

External Credit Assessment and Mapping Process

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Tools: SQLite, Excel

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Background Information

The Office of the Superintendent of Financial Institutions (OSFI) has raised a new set of requirements to direct the usage of external credit assessments by big banks. After a review process of the major international rating agencies, OSFI has permitted banks to recognize credit ratings from the following rating agencies for capital adequacy purposes.

- DBRS
- Moody's Investors Service
- Standard and Poor's (S&P)
- Fitch Rating Services

Each bank will be responsible for assigning eligible External Credit Assessment Institutions (ECAIs)' assessments to the risk weights available under the standardized risk weighting framework, i.e. deciding which assessment categories correspond to which risk weights.

The mapping process should be objective and should result in a risk weight assignment consistent with that of the level of credit risk reflected in the tables above. It should cover the full spectrum of risk weights. The following table provides guidance as to how such a mapping process may be conducted:

RTG_MOODY	RTG_SP	RTG_DBRS	RTG_FITCH
Aaa	AAA	AAA	AAA
Aa1	AA+	AAH	AA+
Aa2	AA	AA	AA
Aa3	AA-	AAL	AA-
A1	A+	AH	A+
A2	A	A	A
A3	A-	AL	A-
Baa1	BBB+	BBBH	BBB+
Baa2	BBB	BBB	BBB
Baa3	BBB-	BBBL	BBB-
Ba1	BB+	BBH	BB+
Ba2	BB	BB	BB
Ba3	BB-	BBL	BB-
B1	B+	BH	B+
B2	B	B	B
B3	B-	BL	B-
Caa1	CCC+	CCCH	CCC+
Caa2	CCC	CCC	CCC
Caa3	CCC-	CCCL	CCC-
Ca	CC	CC	CC

Figure I: Credit assessment systems used by different organizations

Rules

- **Internal Grade (IG)** is usually assigned by analysts themselves, which are designed to reasonably matching with external credit ratings.
- **Higher** the **IG** (Internal Grade), **lower** the **risk weight**.
- If there is only one assessment by an ECAI chosen by a bank for a particular claim, that assessment should be used to determine the risk weight of the claim.
- If there are **two assessments** by ECAIs chosen by a bank which map into different risk weights, the **higher risk weight** will be applied.
- If there are **three or more** assessments with different risk weights, the assessments corresponding to the **two lowest risk weights** should be referred to and the **higher of those two** risk weights will be applied.
- For the instrument issued by **US or Canadian government**, if there is no external rating available, default the grade to 'AAA'.
- For the instrument issued by other **foreign government**, if there is no external rating available, default the grade to 'A'.

Objectives

For each security issuer, derive the "standardized risk weighting" from the ratings provided by ECAIs, based on OSFI's specific rules.

Inputs

The inputs provided are:

✓ All the fixed income securities that the bank is holding as of Jan 2020. ("bond_jan_2020.csv")

ID_CUSIP	ID_ISIN	Issuer	PARENT_COMP_NA	CRNCY	Maturity	PX_LAST	MARKET_	ISSUER_IN INDUSTRY	Industry_	Industry_	COLLAT_T	RTG_MOODY	RTG_SP
845467208	US8454672085	SOUTHWESTERN ENERGY CO	#N/A	USD	1/15/2018	#N/A	Pfd	GAS TRAN	Energy	Oil&Gas	Oil Comp- NEW MO	#N/A	#N/A
902494301	US9024943014	TYSON FOODS INC	#N/A	USD	7/15/2017	#N/A	Pfd	INDUSTRI	Consumer Food	Food-Mea NEW MO	#N/A	#N/A	#N/A
00182FAY2	US00182FAY25	ANZ NEW ZEALAND INTL/LDN	ANZ New Zealand Lt	USD	2/1/2019	#N/A	Corp	BANK	Financial	Banks	Commer E COMPAN\Aa3		AA-
00182FAZ9	US00182FAZ99	ANZ NEW ZEALAND INTL/LDN	ANZ New Zealand Lt	USD	2/3/2021	#N/A	Corp	BANK	Financial	Banks	Commer E COMPAN\Aa3		AA-
04010LAM5	US04010LAM54	ARES CAPITAL CORP	#N/A	USD	1/15/2019	#N/A	Corp	FINANCIA	Financial	Investmet	Investmet SR UNSECI	#N/A	BBB
060505EL4	US060505EL47	BANK OF AMERICA CORP	#N/A	USD	#N/A	#N/A	Corp	BANK	Financial	Banks	Diversifie JR SUBORI\Ba2		BB+
06417HS64	US06417HS643	BANK OF NOVA SCOTIA HOUS	Bank of Nova Scotia	USD	11/7/2016	#N/A	Corp	BANK	Financial	Banks	Commer E CERT OF D\Aa3		#N/A
126349AC3	US126349AC33	CSG SYSTEMS INTL INC	#N/A	USD	3/1/2017	#N/A	Corp	INDUSTRI	Technolog	Software	Data Proci SR SUBOR	#N/A	#N/A
172967KD2	US172967KD27	CITIGROUP INC	#N/A	USD	#N/A	#N/A	Corp	FINANCIA	Financial	Banks	Diversifie JR SUBORI\Ba2		#N/A
202712BD6	CA202712BD64	COMMONWEALTH BANK AUST	#N/A	CAD	4/9/2020	#N/A	Corp	BANK	Financial	Banks	Commer E SR UNSECI\Aa2		#N/A
227107AE9	CA227107AE98	CROMBIE REAL ESTATE INVE	#N/A	CAD	3/31/2021	#N/A	Corp	INDUSTRI	Financial	REITS	REITS-Div\ SUBORDIN	#N/A	#N/A
30161N127	US30161N1274	EXELON CORP	#N/A	USD	6/1/2017	#N/A	Pfd	UTILITY - E	Utilities	Electric	Electric-In NEW MO	#N/A	#N/A
3128E6BL0	US3128E6BL01	Freddie Mac	Freddie Mac	USD	4/1/2032	#N/A	Mtge	#N/A	Mortgage	FGLMC Co	FGLMC Sin FGTW	#N/A	#N/A
31371KZB0	US31371KZB06	Fannie Mae	Fannie Mae	USD	2/1/2033	#N/A	Mtge	#N/A	Mortgage	FNMA Col	FNMA Sin FNCL	#N/A	#N/A
31943BBL3	CA31943BBL32	FIRST CAP REALTY INC	#N/A	CAD	3/31/2018	#N/A	Corp	FINANCIA	Financial	Real Estat	Real Estat SUBORDIN	#N/A	#N/A
36177TLX3	US36177TLX36	Government National Mortgage A	Ginnie Mae	USD	5/15/2042	#N/A	Mtge	#N/A	Mortgage	GNMA Col	GNMA Sin GNSF	#N/A	#N/A
400653FP1	US400653FP16	GUAM PWR AUTH REVENUE	#N/A	USD	10/1/2034	#N/A	Muni	PWR	Government	Municipal	US Muni	#N/A	Baa3
404280AR0	US404280AR04	HSBC HOLDINGS PLC	#N/A	USD	#N/A	#N/A	Corp	BANK	Financial	Banks	Diversifie JR SUBORI\Baa3		#N/A
44986UAC3	US44986UAC36	INEOS GROUP HOLDINGS SA	INEOS Holdings Lux	USD	2/15/2019	#N/A	Corp	INDUSTRI	Basic Mat	Chemicals	Chemicals SECURED	B3	B-
451055AF4	US451055AF44	ICONIX BRAND GROUP INC	#N/A	USD	3/15/2018	#N/A	Corp	INDUSTRI	Consumer	Apparel	Footwear SR SUBOR	#N/A	#N/A
458140AF7	US458140AF79	INTEL CORP	#N/A	USD	8/1/2039	#N/A	Corp	INDUSTRI	Technolog	Semicond	Electronic JR SUBORI\A2		A-
47787ZAW2	CA47787ZAW29	JOHN DEERE CANADA FND IN	John Deere Financi	CAD	5/13/2022	#N/A	Corp	SPECIAL P	Industrial	Machinen	Machinen COMPANY\A2		A
48127FAA1	US48127FAA12	JPMORGAN CHASE & CO	#N/A	USD	#N/A	#N/A	Corp	FINANCIA	Financial	Banks	Diversifie JR SUBORI\Baa3		BBB-
49456B200	US49456B2007	KINDER MORGAN INC/DELAWA	#N/A	USD	10/26/2018	#N/A	Pfd	INDUSTRI	Energy	Pipelines	Pipelines NEW MO	#N/A	#N/A
500769GV0	US500769GV07	KFW	Federal Republic of	USD	2/6/2019	#N/A	Corp	BANK	Financial	Banks	Special Pu GOVT GUZ\Aaa		AAA
500769GW8	US500769GW89	KFW	Federal Republic of	USD	12/29/2017	#N/A	Corp	BANK	Financial	Banks	Special Pu GOVT GUZ\Aaa		AAA

Fig. II: Partial view of securities holding by bank as of Jan 2020

✓ Mapping table from external rating to internal rating. (“lt_rating_to_ig.csv”)

Higher the **IG**, **lower** the **risk weight**.

RTG_MOODY	RTG_SP	RTG_DBRS	RTG_FITCH	IG
Aaa	AAA	AAA	AAA	99
Aa1	AA+	AAH	AA+	98
Aa2	AA	AA	AA	96
Aa3	AA-	AAL	AA-	95
A1	A+	AH	A+	94
A2	A	A	A	92
A3	A-	AL	A-	90
Baa1	BBB+	BBBH	BBB+	87
Baa2	BBB	BBB	BBB	85
Baa3	BBB-	BBBL	BBB-	83
Ba1	BB+	BBH	BB+	80
Ba2	BB	BB	BB	77
Ba3	BB-	BBL	BB-	75
B1	B+	BH	B+	73
B2	B	B	B	70
B3	B-	BL	B-	68
Caa1	CCC+	CCCH	CCC+	65
Caa2	CCC	CCC	CCC	60
Caa3	CCC-	CCCL	CCC-	50
Ca	CC	CC	CC	40

Fig. III: Corresponding Investment Grade(IG) matching with credit assessments from other organizations.

✓ Mapping table from internal grade (IG) to internal rating (desired **Standardized Risk Weighting**). (“ig_to_rating.csv”)

IG	RTG_FINAL
99	AAA
98	AA+
96	AA
95	AA-
94	A+
92	A
90	A-
87	BBB+
85	BBB
83	BBB-
80	BB+
77	BB
75	BB-
73	B+
70	B
68	B-
65	CCC+
60	CCC
50	CCC-
40	CC

Fig. III: Conversion from Investment Grade(IG) to our own Standardized Risk Weighting (RTG_FINAL)

Note: “lt_rating_to_ig.csv” and “ig_to_rating.csv” are derived from the above-mentioned OSFI's guidance.

Build Up

1. Import Source Files into SQLite Studio

The first table we need to import is, **Bond_Jan_2020**, from file “**Bond_Jan_2020.csv**”. Contains all information of bond issued as of Jan 2020, where **primary key** is ‘ID_CUSIP’.

```
CREATE TABLE `Bond_Jan_2020` (
  `ID_CUSIP` TEXT,
  `ID_ISIN` TEXT,
  `Issuer` TEXT,
  `PARENT_COMP_NAME` TEXT,
  `CRNCY` TEXT,
  `Maturity` TEXT,
  `PX_LAST` TEXT,
  `MARKET_SECTOR_DES` TEXT,
  `ISSUER_INDUSTRY` TEXT,
  `INDUSTRY_SECTOR` TEXT,
  `Industry_Group` TEXT,
  `Industry_Subgroup` TEXT,
  `COLLAT_TYP` TEXT,
  `RTG_MOODY` TEXT,
  `RTG_SP` TEXT,
  `RTG_DBRS` TEXT,
  `RTG_FITCH` TEXT,
  `RTG_MDY_ISSUER` TEXT,
  `RTG_SP_LT_LC_ISSUER_CREDIT` TEXT,
  `RTG_DBRS_LT_ISSUER_RATING` TEXT,
  `RTG_FITCH_SEN_UNSECURED` TEXT,
  `Callable` TEXT,
  `Is_Subordinated` TEXT, `PRVT_PLACE` TEXT,
  `SERIES` TEXT, `GUARANTOR_TYPE` TEXT,
  `CNTRY_OF_INCORPORATION` TEXT,
  `CNTRY_OF_DOMICILE` TEXT,
  `Security_Type` TEXT , primary key (ID_CUSIP) );
```

Figure 1-1: Query to construct table Bond_Jan_2020

Then we replace ‘#N/A’ in the source file *Fig. II: Partial view of securities holding by bank as of Jan 2020* with **NULL** then import data in SQL:

	ID_CUSIP	ID_ISIN	Issuer	PARENT_COMP_NAME	CRNCY	Maturity	PX_LAST	MARKET_SECTOR_DES	ISSUER_INDUSTRY	INDUSTRY
1	845467208	US8454672085	SOUTHWESTERN ENERGY CO	NULL	USD	1/15/2018	NULL	Pfd	GAS TRANSMISSION	Energy
2	902494301	US9024943014	TYSON FOODS INC	NULL	USD	7/15/2017	NULL	Pfd	INDUSTRIAL	Consumer,
3	00182FAY2	US00182FAY25	ANZ NEW ZEALAND INTL/LDN	ANZ New Zealand Int'l Ltd/New	USD	2/1/2019	NULL	Corp	BANK	Financial
4	00182FAZ9	US00182FAZ99	ANZ NEW ZEALAND INTL/LDN	ANZ New Zealand Int'l Ltd/New	USD	2/3/2021	NULL	Corp	BANK	Financial
5	04010LAM5	US04010LAM54	ARES CAPITAL CORP	NULL	USD	1/15/2019	NULL	Corp	FINANCIAL	Financial
6	060505EL4	US060505EL47	BANK OF AMERICA CORP	NULL	USD	NULL	NULL	Corp	BANK	Financial
7	06417HS64	US06417HS643	BANK OF NOVA SCOTIA HOUS	Bank of Nova Scotia/The	USD	11/7/2016	NULL	Corp	BANK	Financial
8	126349AC3	US126349AC33	CSG SYSTEMS INTL INC	NULL	USD	3/1/2017	NULL	Corp	INDUSTRIAL	Technology
9	172967KD2	US172967KD27	CITIGROUP INC	NULL	USD	NULL	NULL	Corp	FINANCIAL	Financial
10	202712BD6	CA202712BD64	COMMONWEALTH BANK AUST	NULL	CAD	4/9/2020	NULL	Corp	BANK	Financial
11	227107AE9	CA227107AE98	CROMBIE REAL ESTATE INVE	NULL	CAD	3/31/2021	NULL	Corp	INDUSTRIAL	Financial
12	30161N127	US30161N1274	EXELON CORP	NULL	USD	6/1/2017	NULL	Pfd	UTILITY - ELEC	Utilities
13	31286BBL0	US31286BBL01	Freddie Mac	Freddie Mac	USD	4/1/2032	NULL	Mtge	NULL	Mortgage S
14	31371KZB0	US31371KZB06	Fannie Mae	Fannie Mae	USD	2/1/2033	NULL	Mtge	NULL	Mortgage S
15	31943BBL3	CA31943BBL32	FIRST CAP REALTY INC	NULL	CAD	3/31/2018	NULL	Corp	FINANCIAL	Financial
16	36177TLX3	US36177TLX36	Government National Mortgage A	Ginnie Mae	USD	5/15/2042	NULL	Mtge	NULL	Mortgage S
17	400653FP1	US400653FP16	GUAM PWR AUTH REVENUE	NULL	USD	10/1/2034	NULL	Muni	PWR	Government
18	404280AR0	US404280AR04	HSBC HOLDINGS PLC	NULL	USD	NULL	NULL	Corp	BANK	Financial
19	44986UAC3	US44986UAC36	INEOS GROUP HOLDINGS SA	INEOS Holdings Luxembourg SA	USD	2/15/2019	NULL	Corp	INDUSTRIAL	Basic Mater
20	451055AF4	US451055AF44	ICONIX BRAND GROUP INC	NULL	USD	3/15/2018	NULL	Corp	INDUSTRIAL	Consumer,
21	458140AF7	US458140AF79	INTEL CORP	NULL	USD	8/1/2039	NULL	Corp	INDUSTRIAL	Technology
22	47787ZAW2	CA47787ZAW29	JOHN DEERE CANADA FND IN	John Deere Financial Inc	CAD	5/13/2022	NULL	Corp	SPECIAL PURPOSE	Industrial
23	48127FAA1	US48127FAA12	JPMORGAN CHASE & CO	NULL	USD	NULL	NULL	Corp	FINANCIAL	Financial
24	49456B200	US49456B2007	KINDER MORGAN INC/DELAWA	NULL	USD	10/26/2018	NULL	Pfd	INDUSTRIAL	Energy

Figure 1-2: Table Bond_Jan_2020 after NULL value applied

The second table we imported is '**IG_To_Rating**' from source file "**IG_To_Rating.csv**". This table contains our matching schema from Internal Grade (IG) to Final Standardized Risk Weighting (RTG_FINAL).

```
CREATE TABLE `IG_to_Rating` (
  `IG` TEXT,
  `RTG_FINAL` TEXT
);
```

Figure 1-3: Query to construct table: IG_To_Rating

IG	RTG_FINAL
99	AAA
98	AA+
96	AA
95	AA-
94	A+
92	A
90	A-
87	BBB+
85	BBB
83	BBB-
80	BB+
77	BB
75	BB-
73	B+
70	B
68	B-
65	CCC+
60	CCC
50	CCC-
40	CC

Figure 1-4: Conversion schema from Internal Grade (IG) to Internal Credit Ratings (RTG_FINAL)

The third table we need to import is '**LT_Rating_to_IG**' from source file "**LT_Rating_to_IG.csv**", which contains the Internal Grade (IG) that matching with the risk weightings from external rating agencies.

```
CREATE TABLE `LT_Rating_to_IG` (
  `RTG_MOODY` TEXT,
  `RTG_SP` TEXT,
  `RTG_DBRS` TEXT,
  `RTG_FITCH` TEXT,
  `IG` TEXT
);
```

Figure 1-5: Query to construct table LT_Rating_to_IG

RTG_MOODY	RTG_SP	RTG_DBRS	RTG_FITCH	IG
Aaa	AAA	AAA	AAA	99
Aa1	AA+	AAH	AA+	98
Aa2	AA	AA	AA	96
Aa3	AA-	AAL	AA-	95
A1	A+	AH	A+	94
A2	A	A	A	92
A3	A-	AL	A-	90
Baa1	BBB+	BBBH	BBB+	87
Baa2	BBB	BBB	BBB	85
Baa3	BBB-	BBBL	BBB-	83
Ba1	BB+	BBH	BB+	80
Ba2	BB	BB	BB	77
Ba3	BB-	BBL	BB-	75
B1	B+	BH	B+	73
B2	B	B	B	70
B3	B-	BL	B-	68
Caa1	CCC+	CCCH	CCC+	65
Caa2	CCC	CCC	CCC	60
Caa3	CCC-	CCCL	CCC-	50
Ca	CC	CC	CC	40

Figure 1-6: Internal Grade (IG) matching with external credit ratings

2. Convert External Risk Weights into Internal Grades (IG)

We need first to convert the external risk weights i.e. ‘RTG_MOODY’, ‘RTG_SP’, ‘RTG_DBRS’, ‘RTG_FITCH’ into **IG_MOODY**, **IG_SP**, **IG_DBRS**, **IG_FITCH** respectively. And count how many rating agencies have given ratings to one specific security (*ratings_received*) using table ‘**bond_jan_2020**’ and ‘**LT_Rating_to_IG**’.

Generate new table: **derive_rating**

```
CREATE TABLE derive_rating AS
SELECT
  a.ID_CUSIP,
  a.Issuer,
  a.CRNCY,
  a.INDUSTRY_SECTOR,
  a.CNTRY_OF_INCORPORATION,
  b.ig as ig_moody,
  c.ig as ig_sp,
  d.ig as ig_dbrs,
  e.ig as ig_fitch,
  --- count how many agencies have assigned risk weight to one specific security
  --- Note that different agencies may given SAME rating
  (
    case when b.ig is null then 0 else 1 end
    + case when c.ig is null then 0 else 1 end
    + case when d.ig is null then 0 else 1 end
    + case when e.ig is null then 0 else 1 end
  ) as ratings_received
FROM bond_jan_2020 AS a
LEFT JOIN LT_Rating_to_IG AS b ON a.rtg_moody = b.rtg_moody
LEFT JOIN LT_Rating_to_IG AS c ON a.rtg_sp = c.rtg_sp
LEFT JOIN LT_Rating_to_IG AS d ON a.rtg_dbrs = d.rtg_dbrs
LEFT JOIN LT_Rating_to_IG AS e ON a.rtg_fitch = e.rtg_fitch
```

Figure 2-1: Query to convert external ratings to Internal Grade (IG), generates new table: derive_rating.

We get:

	ID_CUSIP	Issuer	CRNCY	INDUSTRY_SECTOR	CNTRY_OF_INCORPORATION	ig_moody	ig_sp	ig_dbbs	ig_fitch	ratings_received
1	845467208	SOUTHWESTERN ENERGY CO	USD	Energy	US	NULL	NULL	NULL	NULL	0
2	902494301	TYSON FOODS INC	USD	Consumer, Non-cyclical	US	NULL	NULL	NULL	NULL	0
3	00182FAY2	ANZ NEW ZEALAND INTL/LDN	USD	Financial	NZ	95	95	NULL	NULL	2
4	00182FAZ9	ANZ NEW ZEALAND INTL/LDN	USD	Financial	NZ	95	95	NULL	NULL	2
5	04010LAM5	ARES CAPITAL CORP	USD	Financial	US	NULL	85	NULL	NULL	1
6	060505EL4	BANK OF AMERICA CORP	USD	Financial	US	77	80	83	NULL	3
7	06417HS64	BANK OF NOVA SCOTIA HOUS	USD	Financial	CA	95	NULL	NULL	NULL	1
8	126349AC3	CSG SYSTEMS INTL INC	USD	Technology	US	NULL	NULL	NULL	NULL	0
9	172967KD2	CITIGROUP INC	USD	Financial	US	77	NULL	85	NULL	2
10	202712BD6	COMMONWEALTH BANK AUST	CAD	Financial	AU	96	NULL	96	NULL	2
11	227107AE9	CROMBIE REAL ESTATE INVE	CAD	Financial	CA	NULL	NULL	NULL	NULL	0
12	30161N127	EXELON CORP	USD	Utilities	US	NULL	NULL	NULL	NULL	0
13	3128E6BL0	Freddie Mac	USD	Mortgage Securities	NULL	NULL	NULL	NULL	NULL	0
14	31371KZB0	Fannie Mae	USD	Mortgage Securities	NULL	NULL	NULL	NULL	NULL	0
15	31943BBL3	FIRST CAP REALTY INC	CAD	Financial	CA	NULL	NULL	NULL	NULL	0
16	36177TLX3	Government National Mortgage A	USD	Mortgage Securities	NULL	NULL	NULL	NULL	NULL	0
17	400653FP1	GUAM PWR AUTH REVENUE	USD	Government	NULL	83	NULL	NULL	NULL	1
18	404280AR0	HSBC HOLDINGS PLC	USD	Financial	GB	83	NULL	NULL	NULL	1
19	44986UAC3	INEOS GROUP HOLDINGS SA	USD	Basic Materials	LU	68	68	NULL	NULL	2
20	451055AF4	ICONIX BRAND GROUP INC	USD	Consumer, Cyclical	US	NULL	NULL	NULL	NULL	0
21	458140AF7	INTEL CORP	USD	Technology	US	92	90	NULL	NULL	2
22	47787ZAW2	JOHN DEERE CANADA FND IN	CAD	Industrial	CA	92	92	92	NULL	3
23	48127FAA1	JPMORGAN CHASE & CO	USD	Financial	US	83	83	NULL	NULL	2
24	49456B200	KINDER MORGAN INC/DELAWA	USD	Energy	US	NULL	NULL	NULL	NULL	0
25	500769GV0	KFW	USD	Financial	DE	99	99	NULL	NULL	2

Figure 2-2: Partial view of data in table derive_rating

3. Determine Number of Different External Ratings Received for Each Security

To achieve the title, we first need to put all securities' **different** external ratings into one column and making sure **no duplicates** are included we named the column as "IG_val".

We get table **derive_rating_1** as:

```
CREATE TABLE derive_rating_1 AS
SELECT id_cusip, ig_moody as IG_val from derive_rating
UNION
SELECT id_cusip, ig_sp from derive_rating
UNION
SELECT id_cusip, ig_dbbs from derive_rating
UNION
SELECT id_cusip, ig_fitch from derive_rating
ORDER BY id_cusip asc, IG_val desc
;
```

Figure 3-1: Putting all external ratings into 1 column. New table: derive_rating_1

id_cusip	IG_val
00182FAY2	95
00182FAY2	NULL
00182FAZ9	95
00182FAZ9	NULL
04010LAM5	85
04010LAM5	NULL
060505EL4	83
060505EL4	80
060505EL4	77
060505EL4	NULL
06417HS64	95
06417HS64	NULL
126349AC3	NULL
172967KD2	85
172967KD2	77
172967KD2	NULL
202712BD6	96
202712BD6	NULL

Figure 3-2: Partial view of derive_rating_1, which contains NULL values

Now, in table **derive_rating_2** we remove rows with of NULL values in “IG_val”

```

----- eliminate NULL values
CREATE TABLE derive_rating_2 AS
SELECT *
FROM derive_rating_1
WHERE IG_val is not null
;

```

Figure 3-3: Query to eliminate NULL values from derive_rating_1 table

We get:

ID_CUSIP	IG_val
00182FAY2	95
00182FAZ9	95
04010LAM5	85
060505EL4	83
060505EL4	80
060505EL4	77
06417HS64	95
172967KD2	85
172967KD2	77
202712BD6	96
400653FP1	83
404280AR0	83
44986UAC3	68
458140AF7	92
458140AF7	90
47787ZAW2	92
48127FAA1	83
500769GV0	99

Figure 3-4: Table derive_rating_2 with no NULL values

Lastly, we count how many **DISTINCT** external ratings received for each security as 'num_record'. Note, **different** rating agencies may give **same** risk weights to a security.

Thus we produce table **derive_rating_3** as:

```
CREATE TABLE derive_rating_3 AS
SELECT
  a.*,
  (
    select count(*) from derive_rating_2 as b
    where b.id_cusip = a.id_cusip
  ) as num_record
FROM derive_rating_2 a
;
```

Figure 3-5: Query to construct derive_rating_3, with distinct ratings

We get:

ID_CUSIP	IG_val	num_record
00182FAY2	95	1
00182FAZ9	95	1
04010LAM5	85	1
060505EL4	83	3
060505EL4	80	3
060505EL4	77	3
06417HS64	95	1
172967KD2	85	2
172967KD2	77	2
202712BD6	96	1
400653FP1	83	1
404280AR0	83	1
44986UAC3	68	1
458140AF7	92	2
458140AF7	90	2
47787ZAW2	92	1

Figure 3-6: Table derive_rating_3 records number of different ratings for each security

4. Obtain Proper IG Value when Security Has Multiple Ratings

We first obtain all the **DISTINCT ID_CUSIP** from '**bond_jan_2020**' for future use.

Table **unique_cusip**:

```
CREATE TABLE unique_cusip AS
SELECT distinct ID_CUSIP
FROM bond_jan_2020
--- making sure that id_cusip is not a string with length 0
where id_cusip <> ''
;
```

Figure 4-1: Construct table unique_cusip, which contains all distinct ID_CUSIP

We get:

	ID_CUSIP
1	00182FAY2
2	00182FAZ9
3	04010LAM5
4	060505EL4
5	06417HS64
6	126349AC3
7	172967KD2
8	202712BD6
9	227107AE9
10	30161N127
11	3128E6BL0
12	31371KZB0
13	31943BBL3
14	36177TLX3
15	400653FP1
16	404280AR0
17	44986UAC3
18	451055AF4

Figure 4-2: Table unique_cusip

We now discuss how to get desired **Internal Grade (IG)** when a security has **multiple different ratings**.

NOTE: **Higher** the **IG** (Internal Grade), **lower** the **risk weight**.

Case	Rules	Example	Result
Security has 2 different risk weights	the higher risk weight (i.e. lower IG) will be applied	IG : (85,81). 81 is the lower IG (i.e. higher risk weight) thus 81 is the desired IG value	81
Security has 3 or more different risk weights	two lowest risk weights (i.e. two highest IG) should be referred to and the higher of those two risk weights (i.e. the lower IG value among the two) will be applied	IG: (83, 80, 77). Since (83,80) are the 2 lowest risk weight (i.e. 2 highest IG), and 80 is the highest risk weight among the two , so 80 is the desired IG value.	80

Table 4-4-1: Discussion when security has multiple risk weights

The SQLite query of table '**derive_rating_4**' can be written as:

```

CREATE TABLE derive_rating_4 AS
SELECT
    a.id_cusip,
    (
        select IG_VAL
        from derive_rating_3 b
        where b.id_cusip = a.id_cusip
            and b.num_record > 1
        limit 1, 1
        -- Higher the IG, Lower the risk weight
        -- when have ratings >= 3 ex: (83, 80, 77), select 2 higher IGs : 83, 80 (2 lower risk weights),
        ----- and the lowest IG 80 (highest risk weights among the two) got selected
    ) final_rating
FROM unique_cusip a
--- may produce NULL because this exculdes num_record = 1
WHERE final_rating IS NOT NULL

UNION

SELECT
    id_cusip,
    IG_val
FROM derive_rating_3
WHERE num_record = 1
;

```

Figure 4-3: Table derive_rating_4

The **UNION** clause combined securities with **multiple ratings** and securities with **one rating**.

We get:

id_cusip	final_rating
00182FAY2	95
00182FAZ9	95
04010LAM5	85
060505EL4	80
06417HS64	95
172967KD2	77
202712BD6	96
400653FP1	83
404280AR0	83
44986UAC3	68
458140AF7	90
47787ZAW2	92
48127FAA1	83
500769GV0	99
500769GW8	99
526057BG8	77
55608RAT7	92
65339F846	85
67066GAC8	80

Figure 4-4: Partial view of table derive_rating_4

5. Convert IG to desired Standardized Risk Weighting (RTG_FINAL)

First, we apprehend column **'final_rating'** onto table **'derive_rating'**

Table **'derive_rating_5'**:

```
CREATE TABLE derive_rating_5 AS
SELECT
    a.ID_CUSIP,
    a.Issuer,
    a.CRNCY,
    a.INDUSTRY_SECTOR,
    a.CNTRY_OF_INCORPORATION,
    b.final_rating as final_ig
FROM derive_rating a
LEFT JOIN derive_rating_4 b
ON a.id_cusip = b.id_cusip
;
```

Figure 5-1: Query to construct table derive_rating_5

We get:

ID_CUSIP	Issuer	CRNCY	INDUSTRY_SECTOR	CNTRY_OF_INCORPORATION	final_ig
172967KD2	CITIGROUP INC	USD	Financial	US	77
202712BD6	COMMONWEALTH BANK AUST	CAD	Financial	AU	96
227107AE9	CROMBIE REAL ESTATE INVE	CAD	Financial	CA	NULL
30161N127	EXELON CORP	USD	Utilities	US	NULL
3128E6BL0	Freddie Mac	USD	Mortgage Securities	NULL	NULL
31371KZB0	Fannie Mae	USD	Mortgage Securities	NULL	NULL
31943BBL3	FIRST CAP REALTY INC	CAD	Financial	CA	NULL
36177TLX3	Government National Mortgage A	USD	Mortgage Securities	NULL	NULL
400653FP1	GUAM PWR AUTH REVENUE	USD	Government	NULL	83
404280AR0	HSBC HOLDINGS PLC	USD	Financial	GB	83
44986UAC3	INEOS GROUP HOLDINGS SA	USD	Basic Materials	LU	68
451055AF4	ICONIX BRAND GROUP INC	USD	Consumer, Cyclical	US	NULL
458140AF7	INTEL CORP	USD	Technology	US	90
47787ZAW2	JOHN DEERE CANADA FND IN	CAD	Industrial	CA	92
48127FAA1	JPMORGAN CHASE & CO	USD	Financial	US	83
49456B200	KINDER MORGAN INC/DELAWA	USD	Energy	US	NULL
500769GV0	KFW	USD	Financial	DE	99
500769GW8	KFW	USD	Financial	DE	99
526057BG8	LENNAR CORP	USD	Consumer, Cyclical	US	77

Figure 5-2: View of table derive_rating_5, with new column 'final_ig'

Next, we replace **NULL** value with '**N/A**', and convert '**final_ig**' into our desired **Standardized Risk Weighting (Final_Rating)** which is required by the report.

Table **'derive_rating_6'**

```

----- and replace NULL with 'N/A'
CREATE TABLE derive_rating_6 AS
SELECT
    a.*,
    coalesce (b.rtg_final, 'N/A') as Final_Rating
FROM derive_rating_5 a
LEFT JOIN IG_to_Rating b
on a.final_ig = b.ig
;

```

Figure 5-3: Query that produce derive_rating_6, with all NULL value being replaced

We get:

ID_CUSIP	Issuer	CRNCY	INDUSTRY_SECTOR	CNTRY_OF_INCORPORATION	final_ig	Final_Rating
845467208	SOUTHWESTERN ENERGY CO	USD	Energy	US	NULL	N/A
902494301	TYSON FOODS INC	USD	Consumer, Non-cyclical	US	NULL	N/A
00182FAY2	ANZ NEW ZEALAND INTL/LDN	USD	Financial	NZ	95	AA-
00182FAZ9	ANZ NEW ZEALAND INTL/LDN	USD	Financial	NZ	95	AA-
04010LAM5	ARES CAPITAL CORP	USD	Financial	US	85	BBB
060505EL4	BANK OF AMERICA CORP	USD	Financial	US	80	BB+
06417HS64	BANK OF NOVA SCOTIA HOUS	USD	Financial	CA	95	AA-
126349AC3	CSG SYSTEMS INTL INC	USD	Technology	US	NULL	N/A
172967KD2	CITIGROUP INC	USD	Financial	US	77	BB
202712BD6	COMMONWEALTH BANK AUST	CAD	Financial	AU	96	AA
227107AE9	CROMBIE REAL ESTATE INVE	CAD	Financial	CA	NULL	N/A
30161N127	EXELON CORP	USD	Utilities	US	NULL	N/A
3128E6BL0	Freddie Mac	USD	Mortgage Securities	NULL	NULL	N/A
31371KZB0	Fannie Mae	USD	Mortgage Securities	NULL	NULL	N/A
31943BBL3	FIRST CAP REALTY INC	CAD	Financial	CA	NULL	N/A
36177TLX3	Government National Mortgage A	USD	Mortgage Securities	NULL	NULL	N/A
400653FP1	GUAM PWR AUTH REVENUE	USD	Government	NULL	83	BBB-
404280AR0	HSBC HOLDINGS PLC	USD	Financial	GB	83	BBB-
44986UAC3	INEOS GROUP HOLDINGS SA	USD	Basic Materials	LU	68	B-

Figure 5-4: derive_rating_6 with desired column Final_rating

6. Discuss securities issued by Governments and generate Final Report

The final case we need to discuss is:

Case	In query	Final_Rating
When no ratings applied to 'US' or 'CA' government issued bonds	cntry_of_incorporation in ('US','CA') AND industry_sector = 'Government' AND final_rating = 'N/A'	'AAA'
When no ratings applied to any other foreign government issued bonds	cntry_of_incorporation NOT in ('US','CA') AND industry_sector = 'Government' AND final_rating = 'N/A'	'A'

Table 6-1: Case discussion when no ratings assigned to government issued bonds

Now we can derive our final table for report: **'derive_rating_report'**

```
CREATE TABLE derive_rating_report AS
SELECT
  *,
  CASE WHEN cntry_of_incorporation in ('US','CA')
        AND industry_sector = 'Government'
        AND final_rating = 'N/A'
  THEN 'AAA'
  WHEN cntry_of_incorporation not in ('US','CA')
        AND industry_sector = 'Government'
        AND final_rating = 'N/A'
  THEN 'A'
  ELSE final_rating
  END AS final_rating_adj
FROM derive_rating_6
```

Table 6-2: Produced Final report after discussion of no ratings to government bonds

We get:

	ID_CUSIP	Issuer	CRNCY	INDUSTRY_SECTOR	CNTRY_OF_INCORPORATION	final_jg	Final_Rating	final_rating_adj
1	47787ZAW2	JOHN DEERE CANADA FND IN	CAD	Industrial	CA	92	A	A
2	55608RAT7	MACQUARIE BANK LTD	USD	Financial	AU	92	A	A
3	EI1204540	BONOS TESORERIA PESOS	CLP	Government	CL	NULL	N/A	A
4	EJ3997248	MIZUHO BANK LTD	USD	Financial	JP	92	A	A
5	EK6548193	TREASURY CERTIFICATES	EUR	Government	BE	NULL	N/A	A
6	EK6593843	TREASURY CERTIFICATES	EUR	Government	BE	NULL	N/A	A
7	EK7932602	SPAIN LETRAS DEL TESORO	EUR	Government	ES	NULL	N/A	A
8	EK8199722	NETHERLANDS GOVERNMENT	EUR	Government	NL	NULL	N/A	A
9	GB00BXR83C02	UK TREASURY BILL GBP	GBP	Government	GB	NULL	N/A	A
10	JV0604795	BUONI ORDINARI DEL TES	EUR	Government	IT	NULL	N/A	A
11	JV4742062	FRENCH DISCOUNT T-BILL	EUR	Government	FR	NULL	N/A	A
12	JV4742419	UK TREASURY BILL GBP	GBP	Government	GB	NULL	N/A	A
13	JV5031986	BUONI ORDINARI DEL TES	EUR	Government	IT	NULL	N/A	A
14	JV6072112	BELGIUM KINGDOM	EUR	Government	BE	NULL	N/A	A
15	JV6797395	SPAIN LETRAS DEL TESORO	EUR	Government	ES	NULL	N/A	A

Table 6-3: Final Report with desired Standardized Risk Weighting (Final_rating_adj)

From the table we can clearly observe that some Government issued securities with no initial external ratings have been adjusted into our desired **Standardized Risk Weighting (Final_rating_adj)**.

Hence, the Report of External Credit Assessments and Mapping Process has completed.