Connectivity Analyses

Maximilian A. Müller Gaizka Ormazabal
Thorsten Sellhorn Victor Wagner

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```
# echo: false
# output: asis

# # pdf:
# #         geometry:
# #             - paper=a4paper
```

```
# beamer:
#         aspectratio: 169
#         header-includes: |
#             \setbeamertemplate{navigation symbols}{}
#             \setbeamertemplate{footline}[page number]
```

1 Technical stuff

> ⚠ Warning
>
> This is the technical step-by-step procedure. Not interesting.

1.1 Getting started

- imports
- SRN data
- (check which firms and documents are needed and which are already here); Currently, we base our analyses on the documents that have already been manually coded (bottom-up); in the future, however, we do it top-down based on Euro Stoxx 600
- read in document data
  - read in manually coded documents
  - check which have to be downloaded (b/c they are not here) and update
  - check which have to be extracted (b/c it hasn't been done) and update
  - prepare for later analysis and merge with other data

```
import sys, os, json, re
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from scipy import stats

# path to Dropbox directory with 'pdf', 'pdf-decrypt', 'docs_clean.json' and 'raw_text
BASE_PATH = "/Users/victor.wagner/Dropbox/_Connectivity-Data"
```

```
API_PATH  = "https://api.sustainabilityreportingnavigator.com/api/"
```

```
companies = pd.read_json(f'{API_PATH}companies')
documents = pd.read_json(f'{API_PATH}documents')
indices   = pd.read_json(f'{API_PATH}indices')
```

```
# es600 = companies[['1cc738c1-e6b1-4f2b-8bec-2d963118de59' in ind for ind in companie

# es600[['id', 'name', 'isin', 'country', 'sector']].merge(
#     documents[['id', 'year', 'type', 'company_id']],
#     left_on='id', right_on='company_id',
#     suffixes=('_company', '_document')
# ).query()
```

1.1.1 Read in manually collected start/end pages

```
from mergeManualCollections import mergeManualCollections
manual_collections = mergeManualCollections([
    '../data/connectivity-manual_collection - lmu_cologne - 20230926.csv',
    '../data/connectivity-manual_collection-iese - main - 20230926.csv',
    '../data/connectivity-manual_collection-iese - second_round - 20230926.csv',
])

print('We have', len(manual_collections), 'manually coded documents, of which',
      len(set(manual_collections.index).difference(set([x[:36] for x in os.listdir(BAS
      'are not downloaded.')
```

Use the following with caution, this will download, extract and clean all documents if they are not stored locally.

1.1.2 Update pdfs if not all are downloaded yet

```
from downloadPdfs import downloadPdfs
doc_status = downloadPdfs(
    BASE_PATH,
    zip(manual_collections['href_doc'],
        manual_collections.index)
)
print('There were', sum([x == 'downloaded' for x in doc_status]), 'new downloads,',
      sum([x == 'no download' for x in doc_status]), 'document could not be downloaded
```

```
There were 51 new downloads, 1 document could not be downloaded.
```

1.1.3 Extract text from pdfs if not done so yet

```
raw_texts_old = pd.read_json(f"{BASE_PATH}/pdf/../raw_texts.json")
print('We already have raw text for', len(raw_texts_old), 'documents, decrypting and r
     len(manual_collections)-len(raw_texts_old), 'documents now.')

from readTextFromPdf import readTextFromPdf
raw_texts_new, doc_status_new = [], []
raw_texts_new, doc_status_new = map(
    list,
    zip(*[readTextFromPdf(BASE_PATH, doc_id) for doc_id in manual_collections.index])
)
raw_texts_newDict = {doc_id: (r,s) for doc_id,r,s in zip(manual_collections.index, raw
```

```
We already have raw text for 961 documents, decrypting and reading 0 documents now.
```

```
from updateRawTexts import updateRawTexts
raw_texts_final = updateRawTexts(raw_texts_old, raw_texts_newDict)
raw_texts_final.to_json(f"{BASE_PATH}/pdf/../raw_texts.json")

print('There are', sum([x == 'problem_decrypting' for x in raw_texts_final.status]), '
     'and', sum([x == 'problem_opening' for x in raw_texts_final.status]), 'documents
print('This leaves us with a readable sample of', sum([x == 'fine' for x in raw_texts_
```

```
There are 184 documents with decryption problems and 0 documents that could not be read.
This leaves us with a readable sample of 777 documents.
```

1.1.4 Clean text if not done so yet

```
docs_cleaned_old = pd.read_json(f"{BASE_PATH}/docs_clean.json")
print('There is already clean data for', len(docs_cleaned_old), 'documents, cleaning',
     len(raw_texts_final.query('status == "fine"'))-len(docs_cleaned_old), 'documents.

from updateAndCleanText import updateAndCleanText
docs_cleaned_new = updateAndCleanText(docs_cleaned_old, raw_texts_final)
docs_cleaned_new.to_json(f"{BASE_PATH}/pdf/../docs_clean.json")
```

```
There is already clean data for 961 documents, cleaning -184 documents.
```

```
del raw_texts_final, raw_texts_new, raw_texts_newDict, raw_texts_old
del docs_cleaned_old
```

1.1.5 Merge other data to documents

```
#docs_cleaned_new.drop(columns=['clean_text_full'], inplace=True)

docs = docs_cleaned_new.merge(
    documents[['id', 'company_id', 'year']],
    left_index=True, right_on='id'
).merge(
    companies[['id', 'name', 'isin', 'country', 'sector']],
    left_on='company_id', right_on='id',
    suffixes=('', '_company')
).set_index(
    'id', drop=True
).drop(
    'id_company', axis=1
)
```

1.1.6 Merge manually coded section data

```
docs = docs.merge(
    manual_collections[['mda_begin', 'mda_end', 'fs_begin', 'fs_end', 'audit_begin', '
    left_index=True, right_index=True
)
```

```
docs = docs.reset_index(
).merge(
    docs.groupby(
        ['company_id']).size().reset_index(
    ).rename(
        columns={0: 'company_years_avlbl'}), on='company_id'
).set_index('index')

# Drop obvious outlier
docs.drop(docs[(docs['isin'] == 'ES0130670112') & (docs['year'] == 2020)].index, inpla
```

1.2 Document sample selection

We distributed the EURO Stoxx 600 firms to student assistants to extract information on the structure of annual reports. So far, this resulted in the following documents sample: 1. no metadata in the SRN database yet, 1. after removing not readable pdfs, 2. pdfs where no text was scanned, and 3. pdfs with too little words (documents where the average clean text characters are less than 1,500 in a document).

```
docs0 = docs.query('status == "fine"')
docs1 = docs0.query('clean_text_len > 0')
docs2 = docs1.query('avgCleanTextPerPage > 1500')

TpdfSample = pd.DataFrame(columns=['', 'less', 'resulting'])

TpdfSample.loc[len(TpdfSample),:] = ['downloaded pdfs',      '',
TpdfSample.loc[len(TpdfSample),:] = ['no metadata',       '-'+str(len(docs_cleaned_new
TpdfSample.loc[len(TpdfSample),:] = ['not readable',      '-'+str(len(docs) -len(docs0
TpdfSample.loc[len(TpdfSample),:] = ['zero text scanned', '-'+str(len(docs0)-len(docs1
TpdfSample.loc[len(TpdfSample),:] = ['too little words*', '-'+str(len(docs1)-len(docs2

#print(TpdfSample.to_markdown(index=False))
#print('\nThis leaves us with', len(docs2['company_id'].unique()), 'unique firms.')
```

```
TpdfSample.reset_index(drop=True)
```

Table 1: Sample selection documents

		less	resulting
0	downloaded pdfs		961
1	no metadata	-53	908
2	not readable	-168	740
3	zero text scanned	-28	712
4	too little words*	-102	610

1.3 Keyword search

```
from findSections import findSections
pd.options.mode.chained_assignment = None  # default='warn'

docsa = findSections(docs2)
```

```
search_patterns = ['ghg', 'co2', 'carbon', 'climat', 'emission', 'regulatory risk', 'p
print(search_patterns)
```

```
['ghg', 'co2', 'carbon', 'climat', 'emission', 'regulatory risk', 'physical risk', 'trans
```

```
lim = 200

def searchText(doc, search_patterns):
    matches = []
    for section in ['mda_text', 'fs_text', 'audit_text', 'other_text']:
        for pat in search_patterns:
            for page, text in doc[section+'_dict'].items():
                for hit in re.finditer(pat, text):
                    matches.append({
                        'pattern': pat,
                        'section': section[:-5],
                        'snippet': text[hit.start()-lim : hit.start()+len(pat)+lim],
                        'page'   : page
                    })

    return matches

docsa['hits'] = [pd.DataFrame(searchText(doc, search_patterns)) for _, doc in docsa.it
```

```
# for sec in sections:
#     docsamax[sec+'_hit'] = [len(list(filter(lambda hit: hit['section'] == sec, searc

# for pat in search_patterns:
#     docsamax[pat+'_hit'] = [len(list(filter(lambda hit: hit['pattern'] == pat, searc
#     docsamax[pat+'_fs_hit'] = [len(list(filter(lambda hit: (hit['pattern'] == pat) a
```

```
# snippets = pd.DataFrame(columns=['document_id', 'isin', 'year', 'pattern', 'section'

# for idx, doc in docsa.iterrows():
#     for _, hit in doc.hits.iterrows():
#         snippets.loc[len(snippets)] = [idx, doc['isin'], doc['year'], hit['pattern']

# snippets.info()
# snippets.to_csv('snippets.csv', index=False)
```

```
pd.read_csv('../data/worldscope_msci_carbon.csv')
```

2 Analyses

```
import matplotlib as mpl
mpl.rcParams['figure.dpi'] = 200
sections = ['fs', 'audit', 'mda', 'other']
years = sorted(docsa.year.unique())
colors = ['#ff1f5b', '#009ade', '#af58ba', '#ffc61e']
```

2.1 Sample and method

- We downloaded 961 annual reports from Euro Stoxx 600 firms in pdf format
- After cleaning (see more Section 1.2), we were able to extract text from 611 documents
- We then manually classified different sections of these reports
  - MD&A (a.k.a. management report, Lagebericht, etc.)
  - Financial Statements and Notes
  - Auditor's Report
- And searched for climate-related keywords

2.2 Keywords over time

```
data = docsa.copy()

for sec in sections:
    data[sec+'_hits'] = [len(list(filter(lambda hit: hit['section'] == sec, searchText

data['total_hits'] = [len(searchText(doc, search_patterns)) for _, doc in docsa.iterro
```

```
avg_hits_perSec_perYear = [[np.mean(data.query('year == @year')[sec+'_hits']) for year
med_hits_perSec_perYear = [[np.median(data.query('year == @year')[sec+'_hits']) for ye
avg_hitsPerPage_perSec_perYear = [[np.mean(data.query('year == @year')[sec+'_hits']/da
```

```
fs_hits_avg_yrs =    [np.mean(data.query('year == @year')['fs_hits'])    for year in y
audit_hits_avg_yrs = [np.mean(data.query('year == @year')['audit_hits']) for year in y
```

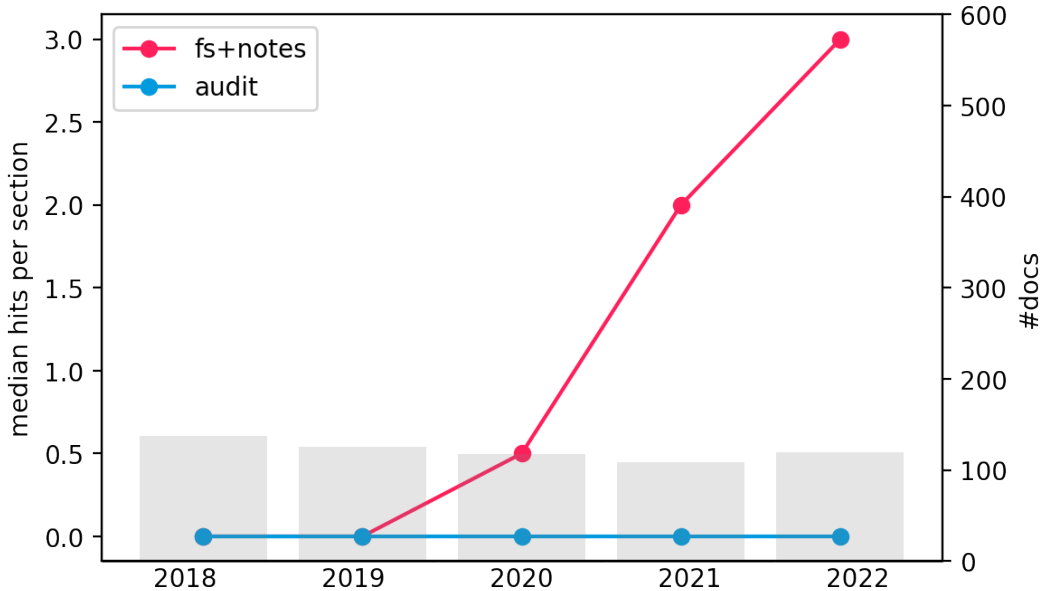
```
mda_hits_avg_yrs =   [np.mean(data.query('year == @year')['mda_hits'])   for year in y
other_hits_avg_yrs = [np.mean(data.query('year == @year')['other_hits']) for year in y

fs_hits_med_yrs =    [np.median(data.query('year == @year')['fs_hits'])    for year in
audit_hits_med_yrs = [np.median(data.query('year == @year')['audit_hits']) for year in
mda_hits_med_yrs =   [np.median(data.query('year == @year')['mda_hits'])   for year in
other_hits_med_yrs = [np.median(data.query('year == @year')['other_hits']) for year in
```

```
fs_hits_byY = [data.query('year == @year')['fs_hits'].values for year in years]
fs_hits_ci  = [stats.t.interval(0.95, len(hits_byY)-1, loc=hits_byY.mean(), scale=hits
fs_hits_iqr = [stats.iqr(x) for x in fs_hits_byY]
fs_hits_q1  = [np.quantile(data.query('year == @year')['fs_hits'], 0.25) for year in y
fs_hits_q3  = [np.quantile(data.query('year == @year')['fs_hits'], 0.75) for year in y

audit_hits_byY = [data.query('year == @year')['audit_hits'].values for year in years]
audit_hits_ci  = [stats.t.interval(0.95, len(hits_byY)-1, loc=hits_byY.mean(), scale=h
audit_hits_iqr = [stats.iqr(x) for x in audit_hits_byY]
audit_hits_q1  = [np.quantile(data.query('year == @year')['audit_hits'], 0.25) for yea
audit_hits_q3  = [np.quantile(data.query('year == @year')['audit_hits'], 0.75) for yea
```

```
fig, ax1 = plt.subplots()

ax1.plot(years, med_hits_perSec_perYear[0], 'o-', color='#ff1f5b', label='fs+notes')
ax1.plot(years, med_hits_perSec_perYear[1], 'o-', color='#009ade', label='audit')

# for year, n in zip(years, range(len(years))):
#     ax1.plot(
#         (year, year),
#         (med_hits_perSec_perYear[0][n]+fs_hits_q3[n],
#          med_hits_perSec_perYear[0][n]-fs_hits_q1[n]),
#         '_-', color='#ff1f5b', alpha=0.5
#     )
#     ax1.plot(
#         (year, year),
#         (med_hits_perSec_perYear[1][n]+audit_hits_q3[n],
#          med_hits_perSec_perYear[1][n]-audit_hits_q1[n]),
#         '_-', color='#009ade', alpha=0.5
#     )

ax1.set_ylabel('median hits per section')
```

```
docsPerYear = [len(data.query('year == @year')) for year in years]
ax2 = ax1.twinx()
ax2.bar(x=years, height=docsPerYear, color='gray', alpha=0.2)
ax2.set_ylim([0,600])
ax2.tick_params(axis='y')
ax2.set_ylabel('#docs')

plt.table([[round(y, 2) for y in x] for x in med_hits_perSec_perYear+[docsPerYear]],
          rowLabels=['fs+notes', 'audit', 'mda', 'other', '#docs'],
          rowColours=['#ff1f5b', '#009ade', '#ffffff', '#ffffff', 'lightgray'],
          colLabels=years, loc='bottom', cellLoc='right', edges='horizontal', bbox=[0,

ax1.set_xticks([])
ax2.set_xticks([])
#ax1.set_title(f'n={len(data)} reports with {sum(data["total_hits"])} total keyword hi
ax1.legend()#ncol=4, bbox_to_anchor=(0.75,-0.1))

#fig.savefig('figures/fig202309271823.png', dpi=400, bbox_inches='tight')
plt.show()
```

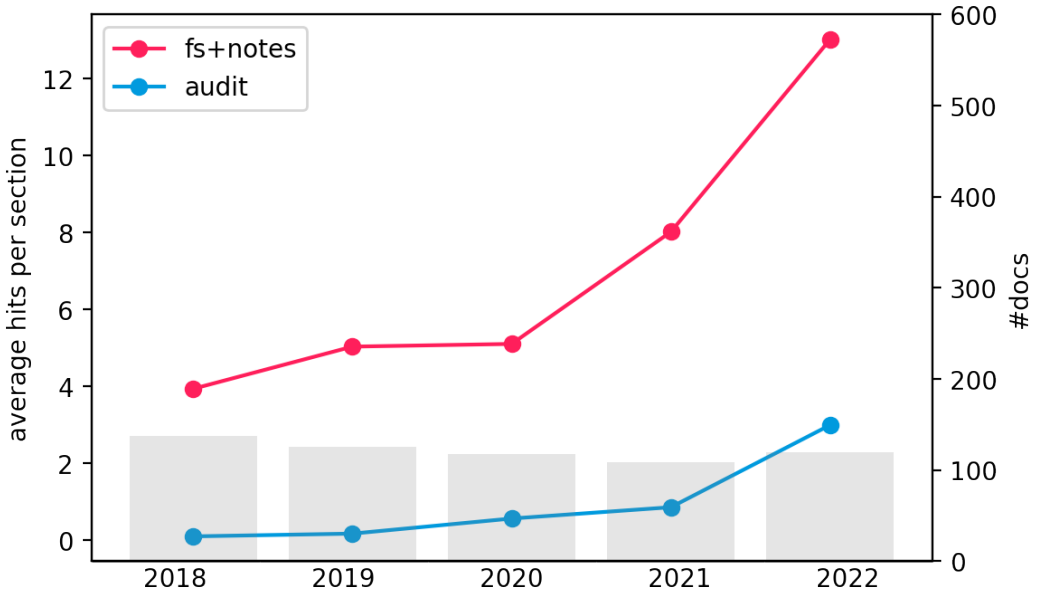
```
fig, ax1 = plt.subplots()

ax1.plot(years, avg_hits_perSec_perYear[0], 'o-', color='#ff1f5b', label='fs+notes')
ax1.plot(years, avg_hits_perSec_perYear[1], 'o-', color='#009ade', label='audit')

# for year, n in zip(years, range(len(years))):
#     ax1.plot(
#         (year, year),
#         (avg_hits_perSec_perYear[0][n]+fs_hits_ci[n][0],
#          avg_hits_perSec_perYear[0][n]+fs_hits_ci[n][1]),
#         '_-', color='#ff1f5b', alpha=0.5)
#     ax1.plot(
#         (year, year),
#         (avg_hits_perSec_perYear[1][n]+audit_hits_ci[n],
#          avg_hits_perSec_perYear[1][n]+audit_hits_ci[n]),
#         '_-', color='#009ade', alpha=0.5)

ax1.set_ylabel('average hits per section')

docsPerYear = [len(data.query('year == @year')) for year in years]
ax2 = ax1.twinx()
ax2.bar(x=years, height=docsPerYear, color='gray', alpha=0.2)
```



fs+notes	0.0	0.0	0.5	2.0	3.0
audit	0.0	0.0	0.0	0.0	0.0
mda	18.0	28.0	45.5	67.0	130.0
other	4.0	5.5	6.5	13.0	22.0
#docs	137	126	118	109	120

Figure 1: Median keyword hits per section over time

```
ax2.set_ylim([0,600])
ax2.tick_params(axis='y')
ax2.set_ylabel('#docs')

plt.table([[round(y, 2) for y in x] for x in avg_hits_perSec_perYear+[docsPerYear]],
          rowLabels=['fs+notes', 'audit', 'mda', 'other', '#docs'],
          rowColours=['#ff1f5b', '#009ade', '#ffffff', '#ffffff', 'lightgray'],
          colLabels=years, loc='bottom', cellLoc='right', edges='horizontal', bbox=[0,

ax1.set_xticks([])
ax2.set_xticks([])
#ax1.set_title(f'n={len(data)} reports with {sum(data["total_hits"])} total keyword hi
ax1.legend()#ncol=4, bbox_to_anchor=(0.75,-0.1))

#fig.savefig('figures/fig202309280927.png', dpi=400, bbox_inches='tight')
plt.show()
```

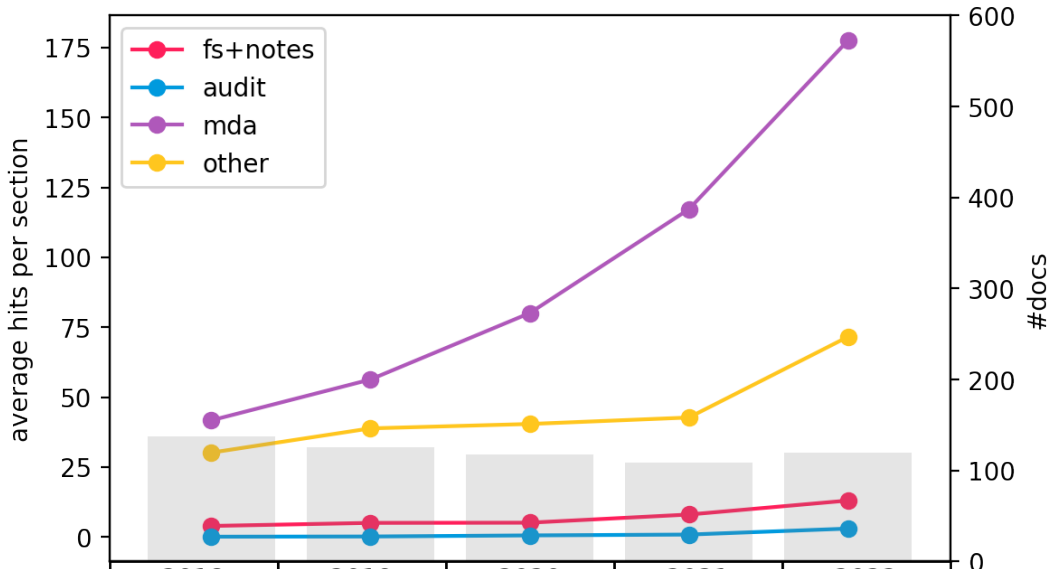


	2018	2019	2020	2021	2022
fs+notes	3.93	5.03	5.1	8.02	13.02
audit	0.09	0.17	0.56	0.85	2.99
mda	41.69	56.3	80.04	117.19	177.58
other	30.15	38.83	40.4	42.71	71.59
#docs	137	126	118	109	120

Figure 2: Average keyword hits per section over time

```
fig, ax1 = plt.subplots()

ax1.plot(years, avg_hits_perSec_perYear[0],    'o-', color='#ff1f5b', label='fs+notes'
ax1.plot(years, avg_hits_perSec_perYear[1], 'o-', color='#009ade', label='audit')
ax1.plot(years, avg_hits_perSec_perYear[2],   'o-', color='#af58ba', label='mda')
ax1.plot(years, avg_hits_perSec_perYear[3], 'o-', color='#ffc61e', label='other')

ax1.set_ylabel('average hits per section')

docsPerYear = [len(data.query('year == @year')) for year in years]
ax2 = ax1.twinx()
ax2.bar(x=years, height=docsPerYear, color='gray', alpha=0.2)
ax2.set_ylim([0,600])
ax2.tick_params(axis='y')
ax2.set_ylabel('#docs')
```

```
plt.table([[round(y, 2) for y in x] for x in avg_hits_perSec_perYear+[docsPerYear]],
          rowLabels=['fs+notes', 'audit', 'mda', 'other', '#docs'],
          rowColours=['#ff1f5b', '#009ade', '#af58ba', '#ffc61e', 'lightgray'],
          colLabels=years, loc='bottom', cellLoc='right', bbox=[0, -0.4, 1, 0.4])

ax1.set_xticks([])
ax2.set_xticks([])
#ax1.set_title(f'n={len(data)} reports with {sum(data["total_hits"])} total keyword hi
ax1.legend()#ncol=4, bbox_to_anchor=(0.75,-0.1))

#fig.savefig('figures/fig202309272029.png', dpi=400, bbox_inches='tight')
plt.show()
```



	2018	2019	2020	2021	2022
fs+notes	3.93	5.03	5.1	8.02	13.02
audit	0.09	0.17	0.56	0.85	2.99
mda	41.69	56.3	80.04	117.19	177.58
other	30.15	38.83	40.4	42.71	71.59
#docs	137	126	118	109	120

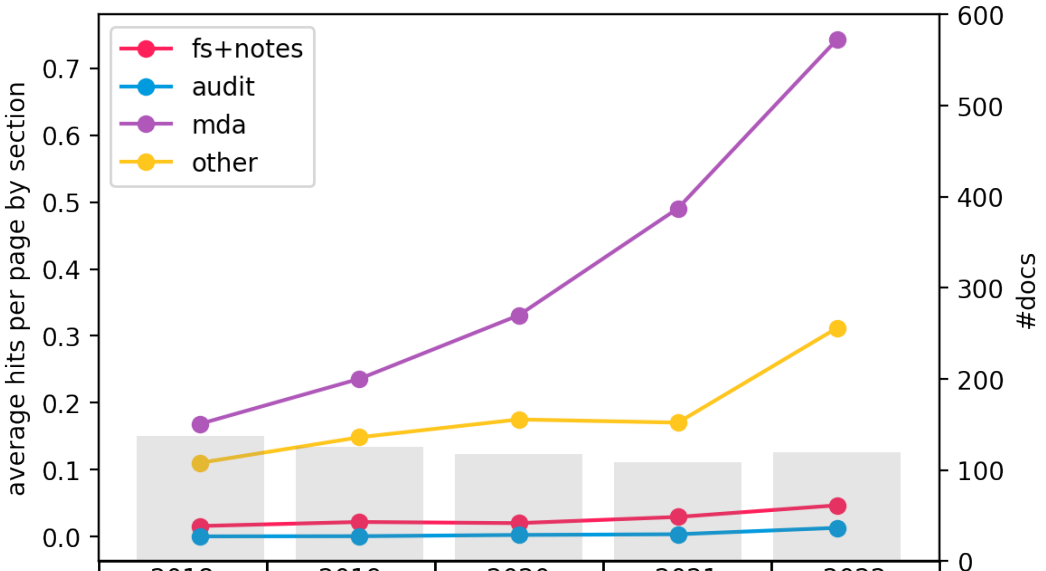
Figure 3: Average keyword hits

```
fig, ax1 = plt.subplots()

ax1.plot(years, avg_hitsPerPage_perSec_perYear[0], 'o-', color='#ff1f5b', label='fs+no
```

```
ax1.plot(years, avg_hitsPerPage_perSec_perYear[1], 'o-', color='#009ade', label='audit
ax1.plot(years, avg_hitsPerPage_perSec_perYear[2], 'o-', color='#af58ba', label='mda')
ax1.plot(years, avg_hitsPerPage_perSec_perYear[3], 'o-', color='#ffc61e', label='other

ax1.set_ylabel('average hits per page by section')

docsPerYear = [len(data.query('year == @year')) for year in years]
ax2 = ax1.twinx()
ax2.bar(x=years, height=docsPerYear, color='gray', alpha=0.2)
ax2.set_ylim([0,600])
ax2.tick_params(axis='y')
ax2.set_ylabel('#docs')

plt.table([[round(y, 2) for y in x] for x in avg_hitsPerPage_perSec_perYear+[docsPerYe
          rowLabels=['fs+notes', 'audit', 'mda', 'other', '#docs'],
          rowColours=['#ff1f5b', '#009ade', '#af58ba', '#ffc61e', 'lightgray'],
          colLabels=years, loc='bottom', cellLoc='right', bbox=[0, -0.4, 1, 0.4])

ax1.set_xticks([])
ax2.set_xticks([])
#ax1.set_title(f'n={len(data)} reports with {sum(data["total_hits"])} total keyword hi
ax1.legend()#ncol=4, bbox_to_anchor=(0.75,-0.1))

#fig.savefig('figures/fig202309272029.png', dpi=400, bbox_inches='tight')
plt.show()
```

2.3 Keyword distribution in the reports

```
# fig, ax = plt.subplots(1,4,figsize=(12,3), sharey=True)

# #ax[0].hist(data.total_hits, color='lightgray')
# ax[0].hist(data.fs_hits,    color='#ff1f5b')
# ax[1].hist(data.audit_hits, color='#009ade')
# ax[2].hist(data.mda_hits,   color='#af58ba')
# ax[3].hist(data.other_hits, color='#ffc61e')

# for n, title in zip(range(4), ['fs+notes', 'audit', 'mda', 'other']):
#     ax[n].set_title(title)

# plt.suptitle(f'Distribution of hits per document by section', y=1.1)
```



	2018	2019	2020	2021	2022
fs+notes	0.02	0.02	0.02	0.03	0.05
audit	0.0	0.0	0.0	0.0	0.01
mda	0.17	0.24	0.33	0.49	0.74
other	0.11	0.15	0.18	0.17	0.31
#docs	137	126	118	109	120

Figure 4: **?(caption)**

```
# plt.savefig('figures/fig202309271836.png', dpi=400, bbox_inches='tight')
```

2.4 Keyword ranking

```
data = docsa.copy()

for pat in search_patterns:
    data[pat] = [len(list(filter(lambda hit: hit['pattern'] == pat, searchText(doc, se

data['total_hits'] = [len(searchText(doc, search_patterns)) for _, doc in docsa.iterro
```

```
fig, ax = plt.subplots()

ax.bar(search_patterns, [np.sum(data[pat].values) for pat in search_patterns], color='
```

```
#ax.set_title(f'Distribution of hits per keyword (total hits={sum(data.total_hits)})')
ax.text(6.45,30500,f'n={sum(data.total_hits)}')

plt.grid(axis='y', color='lightgray', zorder=0)

plt.xticks(rotation=90)
plt.savefig('figures/fig202309272100.png', dpi=400, bbox_inches='tight')
```

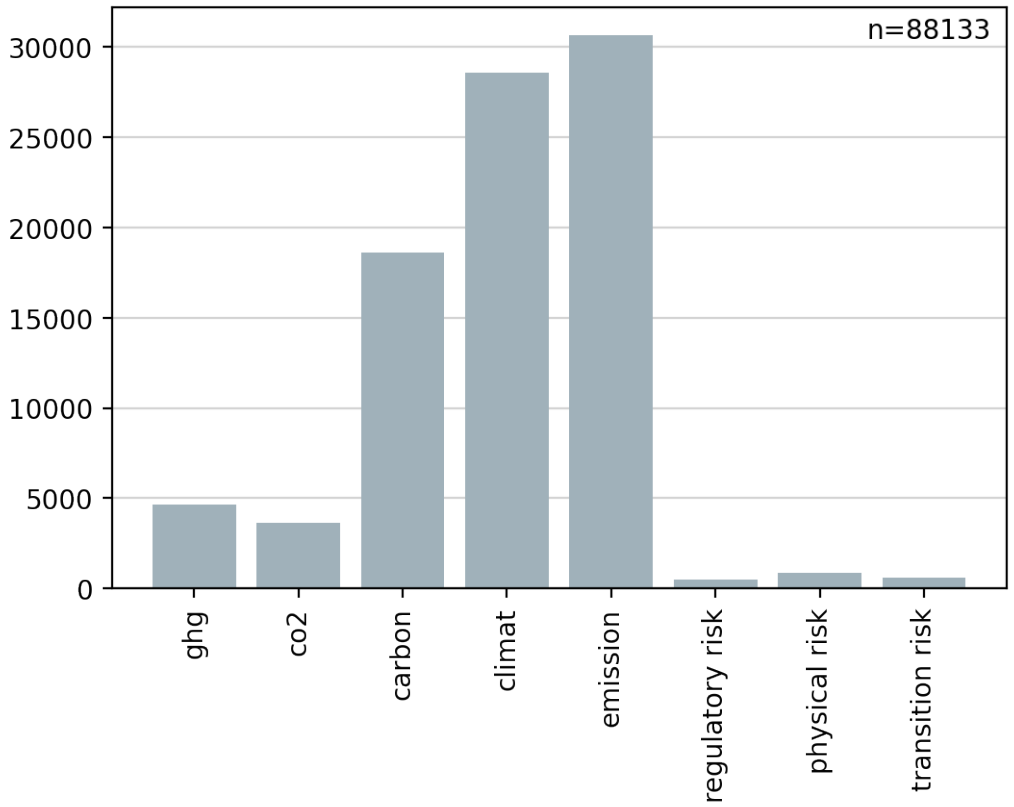


Figure 5: **?(caption)**

2.5 Keyword ranking by section

The difference b/w the total number of search hits is because from here, I included `ghg` and `co2`

```
sections = ['fs', 'audit', 'mda', 'other']
```

```
totals = {k:v for k,v in zip(
    sections,
    [[sum(len(list(filter(lambda hit: (hit['section'] == sec) & (hit['pattern'] == pat
          for _, doc in docsa.iterrows())
      for pat in search_patterns]
     for sec in sections]
)}
```

```
import matplotlib as mpl
mpl.rcParams['axes.prop_cycle'] = mpl.cycler(color=['#ff1f5b', '#009ade', '#af58ba', '

fig, ax = plt.subplots()

width = 0.2
label_locs = np.arange(len(search_patterns))
multiplier = 0

for sec in list(totals.keys())[:2]:
    offset = width * multiplier
    ax.bar(label_locs+offset, totals[sec], width=width, label=sec, edgecolor='w')
    #ax.bar_label(rects, padding=3)
    multiplier += 1

ax.set_xticks(label_locs+width)
ax.set_xticklabels(search_patterns)
plt.xticks(rotation=90)
ax.legend()

plt.savefig('figures/fig202309272158.png', dpi=400, bbox_inches='tight')
```

```
fig, ax = plt.subplots()

width = 0.2
label_locs = np.arange(len(search_patterns))
multiplier = 0

for sec, byKeyword in totals.items():
    offset = width * multiplier
    ax.bar(label_locs+offset, byKeyword, width=width, label=sec, edgecolor='w')
    #ax.bar_label(rects, padding=3)
    multiplier += 1
```

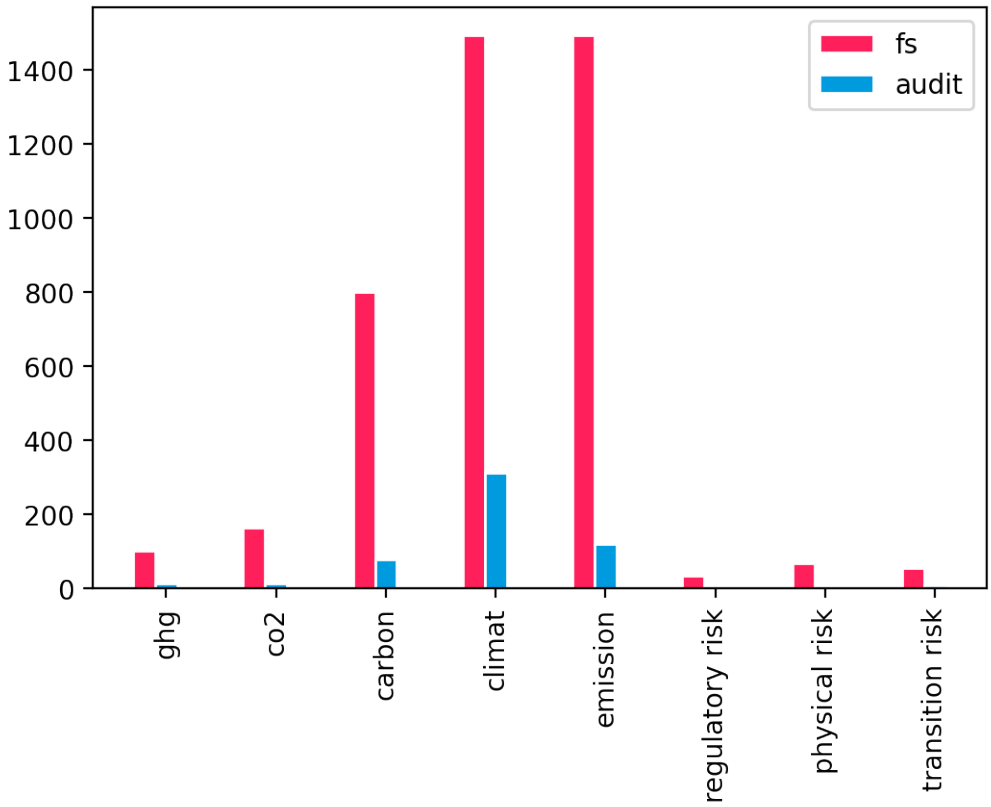


Figure 6: **?(caption)**

```
ax.set_xticks(label_locs+width)
ax.set_xticklabels(search_patterns)
plt.xticks(rotation=90)
ax.legend(loc='upper right')

plt.savefig('figures/fig202309272147.png', dpi=400, bbox_inches='tight')
```

2.6 Heatmap of hits in the document

```
data1 = pd.DataFrame(columns=[
    'document_id', 'company_id', 'year', 'fs_begin', 'fs_end', 'audit_begin', 'audit_e
    'pattern', 'section', 'page'
])
```

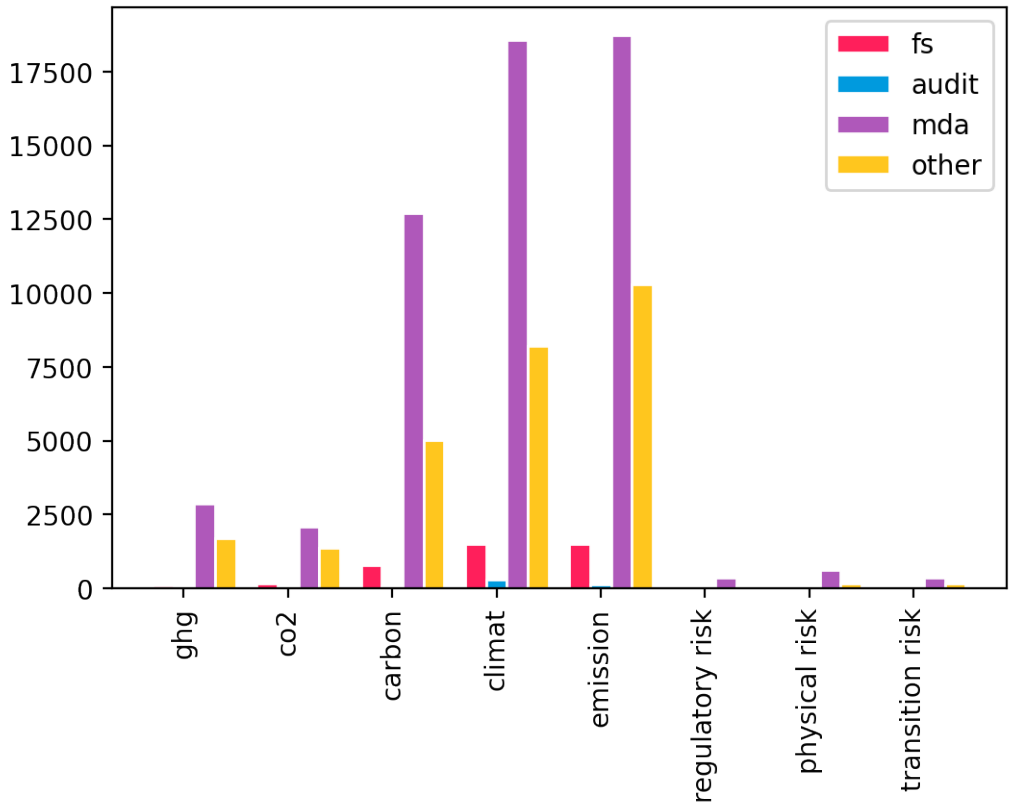


Figure 7: **?(caption)**

```
for doc_id, doc in docsa.iterrows():
    for _, hit in doc.hits.iterrows():
        if (hit.section == 'fs') or (hit.section == 'audit'):
            data1.loc[len(data1)] = [
                doc_id, doc.company_id, doc.year, doc.fs_begin, doc.fs_end, doc.audit_
                hit.pattern, hit.section, hit.page
            ]
```

```
data1_onlyFS    = data1.query('section == "fs"').drop(['audit_begin', 'audit_end', 'se
data1_onlyaudit = data1.query('section == "audit"').drop(['fs_begin', 'fs_end', 'secti
```

```
data1_onlyFS_noMult = data1_onlyFS[[',' not in str(x) for x in data1_onlyFS['fs_begin'
data1_onlyaudit_noMult = data1_onlyaudit[[',' not in str(x) for x in data1_onlyaudit['
print('By restricting to no multi-start sections, we lose',
      len(data1_onlyFS)-len(data1_onlyFS_noMult), 'snippets.\n',
```

```
      'Left:', len(data1_onlyFS_noMult))
```

```
By restricting to no multi-start sections, we lose 34 snippets.
 Left: 4178
```

```
data1_onlyFS_noMult['location'] = [int(snip['page']) / int(snip['fs_end']) for _,snip
data1_onlyaudit_noMult['location'] = [int(snip['page']) / int(snip['audit_end']) for _
```

```
fig, ax = plt.subplots(nrows=3, ncols=1, sharex=True, figsize=(6,6))

customprops = dict(linestyle='--', linewidth=1, color='gray')

# ax.boxplot(data1_onlyFS_noMult['location'], showfliers=0, showmeans=1, meanline=1, s
#            boxprops=customprops, whiskerprops=customprops, capprops=customprops,
#            medianprops=dict(color='#ff1f5b'), meanprops=dict(linestyle=':', linewidt

for n, year in enumerate([2018, 2020, 2022]):
    sns.stripplot(data=data1_onlyFS_noMult.query('year == @year'),
                  x='location', y='pattern',
                  color=colors[n], alpha=0.4, size=2.5, ax=ax[n], order=search_pattern
    ax[n].grid(color='lightgray', axis='y', linestyle='dashed')
    ax[n].set_ylabel('')
    ax[n].set_title(year)


ax[0].set_xlim([0,1])
ax[2].set_xlabel('')

plt.show()
```

2.7 Cross-sectional splits

```
snippets[snippets.document_id == 'f6d019db-5b4d-4b4b-b989-427262d0873b'].query('sectio
```

	document_id	isin	year	pattern	section	snippet
87779	f6d019db-5b4d-4b4b-b989-427262d0873b	DE000DTR0CK8	2021	carbon	fs	joint ve
87780	f6d019db-5b4d-4b4b-b989-427262d0873b	DE000DTR0CK8	2021	emission	fs	t can or
87781	f6d019db-5b4d-4b4b-b989-427262d0873b	DE000DTR0CK8	2021	emission	fs	ainable

	document_id	isin	year	pattern	section	snippet
87782	f6d019db-5b4d-4b4b-b989-427262d0873b	DE000DTR0CK8	2021	emission	fs	echnolo
87783	f6d019db-5b4d-4b4b-b989-427262d0873b	DE000DTR0CK8	2021	emission	fs	orecaste
87784	f6d019db-5b4d-4b4b-b989-427262d0873b	DE000DTR0CK8	2021	emission	fs	her euro

2.8 Interactive

```
# #| fig-cap: Average keyword hits per section over time
# fig, ax1 = plt.subplots()

# ax1.plot(years, avg_hits_perSec_perYear[0], 'o-', color='#ff1f5b', label='fs+notes')
# ax1.plot(years, avg_hits_perSec_perYear[1], 'o-', color='#009ade', label='audit')

# ax1.set_ylabel('average hits per section')
# ax1.set_xticks(years)
# ax1.legend()

# plt.show()
```

```
IntSlider(value=0)
```

2.9 Document descriptives

```
fig, ax = plt.subplots(1,3, figsize=(12,3))

ax[0].hist(docsa['n_pages'], edgecolor="w", bins=25, color='#a0b1ba')
ax[0].set_title(f'Panel A. Total page numbers')

ax[1].hist(docsa['clean_text_len'], edgecolor="w", bins=25, color='#a0b1ba')
ax[1].set_title(f'Panel B. Clean text lengths')

ax[2].hist(docsa['avgCleanTextPerPage'], edgecolor="w", bins=25, color='#a0b1ba')
ax[2].set_title(f'Panel C. Clean text lengths per page')
ax[2].text(x=8400, y=-20, s=f'Cropped at 1,500', ha='right')

fig.suptitle(f"n={len(docsa)} documents", y=1.1)
plt.show()
```

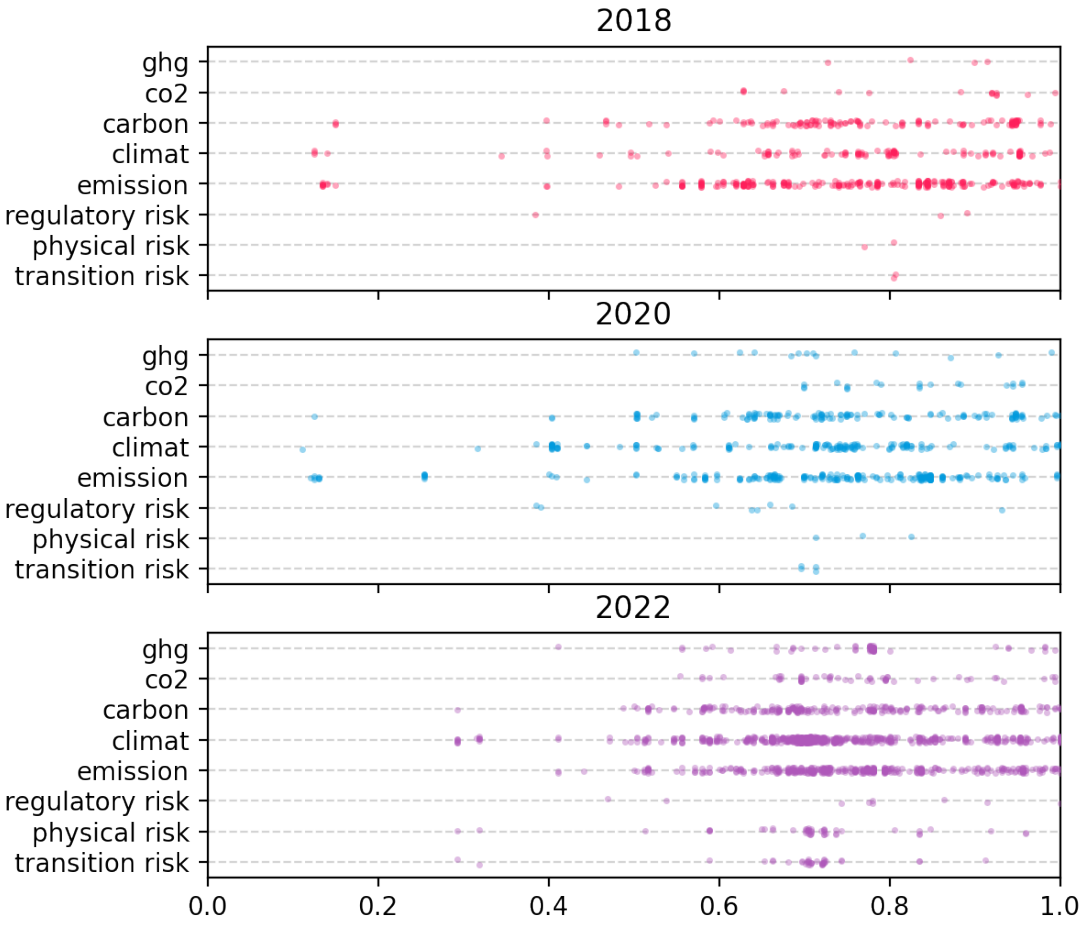


Figure 8: Relative location

```
#fig.savefig('figures/fig202309272049.png', dpi=400, bbox_inches='tight')
```

```
import nltk
```

```
from nltk.tokenize import sent_tokenize, word_tokenize
```

```
x = sent_tokenize(docsa.iloc[0]['fs_text'])
x
```

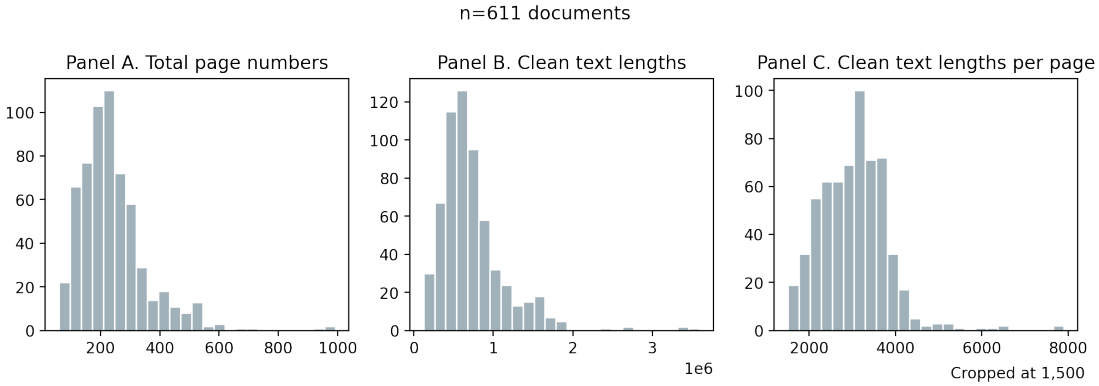


Figure 9: **?(caption)**