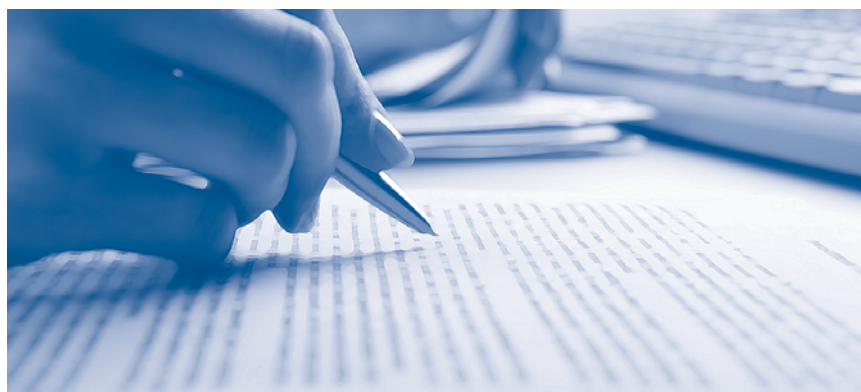


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Converting the NPL Ratio into a Comparable Long Term Metric*

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Abstract

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The NPL ratio is probably the most widely used metric to measure the credit risk present in the loan portfolio of financial institutions. However, factors other than credit risk, such as the time a loan remains in the NPL condition, the distribution of defaults over time within a certain vintage, the growth rate of the loan portfolio and its term to maturity, may influence its dynamics. Moreover, accounting differences related to recognition and definition of an event of default makes it difficult to compare this metric across different countries.

In this paper, we propose an alternative metric to assess the dynamics of credit risk in the loan portfolio. Based on a theoretical portfolio, we develop an analytical model in order to estimate the weighted average of lifetime default ratios of all vintages where the weight is assigned based on the contribution of each vintage to the current stock of loans. We call it implied NPL ratio, which consists of a transformation that adjusts the observed NPL ratio for the effects of changes in the portfolio growth rate and in its average term to maturity, and also takes into account differences in the default distribution across time and the amount of time a past due loan remains in the balance sheet.

The results of applying this transformation to the three most relevant types of loans to households in Brazil (auto loans, housing financing and payroll-deducted loans) demonstrate that (a) the implied NPL ratio was a good forecast of the portfolio lifetime default; (b) changes in the components mentioned above affected the dynamics of the NPL ratio and therefore compromised the assessment of credit risk based on this metric (c) the analysis of differences in the evolution of NPL and INPL gives rise to important insights regarding the dynamics of credit risk.

JEL Codes: G21, E32, E44.

Keywords: Nonperforming loans; risk measurement; vintage.

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1 Introduction

In recent years, many countries have experienced credit buildups for various reasons such as rises in income, low interest rates for long period of time, improvements in the legal framework, development of credit risk transfer instruments, large capital inflows, establishment of lower risk loan categories, and in some cases, a relatively low initial base¹.

In situations like this, one of the major challenges is to assess the credit risk that is being generated and how it evolves over time. Also important is to be able to compare domestic results with those from other countries. Given the difficulties in harmonizing differences regarding accounting rules, related to the recognition and definition of default, the varying depth of information available across financial institutions and countries, the metric called nonperforming loans ratio, NPL, has become one of the most popular metric for this purpose due to the simplicity of its calculation and interpretation.

A few examples where the NPL ratio is widely used are academic papers searching among possible macroeconomic, financial and institutional variables the determinants of its variations²; assessment programs seeking to analyze a country's financial sector³; rating agencies evaluating individual institutions; and supervisors assessing the capacity of financial institutions to absorb expected losses.

Although the problems arising from differences in accounting rules and in the definition of default are mitigated by the use of the classic NPL ratio, and even considering improvements made by the IMF in order to make this metric comparable internationally⁴, there are some characteristics inherent to the classic NPL ratio that bring some challenges to its use for the assessment of credit risk.

¹ See Elekdag and Wu (2011) for a comprehensive review of credit boom events.

² See, for example, Brookes, Dicks, and Pradhan (1994), Nkusu (2011), and Rinaldi and Sanchis-Arellano (2006).

³ See World Bank and International Monetary Fund (2005)

⁴ The Compilation Guide on Financial Soundness Indicators (2004) “recommends that loans (and other assets) should be classified as NPL when (1) payments of principal and interest are past due by three months (90 days) or more, or (2) interest payments equal to three months (90 days) interest or more have been capitalized (reinvested into the principal amount), refinanced, or rolled over (that is, payment has been delayed by agreement). [...] In addition, NPLs should also include those loans with payments less than 90 days past due that are recognized as nonperforming under national supervisory guidance - that is, evidence exists to classify a loan as nonperforming even in the absence of a 90-day past due payment, such as when the debtor files for bankruptcy. [...] The amount of loans (and other assets) recorded as nonperforming should be the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue.”

The NPL behavior is influenced not only by the credit risk of the portfolio but also by other factors. Other characteristics inherent to this metric, such as the time a loan remains in the NPL condition, the distribution of defaults over time, the growth rate of the loan portfolio and its term to maturity also affect the behavior of this metric, as discussed below, compromising international comparison, and also imposing some restrictions for domestic use as well.

Essentially, the NPL is described by the ratio, at a given moment in time, between the amount of loans past due ninety days or more and total amount of loans outstanding. This definition gives rise to problems as the dynamics of the variables involved are determined by events that occur at different moments in time - while the numerator is defined by credit characteristics established at origination and also by current macroeconomic conditions, the denominator is determined by changes in the present stock of credit.

This fact is a major drawback as variations in the NPL ratio are not necessarily associated with changes in credit risk. The numerator, the amount of loans past due, depends not only on the quality of credit at origination, where each vintage granted on a certain month has a different behavior in terms of distribution of defaults over time, but also on the average term to maturity and the average time a loan remains in the NPL condition. The lengthening of the term to maturity, for example, causes the default events to be diluted in time, thus reducing the concentration of NPL in the early years of each vintage.

The time a loan remains in the NPL condition varies with the speed and quantity of renegotiation processes, as well as with the causes that led to the default and how write-off criteria applies to specific situations. These events will only affect the metric over the lifetime of the portfolio and consequently, it will cause a delay between the improvement or worsening of credit quality conditions and the impact on the value of the metric. Changes in the average time that a loan remains in the NPL may arise for example due to more restrict renegotiation conditions, more lenient write-off rules, and delay in collection process. As an example of how changes in this parameter may affect the NPL ratio, assume that the average time that a loan remains in the NPL condition increases while the quality of the portfolio remains unchanged. In this situation, the amount of nonperforming loans in the balance sheet will rise as inflows in the stock of

nonperforming loans will remain unaffected whereas outflows will decline and, as a result, the NPL will rise.

On the denominator side, the problems are different. On one hand, credit booms cause the NPL ratio to shrink, without necessarily representing an improvement in the quality of the credit of the portfolio. Credit crunches, on the other, have the opposite effect, as a reduction in the denominator results in an uptick in the NPL, although the quality of the portfolio has not essentially been changed.

In other words, part of the increase/decrease in the NPL arises naturally from the essence of the variables involved in the calculation. Changes in the current NPL ratio will therefore mirror not only the dynamics of credit risk but will also reflect the behavior of other components not necessarily related to quality of the portfolio. The key question here is what part of that behavior occurs by a purely mathematical matter and what part can be really attributed to an increase/decrease in credit risk.

Thus, the measurement of the NPL ratio is affected by changes in the credit risk but also by factors such as the growth rate of the loan portfolio, its maturity, the behavior of borrowers in each vintage, and the time a loan remains in the NPL condition, before being renegotiated, regularized or written-off. Consequently, modifications in the level of credit risk may be offset by movements in any of these other drivers and therefore be concealed or amplified, which in turn could make the NPL ratio procyclical.

This is extremely important as the buildup of credit risk usually occurs during upturns but only materializes during downturns⁵. Therefore, any deterioration of portfolio quality during its expansion cycle tends to be hidden by the behavior of these other variables, creating a shortfall of provisions and, consequently, requiring rapid adjustments of greater magnitude at the time of the reversal of the cycle and thus, exacerbating the perceived worsening of the portfolio quality.

Additionally, the last financial crisis has highlighted problems related to the current incurred loss based provisioning model and the need to move to an earlier recognition of expected losses approach⁶. Furthermore, it has also called for a change in the time horizon of forecasts on which calculations of expected losses are based from a

⁵ See, for instance, Drehmann et al. (2011), Drehmann et al. (2010), Jimenez and Saurina (2006), Lowe (2002), and Saurina (2009).

⁶ See IASB (2009) and BIS (2009).

12 month timeframe to a full remaining lifetime horizon in situations characterized by expected deterioration in the financial performance of the borrower combined with an increase in uncertainty about the ability to recover cash flows⁷.

In this paper, we propose an alternative metric to assess the dynamics of the loan portfolio quality. Based on a theoretical portfolio, we develop an analytical model in order to estimate the actual NPL existing in the portfolio at a specific point of time, which is basically an estimate of the share of all loans that will default during the entire lifetime of the portfolio given current conditions. Strictly speaking, the proposed metric measures the weighted average of lifetime default ratios of all vintages where the weight is assigned based on the contribution of each vintage to the current stock of loans. We call it implied NPL ratio (INPL) and it consists of a transformation that adjusts the observed NPL ratio for the effects of changes in the portfolio growth rate and in its average term to maturity, and also takes into account differences in the default distribution across time and the time a loan remains in the NPL condition.

Concerned about the problem of data availability, the transformation has been designed as a function based on inputs that are readily available or can be easily generated, and in some cases may even be arbitrated by the regulator.

By applying this transformation, the NPL ceases to be a procyclical metric to become a long term measure that represents defaults which the portfolio intrinsically carries and that will materialize over time. This feature makes it a candidate for estimating lifetime expected losses under the new accounting framework going forward. Furthermore, this framework makes the NPL of different countries more comparable, eliminating some local idiosyncrasies that may give NPL a particular behavior.

Moreover, the proposed framework may be considered a useful tool for identifying the buildup of credit risk at an earlier stage to the extent that this movement is concealed by changes in the factors mentioned above, consequently allowing banks and supervisors to make appropriate adjustments outside periods of stress. This adjustment also contributes to econometric analysis seeking to determine the dynamics of credit risk by removing possible spurious correlations, and thus enabling the assessment of the true contribution of each variable. Finally, given that the NPL ratio is commonly used to assess the adequacy of the provisioning level, the identification of

⁷ See IASB (2011).

credit risk at the time it is building up will help to avoid abrupt valuation adjustments, mispricing of risks and the resulting need for capitalization.

The remainder of this paper is organized as follows. In section 2, the proposed model is described. The application of the model using data for the three most relevant types of loans to households in Brazil is presented in section 3. Section 4 concludes.

2 Methodology

The methodology presented in this section demonstrates how we departure from the classic NPL ratio to obtain the implied NPL, by combining the effects of the following variables: growth rate of the portfolio (β); its term to maturity (T_m); time a loan remains in the NPL status (T_w); and the distribution of defaults across time for each vintage.

The development of the framework occurs in a controlled environment characterized by the assumptions described below, and its application is subsequently generalized to day-to-day situations.

The model assumes that the stock of loans at a given instant of time consists of the sum of several vintages of loans with identical term to maturity T_m (in months) and uniform repayment schedule. In addition, the amount granted in each instant of time is greater than the amount granted in the instant before by a factor of $1 + \beta$.

It can be shown that the stock of credit in a given month t for this model is given by:

$$Loan_t = \frac{A_0}{T_m} \sum_{i=1}^{T_m} i(1 + \beta)^{t-T_m+i} \quad (1)$$

where A_0 is the amount granted at $t = 0$

Moreover, the amount of loans that are ninety days or more past due is defined by the lifetime default ratio α , a parameter γ that describes the cumulative distribution of defaults over the lifetime of each vintage (explained in more detail below), and T_w , which is the number of months a loan remains in the balance sheet after it becomes past due.

$$\begin{aligned}
PastDue90_t = \alpha A_0 & \frac{\gamma(1+\gamma)^{T_m-1}}{(1+\gamma)^{T_m}-1} \left\{ \sum_{i=1}^{T_w-3} \left[\frac{(1+\gamma)^{T_m}-1}{\gamma(1+\gamma)^{T_m-1}} \right. \right. \\
& - \left. \frac{(1+\gamma)^{T_m-i}-1}{\gamma(1+\gamma)^{T_m-i-1}} \right] (1+\beta)^{t+i-T_m-T_w} \\
& + \sum_{i=1}^{T_m-T_w+2} \left[\frac{(1+\gamma)^{T_m-i}-1}{\gamma(1+\gamma)^{T_m-i-1}} - \frac{(1+\gamma)^{T_m-T_w+3-i}-1}{\gamma(1+\gamma)^{T_m-T_w+2-i}} \right] (1+\beta)^{t+i-T_m-3} \\
& \left. + \sum_{i=1}^{T_w-3} \left[\frac{(1+\gamma)^{T_w-2-i}-1}{\gamma(1+\gamma)^{T_w-3-i}} \right] (1+\beta)^{t+i-T_w-1} \right\} \quad (2)
\end{aligned}$$

Roughly speaking, the above equation states that the amount of loans overdue at any point in time is given by the sum of delinquent loans of all vintages, where the oldest vintages contribute with loans that become overdue in the end of the lifetime of that vintage whereas the most recent vintages contribute with loans that become past due shortly after the loan is granted. The first component of the equation represents the contribution of the oldest vintages while the third is related to the contribution of most recent vintages. The second component is related to the remaining vintages that have been granted some time in between the more mature and the newer vintages.

It is possible to show that the above equations can be rewritten as follows:

$$Loan_t = \frac{A_0}{T_m} (1+\beta)^{t+1} \left[\frac{(1+\beta)^{T_m} (\beta T_m - 1) + 1}{\beta^2 (1+\beta)^{T_m}} \right] \quad (3)$$

$$PastDue90_t = \alpha \frac{A_0}{T_m} (1+\beta)^{t+1} \frac{\gamma[(1+\beta)^{T_w-3} - 1][(1+\beta)^{T_m} (1+\gamma)^{T_m} - 1]}{\beta[(1+\beta)(1+\gamma) - 1][(1+\gamma)^{T_m} - 1](1+\beta)^{T_m+T_w}} \quad (4)$$

Thus, the classic NPL, given by the ratio of loans that are ninety days or more past due and the contemporary stock of loans, NPL, is given by:

$$\begin{aligned}
NPL &= f(\beta, \gamma, T_m, T_w) \alpha \\
&= \frac{[(1+\beta)^{T_w-3} - 1][(1+\beta)^{T_m} (1+\gamma)^{T_m} - 1] \beta \gamma T_m}{[(1+\beta)(1+\gamma) - 1][(1+\gamma)^{T_m} - 1][(1+\beta)^{T_m} (\beta T_m - 1) + 1](1+\beta)^{T_w}} \alpha \quad (5)
\end{aligned}$$

$$\beta \frac{\partial f}{\partial \gamma} > 0, \frac{\partial f}{\partial T_m} < 0, \frac{\partial f}{\partial T_w} > 0$$

The above equation relates NPL ratio to the actual default ratio through a transformation that depends on the growth rate of the portfolio, the vintage cumulative

distribution of defaults, the average term to maturity and the average time loan remains in the NPL condition.

The effect of a rise in growth rates on the NPL ratio depends on the value of γ . If γ assumes relatively low or negative values, then the volume of loans that will default within each vintage in the first months of its lifetime is not significant. As a result, increases in the portfolio will have larger impact on the amount of loans outstanding than in the volume overdue loans and, consequently, NPL will decline. Conversely, if the value of γ is sufficiently large, the increase in loans past due will be proportionately higher, meaning that NPL will rise.

Similarly, the effect of increasing γ also depends on the growth rate of the portfolio. If β is positive, more recent vintages are larger than older ones. As rises in γ result in newer vintages carrying a higher share of defaults, the outcome is a boost in the NPL. On the other hand, if the growth rate is negative, newer vintages are smaller than more mature ones. As older vintages marginal contribution to the amount of loans past due comes from those loans that become past due later in the lifetime of the vintage, an increase in γ represents a downswing in the NPL ratio.

The increase in the average term to maturity of the portfolio, holding everything else constant, has the effect of reducing the NPL ratio. Since the actual default does not change, an increase in the average term to maturity means a dilution of defaults over the lifetime of each vintage. Conversely, the increase of the average time a loan remains in the NPL condition tends to amplify the NPL ratio. This follows from the fact that the amount of loans past due will then carry defaults that occurred over a stretched time horizon.

In the special situation in which the growth rate of the portfolio is close to zero, the above equation can be approximated by the following relationship:

$$NPL \approx \alpha \frac{T_w - 3}{(T_m + 1)/2} \quad (6)$$

As loans are considered nonperforming only after 3 months overdue and exit the NPL condition after T_w months regardless of the maturity of the loan, the above rule is nothing more than proportionality adjustment to address the different time horizons considered in the numerator and in the denominator.

Another important outcome is that for a mature portfolio⁸ with relatively stable growth rate, cumulative distribution of default, average term to maturity, and average time a loan remains in the NPL condition, apart from the difference in level between the two curves, the dynamics of the NPL ratio and of the actual default ratio are similar. This means that the classic NPL ratio can be considered an appropriate metric for evaluating the dynamics of credit risk under some circumstances.

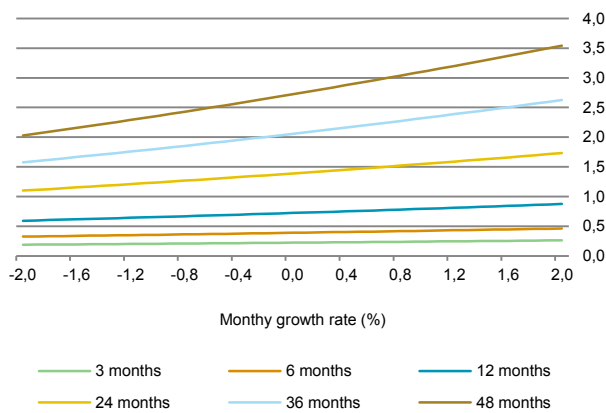
On the other hand, if either of these variables present significant variation over the period analyzed, then the assessment of the dynamics of the portfolio quality based on the observation of the NPL ratio will be compromised.

In practice, the observed metric is the NPL ratio which may be in turn used to estimate the actual default ratio. Therefore, we can rewrite the above equation to obtain the relation between the actual default ratio, henceforth called Implied NPL ratio:

$$\begin{aligned} \text{Implied NPL} &= f(\beta, \gamma, T_m, T_w) \text{NPL} \\ &= \frac{[(1 + \beta)(1 + \gamma) - 1][(1 + \gamma)^{T_m} - 1][(1 + \beta)^{T_m} (\beta T_m - 1) + 1](1 + \beta)^{T_w}}{[(1 + \beta)^{T_w - 3} - 1][(1 + \beta)^{T_m} (1 + \gamma)^{T_m} - 1] \beta \gamma T_m} \text{NPL} \end{aligned} \quad (7)$$

The chart below shows the behavior of the above transformation between the classic NPL and the implied NPL ratio for different combinations of term to maturity and growth rates, for T_w of 12 months and γ of 1%. It may be observed that the longer the term to maturity of the portfolio, the greater the effect of an increase in the growth rate. Furthermore, for low values of average maturity the relationship becomes smaller than one, indicating that the classic NPL will overestimate the actual default ratio.

Chart 1 - Implied NPL/Classic NPL



⁸ In the context of the proposed framework, a portfolio is considered mature if its age is long enough as to allow the write-off of all loans past due originally granted when the portfolio was first produced. In mathematical terms, the age of the portfolio must be higher than $T_w + T_m - 1$.

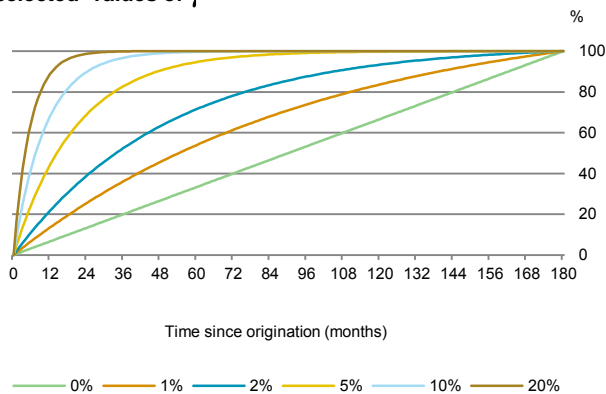
2.1 Calibration of the parameter γ

The speed at which a specific vintage of loans defaults over its lifetime depends on several factors such as the type of the loan, underwriting standards, collateral and guarantees offered, maturity, interest rate and macroeconomic conditions. Thus, in order to avoid establishing an ad hoc hypothesis about this behavior and to allow the model to be applied to different situations, we included in the framework the parameter γ . Basically, it determines for a vintage of loans the relationship between the amounts that defaults in each month in relation to the amounts of the previous month. More specifically, this relationship is given by:

$$Default_t = \frac{Default_{t-1}}{1 + \gamma} \quad (8)$$

For values close to zero, defaults are evenly distributed over the lifetime of the portfolio. For positive values, on the other hand, the larger the parameter, the more concentrated in months close to origination defaults will be. On the other extreme, if γ assumes negatives values, defaults will increase exponentially. This situation is atypical during normal times but may occur for short periods during stress episodes.

Chart 2 - Cumulative distribution of default for selected values of γ



Unlike what happens for the other variables in the model, determining the instantaneous value of γ is a complex task. The portfolio consists of various vintages, which do not necessarily behave in the same way over time. As a result, here in this paper we use a constant value for γ estimated based on the observation of the behavior

of several vintages over a period of relative stability. Therefore, the estimation of an instantaneous value for this parameter remains as a challenge for future work.

2.2 Estimation of the term to maturity T_m

In general, the average maturity of the portfolio is more easily obtainable than the term to maturity, especially considering that a real portfolio is composed of several loans. Thus, it is desirable to estimate a relationship between the term to maturity, T_m , and the average maturity, T_a .

For the theoretical model, it can be shown that:

$$T_a = \frac{[(\beta T_m - 1)^2 + (\beta^2 T_m + 1)](1 + \beta)^{T_m} - 2}{2\beta[(1 + \beta)^{T_m}(\beta T_m - 1) + 1]} \quad (9)$$

For values of β close to zero, the above equation can be approximated by the following relationship:

$$T_m \approx 3T_a - 2 \quad (10)$$

2.3 Converting the classic NPL into a cash flow variable

The transformation developed in this article was based on an environment of cash flow variables which contrasts with the fact that the classic NPL is an accounting variable. More specifically, the classic NPL in equation (7) is the ratio of loans more than ninety days past due and the sum of all future principal and interest payments, which is different from the amount of loans outstanding. This is the case, for instance, if loans have constant monthly payments as this would imply that principal payments are smaller in the beginning and increases over the lifetime of the loan. As a result, in order to be able to apply the transformation properly for situations like this, it is necessary to perform the following modification to (7):

$$\text{Implied NPL} \approx f(\beta, \gamma, T_m, T_w) \frac{2[(1 + r)^{T_m} (rT_m + 1)]}{T_m r [(1 + r)^{T_m} - 1]} \text{NPL} \quad (11)$$

where r is the average interest rate of the portfolio.

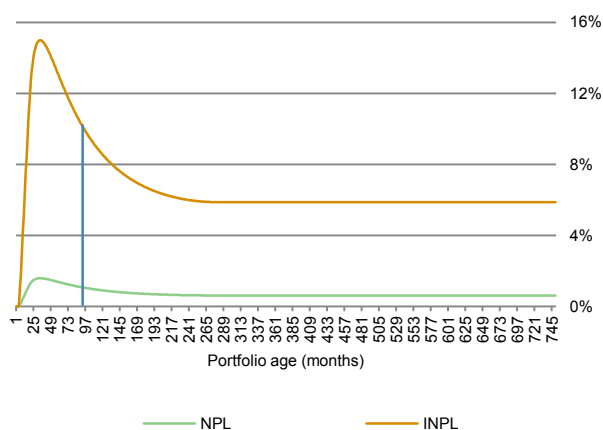
On the other hand, if loans have a constant amortization schedule as most loans related to housing financing in Brazil, then the accounting figure is closer to the one of the model, meaning that no adjustment to (7) is required.

2.4 Violation of the portfolio maturity assumption

A fundamental assumption made in the context of the proposed model is that the portfolio is mature, meaning that it is composed vintages that have just been granted, intermediary vintages and also vintages that are at the end of its lifetime. This implies that this set of vintages covers the entire spectrum of the temporal distribution of defaults. If, on the other hand, the portfolio has not yet reached this stage, most of the vintages will be concentrated at the beginning of the distribution. This fact is important because in most cases the distribution of defaults over the lifetime of each vintage is not uniform. In fact, defaults tend to be higher at the beginning of the vintage. Thus, *ceteris paribus*, mature portfolios will present lower NPL than those that have not yet reached this stage and therefore will also present greater INPL.

In order to shed some light on this discussion, we present below the default behavior of a portfolio with constant amortization schedule, vintages of constant size, term to maturity of 300 months, average time a loan remains in the NPL condition of 18 months, γ of 4% and actual default ratio of 6%. Since γ is positive, more loans will become past due at the beginning of the vintage. Thus, the NPL numerator will grow faster than the denominator. As time passes, the numerator growth rate begins to fall, so that after a period equivalent to the term to maturity, the NPL stabilizes and the implied NPL converges to the value of the actual default ratio. Therefore, the NPL and, consequently, the implied NPL will overestimate the actual default ratio if the loan portfolio is not mature. Please note that while the relation between the INPL ratio and the actual default ratio for a non-mature portfolio is compromised, the comparison between the NPL and the INPL ratio is still consistent, as both variables are affected in the same manner by this assumption violation.

Chart 3 - Non-mature portfolio development



2.5 The framework in action

Here we present three hypothetical situations to demonstrate how the proposed model works.

In the first exercise, we simulated a loosening of credit standards driven by a fast expansion of the portfolio. In other words, every vintage of loans granted at each instant of time is larger than the previous one and has higher actual default ratio than the vintages granted before.

Chart 4 - Loosening of credit standards

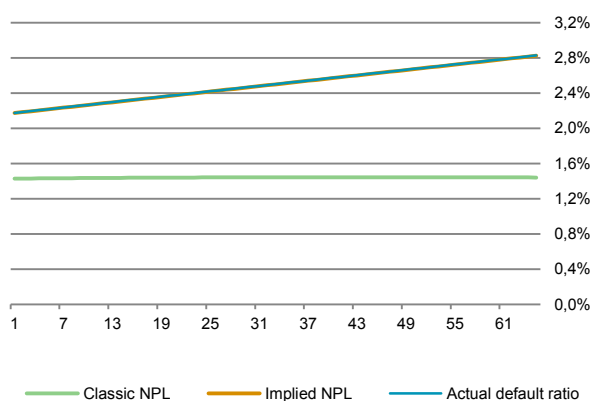
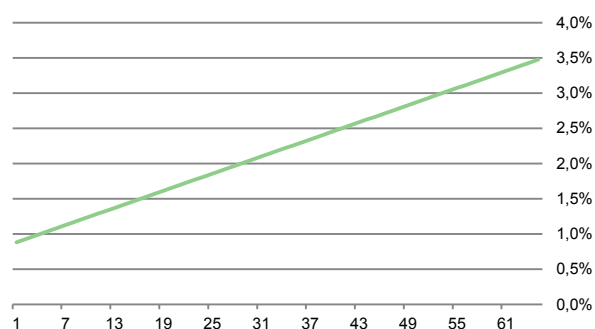


Chart 5 - Monthly growth rate



As expected, the evaluation of the classic NPL under this scenario would lead to incorrect conclusions as the rapid growth causes a decrease of this variable, while both the actual default ratio and the implied NPL show⁹ deterioration of the portfolio quality.

⁹ Both lines overlap each other.

In the second exercise, we simulated a credit crunch, represented by a plunge in the monthly growth rate from 2% to -1%. Throughout the entire period all remaining parameters of the portfolio are kept constant and its actual default ratio is set at 1%.

Chart 6 - Credit crunch

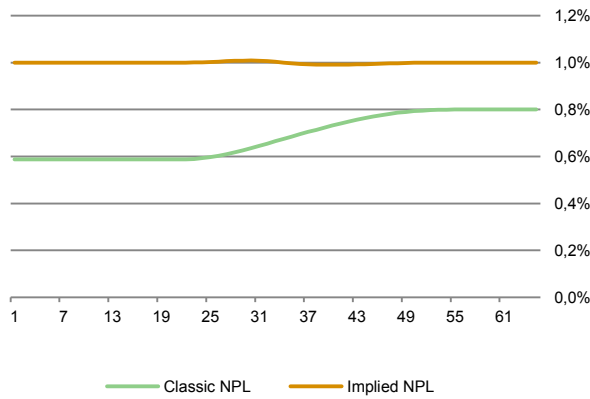
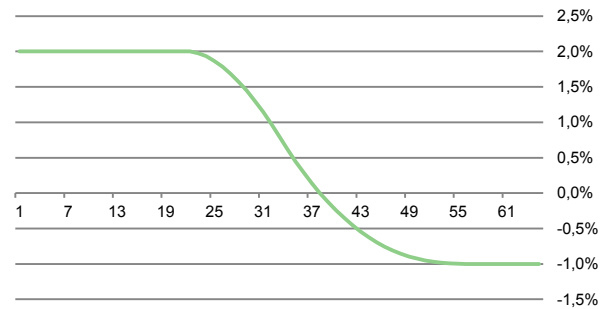


Chart 7 - Monthly growth rate



The results above show how important the impact of a sudden change in the growth rate on the classic NPL ratio is and also how this result can lead to wrong conclusions, given that the observation of the NPL dynamics would point to a worsening of credit risk. Conversely, the implied NPL remained virtually unchanged throughout the whole period, following closely the dynamics of the actual default ratio.

Finally, generalizing the previous case, we conducted an exercise in which the growth rate of each vintage in relation to the previous vintage follows a random walk, while holding all the remaining parameters constant. The following is an example of this exercise:

Chart 8 - Random growth

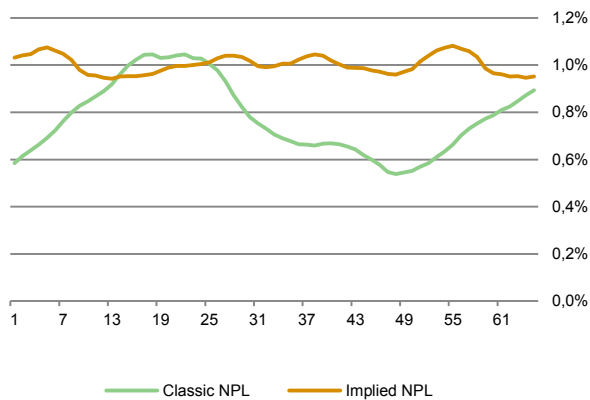
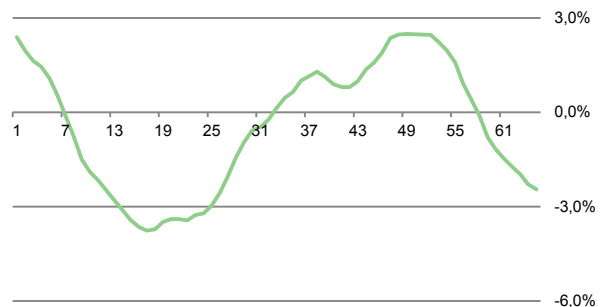


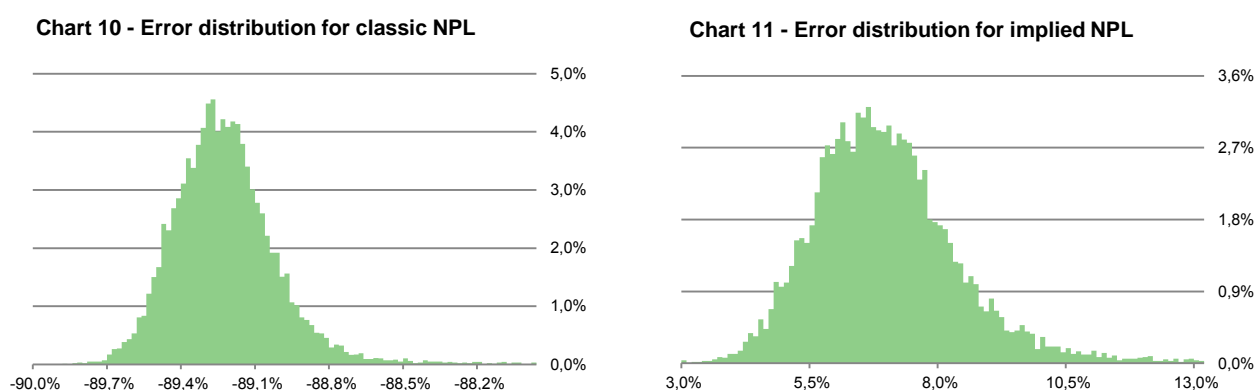
Chart 9 - Monthly growth rate



Here again are evident the harmful effects of changes of the growth rate on the evaluation of credit risk and also the effectiveness of the proposed adjustment. In a scenario where the default rate has not changed during the entire period, the classic NPL ratio showed significant worsening of the portfolio quality followed by a strong recovery, whereas the implied NPL remained fairly stable.

2.6 Accounting for parameter heterogeneity

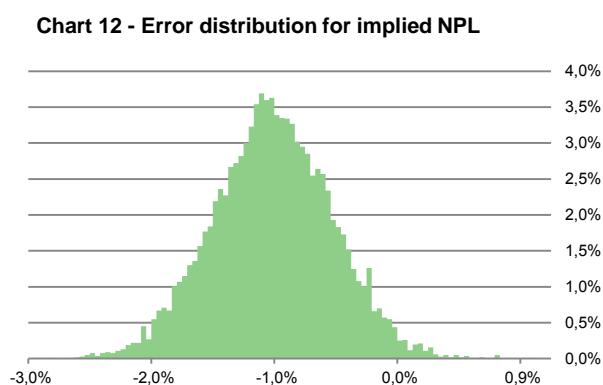
The model has been developed based on a portfolio of loans with identical values of T_a , T_w , γ and β . In practice, however, the portfolio is comprised of various types of loans which, in turn, are composed of several vintages, each with its own characteristics. In order to assess the impact of relaxing the assumption of homogeneity used in the model, we ran a Monte Carlo simulation. In this simulation, we constructed a hypothetical portfolio comprised of 1,000 different portfolios, each with random values for T_a , β , and actual default ratio defined by specific frequency distributions¹⁰. Based on this portfolio, we ran 10,000 simulations and calculated for each one of them the following variables for the portfolio as a whole: average maturity, growth rate and average time a loan remains in the NPL condition. We then calculated the classic NPL ratio and estimated the implied NPL ratio using these parameters and compared the results with the actual default ratio of each simulation. The results are shown in the charts below:



¹⁰ T_a has a normal distribution with mean of 60 months and a standard deviation of 15 months. β follows a normal distribution with mean of 0% and a standard deviation of 1%. The actual default ratio has a uniform distribution consisting of values from 0 to 5%. T_w equals to 12 months and γ was assumed to be equal to 3%.

The results indicate that for the specified frequency distributions, the classic NPL underestimates the actual default ratio by a factor of approximately 89%. On the other hand, the implied NPL ratio overestimates it by an average of 7%. Although the result for the implied NPL is clearly superior to the one obtained for the classic NPL ratio, it can be shown that the difference between the implied NPL and the actual default ratio will be greater the higher the dispersion of each of the parameters and thus this caveat should be kept in mind when using the proposed framework. This means that the model will have better results if applied to portfolios composed of loans with more homogeneous characteristics. As a result, when using the proposed framework in a real portfolio, the implied NPL must be calculated for sets of loans with similar characteristics, like loan types, and only then be combined to obtain the implied NPL for the portfolio as a whole.

In order to validate the benefits of carrying out the analysis for more homogenous sets of loans, we reran our Monte Carlo simulations but instead of calculating the implied NPL based on the parameters of the portfolio as a whole, we first combined loans into groups according to their average maturity in buckets with intervals of one year. Next we calculated the parameters for each of these groups and then estimated the implied NPL ratio using the proposed framework. Finally, we computed the implied NPL for the portfolio as a whole as a weighted average of the implied NPL obtained for each group in the previous step.



As expected, the results enhanced significantly in relation to the previous exercise. Not only the dispersion of the error decreased, but the mean converged to zero. This result demonstrates the effectiveness of the proposed model even for heterogeneous portfolios.

3 Results

In this section we present the results of applying the proposed model to the three most relevant types of credit to households in Brazil: auto loans, housing financing and payroll-deducted loans. These credit modalities combined accounted for roughly 56% of the loan portfolio to households in December 2011. Using existing data from the Central Bank of Brazil Credit Bureau, we estimated all variables needed to apply the proposed transformation for the period of 2006 to 2012. This period encompasses the international financial crisis, which had its more prominent effects in Brazil between the fourth quarter 2008 and third quarter of 2009.

Each type of credit has different characteristics: for payroll-deducted loans, payments are constant and are deducted directly from the borrower salary. The current average term to maturity is about 63 months and interest rates are at around 28% per annum. As for auto loans, payments are also constant and the vehicle being financed is used as collateral. Its average term to maturity is approximately 54 months and interest rates stand at 25%. Housing financing payments follow a constant amortization system and the rights over the property being financed is transferred to the lender until the loan is repaid. This credit type has an average term to maturity of 24 years and an interest rate of 8%.

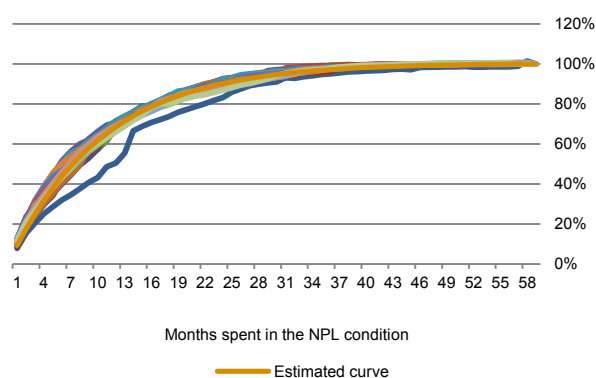
The first two credit types have a historic record long enough to be considered mature. As for housing financing, although it has also a long record of loans granted, in 2004 a significant structural change was introduced regarding the legal treatment of collateral. Up until that moment, property rights remained with the borrower during the lifetime of the loan thus hampering the ability of the lender to recover the property in the case of default. As of 2004, however, property rights remained with the lender until the loan was entirely repaid which in turn resulted in a significant fall in defaults. Given the importance of this change and the long average term to maturity of real estate loans, this credit type cannot be considered mature. As explained earlier, this implies that the NPL level will be overestimated. The comparison of the NPL and the implied NPL, on the other hand, is still valid as both variables are equally affected by the maturity assumption violation.

3.1 Parameter calculation

All parameters required for the calculation of the implied NPL for each credit type have been estimated based on data submitted to the Central Bank of Brazil on a monthly basis. The classic NPL, the portfolio growth rate, the interest rate, the term to maturity, and the average time a loan remains in the NPL condition, have all been estimated on an aggregate basis for all banks within the Brazilian financial system.

In order to estimate the parameter γ we used several vintages and estimated the distribution of defaults over the lifetime of each vintage. We then adjusted γ using equation (8) so that we had the best fit in relation to the average behavior of all vintages. Chart 3.1 shows several vintages of auto loans and the curve obtained for a γ of 10%.

Chart 13 - γ calibration
Auto loans



3.2 The implied NPL ratio as a forecast of portfolio lifetime default

To the extent that implied NPL is an estimate of the portfolio lifetime default, the first analysis consists of checking whether the estimate is consistent with the observed full lifetime default of past vintages.

To this end we compared the outcome of the INPL calculation with the observed full lifetime default ratio of the portfolio which was estimated using all vintages whose age was at least equal to its term to maturity. More specifically, we broke down the volume of loans outstanding by the month when the loan was extended and then used these figures as weights in order to estimate a weighted average lifetime default ratio for the portfolio at each month.

Chart 14 - Backtesting
Auto loans

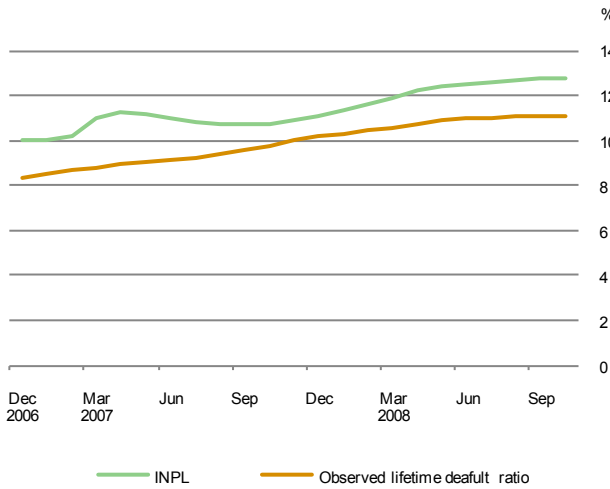
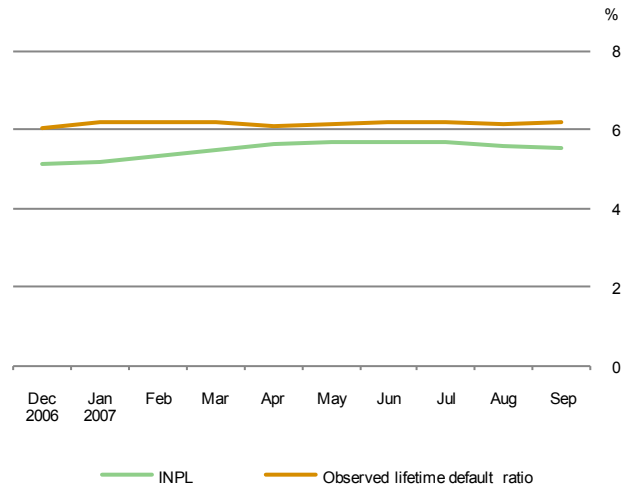


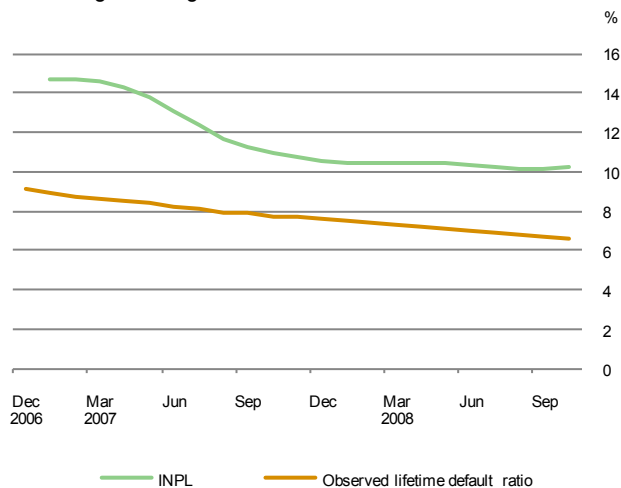
Chart 15 - Backtesting
Payroll-deducted loans



The results show that for both auto loans and for payroll-deducted loans, the implied NPL ratio was a good forecast of the portfolio lifetime default. To the extent that the implied NPL ratio is estimated with information available up to that moment and that some vintages had just been granted at that moment, the forecast may be considered significant.

In the case of housing financing, this same analysis was not possible because, as mentioned earlier, the portfolio is not mature. However, based on a forecast using the first vintages available and assuming that the behavior of each vintage will not change until it reaches its term to maturity, we were able to estimate the lifetime default ratio for each one of them and, then, the lifetime default ratio of the portfolio using the approach described in the previous paragraph.

Chart 16 - Backtesting
Housing financing



It can be seen that the implied NPL ratio is larger than the weighted average of full lifetime default ratios of the available vintages. The reasoning behind this result can be explained with the aid of chart 3 where we simulated a portfolio from its first vintage until it reaches maturity with similar characteristics from the current one. As mentioned earlier, both the NPL and the implied NPL ratio will be overestimated for a non-mature portfolio. What this chart shows is that a portfolio with these characteristics and a full lifetime default ratio of 6%, will present a INPL of 10% after 8 years (age of the housing financing portfolio), which is consistent with the obtained result.

3.3 Differences in the dynamics of the NPL and the implied NPL ratio

Although the classic NPL and the implied NPL ratio have different levels, in a portfolio with invariable characteristics (growth rate, term to maturity, interest rate, average time a loan remain in the NPL condition, and distribution of default over time), these two metrics have a constant relationship, even if the portfolio is not mature yet (chart 3). Therefore, the analysis of differences in the evolution of these two metrics gives rise to important insights regarding the dynamics of credit risk. Obviously, there are periods during which the two curves move together, meaning that the interpretation of the behavior of credit risk in the portfolio from the NPL is straightforward. However, charts 17 to 22 show that not always the NPL and the implied NPL move together. When this happens, one has to dig deeper to understand what is happening.

Chart 17 - Non performing loans
Auto loans

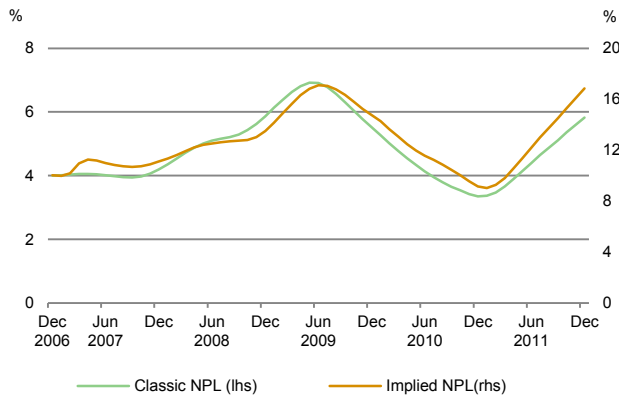


Chart 18 - INPL/NPL
Auto loans
Dec/2006 = 100

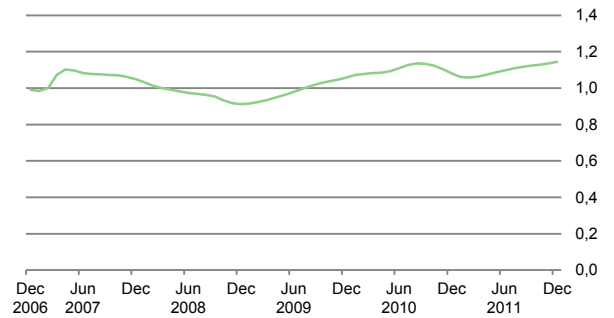


Chart 19 - Non performing loans
Payroll-deducted loans

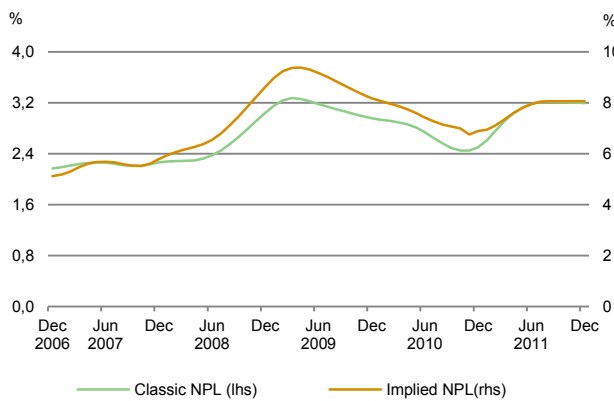


Chart 20 - INPL/NPL
Payroll-deducted loans
Dec/2006 = 100

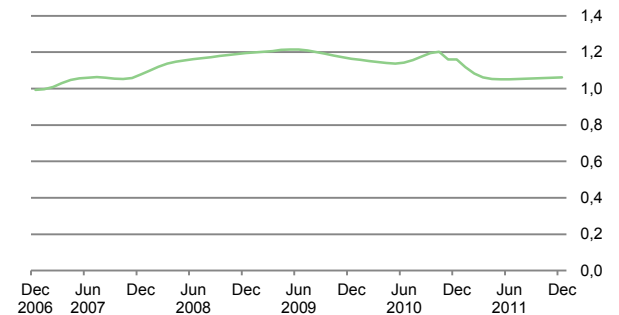


Chart 21 - Non performing loans
Housing financing

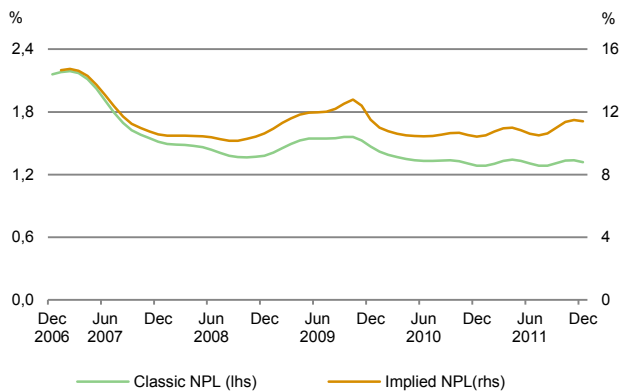
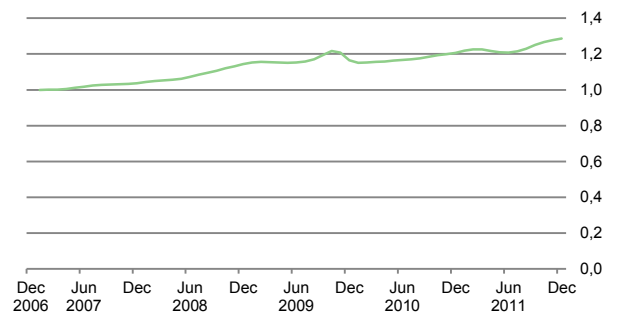


Chart 22 - INPL/NPL
Housing financing
Dec/2006 = 100



In the case of auto loans, the comparison between the classic NPL and the implied NPL indicates that, despite the high volatility of both series resulting from the effects of the international financial crisis and also from changes in lending standards during the analyzed period, the implied NPL is growing at a faster rate, showing that

credit risk is actually increasing more than the NPL shows. This difference was mainly driven by a fall in the average time a loan remains in the NPL condition, which in turn reduced the NPL growth rate.

With regard to payroll-deducted loans, although the evolution of INPL and NPL is almost the same during the entire period analyzed, two moments stand out. During the first half of 2008, the INPL grew faster than the NPL, anticipating the effects of international crisis, which were felt in Brazil mainly during the second half of 2008 until the second half of 2009. At that moment, the deterioration was concealed by the lengthening of the portfolio term to maturity. In the second moment, in the first half of 2011, the NPL rises faster than the INPL as a result of a stretch in the average time a past due loan remained in the balance sheet. The milder increase observed in the INPL is consistent with policies taken by the government to increase credit growth sustainability.

As for housing financing, while the NPL shows a downward trend, the INPL is stable with a recent slight upward trend. This is mainly due to the lengthening of the term to maturity combined with a fast growth rate. This result is driven in part by government programs that boosted housing financing for lower income classes, who are more susceptible to changes in the macroeconomic environment.

These results show how powerful this tool is in terms of anticipating potential problems that had been masked by changes in factors other than credit risk itself.

4 Conclusion

The NPL ratio is probably the most widely used metric to measure the credit risk present in the loan portfolio of financial institutions. However, factors other than credit risk may influence its dynamics. Moreover, accounting differences related to recognition and definition of an event of default makes it difficult to compare this metric across different countries.

In this paper, we propose an alternative metric to assess the dynamics of credit risk in the loan portfolio. Based on a theoretical portfolio, we develop an analytical model in order to estimate the share of all loans that will default during the entire lifetime of the portfolio given current conditions. We call it implied NPL ratio, which consists of a transformation that adjusts the observed NPL ratio for the effects of

changes in the portfolio growth rate and in its average term to maturity, and also takes into account differences in the default distribution across time and the amount of time a past due loan remains in the balance sheet.

The results of applying this transformation to three different types of loans in Brazil demonstrate that changes in the components mentioned above affected the dynamics of the NPL ratio and therefore compromised the assessment of credit risk based on this metric. This also means that the analysis of differences in the evolution of NPL and INPL gives rise to important insights regarding the dynamics of credit risk.

Finally, the comparison between the INPL ratio and the lifetime default ratios of past vintages proved that the implied NPL ratio is a good forecast of the portfolio lifetime default.

A possible extension of this work consists of assessing the impacts of relaxing some assumptions made by this model, with possible changes to its framework. In particular, it is necessary to assess the impacts of the violation of the hypothesis of constant payments within each vintage and the assumption of a stable distribution of defaults, and also the effects of interest rates on the level and dynamics of the implied NPL ratio.

Other possible lines of research are the use of this metric to assist in the calculation of full lifetime expected losses as proposed by IASB in the context of financial assets measurement, and, similarly, in the assessment of the adequacy of the provisioning level and the pricing of the portfolio.

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6 Annex

Chart 23 - Monthly growth rate

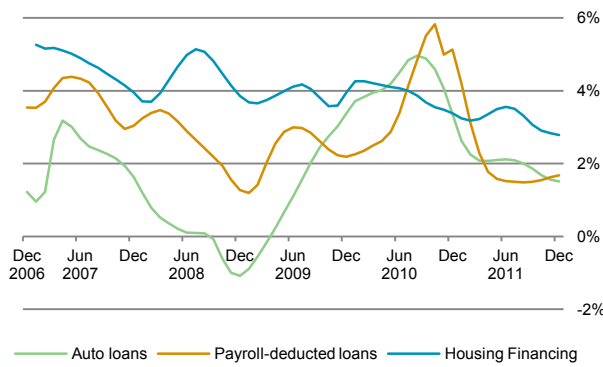


Chart 24 - Average term to maturity

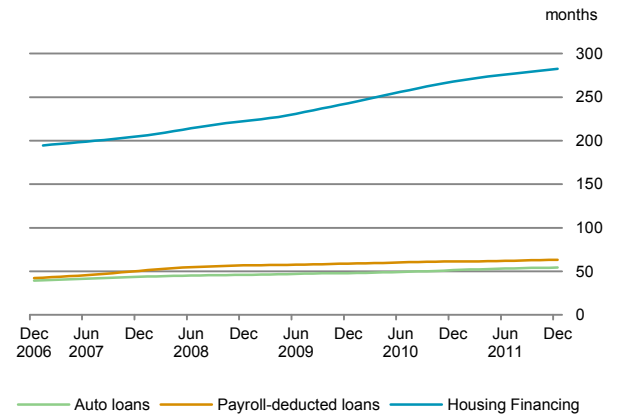


Chart 25 - Tw

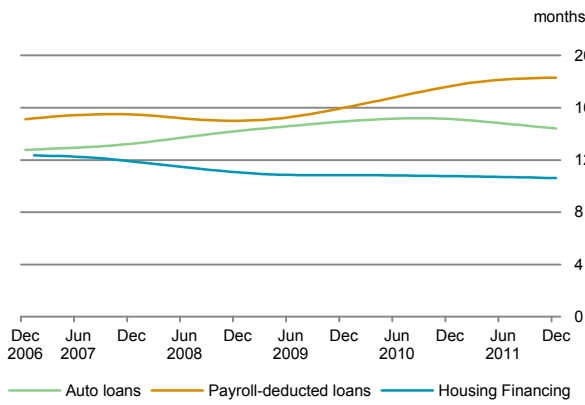


Chart 26 - γ

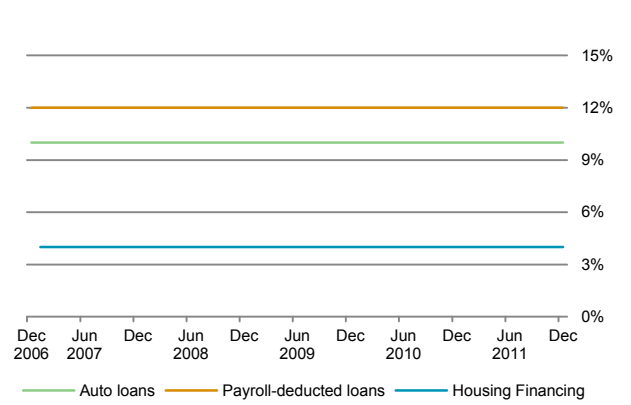
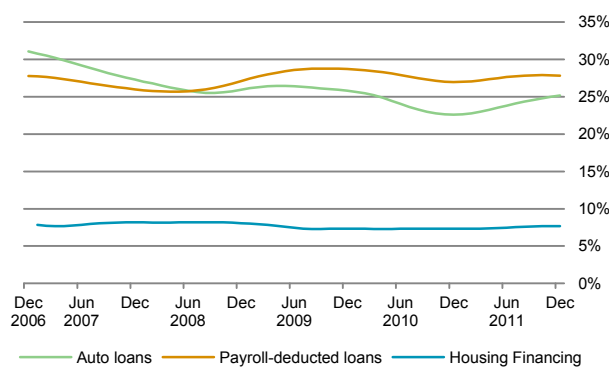


Chart 27 - Interest rates
Per annum



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