The unwanted free rider: Covid-19

Falk, Martin[1]; Hagsten, Eva[2]

[1] Department of Business and IT - University of South-Eastern Norway
[2] Háskóli íslands – University of Iceland

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Martin Thomas Falk*

University of South Eastern Norway (USN)

Eva Hagsten

University of Iceland

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Abstract

Winter holidays in the European Alps early 2020 led to unexpected challenges for the Scandinavian countries (Denmark, Norway and Sweden), since many travellers brought home a free rider virus, Covid-19. In this study a modified gravity model is used to investigate how important destination country, size and geographical distance are for the extent to which the virus was carried to Scandinavia. The number of reported Covid-19 positive cases is highest from Austria (1150 individuals), Italy (68) and Spain (90). Count data model estimations confirm that the number of Covid-19 cases in Scandinavia mainly originates from Austria and Italy, followed by Iran. The number of positive cases brought from abroad decreases significantly with the geographical distance between the home country and the destination. There is also a clear surge of infections at the beginning of the observation period (March 11 to March 15, 2020), before the introduction of travel restrictions.

Keywords: Covid-19, destination country, winter holidays, gravity model, count data model, Scandinavia.

*University of South-Eastern Norway (USN), Campus Bø, Norway, School of Business, Department of Business and IT, email: martin.falk@usn.no

1. Introduction

February to early March is the typical period for the winter school breaks in the Scandinavian countries (Denmark, Norway and Sweden). The European Alps (together with the Scandinavian mountains) are common destinations for families during this one-week time off. There are frequent flight connections from the main Scandinavian airports and the winter sport destinations in the European Alps (Austria, France, Italy and Switzerland), allowing a convenient travel.

Somewhat surprisingly, several travellers from the Scandinavian countries fell ill already during their holidays or shortly after their return, despite having spent most of their time outdoors on the ski slopes, supposedly far away from the local outbreak of the novel Covid-19 virus in the North-east of Italy. Soon authorities warned against travel to the North of Italy, although a further spread to other European countries was not considered at the time. This view did not change until the Icelandic authorities suddenly raised a sharp travel warning about Tyrol in Austria on the 5th of March 2020, after finding that several persons returning back from their skiing holidays were infected (www.landlaeknir.is, information retrieved 31 March 2020). The Scandinavian countries followed this warning on the 10th of March, implying that the group of countries with recommendations against travel (China, Iran, Italy and South Korea) were extended to include also Tyrol in Austria (www.regeringen.se; www.regieringen.no and www.um.dk, information retrieved 31 March 2020).

This study aims to investigate if destination country, size and distance are important for the extent to which the Covid-19 virus free rode to Scandinavia with travellers returning from trips abroad in February-March 2020. The extent of the number of infected travellers from different destinations is specified as a modified gravity for which a count data estimator is employed.

Information on number of infected Scandinavian travellers originate from the public authorities in each country (for sources, see Data Section).

This study complements recent literature on short term effects on the tourism sector (for instance, Gössling, Hall and Scott, 2020), by investigating how typical leisure trips contribute to the spread of the Covid-19. Earlier studies focus on business travels and family visits (Chen et al., 2020, Chinazzi et al., 2020; Gilbert et al., 2020). By controlling for size and distance in the gravity estimation it is possible to show how countries are represented as sources for the initial spread of the Covid-19 virus.

2. Conceptual background and empirical model

Previous literature shows that the probability of appearance and the speed of spread of the Covid-19 virus is related to business travel or visiting friends and relatives. For China, Chinazzi et al. (2020) model the probability of the virus spread as a function of the number of infected individuals travelling from affected areas (X) to a specific destination country (Z). Gilbert et al. (2020) suggest that the spread of the Covid-19 virus is mainly related to business travel. This conclusion is reached based on estimations of the number of air travellers bound for Africa from infected provinces in China. According to Chen et al. (2020), government officials and researchers in China feared that the mass movement of people at the end of the Lunar New Year holiday on 31 January 2020 would further spread Covid-19. The authors emphasise that these trips are usually short, implying that there is a high risk of a transmission because the incubation is relatively long, up to two weeks and several infected persons do not fall ill until they are back home again.

A typical winter holiday in Scandinavia is one week long and coincides with school schedules. This means that also the supply of accommodation in winter sport areas to a large extent is based on weekly arrangements. Thus, this is a time frame that allows a hidden virus to accompany the traveller all the way home. Kucharski et al. (2020) estimate a model on how the virus is transferred from Wuhan in China and finds that at least four independent cases are needed for a 50 per cent chance that it should be established in a new location (given reasonably similar conditions as in Wuhan).

The empirical approach is based on a gravity model and a count data estimator. Gravity models originate from the physical theory of gravitation developed by Newton proving that the gravitational attraction between two objects is proportional to the product of their masses and inversely proportional to the square of the distance between them. In the present context, this translates into the expectation that larger destination (or home) countries, measured by population, should send (or receive) more infected travellers, while greater geographical distance would moderate this relationship. The related tourism literature finds that traditional gravity factors are among the most robust determinants of travel flows between home and destination countries (Morley, Rosselló and Santana-Gallego, 2014). Recent empirical applications include, for instance, the demand for agritourism in Italy and the effect of different time zones on tourism demand (Santeramo and Morelli, 2016; Czaika and Neumayer, 2020).

Based on a gravity-type equation the number of travellers from the Scandinavian countries that are found to be carrying the free riding Covid-19 virus from abroad, Y_{ijt}, is modelled as a function of population, distance as well as a set of dummy variables for destination and reporting date:

$$Y_{ijt} = ß_0 + ß_1 ln(POP\_HOME_i) + ß_2 ln(POP\_DEST_j) + ß_3 ln(DIST_{ij}) + \sum_{D=1}^{25} ß_{4D} CO\_DEST_j^D + \sum_{T=1}^{15} ß_{5T} DATE_t^T + \varepsilon_{ijt}.$$

Subscript *i* denotes the home country (*i*=Denmark, Norway and Sweden) and *j* denotes the destination country (*j*=1,..,29), *t* (*t*=11.3.2020,…,26.3.2020) is the reporting date of the infected case and $ln()$ is the natural logarithm. POP_HOME_i and POP_DEST_j illustrate the population size of home and destination countries, respectively. *DIST* is the weighted geographical distance between the capital cities of the country pairs measured in kilometres. Two sets of dummy variables are included, *CO_DEST* for the destination countries (with China and Thailand as the reference category) and *DATE* for the day when the infection is reported. In the estimation POP_HOME_i can be replaced by dummy variables since the number of home countries is three.

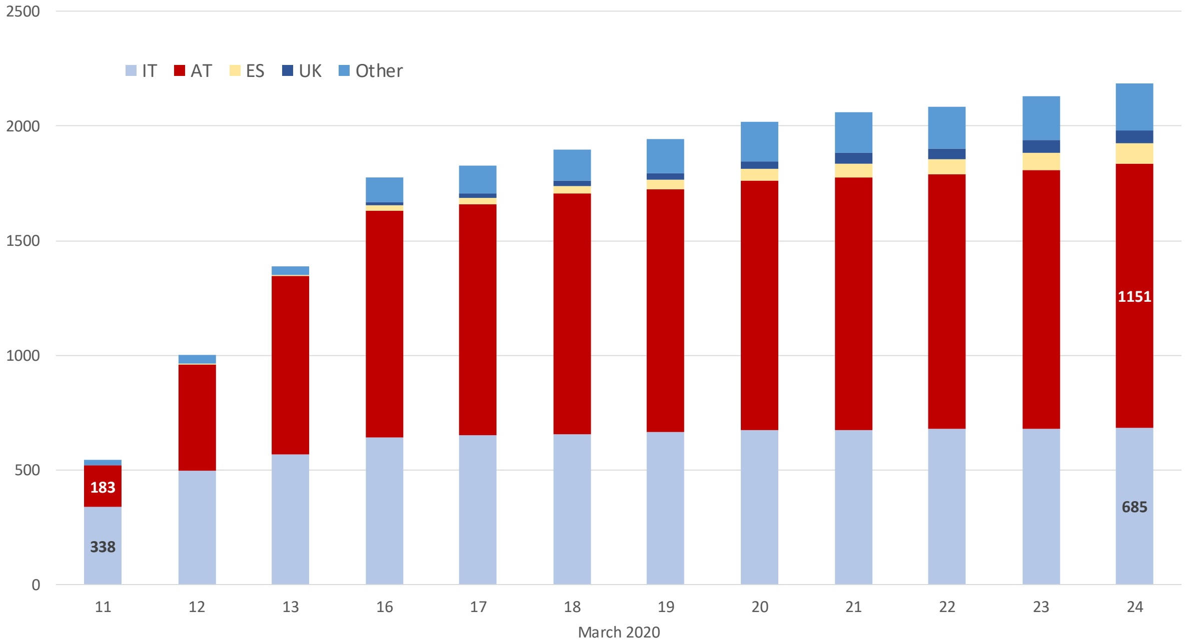
The dependent variable is highly unevenly distributed with many infected travellers arriving back home from Italy and Austria and fewer or zero from other countries. This means that there is a significant degree of over-dispersion the variance considerably exceeds the mean. The most common estimators used for count variables are the Poisson regression and negative binomial models, the latter being an extension of the former (Cameron and Trivedi, 2013). Due to the apparent over-dispersion, the negative binomial regression model is used. The estimates can be presented as incidence rate ratios (IRR) which are exponentiated coefficients. IRRs with significant values smaller (higher) than 1 refer to proportionally less (more) infected cases. A Likelihood ratio test can be used to examine which of the models, the negative binomial or the Poisson, that are best suited for the estimation. As an alternative to the pooled negative binomial or Poisson model the random effects negative binomial model could be considered. However, in this case there is no time varying information available except the reporting date to promote such a choice.

3. Dataset and descriptive statistics

Data on the number of persons carrying the Covid-19 infection from abroad is provided by public health agencies in each Scandinavian country (https://www.fhi.no/en/; www.folkhalsomyndigheten.se and https://www.sst.dk/, information retrieved 31 March

2020). Since the end of February, these agencies trace the origin of positive cases and found them primarily relating to travellers returning home from winter holidays. These holidays often coincide with the official weekly winter breaks of schools, which take place during February or early March each year. In 2020, the capital cities of Copenhagen and Oslo held their school breaks during week 8 and Stockholm during week 9, a time when the virus was still spreading undetected in several areas. The databases contain information on the number of reported Covid-19 infected persons by destination country from March 11 to March 26, 2020. There are also cases without information on the destination country so the reported cases can be regarded as the minimum value. The majority of Covid-19 positive travellers returned from Austria and Italy (Figure 1 and Table 2 in Appendix).

Figure 1: Number of Covid-19 infected Scandinavian travellers by destination country



Notes: Country codes are based on ISO 3166-1 (https://www.unece.org/cefact/locode/service/location, retrieved 31 March 2020).
Source: https://www.fhi.no/en/; www.folkhalsomyndigheten.se and https://www.sst.dk/

As of 24 March 2020, when most European borders closed in attempts to block the spread of the virus, a majority of cases are identified from Austria (1150) followed by Italy (680), Spain (80) and some more distant countries including the United States and Iran. The distribution of the virus varies across the Scandinavian home countries with Sweden having more Covid-19 free riders from Italy and Denmark and Norway most infected travellers from Austria. Information on population refers to the year 2018 and originates from the World Bank development indicators (https://databank.worldbank.org/source/world-development-indicators, retrieved 31 March 2020). Population weighted distance data is available in Mayer and Zignago (2011).

4. Empirical results

The negative binomial model estimations show that the number of travellers carrying the free riding Covid-19 virus relates significantly to the destination country, the geographical distance between the capital cities of the home and destination country, home country and the reporting date, although the size of the destination country is not relevant (Table 1). The Incidence Rate Ratio (IRR) and the corresponding z-statistics are given for three different specifications: i) standard, ii) quadratic specification for the destination-home pairs and iii) quadratic specification for the time trend. The estimated number of Scandinavian travellers reportedly carrying the Covid-19 virus home coincides with the descriptive statistics for Austria and Italy, although Iran and not Spain shows the third strongest relationship. The number of reported cases brought home from abroad decreases significantly with geographical distance between the home and destination country (Specification i). A linear relationship between geographical distance and number of Covid-19 cases from abroad is indicated by the insignificant quadratic term (Specification ii) and the time dummy variables reveal that the surge in the number of cases is most pronounced at the beginning of the time period (11 to 13 March, 2020). However, the speed of increase in Covid-19 cases from abroad decreases over time as indicated by the negative and significant coefficient of the squared term of the time variable (Specification iii). This is likely due to the closure of hotels and major tourist attractions in the European Alps, introduction of travel restrictions, travel warnings and partly closed borders for non-residents after the weekend 14 to 15 March 2020.

The Incidence Rate Ratio shows that significant values higher (lower) than 1 means proportionally more (less) Covid-19 infected cases, such as the travellers returning back home from Austria with on average 100 times higher risk of being infected than the reference country China (and Thailand), followed by Italy (83 times higher) and then a group of countries (Spain, United States and Iran) with approximately four to five times higher risk. The significant dummy variables for the (daily) reporting date show that the number of infected travellers accumulate over time while the negative squared term indicates a decrease in speed (specification iii).

Table 1: Number of Covid-19 infected Scandinavian travellers by destination country, Negative binomial estimations

		(i)			(ii)			(ii)	
	IRR		z-stat	IRR		z-stat	IRR		z-stat
ln population destination country	1.02		0.17	1.03		0.20	1.03		0.18
Home country dummy variables (ref cat DK)									
NO	5.02	***	11.59	5.04	***	11.42	5.14	***	11.84
SE	4.02	***	10.46	4.03	***	10.29	4.12	***	10.72
ln geographical distance	0.37	***	-3.02	0.36	***	-2.73	0.37	***	-3.05
ln geographical distance squared				1.03		0.14			
Destination country dummy variables (ref CN and TH)									
AD	1.03		0.02	1.18		0.10	1.02		0.02
AE	0.38		-1.43	0.41		-1.10	0.39		-1.42
AT	99.59	***	5.29	111.54	***	4.02	98.65	***	5.27
BE	0.04	***	-3.14	0.05	**	-2.41	0.04	***	-3.15
CH	2.25		0.95	2.53		0.79	2.23		0.94
CV	0.38		-0.94	0.41		-0.80	0.38		-0.94
CY	0.03	***	-2.61	0.03	**	-2.21	0.03	***	-2.61
DE	0.65		-0.53	0.72		-0.32	0.64		-0.56
DK	0.20		-1.32	0.22		-1.17	0.19		-1.34
DZ	0.95		-0.08	1.05		0.05	0.93		-0.11
ES	5.07	***	2.91	5.59	*	1.95	5.03	***	2.89
FI	0.30		-1.07	0.32		-0.86	0.29		-1.09
FR	2.43		1.37	2.70		1.02	2.39		1.34
HR	0.14	**	-2.03	0.16		-1.45	0.14	**	-2.04
HU	0.12	**	-2.30	0.13	*	-1.66	0.12	**	-2.32
IE	0.26		-1.42	0.29		-0.98	0.25		-1.44
IQ	0.31	**	-1.98	0.33		-1.35	0.30	**	-1.99
IR	5.41	***	4.21	5.80	***	2.77	5.36	***	4.18
IT	84.09	***	7.27	93.22	***	4.81	82.36	***	7.22
MT	0.02	***	-3.55	0.02	***	-2.89	0.02	***	-3.55
NL	0.31		-1.25	0.35		-0.91	0.31		-1.27
NO	0.10	*	-1.94	0.11	*	-1.69	0.10	**	-1.97
PT	0.47		-1.09	0.52		-0.67	0.47		-1.09
TZ	0.13	***	-2.62	0.13	***	-2.58	0.13	***	-2.60

UK	1.57		0.61	1.74		0.54	1.54		0.58
US	5.18	***	6.65	5.23	***	6.44	5.19	***	6.64
ZA	0.17	**	-2.28	0.16	**	-2.27	0.17	**	-2.26
Mar-12 (reference category Mar-11)	1.53	**	1.96	1.53	**	1.97			
Mar-13	1.92	***	3.07	1.92	***	3.08			
Mar-14	2.57	***	4.27	2.57	***	4.27			
Mar-15	3.11	***	5.19	3.11	***	5.20			
Mar-16	3.53	***	6.09	3.53	***	6.09			
Mar-17	3.94	***	6.61	3.94	***	6.61			
Mar-18	4.42	***	7.20	4.42	***	7.20			
Mar-19	4.88	***	7.69	4.88	***	7.70			
Mar-20	5.76	***	8.51	5.76	***	8.51			
Mar-21	6.10	***	8.81	6.10	***	8.81			
Mar-22	6.21	***	8.91	6.21	***	8.91			
Mar-23	6.82	***	9.37	6.82	***	9.37			
Mar-24	7.29	***	9.71	7.29	***	9.72			
Mar-25	8.78	***	10.22	8.78	***	10.22			
Mar-26	9.97	***	10.80	9.97	***	10.81			
Time trend							1.27	***	7.53
Time trend squared							0.99	***	-3.72
Constant	0.33		-0.98	0.29		-0.86	0.33		-1.01
Overdispersion parameter alpha	0.34	***		0.34	***		0.35	***	
Number of observations	795			795			795		
Log pseudolikelihood	-1825			-1825			-1828		
McFadden's Adjusted R^2	0.31			0.31			0.30		

Notes: ***, ** and * denote significance at the 1, 5 and 10 per cent significance levels. The dependent variable is the number of imported Covid-19 cases by infection source country (from destination country i to home country j) for the period March 11 to 26, 2020. The *nbreg* command in STATA 15 with the mean-dispersion option (the default) is used. No exposure variable is specified so that all observations in the data have the same opportunity to observe an event. The likelihood ratio test of the Poisson against the Negative Binomial regression model shows that the null hypothesis that the overdispersion parameter alpha is equal to zero can be rejected at the 1 per cent significance level. Country codes are based on the ISO 3166-1 (https://www.unece.org/cefact/locode/service/location, retrieved 31 March 2020).

5. Conclusions and implications

This study investigates the importance of country size, destination country and distance for the extent to which the Covid-19 virus was free riding to Scandinavia with travellers returning from abroad during the hectic winter holidaying period in 2020. by use of a gravity model and count data estimations. Descriptive statistics indicate that travellers from Austria, Italy and Spain carried most cases back home. Count data estimations of a gravity-type model including control variables indicate the importance of Austria, Italy and Iran for the transmission across borders of the virus. The number of Covid-19 cases decreases significantly with the geographical distance between the home and destination country. There is a surge in the number of cases at the beginning of the reporting period (weekend 14 to 15 March 2020) that flattens out with the closure of the tourism infrastructure and introduction of travel restrictions.

This study illustrates that the spread of the Covid-19 virus to Scandinavia is related to winter holiday and leisure travel within Europe. This adds a new dimension to earlier research where mainly travel for visiting friends and relatives as well as for businesses are considered as the main facilitators of spreading the virus. A gravity model also appears functional for this specific research question.

Several limitations need to be kept in mind. To further detail the analysis additional information about for instance regional characteristics would have been beneficial. However, such data is only available with longer time delay and thus is left for future research. There might also be differences in the reporting of cases among the countries in question, although in the initial phases of the pandemic, when there were still hopes to block a general spread, this variation is assumed to be small. The results of the analysis cannot be used as a forecast for the general transmission of the virus, this is work for the epidemiologists to continue with.

References

Cameron, A. C., & Trivedi, P. K. (2013). Regression analysis of count data (Vol. 53). Cambridge university press.

Chen, S., Yang, J., Yang, W., Wang, C., & Bärnighausen, T. (2020). COVID-19 control in China during mass population movements at New Year. *The Lancet*, *395*(10226), 764–766.

Chinazzi, M., Davis, J. T., Ajelli, M., Gioannini, C., Litvinova, M., Merler, S., ... & Viboud, C. (2020). The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. *Science*.

Czaika, M., & Neumayer, E. (2020). On the negative impact of time zone differences on international tourism. *Current Issues in Tourism,* 23(10), 1181–1185.

Gilbert, M., Pullano, G., Pinotti, F., Valdano, E., Poletto, C., Boëlle, P. Y., ... & Gutierrez, B. (2020). Preparedness and vulnerability of African countries against importations of COVID-19: a modelling study. *The Lancet*, *395*(10227), 871–877.

Gössling, S., Scott, D., & Hall, C. M. (2020). Pandemics, tourism and global change: a rapid assessment of COVID-19. *Journal of Sustainable Tourism*, 1–20.

Kucharski, A. J., Russell, T. W., Diamond, C., Liu, Y., Edmunds, J., Funk, S., ... & Davies, N. (2020). Early dynamics of transmission and control of COVID-19: a mathematical modelling study. *The Lancet Infectious Diseases*.

Mayer, T., & Zignago, S. (2011). Notes on CEPII's distances measures: The GeoDist database.

Morley, C., Rosselló, J., & Santana-Gallego, M. (2014). Gravity models for tourism demand: theory and use. *Annals of Tourism Research*, *48*, 1–10.

Santeramo, F. G., & Morelli, M. (2016). Modelling tourism flows through gravity models: a quantile regression approach. *Current Issues in Tourism*, 19(11), 1077–1083.

Online Appendix

Table 2: Number of Covid-19 infected travellers by individual country-pairs

	Home country					
	DK	DK	NO	NO	SE	SE
	12.3	24.3	12.3	24.3	12.3	24.3
Destination country						
AD					0	5
AE	0	1			0	0
AT	139	298	252	594	74	259
BE					0	1
CH	0	1	0	34	0	14
CN					1	1
CV					0	1
CY					0	0
DE	2	2	0	14	2	5
DK					0	7
DZ	0	1				
ES	1	7	0	69	0	13
FI					0	5
FR	0	2	0	17	4	33
HR	0	1			0	0
HU					0	1
IE	0	1	0	3		
IQ					0	1
IR	1	1	5	5	14	15
IT	30	61	115	157	351	467
MT					0	0
NL	1	1			2	2
NO	0	2			0	2
PT	0	1	0	0	2	3
TH	0	1			0	1
TZ					0	0
UK	0	3	0	45	0	10
US	1	4	0	9	4	7
ZA					0	0

Notes: Country codes are based on ISO 3166-1 (https://www.unece.org/cefact/locode/service/location, retrieved 31 March 2020).
Source: (https://www.fhi.no/en/; www.folkhalsomyndigheten.se and https://www.sst.dk/).