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(54) Title: METHOD FOR MORTGAGE AND CLOSED END LOAN PORTFOLIO MANAGEMENT

(57) Abstract

A method for mortgage and closed end loan portfolio management in the form of an analytic tool designed to improve analysis of past and future performance of loan portfolios. In accordance with one aspect thereof, the invention aggregates loan units into loan vintages, wherein the loans in each vintage originate within a predetermined time interval of one another. The invention compares different vintages to one another in a manner such that the ages of the loans in the different vintages are comparable to one another. An early warning component of the system predicts delinquency rates expected for a portfolio of loans during a forward looking time window. A matrix link component of the invention combines the loan vintage analysis with the early warning component of the invention and predicts the default rate of the loan portfolios at a selected future point in time. The results of the analysis are graphically depicted and/or automatically fedback to provide "yes" or "no" decisions regarding investments in various loan portfolios.

METHOD FOR MORTGAGE AND

CLOSED END LOAN PORTFOLIO MANAGEMENT

BACKGROUND OF THE INVENTION

The present invention relates to banking and,

5   more particularly, to a loan performance analytic tool

designed to improve analysis of past and future

performance of loan portfolios.

Financial institutions such as banks own large

portfolios of mortgage and other closed end loan

10   instruments. Further, there is a constant influx of

applications for new loans and mortgages and, moreover,

existing loans are treated by banks as commodities or

products which they trade among themselves. Banks

underwrite loans and/or purchase loan portfolios of other

15   banks or sell portions of their own loan portfolios. In

doing so, banks customarily continually assess and

reassess the quality of various loan portfolios, which

quality depends on the interest rates earned on those

loans, the customer payment history on the loans and

20   other criteria.

As regards newly originated loans, the process

begins with loan applicants submitting applications to

financial institutions which then triggers an

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investigation by either the bank and/or related service
organizations which check the credit history of the
applicant before the loan is approved. Typically, the
decision to grant or not grant a loan implicates various

5   credit screens that examine such factors as the loan to
value ratio (LTV) of the particular application or the
debt to income ratio (D/I) of the applicant and other
historical facts, which shed light on the commercial
worthiness of the given loan transaction. Once a loan is

10   granted, it becomes part of an aforementioned vast
portfolio of loans which a given financial institution
owns and/or services. The "quality" of the particular
loan heavily depends on the interest fees earned by the
financial institution on each loan and on the performance

15   of the loan which is dependent on the timeliness of the
payments by the loan applicant and/or on loan prepayment.

        Loan portfolios represent to banks two separate
and distinct lines of business or sources of income. One
business line or source of income flows from the

20   ownership of the loans and the earning of interest fees
thereon. The second line of business involves the
servicing of the loan, for example, the keeping of
records, collection of periodic payments, enforcement in
the form of loan foreclosures, etc. Banks can earn fees

25   on servicing of loans which they either own outright or

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which they service on behalf of other financial

institutions. This is because it is traditional in the

banking industry to attribute to each loan a basic cost

of servicing which is included in the interest fees

5   charged to the customer. If a bank is able to carry out

or perform these servicing tasks at a cost structure

which is below the originally attributed servicing cost,

the bank is able to realize a profit from its loan

servicing business.

10   It is not uncommon for large financial

institutions to immediately turn around and sell to other

investors portions of the loans that they have booked, to

spread the credit risks and in order to diversify the

types of loan instruments that they are holding. The

15   same is true of the services end of the business with

respect to which decisions are constantly made as to

whether retain or sell the servicing components of

various groups of loans.

The loans that are retained for servicing are

20   assigned to a subsidiary of the financial institution

which is a purely service organization that has developed

the methodology and procedures for servicing loans. A

portion of the loan portfolio can be sold to third party

loan servicing bureaus. It is common for banks which

25   sell loans to retain ownership of the servicing rights to

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earn the fee income thereon. In addition, many financial
institutions may decide to purchase servicing rights from
other financial institutions.

In any case, bank managers are responsible for
5   managing loans totalling billions of dollars both as pure
loan instruments and as products that require servicing.
The decisions whether to retain different groups of loans
or whether to sell them off to other investors and, on
the other hand, whether to purchase loan portfolios from
10   other institution for ownership or servicing purposes are
bottom line decisions that have the potential to affect
the financial institution's profits and/or losses to the
tune of tens or even hundreds of millions of dollars.
Hence, loan portfolios are constantly examined by bank
15   managers very carefully since different vintages of loans
can perform quite differently from one another.

For example, a portfolio of loans representing
mortgages granted in a particular locality during a
particular time frame might be deemed to represent high
20   quality loan instruments, as for example in the situation
where the history of these groups of loans has shown that
the rate of default for that group of loans has been
extremely low and the interest rate on those loans is
high compared to present interest rates. Conversely,
25   another portfolio of loans granted in another region of

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the country which may have suffered economic decline may

result at some future date in large rates of default.

Assuming further that these loans were issued at a low

interest rate, it is not difficult to understand that the

5   particular "product" -- the portfolio of loans -- would

be deemed to possess low value and be a good candidate

for being sold. Alternatively, a shrewd bank manager

might see future value in a presently poorly performing

loan portfolio and seek to buy at its current low price

10   structure for its potential improvement. In the same

vein, the "servicing" of such loans may be more difficult

and expensive due to higher default instances. A bank

might wish to sell off the ownership component of such a

loan portfolio, or the servicing rights thereof, or both.

15   Sometimes, however, a financial institution which has a

"servicing" subsidiary that is being underutilized may be

willing to accept loan portfolios of servicing rights

considered unattractive by other financial institutions.

        In the prior art, bank managers entrusted with

20   making the aforementioned decisions have often resorted

to and relied on manual research and their intuition in

their attempts to predict, manage and select loan

portfolios for ownership and servicing purposes. The

prior art approach has failed to provide a

25   straightforward and easy to comprehend and administer

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system for assessing the past performance and future
likely course of loan instruments.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present
invention to provide a system and method which improves
the understanding of the past performance of loan
portfolios.

It is another object of the invention to
provide a system which enhances the ability of financial
institution managers to choose which mortgage and other
debt instrument applications to underwrite.

Yet another object of the present invention is
to provide a system and method which enhances the ability
of financial institution personnel to make decisions
whether to retain or dispose of different groups of
loans.

It is also an object of the present invention
to provide a system and a method which is able to
dynamically and automatically evolve loan underwriting
criteria.

It is yet another object of the present
invention to provide a dynamic underwriting model which
is capable of being implemented in a general purpose
computer.

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It is also a further object of the present
invention to provide a system and methodology which
enables automatic processing of loan applications through
a system that feedbacks information from a dynamic

5   processor and which allows loan acceptance decisions to
be made automatically and rapidly.

       The foregoing and other objects of the
invention are realized by a system and process which is
tailored to analyze and select loan portfolios for either

10   continued or future investment by a financial
institution. Each loan portfolio comprises a plurality
of loan units and the system operates by separating the
loan portfolios into a plurality of loan vintages, in a
manner such that the loans included in each loan vintage

15   have origination dates that are on average of the same
age. The system of the invention produces an analysis of
the past performance of loan portfolios, as well as an
indication of the future performance thereof in two
different formats.

20   As to past performance, the invention develops
the loan vintages in a manner such that vintages of
different years can be compared to one another
meaningfully because the loan units in each of the
different vintages are actually of the same comparative

25   ages. For example, when 1993 and 1994 loan vintages are

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compared, the loans units that are being compared are of
the same age to provide more meaningful comparisons.
This is referred to in the ensuing description as the
Crus Classes analysis system. In one embodiment of the
5   Crus Classes system, output results are graphically
depicted by means of a curve which represents the
difference between the delinquency rates of loans in the
two yearly vintages. To improve the reliability of the
results, an area of uncertainty is superimposed over the
10   difference to allow users to focus their analysis on
those locations on the difference plot which lies outside
the area of uncertainty. This increases the reliability
of the analysis and the ability to trust its results.
The area of uncertainty can be calculated as a +1 and -1
15   standard deviation, but the actual size thereof is a
matter of personal choice.

The early warning system (EWS) constituent of
the invention is one of the systems and processes which
predicts the percentage of the loans in a given loan
20   vintage which are likely to enter a "bad" state within a
predefined forward looking time window, for example, the
next two years. The prediction is calculated by using a
logistic regression formula which has been developed in
part on the basis of the analytic results obtained from
25   the Crus Classes analysis component of the invention.

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        Finally, the so-called matrix link component of
the present invention is generally similar to the
aforementioned early warning system in that it is a
prediction tool. It differs from the early warning
5   system in the respect that it is capable of forecasting
the percentage of loans that are likely to be bad at a
date certain within the aforementioned forward looking
time window. In all cases, the results of the analysis
can be graphically depicted by comparing vintages to one
10   another, using various curves, bar charts and the like in
a manner described herein. For imposing the integrity of
the results it is desirable that the number of loan units
in the analysis be large, preferably in the hundreds of
thousands of loan units and preferably at least 50,000
15   loan units.

        As a general note and definition applicable to
throughout the present specification and claims, the term
"loan portfolios" means, includes and/or refers to booked
loans, applications for loans for which underwriting
20   decisions have to be made and the aforementioned loan
servicing rights.

        Other features and advantages of the present
invention will become apparent from the following
description of the invention which refers to the
25   accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an overall block diagram of a dynamic underwriting system and method in accordance with the present invention.

5   Fig. 1A is an explanatory chart which shows an example of the delinquency rates of various loans by vintage year for a given loan portfolio.

Fig. 1B is a tree chart and exemplar of an actual family of different types of loan groups and shows

10   the rate of delinquency associated therewith.

Fig. 2 illustrates a prior art method for assessing the profitability and performance of a portfolio on a yearly vintage basis.

Fig. 3 illustrates a novel method of assessing

15   the past performance of loan portfolios based on yearly vintages in accordance with the present invention.

Fig. 4 is a graphic that illustrates a method of the present invention involving assessing the relative value of different vintage loan portfolios.

20   Fig. 4A is a table which illustrates calculations performed to obtain data for the graphic of Fig. 4.

Fig. 5 illustrates a further graphical method of the present invention for showing both the past

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performance and the future predicted performance of loan portfolios.

Fig. 6 is an explanatory graph provided for explaining how a portion of the graph of Fig. 5 is obtained.

Fig. 7 illustrates the format of a roll rate delinquency table for one year which is used in the matrix link analysis module of the present invention.

Fig. 8 is a table which shows the methodology and equations used in forecasting bad rate probabilities in the matrix link component of the present invention.

Fig. 9 is a plot of the final results obtained with the matrix link component of the present invention.

Fig. 10 is a hardware/software block diagram of key components of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

By way of background and introduction, the general environment for the method and system of the present invention can be better appreciated by initial reference to Fig. 1. As illustrated therein, home buyers and refinanciers 12 typically submit applications for loans to one or more financial institutions 14. These institutions include loan granting departments that decide whether or not to book given loans by applying

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various credit screens, i.e. criteria. One screen may
focus on the applicable LTV (loan to value) of a
transaction, the D/I (debt to income) ratio of the
involved transaction and/or on the credit history of the
5   particular applicant.

Based on the aforementioned and other criteria,
a decision is made to accept or reject a particular loan
application. Each loan that has been accepted is added
as another loan unit to a large portfolio of similar
10   families of loans, e.g. conforming loans, jumbo loans,
government loans, etc. A loan has typically a loan start
date and a date by which the loan is expected to be fully
paid up, as is typical of home mortgage loans. A loan
that is issued for a fixed amount and period of time is
15   known in the trade as a closed loan. These closed loans
16 are artificially split and treated as two business
securities or entities -- namely as a "loan" entity and
as a "servicing" right, as indicated at 32.

Each loan unit or instrument represents to the
20   financial institution an opportunity to earn a profit on
the differential between its cost of money and the amount
of interest earned from the borrower. Another profit
component is realizable from the servicing element of
each loan entity. That is, a finite budget for labor and
25   equipment use must be allocated when the loan is issued

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to service each loan over its life time. The banking
trade has traditionally derived substantial revenues from
the servicing of loan portfolios, to the extent that they
were able to service loans at a cost below the originally
5   calculated service allocation. Consequently, banks and
other financial institutions sometimes trade loan
"servicing" contracts. These contracts are routinely
purchased and sold in large units since they represent
income opportunities. For example, a bank which lacks a
10   servicing department might contract with another bank to
service its loans at a set, per loan pricing arrangement.
The bank that purchases the contract does so with the
expectation of earning a profit on the project. If it
develops later that a particular loan portfolio
15   experiences a large rate of defaults, the extra servicing
needed to collect funds on the loans might render the
particular servicing contract unprofitable. In such a
situation, the service organization might attempt to
resell the service contract to another service
20   organization which might be interested in it, for
example, at an increased service rate.

        With further reference to Fig. 1, block 18
represents the department of the financial institution
which makes the decision whether to retain or sell a
25   particular loan portfolio. Typically these loans are

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sold in very large blocks, each containing thousands of
individual loan units. Those loan units originating at
block 12 which are retained by the given financial
institution are represented by block 20. On the other

5   hand, as indicated by the block 22, a portion of the book
of loans is sometimes sold off to investors and is
securitized. Therefore, it will be appreciated that
selling and purchasing loan portfolios requires careful
examination of various loan product lines to assess their

10   viability, profitability and related factors.

As already noted, another source of profit
flows from the servicing portion of the loans. Block 24
identifies the step which decides whether to retain or
sell the servicing component of a loan portfolio. Those

15   loans for which servicing is retained are serviced at the
bank which originated the loans as indicated at 26. The
servicing of the balance of the loans procured at block
14 is contracted out to third parties for services as
indicated at block 28. In addition, the servicing end 26

20   of the banking business is also able to purchase the
servicing rights as indicated at 32.

As described, the banking industry
distinguishes between ownership of loans and the
servicing thereof. Loans that are owned by a given

25   financial institution can be serviced by that

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institution's own servicing subsidiary or the servicing

part can be contracted to third party servicing bureaus.

Indeed, not all financial institution have loan servicing

departments. Conversely, a bank with a servicing

5   organization can purchase the "servicing" component

associated with loans owned by other banks and render the

servicing thereon.

In any case, it is self-evident that the

profits from earning interest on loan portfolios and from

10   the loan servicing line of business is heavily influenced

by the performance of various loan groups vis-a-vis the

default rate of these loans over the life of the loans,

foreclosures, collection efforts, loan prepayment and the

like. Loan portfolios which experience low default rates

15   are easy to service and are highly profitable to

financial institutions.

Traditionally, the decision to purchase,

retain, sell or create loan portfolios demands critical

analysis of the past performance of the loan portfolios

20   under consideration. Moreover, such decisions invariably

implicate assumptions and predictions as to how such loan

portfolios will perform in the future. Not surprisingly,

the decisions to book loans at block 14 typically

depended on and required analysis and consideration by

25   highly skilled and experienced persons having very keen

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and sharp analytical powers to determine the potential
profitability of loan portfolios being considered.

    The present invention departs from the prior
art by providing a dynamic underwriting method and system
5   30 comprising several key components including an early
warning system 32, a Crus Classes analysis section 34 and
a matrix link 36, all to be described further on.
Essentially, the information obtained from the subsystems
32, 34 and 36 is designed to be applied, via feedback
10   line 38, to the decision box 14 in a manner which
systemizes and provides a standardized approach to
forming the decisions whether to book loans. The
invention substantially increases the reliability,
consistency and speed of the loan acceptance decision
15   process. Further, the dynamic underwriting system 30 of
the present invention can also be applied via feedback
line 40 to the decisional box 32 which addresses the
decisions at block 32 whether to purchase loan servicing
rights of loans owned by other financial institutions.
20   Finally, the feedback line 41 provides feedback for
forming the decisions identified in blocks 18 and 24.

    The invention shall now be described with
respect to the subcomponents of the invention, including
the aforementioned subsystems 32, 34 and 36, beginning
25   first with the Crus Classes component 34.

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Experience has shown that the past performance
of a group of loans is often a key indicator of its
future behavior. Therefore, the first step in the
analysis process focuses on providing an improved
5   analytical tool for the examination of the loans' past
performance. This is the function provided by the Crus
Classes system 34. The Crus Classes subsystem 34
essentially represents a fresh approach to the analysis
of the prior performance of already booked groups of
10 loans. The early warning system 32 is a forward looking
system which comprises a method and process that is able
to predict what portion of the overall number of loans in
a particular loan group will experience 90÷ day tardiness
in payments by the borrower(s) thereof at anytime within
15 a predefined time period, for example, the next two
years. By way of example, if the system predicts that
thirty loans out of a thousand in a given loan portfolio
will experience 90+ day delay in payment at any time
within the next two years, the EWS (Early Warning System)
20 32 will return the value .03 to indicate that it expects
3% of the loans in the given group to go "bad" at least
once during the predefined time period. Finally, the
matrix link component 36 provides a more sophisticated
analytical model, in that it not only assigns a
25 probability to how many loans will enter a 90-day default

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but, moreover, calculates the expected number of loans in
default on a specific future date.

Turning first to the Crus Classes system 34, a
common technique used in credit risk management in the
5   mortgage industry is to group loans by common intervals
of origination, e.g. annually, to compare their
performances. For example, the mortgage industry might
typically wish to analyze the performance of 1994 vintage
loans. Vintage in this context means all loans that have
10   been originated in 1994. The classification of loans
into yearly vintages by the prior art has often resulted
in significant distortions of analytical conclusions.
Unlike wines for which classification into yearly
vintages makes sense, lumping all loans originating in
15   the same year into a same "vintage" distorts results
because there are several exogenous factors which affect
how these loans perform and these factors intrinsically
vary over time in a manner which can produce significant
quarterly, and even monthly loan performance
20   fluctuations.

The present inventors have opted to use the
term "Crus Classes" for its similarity to the wine
industry. But Crus Classes, as used herein, differs from
and departs from the prior art approach of grouping loans
25   by annual origination dates. The invention overcomes

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some of the statistical inaccuracies associated with the prior art's attempts to lump loans into yearly vintages solely on the basis of the origination of a loan in a given year.

5   Traditional vintage techniques in the mortgage industry allow bankers to gauge the quality of mortgages as they are "aging". However, the inventors have added certain statistical procedures, such as hypothesis testing, used in the process control manufacturing

10   environment, that allow the method of the invention to test for the statistical significance of the differences in performance among the "vintages". The result and benefits of the Crus Classes method to be described below is that it provides several advantages over the typical,

15   prior art vintage analysis. For example, it incorporates a measure of dispersion. Further, it sets an analysis interval time shorter than a year to increase accuracy. This produces several advantages over traditional vintage analysis: (1) it automatically adjusts the comparison to

20   account for different numbers of loans and for different size loans; (2) the Crus Classes method also allows management to set the confidence intervals; and (3) it automatically adjusts the year-to-year comparisons for loans with different credit volatility.

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However, prior to describing the specific
features of the Crus Classes method of the present
invention it is worthwhile to introduce the following
background information. Mortgage companies are vitally

5   concerned with the performance of the loans they service
and own. Active management of any loan portfolio
requires the information needed to properly categorize
the performance of the underlying loans. On an extremely
broad and wide-sweeping comparison, delinquency rates are

10   generated and compared to various classes of mortgage
loans and summarized on a national level.

It is common in the industry for different
financial institutions to share data about the total
number of loans serviced by them and the appropriate

15   number of loans that are in some form of delinquency.
Delinquency categories or "buckets" range from the least
serious, e.g. one payment past due, to the most serious
category -- namely, in foreclosure. The following is an
example prepared by the MORTGAGE BANKERS ASSOCIATION of a

20   delinquency chart:

Total Loans Serviced or Outstanding of 22,426,005	1 Payment Past Due or 30 Days of 733,330	2 Payments Past Due or 60 Days of 163,710	3 Payments Past Due or 90 Days of 141,284	Loans in Foreclosure or F/C of 230,988	Total Loans Delinquent or Total of 1,269,312
% Delinquent	3.27%	0.73%	0.63%	1.03%	5.66%

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Presenting delinquency performance in this manner is helpful in quantifying total delinquency, but it reveals nothing about the endogenous factors contributing to the default performance of the underlying loans. These endogenous factors which affect the performance of loan portfolios include, but are not limited to, some form of:

- Performance history or age of the loan,
- remaining time to maturity,
- loan amount,
- interest rate,
- borrower's credit worthiness,
- geographic locations, and
- underlying collateral type.

However, the effect of "age" on the performance of loans is a main factor that mortgage originators use to discern whether a group of loans was (or is) "good" or "bad".

The vintage of the loan refers to the time when the given loan or family or group or set of loans has originated or has been placed on the books of the lending institution. In the mortgage industry, loans are categorized by year of origination, where all of the loans originated between January 1, 1996 and December 31, 1996 are referred to as '96 vintage loans. The yearly vintages and their corresponding delinquency rates are

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compared to each other to estimate relative performance
and value. Fig. 1A is an example of one such vintage
chart listing multiple vintages. This is a snapshot
taken at the last quarter of 1996. Therefore, the oldest
5   1995 vintage is twenty one months old. In the figure,
the 1995 curve shows a delinquency rate on the order of
about 3% for the 1995, twenty one month old vintage. In
contrast, the 1994 vintage curve shows a delinquency rate
approximately one half the size of the 1995 vintage for
10   the same twenty one month vintage. The mortgage default
rates of Fig. 1A significantly affect future loan
performance. Indeed, a single percentage rise in the
delinquency rate represents many millions of dollars in
losses to the typical financial institution which carries
15   a very large portfolio of loans.

        Further by way of background, mortgage loan
portfolios are quite heterogeneous, with many subtle and
changing variations in the basic product characteristics
and behavior. An important consideration in the
20   methodology of the present invention is the evolvement of
a model that preserves the heterogeneous nature of the
mortgages. Therefore, the inventors have grouped the
mortgages by various (endogenous) characteristics and
made inferences about the relationship between each of
25   these characteristics and the resulting level of default.

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A large number of characteristics results in an extremely large number of combinations of groups to consider.

  Fig. 1B illustrates the significance of maintaining proper distinction lines between various loan

5 instruments based on origination. Thus, Fig. 1B shows for a given financial institution a total loan portfolio value of, for example, several billions of dollars, with respect to which the overall rate of delinquency is .36% (at tier 11 of the loan tree of Fig. 1B). However, for

10 proper analysis the invention divides that loan portfolio into loan types including "conforming", "jumbo" and "government" (originated) loans, as indicated at tier 13. Note that the overall rate .86% of default is the weighed average of the delinquency rate which varies from 1.25%

15 for conforming loans, .55% for jumbo loans, and 9.98% for government originated loans. Still further, each of the broad categories of conforming, jumbo and government loans are further divided (at tier 15) into ARM (adjusted rate mortgages) and fixed loans. Note the significant

20 divergence in the rates of default. The same is true for the next subdivision (grouping) which hierarchically separates the third tier loan groups into low LTV loans and high LTV loans. For example, a government, ARM and low LTV loan at tier 17 has a rate of default of 0%,

25 whereas a government, fixed and high LTV loan indicates

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(for the sample shown in Fig. 1B) a delinquency rate of
13.51%.

The invention applies the Crus Classes method
on each node of the loan tree shown in Fig. 1B and then
5   runs a hypothesis test to see if the performance of each
year vintage is better, worse or statistically the same
(at a confidence level of one standard deviation). It is
estimated that there are 308 different combinations and
that it takes approximately 100 megabytes of computer
10   storage memory to analyze and graph the results for the
model shown in Fig. 1B.

Analysis of past performance of loan portfolios
requires making a decision as to what constitutes a
delinquent or "bad" loan, as for example for the purposes
15   of creating a chart such as in Fig. 1A. In an embodiment
of the invention which has been reduced to practice a
first selection was to choose the definition of a "bad"
loan. It was chosen to represent a loan on which
interest and principal payments were at least 90 days
20   delinquent. That is, loans which are non-accruing or
non-performing for a period greater than 90 days are
deemed "bad".

Further, since the industry is accustomed to
and prefers to refer to the "vintage" of a group of
25   loans, for example 1993 vintage, 1994 vintage, etc., the

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Crus Classes method 34 also produces and presents its results in terms of loan vintages. But, it groups and selects vintages differently than the prior art.

5   The difference in "vintage" selection can be appreciated from the matrix tables of Figs. 2 and 3. The abscissa axis 50 in Fig. 2 indicates the yearly quarter of origination, for example, March '93, June '93, etc. The ordinate axis 52 indicates the end quarter of a group of loans, for example, June '96, March '96, March '95,

10 etc. The matrix data in Fig. 2 indicate the number of months that have elapsed from the quarter of origination to the end point. For example, a loan originating in March '93 is 36 months old in March '96 as indicated by reference numeral 54. Similarly, a loan originating in

15 June '93 is 15 months old in June '94 as indicated by reference numeral 56.

The approach of the prior art has been to select and aggregate as 1993 and 1994 loan vintages all of the loans between the bracket lines 58 and 60 for the

20 respective years 1993 and 1994. Carefully comparing the precise ages of the 1993 and 1994 vintage loans reveals two aspects which may undermine and distort the comparisons. First, the traditional approach reflected by Fig. 2 compares loans whose ages differ on average by

25 twelve months. Indeed, some of the 1993 loans which are

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thirty six months old (see reference numeral 54) are two

years older than the twelve month old 1994 loans

(reference numeral 55). The above approach skews the

results considerably since the performance of loans is

5   very age sensitive as can be appreciated from Fig. 1A.

It is far more meaningful to compare loans of the same

age which originate in different years. Therefore, it is

far more relevant to be able to compare the performance

of different loan vintages, as of the time when they were

10   at the same ages. For example, in seeking to answer the

question: which loan vintage 1993 or 1994 is better, it

is more relevant to know and compare the comparative

performances of the above noted loan vintages when each

was, for example, two years old. The Crus Classes method

15   34 of the present invention is able to do so.

With reference to Fig. 3, the present invention

selects as the 1993 and 1994 loan vintages, those loans

which are bracketed by the diagonally extending lines 62

and 64. In the selection method according to the present

20   invention, the ages of the 1993 and 1994 loan vintages

that are being compared are identical to one another.

For example, for the year 1993 the ages of the loans vary

between 6 months to 24 months and the same is true of the

loans in the 1994 vintage year.

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To further increase the accuracy of the
comparison, each yearly vintage is divided into four
quarterly portfolios, i.e. first, second, third and
fourth quarters. All of the 1993 portfolios of the same
5   quarterly age are summed and divided by the total number
of all the loans with the same respective age. Referring
again to Fig. 3, the present invention separately
compares the 1993 and 1994 24 month old loans, then the
21 month old loans and so on. The actual mathematical
10   calculations/analysis comparing loans originated in 1993
and 1994 and the manner of calculating bad rates is shown
below in Tables I, II and III.

TABLE I

	Age (Months)	3	6	9
1993 Vintage	# of Loans (n)	n_3	n_6	n_9
	BAD rate (r)	r_3	r_6	r_9
	STD	$\mathrm{Sqrt}(r_3*(1-r_3)/n_3)$	$\mathrm{Sqrt}(r_6*(1-r_6)/n_6)$	$\mathrm{Sqrt}(r_9*(1-r_9)/n_9)$
1994 Vintage	# of Loans (N)	N_3	N_6	N_9
	BAD rate (R)	R_3	R_6	R_9
	STD	$\mathrm{Sqrt}(R_3*(1-R_3)/N_3)$	$\mathrm{Sqrt}(R_6*(1-R_6)/N_6)$	$\mathrm{Sqrt}(R_9*(1-R_9)/N_9)$
1994- 1993	Difference (R-r)	R_3-r_3	R_6-r_6	R_9-r_9
	STD of (R-r)	$STD_3=\mathrm{Sqrt}(r_3*(1-r_3)/n_3+R_3*(1-R_3)/N_3)$	$STD_6=\mathrm{Sqrt}(r_6*(1-r_6)/n_6+R_6*(1-R_6)/N_6)$	$STD_9=\mathrm{Sqrt}(r_9*(1-r_9)/n_9+R_9*(1-R_9)/N_9)$
	Upper Bound	$+1*STD_3$	$+1*STD_6$	$+1*STD_9$
	Lower Bound	$-1*STD_3$	$-1*STD_6$	$-1*STD_9$

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TABLE II

	Age (Months)	12	15	18
1993 Vintage	# of Loans (n)	n_{12}	n_{15}	n_{18}
	BAD rate (r)	r_{12}	r_{15}	r_{18}
	STD	$Sqrt(r_{12}*(1-r_{12})/n_{12})$	$Sqrt(r_{15}*(1-r_{15})/n_{15})$	$Sqrt(r_{18}*(1-r_{18})/n_{18})$
1994 Vintage	# of Loans (N)	N_{12}	N_{15}	N_{18}
	BAD rate (R)	R_{12}	R_{15}	R_{18}
	STD	$Sqrt(R_{12}*(1-R_{12})/N_{12})$	$Sqrt(R_{15}*(1-R_{15})/N_{15})$	$Sqrt(R_{18}*(1-R_{18})/N_{18})$
1994-1993	Difference (R-r)	$R_{12}-r_{12}$	$R_{15}-r_{15}$	$R_{18}-r_{18}$
	STD of (R-r)	$STD_{12}=Sqrt(r_{12}*(1-r_{12})/n_{12}+R_{12}*(1-R_{12})/N_{12})$	$STD_{15}=Sqrt(r_{15}*(1-r_{15})/n_{15}+R_{15}*(1-R_{15})/N_{15})$	$STD_{18}=Sqrt(r_{18}*(1-r_{18})/n_{18}+R_{18}*(1-R_{18})/N_{18})$
	Upper Bound	$+1*STD_{12}$	$+1*STD_{15}$	$+1*STD_{18}$
	Lower Bound	$-1*STD_{12}$	$-1*STD_{15}$	$-1*STD_{18}$

TABLE III

	Age (Months)	21	24	27
1993 Vintage	# of Loans (n)	n_{21}	n_{24}	n_{27}
	BAD rate (r)	r_{21}	r_{24}	r_{27}
	STD	$Sqrt(r_{21}*(1-r_{21})/n_{21})$	$Sqrt(r_{24}*(1-r_{24})/n_{24})$	$Sqrt(r_{27}*(1-r_{27})/n_{27})$
1994 Vintage	# of Loans (N)	N_{21}	N_{24}	N_{27}
	BAD rate (R)	R_{21}	R_{24}	R_{27}
	STD	$Sqrt(R_{21}*(1-R_{21})/N_{21})$	$Sqrt(R_{24}*(1-R_{24})/N_{24})$	$Sqrt(R_{27}*(1-R_{27})/N_{27})$
1994-1993	Difference (R-r)	$R_{21}-r_{21}$	$R_{24}-r_{24}$	$R_{27}-r_{27}$
	STD of (R-r)	$STD_{21}=Sqrt(r_{21}*(1-r_{21})/n_{21}+R_{21}*(1-R_{21})/N_{21})$	$STD_{24}=Sqrt(r_{24}*(1-r_{24})/n_{24}+R_{24}*(1-R_{24})/N_{24})$	$STD_{27}=Sqrt(r_{27}*(1-r_{27})/n_{27}+R_{27}*(1-R_{27})/N_{27})$
	Upper Bound	$+1*STD_{21}$	$+1*STD_{24}$	$+1*STD_{27}$
	Lower Bound	$-1*STD_{21}$	$-1*STD_{24}$	$-1*STD_{27}$

Table I contains the calculations and comparisons for 1993 and 1994 loans which have vintage ages of 3, 6 and 9 months; Table II does the same for loans aged 12, 15 and 18 months; and Table III does so for loans that are 21, 24 and 27 months. The first line in Tables I-III sets forth the total number (n_3, n_6, etc.) of loans of the given vintage. The second line in the

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Tables sets forth the bad rates (r_3, r_6, etc.) for each
vintage age. The third line calculates the standard
deviation (STD) of the bad rate, using the indicated
equations. The first three lines of Table I supply the
relevant information and calculations for the 3, 6 and 9
month old 1993 vintage. The next three lines of Table I
supply the same information for the 1994 vintage. The
bottom four lines of Table I calculate the differences
and compare the results for 1993 and 1994 vintage years.
The last two lines calculate upper and lower bounds for
the standard of deviation. The two bounds are plus one
and minus one standard deviation, but management can set
this based on their tolerance for default risk. These
calculations constitute the Crus Classes method 30 of the
invention whose effect can be appreciated from reviewing
the analysis results plotted in Fig. 4.

That is the values calculated in Tables I, II
and III above for the differences between vintages 1994
and 1993 are plotted in the graph of Fig. 4 relative to a
zero percentage base 71. The curve 70 represents the
magnitude of the difference in the "bad" rates of loans
of the same age. The value of the curve 70 equals r_3-R_3;
r_6-R_6; etc. shown in Tables I-III. One would be tempted
to assume that the 1994 vintage performs better than the
1993 anytime the value of the curve 70 goes over zero

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percent and vise versa. However, such a mode of

analyzing the data would be subject to reaching wrong

conclusions due to statistical variations. To overcome

this drawback, it is more significant to ask whether a

5   vintage that appears to perform better does so in fact or

whether it merely reflects a temporary phenomenon. To

answer the question, the invention uses a hypothesis

testing technique which allows the analyst to set a

confidence interval which is adjustable to allow for

10   different corporate risk tolerance levels. Thus, the

confidence interval can be equated to the amount of risk

tolerance management will accept in originating,

purchasing, retaining or servicing loan portfolios.

These confidence intervals can also be used in product

15   profitability and capital allocations. Management can

then rank the vintages by product, program, age and size.

To this end, the Tables presented above also calculate

the standard deviation of the difference in performance

and sets upper bounds and lower bound of +1 and -1

20   standard deviations for each quarterly vintage. These

upper and lower limits which appear in the last two lines

of Tables I, II, III are plotted in the form of curves 66

and 68 in Fig. 4. The area between the curves 66 and 68

is an area of uncertainty.

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With this in mind, since the invention superimposes the curve 70 over the area of uncertainty, one can state with greater certainty which vintage performs better only in the areas outside the area of

5   uncertainty. Thus, the graph of Fig. 4 shows that the 1994 loan vintages are "better" than corresponding 1993 loan vintages for loans that are 6, 21 and 24 months old. On the other hand, the 1993 vintage appears to be better for loans that are 27 and 30 months old. During other

10   months, the result is too close to conclude with the chosen degree of certainty which vintage is better. The chart of Fig. 4 underscores the fallacy of the prior art in referring to yearly vintages as better or worse. One must be more specific as to time and other criteria,

15   since relative performance changes dynamically with time.

While the invention has been described above in relation to the consideration of vintages in yearly quarterly units, note that in the loan industry exogenous factors such as changes in economy, unemployment and

20   inflation are time varying factors that vary greatly over an annual interval and therefore the system of the invention permits analysis based on the choice of any interval unit. The important thing to realize is that in general, a new mortgage loan is more sensitive to small

25   changes in delinquency performance than an older

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mortgage.   This is shown by widening of the confidence

interval bands over time.   So in essence, the application

of the above described Crus Classes method corrects for

this fact.

5   The invention also takes and adjusts the

vintage rating based on quality comparisons for different

volatilities of default.   In essence, using the system

lets the user to set policies with respect to

volatilities of default which is another form of risk

10   management.   This is new to the industry.

The confidence level in the assessment of the

difference in quality between groups of loans depends to

a certain degree on the sample size of the loans.   For

small groups of loans, one will always be less certain of

15   their performance.   The real question is how much less

certain.   This is answered with the Crus Classes method.

The Crus Classes method also automatically adjusts the

comparison for different sample sizes of loans in each

node or product.   This is evident in the calculations in

20   the previously presented tables which always take into

account the number of loans.   An actual calculation that

has been carried out to evolve the vintage comparison

graph of Fig. 4 in accordance with Tables I, II and III

is presented in Fig. 4A.

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As described above, the Crus Classes method 34
delivers a comparison of two loan vintages either in the
form of a graph or tabulated data which permits one to
get a sense of which vintages are performing better.
5   This information can then be used in making manual or
automatic, computer generated yes/no decisions whether to
originate, purchase, or to maintain and sell various
vintages of loan products or servicing rights as needed
at the decisional blocks 13, 24 and 32 of Fig. 1.
10   The basic premise of the Crus Classes analysis
is that the future performance of these loan vintages
will match the past pattern. This may not necessarily be
true. To this end, the early warning system (EWS) 32 of
the present invention further enhances the loan analysis
15   process by incorporating an application of behavioral
scoring that has been specifically designed to be used on
closed end loans with longer maturities such as
mortgages. The EWS 32 is able to statistically predict
the probability that a group of loans will experience
20   credit performance problems during a future preselected
time period, without waiting for that loan to season. In
the case of mortgages, the time to season is typically
three to seven years. The EWS 34 is intended to provide
management with automated analytical tools which allow

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making decisions well in advance of the aforementioned
three to seven "seasoning" period.

By utilizing the EWS, a mortgage originator can
perform portfolio analysis and ascertain which product
5   type, program, type of underwriting, property type, type
of customer, origination channel, etc. is at risk,
without waiting for the mortgages to actually mature and
enter default. The only constraint is the amount of data
attributes that the mortgage loan originator keeps on any
10   customer over time, which for the purposes of the present
invention may be two years. The mortgage originator can
then dynamically adjust the flow of origination by
altering any credit criteria derived from a particular
attribute.

15   The EWS 34 constitutes the dynamic component of
the underwriting concept of the present invention. With
this concept, the decision maker can estimate
improvements in credit quality for each specific type or
amount of change in a criteria, i.e. he or she can
20   calculate the marginal contribution of any attribute on
record.

More specifically, the forward looking feature
of the EWS component of the invention attempts to
forecast the likelihood the borrowers will enter a 90+
25   days past due delinquency on their mortgages. This

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condition -- the occurrence of a 90-day past due
delinquency -- is defined as a "bad" condition relative
to any loan. The EWS calculates the probabilities of bad
conditions occurring by combining loan information with
5   the credit bureau's current behavioral score for the
given borrower. In other words, the EWS combines the
borrower's current mortgage status (default status and
age) with a forecast that is based on the borrower's
performance on other obligations and uses this
10   information to forecast the bad condition. The EWS
system makes three major assumptions:

- The future performance pattern of defaults
  will be the same as in the past;

- The future performance depends upon the
15   current loan characteristics and is
  dependent on past performance only through
  the credit bureau scores. Therefore, the
  EWS also carries all the assumption of the
  credit bureau's score that was used; and

20 - The EWS employs a logistic regression model
  to accurately and sufficiently predict
  default behavior.

The aforementioned "bad" condition is a
discrete (yes or no) event that occurs when and if an
25   individual loan is at least once three payments past due

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at any point during a forward looking preset time period, for example, two years. Bad loans are assigned the value "1" and good loans the value "0". How many times the loan enters "bad" is not considered in the EWS. A good loan is never three payments past due over the aforementioned two year time frame and therefore is assigned a loan of a value "0". Preferably, in order to provide reliable information using the EWS system, the underlying portfolio should have at least 100,000 loans and the loans should consist of different distributions of ages, types, locations, etc. In an embodiment of the invention which has been reduced to practice the number of loans in the portfolio exceeded one million.

The EWS probability of loans entering the bad condition is developed or calculated on the basis of looking backward in time through a development period which may similarly constitute a two-year time period. The EWS formula considers the age of the loan at the beginning of development period; the credit bureau score for the loan at the beginning of the development period; the delinquency status at the beginning of the development period; and the type of product, for example, whether a government or conventional or adjustable rate mortgage, etc.

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The following logistic model has been applied
to the underlying portfolio (government and conventional
loans being considered separately). In the formula shown
below, P is the probability of a loan becoming bad at any
5   time in the coming two years:

$$Log(P/(1-P)) = A + (B_1 * AGE) + B_2 * C0 + B3 * D_1 + B4 * D_2 + B_5 * SCORE + B_6 * NO\ SCORE).$$

In the equation, AGE is defined in categories
of quarters from 1-40. Therefore B_1 and AGE are 40
dimension row and column vectors respectively. SCORE is
10   the mortgage score from a credit bureau rating company
such as the well known Equifax rating bureau, at the
beginning of the two-year time period, i.e. August 1994.
Note, if no such score is available, the invention
assigns the lowest possible value, namely 200. The
15   Equifax scoring scores vary from 200 to 1000. The dummy
variables in the above equation are defined as follows:

$$C0 = \begin{cases} 1 & \text{if the loan is current at the beginning of the time period;} \\ 0 & \text{otherwise.} \end{cases}$$

20

$$D1 = \begin{cases} 1 & \text{if the loan is 1 month past due at the beginning of the time period;} \\ 0 & \text{otherwise.} \end{cases}$$

$$D2 = \begin{cases} 1 & \text{if the loan is 2 months past due at the beginning of the time period;} \\ 0 & \text{otherwise.} \end{cases}$$

$$NO\ SCORE = \begin{cases} 1 & \text{if the loan has no credit score available at the beginning of the time period;} \\ 0 & \text{otherwise.} \end{cases}$$

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The coefficients A, B_1, B_2, B_3, B_4, B_5 and B_6 are estimated by running the model over the underlying portfolio.

All of the forecasting is done at the individual loan level and then the results are aggregated into the portfolio of interest by defining or grouping certain loan characteristics (location, rate type, maturity, LTV, etc.) to make comparisons. Even though the invention presents the mean probability for a predicted group, the information contained in the individual loan level data is preserved because the invention explicitly considers the dispersion around the mean of the bad rate over time.

To forecast the probability of an individual loan entering 90+ day default during the predetermined time period (i.e. the two year time frame), all one need do is insert the estimated coefficients and the characteristics of that individual loan into the logistic equation for "P" presented earlier.

The logistic model in the form of the aforementioned equation provides numerical results which are suitable of being graphically presented as shown in Fig. 5. The graph enables management to readily interpret and form decisions based on the predictions which it contains. In accordance with a further embodiment of the invention, the results are feedback by

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the computer which then provides yes/no decisions based on predetermined default risk or profit criteria set by the operator.

Fig. 5 is a snapshot taken in 1996 and depicts loan experience looking both backwards to the past two years and forwards over a similar two year time span. The vertical solid bars 72 represent the current mean (expost) bad rates for a particular group over the past two years. In other words, these bars show the mean bad rate percentages of a group of loans that originated in a particular year. For example, the bar 72 for the loans originated in 1989 shows a bad rate of about 12.5%. The score for the 1991 loans is just about 8% whereas the bad rate for 1996 is quite low (under 5%), reflecting the fact that this vintage of loan has not yet matured sufficiently.

The hatched vertical bars 74 represent the forecasted mean bad rates (exante) for the same group of loans over the next two years. The value for the 1996 vintage is somewhere around 7% indicating an expected delinquency rate of 7% even though the past two-year performance had an actual bad rate of only about 2.5%. The curve 76 represents the expected bad rate curve that is obtained by modifying the forecasted bad rates by the

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risk ratio on nearby vintages, and this shall be
explained more fully later on.

One should not place much emphasis on whether
the curve 76 is above the solid bars 72, since this may
5   merely reflect the normal pattern of seasoning for
mortgages. Nor should one place much emphasis on the
absolute height of each bar, since this may reflect
different expectations among the various groups or types
of loans that are being analyzed. Instead, the graph of
10   Fig. 5 indicates three important benchmarks for reviewing
and forecasting the risk in the given loan portfolio.
First, note the jump which is indicated by the arrow 84.
It represents a jump which occurs when the difference
between the hatched bars 74 and the solid bars 72 is
15   greater than one standard deviation above the historical
age weighed performance for that vintage. The bigger the
jump, the more serious the quality problem. This measure
is particularly useful on younger vintages, e.g. the 1996
vintage to which the arrow 84 is pointed.

20   Second, the size of the portion of the hatched
bars 74 which protrudes above the expected bad curve 76
indicates an unusual level of risk in the past or the
future for that group of loans. Note the arrows 80 and
82 which indicates such conditions. Finally, the arrow
25   78 indicates a turning point which represents the point

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at which the first derivative of the expected BAD rate
curve changes sign from positive to negative: i.e. the
first time the bad rate drops as the loans age increases.
The younger the age at which the turning point occurs,
the earlier the portfolio's credit performance will or
has matured.

The manner in which the curve 76 of Fig. 5 is
derived may be better understood by reviewing Figs. 6 and
7. More specifically, the curve 86 is developed by
taking a snapshot at a point in time looking at loans of
different quarterly ages and asking how many in each age
group entered the "bad" state during the preceding
predetermined time period, e.g. two years.

Initially, the EWS 34 develops for each
empirical two-year period of performance the bad rate
curve as a function of age in quarters. See the
quarterly bad rate curve 86 in Fig. 6.

Next, using a moving average, the invention
smooths each curve to reduce the randomness of the
quarterly performance, thus obtaining the smooth curve 88
in Fig. 6. In fact, the slopes of the yearly bad rate
curve are calculated as the percentage change in bad
rates from one year to another year, which is known as
the risk ratio. To improve the integrity of the results
and protect against possible statistical aberrations, at

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least eight two-year time periods are considered, with
the means and standard deviations of the risk ratios
calculated.

To find the point on line 76 for 1991, the
5   invention uses the point on line 76 for 1990 which has
the expected bad rate for 1990. Multiplying this bad
rate by the corresponding mean risk ratio from Fig. 6
obtains the expected bad rate for 1991 and its standard
deviation. This expected bad rate is used for the point
10   on line 76 for 1991. However, if the forecast bad rate
(bar 74) is within the expected bad rate, plus or minus
one standard deviation, the invention just substitutes
the expected bad rate by the forecast bad rate so that
the line 76 passes through the top of bar 74.

15   The third in the triad of dynamic underwriting
tools of the present inventions, the matrix link system
36, uses the information developed by the Crus Classes
technique 34 and early warning system 32 to develop a
probability based prediction of how many of a given set
20   of loans will be "bad" at a selected future date.

More specifically, while the Crus Classes
method 34 analyzes the past performance of loan vintages
and the EWS system places a probability on a group of
loans entering the bad state within a preset time frame,
25   i.e. a window, the matrix link system 36 is designed to

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predict the default status performance of a group of
loans at a preset point in time within the window of
operation of the EWS. For example, the EWS method is
able to say with respect to a group of loans that 3% of
5   those loans will enter a bad state (90+ days in arrears)
at one time or another during a two year window. In
comparison, the matrix link is designed to answer the
question how many loans will be non-accruing, i.e. in the
90+ payment overdue state, at the end of the first
10   quarter of the two year window or nine months into the
window and so forth, taking into consideration that some
loans may enter the bad state or exit therefrom due to
prepayment or on account of having been matured, or by
completing foreclosure.

15   To perform its functions, the matrix link
system 36 predicts how many borrowers that enter a
90-days delinquency state remain there, how many loans
will return to "good" status and, finally, in which
quarter over the predefined window, e.g. two years, will
20   these transitions occur. Note that a particular loan can
enter a bad state, return to a good state or remain in a
bad state. Loans may mature, pay off or complete
foreclosure during the predefined window period and thus
exit the loan portfolio being analyzed. In order to
25   provide a quantitative measure of the transitions of

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loans between different states, the present inventors have developed a so-called delinquency transition matrix in a form which, in one embodiment thereof, appears as in the table in Fig. 7.

5   In the table of Fig. 7, use is made of a historical file spanning four years and including vintage years 1993-1996. The table shows the delinquency performance of a particular group of loans. Further, the table stratifies the loans by age of origination. Note

10   that the table lists separately the results for three different types of loans, namely conforming loans, jumbo loans and government loans. In each case, it shows the probability of a loan transitioning (a) from a bad state to a bad state, (b) from a bad state to a good state; (c)

15   exiting, i.e. maturing and therefore being dropped from the sample of loans being considered, (d) from good to bad, (e) from good to good; and (f) from good to exit state.

           Using the percentages listed in the delinquency

20   transition matrix in the Table of Fig. 7, one can then begin to convert the information obtained through the EWS system 32 into the forecasts of how the Crus Classes vintages will perform at predefined time periods within the window. The table in Fig. 8 illustrates the formulae

25   evolved by the present inventors which are as follows.

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First, the current age of the loan at the time
of forecast is determined. In the table of Fig. 7, the
age of the loans is indicated in years (1, 2, 3, 4...
10). However, in an actual implementation of the
5   invention, the vintages have been stated and the formula
is calculated in terms of quarters to obtain increased
accuracy.

For each group of loans of a particular age,
the invention uses a 3-month transition matrix to
10   forecast three months forward, a 6-month transition
matrix to forecast six months forward, a 9-month
transition matrix to forecast nine months forward and a
12-month transition matrix to forecast twelve months
forward.

15   Based on the choice of data in the previous
step, the invention calculates respectively looking
forward three, six, nine and twelve months:

1. how many good loans and bad loans will
exist from the portfolio;

20   2. how many good loans will turn into
bad; and

3. how many bad loans will remain bad.

From the above data, one obtains the classic
"roll-rate" forecast which provides the first component
25   of the forecast. The above approach merely projects

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forward the results that have already occurred in the
past, on the expectation that they will repeat
themselves. However, a greater benefit of the matrix
link technique of the present invention comes from adding
5   the additional information that is contained in and/or
obtained by the early warning system 32.

         To this end, the invention:

              (a) Calculates an empirical ratio
obtained as -- the cumulative number of loans which are
10   90+ at each quarter (EOP) and divides it by the number of
loans that are 90+ at least once during these four
quarters.

              (b) From the EWS, the invention obtains
or forecasts the "bad" rate for the two-year window based
15   on the EWS method 32.

              (c) Using the EWS, the invention
forecasts the bad rate and the empirical ratio above as a
new piece of information to adjust the classic "roll-
rate" forecast. This is in essence what comprises the
20   "matrix link" method 36. Fig. 9 provides the results of
the matrix link in graphical form. In the example shown,
the performance of different vintage loans is predicted
one year forward in quarterly installments starting in
1997.

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For example, the plot 102 shows the two-year
performance of 1995 vintage loans which range in age
(months) from 0 to 24 months, as viewed looking backwards
in time in 1997. The curve 104 shows the delinquency

5   rate percentages predicted for the next twelve months.
For example, when the groups of loans attain an age of
27, the delinquency rate can be read on the ordinate
axis. The same is true for this group of loans when they
reach an age of 30 months, 33 months and 36 months. The

10   reason that the curve 104 has a predicted value below the
actual value is that the prediction in the matrix link
uses a moving sum average which weighs down the actual
sharp up-turn in the "bad" rate which has actually
occurred toward the end of the curve 102.

15   The above remarks are also applicable to the
curves 106, 108 which apply to the 1993 vintage, the
curves 110 and 112 which are applicable to 1994 vintage,
and to the curves 114 and 116 which apply to the 1996
vintage.

20   Note that the Crus Classes are less static than
traditional mortgage vintage analysis. Therefore, the
performance of the last three points of any vintage can
still change somewhat, for better or worse.

         The matrix link lines, i.e. the curve 104, 108,

25   112, and 116 also show where the inventors expect the

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last three Crus Classes points to adjust over the next
nine months.

The system of the present invention lends
itself easily to being implemented through use of a
general purpose programmable computer as illustrated in
Fig. 10. Thus, the general purpose computer 124
communicates with a local database 122 which receives a
wealth of statistical and specific information about
various loans from diverse sources. For example, the
source of the information may be a national loan database
120 which is maintained by certain industry groups. The
general purpose computer 124 has the usual complement of
peripherals including an operator's console 126, ROM 128,
RAM 130 and a hard disk 132.

The computer 124 operates under control of
major software blocks which perform the dynamic analysis
134 in a manner already described. The main software
components are the software routines 136 which handle the
development and analysis of the Crus Classes associated
with the creation of the loan vintages. The early
warning system block 138 calculates probabilities of
loans going bad within a predetermined forward looking
window. Finally, the matrix link software block 140
forecasts the probabilities that a fraction of loans will
go bad within the window at a particular time.

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The analytical results developed by these
software subroutines or blocks 136, 138 and 140 are
tabulated in the tabulation software block 150 and
outputted through an output software block 152. The

5   output can be in the form of a signal which drives a
printer which generates a graphical representation of the
results in the manner previously described.
Alternatively, the output may supply the results to the
console 126 for visual inspection by the operator.

10   Alternatively, the operator may program the computer 124
via the console 126 to provide yes/no answers as to
whether an investment should be made or continued to be
made in a particular loan portfolio, again as already
described.

15   Although the present invention has been
described in relation to particular embodiments thereof,
many other variations and modifications and other uses
will become apparent to those skilled in the art. It is
preferred, therefore, that the present invention be

20   limited not by the specific disclosure herein, but only
by the appended claims.

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WHAT IS CLAIMED IS:

1.   A process for analyzing and selecting loan portfolios, wherein each loan portfolio comprises a plurality of loan units, the process including the steps of:

5   separating the loan portfolios into a plurality of loan vintages in a manner such that the loans included in each loan vintage have origination dates that are on average of the same age and said origination dates of each loan portfolio are all within a first time interval

10   and the respective time periods of the different loan vintages being mutually exclusive of one another;

          counting a bad rate of the loans in each loan vintage by counting the loans in each loan vintage on which payments are in arrears for a time period greater

15   than a second time interval during a time window having a third time interval, wherein the third time interval is substantially greater than said second time interval; and

          providing a comparison of the bad rates of the different loan vintages on a visually perceivable output

20   medium, to allow comparing the bad rates of the different loan vintages.

2.   The process of claim 1, in which the third
time interval is about two years and the third time
interval commences about two years prior to the date of
calculation of the bad rates.

3.   The process of claim 2, in which the first
time interval is about three months.

4.   The process of claim 2, in which the first
time interval is about one year.

5.   The process of claim 4, in which the one
year first time interval coincides with a calendar year.

6.   The process of claim 1, in which the
second time period is about ninety days.

7.   The process of claim 1, in which each loan
vintage comprises at least 50,000 loan units.

8.   The process of claim 1, further including:
       allowing an operator to set the durations of
one or more of the first, second and third time
intervals;

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5   deploying a general purpose computer for

enabling the computer to automatically provide "yes" or

"no" comparisons as to whether a given financial

institution should choose to invest in a particularly

identified loan vintage.

          9.   The process of claim 1, including:

          developing a projection of bad rates for a

plurality of said loan vintages by calculating

probablistic bad rates for said plurality of loan

5   vintages during a forward looking window extending over a

fourth time interval, the projected bad rates comprising

an early warning system whose results are depictable on

the output medium.

          10.   The process of claim 9, in which the step

of calculating the probablistic bad rates for said loan

vintages is carried out by using a logistic regression

formula.

          11.   The process of claim 10, in which the

logistic regression formula is

$$Log(P/(1-P)) = A + (B_1 * AGE) + B_2 * C0 + B3 * D_1 + B4 * D_2 + B_5 * SCORE + B_6 * NO\ SCORE)$$

wherein, P is the predicted bad rate, AGE is defined as

5   the age of the loan vintage and B_1 and AGE are row and

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column vectors of a dimension matrix of a predetermined
size, SCORE is a mortgage score from a credit bureau and
CO, D_1, D_2 and NO SCORE are dummy variables, and the
coefficients A, B_1, B_2, B_3, B_4, B_5 and B_6 are estimated by
10   running a model of the equation over a preselected loan
portfolio.

12.   The process of claim 11, wherein the value
CO is assigned a value of one if the loan is current at
the beginning of the third time interval and zero
otherwise, the variable D_1 equals one if the loan is one
5   month past due at the beginning of third time interval
and is zero otherwise, D_2 is assigned a value of one if
the loan is two months past due at the beginning of the
third time interval and zero otherwise, and NO SCORE
equals one if the loan has no credit score available at
10   the beginning of the third time interval and zero
otherwise.

13.   The process of claim 10, wherein the
fourth time interval is of the same duration as the third
time interval.

14.   The process of claim 1, wherein the loan
units are closed loan units.

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15. The process of claim 14, wherein the loans
are mortgage loans.

16. The process of claim 1, including
separating all loan units into different groups based on
type and thereafter carrying out said separation of said
loan portfolios into separate loan vintages based on each
5   type of loan.

17. The process of claim 16, wherein the types
include conventional loans, jumbo loans and government
originated loans.

18. The process of claim 9, including
separating all loan units into different groups based on
type and thereafter carrying out said separation of said
loan portfolios into separate loan vintages based on each
5   type of loan.

19. The process of claim 18, wherein the types
include conventional loans, jumbo loans and government
originated loans.

20. The process of claim 1, in which the
output medium is a graphical chart.

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21. The process of claim 9, wherein the output medium is a graphical chart.

22. The process of claim 20, which includes creating the graphical chart by plotting a difference between the bad rates calculated for a preselected pair of loan vintages and including on the graphical chart an
5 area of uncertainty.

23. The process of claim 22, wherein the area of uncertainty is selected as a +1 and -1 standard deviation of the difference in the bad rates for the preselected pair of loan vintages.

24. The process of claim 21, including plotting on the graphical chart the probablistic bad rates in the form of a first curve.

25. The process of claim 9, including developing a matrix link by calculating a bad rate of a preselected loan vintage as of a definite time within the fourth time interval.

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26.   The process of claim 25, including developing delinquency transition figures for selected ones of said loan vintages.

27.   The process of claim 26, including developing the delinquency transition figures by counting the numbers of loans which have transitioned from (a) good to bad state; (b) bad to good state; and (c) a
5   status as a loan.

28.   The process of claim 27, further including counting the number of loans which have remained in a bad state and counting loans which have remained in a good state.

29.   The process of claim 25, including calculating for at least one of the loan vintages matrix link results comprising a ratio of a predicted number of bad loans divided by a predicted number of new loans.

30.   The process of claim 29, including plotting the ratio on the output medium.

31.   The process of claim 9, including automatically providing yes/no decisions whether to

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invest in selected loan vintages using the early warning
system.

32.   The process of claim 25, including
automatically providing yes/no decisions using the matrix
link system.

33.   A process for analyzing and selecting loan
portfolios, wherein each loan portfolio comprises a
plurality of loan units, the process including the steps
of:

5   separating the loan portfolios into a plurality
of loan vintages;

developing a projection of bad rates for the
plurality of said loan vintages by calculating predicted
bad rates for said plurality of loan vintages during a
10   forward looking window extending over a predetermined
first time interval, the predicted bad rates comprising
an early warning system the results of which are
depictable on a visually perceivable output medium, a
loan unit being included in the bad rates when payments
15   on the loan unit are in arrears for a time period greater
than a second time interval occurring during the forward
looking window, the first time interval being
substantially longer than the second time interval.

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34.   The process of claim 33, in which the step
of calculating the predicted bad rates for said loan
vintages is carried out by using a logistic regression
formula.

35.   The process of claim 34, in which the
logistic regression formula is

$$Log(P/(1-P)) = A + (B_1*AGE) - B_2*C0 - B3*D_1 - B4*D_2 - B_5*SCORE + B_6*NO\ SCORE)$$

wherein P is the predicted bad rate, AGE is defined as

5   the age of the loan vintage and B_1 and AGE are row and
column vectors of a dimension matrix of a predetermined
size, SCORE is a mortgage score from a credit bureau and
$C0$, D_1, D_2 and NO SCORE are dummy variables, and the
coefficients A, B_1, B_2, B_3, B_4, B_5 and B_6 are estimated by

10   running a model of the equation over a preselected loan
portfolio.

36.   The process of claim 35, wherein the value
C0 is assigned a value of one if the loan is current at
the beginning of the first time interval and zero
otherwise, the variable D_1 equals one if the loan is one
month past due at the beginning of first time interval
and is zero otherwise, D_2 is assigned a value of one if
the loan is two months past due at the beginning of the
first time interval and zero otherwise, and NO SCORE

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equals one if the loan has no credit score available at
the beginning of the first time interval and zero
otherwise.

37. The process of claim 33, including
depicting graphically in the form of a first curve an
expected bad rate curve.

38. The process of claim 37, including
producing a bar chart showing current mean bad rates and
forecasted mean bad rates and superimposing the first
curve over the bar chart.

39. The process of claim 38, including
creating the first curve by creating a quarterly bad rate
curve, smoothing the quarterly bad rate curve by
averaging the values thereof with one another and further
5   smoothing the curve by taking a risk ratio thereof.

40. The process of claim 39, including
creating markers on the curves including markers which
show the changes in the first curve at a positive to a
negative slope transition thereof and markers which show
5   jump points of a predetermined size.

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FIG. 1

FIG. 1A

DELINQUENCY RATES BY VINTAGE
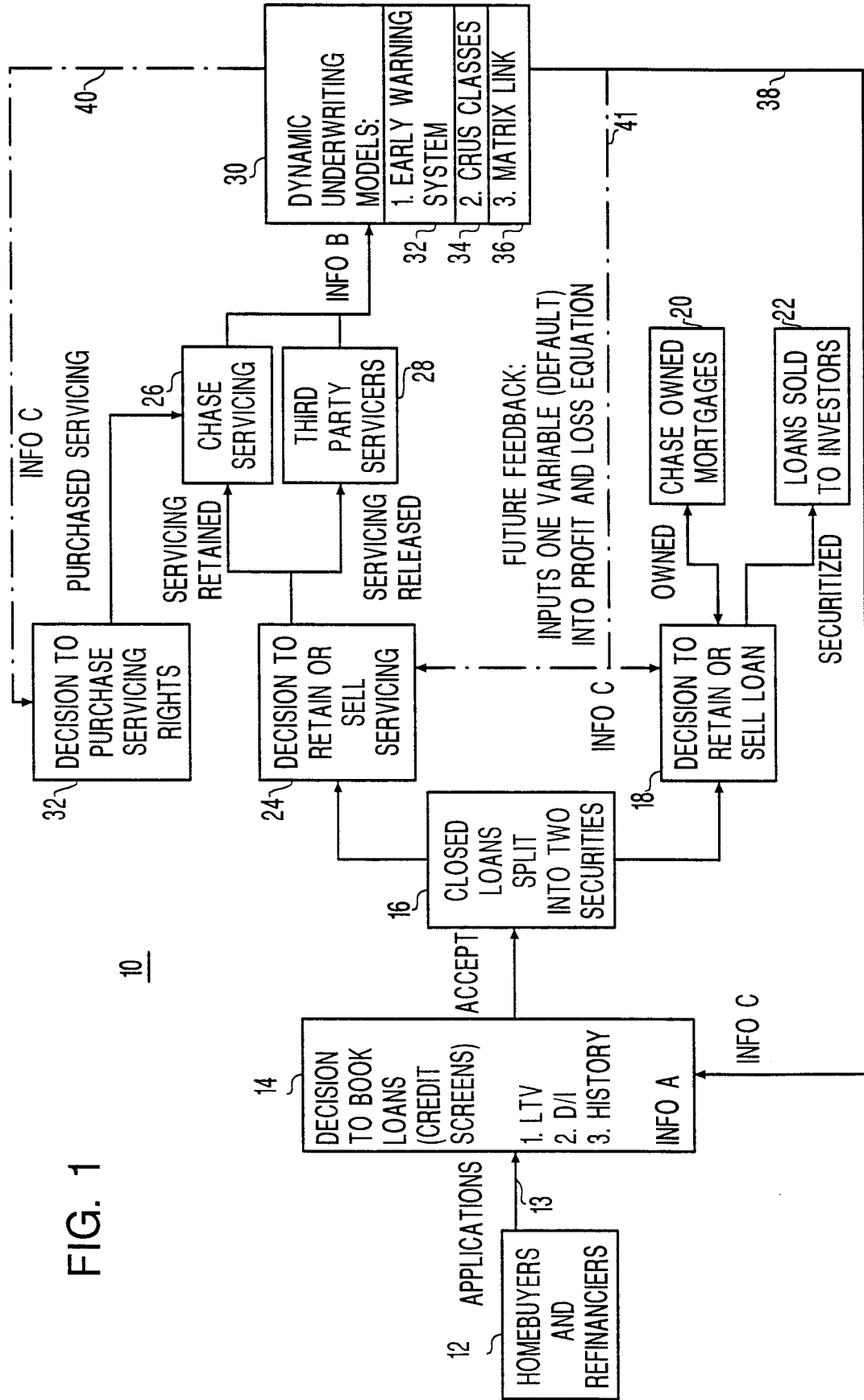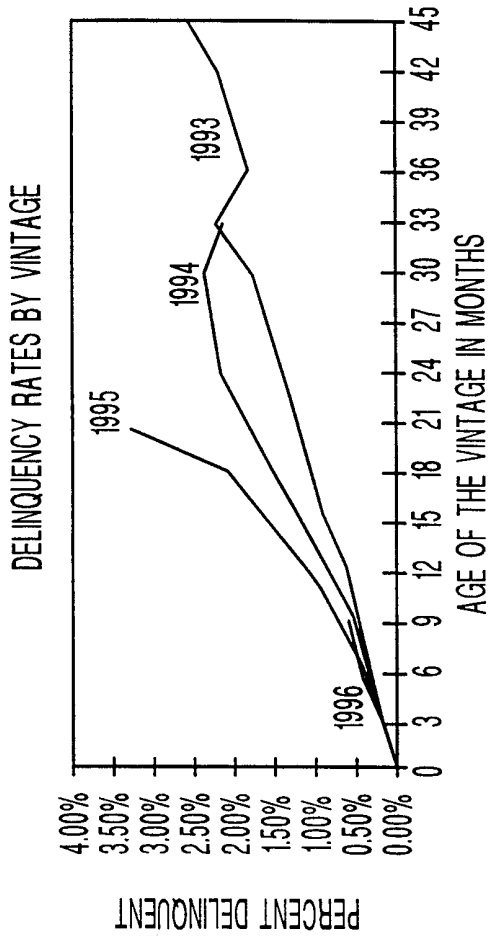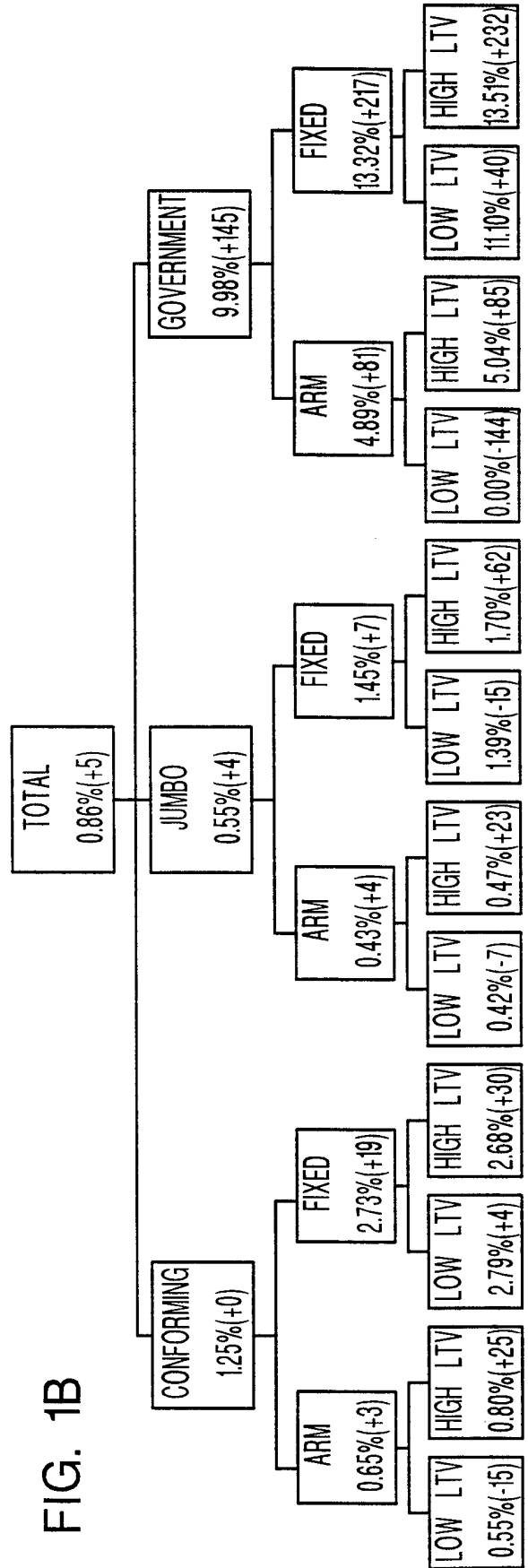
FIG. 1B

FIG. 2

TRADITIONAL COMPARISON/ HORIZONTAL COMPARISON
AGE OF LOANS IN MONTHS

QUARTER OF ORIGINATION ⟶ (50)

QUARTER ENDING ⟶	MAR-93	JUN-93	SEP-93	DEC-93	MAR-94	JUN-94	SEP-94	DEC-94	MAR-95	JUN-95	SEP-95	DEC-95
JUNE-96	39	39	39	39	27	27	27	27	15	15	15	15
MAR-96	36	36	36	36	24	24	24	24	12	12	12	12
DEC-95	33	33	33	33	21	21	21	21	9	9	9	N/A
SEP-95	30	30	30	30	18	18	18	18	6	6	N/A	N/A
JUN-95	27	27	27	27	15	15	15	15	3	N/A	N/A	N/A
MAR-95	24	24	24	24	12	12	12	12	N/A	N/A	N/A	N/A
DEC-94	21	21	21	21	9	9	9	N/A	N/A	N/A	N/A	N/A
SEP-94	18	18	18	18	6	6	N/A	N/A	N/A	N/A	N/A	N/A
JUN-94	15	15	15	15	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAR-94	12	12	12	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DEC-93	9	9	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SEP-93	6	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
JUN-93	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAR-93	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Reference labels: 50, 52, 54, 55, 56, 58, 60

FIG. 3

TIME ADJUSTED COMPARISON/ DIAGONAL COMPARISON
AGE OF LOANS IN MONTHS

QUARTER OF ORIGINATION →

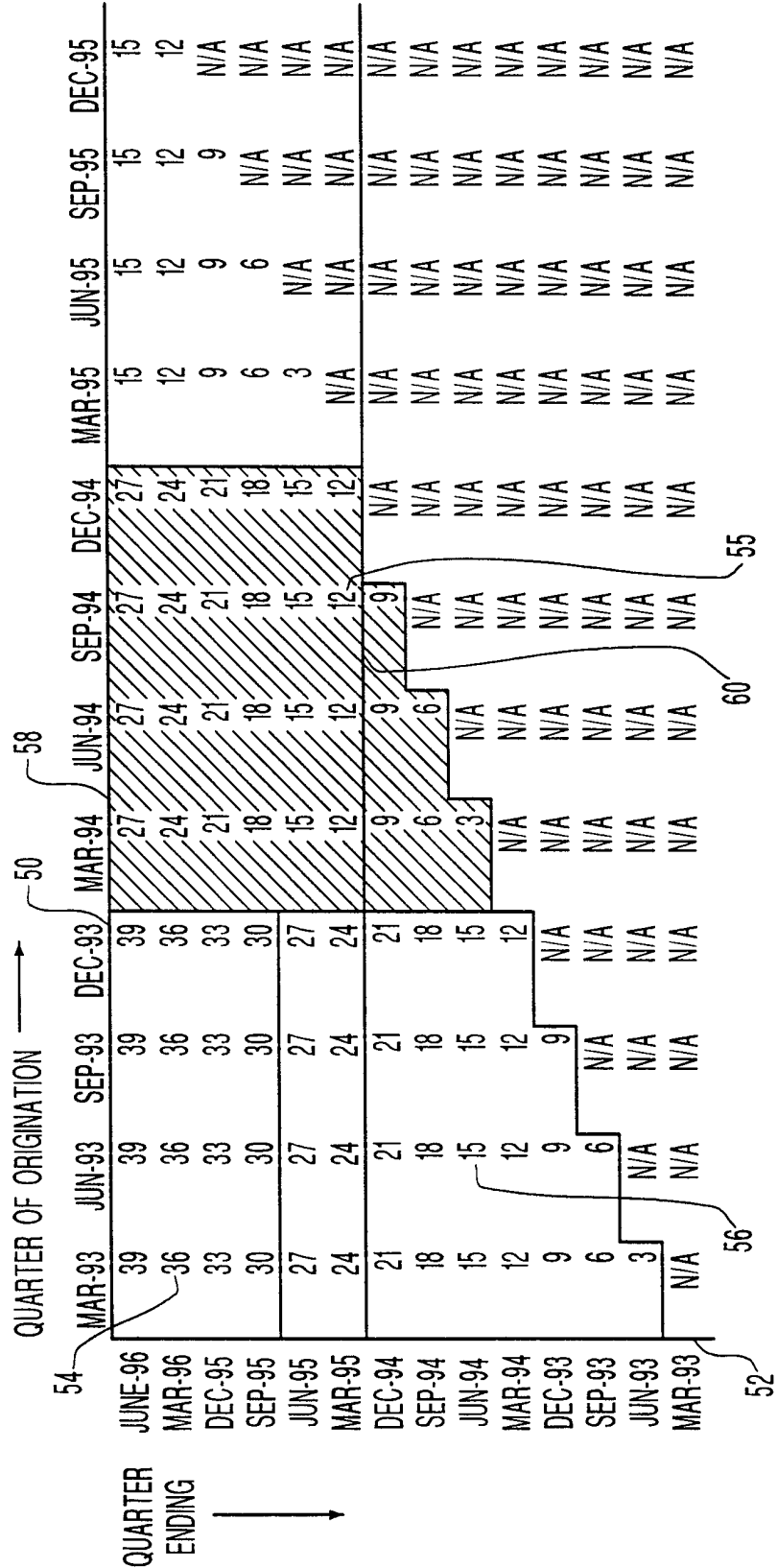| QUARTER ENDING →	MAR-93	JUN-93	SEP-93	DEC-93	MAR-94	JUN-94	SEP-94	DEC-94	MAR-95	JUN-95	SEP-95	DEC-95
JUNE-96	39	36	33	30	27	24	21	18	15	12	9	6
MAR-96	36	33	30	27	24	21	18	15	12	9	6	3
DEC-95	33	30	27	24	21	18	15	12	9	6	3	N/A
SEP-95	30	27	24	21	18	15	12	9	6	3	N/A	N/A
JUN-95	27	24	21	18	15	12	9	6	3	N/A	N/A	N/A
MAR-95	24	21	18	15	12	9	6	3	N/A	N/A	N/A	N/A
DEC-94	21	18	15	12	9	6	3	N/A	N/A	N/A	N/A	N/A
SEP-94	18	15	12	9	6	3	N/A	N/A	N/A	N/A	N/A	N/A
JUN-94	15	12	9	6	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAR-94	12	9	6	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DEC-93	9	6	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SEP-93	6	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
JUN-93	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAR-93	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

62

64

FIG. 4

HYPOTHESIS: IS '94 VINTAGE BETTER OR WORSE THAN '93?
GIVEN +/- ONE STANDARD DEVIATION

71

1993-1994

0.40%
0.20%
0.00%
-0.20%
-0.40%

PERCENT

BETTER   66

70

AREA OF UNCERTAINTY

68 WORSE

3 MTHS   6 MTHS   9 MTHS   12 MTHS   15 MTHS   18 MTHS   21 MTHS   24 MTHS   27 MTHS   30 MTHS

AGE OF LOANS SINCE ORIGINATION

— UPPER BOUND   — LOWER BOUND   — 1993-1994
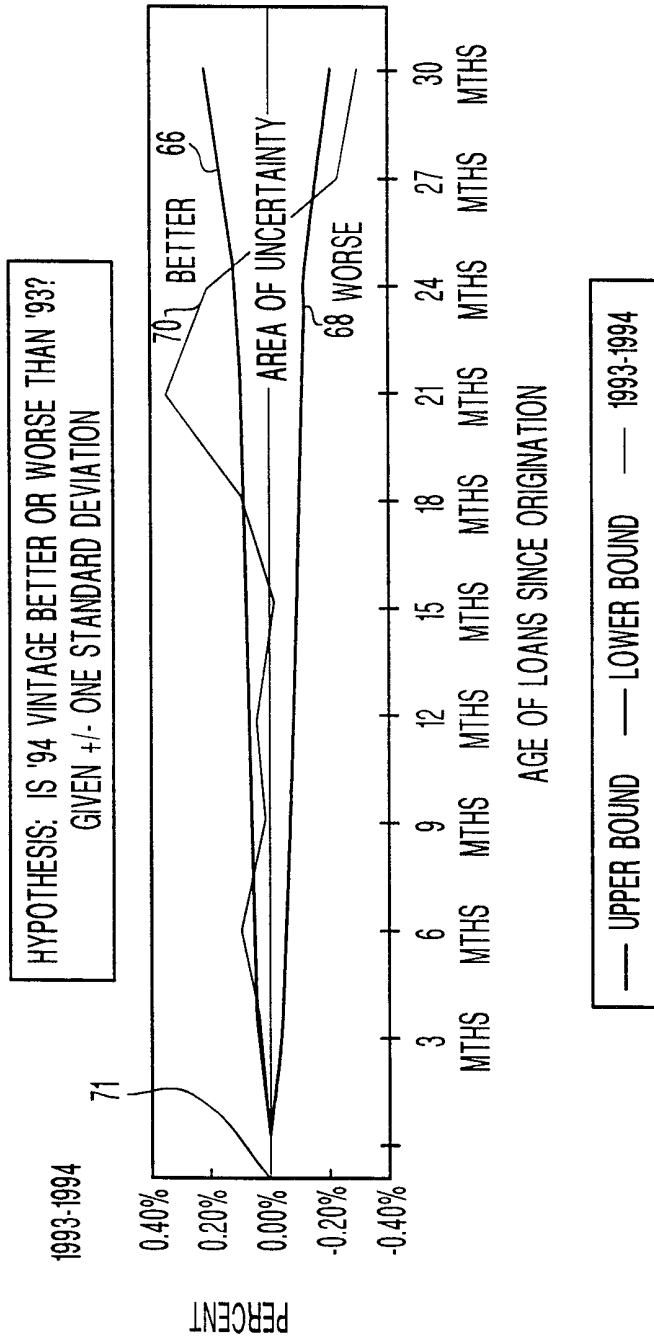
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FIG. 4A-1

DATA RESULTS EXTRACT OF CALCULATIONS

TOTAL NUMBER OF "BAD" LOANS

ORIGINATION   AGE ⟶

MONTH/YR	3 MTHS	6 MTHS	9 MTHS	12 MTHS	15 MTHS	18 MTHS	21 MTHS	24 MTHS	27 MTHS	30 MTHS	33 MTHS	36 MTHS	39 MTHS	42 MTHS
MAR-93	2	2	8	6	6	11	29	27	31	28	30	19	24	27
JUN-93	8	5	9	14	7	19	28	41	42	34	20	32	36	
SEP-93	9	16	14	17	31	37	53	36	38	22	27	59		
DEC-93	34	39	30	35	40	45	42	38	22	36	65			
MAR-94	20	19	24	23	26	34	24	13	27	43				
JUN-94	9	7	19	26	48	45	24	34	65					
SEP-94	6	7	13	22	26	17	24	45						
DEC-94	3	11	13	17	9	23	39							
MAR-95	0	7	14	10	16	30								
JUN-95	2	9	11	10	30									
SEP-95	1	2	7	22										
DEC-95	1	2	7											
MAR-96	1	7												
JUN-96	3													

TOTAL NUMBER OF LOANS ("BAD" & "GOOD")

ORIGINATION   AGE ⟶

MONTH/YR	3 MTHS	6 MTHS	9 MTHS	12 MTHS	15 MTHS	18 MTHS	21 MTHS	24 MTHS	27 MTHS	30 MTHS	33 MTHS	36 MTHS	39 MTHS	42 MTHS
MAR-93	6,350	5,325	4,961	2,243	2,204	2,212	2,232	2,286	2,254	2,201	3,809	1,977	1,578	986
JUN-93	7,305	5,972	3,105	3,060	2,998	3,003	3,109	3,088	3,055	2,712	2,538	2,344	1,325	
SEP-93	7,191	4,022	3,890	3,808	3,786	3,785	3,743	3,743	3,204	3,009	2,898	1,918		
DEC-93	9,712	7,299	6,910	6,719	6,607	6,502	6,395	5,744	5,116	4,711	3,744			
MAR-94	7,784	6,443	6,150	5,970	5,869	5,741	5,307	4,824	4,189	3,448				
JUN-94	5,985	5,634	5,529	5,391	5,098	4,633	4,284	3,951	3,339					
SEP-94	6,540	6,345	6,227	5,271	4,681	4,290	3,994	3,443						
DEC-94	5,979	5,856	5,159	4,653	4,354	4,099	3,626							
MAR-95	3,864	3,313	3,127	2,918	2,772	2,576								
JUN-95	6,322	6,204	5,991	5,791	5,425									
SEP-95	3,546	3,482	3,446	3,091										
DEC-95	3,231	3,271	3,089											
MAR-96	2,401	2,454												
JUN-96	4,173													

FIG. 4A-2

SUM OF 4 QUARTERS

BAD LOANS — AGE →

ORIGINATION MONTH/YR	3 MTHS	6 MTHS	9 MTHS	12 MTHS	15 MTHS	18 MTHS	21 MTHS	24 MTHS	27 MTHS	30 MTHS	33 MTHS	36 MTHS	39 MTHS	42 MTHS
1993	53	62	61	72	84	112	152	142	133	120	142	110	60	27
1994	38	44	69	88	109	119	111	92	92	43	0	0	0	0

ALL LOANS — AGE →

ORIGINATION MONTH/YR	3 MTHS	6 MTHS	9 MTHS	12 MTHS	15 MTHS	18 MTHS	21 MTHS	24 MTHS	27 MTHS	30 MTHS	33 MTHS	36 MTHS	39 MTHS	42 MTHS
1993	30,558	22,618	18,866	15,830	15,595	15,502	15,479	14,861	13,629	12,633	12,989	6,239	2,903	986
1994	26,288	24,278	23,065	21,285	20,002	18,763	17,211	12,218	7,528	3,448	0	0	0	0

BAD RATE — AGE →

ORIGINATION MONTH/YR	3 MTHS	6 MTHS	9 MTHS	12 MTHS	15 MTHS	18 MTHS	21 MTHS	24 MTHS	27 MTHS	30 MTHS	33 MTHS	36 MTHS	39 MTHS	42 MTHS
1993	0.17%	0.27%	0.32%	0.45%	0.54%	0.72%	0.98%	0.96%	0.98%	0.95%	1.09%	1.76%	2.07%	2.74%
1994	0.14%	0.18%	0.30%	0.41%	0.54%	0.63%	0.64%	0.75%	1.22%	1.25%	N/A	N/A	N/A	N/A

STD DEV — AGE →

ORIGINATION MONTH/YR	3 MTHS	6 MTHS	9 MTHS	12 MTHS	15 MTHS	18 MTHS	21 MTHS	24 MTHS	27 MTHS	30 MTHS	33 MTHS	36 MTHS	39 MTHS	42 MTHS
1993	0.02%	0.03%	0.04%	0.05%	0.06%	0.07%	0.08%	0.08%	0.08%	0.09%	0.09%	0.17%	0.26%	0.52%
1994	0.02%	0.03%	0.04%	0.04%	0.05%	0.06%	0.06%	0.08%	0.13%	0.19%				

RATE DIFFERENCE — AGE →

	3 MTHS	6 MTHS	9 MTHS	12 MTHS	15 MTHS	18 MTHS	21 MTHS	24 MTHS	27 MTHS	30 MTHS	33 MTHS	36 MTHS	39 MTHS	42 MTHS
1993-1994	0.03%	0.09%	0.02%	0.04%	-0.01%	0.09%	0.34%	0.20%	-0.25%	-0.30%	1.09%	1.76%	2.07%	2.74%
STD DEV	0.03%	0.04%	0.05%	0.07%	0.08%	0.09%	0.10%	0.11%	0.15%	0.21%				
STD DEV	-0.03%	-0.04%	-0.05%	-0.07%	-0.08%	-0.09%	-0.10%	-0.11%	-0.15%	-0.21%				

FIG. 5

ACTUAL VS. PROJECTED RISK OF ENTERING BAD
IN 2 YEARS
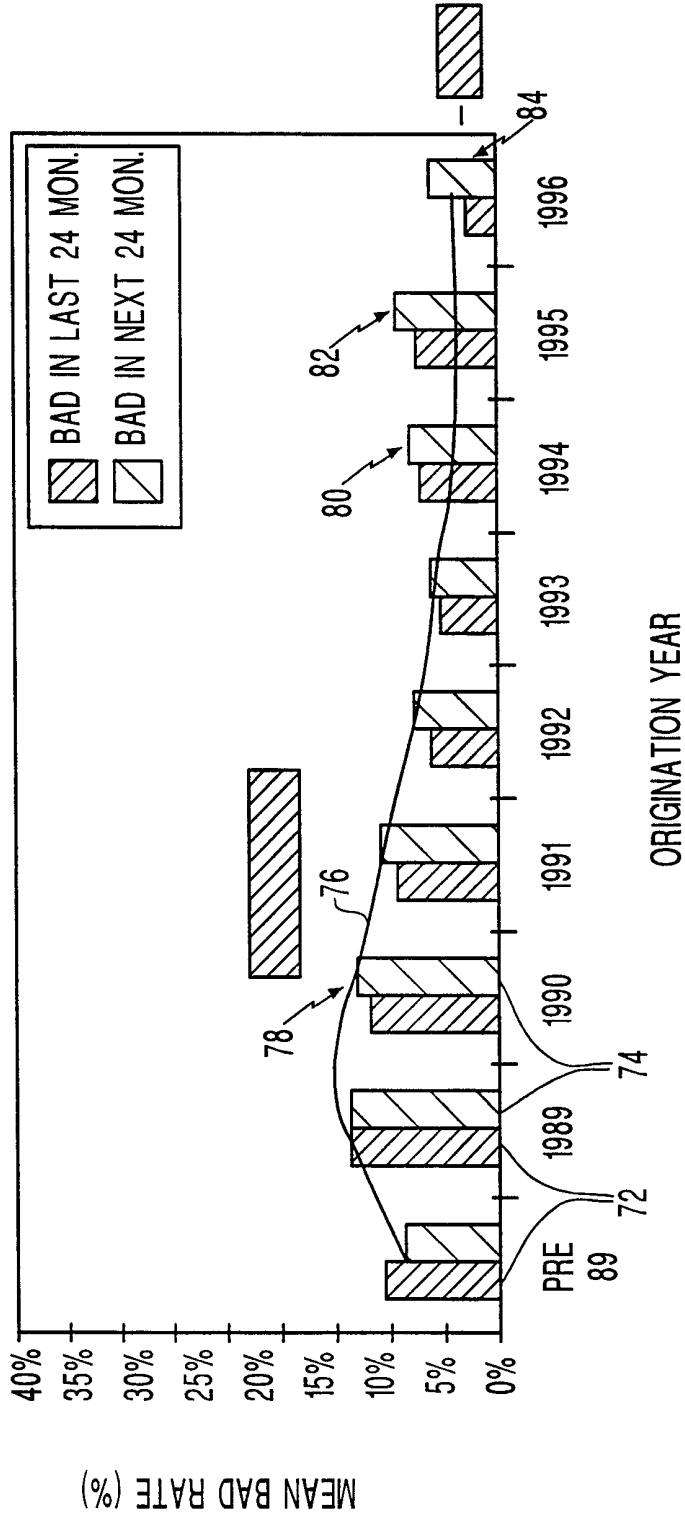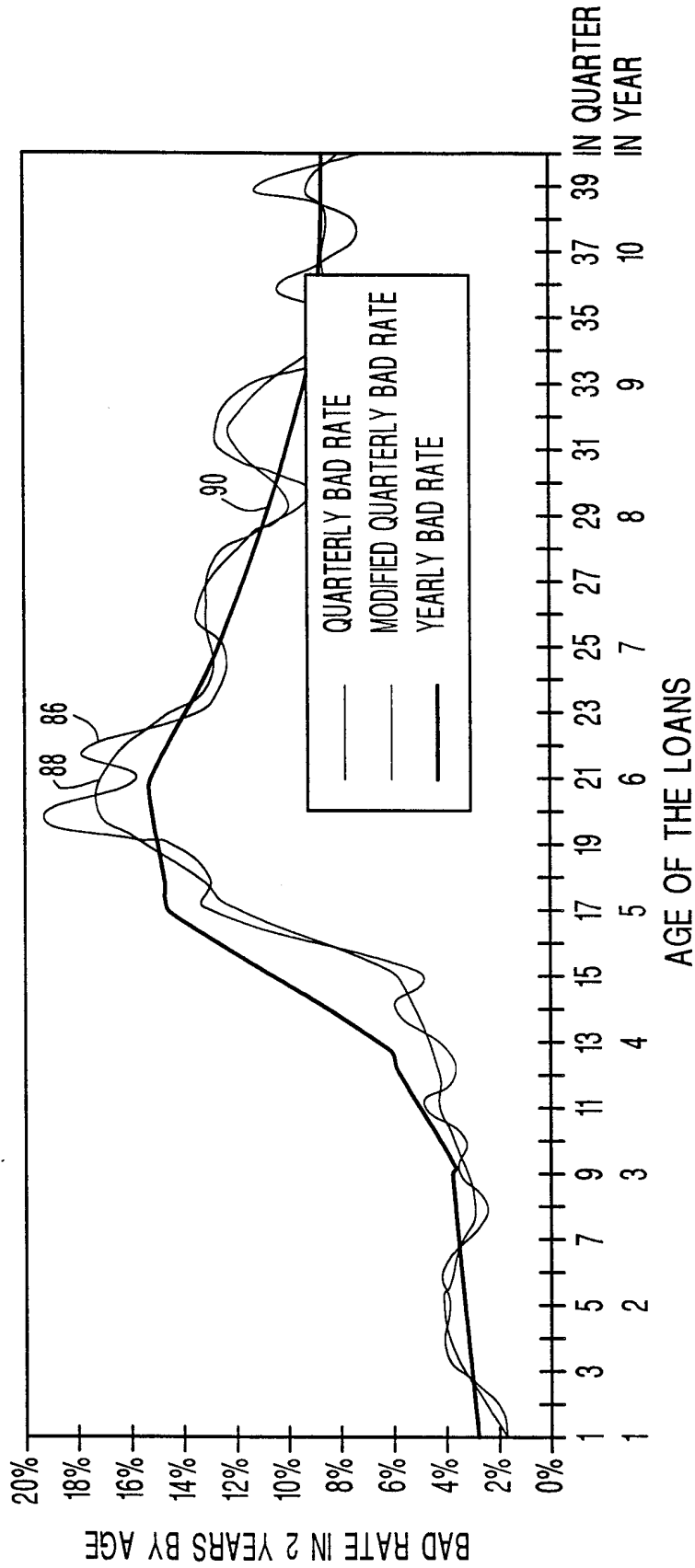
FIG. 6

EMPIRICAL BAD RATE IN TWO YEARS BY AGE

CHART 1: ONE EXAMPLE OF THE BAD RATE CURVE
(DATA IS FOR DEMONSTRATION ONLY)

FIG. 7

ROLL RATE OF DELINQUENCY FOR ONE YEAR

AGE OF LOANS	FROM	CONFORMING LOANS			JUMBO LOANS			GOVERNMENT LOANS		
	TO →	BAD	GOOD	EXIT	BAD	GOOD	EXIT	BAD	GOOD	EXIT
1 YEAR	BAD	43.08%	38.46%	18.46%	28.15%	48.89%	22.96%	69.83%	23.05%	7.11%
	GOOD	0.27%	72.52%	27.21%	0.31%	82.69%	17.01%	1.60%	91.63%	6.77%
2 YEAR	BAD	63.93%	19.17%	16.90%	57.61%	20.58%	21.81%	78.76%	11.76%	9.49%
	GOOD	0.30%	71.00%	28.70%	0.38%	80.63%	18.99%	1.99%	87.77%	10.24%
3 YEAR	BAD	65.78%	14.65%	19.57%	55.04%	11.17%	33.79%	76.28%	7.81%	15.91%
	GOOD	0.46%	72.34%	27.19%	0.58%	79.77%	19.65%	2.48%	84.47%	13.05%
4 YEAR	BAD	55.19%	9.62%	35.20%	39.47%	6.95%	53.57%	75.15%	6.21%	18.63%
	GOOD	1.22%	72.64%	26.13%	1.42%	77.08%	21.50%	3.12%	80.76%	16.11%
5 YEAR	BAD	53.51%	9.36%	37.13%	33.69%	5.79%	60.52%	72.55%	5.97%	21.48%
	GOOD	2.08%	74.66%	23.26%	2.41%	74.15%	23.44%	3.69%	79.72%	16.59%
6 YEAR	BAD	46.57%	8.69%	44.74%	36.48%	4.72%	58.80%	71.73%	6.99%	21.28%
	GOOD	1.55%	75.70%	22.74%	1.36%	71.42%	27.22%	3.64%	78.86%	17.50%
7 YEAR	BAD	65.51%	10.65%	23.84%	56.91%	10.57%	32.52%	69.34%	8.66%	22.00%
	GOOD	1.34%	77.12%	21.54%	1.03%	69.20%	29.76%	2.88%	78.69%	18.42%
8 YEAR	BAD	71.60%	13.12%	15.28%	81.82%	5.19%	12.99%	70.53%	10.67%	18.80%
	GOOD	0.98%	75.85%	23.17%	0.94%	80.49%	18.57%	2.83%	80.61%	16.56%
9 YEAR	BAD	67.03%	14.98%	18.00%	63.64%	21.21%	15.15%	70.88%	11.09%	18.03%
	GOOD	1.00%	74.59%	24.40%	0.54%	81.68%	17.77%	2.48%	83.65%	13.87%
10 YEAR	BAD	62.10%	12.17%	25.73%	83.33%	8.33%	8.33%	73.86%	9.52%	16.61%
	GOOD	0.77%	70.16%	29.06%	2.37%	71.60%	26.04%	2.84%	79.52%	17.64%

FIG. 8

THE CLASSIC ROLL-RATE FORECAST

ORIG. QUARTER	CURRENT INFORMATION			ROLL RATE FROM BAD TO		ROLL RATE FROM GOOD TO		INFORMATION AT THE END OF THE NEXT QUARTER (FORECAST)			
	AGE	# OF LOANS	BAD RATE	BAD	EXIT	BAD	EXIT	AGE	NEW # OF LOANS	NEW # OF BAD LOANS	BAD RATE
1Q, 1995	8	N_8	R_8	$B(8,1)$	$E(8,1)$	$b(8,1)$	$e(8,1)$	9	$N_8*R_8*(1-E(8,1))+ N_8*(1-R_8)*(1-e(8,1))$	$N_8*R_8*B(8,1)+ N_8*(1-R_8)*b(8,1)$	NEW # OF BAD LOANS / NEW # OF LOANS
2Q, 1995	7	N_7	R_7	$B(7,1)$	$E(7,1)$	$b(7,1)$	$e(7,1)$	8	$N_7*R_7*(1-E(7,1))+ N_7*(1-R_7)*(1-e(7,1))$	$N_7*R_7*B(7,1)+ N_7*(1-R_7)*b(7,1)$	NEW # OF BAD LOANS / NEW # OF LOANS
3Q, 1995	6	N_6	R_6	$B(6,1)$	$E(6,1)$	$b(6,1)$	$e(6,1)$	7	$N_6*R_6*(1-E(6,1))+ N_6*(1-R_6)*(1-e(6,1))$	$N_6*R_6*B(6,1)+ N_6*(1-R_6)*b(6,1)$	NEW # OF BAD LOANS / NEW # OF LOANS
4Q, 1995	5	N_5	R_5	$B(5,1)$	$E(5,1)$	$b(5,1)$	$e(5,1)$	6	$N_5*R_5*(1-E(5,1))+ N_5*(1-R_5)*(1-e(5,1))$	$N_5*R_5*B(5,1)+ N_5*(1-R_5)*b(5,1)$	NEW # OF BAD LOANS / NEW # OF LOANS

NOTE: THE AGE IS IN QUARTERS.
NOTE: THE PARAMETERS IN B(8,1) HAVE THE FOLLOWING MEANING: 8 IS THE AGE (IN QUARTERS), 1 IS THE FORECAST TIME PERIOD (IN QUARTER).

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FIG. 9

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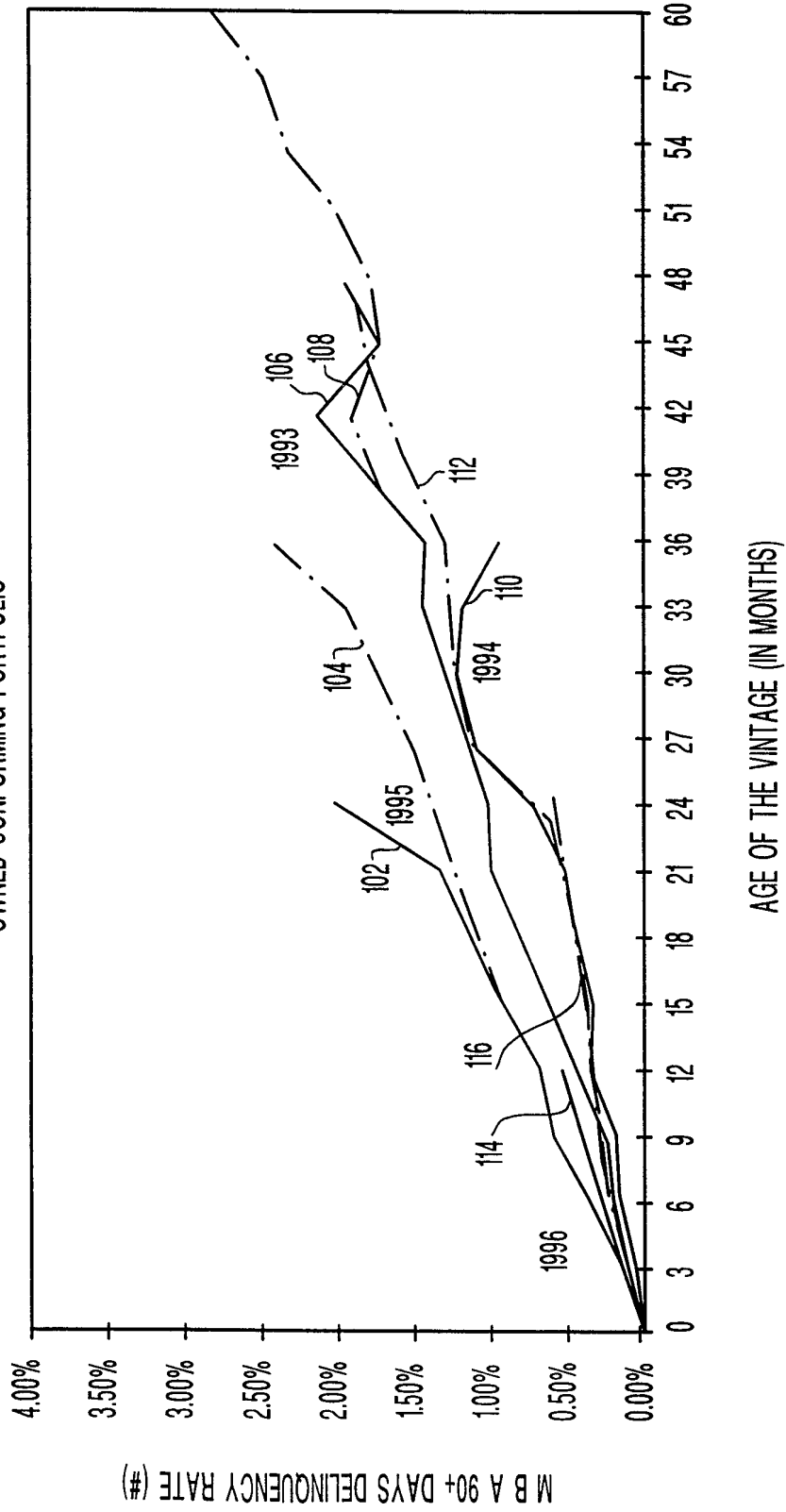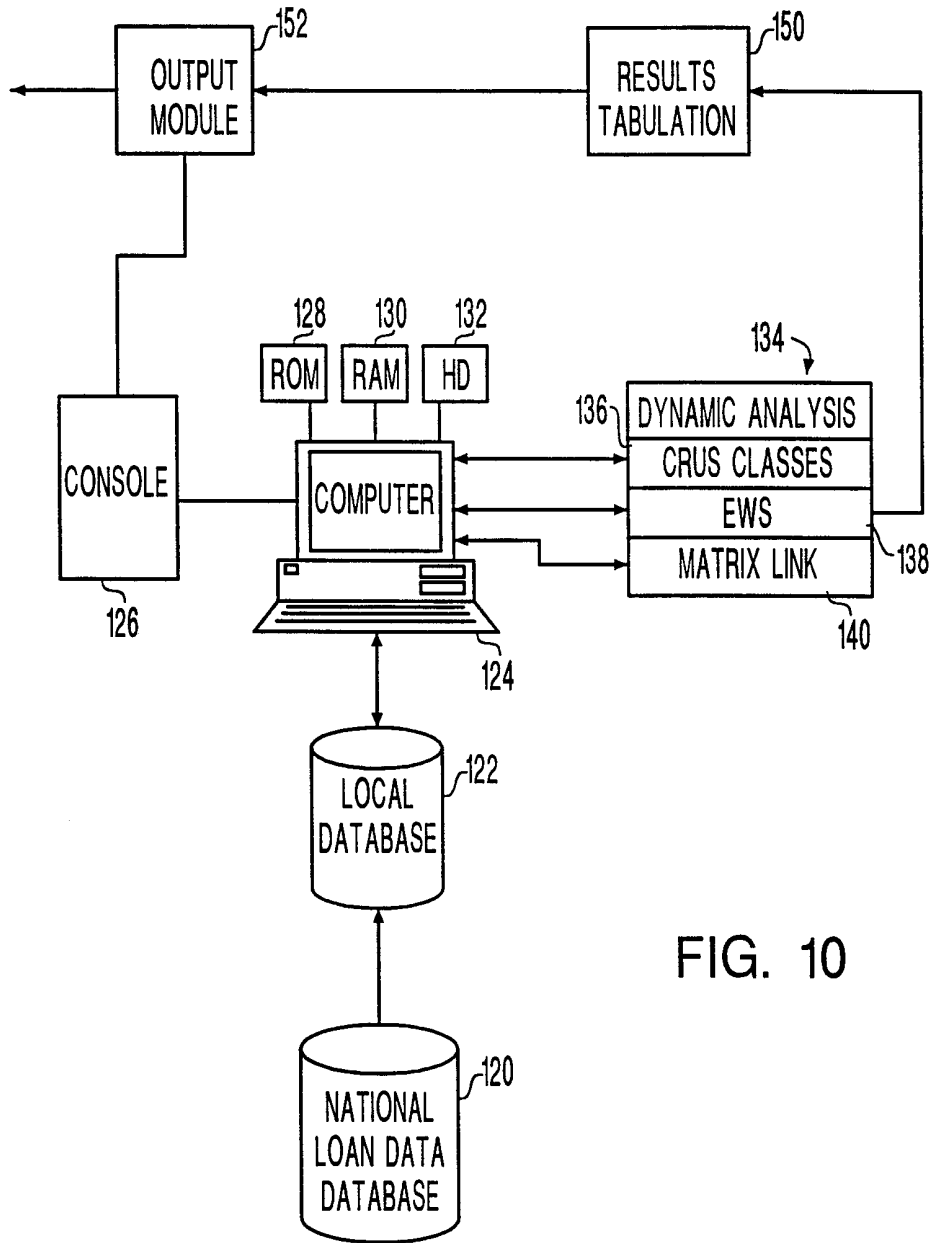
FIG. 10

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   G06F17/60

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SMITH L D ET AL: "A comprehensive model for managing credit risk on home mortgage portfolios" DECISION SCIENCES, SPRING 1996, DECISION SCI. INST, USA, vol. 27, no. 2, pages 291-317, XP002078224 ISSN 0011-7315 see abstract see page 292, line 6 see page 293, line 31 – page 294, line 17 see page 294, line 37 – page 295, line 32 see page 306, line 22 – line 28	1-21, 24-37
Y	see figure 2 ___ -/--	22,23, 38-40

[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 September 1998	07/10/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Pedersen, N

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page 1 of 3

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	MATHIESON M: "Ordinal models for neural networks" NEURAL NETWORKS IN FINANCIAL ENGINEERING. PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE ON NEURAL NETWORKS IN THE CAPITAL MARKETS, PROCEEDINGS OF THE 3RD INTERNATIONAL CONFERENCE ON NEURAL NETWORKS IN FINANCIAL ENGINEERING, LONDON, UK., 11 - 13 October 1996, pages 523-536, XP002078225 ISBN 981-02-2480-X, Singapore, World Scientific, Singapore see abstract see page 526, line 12 - line 15 see figure 4(b)	22,23
Y	WO 96 06402 A (FINANCIAL MODELS COMPANY INC ;KNOWLES JAMES A (CA); TEDER TOOMAS J) 29 February 1996 see page 1, line 1 - line 6 see page 66, line 12 - line 15 see page 67, line 1 - line 5	38-40
A	PINDER, J. P.: "Decision analysis using multinomial logit models: Mortgage portfolio valuation." JOURNAL OF ECONOMICS AND BUSINESS, vol. 48, no. 1, 1996, pages 67-77, XP002078226 see page 69, line 17 - line 30 see page 71, line 14 - line 35 see figures 2-4	1-40
A	JOHN G H ET AL: "Mortgage data mining" PROCEEDINGS OF THE IEEE/IAFE 1997 COMPUTATIONAL INTELLIGENCE FOR FINANCIAL ENGINEERING (CIFER) (CAT. NO.97TH8304), NY, USA, 24 - 25 March 1997, pages 232-236, XP002078227 ISBN 0-7803-4133-3 see page 232, column 2, line 29 - line 35 see page 234, column 2, line 9 - line 11 see figure 2	1-40

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	DESAI V S ET AL: "A comparison of neural networks and linear scoring models in the credit union environment" EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 22 NOV. 1996, ELSEVIER, NETHERLANDS, vol. 95, no. 1, pages 24-37, XP002078228 ISSN 0377-2217 see page 24, column 1, line 1 - column 2, line 4 see page 26, column 2, line 38 - page 27, column 1, line 3 see page 31, column 1, line 17 - column 2, line 8 see table 1 _____	1-40

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INTERNATIONAL SEARCH REPORT

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