Mobility during the first week of the second lockdown in France

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RESUME

La France traverse un deuxième confinement afin d'arrêter la deuxième vague de la COVID-19. Les fermetures et restrictions ont un impact sur la mobilité à différentes échelles spatiales et temporelles. Nous utilisons les données des téléphones mobiles pour analyser la mobilité de la population française au cours de la première semaine ouvrée du confinement actuel (du 2 au 6 novembre 2020). Une analyse spatiale (mobilité nationale, régionale et locale), temporelle (par semaine, par jour, par heure) et par classe d'âge (jeunes, adultes, seniors) est produite. Nous comparons alors la mobilité avec celle enregistrée au cours de la première semaine de travail du premier confinement (23-27 mars 2020). Nous trouvons que la mobilité actuelle est inférieure au niveau pré-pandémique de 33%, ce qui correspond à une réduction beaucoup plus faible que lors du premier confinement (67% sous les niveaux pré-pandémique). Les réductions de mobilité diurnes sont du même ordre que la moyenne quotidienne, avec néanmoins des réductions modestes pendant les heures de pointe du matin - une caractéristique clé du confinement actuel, et qui n'a pas été constatée lors du premier confinement. Une moindre réduction qui s'explique aussi probablement par le maintien ouvert des écoles et d'un plus grand nombre de secteurs d'activité. De plus, l'analyse de la mobilité faite au niveau régional met en exergue que la plupart des régions ont des réductions de mobilité inférieures à la moyenne nationale tandis que l'Île-de-France connait une réduction nettement supérieure à cette moyenne. Les variations régionales mesurées pendant ce deuxième confinement sont corrélées avec celles mesurées lors du 1er, mais plus prononcées. L'analyse à une échelle plus fine montre que les réductions supérieures à la moyenne se concentrent en région parisienne et à proximité des zones montagneuses. Nous mesurons également une forte association entre la réduction de la mobilité et les indicateurs socio-économiques, indiquant que les restrictions de mobilité sont les plus prononcées parmi les catégories de population les plus aisées, confirmant les résultats déjà trouvés lors du premier confinement. Enfin, nous mesurons le trafic entre les plus villes peuplées, et trouvons qu'il est systématiquement plus élevé que lors du 1er confinement. Notre

analyse montre une première évaluation quantitative de la mobilité de la population pendant le confinement actuel en le comparant au premier. Il participe à évaluer l'efficience des politiques actuelles et à éclairer les futurs ajustements possibles.

SUMMARY

France is on a second lockdown to stop the second wave of COVID-19. Closures and restrictions are impacting mobility at different spatial and temporal scales. We use mobile phone data to analyze mobility patterns during the first full working week of the current lockdown (Nov 2-6, 2020). We break down our analysis by space (country-level, regional, local mobility), by time (weekly, daily, hourly), and by age class (young, adults, seniors). We compare mobility patterns with the ones registered during the first full working week of the first lockdown (Mar 23-27, 2020). Current mobility is down 33% below pre-pandemic levels, achieving a much smaller reduction than the 1st lockdown (67% below pre-pandemic levels). Daytime mobility reductions follow daily averages, but modest reductions are observed during morning rush hours – a key feature of the current lockdown, not shared by the previous one, and likely due to keeping school opens and larger number of productive sectors open. An analysis of regional mobility highlights a split between most regions reaching below-average mobility reductions, and Île-de-France reaching a markedly above-average reduction. Regional variations in this 2ndlockdown are correlated with what measured in the 1st, but more pronounced. Analysis at a finer spatial scale shows that higher-than-average reductions are concentrated in the Paris area, and close to the mountains. We also measure a strong association between mobility reduction and socioeconomic indicators, indicating that mobility restrictions are most effective among wealthier population strata, confirming results already found during the 1st lockdown. Finally, we measure traffic among France's largest cities, and find it to be consistently higher than during the 1st lockdown, when it all but stopped. Our analysis provides a first quantitative assessment of the ongoing lockdown on population mobility patterns, comparing them to the 1st lockdown. It helps evaluate the performance of current policies, and inform future possible adjustments.

INTRODUCTION

France entered a second lockdown since Friday, October 30, to control the second wave of COVID-19 epidemic. Using mobile phone data [1] we measured the impact of the current closures and restrictions on population mobility patterns, at different spatial scales. We compared currently achieved mobility reductions with the ones registered in the first lockdown (March 17 to May 11, 2020). Current restrictions are less pervasive than the first lockdown: schools are open and presence at workplace is higher, as more productive sectors are allowed to continue functioning [2]. Consequently, mobility is expected to be higher than during the 1st lockdown. It is however not known to what extent mobility is being reduced, and how this may change geographically. We present here a quantitative comparative analysis, to profile the impact of the current intervention and inform future policies. **This report includes mobility data from Jan 1, 2020, to November 6, 2020**. It informs on:

- How the current lockdown changed mobility patterns across:

    - space (regions, cities),
    - time of day,
    - age,
    - range (short-range vs. long-range mobility);
- How mobility compared to the first full week of the first lockdown (March 23-27, 2020).

METHODS

Data. Mobility data were provided by the Orange Business Service Flux Vision in the form of displacement matrices, within the INSERM-Orange collaboration in the ANR research project EVALCOVID-19. The data contained travel flows among 1,436 geographic areas of mainland France (2018 EPCI, Établissements Publics de Coopération Intercommunale). For each pair of locations and any given day, data were provided stratified by age class, and time of day. More details are available in Ref. [1]. Internal mobility in a geographic area was defined as the number of trips starting and ending within that area. Outgoing mobility was defined as the number of trips starting inside the area, and ending outside that area, and within metropolitan France. We used the week Feb. 3-7, 2020 as a benchmark mobility in the pre-pandemic phase (chosen also to avoid school holidays and major transportation disruptions).

Demographic and economic data are from INSEE [3]. School calendar is obtained from the Ministry of Education [4].

RESULTS

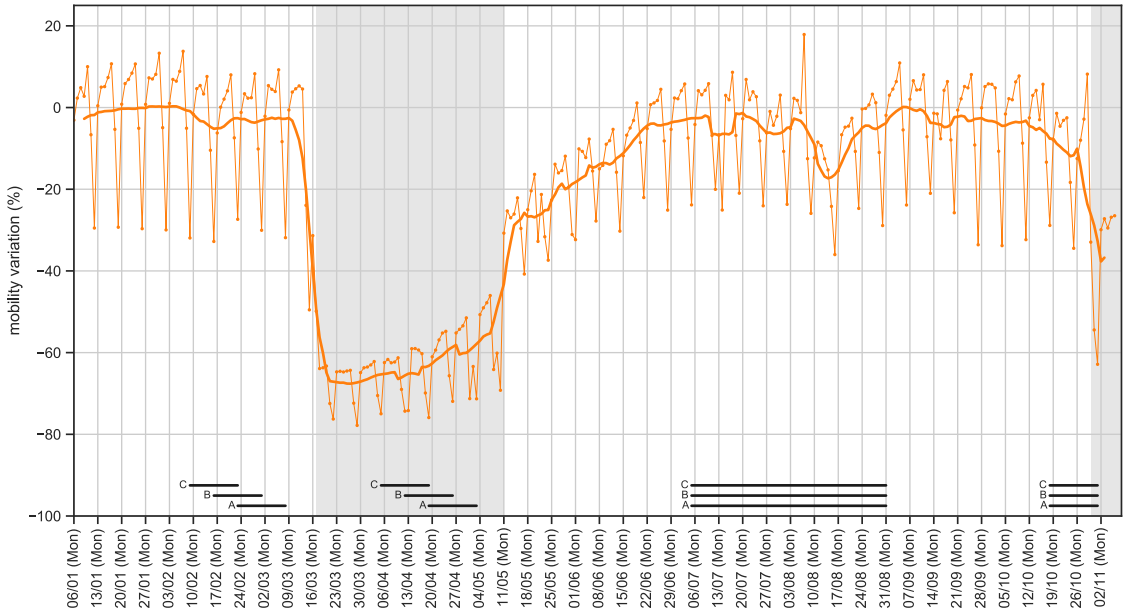

Figure 1. Mobility in France, in 2020. Daily mobility in France, from Jan 6, 2020, to Nov 6, 2020, defined as the relative variation in number of trips taken in mainland France, with respect to the average number of trips during the benchmark full week in the pre-pandemic phase (Feb 3-9, 2020). Dots and thin line indicate daily values, thick line indicates rolling average with a 7-day window. Positive values indicate higher mobility than during the benchmark week, negative values indicate lower mobility. Gray shaded areas indicate the 1st and the 2nd lockdown. Horizontal solid black lines mark school holidays in the three geographic areas (A,B,C) as defined by the Ministry of Education.

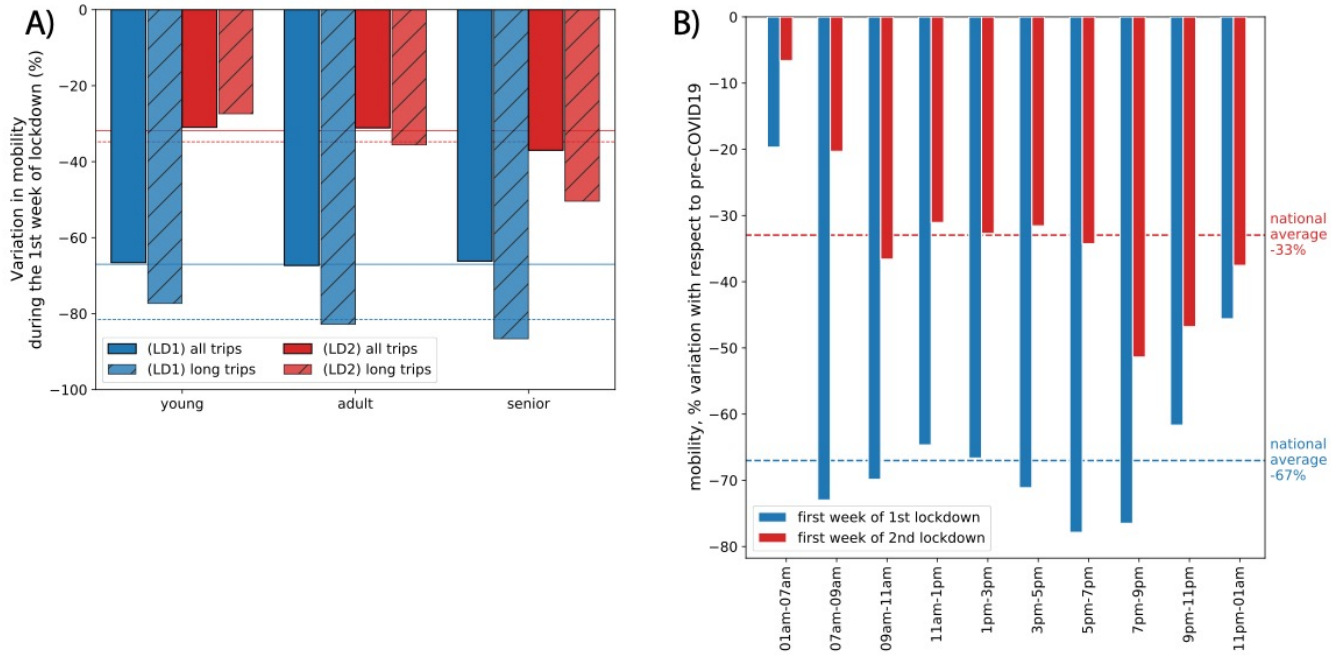

Figure 2. Comparing 1st and 2nd lockdown – national data. Mobility averaged over the 1st full working week of the 1st LD (blue - Mon 23 to Fri 27 Mar, 2020) and of the 2nd LD (red - Mon 2 to Fri 6 Nov, 2020). Mobility is defined as the relative variation in number of trips taken in

mainland France, with respect to the average number of trips during the benchmark week in the pre-pandemic phase (working days only, Feb 3-7, 2020). A) breaks down mobility by age class (<18 years old for young, 18-64 for adult, >64 for senior) and trip distance (hatched bars for long trips - longer than 100 km in geodesic distance). The national averages are -67% for all trips (blue solid line) and -82% for long trips (blue dotted line) during the 1st lockdown and -33% for all trips (red solid line) and -35% for long trips (red dotted line) during the 2nd lockdown. Panel (B) shows variation of internal mobility broken down by time of day.

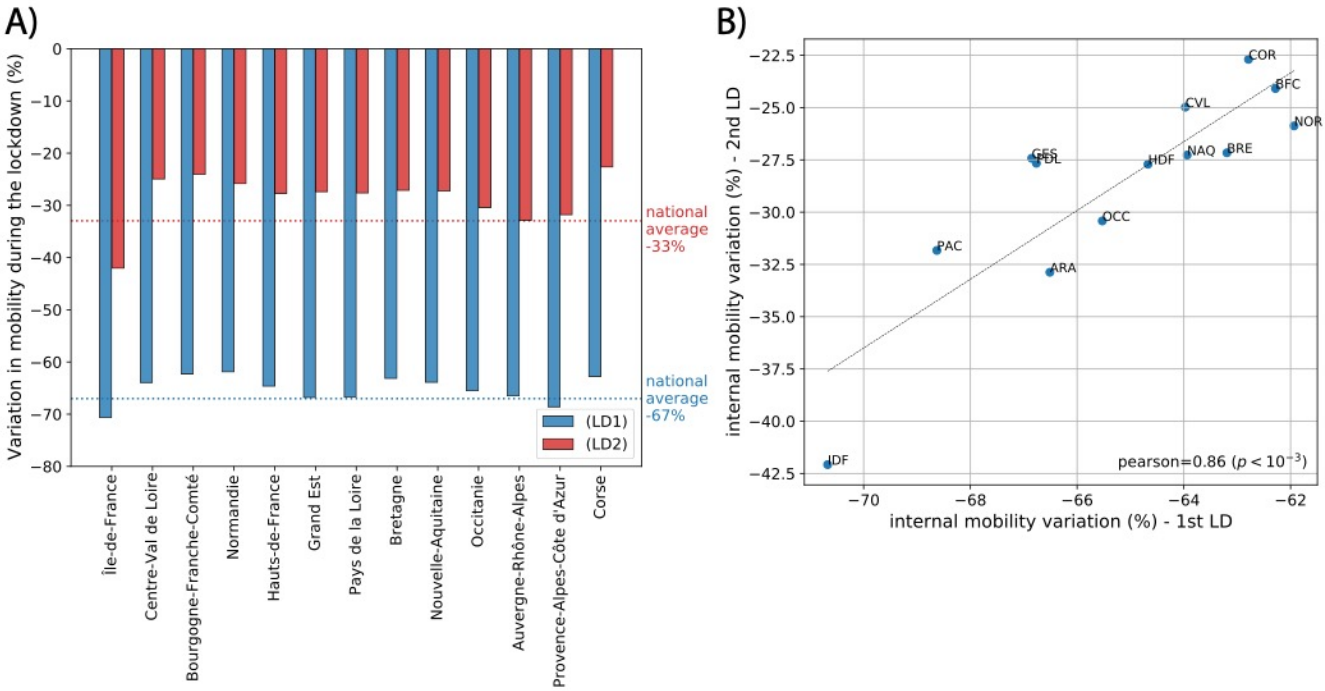

Figure 3. Comparing 1st and 2nd lockdown – regional data. Internal mobility in each of the 13 regions of mainland France, averaged over the 1st full working week of the 1st LD (blue - Mon 23 to Fri 27 Mar, 2020) and of the 2nd LD (red - Mon 2 to Fri 6 Nov, 2020). A) reports mobility in each region during both LDs, B) correlates regional mobility between LDs, and reports Pearson correlation.

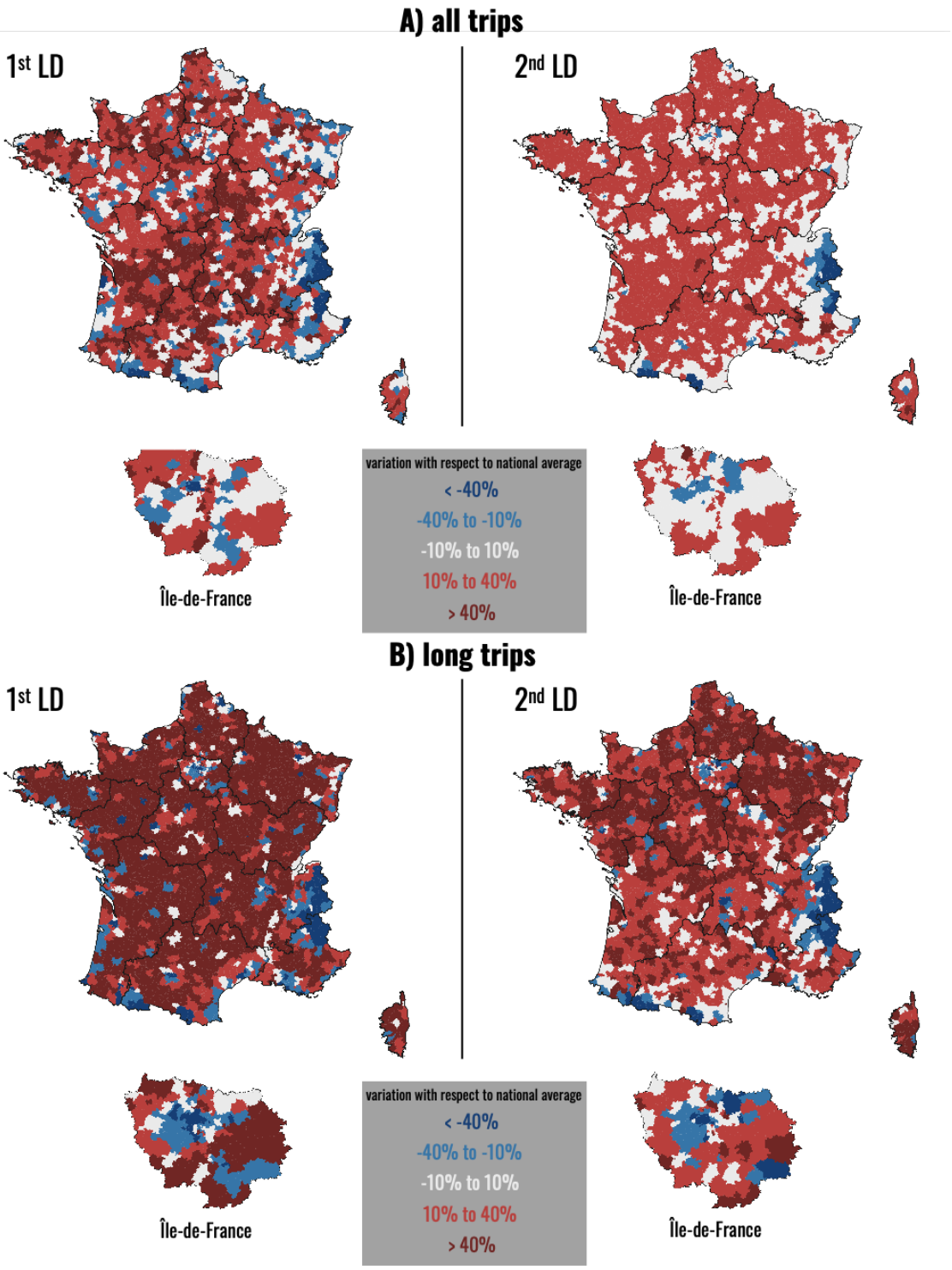

Figure 4. Comparing 1st and 2nd lockdown – deviations from national average. Geographic variation in mobility with respect to national average, during the first full week of the 1st and 2nd LD. Mobility in blue areas was lower than the national average (so, larger reductions than the average), mobility in red areas was higher than national average (smaller reductions than the average). The bottom panels zoom on Île-de-France, the region of Paris.

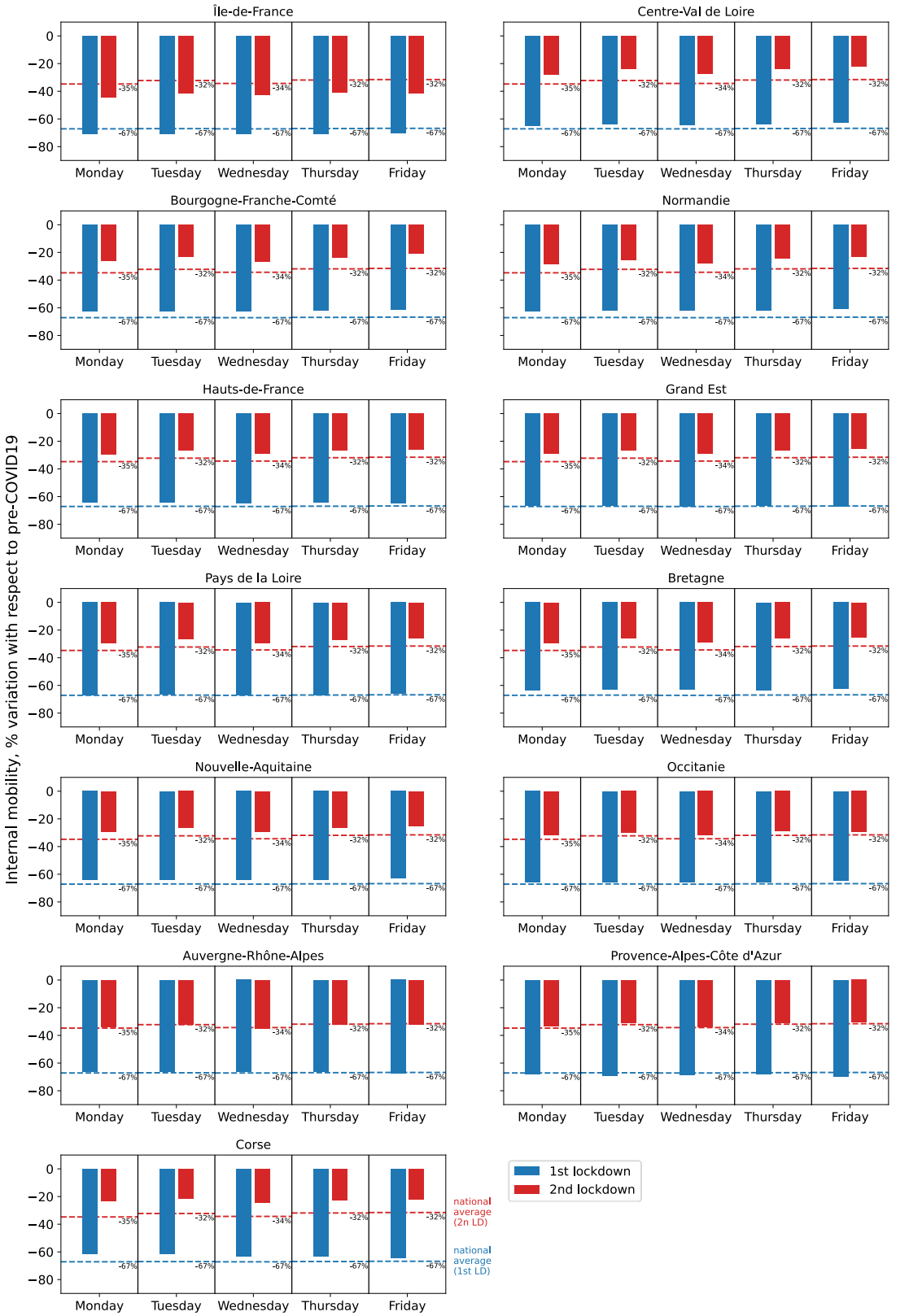

Figure 5. Regional variation of internal mobility on each of the days considered: 1st full working week of the 1st LD (blue - Mon 23 to Fri 27 Mar, 2020) and of the 2nd LD (red - Mon 2 to Fri 6 Nov, 2020. Dashed lines represent the national average.

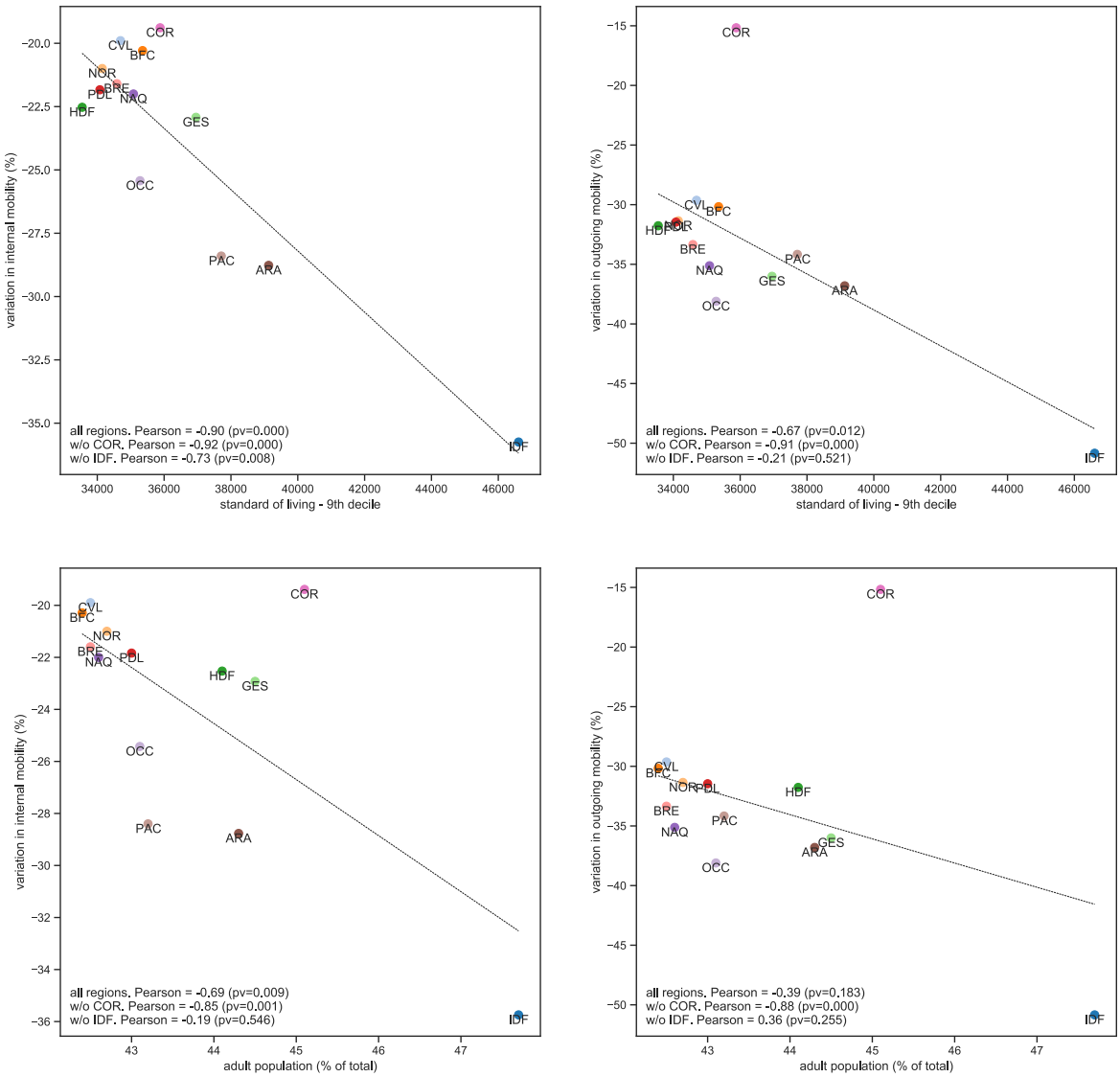

Figure 6. Correlating changes in mobility and demographic, economic factors. Internal (left) and outgoing (right) mobility against the 9th decile of regional standard of living defined by INSEE (top), and the percentage of adult population (25-29-year old, bottom).

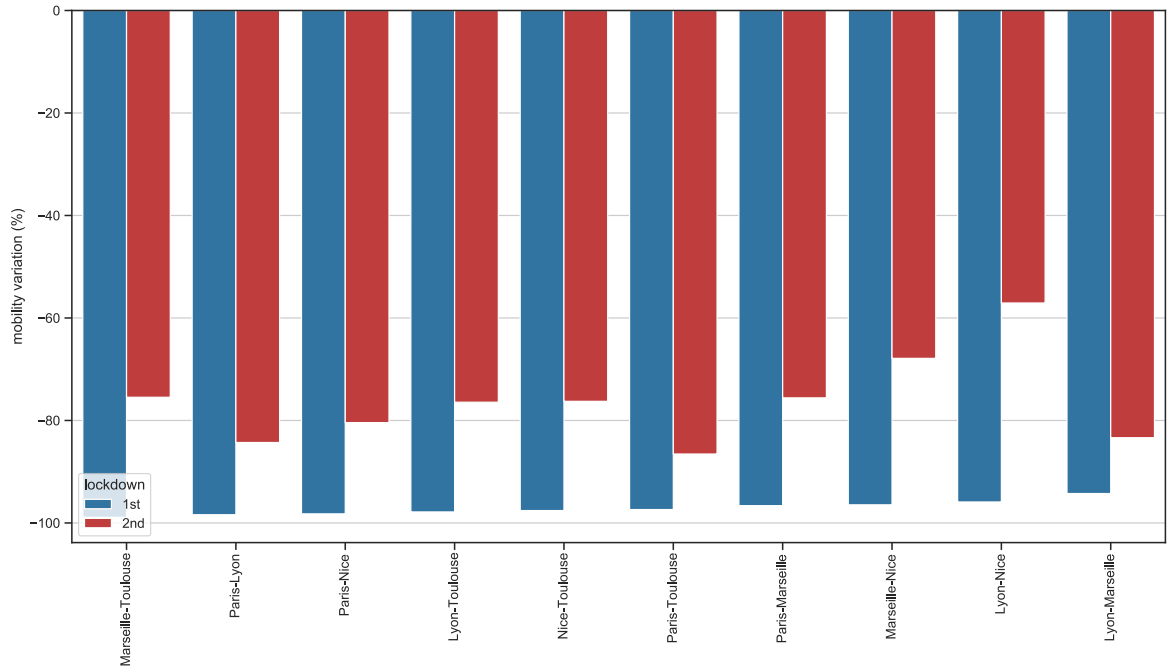

Figure 7. Traffic between main cities. Comparing variation of traffic during the first full working weeks of the 1st and 2nd LD among the top 5 French cities by population: Paris, Marseille, Lyon, Toulouse, Nice. Traffic is considered in both directions, and sorted by increasing variation during the 1st LD.

KEY FINDINGS

Overall mobility (Fig. 1). In the first full week of the 2nd LD, mobility in France has dropped to 27% below pre-pandemic levels. Long-range mobility has decreased to a further 40% below pre-pandemic levels. Mobility during the 1st LD was 2.5 times lower (65% below pre-pandemic), and long-range mobility 2 times lower (83% below pre-pandemic), than the current values. The current LD has caused a consistently smaller decrease in mobility than the previous one. It has curbed long-range mobility more efficiently than short-range mobility, analogously to what happened during the 1st LD.

Mobility by age (Fig. 1, 2). No difference in mobility of young and mobility of adults is visible during the current LD. Mobility of seniors, instead, has been 5 points lower than average. Age differences in long-range mobility are stronger: the number of long-range trips taken by the young is 7 points above average; the number of long-range trips taken by seniors is 15 below average. **These age differences in mobility are new, and were not present during the 1st LD**, with the exception of seniors taking fewer long trips than average (5-point difference). Three factors might drive this: 1) keeping schools open boosts mobility of young, 2) larger number of productive sectors open raise mobility in the active population,

resulting in a net reduction among seniors; 3) risk aversion among seniors [5], who are at highest risk of severe COVID-19.

Mobility by time of day (Fig. 2). In the current LD, daytime mobility (9am to 7pm – more than half of total mobility before the pandemic) has driven daily average reductions, consistently dropping to around 33% below pre-pandemic levels. The largest drop has instead occurred after 7pm, and before 1am, a time range comprising 1/5 of daily mobility in the pre-pandemic period. Reductions have instead been modest during late nights (1am to 7am), but with probably little impact as this time range contributed to less than 1/10 of daily mobility. More notably, a modest reduction (20% below pre-pandemic level) has been observed in the morning rush hours (7am-9am), which comprise alone 15% of daily mobility. This is likely the result of open schools and increased displacements for work. This is however at odds with mobility during evening rush hours (5pm-7pm) being in line with the daily average. This might hint at home-to-school and home-to-workplace commuting being concentrated during usual morning rush hours, while return journeys being spread out along the afternoons.
Comparison with the 1st LD reveals a different picture: the largest reductions used to be observed during the day, the rush hours – when the 2nd LD seems to have limited impact -, and the smallest reductions during late evenings, when instead the 2nd LD is having the most impact.

Geographic heterogeneities in mobility patterns, and impact of demographic and socio-economic aspects (Fig. 3-6). The change in mobility induced by the current LD varies across regions. Mobility in 11 out of 13 regions is higher than national average, and highest in Corsica (23% below pre-pandemic levels). It equals national average in Auvergne-Rhône-Alpes, and – most notably – it is lowest in Île-de-France (the region of Paris). There, its reaches 42% below pre-pandemic levels, 9 points below current national average. This underscores the divide between Île-de-France, that exhibits the largest reduction in mobility, and drives national average down, and the rest of France, featuring a more modest decrease. Variations across regions during the 1st LD were smaller than what currently observed, despite the overall largest drop in mobility. Such variations nonetheless were visible, and highly correlated with current variations (Pearson $r = 0.89$, p-value$<10^{-3}$). This means that the current LD has seemingly amplified regional heterogeneities which were already present during the 1st LD, albeit weaker.
The regional heterogeneity observed warrants an analysis of mobility patterns at the finest spatial scale allowed by the data (EPCI). Such analysis highlighted that the Paris metropolitan areas and large portions of the Alps and the Pyrenees showed consistently lower-than-average mobility in both LDs (i.e. larger reductions). Also, this feature is more marked when considering long-range mobility. During the 1st LD coastal regions along both the Mediterranean and the Atlantic Ocean showed similar lower-than-average mobility. This is no longer the case in the current LD. We have also measured mobility separately in each region and each day of the working week: variations are stable across days, confirming the validity of our weekly indicators.
We correlated regional mobility variations in the first full working week of the 1st LD with the fraction of resident population in working age, and socio-economic indicators (regional standard of living measured

by INSEE). We found that a higher proportion of residents in working age is associated to lower mobility. Also, higher income was associated to lower mobility. This association was robust also after adjusting for the fraction of active population. This connection between income and mobility has already been documented by our prior analysis in France [1], and confirmed elsewhere [6,7], and it has likely contributed to the disproportionate impact of the COVID-19 pandemic among the underprivileged [8].

Traffic among largest cities (Fig. 7). Long-range traffic includes mobility among main cities. We looked at how that changed, focusing on the top 5 most populous cities (Paris, Marseille, Lyon, Toulouse, Nice). The connection between Paris and Toulouse has seen the largest drop (87% below pre-pandemic levels), the connection between Lyon and Nice smallest (57% below pre-pandemic levels). Also, mobility among main cities has been consistently less disrupted than during the 1st LD, when it all but stopped (between 90% and 100% below pre-pandemic levels) across all connections considered.

LIMITATIONS

- Potential inaccuracy inherent to using mobile phone data to quantify mobility, such as population representativeness, geographical coverage, and heterogeneity in user activity. The data owner has adjusted the data to maximize spatial and temporal representativeness (more details in [1]), and mobile phone data have now a proven record of being a reliable proxy for population-level mobility, for COVID-19 [9], and in other epidemiological contexts [10,11].
- The data record the number of trips among geographic patches (EPCI). As such, it cannot provide information on mobility within this resolution scale.

ACKNOWLEDGMENTS

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