SAS WORKSHOP

SAS Programming: Base and Beyond

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CECL: CURRENT EXPECTED CREDIT LOSS

- CECL is the new accounting standard by FASB (Financial Accounting Standards Board)
- FASB is replacing the current “incurred loss” accounting model with an “expected loss” model – CECL.
- Banking regulators have referred to CECL as “the biggest change ever to bank accounting.”

CREDIT LOSSES

ASU 2016-13 FINANCIAL INSTRUMENTS—CREDIT LOSSES (TOPIC 326)

Overview

On June 16, 2016, the FASB completed its Financial Instruments—Credit Losses project by issuing ASU No. 2016-13, *Financial Instruments—Credit Losses (Topic 326)*. The new guidance requires organizations to measure all expected credit losses for financial instruments held at the reporting date based on historical experience, current conditions and reasonable and supportable forecasts.

PURPOSE OF CECL

- **"CECL"** – **C**urrent **E**xpected **C**redit **L**oss model
  - Forward looking requirements
  - Removes "Probable Loss" threshold
  - Longer loss horizon
  - Need for loan-level data

- **Overall Goal:** Quicker recognition of losses.
- Changes in the ALLL (Allowance for Loan and Leases) reserve balances under CECL will primarily reflect changes in credit quality, and flow through a bank's earnings. The hope is to improve transparency for financial statement users.

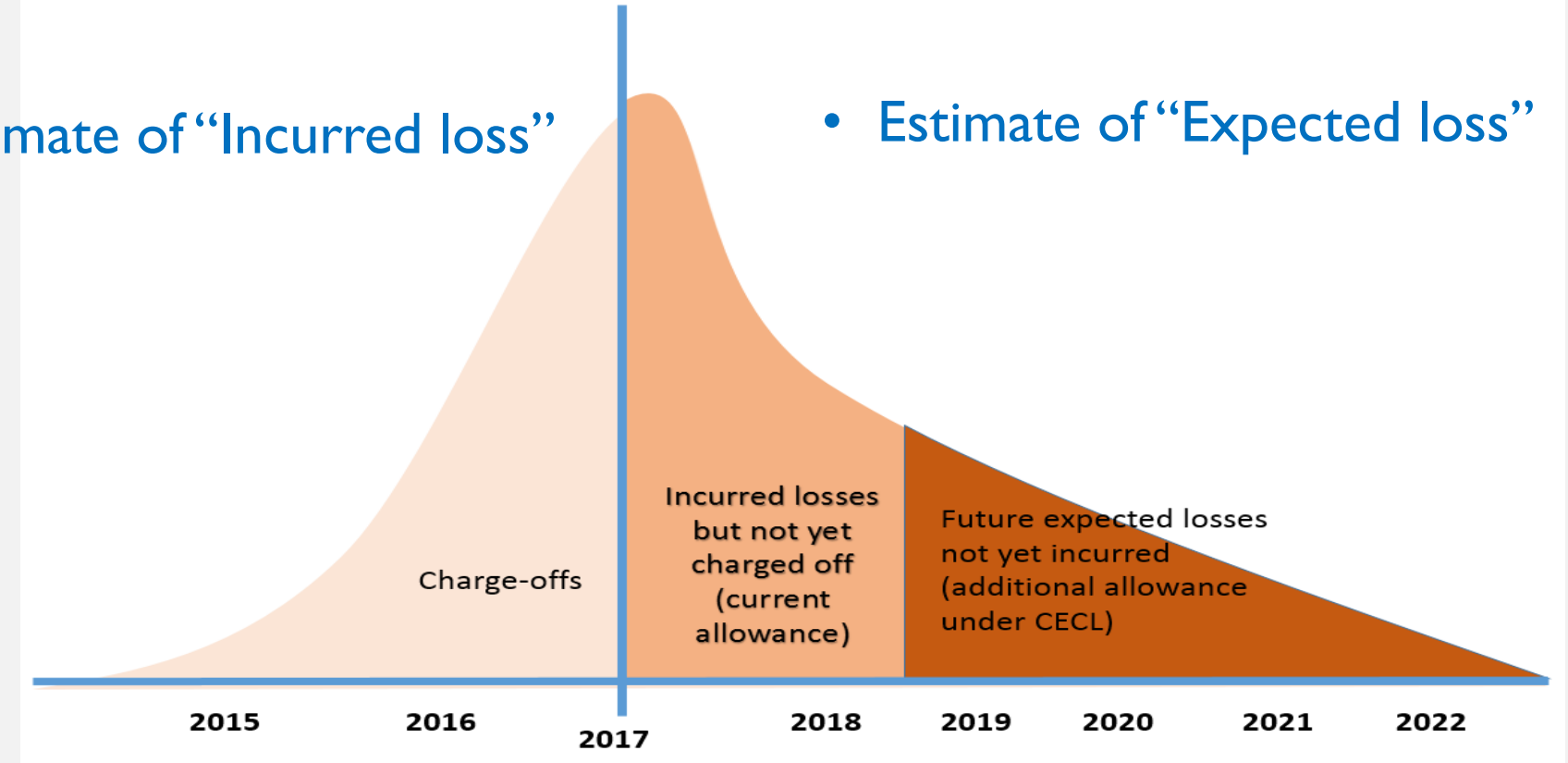
THE CHANGE TO CECL

FAS 5: "Losses in the Portfolio"

- Estimate of "Incurred loss"

CECL: "Risk in the Portfolio"

- Estimate of "Expected loss"



CECL: EXPECTED CREDIT LOSSES OVER LIFE OF LOAN OR PORTFOLIO

- Life of Loan (LOL) loss expectation (pool basis) effectively recorded at origination
- Forecast of the future to LOL required
- Historic averages of "life of loan" losses
  - Used as starting point for estimates
  - Applied to periods beyond "forecastable future."

CECL EFFECTIVE DATES

CECL Effective Dates		
Entity Type	**U.S. GAAP Effective Date**	**Regulatory Report Effective Date***
Public Business Entities (PBEs) that are SEC Filers	Fiscal years beginning after 15 December 2019, including interim periods within those fiscal years	**Q1 2020**
Other PBEs (Non-SEC Filers)**	Fiscal years beginning after 15 December 2020, including interim periods within those fiscal years	**Q1 2021**
Non-PBEs	Fiscal years beginning after 15 December 2020, including interim periods beginning after 15 December 2021	**Q4 2021**
Early Application	Early application permitted for fiscal years beginning after 15 December 2018, including interim periods within those fiscal years	**Permissible No earlier than 31 March 2019**

** For institutions with calendar year ends.*

*** A public business entity that is not an SEC filer would include (1) an entity that has issued securities that are traded, listed, or quoted on an over-the-counter market, and (2) an entity that has issued one or more securities that are not subject to contractual restrictions on transfer and is required by law, contract, or regulation to prepare U.S. GAAP financial statements and make them publicly available periodically (e.g., pursuant to Section 36 of the Federal Deposit Insurance Act and Part 363 of the FDIC's regulations).*

ECL MODEL

- Expected Credit Loss

  = Probability of Default (PD) * Loss Given Default (LGD) * Exposure at Default (EAD)

Loan Number	Current Balance (A)	Probability of Default (PD)	Collateral Value (B)	Superior Mortgage (C)	Costs to Sell (D)	Loss Given Default ($) (LGD) [(B)-(C)-(D)-(A)]	Expected Credit Loss [(PD) * (LGD)]
1	5,000	5.00%	0	0	0	-5,000	-250
2	25,000	2.00%	18,000	0	1,800	-8,800	-176
3	150,000	100.00%	250,000	0	25,000	0	0
4	7,500	5.00%	0	0	0	-7,500	-375
5	25,000	3.00%	150,000	125,000	19,000	-19,000	-570
Total	212,500					-40,300	-1,371

PD MODEL: LINEAR REGRESSION

```
libname bankdata "/folders/myfolders/bank_data";
proc reg data=bankdata.mortgage;
        model default_time = FICO_orig_time LTV_time gdp_time;
run;
```

PD MODEL: LOGIT MODEL

```
proc logistic data=bankdata.mortgage;
        model default_time = FICO_orig_time LTV_time gdp_time /link=logit;
run;
```

PD MODEL: PROBIT MODEL

```
proc logistic data=bankdata.mortgage;
        model default_time = FICO_orig_time LTV_time gdp_time /link=probit;
run;
```

LGD MODELS: DATA PREP

```
libname bankdata "/folders/myfolders/bank_data";
FILENAME REFFILE '/folders/myfolders/bank_data/lgd.csv';
PROC IMPORT DATAFILE=REFFILE
                DBMS=CSV
                OUT=bankdata.lgd;
                GETNAMES=YES;
RUN;
data mylgd ;
                set bankdata.lgd;
                y_logistic=log(lgd_time/(1-lgd_time));
                y_probit=probit(lgd_time);
                lnrr=log(1-lgd_time);
run;
```

LGD MODEL: LINEAR REGRESSION

```
proc reg data=mylgd;
        model lgd_time=ltv;
run;
```

LGD MODEL: LOGIT MODEL

```
proc reg data=mylgd;
        model y_logistic=ltv;
run;
```

LGD MODEL: PROBIT MODEL

```
proc reg data=mylgd;
        model y_probit=ltv purpose1;
run;
```

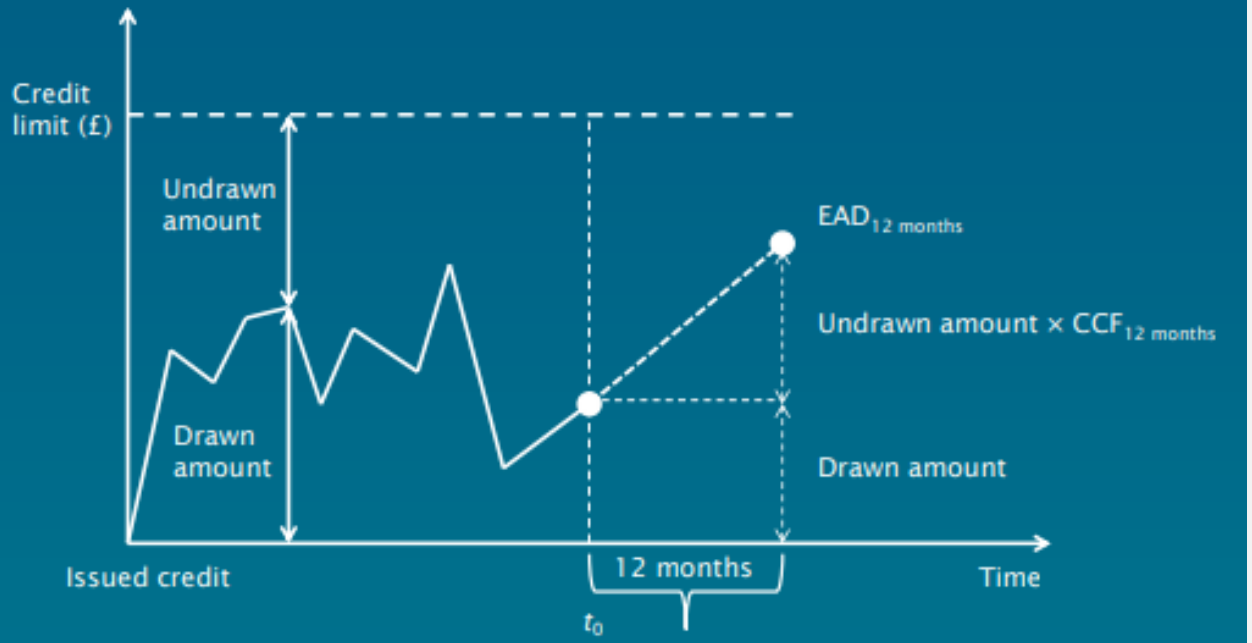
EAD MODEL: CCF

- CCF: Credit Conversion Factor
- CCF = (EAD-Drawn)/(Limit – Drawn)
- Assumption: future CCF could be forecasted based on historical CCFs

- Future EAD = Current Drawn + (Limit – Current Drawn) * CCF Forcast

EAD model approaches

Notation
$E(t_d)$ = EAD
$E(t_r)$ = balance at time r
$L(t_r)$ = limit at time r



Credit conversion factor (Taplin et al. 2007, Jacobs 2010, Qi 2009)

$$CCF = \frac{E(t_d) - E(t_r)}{L(t_r) - E(t_r)}$$

EAD MODEL: CEQ MODEL

- CEQ: Credit EQuivalent
- CEQ = (EAD-Drawn)/Limit
- Assumption: future CEQ could be forecasted based on historical CEQ

- Future EAD = Current Drawn + Limit * CEQ Forcast

EAD model approaches (cont'd)

Notation
$E(t_d)$ = EAD
$E(t_r)$ = balance at time r
$L(t_r)$ = limit at time r

Utilization change (Yang & Tkachenko, 2012)

$$util_{ch} = \frac{E(t_d) - E(t_r)}{L(t_r)}$$

Direct EAD based on OLS (Taplin et al., 2007)

Mixture models (Witzany, 2011, Leow & Crook, 2013)

EAD MODELS: DATA PREP

```
libname bankdata "/folders/myfolders/bank_data";
proc sort data=bankdata.mortgage;
    by id time;
run;
%let precision=1e-6;
data ead (drop=diff_limit_drawn);
    set bankdata.mortgage;
    by id time;
    array x(*) lag1-lag4;
    /* Define lag variables - time period is quarterly*/
    lag1=LAG1(balance_time);
    lag2=LAG2(balance_time);
    lag3=LAG3(balance_time);
    lag4=LAG4(balance_time);
    limit=balance_orig_time;
    drawn=lag4;
    exposure=balance_time;
    if  drawn EQ .
        or limit EQ .
        or exposure EQ .
        or exposure EQ 0 then delete;
    /*Cap Exposure bound */
    if exposure > limit then
        exposure=limit;
    if drawn > limit then
        drawn=limit;
    /*Credit Conversion Factor - CCF */
    diff_limit_drawn=limit-drawn;
    if (abs(diff_limit_drawn)>&precision) then
        CCF=(exposure-drawn)/diff_limit_drawn;
    else
        CCF=0;
    /*CEQ  -  credit equivalent */
    if (limit > &precision) then
        CEQ=(exposure-drawn)/limit;
    else
        CEQ=0;
run;
```

EAD MODELS: DATA PREP

```
data ead2;
    set ead;
    where drawn NE .
        and limit NE .
        and exposure NE .
        and exposure NE 0;
run;

proc means data=ead2 p1 p99;
    var CCF CEQ LCF UACF;
run;
```

```
data ead_default;
    set ead2;
    where default_time=1;
    if CCF <= -18.05 then CCF=-18.05;
    else if CCF >= 0.99 then CCF=0.99;
    if CEQ <= -0.13  then CEQ=-0.13;
    else if CEQ >=0.103 then CEQ=0.103;
run;
```

EAD MODELS

```
/*Check Histogram */
proc univariate data=ead_default;
    var CCF CEQ;
    histogram;
run;
```

```
/* CCF Model */
proc reg data=ead_default;
    model CCF=LTV_time;
run;

/* CEQ Model */
proc reg data=ead_default;
    model CEQ=LTV_time;
run;
```

ECL: COMBINE ALL TOGETHER

$$\text{ECL} = \sum_{t=1}^{T} \frac{PD\,(t)\,LGD\,(t)\,EAD\,(t)}{(1+r)^{t}}$$

DATA SETS FOR YOUR CECL PROJECT

- Two Data Sets in "bank_data" folder that you have downloaded from Bitbucket:
  - Mortgage Data (mortgage.sas7bdat):
    - The data set mortgage is in panel form and reports origination and performance observations for 50,000 residential U.S. mortgage borrowers over 60 periods.

  - LGD Data (lgd.csv):

    The data set includes 2,545 observations on loans and LGDs. Key variables are:

    - LTV: Loan-to-value ratio, in %
    - Recovery_rate: Recovery rate, in %
    - lgd_time: Loss rate given default (LGD), in %
    - y_logistic: Logistic transformation of the LGD
    - lnrr: Natural logarithm of the recovery rate
    - Y_probit: Probit transformation of the LGD
    - purpose1: Indicator variable for the purpose of the loan; 1 = renting purpose, 0 = other
    - event: Indicator variable for a default or cure event; 1 = event, 0 = no event

YOUR CECL PROJECT

- Estimate Expected Credit Loss for one period for all loans in the mortgage data.
- Hints:
  - Cluster mortgage loans
  - Build a PD champion model and a PD challenge model for each cluster
  - Build an LGD model using the lgd.csv data file.
  - Build an EAD model
  - Calculate ECL for each loan
  - Sum ECL for each cluster
  - Sum ECL for the entire mortgage portfolio of the Bank.
- Bonus:
  - Estimate Expected Credit Loss for the next 4 periods.