrestructured.

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in bankruptcy regimes explain the intensity of collateral use.

[10] The relatively short average relationship is due to the fact that the bank was created in 1985, after the deregulation of the Portuguese banking system.

The second methodological issue relates to the measurement of recovery on defaulted loans, as provisions will be the amount that will not be recovered. There are two approaches, market LGD and workout LGD (Schuermann, 2005):

i) The price of the loan, defined most frequently as the trading price one month after the default (For instance, Emery, Cantor and Arner, 2004, and Varma and Cantor, 2005).

ii) In the workout LGD, the recovery is equal to the discounted value of future cash flows recovered over time after the default date.

As no market price data are readily available for defaulted bank loans in Portugal, the second methodology -the present value of actual recovered cash flows- is the only feasible alternative. This approach was adopted by Asarnow and Edwards (1995), Carty and Lieberman (1996), and Araten et al. (2004) for the US, Hurt and Felsovalyi (1998) for Latin America, Franks et al. (2004) for France, Germany and UK, and Gruner and Weber (2005) for Germany. While these authors did not have access to the interest rate charged on individual loans and had to rely on an approximation of credit-risk adjusted yield curve, data on interest rates charged on the loans are available in this study. The present value of cash flows recovered on impaired loans allows to measure the proportion of principal and interest that is recovered after the default date. This approach has the advantage that, if a loan is fully repaid, the present value of actual cash flows recovered will be equal to the outstanding balance at the default date. It should be noted that this amount could differ from the price of the loan at a time of default, which would incorporate the expected cash flows and adequate risk or liquidity premia[11].

In order to measure the cash flows recovered after a default event, we tracked, each month, the post-default credit balances. Capital recovery is a reduction in the total balance. The total cash flow recovered is this capital recovery plus the interest on the outstanding balance.

[11] Note that the direction of the valuation bias is uncertain. Maclachlan (2004) estimate the risk premium required to value expected cash flows on distressed loans at 2%, somewhat lower than the credit risk spread build in the contractual loan rate that is used for discounting.

4 Loan-Loss Provisioning, Empirical Evidence with a Mortality-based Approach

The application of the mortality-based approach to calculate dynamic provisions is followed by a comparison with the mandatory dynamic provisioning imposed by the Central Bank of Portugal.

4.1 Dynamic Loan-Loss Provisioning, Empirical Evidence

The sample marginal and cumulative recovery rates for the sample T months after the default date, SMRR_T and SCRR_T, respectively, are reproduced in Figures 1 and 2. One observes, in Figure 1, that most of the marginal recovery rates in excess of 5 % occur in the first five months after the default. In Figure 2, one observes that the cumulative recovery rate is almost completed after 48 months, and that the weighted cumulative recovery rates are lower than the unweighted cumulative recovery rates. For instance, the unweighted cumulative recovery rate after 48 months is 70%, while the weighted recovery rate is 56.3 %. This is indicative of a size effect. Cumulative recovery on large loans appears to be lower.

Cumulative recovery on outstanding balances on bad and doubtful loans are reported in Table 3. These dynamic cumulative recoveries are calculated on loan balances outstanding n months after the default date, with n varying from 0, the time of financial distress, to 37 months after the default date. Estimates of dynamic recoveries will allow the calculation of dynamic provisioning on expected loan-losses, n months after the default date. One first observes, for the total sample, that the reported difference between unweighted and weighted recoveries is significant at time zero, the time of default, (72.6% vs. 63.8%, respectively), but less significant at later dates (for instance, 33% vs 35.8%, 19 months after the default date). This is expected as, in Figure 2, the difference between the weighted and the unweighted cumulative recovery rates does not increase through time. Over time, the weighted (and unweighted) cumulative recovery rates on the unpaid loan balance are decreasing monotonously over time, 55.7% (57.8%) in period 4, to 23,3% (17.1%) in period 37. More complete information is obtained, in Table 3, by dividing the sample into three groups, according to the absence of personal guarantee/collateral, the existence of personal guarantee, or the existence of collateral support. As expected, the cumulative recovery rates (unweighted, so as not to be affected by the size effect) is the highest for the case of loans with collateral for every period, for instance 85.3% at time 0, the default date. A counterintuitive and significant observation is that the (unweighted) cumulative recovery rates on loans without any type of real or personal guarantee dominates, in every period, the cumulative recovery rate on loans with personal guarantees. For instance, at time 0, (unweighted) recoveries on loans without any type of guarantee/collateral is 80.6%, vs.63.9% for recoveries on loans with personal guarantee (or 47.0% vs. 20.8%, 19 months after the default date). This empirical result could be caused by two factors. First, guarantee or collateral support is not usually requested from reliable clients, so that the existence of a guarantee is an indicator of greater risk. Second, some borrowers are able to shift ownership of personal assets to other persons, so that, when the bank tries to execute the debt, there is not much left. This empirical result, if confirmed in other studies, implies that regulatory provisions should not penalize loans without personal guarantee, as the absence of a guarantee might be justified by higher expected recoveries.

In Figures 3a and b, we show the dynamic cumulative recoveries on unpaid balance at months 4 and 25. Cumulative recovery after 68 months reaches 60% on loan balances outstanding four months after the default date. It reaches around 30% on loan balances outstanding 25 months after the default date. The frequency of cumulative recoveries on unpaid balance at months 4 and 25 are reported in Figures 4a and b. These show a bipolar distribution of cumulative recoveries on outstanding balance at month 4, but that there are few cases of full recovery on balances outstanding at month 25[12].

4.2 Loan-Loss Provisioning: Central Bank Mandatory Provisions vs. Mortality-based Provisions

In Table 4, we report the provisions rules of the Bank of Portugal for bad and doubtful loans for applications other than consumer credit or residence credit. The 1% provisions rule for time "0 to 3 months after default" reflects

[12]Bimodal recovery distributions are similar to those reported by Asarnow and Edwards (1995) and Araten et al. (2004) for the US, Hurt and Felosvalyi (1998) for Latin America, Frank et al. (2004) for France, Gunert and Weber for Germany (2005) and Dermine and Neto de Carvalho for Portugal (2005a).

the central bank's policy of imposing a conservative general provisions of 1% on all outstanding bank loans in Portugal. A first observation is that specific provisioning on bad and doubtful loans starts 3 months after the default date, that is, two months after the loan is reported to the Bank of Portugal. A second observation is that provisioning is increasing through time with 100% provision required at month 13 for loans with no personal guarantee/collateral, at month 19 for loans with personal guarantee, and at month 31 for loans with collateral. A third observation is that recoveries on loans without guarantee/collateral are assumed to be the lowest, at all points in time. It is quite interesting to compare the regulatory provisioning schedule of a central bank, from the one that could be inferred from the empirical estimates of cumulative recoveries. A word of caution applies. The comparison, being based on a data set of a single bank, can capture some of the bank's idiosyncracies.

In Figures 5a,b,c, we report the provisioning schedule of the central bank several months after the default date and the provisioning schedule implied by the estimates reported in Table 3, for loans with no guarantee/collateral, loans with personal guarantee, and loans with collateral support. A first observation is that the regulatory practice of enforcing specific provisions three months after the default event does not seem justified by the data. Provisioning should start at the time of the default event. A second observation is that the provisioning on loans without guarantee/collateral is excessively conservative. It calls for 100% provisioning 13 months after the default date, when our data shows an expected (weighted) recovery of 66.7%. A third observation is that the provisioning on loans with personal guarantee is too optimistic. It calls for provisioning of 50%, 13 months after the default date, when the data shows an expected recovery of only 20.5%. It is only in the case of loans with collateral support that the divergence between the estimated and the regulatory schedule is minimal.

5 Loan-Loss Provisioning, a Multivariate Analysis

In the previous section, univariate mortality-based estimates of cumulative recoveries and provisions were provided. In this section, we attempt to estimate empirically the determinants of the cumulative recovery rates and dynamic provisions. A discussion of the choice of explanatory variables and the econometric specification is followed by the empirical results.

5.1 Explanatory variables and econometric specification

Explanatory variables include the size of the loan, past cumulative recovery rate, the default year, the age of the firm, the industry sector and the type of guarantee/collateral support. The size of the loan is included because some empirical studies and the sample univariate weighted and unweighted average cumulative recovery data have pointed out the effect of the loan size. Past cumulative collection is included on the assumption that a good level of collection could indicate a genuine effort by the borrower to repay the loan fully. A year dummy will capture the volatility of the recovery rate over time. The age of the firm is included because problems of asymmetric information could be reduced in the case of older, more established firms. The industry sector will allow to test whether activities with well identified real assets, such as land, mines or real estate property, show higher recoveries on bad and doubtful loans. Finally, it is of interest to know the impact of guarantee/collateral, as, if statistically significant, this variable could be taken into account in calculating loan-loss provisions on bad and doubtful loans.

Additional explanatory variables have also been tested: the number of years of the client's relationship with the bank, the annual GDP rate of growth, the frequency of default in the industry sector, the rating of the borrower, and the interest rate on the loan. The number of years of relationship could have an effect on the effort of a distressed borrower to repay his or her debt, to protect the information-based value created by the relationship. GDP growth or the frequency of default in the industry could affect the level of recovery, as some studies (for instance Frye, 2000a,b and 2003, Altman et al., 2003, Acharya et al. 2003a) have found a negative correlation between economic activity and recovery level, in confirmation of the theoretical arguments of Shleifer and Vishny (1992).

The size of loan, GDP growth, age of the firm, and length of relationship excepted, the explanatory variables will be represented by 'dummy' variables. The dependent variable, the cumulative loan recovery rate, is a continuous variable over the interval [0-1]. As in Dermine-Neto de Carvalho (2005a), a log-log function is empirically estimated. It is defined as :

$$G(x\beta) = e^{-e^{-x\beta}}$$

Following up on Papke and Wooldridge (1996), the non-linear estimation procedure maximizes a Bernoulli log-likelihood function:

$$l_i\,(b) = y_i\,[\log G\,(x_i\,b)] + (1\text{-}y_i)\,\log\,[1\text{-}G(x_i\,b)]$$

The quasi-maximum likelihood (QMLE) estimators of beta are consistent and asymptotically normal (Gourieroux, Montfort and Trognon, 1984).

5.2 Empirical Results

The log-log function has been estimated for the cumulative recovery rates (recovery measured until month 48)[13] on balances outstanding at month 0, 4, 7, 13, 19, 25, and 37. The results are reported in Table 5. The results confirm those of the univariate mortality-based approach, and add new insights. First the coefficient of the personal guarantee is negative and statistically significant at most time horizons. That is, losses and provisions on loans with personal guarantee are significantly higher than on loans with no guarantee/collateral. They should not receive preferential treatment in terms of provisioning. Second, the coefficient of collateral is positive at all time intervals, although statistically significant at two horizons only, 0 and 4 months. Third, and most interestingly, is the sign of the past recovery variable. It is positive and statistically significant at all horizons, 4 to 37 months, indicating that past recovery is a good indicator of future recovery. Fourth, the loan size has a negative impact on recovery at time zero, confirming the observed univariate differences between unweighted and weighted recoveries. The loan variable was not included in the regressions on later recoveries, as it was found to be negatively correlated with the past recovery variable. Fifth, the manufacturing and trade sectors have lower recoveries than the real sector,

[13] Because of data limitation (five years), the cumulative recovery is calculated up to 48 months after default. This does not seem too restrictive as Figure 2 indicates that most of the recovery is achieved 48 months after default.

which includes agriculture, mining, construction, hotel/restaurant, and real estate. Finally, the age of the firm has a positive impact on the cumulative recovery calculated from the time of default.

To assess further the magnitude of the impact of past recovery on fair loan-loss provision, we use the estimated regression to simulate the level of fair provisions for different levels of past recovery. These are reported in Table 6. If, for instance, one considers the balance outstanding seven months after the default date on a loan with no guarantee/collateral, one observes that the level of provisions should be 53% when past recovery has been zero, but that this provisions falls to 18% in the case of a past recovery of 50%. Although one would need additional empirical research to confirm these results, it appears that, for this sample of loans, past recovery has a significant impact on loan-loss recoveries and on the level of fair loan-loss provisions.

6 Conclusions

A fair level of provisions on bad and doubtful debt is an essential part of capital regulation and bank solvency. Micro data on recovery overtime on bad and doubtful loans allows us to provide two methodologies to compute dynamic provisions, at the time of default and over time. A univariate mortality-based approach allows us to compute provisions for three classes of loans: no guarantee/collateral, personal guarantee only, and collateral with or without guarantee. A multivariate approach facilitates analyzing more precisely the determinants of loan recoveries and provisions over time. Three main empirical results are as follows. First, bad and doubtful loans with no guarantee/collateral exhibit better recoveries than loans with personal guarantee. This could be due to the fact that the decision to lend without guarantee took into account the higher expected recovery rates. Second, the past recovery history has a highly significant positive impact on future recovery. Third, a comparison with the Bank of Portugal mandatory provisioning rules indicates some regulatory conservatism in calling for 100% provision 31 months after the default date, when, in fact, significant amounts are still recovered after that date. But, much more stringent provisions should be enforced in the shorter run, before the "90-day"- provisioning trigger date. A word of caution is that this study, being based on a dataset of a single bank in a specific time period, can capture some of the bank's idiosyncracies. Additional empirical studies are needed to validate the empirical findings of the paper, but the two methodologies presented in this paper provides a basis to estimate loan-loss provisions on bad and doubtful bank loans.

Table 1: Descriptive Statistics for the Sample of Bad and Doubtful Loans[1]

Panel A: Number of Loans with Personal Guarantee or Collateral		
	Number of Observations	Percentage
No Guarantee/Collateral	133	35.6%
Personal Guarantee	218	58.3%
Real Estate Collateral	26	7.0%
Physical Collateral	7	1,9%
Financial Collateral	23	6.1%

Panel B: Age of Borrowing Firm and Age of Relationship with the Bank (Years)				
	Mean	Median	Min	Max
Age of Borrowing Firm	17	12.3	0.5	121
Age of Relationship	6	6	0.5	14

[1] In the cases of firms with a history of multiple defaults, only the first default case is included.

Table 2: Number of Default Cases, and Use of Collateral/ Guarantee by Industrial Sectors (1995-1999)

Sectors of Activities	Number of defaults		Value-weighted Default Distribution	Number of Defaults with Guarantees (% of number of defaults in that industry)	Number of Defaults with Collateral (% of number of defaults in that industry)
1.Agriculture/Fishing	6	2%	8%	4 (67%)	2 (33%)
2.Mining	8	2%	1%	3 (38%)	1 (13%)
3. Construction	50	13%	15%	28(56%)	4 (8%)
4.Hotel/Restaurant	9	2%	3%	6(67%)	2 (22%)
5.Real Estate	10	3%	4%	6 (60%)	3 (30%)
6.Food/Beverages	12	3%	13%	6 (50%)	2 (17%)
7.Textiles	15	4%	2%	8 (53%)	0 (0%)
8.Chemicals	3	1%	3%	2 (66%)	1 (33%)
9.Machinery	20	5%	2%	9 (45%)	5 (25%)
10.Paper/Printing	12	3%	3%	8 (75%)	4 (33%)
11.Other Non-mineral	15	4%	3%	8 (53%)	2 (13%)
12.Wholesale Trade	122	33%	23%	85 (70%)	13 (11%)
13.Retail Trade	41	11%	9%	23 (56%)	7 (17%)
14.Transport	15	4%	3%	6 (40%)	2 (13%)
15.Other Services	36	10%	10%	16 (44%)	8 (22%)
Aggregated Sectors					
I. Real	83	22%	31%	47 (57%)	12 (14%)
II. Manufacturing	77	21%	25%	41 (53%)	14 (18%)
III. Trade	163	44%	32%	108 (66%)	20 (12%)
IV. Services	51	14%	12%	22 (43%)	10 (20%
Total	374	100%	100 %	218 (58%)	56 (15%)

Note: With reference to European Union economic activities codes (NACE), the 15 sectors are defined as follows: Sector 1 (Agriculture/Fishing): 1, 2, 5, 20 ; Sector 2 (Mining): 11,13,14 ; Sector 3 (Construction): 45; Sector 4 (Hotel/Restaurant): 55; Sector 5 (Real Estate): 70; Sector 6 (Food/Beverages): 15, 16; Sector 7 (Textiles): 17, 18, 19; Sector 8 (Chemicals): 23, 24, 25; Sector 9 (Machinery): 26 to 37; Sector 10 (Paper/Printing): 21, 22; Sector 11 (Other mineral; cement): 26; Sector 12 (Wholesale trade): 50, 51; Sector 13 (Retail Trade): 52; Sector 14 (Transport): 60 to 64; Sector 15 (Other Services): 71 to 93. Aggregated sectors: Real (sectors 1 to 5); Manufacturing (sectors 5 to 11), Trade, (sectors 12+13), Services (sectors 14+15).

Table 3. Mortality-based estimate of cumulative recoveries on loan balances outstanding n months after default

	Total sample		No Collateral / No Guarantee		Personal Guarantee only		Collateral with or without guarantee	
Number of months after default (n)	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
0	72.6%	63.8 %	80.6%	80.0%	63.9%	45.9%	85.3%	63.8%
4	57.8%	55.7%	69.6%	75.3%	46.8%	33.4%	74.1%	66.2%
7	50.2%	47.7%	63.3%	70.8%	38.5%	27.0%	69.2%	50.3%
13	41.03%	42.1%	56.6%	66.7%	27.6%	20.5%	63.2%	46.14%
19	33.0%	35.8%	47.0%	59.4%	20.8%	13.6%	60.0%	41.5%
25	27.1%	32.2%	41.3%	56.7%	16.3%	11.6%	53.7%	36.1%
37	17.1%	23.3%	28.3%	43.2%	8.6%	6.9%	46.5%	29.8%

Note: These are cumulative recovery rates up to month 68, calculated on the loan balance outstanding n months after the default date. The unweighed average recovery is the arithmetic average of recoveries on individual loans. Weighted average recovery are weighted by loan balances.

Table 4. Bank of Portugal Provisions Rules for Applications other than Consumer Credit or Residence Credit

Risk Class	Time period	If the credit has no guarantee/collateral	If the credit has a personal guarantee	If the credit has a real guarantee
Class I	From 0 to 3 months	1%	1%	1%
Class II	From more than 3 months to 6 months	25%	10%	10%
Class III	From more than 6 months to 9 months	50%	25%	25%
Class IV	From more than 9 months to 12 months	75%	25%	25%
Class V	From more than 12 months to 15 months	100%	50%	50%
Class VI	From more than 15 months to 18 months	100%	75%	50%
Class VII	From more than 18 months to 24 months	100%	100%	75%
Class VIII	From more than 24 months to 30 months	100%	100%	75%
Class IX	From more than 30 months to 36 months	100%	100%	100%
Class X	From more than 36 months to 48 months	100%	100%	100%
Class XI	From more than 48 months to 60 months	100%	100%	100%
Class XII	More than 60 months	100%	100%	100%

Source: Aviso de Banco de Portugal nº 8/2003, Diário da República - I Série - B, Nº 33, 8 February 2003

Table 5. Statistical estimate of cumulative recoveries on loan balances outstanding n months after default

(The estimate of the parameter is followed by the p-value)

	Number of Months after Default (n)						
	0	**4**	**7**	**13**	**19**	**25**	**37**
Constant	1.79	1.08	1.33	0.93	0.63	0.66	-0.28
	(0.00*)	0.02*)	(0.01*)	(0.07)	(0.21)	(0.2)	(0.53)
Past Recovery	NM	5.18	2.76	2.30	1.92	1.7	1.68
		(0.00*)	(0.00)	(0.00*)	(0.00*)	(0.00*)	(0.001*)
Loan Size	-0.77	-	-	-	-	-	-
	(0.00*)						
Year 1996	0.31	0.11	-0.28	-0.16	-0.07	-0.15	-0.5
	(0.24)	(0.65)	(0.24)	(0.50)	(0.75)	(0.48)	(0.04*)
Personal Guarantee	-0.38	-.43	-0.65	-0.75	-0.63	-0.63	-0.80
	(0.15)	(0.08)	(0.01)	(0.00)	(0.01*)	(0.01*)	(0.002*)
Collateral	1.72	0.87	0.63	0.45	0.39	0.20	0.85
	(0.00*)	(0.01*)	(0.17)	(0.30)	(0.39)	(0.68)	(0.18)
II.Manufacturing sector	-1.2	-1.08	-0.91	-0.84	-0.90	-1.06	-0.69
	(0.02*)	(0.02*)	(0.05*)	(0.08)	(0.07)	0.04)	(0.2)
III.Trade sector	-1.25	-1.17	-1.18	-0.99	-0.96	-0.95	-0.30
	(0.01*)	(0.01*)	(0.01*)	(0.04*)	(0.05)	(0.3)	(0.55)
IV.Services	-0.42	-0.59	-0.37	-0.12	-0.17	-0.77	0.14
	(0.48)	(0.3)	(0.53)	(0.83)	(0.77)	(0.17)	(0.8)
Age of firm	0.01	0.001	-0.0007	-0.0002	0.00	-0.0007	-0.0006
	(0.04*)	(0.06)	(0.39)	(0.88)	(0.76)	(0.3)	(0.20)
Pseudo R^2	0.18	0.36	0.35	0.41	0.43	0.44	0.52
Wald test	43.4	65.1	43.9	55.9	54.8	36	33
	(0.00*)	(0.00*)	(0.00*)	(0.00)	(0.00*)	(0.00*)	(0.00*)
Reset	0.23	-0.39	-0.79	0.22	0.95	1.0	0.13
	(0.82*)	(0.69*)	(0.43*)	(0.83*)	(0.34*)	(0.31*)	(0.89*)
Number of observations	153	125	112	96	85	77	66

NM: not meaningful

*: Significant at the 5% level.

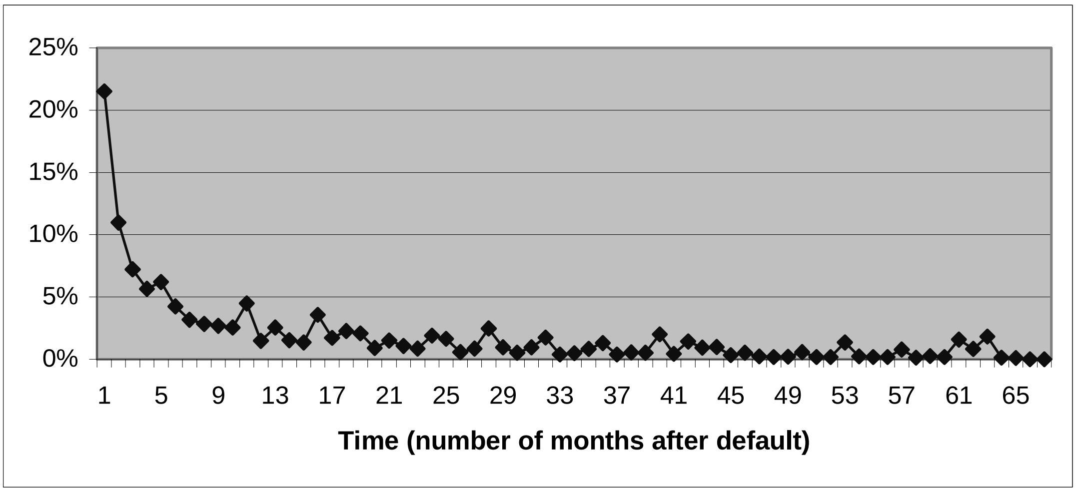
Note: The table presents the result of the log-log regression. The dependent variable is the cumulative recovery rate on loan balances outstanding at 4, 7, 13, 19 , 25, and 37 months after the default date. The explanatory variables include a constant term, the percentage for the initial loan already recovered, the loan size, a dummy for personal guarantee, and collateral. Because of data availability, the cumulative recovery is calculated up to 48 months after the default date. This is unlikely to create a bias as Figure Two indicates that most of the recovery is achieved 48 months after the default date.

Table 6. Multivariate-estimate of provisions vs. Central bank (CB) mandatory provisioning (in percentage)

Period	No Guarantee				Personal Guarantee				Collateral			
	CB	Level of past recovery			CB	Level of past recovery			CB	Level of past recovery		
		0%	20%	50%		0%	20%	50%		0%	20%	50%
4	25	49	12	5	10	64	31	8	10	23	9	2
7	50	53	35	18	25	77	57	31	25	33	21	10
13	100	64	48	28	50	89	75	51	50	47	33	19
19	100	75	61	43	100	93	85	66	100	58	45	29
25	100	80	68	50	100	95	88	73	100	73	60	43
37	100	99	97	89	100	100	100	99	100	88	78	60

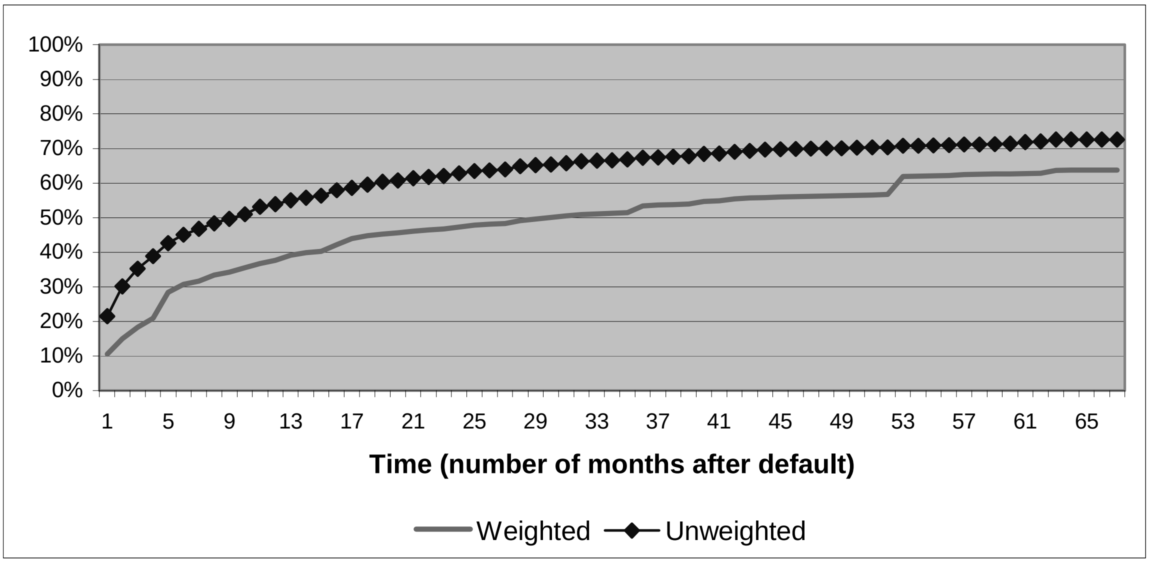
Note: The level of provisioning (provision = 1 − cumulative future recovery) is estimated with the regressions reported in Table 4. These are estimates for the manufacturing sector for a loan with average size and average age.

Figure 1: Sample Unweighted Marginal Recovery Rate at month t+n (SMRRt+n)



Note: This figure presents the marginal recovery n- months after default. The mortality-based approach is used to calculate the marginal recoveries.

Figure 2: Sample Unweighted and Weighted Cumulative Recovery Rate at month t+n (SCRR t+n) on Balances outstanding at the default date, month 0



Notes: The figure presents the cumulative weighted and unweighted recovery rates n-months after default. They have been calculated with the mortality-based approach.

Figure 3a: Cumulative recoveries as a % of loan outstanding in month 4

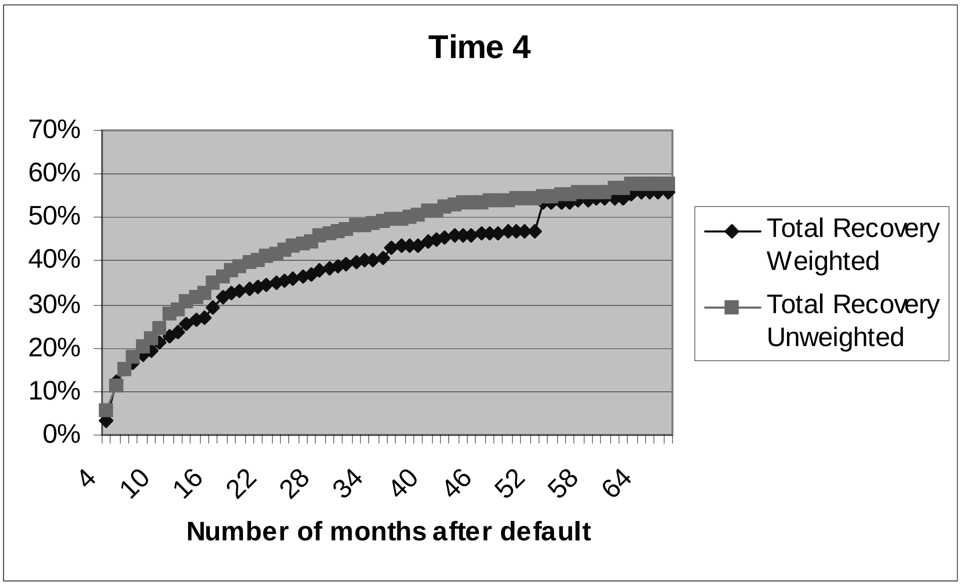


Figure 3b: Cumulative recoveries as a % of loans outstanding in month 25

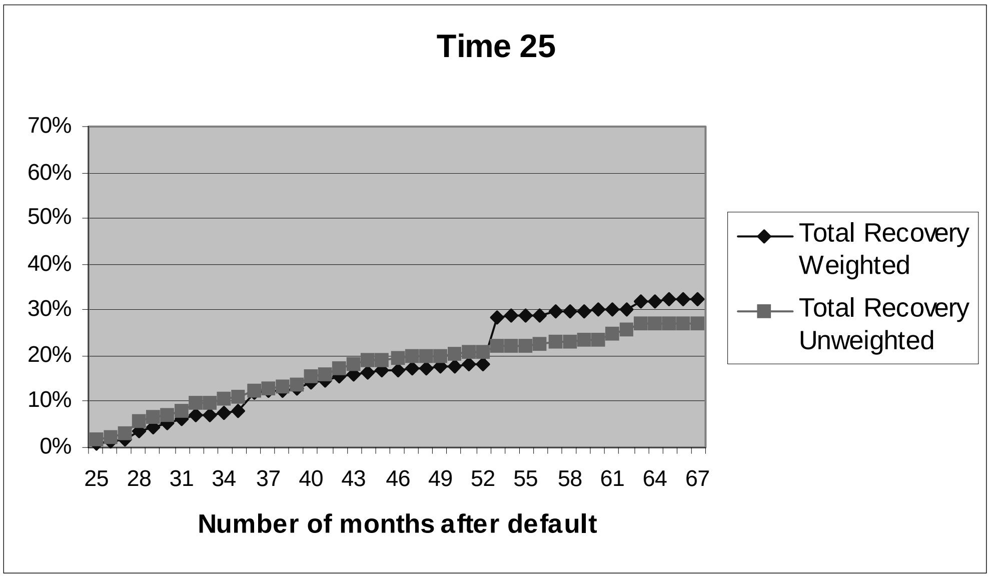


Figure 4a: Frequency of cumulative recoveries on loans outstanding 4 months after the default date

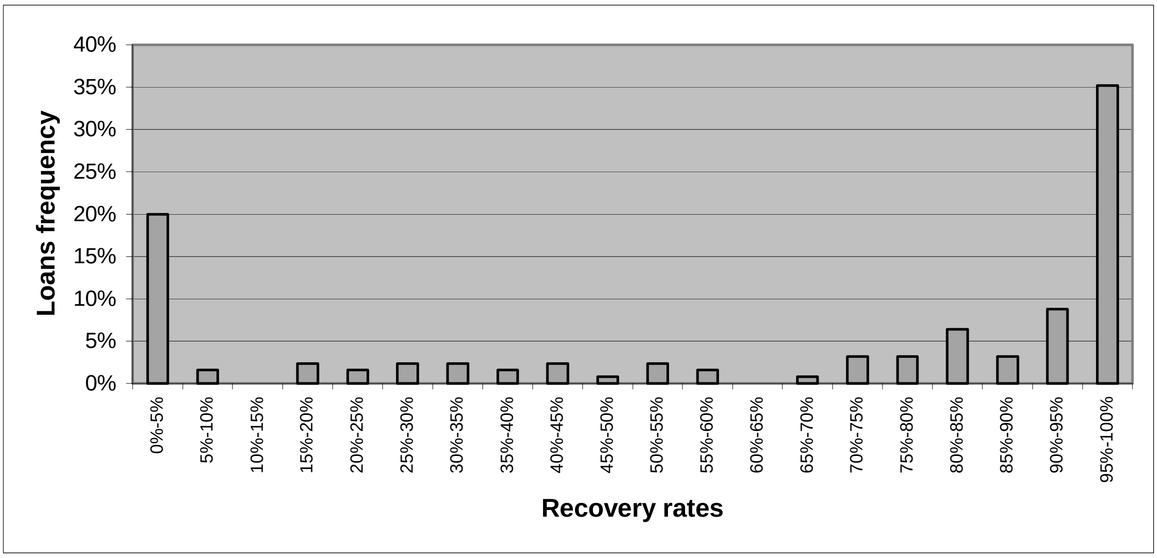
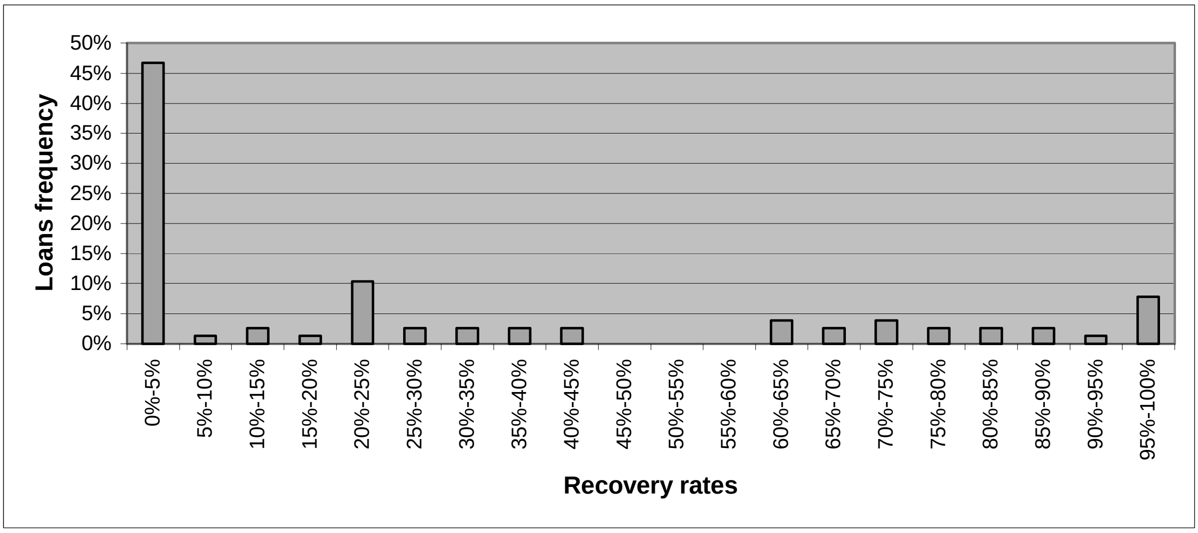


Figure 4b: Frequency of cumulative recoveries on loans outstanding 25 months after the default date



Note : The figure presents the frequency of cumulative recovery on individual loans, 48 months after default.

Figure 5a: Comparison of empirical (weighted) estimates of loan-loss provisions to those imposed by the central bank, for the loans without collateral or personal guarantee

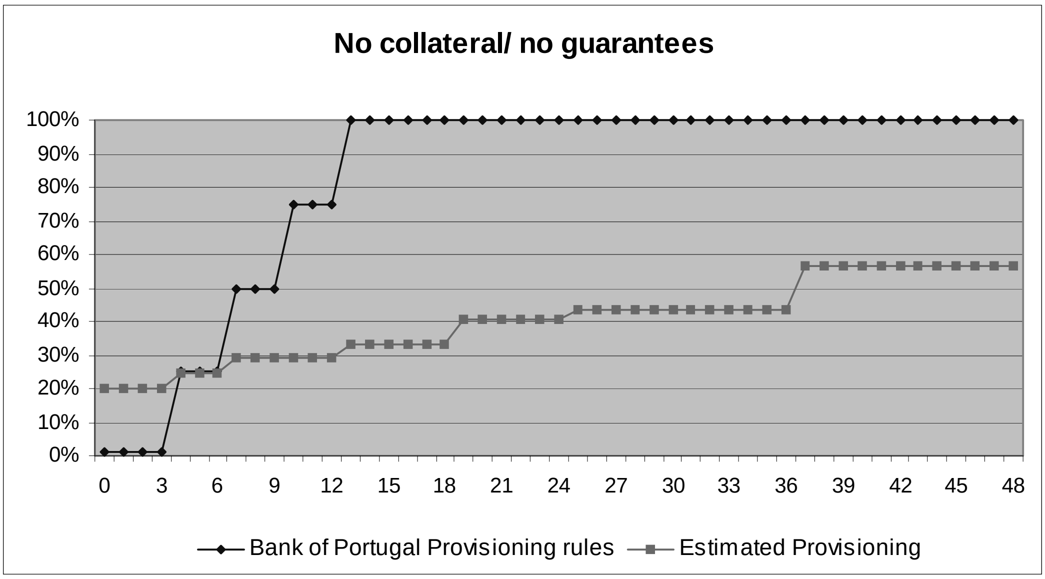


Figure 5b: Comparison of empirical estimates to those imposed by the central bank for the loans with personal guarantee

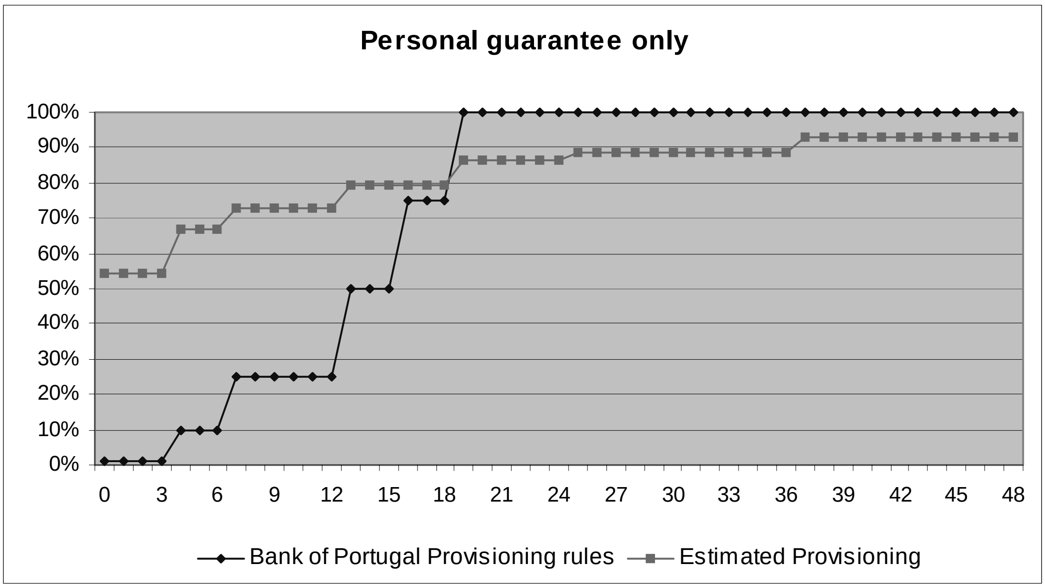
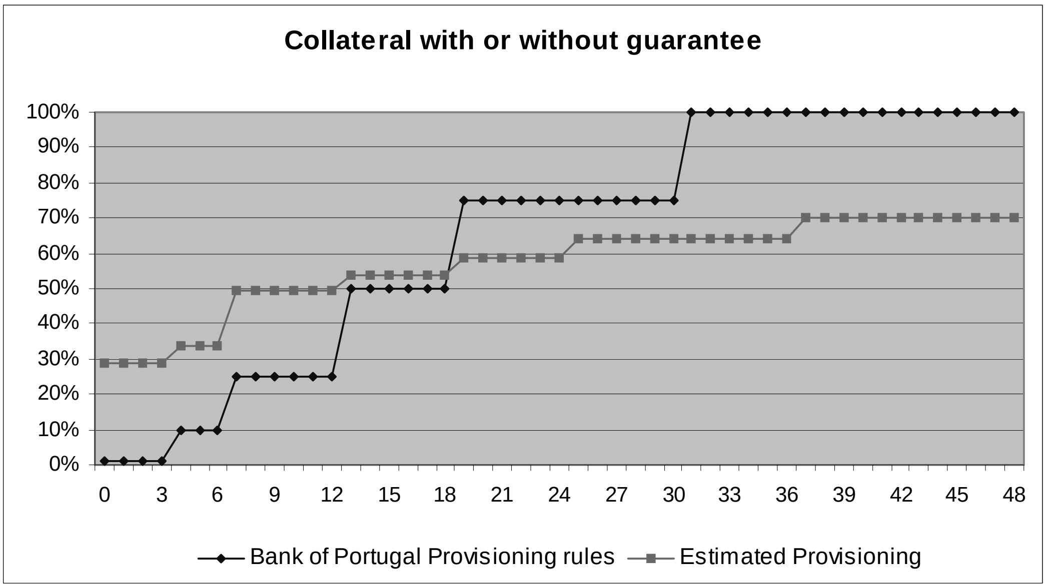


Figure 5c: Comparison of empirical estimates to those imposed by the central bank for the loans with collateral (with or without personal guarantee)



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