Escaping from home: where do academics perform their research work during Covid-19 pandemic?

ABSTRACT

The Covid-19 pandemic has forced most workers to work from home (WFH). At a first glance, this seems not a big change for academics, who, even in normal time, are used to performing their research activities autonomously and to balancing on-campus and off-campus locations. Instead, exactly for their flexible habits it is interesting to study where academics have worked during the Covid-19 pandemic and which factors relate to their location choices. This paper addresses these issues by relying on survey data from a sample of 7,865 Italian tenured academics. First, cluster analysis unveils four main location choices of Italian academics during the Covid-19 pandemic depending on the frequency of access to home, university or other spaces, namely *Home-centric*, *University-centric*, *Between home and university* and *Multi-located*. Second, multinomial probit models reveal a nuanced picture of the factors associated to the belonging to each cluster. Decisions over location choice depend, mostly, on *work-related* factors (*i.e.*, discipline); then on *space-related* factors (*i.e.*, satisfaction towards campus workspace characteristics and the need of a laboratory); finally, on, *life-related* factors (*i.e.*, living with school children or a partner) and *other* factors (*i.e.*, commuting times and gender). However, each of the four location patterns depend on different determinants. The results offer university and practice-wide implications anticipating future changes in how work in academia is spatially organized.

Keywords – Covid-19; University; Location choice; Workspace; Research work; Knowledge-work, Survey, Econometric analysis, Cluster analysis.

1. INTRODUCTION

Work autonomy, low degree of formalization, and unconventional organizational structure characterize academia (Salancik & Pfeffer, 1974; Wilhoit et al., 2016); these features make academics free to choose their work location, differently from their non-academic peers, whose work location choices are more constrained. In recent decades, academics have increasingly performed their research work outside the boundaries of university campuses, in off-campus locations (*e.g.*, houses, libraries, dedicated laboratories, firm premises or even coworking spaces, cafés, and parks). More than other knowledge workers, the "contagious off-site work" (Rockmann and Pratt, 2015) is increasingly relevant in academia and a low occupancy rate is usually associated to university campuses (Lansdale et al., 2011).

Despite the increasing diffusion of phenomenon, up to now, scholars have paid little attention to why and how academics choose the location of their research work. According to scant literature on the topic, the reasons why academics choose to work outside their campus boundaries are twofold. On the one hand, they need to find space for doing collaborative work (*e.g.*, with firms or colleagues from other departments and universities) or conducting entrepreneurial activities (Rajalo and Vadi, 2017); on the other hand, they look for reserved spaces – typically their own houses – to concentrate and perform individual work (Seddigh and Berntson, 2014; Gornall and Salisbury, 2012).

Moving from these premises, it is highly interesting to investigate what happened when the outbreak of Covid-19 disrupted academics' freedom to choose their work location. It is well-known that the pandemic has boosted work from home (WFH). However, we wonder whether the distinctive nature and organization of research work leads academics to *escape from home* and diversify their location choices. At odds with prior contributions that usually focus on single factors driving workers' location choices, the present study jointly considers an ensemble of job-related, life-related, and workspace-related elements, thus depicting a comprehensive overview of the investigated issue. Noteworthy, in line with previous literature, which reveals workspace as the context where academic collaborations emerge (*e.g.*, because of colocation and proximity, Toker and Gray, 2008; Khazanchi et al., 2018), we consider workspace features as key factors in this realm. This paper analyses academics' location choices and their determinants during the Covid-19 pandemic. This topic is relevant for future university planning. Indeed, academic, and administrative offices occupy between 20% and 30% of US and UK university facilities according to DEGW (Harrison and Cairns, 2008). In addition, universities are currently making huge investments in campus upkeep and renovation to adapt to academic new ways of working (Jemine et al., 2021; Gorgievski et al., 2010). Accumulating knowledge (and empirical evidence) on academics' location choice is of utmost importance to support universities in making decisions on their real estate assets and on their work practices.

This paper addresses two main research questions: Where do academics work during the Covid-19 pandemic? Which factors influence the choices of different work locations? We answer these research questions in the context of Italian academia. First, we distribute a survey to the whole population of Italian tenured academics in summer 2020. Second, a cluster analysis on survey data depicted four location patterns that academics chose during the Covid-19 pandemic. Finally,

econometric models find a nuanced pictures of determinants of location choices. To the best of our knowledge, no other studies which document the effects of Covid-19 on academics' location choice as literature have mostly focused on the massive working from home phenomenon caused the pandemic (*e.g*., Raabe et al., 2020). This paper, instead, finds that academics has continued to conduct their research in different locations even during the pandemic and that the spatial features of the university campuses shape their choice to work on campus, above and behind work-related and life-related factors.

The paper proceeds as follows. In section 2, we review literature on location choice and their determinants both in academia and for KWs in general. Section 3 gives an overview of the methodology, while section 4 discusses the findings. Section 5 concludes the paper by summarizing its main results, acknowledging its limitation, sketching direction for future research and providing practical implications.

2. LOCATION PATTERNS IN ACADEMIC WORK AND THEIR DETERMINANTS

2.1 Location patterns

Literature on remote work, telework, WFH (*e.g.*, Sullivan, 2003), flexible work, distributed work (*e.g.*, Bosch-Sijtsema *et al.*, 2011), mobile and multi-local work (*e.g.*, Ojala and Pyöriä, 2017; Hislop & Axtell, 2009; Wheatley, 2020), and new ways of working – NWW (*e.g.*, Jemine et al., 2021) inspired the theoretical framework of this study. The common feature of these labels is that they all assume work being performed from a variety of locations outside the traditional workplace

and usually involving the use of ICTs (Hislop & Axtell, 2009; Sullivan, 2003). It is a fact that the traditional campus-based model shifted from "location-restricted" to "location-independent" (Orel and Bennis, 2020). On the one hand, academics are used to travel internationally beyond strict geographical boundaries (Miguélez and Moreno, 2014; Loacker and Śliwa, 2016; Azoulay et al., 2017), on the other hand, their work can be performed in more than one location on a daily basis, since they regularly access the campus, home and other venues for their research and teaching activities. First, academics' administrative activities, teaching, collaboration, and operative research frequently occurs on-campus. Spaces on-campus are assigned at the time of the scholar recruitment (Stephan, 2012:105). They support productivity (Temple, 2009), shape academic identity (Dowling and Mantai, 2018; Müller, 2014), and influence the cohesion of the research community. Second, academic research occurs frequently at home – especially for concentration and writing activities (Gornall and Salisbury, 2012; Dowling and Mantai, 2018; Crang, 2007). Finally, as partnerships with other institutions are crucial for knowledge production in academia (Baldry and Barnes, 2012; Jones *et al.*, 2008), research work occurs often in workspaces or laboratories pertaining to private or public organizations. For instance, libraries (Di Marino and Lapintie, 2015; Schopfel *et al.*, 2015) and coworking spaces (Clifton *et al.*, 2019; Orel and Bennis, 2020; Bouncken, 2018) are emerging as *other* spaces (beyond the home and the campus) for individual and collaborative work, respectively.

2.2 Determinants of location patterns' choice

In this research we follow up on studies on KWs location choice (*e.g.*, Mokhtarian and Salomon, 1994; Mokhtarian et al., 2004; Ory and Mokhtarian, 2006; Zhu, 2013; Vilhelmson and Thulin, 2016) to explore which determinants are likely to influence the choice of academics for a specific location pattern and, namely, which determinants are related to the pandemic period as an

exceptional contingency. For the sake of simplicity, we recognized four categories of factors (Table 1): (i) *Work-related*; (ii) *Space-related*; (iii) *Life-related*, and (iv) *Other* factors. Below we explain them based on previous studies.

Table 1: Factors influencing location choice considered in the analysis

Work	**Space**	**Life**	**Other**
Collaborative activities	Private office on-campus	Living alone	Age
Familiarity with online tools	Private office at home	School children	Gender
Institutional roles endowment	Laboratory on-campus	Household help	Geographical location
Discipline	Support spaces on-campus		Commuting time
Seniority	Workspace physical characteristics		Living/Working in a Metropolitan area
			Familiarity with work from home

Among *work-related* factors we include all that factors related to research work of academics[1]. Similarly to office workers, desired levels of face-to-face interactions (Bailey and Kurland, 2002) likely orient choice towards the *official* workplace (which corresponds to the campus in the case of academics). Academics generally balance individual and collaborative activities. The extent to which they collaborate is a crucial factor for location choice. Academic collaboration can aim at co-authored publications and teamwork on research projects or be exclusively a form of interaction and support (Lewis *et al.*, 2012). In both cases, a general preference towards face-to-face interactions emerges (Parkin *et al*, 2011; Toker and Gray, 2008). Thus, on the one hand, collaboration occurs in informal and formal spaces on-campus and off-campus; on the other hand, academic work that requires concentration usually drives location choice towards a dedicated space

[1] Teaching commitments are not targeted in this study as they are usually subjected to specific university policies that limit the "free" decision of scholars on where and when to hold their classes and other learning activities.

(*e.g.*, a single office or home). Nonetheless, the tendency of universities to be global institutions rewards research relationships with other academics (Jones et al., 2008), as well as with the industry and governments (Rajalo and Vadi, 2017). These types of interactions can span international borders and take advantage of technologically mediated relations (Knight *et al.,* 2020; Huws *et al.*, 1990). Recent research demonstrated that in the academic context, and especially during Covid-19, digital interaction is likely to increase the inclusivity of knowledge exchange (Pyöriä, 2003), reduces time and costs of organizing academic interactions, and increases flexibility to work together (Schwarz *et al.*, 2020). Moreover, collaboration is strongly discipline-driven (Lewis *et al.*, 2012). Disciplines explain the nature of academic work and their link with different locations and workspaces (Huhtelin and Nenonen, 2019). Academics in the humanities or social sciences are more used to WFH because of the prevalence of individual research (Lewis *et al.,* 2012), while life scientists and physical scientists need specific facilities and equipment available on-campus to perform their research and they are often involved in teamwork (Melin, 2000; Lewis *et al.*, 2012). Seniority emerges as a crucial factor for location choice in the corporate context. Namely, senior employees and managers are more likely to telework, while junior employees are more likely to work at the official workplace because of their lower job autonomy (Huws *et al.,* 1990) or because they perceive a lower freedom in deciding where to work (Spivack and Milosevic, 2018). In the academic context, senior researchers might be involved in institutional roles and responsibilities that require face-to-face meetings and regular monitoring activities that take them on-campus. At the same time, they suffer from interruptions on-campus more than their junior colleagues and may pursue concentration outside the official workplace (Mokhtarian and Bagley, 1998). However, i junior academics – as other junior workers – are likely to be concerned about loss of social interactions when working outside the campus. Similarly, senior academics, as well as other senior

workers, are likely to be concerned about the loss of professional interactions (Mokhtarian and Bagley, 1998).

In sum, we consider the following work-related factors: collaborative activities, familiarity with online tools, familiarity with work from home, discipline, seniority, and institutional roles endowment.

Among the *life-related* factors that are likely to influence location choice, some argue that having children encourages WFH (Mokhtarian and Bagley, 1998). Specifically, if children are young (Vilhelmson and Thulin, 2016), the likelihood increases of combining WFH and work-from-office (Burchell *et al.,* 2020). Conversely, according to other studies, the difficulty to balance child rearing with work discourages WFH (Bailey and Kurland, 2002). Konradt *et al.* (2003) found that kinship and housekeeping duties are stressors of WFH. However, interactions with the partner or with children when WFH are likely to reduce social isolation and substitute loss interactions with co-workers (Feldman, 1997).

In sum, we consider the following life-related factors: having school children, household help presence and living alone (without children, partner, or others).

Among *workspace-related factors* this study considers space at universities, home and other spaces. When at the university, office layout is crucial for supporting research work and scientific productivity (Huhtelin and Nenonen, 2019). The current debate is seeking the optimal balance between shared/open and single offices on-campus. Open plan offices support knowledge sharing (Weijs-Perrée *et al.*, 2019) and collaboration (Parkin *et al.,* 2011; Toker and Gray, 2008), but at the same time hamper productivity and staff satisfaction (Kärnä et al., 2013; Pinder *et al*., 2009; Van Marrewijk and Van den Ende, 2018; Gorgievski *et al*., 2011), and undermine professional

academic identity (Baldry and Barnes, 2012). On the other hand, a private office can meet real needs of individual concentration or only reflect a status (Hopland and Kvamsdal, 2020). Indeed, research and practice usually define academics as low space-demanding workers given the low occupancy rates associated to campuses (Vitasovich et al., 2016; Lansdale et al., 2011). Other than offices, several academics need special facilities and equipment available on campus laboratories (Stephan, 2012: 105-6), not only to perform their research activity but also to advance research through discussion (Dunbar, 1995). Moreover, other support spaces on-campus includes the "interaction nodes" like corridors, hallways, lounges, informal areas, canteens, and break areas which support face-to-face interactions (Vitasovich et al., 2016; Müller, 2014; Weijs-Perrée et al., 2019) and collaboration (Hua et al., 2010).

When working from home, dedicated workspace availability at home and workspace separation from crowded areas of the house impact the WFH experience (Donnelly and Proctor-Thomson, 2015; Huws et al., 1996). However, competing demands between partners or between parents and children over the home space appropriation are not always simple to integrate (Sullivan and Lewis, 2001).

Either at the office (Appel-Meulenbroek *et al.*, 2018; Oksanen and Ståhle, 2013), at home (Peters and Halleran, 2021) or in other spaces, specific characteristics of the physical environment influence workers outcomes and thus – authors argue – the choice of different location for work. Among others, key aspects include: storage availability, privacy, ergonomic comfort, lighting, noise, colour, personalization, ICT, atmosphere, décor, aesthetics, outdoor view, indoor air and thermal quality.

In sum, we consider the following space-related factors: private office on-campus, private office at home, laboratory on-campus, support spaces on-campus, workspace physical characteristics.

Finally, literature recognized *other* factors influencing work location choice, such as gender (Burchell *et al.*, 2020), age as a proxy of seniority (Bailey and Kurland, 2002) and commuting time (Bailey and Kurland, 2002; Mokhtarian and Salomon, 1994), geographic location and, namely, being located in a metropolitan area where services and other third spaces are numerous (Vilhelmson and Thulin, 2016).

In sum, we consider the following *other* factors: age, gender, commuting time, geographical location, living/working in a metropolitan area, familiarity with work from home.

3. METHODOLOGY

3.1 Data collection

The authors administered a survey via email to the whole population of Italian tenured academics, whose contacts are publicly available online thanks to Italian education Ministry's (MIUR) lists[2]. Namely, 52,630 academics compose the target population. They are based all over Italy and cover all scientific sectors of Italian Academia. Survey administration followed a pilot-test and pre-test (Collins, 2003). Participation was voluntary and confidential, and remained open from July 24th to September 24th, 2020. Overall, 11,634 answers were collected (response rate 22,11%). According to the objectives of this paper and to avoid missing variables, we select 7,865 usable and consistent

[2] These lists include all the Italian scholars tenured in public Italian universities but exclude PhD students, post-doc researchers and research grant holders.
Source of the lists: https://cercauniversita.cineca.it/php5/docenti/cerca.php. See supplementary material S1 for the complete list of contacted population.

answers (response rate 14,94%). The sample consists of 3,853 women (48.99%) and 4,012 men (51.01%). Respondents are on average 51 years old. They are geographical distributed all over Italy (North, 48.29%; Centre, 25.86%; South, 25.85%) and cover a broad cross-section of scientific affiliation. Hence, although the modest response rate, generalizability to the full Italian academic population is assured. The survey collected 29 questions. As our research excluded on purpose teaching commitments, every question of the survey explicitly referred only to research activity. Authors complement survey data with additional information from MIUR lists (disciplines, seniority, gender, university affiliation and geographical location). The Harman's one-factor test (Podsakoff and Organ, 1986) was performed to avoid the risk of common method bias due to single-source data[3].

3.2 Analysis

The research follows two phases.

First, we perform a two-step cluster analysis to identify location patterns (*i.e.*, clusters) of academics when performing research during the Covid-19 pandemic. Authors perform cluster analysis three variables capturing frequency time spent (from "never" to "more than five times per week") at different work locations during Covid-19: *Covid_University*, *Covid_Home* and *Covid_Otherspace*[4]. We adopt the hierarchical cluster procedure developed by Ward (1963) to

[3] The principal component analysis of the main variables showed that the unrotated principal components solution extracted 21 factors with eigenvalues greater than 1 jointly accounted for 73 percent of the variance in the data. The first component accounted for only 9.89 percent of the variance, indicating that common method variance is minor in our dataset.

[4] According to the extant literature, 'other spaces' in our survey include: (i) in transit, (ii) at other universities, research centres labs or companies, (iii) third spaces as coworking spaces, archives, public libraries, bars, open air, and parks, and (iv) other environments related to fieldworks or private offices.

determine the number of clusters and their centroids; then, we assign the sample to clusters through the k-medians non-hierarchical clustering method.[5] To check whether original variables significantly differ across clusters, we run a Scheffe post-hoc test for pairwise comparison of means and the one-way analysis of variance (ANOVA) test. In addition, to check whether academics in each cluster significantly changed their habits because of the Covid-19 pandemic, we perform T-test for matched pairs within each cluster for variables capturing frequency time spent at different work locations before (*Before_University; Before_Home; Before_Otherspace*) and during Covid-19 (*Covid_University; Covid_Home; Covid_Otherspace*).

Second, we perform multinomial probit maximum likelihood estimations (Daganzo *et al.,* 1997) to understand which factors influence the likelihood to belong to a specific cluster (*Pattern*). The dependent variable *Pattern* results from the cluster analysis above explained. Multinomial probit is commonly used in modelling spatial choices (Holperin *et al.,* 1984). We model location pattern choice as a function of work-related, space-related, life-related and other variables with pattern 1 as the reference group (baseline) of the estimations. We adjust standard errors by clustering observations at the university level, because academics in the same university are probably not independent. For instance, in some universities the rector, executive committees or local administrations issued recommendations to prefer WFH or to return to the campus.

[5] The Stata commands cluster wardslinkage and cluster kmedians were used to estimate the first and second parts of the cluster analysis, respectively. To determine the number of clusters in the dataset we considered the Duda–Hart stopping rule, and the Calinski–Harabasz pseudo-F yields equivalent clustering.
The k-median method allows to use the vectors of medians of the variables as centroids. This gave us more consistent and reasonable results than using k-means clustering method.

3.3 Variables of the econometric model

While the dependent variable *Pattern* results from the cluster analysis above explained, explanatory variables refer to the four groups discussed in the literature review: *work-related*, *space-related*, *life-related*, and *other* variables.

Among *work-related* variables, the continuous variable *Collaboration* captures the extent of collaborative research from 0 to 1 (equal to the 100% of the work week). The variable *Familiarity_Digital* captures the extent to which the academic was familiar with digital tools for collaborative research before the Covid-19 pandemic. The variable is coded on a 7-points Likert type scale (0= "Never", 6= "Always"). Disciplines are captured by six binary variables. Each refers to our disaggregation of academic disciplines[6]. Each scholar associates only to one discipline. Seniority is depicted by three binary variables equal to 1 if the academic has that professional level, and 0 otherwise (*Full_Professor*; *Associate_Professor*; *Researcher*). The variable *Institutional_role* is a binary variable equal to 1 if the academic has one or more institutional roles within the faculty (*e.g.*, rectoral role, department director, faculty director, etc.), otherwise is 0. Finally, variable *Before_Home* captures the extent to which academics were used to WFH before Covid-19[7].

Among *space-related* variables, five variables capture the frequency time spent in a private office on-campus (*Private_Office*), in dedicated space for work at home (*Home_office*), in a laboratory

[6] We distinguished six sub-disciplines according to their expected different location choices. Namely: *Social_Sciences* (*e.g.*, economics, law, and political sciences); *Humanities* (*e.g.*, arts, history, linguistics, philosophy and psychology); *Physical_Sciences* (*e.g.*, chemistry, earth sciences, mathematics and physics); *Industrial_Engineering* (*e.g.*, industrial engineering and information engineering); *Architecture* (*e.g.*, civil Engineering, architecture); *Life_Sciences* (*e.g.*, medicine; biology).

[7] In addition, the survey collected information on the access to the three locations during the pre-Covid situation *(Before_University; Before_Home; Before_Otherspace*).

(*Laboratory*), or in support spaces (*Support_Spaces*) on-campus Each of these five variables is coded in 5 points Likert scale (0= "Never", 4= "Always"). The variable *University_Home_Index* is the proxy of satisfaction with the physical characteristics of the university space compared to the home space. The variable is built with factor analysis over 14 items[8]. Cronbach alpha was greater than the conventional threshold (0.60) being equal to 0.90. Sampling adequacy is 0.93.

Among *life-related* variables, the dummy variable *Schoolers* capture the presence of one or more school-aged children in the household. The variable *Household_Help* captures the availability of a household help (*e.g.*, babysitter). Finally, the dummy variable *Alone* has value 1 if the academic has no cohabitants (otherwise is 0).

Among *other* variables which we use as controls of our empirical models, we consider *Age*, *Gender* and *Geographical_Dummies* at NUTS2 level. As proxies of commuting times, we consider the variables *Metropolitan_Area* (coded 1 if the academic lives in a metropolitan city[9]) and the variable *Colocation* (coded 1 if academics reside in the same province of the campus where they work). Table 2 outlines independent variables' descriptive statistics, while in supplementary materials we report correlations tests among variables (S2 and S3) and multicollinearity tests (S4)[10].

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[8] The 14 items are: (i) internet connection quality; (ii) availability of space to take a break; (iii) availability of team working spaces (e.g. meeting/calls, etc.); (iv) ability to organise the space (*e.g.*, personalisation); (v) lack of distractions; (vi) privacy; (vii) availability of individual space; (viii) availability of storage for own items/work items; (ix) inspiration given by the environment (*e.g.*, atmosphere, colours); (x) functionality of the workspace (layout); (xi) ergonomics of the workstation (e.g. desk); (xii) indoor environmental quality (e.g. temperature, air quality, light, etc.); (xiii) aesthetics; (xiv) outside view.

[9] Lists of metropolitan cities in Italy retrieved from www.istat.it

[10] We tested correlations for all the variables used in the analysis. Some variables report high magnitude correlation so, before constructing the model, we test multicollinearity amongst the independent variables through testing the variance inflation factor (VIF) values. The findings of the test show that the VIF values of all the independent variables were quite small at less than 2.0, suggesting that multicollinearity of independent variables is not a concern.

Table 2: Description of the independent and control variables of the models.

Variables	Obs	Mean	SD	Min	Max
Work-related					
Full_Professor	7,865	0.19	0.39	0	1
Associate_Professor	7,865	0.45	0.50	0	1
Researcher	7,865	0.36	0.48	0	1
Institutional_role	7,865	0.43	0.50	0	1
Social_Sciences	7,865	0.14	0.35	0	1
Humanities	7,865	0.20	0.40	0	1
Physical_Sciences	7,865	0.22	0.42	0	1
Industrial_Engineering	7,865	0.11	0.31	0	1
Architecture	7,865	0.07	0.26	0	1
Life_Sciences	7,865	0.25	0.43	0	1
Collaboration	7,865	4.22	2.28	0	10
Familiarity_Digital	7,865	2.61	1.49	0	6
Space-related					
Private_Office	7,865	2.19	1.56	0	4
Shared_Office	7,865	1.94	1.49	0	4
Laboratory	7,865	1.46	1.47	0	4
Support_Spaces	7,865	1.61	1.33	0	4
University_Home_Index	7,865	0.002	0.96	-2.27	2.58
Home_Office	7,865	1.91	1.75	0	4
Life-related					
Schoolers	7,865	0.30	0.46	0	1
Alone	7,865	0.14	0.35	0	1
Household_Help	7,865	0.37	0.48	0	1
Other (control variables)					
Age	7,865	51.27	9.33	26	75
Gender (male)	7,865	0.51	0.50	0	1
Geographical_Dummies	7,865	-	-	0	1
Metropolitan_Area	7,865	0.54	0.50	0	1
Colocation	7,865	0.42	0.49	0	1
Before_Home	7,865	2.44	1.95	0	5.5

4. RESULTS AND DISCUSSION

4.1 Cluster analysis results: Unveiling four work location patterns

Cluster analysis unveils four location patterns: (1) home-centric; (2) between home and university; (3) multi-located; and (4) university-centric. For each of the three location variables included in the analysis, Table 3 shows the overall sample means, and the cluster means. ANOVA tests show

that the average values of the variables differ significantly among all the clusters at 99%. Based on the results of the Scheffe post-hoc tests, for each variable we found significant differences across clusters.

Table 3: Cluster analysis results.

		Pattern 1 - Home-centric (n=4,564)	**Pattern 2 - Between Home and University** (n=1,987)	**Pattern 3 - Multi-located** (n=368)	**Pattern 4 - University-centric** (n=946)
Variables	Sample mean	Mean	Mean	Mean	Mean
Covid_University	1.424	0.255 [d]	2.474 [b]	1.614 [c]	4.784 [a]
Covid_Home	4.430	5.395 [a]	3.846 [b]	3.947 [b]	1.188 [c]
Covid_Otherspaces	0.491	0.184 [d]	0.355 [c]	4.508 [a]	0.699 [b]

Note: Based on ANOVA tests, the means of all the variables are significantly different among clusters at 99%. Note that the highest mean of each variable is labelled with "a", the next highest mean with "b" and "c" and the lowest mean with "d". The same superscript label indicates that the mean of the variable is not significantly different in the various clusters.

The cluster *home-centric* (*Pattern*=1) includes more than half of the sample (4,564; 58.03%). Academics in this large group adopt exclusively WFH (5.395 times per week). Based on T-test results[11] on all location variables, home-centric academics radically change their prior habits since they were used to work from multiple locations before the pandemic. This group of academics is now spatially *fixed* (Crang, 2007).

The other half of the sample is divided in the other three clusters. Academics in these three groups – even if differently compared to the before Covid-19 – confirm the *mobile* nature of academic work among two or more work locations (Crang, 2007; Gornall and Salisbury, 2012; Vitasovich *et al.*, 2011) even in the aftermath of a disaster. Clusters 2, 3 and 4 are all different types of *mobile* patterns. The cluster *between home and university* (Pattern 2) covers one fourth of the academics

[11] See T-test results on supplementary materials

in the sample (1,187; 25.26%), namely who locates research activity mainly at home and at the university but barely use other spaces. Academics in this cluster maintain the pattern that they used to adopt before Covid, but significantly increase the average use of home as a research location as well as decrease the average use of the other locations. The cluster *multi-located* (Pattern 3) consists of a small number of academics (368, 4,68%), who do research more frequently from other spaces (4.508 times per week) than from home (3.947 times per week), or from the campus (1.614 times per week). During Covid-19 this group definitively decreases the use of university spaces compared to before. It is curious to observe that the *multi-located* group is the only one registering an increase in the use of spaces *other* than home and the university during the Covid-19 period. Even though this is the smallest cluster taking up only 5% of the academic population, unveiling this pattern suggests that *other* spaces can offer amenities and services that are conducive for research work. Finally, the cluster *university-centric* (Pattern 4) counts a relatively small percentage of academics in our sample (946, 12.03%). This group works mainly on-campus (4.786 times per week), even if they performed a little share of their research time also at home or in other spaces. Interestingly, this is the only group that tend to maintain more stable work location choices than the other three. Figure 1 summarize the weekly mean frequencies of access to university, home and other spaces before and during the Covid-19 period. All mean frequencies are different between the before and the during-Covid according to T-test.

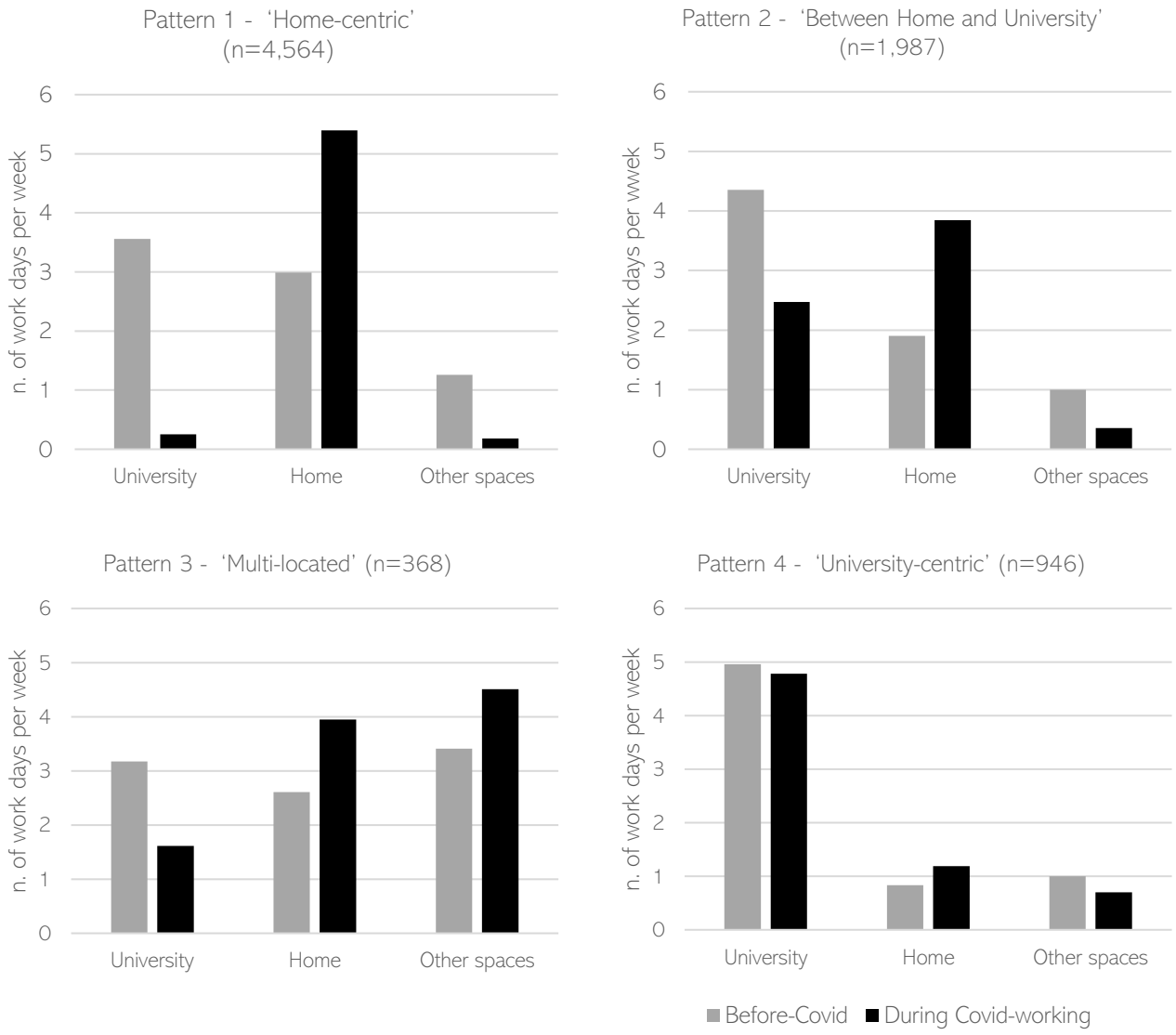

Figure 1: Access to university, home, and other spaces before and during Covid-19 in each of the four clusters.

4.2 Determinants of location patterns' choice

Table 4 reports the results of multinomial probit regressions where *Pattern* is the dependent variable and *Pattern*=1 (*Home-centric*) is taken as the baseline of the regressions. In Model 1 we

included only control variables, whereas Model 2 contains all the explanatory variables (*work-related, life-related, space-related* and *other* factors). Since, in multinomial probit models, a positive coefficient of an explanatory variable does not necessarily correspond to an increase in the probability of a particular outcome category, based on the econometric specification of Model 2, we calculate and comment the marginal effects of the whole set of explanatory variables: *i.e.,* the extent of increase of the likelihood of adopting each location pattern, expressed in percentage points (herein after 'pp')[12]. Marginal effects magnitudes and significance helps in prioritising the determinants of each location pattern choice from the most relevant and significant to the least one (Table 7). Of note, to assess the robustness of our results, we used alternative measures for our key explanatory variables. The results of robustness checks are in line with those of our main analysis, although the magnitude of some coefficients or their statistical significance slightly differ[13].

Table 4: Multinomial probit model of adopting pattern 2, 3 or 4 compared to pattern 1- home-centric (baseline).

	Model 1			***Model 2***		
Outcome reference: 1- Home-centric vs.	*2- Home and University*	*3- Multi-located*	*4- University centric*	*2- Home and University*	*3- Multi-located*	*4- University centric*
Work						
Humanities (reference)						
Physical_Science				0.743***	0.348**	0.887***
				(0.09)	(0.15)	(0.12)
Life_Science				1.423***	1.491***	1.964***
				(0.10)	(0.17)	(0.16)
Architecture				0.220*	0.246	-0.214
				(0.12)	(0.15)	(0.22)
Industrial_Engineer				0.431***	0.008	0.238
				(0.12)	(0.18)	(0.21)
Social_Science				0.398***	0.520***	0.337*
				(0.07)	(0.14)	(0.18)
Full professor (reference)						
Associate_professor				0.017	-0.042	-0.175
				(0.07)	(0.09)	(0.11)

[12] See marginal effects estimations in supplementary material S5.

[13] See robustness checks explanation and results tables in supplementary material S6.

Researcher				0.020	-0.051	-0.065
				(0.08)	(0.14)	(0.11)
Institutional roles				0.134**	0.138*	0.221***
				(0.06)	(0.08)	(0.08)
Collaboration				0.026**	0.051**	0.028
				(0.01)	(0.02)	(0.02)
Familiarity_Digital				-0.055***	-0.054*	-0.073***
				(0.02)	(0.03)	(0.02)
Space						
Private_Office				0.006	-0.062**	0.025
				(0.02)	(0.02)	(0.02)
Laboratory				0.256***	0.114***	0.376***
				(0.02)	(0.04)	(0.03)
Support_Spaces				0.012	0.113***	-0.027
				(0.02)	(0.02)	(0.02)
University_Home_Index				0.195***	0.043	0.447***
				(0.03)	(0.04)	(0.04)
Home_office				-0.041***	0.020	-0.067***
				(0.01)	(0.02)	(0.02)
Life						
Alone				0.060	0.261**	0.448***
				(0.09)	(0.11)	(0.11)
Schoolers				-0.103*	-0.094	-0.335***
				(0.06)	(0.09)	(0.08)
Household_Help				0.142**	0.240***	0.323***
				(0.06)	(0.08)	(0.06)
Other factors						
Age	0.013***	0.009**	0.021***	0.006*	-0.001	0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Gender	0.092	0.207***	0.020	0.202***	0.391***	0.316***
	(0.06)	(0.06)	(0.05)	(0.06)	(0.07)	(0.05)
Geographic_Dummies	included	included	included	included	included	included
Metropolitan_Area	-0.116	-0.115	-0.548***	-0.068	-0.103	-0.504***
	(0.11)	(0.13)	(0.14)	(0.11)	(0.12)	(0.15)
Colocation	0.494***	0.200**	0.700***	0.342***	0.057	0.538***
	(0.05)	(0.08)	(0.08)	(0.06)	(0.07)	(0.10)
Before_Home	-0.266***	-0.127***	-0.607***	-0.119***	-0.032	-0.433***
	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)
_cons	-0.741***	-2.080***	-1.312***	-1.765***	-2.808***	-2.404***
	(0.18)	(0.27)	(0.28)	(0.25)	(0.47)	(0.41)
Observations		7,865			7,865	
Log lik		-7431.0791			-6481.4439	

Parentheses: standard errors clustered by *University*. Note that * p<0.1, ** p<0.05, *** p<0.01

Determinants of the home-centric pattern (pattern 1)

Among to *work-related* factors, all else equal, discipline is the most influential factor. Namely, home-centric academics are more likely to be humanists than to do research in all the other disciplines, since humanists predominantly perform their research individually (Lewis *et al.*, 2012).

In addition, a strong motivation of adopting the home-centric pattern derives also from being familiar with WFH (*Before_Home*) and with online tools before Covid-19 (*Familirity_Digital*). Indeed, as Huws *et al.,* (1990) early stated, workers familiar with technology tend to WFH more. Thus, academics accustomed to technology are facilitated in the transition to WFH during the pandemic. Among life-related variables, unavailability of a household help is the strongest constraint to WFH, indeed the likelihood of being home-centric decreases of 4.2 pp. These results confirm literature on the influence of house duties on the decision to WFH (Vilhelmson and Thulin, 2016; Burchell *et al.*, 2020; Bailey and Kurland, 2002). In addition, *Schoolers* strongly increases the probability of being home-centric (3.2 pp). Because of the pandemic situation, children are alternatively obliged to online learning when at least one of their classmates test positive to Covid, thus academics with school children (<14 y.o.) are more likely to adopt the home-centric pattern. Conversely, living alone (*Alone*) decrease the probability of adopting the home-centric pattern (-3.7 pp). These results confirm that social isolation is a significant drawback of WFH (Feldman, 1997) whilst having children encourages WFH (Mokhtarian and Bagley, 1998). Among space-related variables, the availability of a home-office only slightly increases the likelihood of having a home-centric pattern (0.8 pp), while academics that use laboratories on-campus before Covid-19 have a 5.6 pp lower likelihood of adopting the home-centric pattern. Moreover, academics who are more satisfied with the spatial characteristics of their on-campus workspaces compared to that of their home have a 4.8 pp lower likelihood of being home-centric. As explained above, this synthetic index derives from 14 physical characteristics measured at the home workspace and at the university workspace. The factor is mostly defined by "functionality of the workspace (layout)", "availability of personal space", "inspiration given by the environment (*e.g.*, atmosphere, colours)" and "storage availability". These results confirm that space characteristics are attractors or rejectors

for a specific workspace. Among other variables, the empirical results show that academics discouraged by long commuting time are more likely to be home-centric (7.2 pp). We can assume that Covid-19 increased individuals' sensitivity on commuting time, confirming that – especially in emergency times – perception of a long or dangerous commute is relevant (Mokhtarian and Salomon, 1994). Finally, women have a strong increase of 5.6 pp on the likelihood to be home-centric.

In sum, home-centric academics are more likely to be women in the humanities, who benefit of a household help at home and of a conducive home workspace – in terms of functionality, storage, personal space, and atmosphere and, who lives far from their university.

Determinants of the between home and university pattern (pattern 2)

As to *work-related* variables, it emerges that academics in life science, physical science, industrial engineering, social science and architecture tend to adopt pattern 2. *Life_science* outperforms other disciplines, showing positive coefficients and the highest marginal effects (16.4 pp). Indeed, life scientists are dependent on laboratories and professional tools unavailable off-site (Melin, 2000). As to *life-related* variables, marginal effects do not receive significant estimations. Among *space-related* variables, academics that used laboratories on-campus before Covid-19 have a 3.6 pp likelihood of adopting the 'between home and university' pattern. Other space-related variables are instead less significant. Among *other* factors, it emerges that academics with low commuting time are more likely to adopt this pattern (4.3 pp).

In sum, academics who work between home and university are more likely to be scientists who need a laboratory and live not far from the university.

Determinants of the multi-located (Pattern 3)

As to *work-related* variables, it emerges that the likelihood of adopting the multi-located pattern increases only for life and social scientists. It is plausible that these scientists often collaborate with external organizations or companies (Lewis *et al.*, 2012), and conduct field studies, thus they mix different venues for their research. Among *life-related* variables, living alone (*Alone*) and having a household help (*Household*_help) increase the probability of adopting the multi-located pattern of 1.3 pp and 1.1 pp respectively. Interestingly, among *space-related* variables, the habit of working from support spaces on-campus before Covid-19 slightly increases the likelihood of adopting a multi-located work pattern (0.8 pp). It is possible that, as break areas, cafés and meeting rooms on-campus were inaccessible during Covid-19, academics looked for similar interaction nodes in multiple venues off-campus (Orel and Bennis, 2020). Among *other* factors, it is interesting to note that men increased the likelihood to embrace a multi-located pattern of 2.0 pp. If on the one hand, the ability to work remotely promotes workplace inclusiveness (Pyöriä, 2003), on the other hand location choice responds to gendered norms (Burchell *et al.*, 2020) and during Covid-19 freedom on location choice persisted in being predominantly granted to men. Finally, academics with low commuting time between their home and their office are less likely to be multi-located (-1.0), as they do not need to work in other third locations when they can easily access the campus.

In sum, multi-located academics are more likely to be men in life and social sciences who live alone and benefit of a household help at home.

Determinants of the university-centric pattern (Pattern 4)

As to *work-related* variables, similarly to pattern 2, doing research in life sciences and physical sciences increases the likelihood of adoption of the university-centric pattern (11.2 and 5.2 pp respectively). Of note, being an architect decreases the likelihood of adopting this pattern. It is plausible that architects in Italian academia conduct a freelance activity from their home office (as they are more likely to adopt pattern 2) or form other venues. In addition, endowment in institutional roles within the faculty pushes academics towards the on-campus workspaces (1.5 pp marginal effect) whilst junior faculty is less likely to access on-campus workspaces (-2.0 pp) than their senior colleagues (*i.e.*, full professors). Among *life-related* variables, the strongest determinants of the university-centric pattern are: living alone (4.3 pp) and being freed from home-duties thank to household help (2.5 pp). On the contrary, academics with school children strongly decreased the probability of adopting the university-centric pattern (-3.0 pp). Among *space-related* variables, an increase of the *University_Home_Index* generates an increase of 3.8 pp on the likelihood of adopting the university-centric pattern. Space attractiveness should not be underestimated, since space satisfaction is more influential than the need of a laboratory in the case of university-centric academics (3.8 vs 2.6 pp). Interestingly, the availability of a private office on-campus shows no significance. Our results partially confirm literature that consider single offices not a real need for academics (Hopland and Kvamsdal, 2020; Vitasovich *et al*., 2016; Lansdale et al., 2011) to the point that having a private office does not influence location choice during Covid-19. Among *other* factors, low commuting time strongly encourages the university-centric pattern adoption (3.9 pp) while in metropolitan cities – where distances between home and the universities are expected to be higher – the likelihood of adopting the university-centric pattern strongly decreases (-5.0 pp). Finally, men are more likely than women to be university-centric (1.9 pp),

again because they are more mobile than their female colleagues and they represent most of the senior population in our sample.

In sum, university-centric academics are more likely to be life or physical scientists, with senior and institutional roles, who lives alone and benefit of an household help. They live not far from the campus and are more likely to be men.

Table 5: Determinants of location patterns adoption during the Covid-19 pandemic.

Pattern 1 (Home-centric)	**Pattern 2 (Between Home and University)**	**Pattern 3 (Multi-located)**	**Pattern 4 (University centric)**
Work-related factors			
Familiarity_Digital (1.3 pp)	*Life_Science* (16.40 pp)	*Life_Science* (5.30 pp)	*Life_Science* (11.20 pp)
Istitutional_roles (-3.30 pp)	*Physical_Science* (10.40 pp)	*Social_Science* (2.4 pp)	*Physical_Science* (5.20 pp)
Industrial_Engineer (-7.00 pp)	*Industrial_Engineer* (8.00 pp)		*Istitutional_roles* (1.50 pp)
Social_Science (-8.9 pp)	*Social_Science* (5.60 pp)		*Associate_professor* (-2.00 pp)
Physical_Science (-15.40 pp)	*Architecture* (5.40 pp)		*Architecture* (-3.90 pp)
Life_Science (-33.70 pp)			
Life-related factors			
Schoolers (3.20 pp)		*Alone* (1.30 pp)	*Alone* (**4.30 pp**)
Alone (-3.70 pp)		*Household_help* (1.10 pp)	*Household_help* (**2.50 pp**)
Household_help (**-4.20 pp**)			*Schoolers* (-3.00 pp)
Space-related factors			
Home_office (0.80 pp)	*Laboratory* (3.20 pp)	*Support_Spaces* (0.80 pp)	*University_Home_Index* (3.80 pp)
University_Home_Index - (4.80 pp)	*University_Home_Index* (1.60 pp)		*Laboratory* (2.60 pp)
Laboratory (-5.60 pp)			
Other factors			
Before_Home (3.60 pp)	*Colocation* (**4.30 pp**)	*Gender (male=1)* (2.00 pp)	*Colocation* (**3.90 pp**)
Gender (male=1) (-5.60 pp)		*Colocation* (-1.00 pp)	*Gender (male=1)* (1.90 pp)
Colocation (**-7.20 pp**)			*Before_Home* (-4.00 pp)
			Metropolitan_area (-5.00 pp)

The table reports marginal effects on the likelihood of adopting each location pattern based on the econometric specification of Model 2. The table reports from the highest to the lowest only significant (p value lower than 0.1) and relevant (magnitude > 0.8 pp) values.

5. CONCLUDING REMARKS

This paper studies the work location pattern choice of academics by investigating the effect of the Covid-19 pandemic on previous habits. Covid-19 has increased the "contagious off-site work" (Rockmann and Pratt, 2015) of academics: only one fourth of academics have a strong motivation to use the university facilities for their research work. The other 75% work well both at home and in *other* spaces. In contrast to the recent literature referring to Covid-19 – which focuses on home-based work (*e.g.*, Raabe et al., 2020) – this study finds a sizable group of people who adopted mobile work on a weekly basis, which instead received less attention from the literature (*e.g.*, Koroma et al., 2014). Indeed, even if the home-centric pattern is the largest (58.03% of the sample) and it is likely to remain significant, a sizeable group of academics (41.97% of the sample) balance time on-campus and off-campus. The findings of this study may guide future university decisions. First, university decision-makers should look first and foremost at the type of research work of their staff and consider that the discipline and institutional role are the most binding factors to university campuses. As this paper focuses solely on research activity of academics, future research should address the moderating influence of teaching commitments.

Second, campus and human resources managers should support work location autonomy and base decisions on in-depth analysis of the private life of their staff. When one can freely choose where to work, kinship, household duties and long commuting time are the strongest factors swaying people away from campus and binding them at home. If universities want to attract their research staff back to the campus, measures need to be taken to support household duties, especially for women, who registered the highest likelihood to switch to a home-centric pattern. The men *privilege* in campus access should be counterbalanced by strong welfare policies for an equitable

and just work environment. Even if this study does not consider work outcomes, recent evidence suggests that female academics submit fewer papers compared to men during Covid-19 (Kitchener, 2020). We are already planning to expand the limited knowledge of Covid-19 effect on academic productivity. Then, even if academics' job autonomy and freedom is generally recognized, future research should better explore formal and informal obligations of academia.

Third, even if WFH academics are likely to increase after Covid-19, campus space satisfaction is crucial for attracting academics. Future university campuses should enhance their attractiveness and functionality. Moreover, based on the low significance of the availability of single offices on-campus to drive academics towards the university academics, we suggest that the university environment may be less formal and hierarchic than corporate environments. As Italian campus facilities are mostly organized with small private offices assigned to senior professors, decision-makers might want to consider a re-layout leaving more space for collaboration and interactions. The lack of collaborative spaces will encourage people to choose off-campus locations for this type of work or to work from home and continue to collaborate with their colleagues virtually. Indeed, based on our results, it is reasonable to expect that potentially more than a half of the actual workstations in Italian university campuses would be empty full-time and a significant share would not be occupied for the whole week. The costs of the inefficient use of space are likely to be immense.

Finally, as work will be more mobile, a more sustainable geography of work will emerge thanks to *other spaces* (*e.g.,* coworking spaces or public libraries) that offer favourable commuting times and chances for off-campus collaborations (Clifton et al., 2019; Di Marino and Lapintie, 2015). The availability of other spaces' may be fundamental for at least a portion of the academic population. Universities may think to create partnerships with coworking space suppliers or with corporate

workspaces which may have lower occupancy in the future. These actions may lead to positive results on collaboration and hybridizations of skills. As this study do not dig into different typologies of *other* spaces for research, future research should focus on developing a precise taxonomy of *other* spaces suitable for academic research.

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DECLARATION OF INTERESTS

None

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