

Is Work going Remote?

Investigating the development of remote work in the
Danish labour market for the period 2010-2020

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Abstract

The spread of COVID-19 has forced governments to impose restrictions on the mobility of citizens' to minimize the risk of infection. This has led researchers and several news media to speculate about whether working remotely will be the new normal. In this project, we scrape data from job postings published in the Danish jobportal Jobindex to investigate the development of remote work in Denmark for the period 2010-2020. Our descriptive analysis confirms that the option of working remotely has become increasingly available throughout the whole period, and the global pandemic seems to have created a wave for workplaces to ride on. The potential for remote work in the future depends on the composition of the labour market and the skill level of the labour force, and may also require workplaces to formalize policies or guidelines for remote work to become widespread in the long-run.

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1 Introduction

The spread of COVID-19 has forced governments to impose restrictions on the mobility of citizens' to minimize the risk of infection. This has led researchers and several news media to speculate about whether working remotely will be the new normal. Although the widespread technological development within portable devices and online cloud-sharing has long been expected to transform the modern workplace, no one had foreseen the sudden need for remote work that followed from the outbreak of COVID-19.

In this project, we use data from job postings to *investigate the development of remote work in Denmark for the period 2010-2020*.

We collect data on remote jobs for the period 2010-2020 by scraping the Danish jobportal Jobindex filtering for job listings containing one or more keywords that can be linked to remote work from a list defined by ourselves. The data trends in remote work are then explored graphically and using text analysis. Furthermore, we use a subset of the dataset from 2010-2019 to forecast an artificial counterfactual to the development in remote job listings for 2020 in order to get a rough estimate of the size of the effect the outbreak of COVID-19 has had on remote labour. To the best of our best knowledge, there does not currently exist any studies of the remote labour market in Denmark using data from job postings. Thus, this paper's contribution is to complement the picture of the remote labour market which has already been painted by previous research with insights from the demand side of the Danish labour market.

The rest of the paper is structured as follows: Section 1.1 provides a literature review, Section 2 describes the process of data collection and cleaning, and results from sample controls. Section 3 is a descriptive analysis of the remote labour market in Denmark including a text analysis of the job titles and descriptions. Section 4 explains the theory and methods used for forecasting, followed by a forecasting exercise of the remote labour market in the absence of COVID-19. Section 5 discusses the project's results, strenghts and weaknesses, ideas for further research and conclusion.

1.1 Literature Review

While COVID-19 has led to a renewed interest in the remote labour market, the topic has been studied before. A recent study by Dingel & Neiman (2020)[2] explores the potential for remote work by creating a classification measure from the O*NET survey, that estimates the extent to which an occupation can be performed entirely from home. The authors estimate that 37 pct. of US jobs can plausibly be performed from home, including most jobs in finance, corporate management, and professional and scientific services. On the other hand, very few jobs in agriculture, hotels and restaurants, or retail could be converted to remote positions. The authors also note that there is significant variation in the potential for remote work across geographical areas, depending on the types of jobs and skills of workers in the specific area (Dingel & Neiman, 2020)[2].

OECD (2020)[8] apply this same classification to data from labour force surveys in 27 EU countries, Switzerland, Turkey and the US. They find that cities generally have a larger share of employment in occupations that can work from home and they estimate that at the national level, 40 pct. of Danish jobs can potentially be performed remotely, whereas the number is around 47 pct. for jobs in the Copenhagen area. OECD (2020)[8] also make the point that, since big cities may suffer from a higher risk of COVID-19 contagion because of high population density, a greater potential for working from home can provide a source of resilience to the economic downturn that follows health crisis such as the outbreak of COVID-19 (OECD, 2020)[8].

In the referenced studies, and in most of the literature on remote work, focus is usually placed on the supply side of the labour market by surveying employees about their prospects on working remotely. However, in order for remote work to become widespread, the expectations of both employers and employees must match. Job listings are an interesting source of data because they shed light on the demand side of the labour market, ie. the employer, and their perception on whether a job can be performed remotely.

The method of obtaining text data by webscraping is still relatively new, but it can be very powerful when it comes to gaining insight into otherwise inaccessible data sources. As an example, a management consulting firm

in Denmark has used text data from job postings to generate descriptive statistics about the development of demand in labour within the industries of IT and telecommunications, and the iron, metal and auto sectors[3]. Other projects include feeding job descriptions to a machine learning model to estimate appropriate salary[5].

2 Data

2.1 Data collection

For this project, we scrape job listings from the Danish job portal Jobindex in the period 2010-2020, more specifically the job title, company, and a preview of the full job listing, which are all available on Jobindex’s search results page (see Figure 1 below).

Figure 1: Standard job listing in Jobindex



We have chosen Jobindex, because it includes not only the portal’s own job postings, but also almost all publicly available job posting from other job portals and companies’ webpages.

Unlike some other job portals, Jobindex does not have a filter for “remote” job postings. Therefore, we identify the listings by defining a list

of keywords, that we assume would be mentioned in a posting offering the option of working from home either part time or full time:

["hjemmekontor", "hjemmearbejde", "fjernarbejde", "arbejde hjemmefra", "arbejde hjemme", "remote arbejdsplads", "remote work", "work remotely", "working remotely", "working from home", "home office", "home-office"]

We were aware that multiple keywords could be present in one job posting creating lots of duplicates, but these were easily deleted using other unique variables.

We also wish to classify the job listings according to the location of the position and the industry it falls into. As seen in figure 1, this information is not available when looking at each job listing individually. However, Jobindex allows you to filter the results according to date, job category and geographical area. The job categories are Information Technology, Engineering and Technology, Management and Staff, Trade and Service, Industry and Craft, Sales and Communication, Teaching, Office and Finance, Social and Health and Other positions. The geographical areas we include in our data are: Capital Area, North Zealand, Region Zealand, Funen, North Jutland, Central Jutland, South Jutland, Bornholm and Denmark¹.

The scrape for this project thus modified the Jobindex-url according to all possible combinations between remote keyword, job category and area for the period 2010-2020². Since all current and archived job listings in Jobindex are publicly available and do not contain any personal data, we could not think of any ethical breaches to take into consideration before proceeding with the scraping. The final scrape for this project was obtained on August 26, 2020.

Lastly, to put the development in remote job postings into perspective, we need data for the total monthly job listings for the period 2010-2020 overall and across categories and geographical areas. For this, we change

¹We have experienced, that Denmark is used when no specific region is available. We have excluded Greenland, Faroe Islands and Foreign countries.

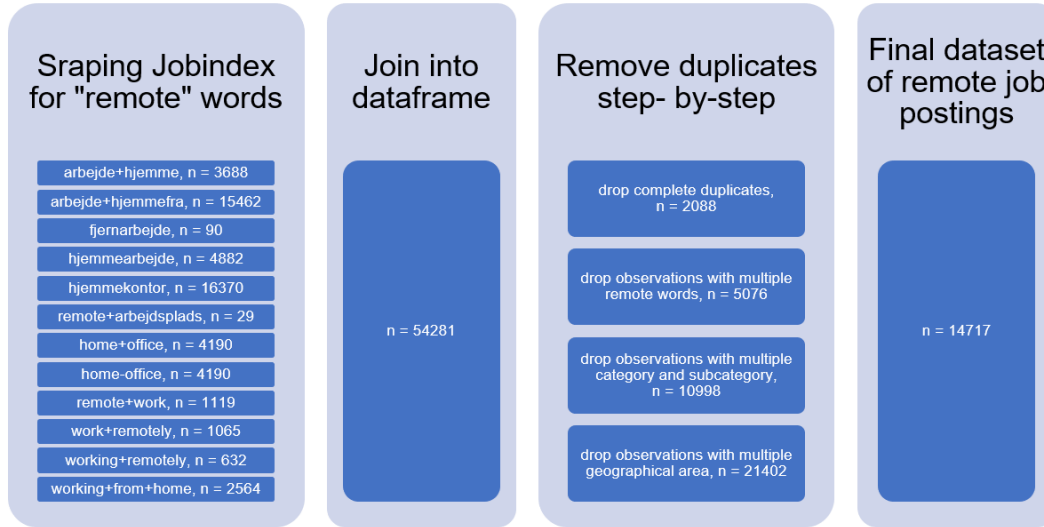
²Ideally, we wanted to scrape the full job listing and not just the preview. However, doing so would require scraping not only Jobindex but also different company websites and PDFs with varying HTML structure; and although we wrote a program that was able to achieve this, once we started running it we realized it would take more time than what we had available for the project. It is also due to these time constraints that we decided not to extend the sample period any further than 2010-2020.

the search filters accordingly and scrape the total number of jobs that match our search.

2.2 Data cleansing

Since the categories and locations provided in Jobindex's search filters are not mutually exclusive, and neither are the remote keywords that we defined, our dataset is bound to have many duplicates. We start with a dataset containing 54281 joblistings and we progressively delete duplicate job listings. The step-by-step process can be found in Figure 2. Notice that the way we have cleaned our data has the implication that if the same job falls under two (or more) job categories, by deleting its duplicates we are randomly assigning one of the two categories and deleting the others. Although this is not ideal, it is the best solution to avoid duplicates. After these steps, we end up with a dataset consisting of 14717 job listings in the period 2010-2020 where at least one of our remote keywords is mentioned.

Figure 2: Data cleansing process



2.3 Sample controls

We validate how accurately our keywords identify remote job listings, ie. we check if our sample actually consists of job listings where working remotely

is advertised, or if it is capturing the keywords being used in other contexts. To do so, we draw 5 random samples of 10 job listings each. For each listing, we go into Jobindex and read the full job description to check whether the possibility of working remotely is actually mentioned. The results of this exercise can be found in Table 1.

Table 1: Testing filter accuracy in identifying remote job listings

Sample	1	2	3	4	5	Average
Accuracy, pct.	0.8	0.7	0.8	0.9	0.8	0.8

Note: Each sample consists of 10 randomly selected job listings

Source: Own calculations

On average, we correctly identify remote job postings 80 pct. of the time and the results are fairly robust across samples, ranging from 70-90 pct. in accuracy. It is also worth noting, that 80 pct. of the joblistings counted as fails weren't "true" fails, but rather cases where we could not get access to the full job listing either due to the link being broken or because Jobindex could not retrieve a copy of the full job listing for archived job postings.

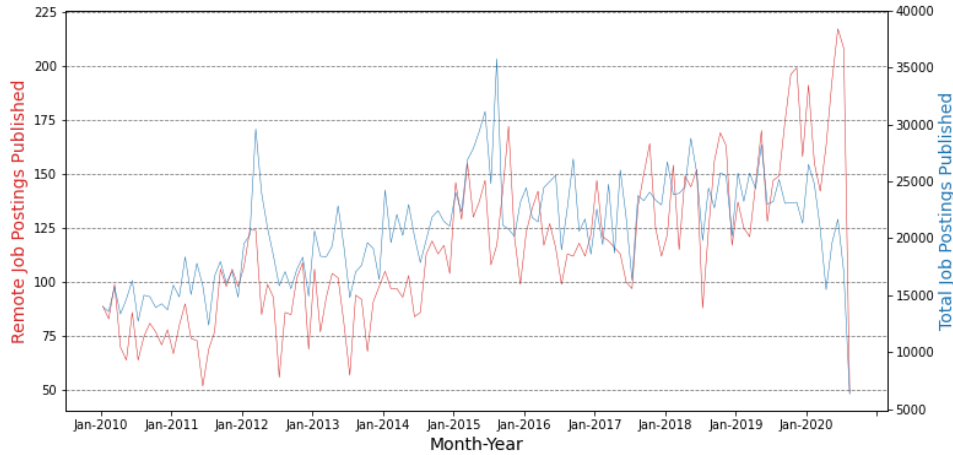
3 Descriptive Analysis

3.1 Graphical Analysis

We start by looking at the overall trend in job postings published in Jobindex in both absolute and relative numbers. Figure 3 shows the monthly trend in the number of remote job postings and in the total number of job postings on Jobindex in the period 2010-2020.

The figure shows an overall increase in both remote and total monthly job postings over the whole period. More specifically, from a level of around 15,000 total job postings per month to almost 20,000, and a 100 pct. increase from around 75 to 150 remote job postings per month (not taking into account the most recent numbers). Note that the number of job postings are generally business cycle dependent, hence showing an increasing labour demand after the 2009 financial crisis and leading to spikes in the total number of job postings around 2012 and 2015. However, zooming in

Figure 3: Remote and total job postings published on Jobindex, 2010-2020



Note: The data is not seasonally adjusted, as we want to investigate the true numbers.

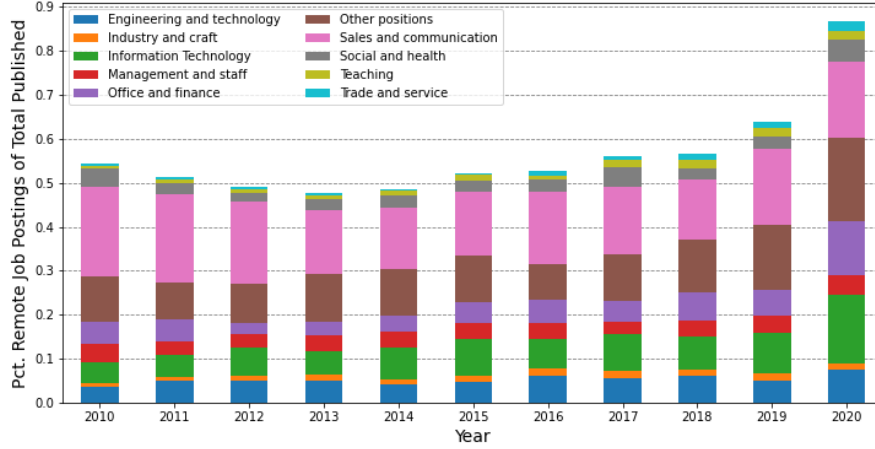
Source: Data scraped from www.jobindex.dk/jobsoegning

on the recent months, the total number of job postings has been decreasing, presumably due to the economic slowdown that resulted from COVID-19 related lock-downs. On the other hand, the number of remote job postings has reached a new high of up to more than 200 remote vacancies published. This rapid increase should also be seen in light of COVID-19, where companies have been forced to adapt to a remote working environment and are therefore both more aware of this option and more capable of offering it to new employees.

As pointed out by earlier research, the potential for working remotely differs between occupations. Next, we look at the differences in remote job postings within different job categories. The bars in Figure 4 depict remote job postings as a share of total job postings per year, whereas the area inside the bar is used to show the distribution of remote postings across job categories for the given year.

Overall, remote job postings make up less than one pct. of the total job postings published in a given year from 2010 to 2020. The percentage level is quite constant around 0.5-0.6 pct. up until 2019, and then increases to almost 0.9 pct. of all job postings published in 2020. Historically, our remote

Figure 4: Remote job postings as a share of total job postings 2010-2020



Note: Share is calculated as ($\#$ remote job postings in category $x / \#$ total job postings) and then stacked to get percentage remote job posting of total job postings. The area inside the bars depicts the distribution of remote postings across job categories for the given year. Data for 2020 only include the months Jan-Aug.

Source: Data scraped from www.jobindex.dk/jobsoegning

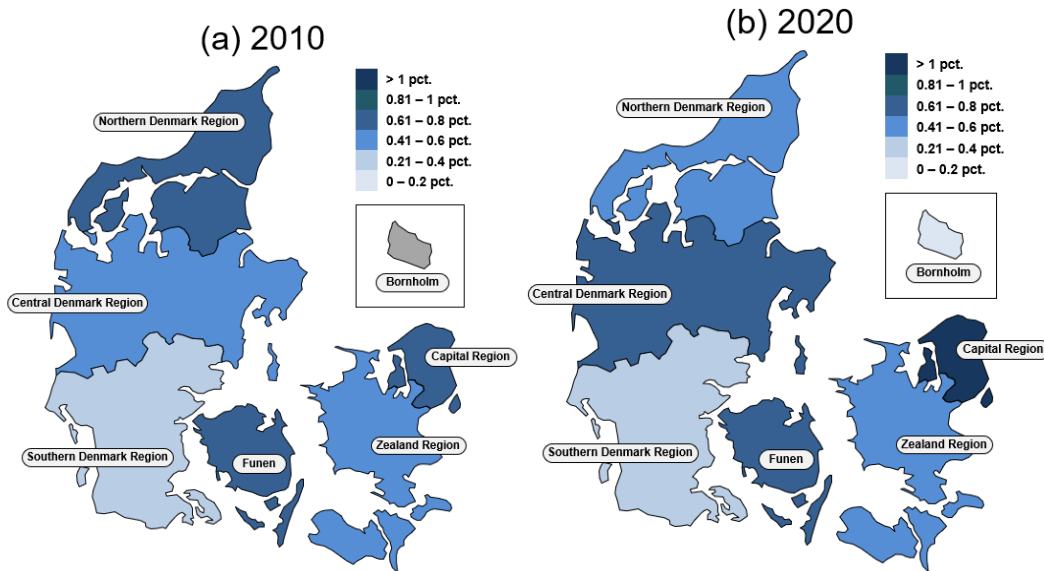
keywords have been linked to positions within the Sales and Communication branch, and when having a look at the samples from our dataset, we see that many of them are advertising for positions as traveling salesmen. However, since 2015, an increasing share of the remote job postings are within Information Technology, and Office and Finance, which often includes “desk jobs” which an employee can do from home. At the other end of the spectrum, we find a low share of remote job postings in the categories of Industry and Craft, Teaching and Social and Health, i.e. occupations that involve manual work or contact with people and therefore require that the worker is physically present.

Part of the attractiveness of working remotely, either full-time or part-time, is the fact that workers need not commute to the workplace. This can save them time, increase flexibility in their everyday life, help the environment, and help reduce traffic jams. This is especially relevant for workplaces in the big cities, where most jobs are usually concentrated and where pressures on the housing market can drive prices up to unaffordable

levels.

Figure 5 shows remote job postings as a share of total jobs postings across different Danish regions in 2010 and 2020. We have chosen these two points in time for multiple reasons, one of them being that they are the first and last points in our dataset.

Figure 5: Percentage remote job postings of total per Danish region, 2010 and 2020



Note: Share is calculated as ($\#$ remote job postings in region x / $\#$ total job postings in region x). Data for 2020 only include the months Jan-Aug.

Source: Data scraped from www.jobindex.dk/jobsoegning

For 2010, we see that around 0.61 and 0.8 pct. of job postings in the Capital Region, Funen and Northern Denmark Region mention remote work, while only 0.33 pct. of job postings in the Southern Denmark Region do. This is not surprising when taking into consideration the pattern we saw across categories since we could expect more manual and service jobs in the Southern Denmark Region relative to a higher concentration of administrative jobs in the bigger cities such as Odense and Copenhagen. When we turn to the map of 2020, the same pattern is present. The regions containing Copenhagen, Aarhus and Odense (the three largest cities) have the highest percentage of remote job postings. Specifically, in the Capital Region the share of remote job postings has increased by 0.56 pct.points from

0.62 pct. to 1.18 pct. Given that cities usually have a highest risk of infection due to their higher population densities, this suggests that workplaces in the cities are quickly adapting to an environment of uncertainty where having well-established systems for working remotely can be of advantage.

3.2 Text analysis

We identify the most frequent words in the job listings that we classified as remote by utilizing text analysis. Since our job listings include both job listings in Danish and English, we made use of a language detector package that allowed us to split the dataset accordingly. We then preprocessed and tokenized all of the text in the short job listing preview scraped from Jobindex. This included getting rid of symbols, numbers and punctuation, setting all text to lowercase, and removing stopwords in Danish and English respectively.

We tried using the Snowball stemmer since it has features for both Danish and English, but found that it shortened words unnecessarily, while it did not change the overall results. First, we looked at word frequency across texts, and found multiple words that had a high frequency but which didn't provide any meaningful insights, so we went back and removed them. The final results can be found in Table 2.

The first thing that comes to mind when looking at Table 2 is how similar the words are across languages. Both in English and Danish, sales is the most frequent word. We also see that Copenhagen is mentioned quite often, which is in line with the trend we saw before whereby remote positions tend to concentrate around the capital.

The fact that the word “mulighed (possibility)” is included when advertising for remote jobs suggests that working remotely is used as a selling point to make a position more attractive to applicants. Take for example the following snippet taken from Jobindex and translated to English: “Your work will take place in our office in Copenhagen, but there will be a possibility of working from home”³. By signaling to job seekers that there is a possibility of working partly or fully remotely, employers can expand their

³“Dit arbejdet vil foregå fra vores kontor i København, men der vil være mulighed for hjemmearbejde”

Table 2: Top 10 most frequent words in remote job postings 2010-2020

Danish	English
Salg	Sales
Udvikling/Udvikle	Team
Erfaring	Solutions
Team	Copenhagen
Samarbejde	Development
København	Customers
Ansvar	Hub
IT	Services
Mulighed	Global
Produkter	Manager
11851 remote job postings	2884 remote job postings

Note: The text analysis is performed using a preview of the full job listing provided by Jobindex

Source: Own calculations using text data from www.jobindex.dk/jobsoegning

pool of applicants not only across geographical location but also socioeconomic background. Evidence of this has been found before; For example, a 2017[4] study about women working in tech found that 76 pct. of the women surveyed listed remote working opportunities as top priority when it comes to closing the gender gap.

Generally, the most frequent words in job postings can be grouped around two major themes, namely IT and sales, which is not surprising given the results in the descriptive analysis. However, one could imagine that not all jobs related to sales and IT can be performed remotely, and we therefore explore in more detail which types of jobs are being advertised as remote. For this, we extract the top 10 most frequent words used in the titles from job listings, where the name of the position is usually mentioned. The same procedure as with the preview of the job listings is followed and the results are found in Table 3 below.

Once again, these words are fairly similar across languages. They both have “manager” as the most frequent word, which together with the word “sap⁴” suggests that remote jobs are mostly advertised for management

⁴In this context most likely referring to Systems Applications and Products in Data Processing

Table 3: Top 10 most frequent words in the title of remote job postings 2010-2020

Danish	English
Manager	Manager
Salgskonsulent	Sales
Account	Developer
Sælger/Sales/Salg	Denmark
Sjælland	Account
Key	Consultant
Konsulent	Engineer
Teknisk	Senior
IT	Sap
Erfaren	Specialist
11851 remote job postings	2884 remote job postings

Note: The text analysis is performed using a preview of the full job listing provided by Jobindex

Source: Own calculations using text data from www.jobindex.dk/jobsoegning

positions. Moreover, as suggested by words like “senior”, “specialist”, “erfaren(experienced)” and “consultant”, it seems that within the IT sector, remote job postings center around senior positions; while, more ambiguous words like “engineer” and “developer” and “teknisk (technical)” could also be used in the context of entry-level jobs. In the case of sales, this analysis does not get us much further than what we already observed.

4 Forecasting

4.1 Searching for a COVID-19 counterfactual

As social scientists, we are often interested in estimating the treatment effect that different exogenous shocks, such as policy changes or natural phenomena, can have on variables on interest. In this case, the mobility restrictions imposed by governments can be seen as an exogenous shock to the remote labour market and it is worth questioning what the magnitude of the effect of this shock has been.

software.

Ideally, we would like to observe our target (remote job listings) in both states of the worlds, that is, both with and without the presence of COVID-19. Although this is impossible, training a model using data for the period prior to the pandemic and making a forecast for 2020 could provide us with an artificial counterfactual to the actual development of remote job listings. Notice that the purpose of this exercise is not to formally estimate the true causal effect of COVID-19 on remote work, but rather to make an educated guess of the magnitude of this effect and thereby motivate future research into how changes in policies such as mobility restrictions can have powerful effects on rearranging the incentives for employers in the labour market.

4.2 Forecasting using the Prophet procedure

Since we have uni-variate time series data on monthly remote job listings, for our forecasting we chose to use the Prophet algorithm developed by Facebook, as it is considered to perform well in modeling data with seasonal effects[6] and shifts in trends. Part of the attractiveness of Prophet is that it automatically finds seasonal trends beneath the data and offers a set of parameters that are easy to understand and can be calibrated accordingly. More specifically, Prophet uses an additive regression to fit the data to a model with three main components:

$$y(t) = g(t) + s(t) + h(t) + \epsilon_t$$

$g(t)$ is a trend function which can be linear or logistic, $s(t)$ captures periodic changes (e.g., weekly and yearly seasonality), and $h(t)$ represents the effects of holidays which occur on potentially irregular schedules.

We can choose the calibration for each of these components or allow Prophet to estimate them on its own. We start by allowing Prophet to calibrate the parameters and then looking at cross-validation metrics to see whether we can improve the model’s performance by changing the hyperparameters that Prophet defined. To evaluate the model, we use Prophet’s built-in cross validation function. This function takes our data and trains the model using a period specified by us, and then predicts a period that we also specify. Prophet will then train our data on a bigger period, then

predict again and this will repeat itself until the end point is reached and the model cannot be further optimized.

Since we want the training data set to have enough data to capture yearly seasonality, we set the cross-validation function to start by using the first 24 months to predict the next 9 months. The Mean Average Percentage Error for the cross-validation exercise using the parameters chosen by Prophet can be found in the first column of Table 4 below.

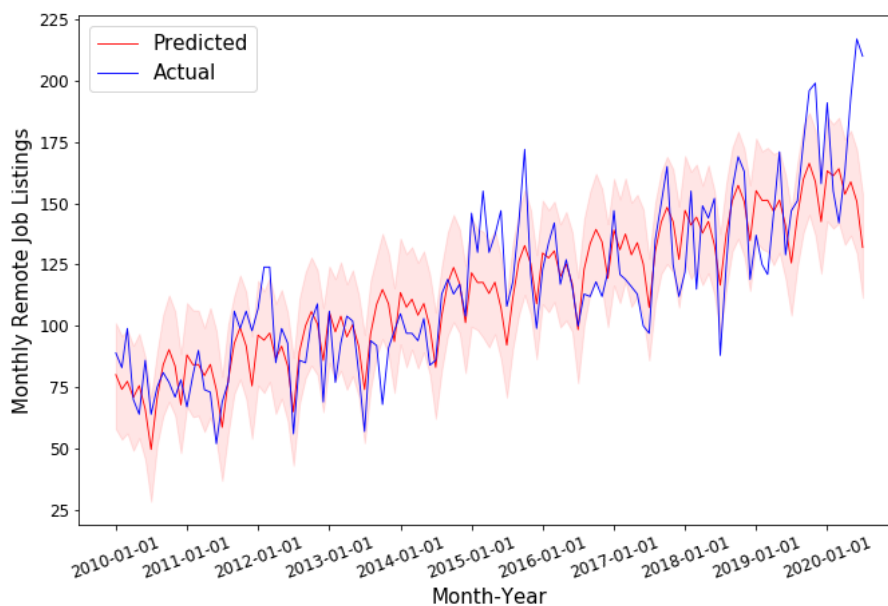
Table 4: Mean Average Percentage Error across differet model specifications

	Prophet	Summer holidays	Monthly seasonality
MAPE	17.17	17.22	65.5

Prophet has found a linear trend to be the best fit and based on what we saw in the graphical analysis we do not have any reason to think that remote job listings will be reaching a saturation point in the near future; therefore, we leave this parameter as it is. However, the graphical analysis above did show that remote job listings tend to be extremely low during the summer holiday. Therefore we specify a holiday component for June of each year, and allow for the effect to extend to days leading to the holiday. We find that although having similar MAPEs, the specification chosen by Prophet beats ours.

Next, we allow for a monthly seasonality component since there has been found to be some persistent patterns across months in data for US job openings. However, doing so significantly worsens the performance of our model and since we cannot come up with any further parameter changes that could improve the model fine-tuned by Prophet, we proceed with using this for our forecasting exercise. The results can be found in Figure 6 below.

Figure 6: Predicted vs. actual monthly remote job listings 2010-2020



Note: Predicted values were estimated by fitting our data to the Prophet model.

Source: Own calculations

We see that the model tends to underpredict the trend in remote job listings, however, the difference between actual and predicted values for the 2020 period stands particularly out which is in line with our suspicion that the outbreak of COVID-19 has accelerated the expansion of remote work.

5 Discussion and conclusion

From our descriptive analysis of remote job listings published in 2020, it is clear that the outbreak of COVID-19 has brought greater focus on remote work from the employers' side.

The relative increase of remote job postings in the Capital Region and the presence of “København/Copenhagen” in the top 10 most frequent words in remote listings are especially in line with findings by OECD (2020) whereby big cities have a larger share of jobs that can be performed remotely and workplaces located in big cities may have higher incentives to adapt

to remote working conditions due to higher risk of contagion. Since the outbreak of the pandemic is still relatively recent, it would be interesting to revisit this analysis again at a later point in time and investigate whether regions with higher potential and incentives for remote were indeed better at handling the economic downturn.

One of the strengths of using job postings data to study the labour market is that it is completely up-to-date, whereas we would otherwise have to wait for official employment statistics to be released. However, we must still be careful with drawing conclusions from a 6-month period, in a time where the economy and labour market has potentially changed on a structural level. Although there has been an evident increase in remote jobs following the outbreak of COVID-19, we do not yet know if this rate of expansion will persist in the long run. So far, the increases in remote labour demand has been welcomed and encouraged by politicians[7] and the employers' organisation, Confederation of Danish Industry (DI). DI further recommends that companies formalize guidelines for remote work and evaluate continuously in order for remote work to be successfully adopted without compromising productivity[1].

Along with companies offering more remote positions comes the need for a way that job seekers can find these positions easily. In this project, we identified remote listings with an average accuracy of 80 pct. by searching for a list of keywords/expressions linked to remote work that we defined. The sudden increase in remote listings provides an opportunity for Jobindex and other job portals to implement a "remote" filter/checkbox to smooth the process of job searching. Such a feature is already implemented in the Careergate jobportal, but it does not seem to work properly⁵ when comparing results from the filter to those found using the keywords. We think this has to do with Careergate labeling a vacancy as remote only if the employer has directly specified so (probably by checking a "remote" box when submitting the job listing) and not by looking through the text. In order to provide job seekers with search results that aren't as sensitive

⁵We take full responsibility for this statement, as it is based solely on our own experience.

to human error, we suggest that such a feature is complemented using text analysis.

Given our constraints on time and space, we had to limit the scope of the project in several dimensions. Initially, we set out to scrape all job postings from Jobindex over the period 2008-2020, so that our sample would include a year prior to the financial crisis and allow us to put the effect of COVID-19 into an even broader perspective. As the program we coded to do this would have taken days to execute, we went through with a shorter period including only data for remote job listings. However, the full dataset would allow for further insight into the remote labour market and how the patterns found in the remote job listings compare to those from the total job listings.

This does not mean that our data isn't interesting enough, one could for example match our data for the name of the company posting the job listing to data from the Central Business register and thereby get a picture industry, size and nationalities of employers offering remote work opportunities. Another interesting exercise, which we ourselves performed but had to exclude to due poor accuracy when testing, is to match the words in the job titles to the job functions included in the DISCO-08 classification, this would tell us with more precision which type of jobs are going remote set-up see whether the pattern found by OECD (2020)[8] whereby the potential of remote work increases with the overall skill level of the population is present.

In conclusion, our descriptive analysis lends support to what media outlets and academics have foreseen, namely, that the option of working remotely is becoming increasingly available, and the global pandemic seems to have created a "remote work" wave for workplaces to ride on. The potential for remote work in the future depends on the composition of the labour market and the skill level of the labour force, and may also require workplaces to formalize policies or guidelines for remote work to become widespread in the long-run.

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