2° Investing Initiative

PACTA for Banks Training Webinar:
Matching a loan book to physical assets in the real economy

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

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What we'll cover

Matching a bank's loan book to physical assets in the real economy, using the Asset-level Data set provided by Asset Resolution and the r2dii.match software package

Agenda

- Recap of methodology & the matching process
- User resources
- Matching work flow with examples and code (r2dii.match)
  - Step 1 – Import files
    - Sector Classification Codes
  - Step 2 – match_name function
    - String Matching algorithms
  - Step 3 – Manual matching
  - Step 4 – Overwrite file
  - Step 5 – Prioritize function
- Next steps
- Q&A

Methodology Recap

Corporate lending portfolios

Alignment of loan books is benchmarked against **climate change scenarios** and the **market**

Loans are mapped to the **physical assets** in **the real economy** and their corresponding **production values**

Climate Change Scenarios

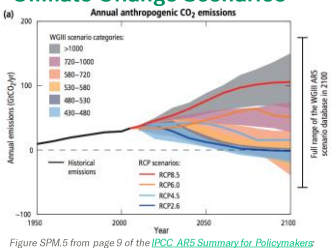
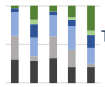
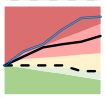


Figure SPM.5 from page 9 of the IPCC AR5 Summary for Policymakers

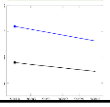
Metrics



Technology mix



Volume trajectory



Emission Intensity

Physical Assets in the Real Economy

Mapping physical assets to a bank's exposures – in practical terms

Corporate lending portfolios

Physical assets in the real economy

r2dii.match

Loan book (LBK)

	A	B	C	D	E	F
1	id_loan	id_direct_	name_dir	id_interm	name_int	id_ultimat
2	L1	c301	BP plc	NA	NA	UP101
3	L2	c301	BP plc	NA	NA	UP101
4	L3	c301	BP	NA	NA	UP101
5	L4	c302	duke ener	NA	NA	UP102
6	L5	c303	duke ener	NA	NA	UP102

Asset Level Data (ALD)

Asset Resolution

	A	B	C	D	E	F
1	name_cor	sector	technolog	year	productio	productio
2	bp plc	oil and gas	gas	2019		GJ
3	bp plc	oil and gas	gas	2019		GJ
4	bp plc	oil and gas	gas	2019		GJ
5	bp plc	oil and gas	gas	2019		GJ
6	bp plc	oil and gas	gas	2019		GJ

Terminology / Disclaimer

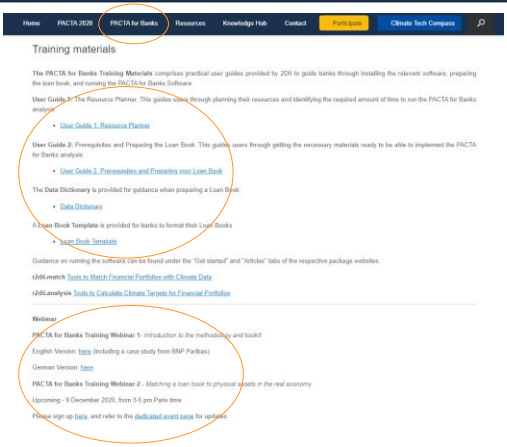
- Examples given in this presentation are illustrative only
- The names of companies may be represented differently in the asset-level data set provided by Asset Resolution

Term	Abbreviation	Description
Asset Level Data	ALD	The data set to which the loan book is being matched
Loan book	LBK	The bank's corporate lending book
Direct Loan Taker	DL	The counter party that receives the loan
Ultimate Parent	UP	The owner of the counter party receiving the loan
2 Degrees Investing Initiative	2DII	The think tank behind the PACTA methodology
Asset Resolution	AR	The data provider proving the free PACTA for banks data set

User resources:
Transition Monitor website

User Guides and templates
User Guide 1 – Resource Planner
User Guide 2 - Prerequisites and Preparing your loan book
Loan Book Template

Webinars
Webinar 1 Introduction to the Methodology and tool kit
Webinar 2 (today) Matching a loan book to physical assets in the real economy
Webinar 3 (TBC) Analysis and Visualisation



User resources: r2dii.match website

Get started – instructions for using the code with reproducible examples and mock data sets

User resources: r2dii.match Website

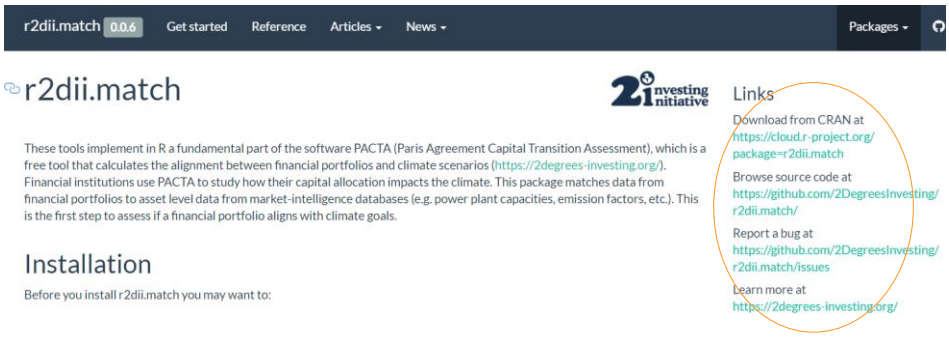
Articles cover certain issues that may arise and other useful topics. For example, matching a large loan book and calculating matching coverage.

User resources: r2dii.match Website

News contains updates on the code. For example, bugs fixes, feature enhancements, new features, etc...

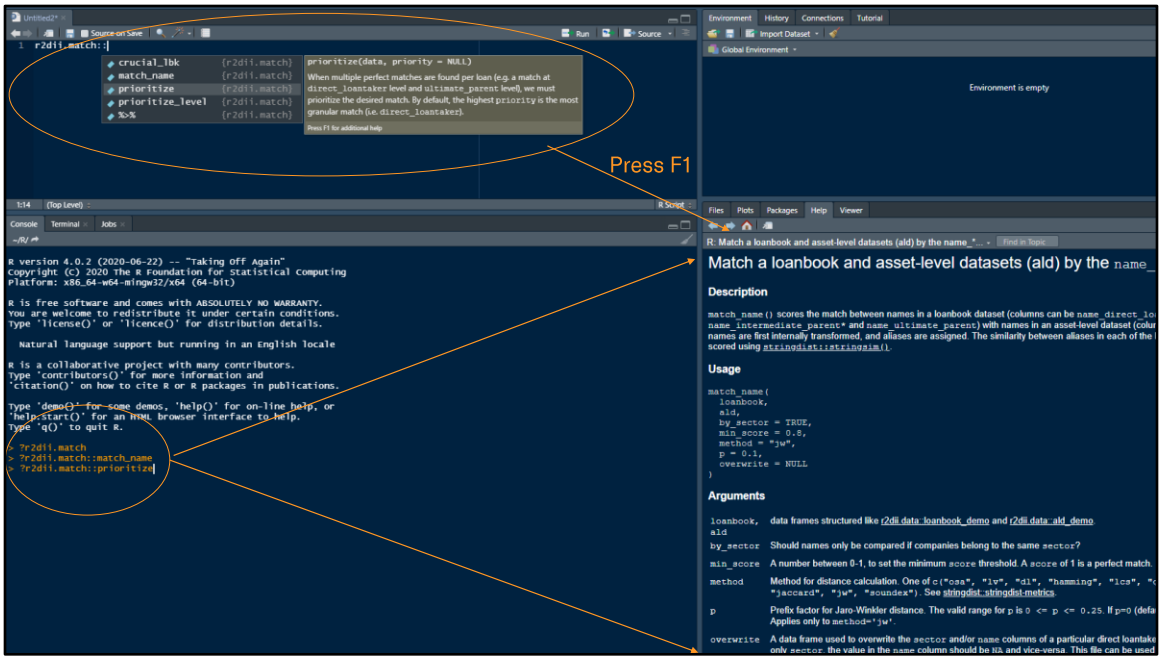
Resources available to a user: r2dii.match Website

Links – here you can find the source codes and report any bugs, new features or feature enhancement



User resources: R-Documentation

- Within the code, you can access the function documentation
- This explains how to use the functions and all the arguments
- This can be accessed by typing
  - In the script, type r2dii.match::match_name
    r2dii.match::prioritize
  - In the console type ?r2dii.match

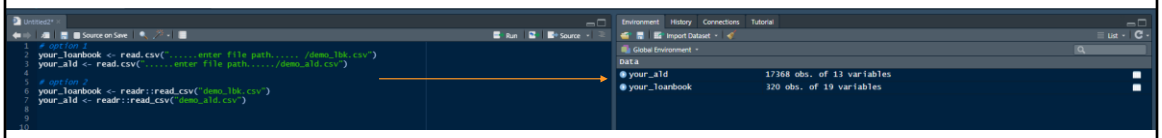

r2dii.match::
crucial_lbk {r2dii.match}
match_name {r2dii.match}
prioritize {r2dii.match}
prioritize_level {r2dii.match}
%>% {r2dii.match}
prioritize(data, priority = NULL)
When multiple perfect matches are found per loan (e.g. a match at direct_loantaker level and ultimate_parent level), we must prioritize the desired match. By default, the highest priority is the most granular match (i.e. direct_loantaker).
Press F1 for additional help
Press F1
R version 4.0.2 (2020-06-22) -- "Taking Off Again"
Copyright (C) 2020 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.
Natural language support but running in an English locale
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
> ?r2dii.match
> ?r2dii.match::match_name
> ?r2dii.match::prioritize
Environment is empty
Match a loanbook and asset-level datasets (ald) by the name_
Description
Usage
Arguments

Resources available to a user: External resources

- You may encounter errors that are unrelated to the r2dii packages
- Read the error messages and work out what is going wrong
- These are some commonly used resources to help overcome common errors messages in R
  - Stackoverflow
  - rstudio community

Work flow:
Step 1. Import files

- Import loan book – in the correct template: r2dii.data::loanbook_demo
- Import Asset level Data set
  - No right way to do this
  - Possible functions
    - Readr
    - Read.csv



- Note (optional) – You may want to segment the LBK and ALD by sectors
  - This will make it more manageable to match and prevent potential issues with the size of the files and memory limits

Templates can be found in r2dii.data
The Asset Level Data set from Asset Resolution can be accessed by filing a data request for free at: https://www.transitionmonitor.com/pacta-for-banks-2020/data/
You can use another data provider but in order to work with the code it must be inputted in the same format in r2dii.data::ald_demo

Code----------

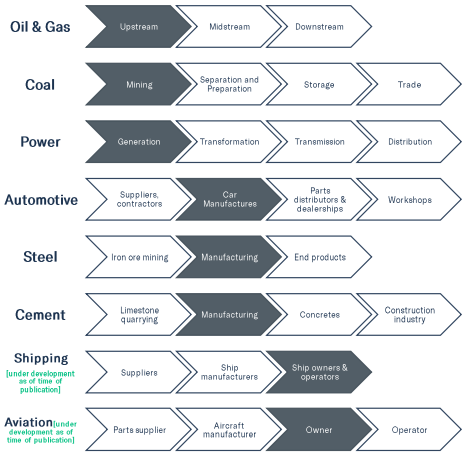
```
# option 1 – Preferred
your_loanbook <- readr::read_csv("demo_lbk.csv")
your_ald <- readr::read_csv("demo_ald.csv")

# note depending on the separator in your csv file you may need to use read_csv2 (;) as opposed to read_csv (,)

# option 2
your_loanbook <- read.csv("......enter file path..... /demo_lbk.csv")
your_ald <- read.csv("......enter file path...../demo_ald.csv")
```

Sector Classification Bridges

- Sector classification bridges between common code systems and 2dii sectors are provided
- Including:
  - **NACE**
  - **GICS**
  - **ISIC**
  - **SIC**
  - **NAICS**
- This can be accessed via r2dii.data::nace_classification
- More codes than are technically in scope are included



The rational behind including more codes than are technically in scope is to capture companies that are misclassified or for what ever reason recorded under the wrong code

You can filter the “borderline” column with in the respective bridges to equal FLASE to find the codes that are precisely in scope

Sector Classification Bridges

Example from the NACE bridge

	original_code	code	code_level	sector	borderline
	All	All	All	gas	All
1	6	60	2	oil and gas	FALSE
2	6.1	610	3	oil and gas	FALSE
3	6.1	6100	4	oil and gas	FALSE
4	6.2	620	3	oil and gas	FALSE
5	6.2	6200	4	oil and gas	FALSE
6	9.1	910	3	oil and gas	TRUE
7	9.1	9100	4	oil and gas	TRUE
8	35.2	352	3	oil and gas	TRUE
9	35.21	3521	4	oil and gas	TRUE
10	35.22	3522	4	oil and gas	TRUE
11	35.23	3523	4	oil and gas	TRUE

Borderline = FALSE
6100 = Extraction of crude petroleum
6200 = Extraction of natural gas

Perfectly in scope

Oil & Gas

Upstream | Midstream | Downstream

Close to scope – there is a chance it is mislabelled

Borderline = TRUE
3521 = Manufacture of gas
3522 = Distribution of gaseous fuels through mains

Work flow: Step 2. Matching

- Match the LBK and the ALD using r2dii.match::match_name

```
# match lbk to ald
match_file <- match_name(your_loanbook, your_ald)
```

```
match_file    404 obs. of 28 variables
your_ald      17368 obs. of 13 variables
your_loanbook 320 obs. of 19 variables
```

- Optional advanced matching
- Within the match_name function there are additional functions allowing a user to customise this stage

```
match_file <- match_name(your_loanbook, your_ald, by_sector = TRUE,
                         min_score = 0.8, method = "jw", p = 0.1, overwrite = NULL)
```

min_score allows you to set the matching score threshold

by_sector allows you to match any names irrespective of the sector classification

- More on overwrite later

Loanbook / ald:

r2dii.data::loanbook_demo r2dii.data::ald_demo

by_sector:

min_score:

Method:

"cosine", "jaccard", "jw", "soundex").
See stringdist::stringdist-metrics.

P: Prefix factor for Jaro-Winkler distance. The valid range for p is 0 <= p <= 0.25. If p=0 (default), the Jaro-distance is returned. Applies only to method='jw'.

Overwrite: A data frame used to overwrite the sector and/or name columns of a particular direct loantaker or ultimate parent. To overwrite only sector, the value in the name column should be NA and vice-versa. This file can be used to manually match loanbook companies to ald.

Code----------

```
# simple version
match_file <- match_name(your_loanbook, your_ald)

# advanced matching
match_file <- match_name(your_loanbook, your_ald, by_sector = TRUE,
                         min_score = 0.8, method = "jw", p = 0.1, overwrite = NULL)
```

String matching

- String matching assesses the characters and the order of the characters between two names
- It then outputs a measure of the similarity of the two words
- For example, there is a 80% similarity between “Royal Dutch Shell” and “R Dutch Shell” based on the order and letters involved

Name in LBK	Name in ALD	Score
BP plc	BP plc	1
BP	BP plc	0.85
British Petroleum	BP plc	0.3
Shell	BP	0

Illustrative example of string matching BP

String matching

There are different algorithms that you can choose from

```
match_file <- match_name(your_loanbook, your_ald, by_sector = TRUE,
                         min_score = 0.8, method = "jw", p = 0.1, overwrite = NULL)
```

The different methods use slightly different algorithms to determine the score in the previous slide

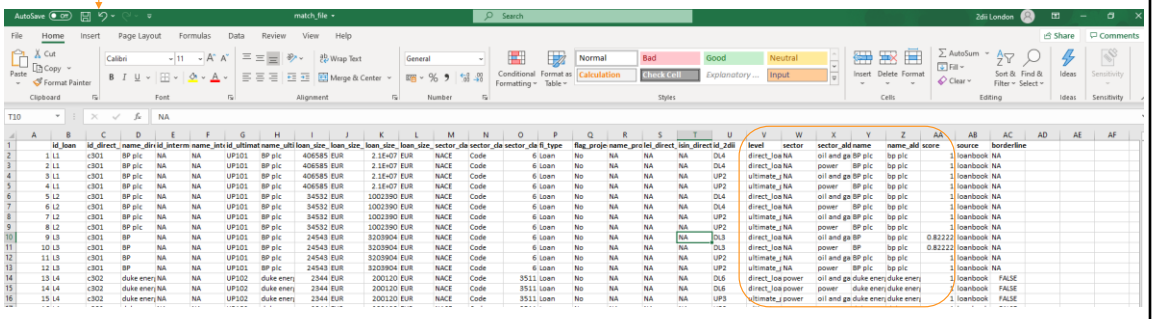
Options:
"osa", "lv", "dl", "hamming", "lcs", "qgram", "cosine", "jaccard", "jw", "soundex".

See stringdist::stringdist-metrics.

Work flow:
Step 3. Manual matching

- Export the “match_file” file from R to Excel

```
#export match_file to excel
write.csv(match_file, ".....filepath..../match_file.csv")
```



Code----------
#export match_file to excel
write.csv(match_file, ".....filepath..../match_file.csv")

#or (preferred)
Write_csv(match_file, ".....filepath..../match_file.csv")

 # note depending on the separator in your csv file you may need to use write_csv2 (;) as a pose to write_csv (,)

Work flow:
Step 3. Manual match

- Allocate 1 = match and 0 = no match - to each loan in the score column
- Tip – allocate 1 or 0 in a separate column – once you are confident of your matches, you can replace the 1/0 in the "Score" column

- **Certain rules apply:**
  1. Never match 1 name in the loan book to 2 names in the ALD
  2. You can however match 2 names in the loan book to 1 name in the ALD

level	sector	sector_ald	name	name_ald	score	manual match	
direct_loantaker	automotive	automotive	Aston Martin	aston martin	1	1	rule 1
direct_loantaker	automotive	automotive	Aston Martin	Aston Martin UK	0.9	0	
direct_loantaker	oil&gas	oil&gas	BP plc	BP plc	1	1	rule 2
direct_loantaker	oil&gas	oil&gas	BP	BP plc	0.9	1	

Extra info of the rules above

1. This would lead the loan being split across two companies

2. This is allowed

Work flow:
Step 3. Manual match

- **Rules continued:**
  3. Do not match a direct loan taker to an ultimate parent – see column "level"

level	sector	sector_ald	name	name_ald	score	manual match	
direct_loantaker	power	power	duke florida	duke	0.8	0	rule 3
ultimate_parent	power	power	duke	duke	1	1	
direct_loantaker	power	power	duke florida	duke florida	1	1	

  4. Do not match across sectors. (This is only relevant when setting the by_sector argument to equal FALSE)

level	sector	sector_ald	name	name_ald	score	manual match	
direct_loantaker	power	power	duke florida	duke florida	1	1	rule 4
direct_loantaker	power	automotive	duke florida	duke florida	1	0	

Extra info of the rules above

3. In doing so you would attribute the production values of the UP to the DL. The UP should be matched to the UP. In reality if you can not match to the DL then the match will be taken at the UP level anyway (this comes in the next step). By doing it this way you can preserve the fact that the match is made at the UP level. This may then be important when considering the match success rate and calculating coverage.

4. See the column "sector" and "sector_ALD". If this is due to the sector being incorrect in the loan book. You can remedy this in the overwrite file (next slide)

Work flow:
Step 3. Manual match

- **Rules continued:**
  5. Do not assume a match to be the same company if it looks "close enough"

level	sector	sector_ald	name	name_ald	score	manual match	
direct_loantaker	cement	cement	cement tex	cementex	0.9	0	rule 5

  6. If you cannot find a match you should look it up in the ALD

level	sector	sector_ald	name	name_ald	score	manual match	
direct_loantaker	oil&gas	oil&gas	pjsc gazprom	wazpromotion	0.8	0	rule 6
direct_loantaker	oil&gas	oil&gas	pjsc gazprom	gazprom pjsc	0.7	1	

Extra info of the rules above

5. There may be cases where the company name appears similar and hence receives a high score in the algorithm. This may in fact be a completely different company and hence matching my cause inaccurate results. A good way to check is by searching for the companies and comparing websites.

6. If the company is in the ALD but not in the match file, due to the name being recorded differently. Then you have two options; either decreases the min_score threshold or failing that you can change the name using the overwrite file. (next slide)

Work flow:
Step 3. Manual match

- **Rules continued:**
  7. Change in ownership of a company not recorded in either the ALD or the LBK – investigate and use the overwrite file (next slide) to change the LBK so the company can be matched to the ALD

  8. If all of the above fail, then it is possible that a company does not exist in the ALD --> Contact the data provider

Extra info of the rules above

7. Mergers and changes of ownership: In cases where you can not find a match and can not find the company in the ALD it is possible that the company has been acquired by a separate entity and is hence recorded as a different company in the ALD or the LBK. Here you can use the overwrite file to change the company name to the one that is present in the ALD.

8. When you can not get a successful match at the DL level you should try to match at the UP level. If the company still can't be found you should **not** attempt to match this to a "similar" company. This should be registered as coverage constraint. You can then explore further options to how to increase the coverage of the ALD – for example by contacting your data provider.

Work flow:
Step 4. Overwrite file

- In certain cases you may wish to change the name or sector of the company in the loan book to match that in the ALD
- To do this, open the overwrite file in excel – this can be found in r2dii.data::overwrite_demo
- Populate it with the name / sector changes you wish to carry out

	A	B	C	D	E	F
1		level	id_2dii	name	sector	source
2	1	direct_loantaker	DL294	bee handshoe	coal	manual
3	2	ultimate_parent	UP15	alpine india	power	manual
4						
5						

- Load this file in as an argument in the r2dii.match::match_name function

```
matched_file_overwrite <- match_name(your_loanbook, your_ald, overwrite = overwrite_file)
```

From the previous slide you may have identified cases where you wish to either change the sector, due to incorrect data entry or misinterpretation of sector classification codes. Or you may want to change the name of a company (note that this is not changing the company but rather changing the way the company is recorded). This may occur due to the name being recorded differently in the two data sets and falling below the matching algorithms minimum threshold. In is also possible that there has been a change in ownership as per the rules in the previous slides.

Code----------

```
# create the overwrite file
ovewrite_file <- r2dii.data::overwrite_demo

# export it to excel
write.csv(ovewrite_file, ".....file path.../overwrite_file.csv")

# populate the overwrite file with the manual matches that you want to change in the Loanbook
# this can be done in excel
```

```
# re-run the match_name stage with the overwrite file
matched_file_overwrite <- match_name(your_loanbook, your_ald, overwrite =
overwite_file)

# export to excel
write.csv(match_file_overwrite, ".....file path.../match_file_overwrite.csv")
```

Work flow:
Step 5.1. Combine all your matches

- All the matches must be combined into one file
- e.g. “validated_matches” file
- This can be done in Excel
- Read the “validated_matches” file back into R

```
validated_matches <- read.csv(".....file path.../validated_matches.csv")
```

NB – It is possible to do this by sector. So you may have validated_match_auto.csv, validated_match_power.csv etc…

You must combine all the matches into one file – This may be from the overwrite_match_file and the Manual_match file. You may have broken up the matching into chucks for different people to do. Which ever way you have done it, it is they must all be combined in the end.

Code----------

```
# combine your previous manual matches and your new matches found in the overwrite phase
# creating a new file "validated_matches"
# this can be done on excel

# read the finalised match file into R

validated_matches <- read.csv(".....file path.../validated_matches.csv")
```

Work flow:
Step 5.2. Prioritize Matches

- The prioritize function selects the best match for the loan
- By default, this is set at the **Direct Loan taker level.** When the Direct loan taker can not be matched, the Ultimate Parent is used

```
lbk_ready <- prioritize(validated_matches)
```

- If instead you would like the production values of the Ultimate Parent to be selected you can do so using the following code

```
lbk_ready <- prioritize(validated_matches, priority = rev)
```

rev – reverses the order of priority

- Note – This is an essential step – do not try to skip it

NB – It is possible to do this by sector. So you will have lbk_ready_auto, lbk_ready_power etc…

Code----------

```
# prioritise the matches - taking the best match e.g. the direct loan taker for each loan
lbk_ready <- prioritize(validated_matches)

# if you want to take the ultimate parent match to be taken forward instead of the
# direct loan taker match you can do so using the following
# (this is only an option)
lbk_ready <- prioritize(validated_matches, priority = rev)
```

Next steps

- **Analysis / Visualisation webinar (date TBC) – www.2degrees-investing.org/events**
- **Follow the instructions on the r2dii.analysis website**
- To access the previous webinar on the methodology and further training materials and user guides, please visit **www.TransitionMonitor.com and the PACTA for Banks Tab**

Q&A

Contacts

- PACTA for Banks related queries: banks@2degrees-investing.org
- General 2DII queries: contact@2degress-investing.org
- www.2degrees-investing.org
- www.transitionmonitor.com

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About our funders: *This project is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag. This project has also received funding from the European Union LIFE program. The views expressed here are the sole responsibility of the authors and do not necessarily reflect the views of the funders.*

Annex
Rules

V	W	X	Y	Z	AA	AB	AC	AD
level	**sector**	**sector_ald**	**name**	**name_ald**	**score**	**manual match**		
direct_loantaker	automotive	automotive	Aston Martin	aston martin	1	1		rule 1
direct_loantaker	automotive	automotive	Aston Martin	Aston Martin UK	0.9	0		
direct_loantaker	oil&gas	oil&gas	BP plc	BP plc	1	1		rule 2
direct_loantaker	oil&gas	oil&gas	BP	BP plc	0.9	1		
direct_loantaker	power	power	duke florida	duke	0.8	0		rule 3
ultimate_parent	power	power	duke	duke	1	1		
direct_loantaker	power	power	duke florida	duke florida	1	1		
direct_loantaker	power	power	duke florida	duke florida	1	1		rule 4
direct_loantaker	power	automotive	duke florida	duke florida	1	0		
direct_loantaker	cement	cement	cement tex	cementex	0.9	0		rule 5
direct_loantaker	oil&gas	oil&gas	pjsc gazprom	wazpromotion	0.8	0		rule 6
direct_loantaker	oil&gas	oil&gas	pjsc gazprom	gazprom pjsc	0.7	1		

Extra info of the rules above

1. This would lead the loan being split across two companies

2. This is allowed

3. In doing so you would attribute the production values of the UP to the DL. The UP should be matched to the UP. In reality if you can not match to the DL then the match will be taken at the UP level anyway (this comes in the next step). By doing it this way you can preserve the fact that the match is made at the UP level. This may then be important when considering the match success rate and calculating coverage.

4. See the column “sector” and “sector_ALD”. If this is due to the sector being incorrect in the loan book. You can remedy this in the overwrite file (next slide)

5. There may be cases where the company name appears similar and hence receives a high score in the algorithm. This may in fact be a completely different company and hence matching my cause inaccurate results. A good way to check is by searching for the companies and comparing websites.

6. If the company is in the ALD but not in the match file, due to the name being recorded differently. Then you have two options; either decreases the min_score threshold or failing that you can change the name using the overwrite file. (next slide)

7. Mergers and changes of ownership: In cases where you can not find a match and can not find the company in the ALD it is possible that the company has been acquired by a separate entity and is hence recorded as a different company in the ALD or the LBK. Here you can use the overwrite file to change the company name to the one that is present in the ALD.

8. When you can not get a successful match at the DL level you should try to match at the UP level. If the company still can't be found you should **not** attempt to match this to a "similar" company. This should be registered as coverage constraint. You can then explore further options to how to increase the coverage of the ALD – for example by contacting your data provider.