Regional Analysis of the Impact of the 2020 Health Crisis on the Private-Sector Wage Bill: Structural and Local Effects

Mallory Bedel-Mattmuller*, Fadia El Kadiri* and Lorraine Felder Zentz*

Abstract – In metropolitan France, the private sector was severely affected by the health crisis: despite the widely deployed partial activity scheme, the wage bill fell on average by 5.3% in 2020. However, this overall drop conceals regional disparities. The aim of this article is to study the heterogeneous impact of the health crisis on the private-sector wage bill by employment zones. The analysis shows that the sectoral employment structure is the key factor: it explains 60% of the variation in the shock broken down by region. However, there are also other effects that appear to be significant in certain zones: the labour force qualification level, the level of concentration of companies and the role played by commuters. The latter show that the presence of a neighbouring residential zone has a negative impact on the change in the private-sector wage bill in the region under consideration. Furthermore, they cause the shock-absorbing effect of temporary employment to spill over into several multiple zones, especially within one cluster identified in Brittany.

AGIRC-ARRCO. Correspondence: *felkadiri@agirc-arrco.fr*

The year 2020 was marked by an exceptional health crisis due to the COVID-19 pandemic. To stop the spread of the virus, governments took unprecedented action: administrative closures of establishments, strict population lockdowns, curfews, etc. This had an unavoidable impact on the economy: at global level, GDP fell by 3.3% in 2020 (International Monetary Fund, 2021). In France in 2020, business suffered a historic decline, with a 7.9% drop in GDP in constant euro terms (Amoureux *et al.*, 2021). The private sector in particular was very severely impacted by the health crisis: the Urssaf Caisse nationale estimate identified 275,800 salaried job losses (Boulliung & Amoros, 2021). Temporary employment in particular levelled out, matching the different restriction measures in the short term. However, job losses in France were avoided thanks to the partial activity scheme and the various aid schemes and arrangements offered by the State (solidarity funds, state-guaranteed loans, direct tax remittances, etc.).

The business sectors are split heterogeneously over French territory, which is why the regions were not affected to the same extent by the economic crisis. As such, departments specialising in tourism or industry were affected first: for example Corsica or Savoie, or even Ain and Pas-de-Calais (Charton & Durieux, 2021). Conversely, regions in which the use of remote working is more common, such as Île-de-France, were relatively more resistant to the health crisis (OECD, 2020).

To better understand the heterogeneous impacts of the health crisis on employment in France, regional analyses have been carried out in order to isolate the effect associated with the sectoral structure of local employment. They are based on the shift-share method, which makes it possible to break down a change or a rate associated with employment (for example, changes in the number of jobs or the rate of use of the partial activity scheme) into a structural effect reflecting the sectoral breakdown of local employment and a local residual effect obtained by difference (Kubrak, 2018). The first analyses of the health crisis show that, although the sectoral employment structure is a significant component in explaining the variability of the shock between the regions, it alone is not sufficient to explain this entirely. For example, works studying the impact of the health crisis based on the change in the number of jobs (Bouvart *et al.*, 2021) or based on the change in the private-sector wage bill (Barrot, 2021) show that these are the local effects that had a determining impact. The regions identified as having best withstood the health crisis thanks to significant local effects are primarily situated in Brittany and Nouvelle-Aquitaine (DATAR, 2021).

In addition to the sectoral structure of local jobs, the issue of the location of the companies therefore appears to play a central role in assessing the local impact of the health crisis. Since the work of Paul Krugman on geographic economy (Krugman, 1991), it is generally recognised that the economic agents are dependent on the local context. Accordingly, companies appear to set up in dense areas as they are looking for clustering economies, which can lead to different ripple effects. As these are associated with the location of the agents, we more often talk of geographic spillover effects (Baumont *et al.*, 2000). These mechanisms could even be the "key driver of performance in regions" and neighbouring regions (Carré *et al.*, 2019; Yang & Wong, 2012). In France, significant spillover effects have been highlighted, in relation to company creations in metropolitan areas (Brunetto & Levratto, 2017) and, in employment areas, in the number of jobs between 2009 and 2015 (Carré *et al.*, 2019).

Can we identify the factors that explain the heterogeneity of the impact of the health crisis accross territories? Are local sectoral structures a key factor? In this article, we study the territorial impact of the health crisis based on the evolution of the wage bill in the private sector, using data from the Agirc-Arrco (the fund for supplementary pensions in the private sector) wage database. We place at the centre of the analysis the concepts of structural effect and local effect, *via* a spatial analysis.

Studying the change in the private wage bill has a double advantage: this indicator makes it possible to account for the effect of the health crisis on the number of jobs, and it also integrates its impact on wages and, thereby, the massive reliance on the partial activity scheme.

We look more deeply into the concept of local effect with spatial econometric methods. Indeed, it appears to be important to gain a better understanding of the local effect, shown in the literature as essentiel, to explaining the heterogeneous impact of the health crisis in France. To account in greater detail for the role played by neighbouring effects, the concept of spatial autocorrelation is used to study the influence of neighbouring regions; it is defined

as the correlation, positive or negative, between a variable for a given zone and the same variable calculated in the neighbouring regions (Loonis & Bellefon, 2018).

After a brief presentation of the data used in section 1, section 2 presents the heterogeneous impact of the 2020 health crisis on the private-sector wage bill at employment zone level. The link between local sectoral composition and the change in private-sector wage bill is analysed using the shift-share method. In section 3, we explore the other factors that explain the differentiated impact of the health crisis by region.

1. Data and Methodology

The scope of the article covers private-sector employees, more specifically AGIRC-ARRCO contributors. In France, private-sector employees and their employers make obligatory contributions to the *Caisse nationale d'assurance vieillesse* (CNAV, the French National Old-Age Pension Fund) or the *Mutualité sociale agricole* (MSA, for the agricultural sector) for their basic retirement pension and to AGIRC-ARRCO for their supplementary pension. AGIRC-ARRCO had 18.9 million contributors at 31 December 2020. The scope of the study does not include employees of private individuals (1.3 million in 2020), those under the MSA scheme (around 1.4 million employees in 2020) or private-sector teachers (around 115,000 employees in 2020).

The database used for the study is the *base individuelle salaires* (individual salaries database). It is constructed based on the 2018 Annual Social Data Declarations (DADS) and monthly data from Nominative Social Declarations (DSN). It is aggregated at job level: individual-establishment identifier (Siret) pair. The available data relate to the employees (age, address, etc.), their employment contract (permanent, fixed-term, full-time, part-time, category status, etc.), gross salary received and the period to which that salary relates. The other information available in the database relates to the employer's establishment: NAF code, address (in particular so as to define the employment zone and whether this is a residential zone or not, etc.) and a potential use of the partial activity scheme.

The 2018 salary database has 30.1 million entries. The 2019 and 2020 salary databases are constructed using DSN data only and comprise 30.6 and 28.5 million entries, respectively. The only external data source used is the unemployment rate in 2019 taken from INSEE data.

The business sectors were studied at level 2 of the French Classification of Activities (NAF), which contains 82 sectors, excluding agricultural subsectors and activities of households as employers. At this aggregation level, specific subsectors that were relatively unaffected by the health crisis are sometimes associated with other sectors that were heavily affected. For example, the "other manufacturing industries" sector includes the medical and dental supplies and instrument manufacturing subgroup, as well as the specific jewellery, games and toys, musical instruments and sporting goods manufacturing subsectors. Furthermore, temporary workers (employment-related activities sector employees) are not classified into the sector in which their contract is performed. However, this form of employment is heavily concentrated in certain sectors (manufacturing industry, construction, transport and storage): the effect of the health crisis on employment may therefore be underestimated in these sectors.

The analysis is restricted to metropolitan France, as French overseas departments and territories were affected differently by the measures seeking to curb the pandemic. The territorial grid used in the study is the employment zone, defined as "a group of municipalities in which most of the active population live and work" (Lévy *et al.*, 2020). This breakdown seems to be the most appropriate for analysing the dynamics of local employment. This zoning, updated in 2020 by INSEE using a detailed analysis of home-work commutes, gives 287 employment zones in metropolitan France.

Unless otherwise specified, the study examines, for all indicators, the year 2020 in its entirety; it does not take an infra-annual approach as is the case for other analyses on this subject. The 2019-2020 annual change ("health crisis" effect) may also be compared to the 2018-2019 annual change.

The key indicator in the study is the average change in the private-sector wage bill between 2019 and 2020 excluding partial activity compensation.[1]

---

1. *Partial activity compensation is not subject to social security contributions and is therefore not included in a private-sector wage bill.*

2. Heterogeneity of the Impact of the Health Crisis by Region and Sectoral Employment Structure

2.1. Pronounced Heterogeneity by Specialisation

The repercussions of the 2020 health crisis on private-sector salaried employment are many: drop in the number of employees over the year (−2%), drop in the number of positions (−6.9%), and drop in the private-sector wage bill (−5.3%). The changes were, however, very different depending on the employment zone, ranging from −21% to +0.7% in the case of the private-sector wage bill. The map (Figure I) shows these local changes, highlighting the heterogeneous impact of the health crisis in metropolitan France.

This heterogeneity seems to be linked to local sector-based specific features. One underlying element was the use of the partial activity scheme, which was very unequal across business sectors (see Appendix 1).

To report on the sectoral specialisation of the regions, we created a specificity index. It is calculated for each zone z and each sector s as follows (Kubrak, 2013):

$$Specificity\,index_{sz} = \frac{Empl._{sz} \ / \ Empl._{z}}{\left(Empl._{s} - Empl._{sz}\right) / \left(Total\,empl \ - Empl._{z}\right)}$$

(with *Empl.* the number of employments).

The index is 0 or higher; when the index is above 1, we estimate that the region is more specialised than the average in the sector under examination (Appendix 2 presents several sectoral specificity indices calculated for 2019 in order to report on the sectoral specialisation of the regions before the health crisis). Some sectoral specificity indices are strongly correlated (Pearson correlation coefficients significantly different from zero) to the change in the 2020 private-sector wage bill (Table 1).

The regions most affected by the health crisis include, in particular, Corsica (Calvi,

Figure I – **Average change in private-sector wage bill by employment zone between 2019 and 2020**
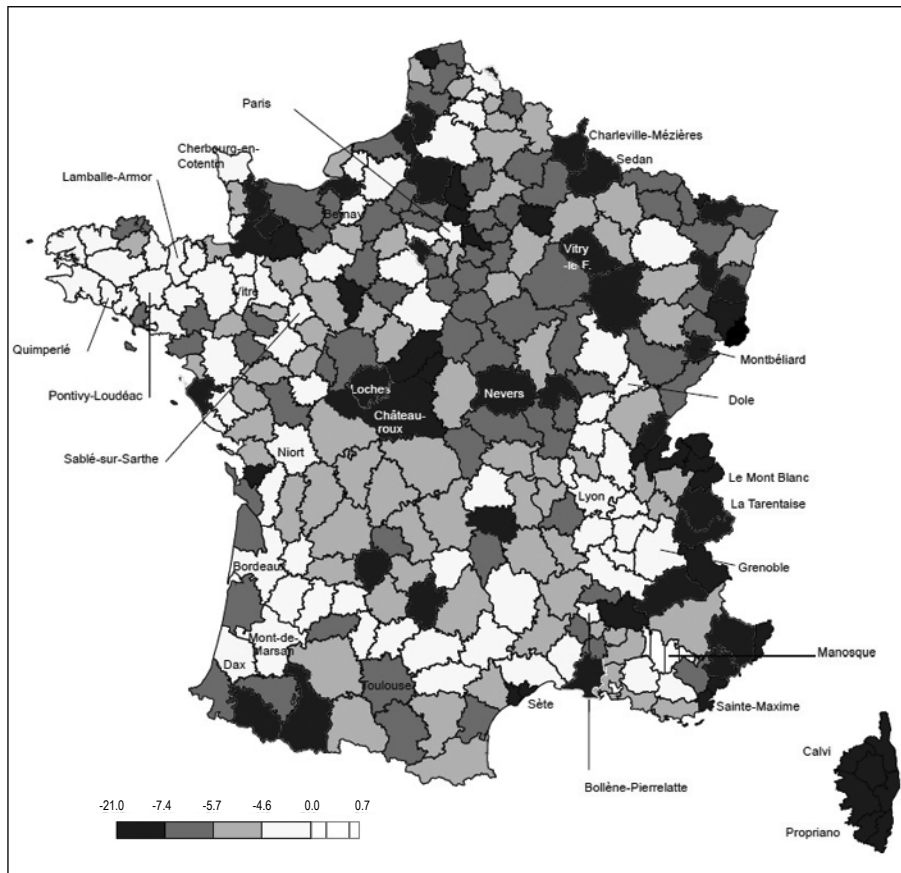
Notes: The categories correspond to the quartiles of the average change in the private-sector wage bill between 2019 and 2020; an additional category relates to the one employment zone (Manosque) that experienced positive growth.
Reading note: In the Calvi employment zone, the private-sector wage bill fell, on average, by 21% between 2019 and 2020.
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

Table 1 – Correlation coefficients between the change in the private-sector wage bill in 2020 and the sectoral specificity indices

Business sector	Correlation coefficients
Hospitality	−0.60***
Construction	−0.21***
Metalworking	−0.13**
Metal product manufacture	−0.12**
Manufacture of motor vehicles	−0.10*
Manufacture of food products	0.23***
Insurance	0.17***
Chemical industry	0.17***
Scientific research and development	0.13**

Notes: The values are different from zero at significance levels alpha=0.01***; alpha=0.05**, alpha=0.1*.
Reading note: The correlation coefficient between the specificity index of the hospitality sector and the change in the wage bill in 2020 is −0.60.
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

for example, with an average change in the private-sector wage bill of −21%) and employment zones situated on the Côte d'Azur or in the Alps. These regions share a high degree of specialisation in the hospitality sector, associated with their tourist appeal (this sector is at least 3.5 times larger in these regions than in the rest of France), and the construction sector, to a lesser extent. However, these specialisations appear to be negatively correlated to the local change in the private-sector wage bill, with the highest specificity index values associated with the lowest wage-bill variation values.

The more industrialised regions belong to the group of zones most impacted by the health crisis. Some regions particularly affected are situated in the north and north-east of France, with employment zones specialising in the automotive industry (specificity indices above 5, see Appendix 2), metalworking (specificity indices above 14) and metal product manufacture (specificity indices above 2.5). This metal specialisation is also found in central France. The changes here are highlighted by Chausse *et al.* (2021).

Conversely, the employment zones least affected by the health crisis are primarily found in the west and south-west of France. This relates firstly to the Breton and western regions as well as employment zones situated further south. These regions specialise in the food industries; as also shown by Bouvart *et al.* (2021), this sector is at least six times larger in these employment zones than in the rest of France. In the west, some regions specialising in the insurance sector were relatively resistant to the health crisis (for example Niort: −1.5%), as were some zones specialising in the manufacture of chemicals and chemical products. This confirms the resilience of the chemical

industry, as also shown by Boisbras (2021). Lastly, some regions in the east were affected to a relatively lesser extent, these regions also specialising in the manufacture of chemicals products (specificity indices above 10), or in scientific research and development (specificity indices above 8).

2.2. Decomposition of Structural and Local Effects

In order to more clearly isolate the effects of the health crisis linked to business sectors, the change in the 2020 private-sector wage bill is broken down into a structural effect, reflecting the sectoral component of the jobs, and a residual effect, which can be interpreted as a local effect.[2] This method is called a shift-share analysis (Kubrak, 2018).

The structural effect is calculated as the difference, for each employment zone z, between the expected change in the private-sector wage bill (MS)[3] and the change at national level:

$$Structural\ effect_z = Expected\ variation\ MS_z - National\ variation\ MS$$

It corresponds to the part of the deviation from the national variation that is explained by the

---

2. *The local effect calculated using the shift-share method depends on the level of aggregation used to define the business sectors, as specific subsectors relatively untouched by the health crisis may be associated with other severely affected sectors.*
3. *For each employment zone* z, *the expected change in the private-sector wage bill between 2019 and 2020 is defined as the change that would have been seen in the region if the wage bill of each business sector* s *of the zone had changed in line with the variation seen for metropolitan France. It is therefore calculated by applying the national changes in the wage bill observed in each sector to the structure of the region's private-sector wage bill:*

$$Expected\ variation\ MS_z = \sum_s \frac{MS_{sz}}{MS_z} \times National\ variation\ MS_s.$$

sectoral employment structure specific to the region. If, all other things being equal, the region is more specialised than the average (i.e. metropolitan France) in the sectors generally spared from the health crisis, its structural effect will be positive.

The difference, for each employment zone z, between the change observed and the change expected forms the local effect: *Local effect$_z$ = Variation MS$_z$ – Expected variation MS$_z$*. It can be interpreted as the gap between the sector-based private-sector wage bill changes at regional and national level, weighted by the wage bill structure by business sector in the zone.

The difference between the change observed at regional level and the national variation allows us to define two groups of regions: if the difference is positive (or negative), this means that the region experienced a higher (lower) variation in the private-sector wage bill than the national change. The employment zone is therefore more (less) dynamic and fared relatively better (worse) in terms of withstanding the health crisis. Furthermore, the difference between the change observed at regional level and the national variation is the same as the sum of the structural and local effects:

Variation MS$_z$ – National variation MS = Structural effect$_z$ + Local effect$_z$

This is why the effects of the health crisis that are explained by the sectoral component of jobs can easily be separated from those associated with a local effect.

The map showing the results of this analysis can be found in Appendix 3 and the regional typology based on this method is presented in Appendix 4. We also provide a particularly focused look at the 20 regions that were most/least affected by the health crisis, the results of which are similar to those obtained by Bouvart *et al.* (2021) in terms of the rate of use of partial activity. This is explained by the choice to examine the change in the private-sector wage bill as it includes the effects backed by the use of the partial activity scheme.[4] For example, regions specialising in sectors heavily impacted by the health crisis are characterised by a strongly negative structural effect (Figure II-A). This is the case for predominantly tourist-based employment zones, which

_____

4. The Pearson correlation coefficient between the change in the private-sector wage bill between 2019 and 2020 and the proportion of days spent in partial activity in 2020 is −0.7. It is significant.

Figure II – **Breakdown of the change in the private-sector wage bill in 2020, as a deviation from the national average according to the shift-share analysis**
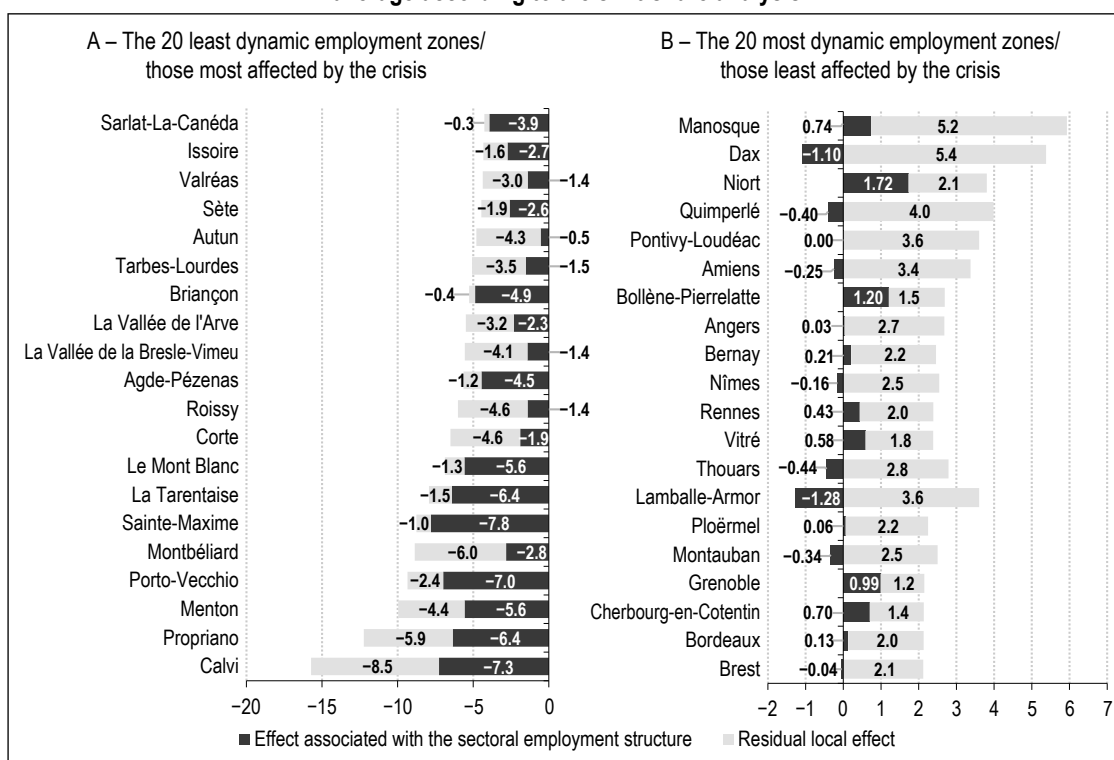
Reading note: In the Calvi employment zone, the deviation from the 2020 national average variation in the wage bill is −15.7%. 7.3% of this deviation is due to the sectoral employment structure and 8.5% is due to the residual local effect.
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

have many jobs in hospitality: Calvi, Propriano, Menton, Porto-Vecchio, Sainte-Maxime, La Tarentaise, Mont-Blanc, Corte, Agde-Pézenas. The least dynamic regions also include industrial zones, such as Roissy (air transport) and Montbéliard (automobile industry and metallurgy). In these zones, the local effect is also negative, and accentuates the sectoral shock associated with the health crisis.

Conversely, in the most dynamic regions (Figure II-B), two positive effects combine. On the one hand, the effect associated with the sectoral employment structure is either negative but weak, or positive. This is explained by the presence of sectors that withstood the health crisis particularly well, such as the food industries (Rennes and Vitré employment zones), the chemicals industry (Bollène-Pierrelatte) or the insurance sector (Niort). On the other hand, the local effect is positive. It therefore seems to be essential to examine the phenomena perceived here.

The shift-share breakdown makes it possible to say that the structural effect associated with the change in the private-sector wage bill is a decisive factor in explaining the heterogeneous impact of the health crisis in the employment zones.[5] However, local effects remain prominent in numerous zones (see Appendix 4: in the regions of group 1 of the typology, the local effect represents, on average, 60% of the deviation from the national average variation). Furthermore, other analyses estimate that it is these local effects that prevail if the impact of the health crisis is examined on the basis of the change in the number of jobs (Bouvart *et al.*, 2021). Therefore, dimensions other than the business sectors must be taken into consideration.

3. The Heterogeneity of the Impact of the Health Crisis by Region Is also Due to Other Local Characteristics

3.1. The Spatial Autocorrelation Is Significant for 2020

Given the literature and recent studies carried out on similar issues, the study of the location of companies and the inclusion of interactions between neighbouring regions seem to be interesting dimensions to analyse. To examine the influences between neighbouring regions, it is necessary to define the concept of proximity. An initial possibility is to base the definition of proximity on the notion of distance between regions. This distance could itself be defined in several ways, using geometric concepts[6] or

based on the closest neighbours. Another possibility, which we have used here, is to take into consideration common borders between regions, i.e. the notion of contiguity. The study data are calculated at employment zone level: these are surface area data, which sometimes correspond to administrative borders. In this case, proximity in the sense of contiguity is commonly used. The concept of proximity is shown statistically by a weighting matrix, W, for which each element defines the proximity link between one region i and another region j. As the primary definition used for proximity is contiguity, the elements of the associated weighting matrix are therefore defined as:

$$w_{ij} = \begin{cases} 1 \text{ if the employment zones } i \text{ and } j \\ \text{ have a common border} \\ 0 \text{ otherwise} \end{cases}$$

There are two statistical tests that can be used to test the presence of spatial autocorrelation, incorporating the proximity relationships defined in W: Moran's I test and Geary's C test – the first being generally preferred in the literature due to its stability. They make it possible to check whether the value obtained in the given region is close to the values obtained for the same variable in the neighbouring zones (Loonis & Bellefon, 2018).

The study of the local variations in the private-sector wage bill in 2020 shows that the spatial autocorrelation is positive and significant: similar values are pooled in neighbouring regions.[7] This result is in line with those of other analyses that highlight the positive spatial autocorrelation of various indicators associated with the labour market (the number of jobs in Levratto *et al.*, 2017; the change in the number of jobs in Carré *et al.*, 2020; the unemployment rate, the rate of informal employment and real salaries in Koike Quintanar, 2019).

---

5. Indeed, the correlation between the deviation from the national average variation and the structural effect increased significantly in 2020 (Dunn test, Dunn & Clark, 1969). Moreover, a study released by the CDC Institute for Research shows that this relationship was stronger in 2020 than it was at the time of the 2008-2009 financial crisis (Pacini et al., 2021). This finding is due to the fact that the change in the private-sector wage bill includes the use of the partial activity scheme, which was more widespread during the 2020 health crisis than during the 2008-2009 crisis, and which differs greatly by business sector (see Appendix 1).

6. "Delaunay triangulation is a geometric method that connects the points in the form of triangles so as to maximise the minimum of all the angles of the triangles (this triangulation tends to avoid sliver triangles). [...]. The sphere of influence graph links two points if their 'circles from the nearest neighbour' intersect. [...]. The Gabriel graph links two points p_i and p_j if and only if all other points are outside the circle with diameter $[p_i ; p_j]$ [...]. The graph of relative neighbours considers two points p_i and p_j to be neighbours if $d(p_i, p_j) \le \max[d(p_i, p_k), d(p_j, p_k)] \ \forall \ k = 1,...,n \ k \ne i, j$ with $d(p_i, p_j)$ the distance between p_i and p_j." (Loonis & Bellefon, 2018).

7. This conclusion is robust as the results are significant irrespective of the concept of proximity used.

The spatial autocorrelation at employment zone level calculated for the 2018-2019 variation is also significant, though to a lesser extent. Moran's index I [8] is 0.2 when calculated for the change in the private-sector wage bill by employment zone between 2018 and 2019 and 0.34 between 2019 and 2020 (Table 2): this suggests that the health crisis has accentuated the overall spatial autocorrelation.

The analysis of the spatial autocorrelation indicators may also be carried out on the structural effects and local effects from the shift-share breakdown (Levratto *et al.*, 2017). As these two variables are correlated to the change in the private-sector wage bill, the tests also conclude that there is a positive and significant spatial autocorrelation. Conversely, the spatial autocorrelation of the structural effects is almost unchanged between 2019 and 2020 (0.29 compared with 0.28), in contrast to the spatial autocorrelation of the local effects (0.15 compared to 0.32). It would therefore seem that the increase in the spatial autocorrelation of the change in the private-sector wage bill is due to an increase in the spatial autocorrelation of local effects during the health crisis. In other words, the more intensive link between neighbouring regions in 2020 is not linked to the regions' sectoral specialisations, but to local effects. Specifying a spatial model will make it possible to clarify these different relationships.

3.2. Estimation of the Impact of the Health Crisis on the Private-Sector Wage Bill with Spatial Econometric Models

3.2.1. Model Specification

A simplified model with the structural effect as the only explanatory variable is tested as part of the initial approach; the model's error term is therefore assimilated to the local effect of the region. Specifying the model in this way makes it possible to test the relationship between the change in the private-sector wage bill in 2020 and the structural effect, on the one hand, and the local (residual) effect, on the other.

For this, and as the spatial autocorrelation of the variation in the private-sector wage bill has been proven, it is possible to introduce the proximity matrix W into the model. As the relationship of proximity may operate on several levels, there are different ways of specifying a spatial model.

Spatial correlation may be present in unobserved characteristics, in which case W intervenes in the model error: this is the SEM (Spatial Error Model), which is formulated as follows: $Y = X\beta + u$, where $u = \lambda W u + \varepsilon$. Starting from the principle that the change in the private-sector wage bill for a given region depends on that of its neighbouring regions, the model, which in this case is a spatial autoregressive model (SAR), also known as an endogenous interaction model, is formulated as follows: $Y = \rho W Y + X\beta + \varepsilon$. The change in the private-sector wage bill of a given region can also depend on the structural effects of its neighbouring regions: $Y = X\beta + WX\theta + \varepsilon$, this is the exogenous interaction model (spatial lag X, SLX). Lastly, the spatial Durbin model (SDM) involves both endogenous and exogenous interactions: $Y = \rho W Y + X\beta + WX\theta + \varepsilon$ [9] (Loonis & Bellefon, 2018). The idea behind this initial approach is twofold: to estimate the variability in the changes in the private-sector wage bill explained by the variability in the structural effects (and therefore to measure the extent to which the sectoral structure is a key factor in explaining the heterogeneous impact of the health crisis), and to identify the level at which the spatial autocorrelation operates when the specified model contains the structural effect as the only explanatory variable. This is why these four models are estimated.

Once the estimates have been carried out for 2020, the different practical approaches [10] lead

---

8. Moran's index is defined for any variable y as:

$$I = \frac{n}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(y_i - \overline{y})(y_j - \overline{y})}{\sum_i (y_i - \overline{y})^2} i \neq j$$

where n is the number of regions and w_{ij} is the relationship of proximity between the zones i and j. The Moran I is between −1 and 1; it is interpreted as a correlation coefficient.
9. *The SDM model is currently used in the literature, as it is more robust against poor specification choices (Loonis & Bellefon, 2018).*
10. *Several approaches coexist for choosing the most appropriate model. The bottom-up approach consists in starting by testing an OLS model, then carrying out Lagrange multiplier tests on λ and ρ (Anselin et al., 1996). The top-down approach consists in starting the other way round, by testing an SDM model (LeSage & Pace, 2009). The mixed approach takes the start of the bottom-up approach, and, in the case of spatial interactions, suggests testing an SDM model (Elhorst, 2010). The summary of these approaches is taken from Loonis & Bellefon (2018).*

Table 2 – **Overall Moran's *I* values in 2019 and 2020 associated with the change in the private-sector wage bill, structural effects and local effects**

	Average change in the wage bill	Structural effects	Local effects
2019	0.20	0.29	0.15
2020	0.34	0.28	0.32

Notes: The values are different from zero at significance level alpha=0.01. Contiguity matrix.
Reading note: The Moran index is 0.29 when it is calculated for the 2019 structural effect and 0.28 when calculated for the 2020 structural change.

us to choose the SEM model as the most robust. With an adjusted R^2 of 0.60 (in other words, 60% of the variability in local changes in the private-sector wage bill is due to the variability in structural effects), the local sectoral structure is therefore the first factor explaining the heterogeneous impact of the health crisis on the private-sector wage bill.

The results of estimating an SEM model also confirm the results presented previously: the change in the private-sector wage bill in 2020 also depends on other unobserved characteristics with a spatial autocorrelation ($\hat{\lambda}$ significantly different from 0), and incorporating the local effect. With the aim of clarifying the local effects, namely variability which is still to be explained, a model containing the structural effect (expressed as the deviation from the average national private-sector wage bill variation between 2019 and 2020) and additional explanatory variables representing other aspects of the local pre-health crisis context (calculated in 2019) is tested as part of the second approach.

There are many determining factors of local effects. The local effect could incorporate other characteristics of the local labour market, such as "the size of the companies established in the local area or the level of qualification of the labour force" (Bouvart *et al.*, 2021), the "contraction in local demand linked to the drop in activity" or even the "development of remote working" but also, given the nature of the 2020 crisis, the potential effect of the local "epidemic intensity" (Barrot, 2021). It is also useful to assimilate the local effect to the more global concept of regional attractiveness (Zaninetti, 2016). Lastly, Levratto & Carré (2013) associate it more with geographic and/or political concepts: "geographic situation in the national economic space, measures taken in favour of or to the detriment of the region, the region's own dynamism, etc.". The Herfindahl index[11] is introduced into the model to represent the size of establishments, and the proportion of executives[12] is selected to reflect the level of qualification of the workforce. The unemployment rate, used as a proxy for the economic situation, is also added.

Furthermore, following other spatial studies on employment (Carré *et al.*, 2020; Brunetto & Levratto, 2017; Levratto *et al.*, 2017), we also introduced the number of jobs per km² (i.e. the job density), which captures clustering effects, and an indicator of the region's predominantly residential nature that represents the openness of the employment zone's activities to the

outside.[13] Lastly, given the specific nature of the employment-related activities sector (temporary employment) during the health crisis, in particular with regard to the partial activity scheme (see Appendix 1), we also introduced the proportion of jobs in this sector.[14]

As for the simplified model, several models (OLS and spatial) are estimated (see Table A5-2 in appendix, and Table A5-1 for comparison with 2019). The different practical approaches this time lead us to choose the SDM model as the most robust; this is also the one that gives the best performance of all the models tested (highest R^2, lowest AIC[15]). The formulation of this model suggests that the spatial autocorrelation no longer functions in the error term – as was the case in the first approach with the structural effect as the sole explanatory variable; the addition of further variables therefore seems to allow for a greater understanding of the local effect that presents a spatial autocorrelation. As the SDM model contains spatially offset variables *WY* and *WX*, the interpretation of the relationships between the change in the private-sector wage bill and the different explanatory variables must still take into consideration interactions and feedback between regions, which is why the direct and indirect effects are generally used to break down these different relationships (Loonis & Bellefon, 2018). The direct effect corresponds to the impact of a change in an explanatory variable in this region on the change in the private-sector wage bill in employment zone *z*. This indicator takes into consideration the feedback effects observed between employment zones: an explanatory

---

11. *For each employment zone, the Herfindahl-Hirschman (HHI) index is equal to the sum of the squares of the shares of the region's establishments in its employment. It is a measure of local market concentration.*

12. *The concept of executive is defined here as belonging to the categories laid down in Articles 4&4 bis or 36 of the French National Collective Agreement on Retirement and Insurance for Executives of 14 March 1947, on the creation of the AGIRC (General Association of Pension Institutions for Executives) scheme. The definition of "executive" within the meaning of the AGIRC does not exactly match that of the INSEE socio-professional nomenclature.*

13. *The "residential zone" indicator is taken from the employment zone typology given in Lévy et al. (2020). It is built around the concept of presential sphere, which "covers activities implemented locally for the production of goods and services aiming at the satisfaction of the needs of persons present in the zone".*

14. *Other variables could have been tested, but they were not ultimately included as they are strongly correlated with the variables selected above. This is the case for the proportion of new jobs in total jobs in 2019, the proportion of permanent contracts in 2019, the decile ratio of salaries in 2019 and the proportion of days spent in partial activity in 2020. As a result, the absence of correlation was verified for all explanatory variables selected (structural effect, Herfindahl index, proportion of executives, unemployment rate, job density, residential zone, and proportion of jobs in the employment-related activities sector).*

15. *The adjusted R² of the SDM model is 0.67, whereas it was 0.60 when the structural effect was the only explanatory variable. This result suggests that the structural effect is the predominant factor explaining the heterogeneous impact of the health crisis on the private-sector wage bill, to a much greater extent than the other local characteristics.*

variable for a given region z can have an effect on the change in the private-sector wage bill in region z, but also on that of its neighbouring regions, which, in return, impacts region z. Symmetrically, the indirect effect corresponds to the impact of a change of explanatory variable in all employment zones other than employment zone z on that latter zone. It therefore represents the spillover effect.

3.2.2. Results

Table 3 presents the results of the estimate of the direct and indirect effects of each explanatory variable.

The local context in 2019, taken from the perspective of the unemployment rate and job density, seems not to have an impact on the change in the private-sector wage bill during the 2020 health crisis; these two variables do not appear significant in terms of either direct effect or indirect effect. This result (also obtained in 2019) is different from that obtained by Carré *et al.* (2020) in relation to the variation in salaried employment. This suggests that the private-sector wage bill (which incorporates the simultaneous effects on workforce and wages) is less sensitive to the economic context and the agglomeration effects than the salaried workforce when considered on its own.

The variables associated with the business sectors (the structural effect and the share of temporary employment in salaried jobs in 2019) have a direct positive effect that is significantly different from zero. The relationship between the change in the private-sector wage bill and the structural effect is therefore again verified using this specification: if, all other things being equal, the region is more specialised than the average (metropolitan France) in sectors heavily impacted by the health crisis, it belongs to the

group of regions for which the private-sector wage bill fell the most. This result suggests that this relationship does not depend on the location of the region and its neighbours. Furthermore, the temporary employment sector (employment-related activities) plays a determining factor in the local variation of the private-sector wage bill. Temporary jobs, characterised by lower wage levels (−23% compared with the average salary per capita in metropolitan France in 2019[16]), are the first to be lost in the event of a crisis, forming a sort of "safety valve" (Pérez *et al.*, 2015). The regions with the highest levels of temporary employment therefore benefitted from a favourable composition effect: their private-sector wage bill fell by less than their workforce numbers.[17] This is particularly prevalent in Brittany, and especially in seven employment zones forming a cluster (Box). For example, in the Pontivy-Loudéac employment zone where 29.1% of jobs in 2019 were held by temporary workers, the number of employees fell by 5.2% and the wage bill by 1.7% in 2020, and in the neighbouring zone of Lamballe-Armor (25.4% temporary jobs in 2019), the number of employees fell by 4.9% while the wage bill fell by 3%. Moreover, due to temporary workers commuting from one employment zone to another (the "commuters"), the temporary employment effect spills over

---

16. By way of comparison, Urssaf Caisse nationale estimates that the average salary per capita of temporary workers is 15% lower than the total average salary per capita in 2020 over a wider scope: metropolitan France and overseas departments and territories (Boulliung & Amoros, 2021).

17. This categorises them in the employment zones having best withstood the health crisis, in the sense of the change in their private-sector wage bill between 2019 and 2020. Conversely, the regions characterised by lower temporary employment (for example, Corsica, see Box) directly accessed the partial activity scheme to withstand the health crisis, which has an immediate effect on their private-sector wage bill (see Appendix 1), an effect accentuated by the salary levels of jobs accessing the partial activity scheme in 2020 (on average 15% higher than the average salary per position in metropolitan France).

Table 3 – **Direct and indirect effects**

Explanatory variables	Direct effects		Indirect effects	
Structural effect (2019-2020 change)	1.430	[1.248,1.611]	−0.013	[−0.518,0.489]
Proportion of executives (2019)	−0.072	[−0.121,−0.021]	0.031	[−0.120,0.187]
Job density (2019)	0.000	[−0.000,0.000]	0.000	[−0.000,0.000]
Unemployment rate (2019)	−0.090	[−0.219,0.031]	0.072	[−0.187,0.330]
Residential zone (2020)	−0.004	[−0.010,0.001]	−0.024	[−0.041,−0.009]
Proportion of jobs in the temporary employment sector (2019)	0.087	[0.045,0.131]	0.148	[0.037,0.267]
Concentration (Herfindahl index – 2019)	−1.349	[−1.913,−0.775]	−0.282	[−1.986,1.499]

Notes: Empirical confidence intervals (2.5% and 97.5% quantiles of 1,000 Bayesian Markov Chain Monte Carlo simulations - MCMC) are given in brackets; if 0 is included in the confidence interval, the effect is not significant.
Reading note: The direct and indirect effects of the proportion of jobs in the temporary employment sector in 2019 are 0.087 and 0.148, respectively. If, other things being equal, the proportion of temporary jobs falls by 10% in an employment zone, its private-sector wage bill falls on average by 0.87%. If, other things being equal, all the neighbouring employment zones of a region see their proportion of temporary jobs fall by 10%, the private-sector wage bill of this region falls on average by 1.48%.
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

Box – **Clusters and Spillover Effects**

To go further in the spatial analysis of the local effect, local Moran's *I* values can be calculated. These are part of the LISA indicators (Local Indicators of Spatial Association) developed by Anselin (1995) and make it possible to detect groupings of similar values, known as clusters. These clusters could reveal potential spillover effects, i.e. spillover mechanisms between regions could influence the local effect and, ultimately, the change in the local wage bill.

Calculating the LISA associated with the local effect identifies two clusters. For almost all employment zones in Corsica, low values for the local effect are associated with equally low values in neighbouring territories (low-low) – which is a sign of a positive local spatial autocorrelation, and has a significant upward influence on the overall spatial autocorrelation process at the level of metropolitan France. In Brittany, in seven employment zones (previously identified as those that best withstood the health crisis), high local effect values are associated with equally high values in neighbouring regions (high-high).

The significant spillover effects (but in this case, in the other direction) highlighted in Corsica and Brittany confirm that the concept of local effect partly overlaps with the specific characteristics of the temporary employment sector, a result that is also suggested by the significance of its indirect effect. In Brittany, the spillover effect probably flows through commuters: in 2019, 37.4% of temporary jobs in the Breton cluster were held by commuters, compared with 31.4% on average.

Table – **Local effects and proportion of temporary jobs (%) in 2019 in the employment zones identified in the clusters**

Region	Employment zone	Local effects in 2020	Proportion of temporary jobs in 2019
Brittany	Auray	2.4	11.3
	Carhaix-Plouguer	0.4	10.2
	Dinan	2.1	29.8
	Lamballe-Armor	3.6	25.4
	Lorient	2.5	15.5
	Ploërmel	2.2	22.6
	Pontivy-Loudéac	3.6	29.1
Corsica	Ajaccio	−2.0	3.3
	Bastia	−3.1	4.6
	Calvi	−8.5	0.0
	Corte	−4.6	0.0
	Ghisonaccia	−1.7	0.0
	Porto-Vecchio	−2.4	1.4
Metropolitan France		-	13.0

into neighbouring regions, hence a significant indirect effect.

The labour market concentration has a negative and significant direct effect on the private-sector wage bill variation. This result, for 2019, confirms the concentration effect shown by Arquié & Bertin (2021), who highlight the fact that "a higher concentration, due to the increased weighting of large employers on the labour market, is accompanied […] by lower salaries, especially for lower paid employees". Furthermore, the effect is accentuated during the health crisis (coefficient −1.330 in 2020 compared with −0.513 in 2019 for SDM models) via an effect on the workforce: Carré *et al.* (2019) suggest that large companies have a greater tendency to reduce their workforce in periods of economic crisis. Moreover, it appears that the labour force qualification level is linked to activity concentration. Indeed, small and medium-sized enterprises (with fewer than

250 employees) have a lower rate of executives than companies with 250 employees or more: 17% compared with 20%. However, the former experienced a smaller drop in their private-sector wage bill than the latter: −4.8% compared with −6.4%. In addition, the estimate shows that the proportion of executives also had a significant and negative direct impact on the change in the private-sector wage bill in 2020.[18] This result, which may seem, at first glance, to be unexpected, is in line with those of Levratto & Garsaa (2016), who also highlight the link with company size, and with the industrial specialisation of certain regions that employ few executives. This would seem to help explain why the Breton regions (average rate of executives of 11.4%) withstood the health crisis particularly well.

Lastly, the residential zone indicator turns out to be non-significant in terms of the direct effect

18. The variable was not, however, significant in 2019.

but significant in terms of the indirect effect. The residential employment zones have more working employees than the number of jobs available in the region, with many of these therefore working in neighbouring regions. While this variable does not have a determining effect on the local variation of the private-sector wage bill, it may, conversely, have an indirect effect via proximity relationships; the location of certain employment zones close to residential zones therefore has a negative effect on the change in their private-sector wage bill. This negative effect seems to be linked to the health crisis as the variable was not significant in 2019. In the Lyon employment zone (Figure III), where the private-sector wage bill fell by 3.6% in 2020 on average, we see a more marked drop in the wage bill of workers commuting from a residential zone (for example, Bourgoin-Jallieu: −4.9%) than among commuters from a non-residential zone (Saint-Etienne: −2.6%) or even than non-commuters (living and working in the Lyon employment zone: −3.7%). This result suggests that the variation in the private-sector wage bill has been detrimentally impacted to a greater extent due to the profile of the commuters coming from residential zones than by that of other employees. Commuters are overrepresented among executives and highly qualified professions (40% of positions in 2019, compared with 32% on average, nationally[19]), who are more likely to have kept their salaries during the 2020 lockdowns due to the use of remote working (Jauneau & Vidalenc, 2020). However, the use of remote working was more difficult to implement in certain situations, such as for people with children to look after.[20] There are more households with children in residential areas, such as Bourgoin-Jallieu (42.5% of households in the employment zone had children in 2018), than in non-residential areas (for example, 35.5% in Lyon in 2018[21]). This result suggests that households with children had a greater tendency to reduce their professional activities than other households due to the closure of schools during the first lockdown (Pailhé *et al*., 2022).

---

19. *This result is consistent with other studies on the subject (Coudène & Lévy, 2016; IAU Île-de-France, 2016).*
20. *Work stoppages were authorised during the first lockdown for parents who had to look after their children due to school closures.*
21. *Source: INSEE. See also Urbalyon (2022).*

Figure III – **Change in 2020 in the private-sector wage bill associated with the jobs of the Lyon employment zone by employment zone in which the employees live**
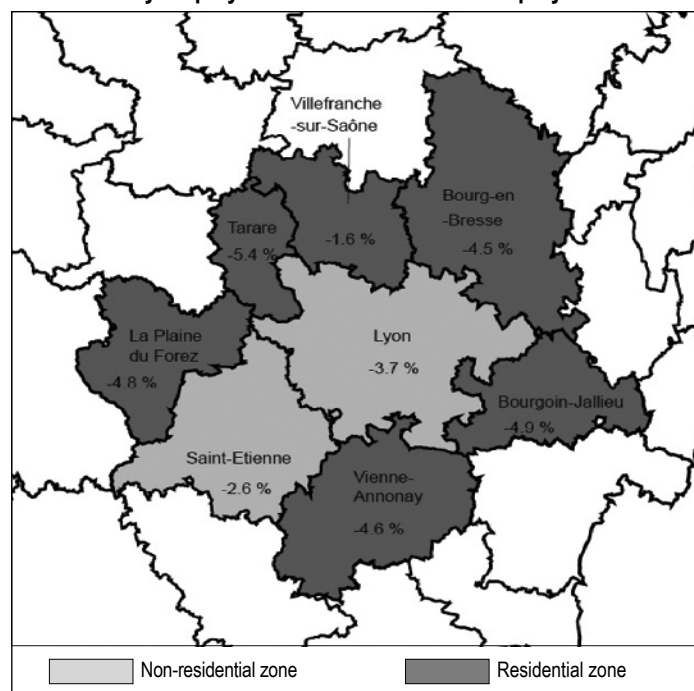
Notes: The change in the private-sector wage bill of the Lyon employment zone was −3.6% in 2020.
Reading note: The private-sector wage bill of employees working in the Lyon employment zone and residing in the Lyon employment zone fell by 3.7% on average in 2020. The private-sector wage bill for employees working in the Lyon employment zone and residing in the neighbouring residential employment zone of Bourgoin-Jallieu fell by 4.9% on average in 2020.
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

* *
*

The article examines the question surrounding the impact of the health crisis in France, broken down into locally established business sectors. It confirms the very clear correlation between the change in the private-sector wage bill and the sectoral composition of local jobs, a result already obtained in other estimations made on the subject. Furthermore, the temporary employment sector played a significant role as a shock-absorber of the effects of the health crisis. The article identifies two other factors associated with the local labour market that explain the different impact of the health crisis on the regions: the labour force qualification level and the concentration of activities. Lastly, the results shows that, for a given region, its neighbouring regions have an influence on the variation in the private-sector wage bill: on the one hand, the shock-absorbing role of the temporary employment sector spills over into neighbouring zones

through commuters, especially in Brittany. On the other hand, the regions neighbouring a residential zone, primarily Paris and Lyon, would have withstood the health crisis more successfully if they had not suffered a shock due to their employees commuting from neighbouring residential zones.

It would be interesting to extend the study to 2021, a year which could be said to be "hybrid": the beginning of the year was still deeply marked by the economic crisis (in April 2021, 2.5 million employees were still in partial activity), the economic recovery began in the second half. Finally, it will certainly be interesting to study, at employment zone level, the link between the characteristics of the local labour markets and the epidemic intensity: the works carried out by Levratto *et al.* (2020), which began at the start of the COVID-19 pandemic, highlight a significant link between the socio-economic factors and the number of hospitalisations and deaths at department level in France, although such a link has not been verified in Italy (Cerqua & Letta, 2021). □

BIBLIOGRAPHY

Amoureux, V., Héam, J.-C. & Laurent, T. (2021). Les comptes de la Nation en 2020 – Baisse historique du PIB, mais résilience du pouvoir d'achat des ménages. *Insee Première* N° 1860.
https://www.insee.fr/fr/statistiques/fichier/version-html/5387891/ip1860.pdf

Anselin, L. (1995). Local Indicators of Spatial Association – LISA. *Geographical Analysis*, 27(2), 93–115.
https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1538-4632.1995.tb00338.x

Anselin, L, Bera, A.-K., Florax, R. & Yoon, M.-J. (1996). Simple diagnostic tests for spatial dependence. *Regional Science and Urban Economics*, 26(1), 77–104.
https://www.sciencedirect.com/science/article/abs/pii/0166046295021116

Arquié, A. & Bertin, J. (2021). La concentration des emplois, une source négligée de disparités territoriales et d'inégalités salariales. *La lettre du CEPII* N° 419, juillet-août.
http://www.cepii.fr/PDF_PUB/lettre/2021/let419.pdf

Barrot, J.-N. (2021). Accélérer le rebond économique des territoires. Rapport au Premier ministre, juin. m-006-
https://www.gouvernement.fr/sites/default/files/document/document/2021/06/m-006-03_2021-rapport_rebond_eco_territoires.pdf

Baumont, C., Ertur, C. & Le Gallo, J. (2000). Geographic spillover and growth (a spatial econometric analysis for european regions). Laboratoire d'analyse et de techniques économiques (LATEC), *Document de travail* N° 2000-07, juin. https://hal.archives-ouvertes.fr/hal-01526987/document

Boisbras, F. (2021). Diagnostic des impacts de la crise économique sur l'emploi industriel. OPCO 2i, juin.
https://www.opco2i.fr/wp-content/uploads/2021/05/OPCO2i-Etude-observatoire-diagnostic-impact-crise-economique-V2.pdf

Boulliung, A. & Amoros, P. (2021). La masse salariale du secteur privé soumise à cotisations sociales enregistre une baisse historique en 2020. Urssaf Caisse nationale, *Acoss Stat* N° 333.
https://www.urssaf.org/files/live/sites/urssaforg/files/Statistiques/Nos%20%c3%a9tudes%20et%20analyses/Employeurs/Nationale/2021/333/Stat_Ur_333.pdf

Bouvart, C., Flamand, J., Dherbécourt, C. & Le Hir, B. (2021). L'emploi en 2020 : géographie d'une crise. France Stratégie, *Note d'analyse* N° 100.
https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-2021-na-100-emploi-2020-geographie-crise-avril_0.pdf

Brunetto, M. & Levratto, N. (2017). Analysis of the job creation process in metropolitan areas: a spatial perspective. EconomiX, *Working paper* N° 2017-36. https://economix.fr/pdf/dt/2017/WP_EcoX_2017-36.pdf

Carré, D. & Levratto, N. (2013). Les entreprises du secteur compétitif dans les territoires, les déterminants de la croissance. Étude AdCF-Institut CDC pour la recherche, juin.
https://www.adcf.org/files/ADCF-EtudeEconomix-130624-web-ok.pdf

Carré, D., Levratto, N. & Frocrain, P. (2019). *L'étonnante disparité des territoires industriels – Comprendre la performance et le déclin*. Paris: Presse des Mines.
https://www.la-fabrique.fr/wp-content/uploads/2019/10/LFI_note-30-web.pdf

Carré, D., Levratto, N., Amdaoud, M. & Tessier, L. (2020). Les performances contrastées des zones d'emploi : observation et modèles. Programme de recherche pour le CGET-Institut CDC pour la recherche, janvier.
https://www.caissedesdepots.fr/sites/default/files/2021-01/Lesperformancesdeszonesdemploi.pdf

Cerqua, A. & Letta, M. (2021). Local inequalities of the COVID-19 crisis. Department of Social Sciences and Economics, Sapienza University of Rome, *Regional Science and Urban Economics*, 92.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8585964/pdf/main.pdf

Charton, C. & Durieux, É. (2021). Confinement du printemps 2020 : un impact économique différencié selon les départements. Insee Références, *La France et ses territoires*, édition 2021, pp. 73–88.
https://www.insee.fr/fr/statistiques/fichier/5040030/FET2021.pdf

Chausse, M.-L., Gouyon, M. & Malard, L. (2021). Cinq trajectoires sectorielles à l'épreuve de la crise sanitaire en 2020. Insee Références, *Emploi, chômage, revenus du travail*, édition 2021, pp. 73–88.
https://www.insee.fr/fr/statistiques/fichier/5392036/ECRT2021-D4.pdf

Cœuré, B. (2021). Comité de suivi et d'évaluation des mesures de soutien financier aux entreprises confrontées à l'épidémie de COVID-19. Inspection générale des finances et France Stratégie, rapport au Premier ministre, juillet. https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs_-_rapport_final_-_comite_coeure_-_27-07-21_0.pdf

Coudène, M., & Lévy, D. (2016). De plus en en plus de personnes travaillent en dehors de leur commune de résidence. *Insee Première* N° 1605.
https://www.insee.fr/fr/statistiques/fichier/version-html/2019022/ip1605.pdf

DATAR (2021). L'impact économique de la crise sur les territoires de la Nouvelle-Aquitaine – Emploi : trajectoires et prévisions. DATAR de la région Nouvelle-Aquitaine, septembre.
https://fr.calameo.com/read/00600927185d8d7bd002e?page=1

Dunn, O. J., & Clark, V. A. (1969). Correlation Coefficients Measured on the Same Individuals. *Journal of the American Statistical Association*, 64, 366–377. https://doi.org/10.2307/2283746

Elhorst, J.-P. (2010). Applied Spatial Econometrics: Raising the Bar. *Spatial Economic Analysis*, 5(1), 9–28. http://web.pdx.edu/~crkl/SEAUG/papers/Elhorst_SEA2010.pdf

IAU Île-de-France (2016). Nouveaux modes de travail et enjeux de mobilité.
https://www.institutparisregion.fr/fileadmin/NewEtudes/Etude_1284/ModesTravail_enjeuxMobilite.pdf

Jauneau, Y. & Vidalenc, J. (2020). Durée travaillée et travail à domicile pendant le confinement : des différences marquées selon les professions. *Insee Focus* N° 207. https://www.insee.fr/fr/statistiques/4801229.

International Monetary Fund (2021). *World Economic Outlook: Managing Divergent Recoveries*. Washington, DC. https://www.imf.org/-/media/Files/Publications/WEO/2021/April/English/text.ashx

Koike Quintanar, S. A. (2019). Spatial Dependence of Labor Market Outcomes: the Case of the Metropolitan Area of Mexico City. *Revue d'Économie Régionale et Urbaine*, 2, 317–354.
https://doi.org/10.3917/reru.192.0317

Krugman, P. (1991). Increasing Returns and Economic Geography. *Journal of Political Economy*, 99(3), 483–499. https://pr.princeton.edu/pictures/g-k/krugman/krugman-increasing_returns_1991.pdf

Kubrak, C. (2013). Concentration et spécialisation des activités économiques : des outils pour analyser les tissus productifs locaux. Insee, *Document de travail* N° H2013/01.
https://www.insee.fr/fr/statistiques/fichier/1380950/h2013-01.pdf

Kubrak, C. (2018). Structurel, résiduel, géographique : principe et mise en œuvre des approches comptable et économétrique. Insee, *Document de travail* N° H2018/01.
https://www.insee.fr/fr/statistiques/fichier/version-html/3315027/H2018-01.pdf

LeSage, J. & Pace, R.-K. (2009). *Introduction to Spatial Econometrics*. New York: Chapman & Hall/CRC. https://www.taylorfrancis.com/books/mono/10.1201/9781420064254/introduction-spatial-econometrics-james-lesage-robert-kelley-pace

Levratto, N. & Carré, D. (2013). La croissance des établissements industriels : une question de localisation. *Région et Développement* N° 38, 93–120.
https://regionetdeveloppement.univ-tln.fr/wp-content/uploads/5_Levratto.pdf

Levratto, N. & Garsaa, A. (2016). Does the employment growth rate depend on the local context? An analysis of French industrial establishments over the 2004-2010 period. *Revue d'économie industrielle*, 153, 47–89. https://doi.org/10.4000/rei.6285

Levratto, N., Brunetto, M., Carré, D. & Tessier, L. (2017). Analyse du lien entre les métropoles et les territoires avoisinants. EconomiX, France Stratégie, CGET et Institut CDC pour la recherche. https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/2017-01-23-rapport_complet-metropoles-final.pdf

Levratto, N., Arcuri, G. & Amdaoud, M. (2020). COVID-19 : analyse spatiale de l'influence des facteurs socio-économiques sur la prévalence et les conséquences de l'épidémie dans les départements français. EconomiX, *Working Paper* N° 2020-04. https://xtra.economix.fr/pdf/dt/2020/WP_EcoX_2020-4.pdf?1.0

Lévy, D., Dubois, M. & Lefebvre, M. (2020). L'orientation économique des zones d'emploi : entre spécialisation et diversification des économies locales. *Insee Première* N° 1814. https://www.insee.fr/fr/statistiques/fichier/version-html/4653582/ip1814.pdf

Loonis, V. & Bellefon, M.-P. (dir.) (2018). Manuel d'analyse spatiale. Théorie et mise en œuvre pratique avec R. Insee et Eurostat, *Insee Méthodes* N° 131. https://www.insee.fr/fr/statistiques/fichier/version-html/3635442/imet131.pdf

Nevoux, S. (2018). Trois essais sur l'activité partielle. Thèse de doctorat en sciences économiques, École Polytechnique, Université de Paris-Saclay. https://www.theses.fr/2018SACLX010

OFCE (2021). Soutenir et relancer l'économie française en période de crise sanitaire. OFCE *Policy brief N° 87*. https://www.ofce.sciences-po.fr/pdf/pbrief/2021/OFCEpbrief87.pdf

OCDE (2020). *OECD Regions and Cities at a Glance 2020*. Paris: Éditions OCDE. https://doi.org/10.1787/959d5ba0-en

Pacini, V., Portier, N. & Portier, O. (2021). Crise covid : une analyse des premiers impacts économiques dans les territoires comparée à la crise de 2008. *Les cahiers de recherche*, Institut CDC pour la recherche. https://www.caissedesdepots.fr/sites/default/files/2022-01/220125_CDD_CDR_COVID_WEB_PL.pdf

Pailhé, A., Solaz, A., Wilner, L. & l'équipe EpiCov (2022). Travail domestique et parental au fil des confinements : comment ont évolué les inégalités socio-économiques et de sexe ? *Economie et Statistique / Economics and Statistics* en ligne 25 juillet 2022. https://www.insee.fr/fr/statistiques/6477736

Perez, C., Thévenot, N., Berta, N., Brochard, D., Delahaie, N., Jallais, S., ... & Valentin, J. (2015). Modes d'ajustement par le travail en temps de crise : des relations professionnelles sous tension. *La Revue de l'Ires*, 84, 59–90. https://doi.org/10.3917/rdli.084.0059

Urbalyon (2022). Mobilité et COVID : l'avènement du télétravail, février. https://www.urbalyon.org/sites/default/storage_files/productions/2022-03/MOB_COVID.pdf

Yang, Y. & Wong, K. K. F. (2021). A Spatial Econometric Approach to Model Spillover Effects in Tourism Flows. *Journal of Travel Research*, 51(6), 768–778. https://doi.org/10.1177/0047287512437855.

Zaninetti, J.-M. (2016). La crise et l'attractivité des villes : Paris en recul. *Population & Avenir*, 730, 4–8. https://doi.org/10.3917/popav.730.0004

PARTIAL ACTIVITY

The partial activity scheme allows an employer to "receive a partial activity payment for its employees to address the drop in the company's activity" in specific cases. Partial activity may take two forms: either a "reduction in the duration of the working week", or a "temporary closure of all or part of the establishment". Between March and May 2020, the employer was compensated for 70% of the gross hourly remuneration, limited to 4.5 times the minimum wage (SMIC) hourly rate. On 1 June 2020, the compensation fell to 60%, except in sectors affected by the crisis (the S1 sectors, which include, in particular, the tourism, hotel, restaurant, sport, culture, air transport, and events sectors, as well as the S1bis and S2 sectors) in which it remained at 70%. (Sources: https://www.service-public.fr/professionnels-entreprises/vosdroits/F23503).

Use of the scheme rose significantly in 2009, linked to the 2008 economic crisis (Nevoux, 2018). It was shown that partial activity had a significant impact on safeguarding jobs in companies experiencing a decline in turnover due to the crisis. The safeguarded jobs are "permanent" jobs (permanent contracts), with partial activity having only a slight impact on "temporary" jobs (temporary employment, fixed-term contracts, etc.). This shock-absorbing role against the impact of the crisis on job losses is also confirmed by the initial analyses of the health crisis. The *Observatoire français des conjonctures économiques* (French Economic Observatory – OFCE) estimates that the partial activity scheme saved 1.4 million FTE jobs in 2020 (OFCE, 2021).

Use of the partial activity scheme is not equal among the business sectors. The sectors that made the greatest use of the partial activity scheme in 2020 are linked to tourism, culture and leisure (Figure A1). These sectors were affected by the two lockdowns in 2020, in spring and autumn (Chausse *et al.*, 2021). Conversely, four sectors used the scheme to a very limited extent: these were those whose activities were heavily required during the health crisis (medical-social and social accommodation, human health activities) as well as other sectors such as financial service activities, and computer programming, consultancy and related activities. These latter two sectors are characterised by a high rate of executives (52% and 76%, respectively, compared with the national average of 19%). The employment-related activities sector (temporary employment) stands out: although it experienced a 15% reduction in the wage bill, it had a lower rate of use of the partial activity scheme (2.5% of days worked in this sector fell under this scheme). Use of the partial activity scheme is also heterogeneous across the regions. Those making the greatest use of the scheme were Provence-Alpes-Côte-d'Azur and Corsica (Cœuré, 2021).

Figure A1 – **Business sectors by change in the private-sector wage bill between 2019 and 2020 and the proportion of days in partial activity in 2020**
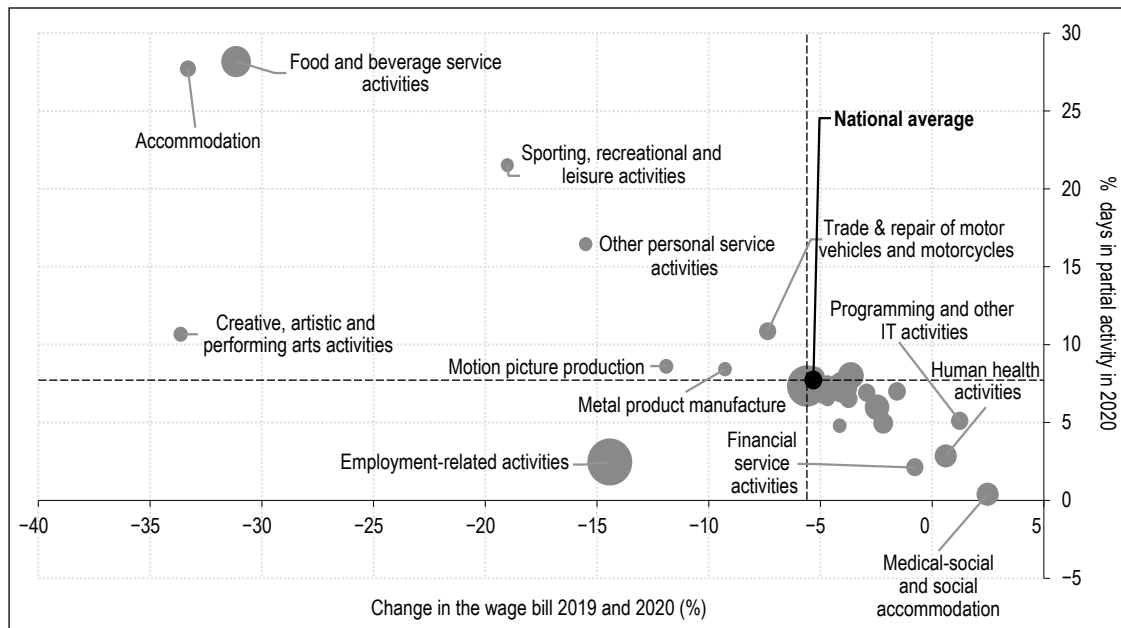
Notes: The size of the circles is proportional to the weighting of the employment in the sector in 2020. For legibility reasons, sectors with a weighting of less than 1% are not represented.
Reading note: The food and beverage service sector represented 5.5% of all positions held in metropolitan France in 2020 in the private sector. Between 2019 and 2020, its wage bill fell by 31.2%; the number of days spent in partial activity in 2020 in this sector represented 28% of the number of days in employment.
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

APPENDIX 2

Table A2 – **Sectoral specificity indices by employment zone in 2019 for certain business sectors**

Employment zone	Hospitality	Construction	Manuf. cars	Empl-related activities	Manuf. agrifood	Manuf. chemicals	Insurance	Metal working	Manuf. metal equipment	Scientific R&D
Calvi	4.9	1.6	0.0	0.0	1.2	0.0	0.1	0.0	0.1	0.4
Propriano	4.1	2.7	0.0	0.0	0.9	0.0	0.1	0.0	0.6	0.0
Porto-Vecchio	4.3	2.1	0.0	0.1	1.1	0.0	0.0	0.0	0.2	0.0
Menton	3.6	1.0	0.0	0.3	1.1	0.1	0.2	0.1	0.1	0.0
Sainte-Maxime	4.4	1.4	0.0	0.3	1.0	0.0	0.0	0.0	0.1	0.0
La Tarentaise	4.4	1.0	0.0	0.4	0.7	0.7	0.0	7.1	0.8	0.0
Le Mont Blanc	3.9	1.1	0.0	0.5	0.8	0.1	0.1	0.0	1.3	0.1
Beauvais	0.7	1.2	5.0	1.3	1.2	1.7	0.6	1.8	2.1	0.4
Montbéliard	0.4	0.7	25.2	1.8	0.7	0.2	0.1	2.5	3.0	0.0
Mulhouse	0.8	1.2	5.2	1.1	1.1	2.5	0.5	0.3	1.1	0.2
Vitry-le-François Saint-Dizier	0.6	1.0	2.2	1.3	1.1	0.9	0.2	22.2	2.9	0.0
Charleville-Mézières	0.6	1.2	0.2	1.0	1.0	0.7	0.3	16.0	5.2	0.0
Sedan	0.6	1.1	0.2	1.2	1.8	1.2	0.1	14.5	6.2	0.0
Châtellerault	0.7	0.7	4.0	1.5	1.1	1.9	0.1	13.3	3.6	0.0
Loches	0.6	1.7	0.0	1.0	1.0	0.3	0.0	1.1	2.4	0.0
Châteauroux	0.7	0.9	0.1	1.3	1.1	0.5	0.3	5.6	1.5	0.0
Romorantin-Lanthenay	1.2	1.3	0.1	1.3	1.4	0.2	0.1	0.0	3.9	0.2
Nevers	0.8	1.1	2.1	1.0	0.5	0.7	0.3	7.3	2.3	0.3
Quimperlé	0.7	0.7	0.1	2.3	8.3	0.2	0.0	0.0	2.4	0.0
Lamballe-Armor	1.1	1.3	2.4	1.9	6.3	0.0	0.0	0.0	1.2	0.2
Vitré	0.4	1.0	0.0	1.7	6.2	2.6	0.0	0.2	0.6	0.1
Pontivy-Loudéac	0.5	0.9	0.3	2.2	5.8	0.9	0.1	0.4	1.0	0.0
Sablé-sur-Sarthe	0.4	0.5	8.1	2.2	8.9	0.5	0.0	1.8	2.6	0.0
Mayenne	0.4	1.1	3.6	1.4	5.7	0.4	0.1	3.6	2.6	0.0
Dax	1.6	1.2	0.2	1.2	3.2	4.0	0.1	0.3	0.6	0.2
Mont-de-Marsan	0.9	1.2	0.2	1.4	3.1	0.7	0.5	0.6	0.5	0.1
Niort	0.6	0.9	0.4	1.0	0.8	0.8	25.5	2.9	0.9	0.0
Rouen	0.8	1.1	2.2	1.1	0.9	1.6	2.9	1.0	1.0	0.1
Bernay	0.5	1.3	0.0	1.8	1.8	5.6	0.1	1.2	2.2	3.3
Cherbourg-en-Cotentin	0.8	1.2	0.1	1.0	1.2	10.2	0.2	0.0	1.4	0.1
Bollène-Pierrelatte	0.7	1.5	0.1	1.1	0.9	16.3	0.1	0.5	0.7	0.6
Dole	0.7	1.2	0.5	1.4	2.4	10.2	0.2	0.3	1.4	0.0
Grenoble	1.0	0.8	0.2	0.8	0.4	0.9	0.5	1.4	1.0	8.8
Manosque	1.2	0.9	0.0	1.9	1.2	5.8	0.1	0.0	0.3	17.1

Reading note: In 2019, the Calvi employment zone had a hospitality sector specificity index of 4.9: this sector is 4.9 times larger in terms of the number of jobs in the Calvi employment zone than the rest of metropolitan France.
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

MAP OF RESULTS OF THE SHIFT-SHARE BREAKDOWN

Figure A3-I – **Structural effect, expressed as the deviation from the average national private-sector wage bill between 2019 and 2020, by employment zone**
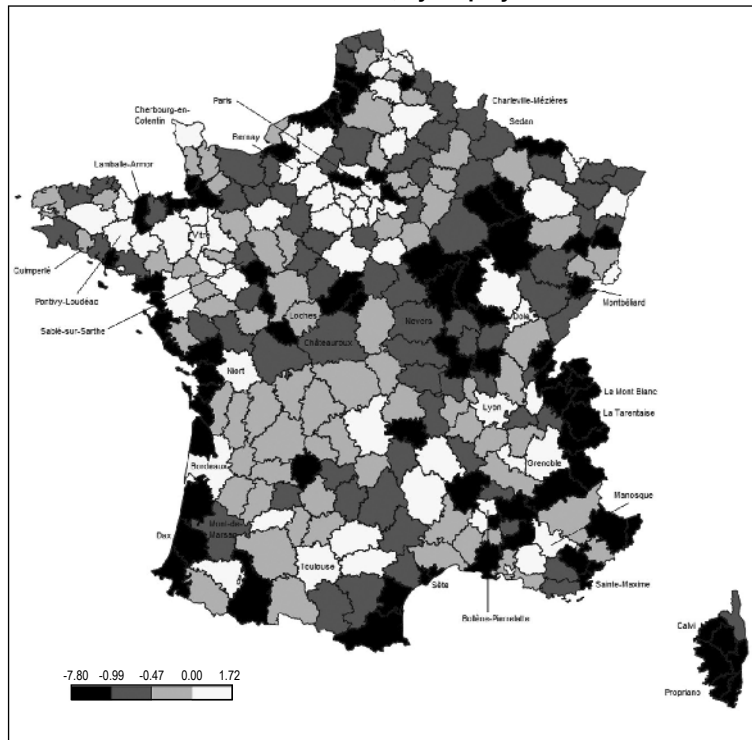
Reading note: The Calvi employment zone shows a negative structural effect (−7.3%).
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.
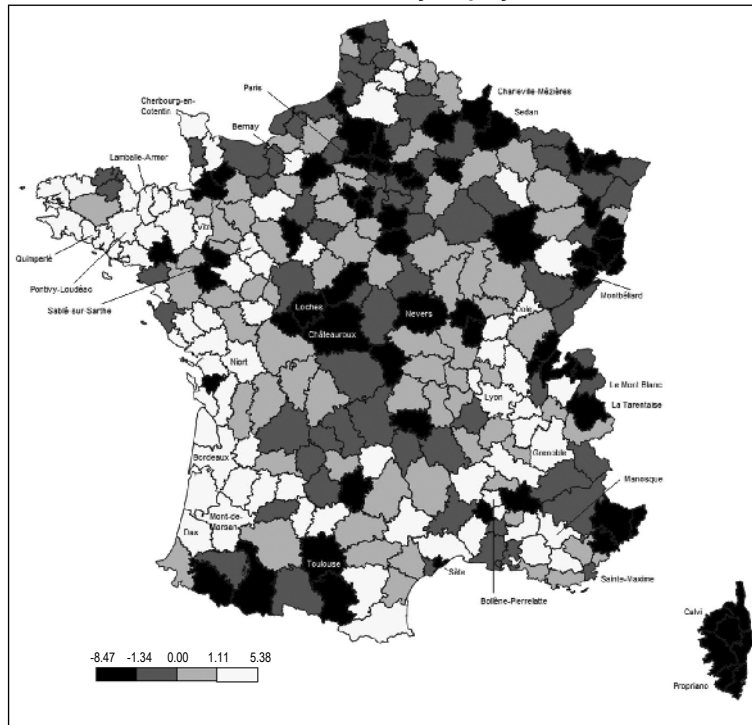
Figure A3-II – **Local effect, expressed as the deviation from the average national private-sector wage bill between 2019 and 2020, by employment zone**

Reading note: The Calvi employment zone shows a negative local effect (−8.5%).
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

REGION TYPOLOGY

The employment zones are categorised into six groups, based on the positive or negative nature of the variables of interest included in the shift-share analysis (Figure A4).

The first group is formed of 34 employment zones, representing 22.1% of salaried jobs in metropolitan France in 2020, which experienced a change in their private-sector wage bill above that observed in metropolitan France, associated with positive structural and local effects; these are the regions that best withstood the health crisis. The second group (71 employment zones, 17.4% of salaried jobs in 2020) includes the regions with resilience in the face of the crisis based on specific local characteristics. The third group (three employment zones, 17.9% of salaried jobs in 2020) is formed of employment zones with resilience in the face of the crisis based on the sectoral employment structure. The fourth group (45 employment zones, 9.7% of salaried jobs in 2020) is formed of the regions for which the negative impact of the health crisis is associated with the sectoral employment structure. The fifth group (23 employment zones, 9.8% of salaried jobs in 2020) is formed of the regions for which the impact of the health crisis is based on specific local characteristics. Lastly, the 111 employment zones that constitute the sixth group (23% of salaried jobs in 2020 in metropolitan France) are the regions in the most difficulty: they combine negative structural and local effects. These are the zones most negatively impacted by the health crisis.

Figure A4 – **Region typology**
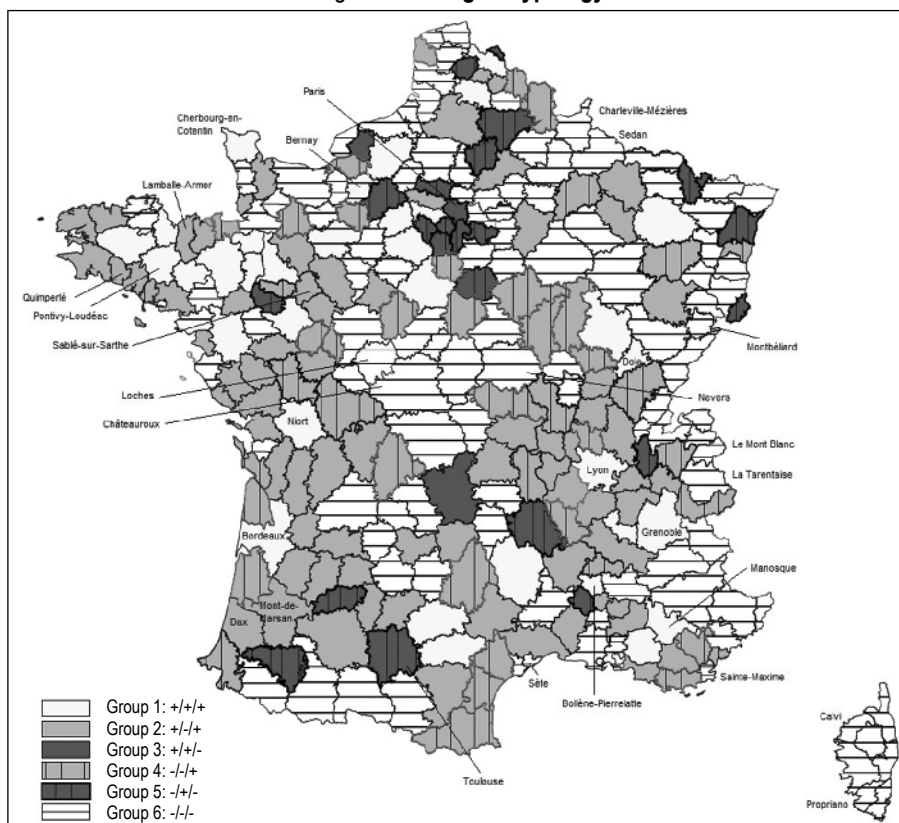
Notes: Group 1: +/+/+; Group 2: +/–/+; Group 3: +/+/–; Group 4: –/–/+; Group 5: –/+/–; Group 6: –/–/–. The first sign corresponds to the change in the wage bill compared to the national average, the second sign to the structural effects and the third sign to the local effects, in line with the method suggested by Carré & Levratto (2013).
Reading note: The Calvi employment zone (group 6) shows a negative deviation from the national average wage bill variation (−15.7%), a negative sector-based effect (−7.3%), and a negative local effect (−8.5%). The Rennes employment zone (group 1) shows a positive deviation from the national average wage bill variation (+2.4%), a positive sector-based effect (+0.4%), and a positive local effect (+2%). The Paris employment zone (group 3) shows a positive deviation from the national average wage bill variation (+0.8%), a positive sector-based effect (+1%), and a negative local effect (−0.2%).
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

ESTIMATION OF DIFFERENT SPATIAL MODELS

Table A5-1 – Estimation results of the variation in the private-sector wage bill between 2018 and 2019

	MCO	SEM	SAR	SLX	SDM
Constant	0.030*** (0.007)	0.028*** (0.007)	0.023*** (0.007)	0.041*** (0.012)	0.038*** (0.012)
Structural effect (variation 2018-2019)	1.806*** (0.312)	1.656*** (0.311)	1.616*** (0.305)	1.540*** (0.325)	1.517*** (0.318)
Proportion of executives (2018)	−0.029 (0.023)	−0.021 (0.023)	−0.023 (0.022)	−0.006 (0.026)	−0.005 (0.026)
Employment density (2018)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unemployment rate (2018)	0.079 (0.050)	0.080 (0.054)	0.057 (0.050)	0.050 (0.072)	0.049 (0.070)
Residential area (2020)	−0.004 (0.003)	−0.003 (0.003)	−0.003 (0.003)	0 (0.003)	0 (0.003)
% employment in temporary jobs (2018)	0.023 (0.022)	0.021 (0.023)	0.024 (0.022)	0.026 (0.024)	0.026 (0.023)
Concentration (Herfindahl index, 2018)	−0.479*** (0.165)	−0.457*** (0.161)	−0.478*** (0.160)	−0.520*** (0.164)	−0.513*** (0.159)
$\hat{\lambda}$		0.177* (0.086)			
$\hat{\rho}$			0.216*** (0.079)		0.074 (0.088)
$\hat{\theta}_{structural\ effect}$				1.804*** (0.665)	1.541** (0.681)
$\hat{\theta}_{proportion\ executives}$				−0.086 (0.054)	−0.082 (0.053)
$\hat{\theta}_{employment\ density}$				0 (0)	0 (0)
$\hat{\theta}_{unemployment\ rate}$				−0.050 (0.105)	−0.046 (0.102)
$\hat{\theta}_{residential\ area}$				−0.009 (0.006)	−0.008 (0.006)
$\hat{\theta}_{employment\ in\ temporary\ jobs}$				0.054 (0.044)	0.047 (0.043)
$\hat{\theta}_{HHI}$				−0.396 (0.333)	−0.343 (0.330)
AIC	−1503	−1504	−1508	−1506	−1505
Adjusted R^2	0.18	0.21	0.22	0.21	0.25

Notes: Contiguity matrix. Standard error in brackets. The values are different from zero at significance level: *** alpha=0.01; ** alpha=0.05; * alpha=0.1.
Sources and coverage: AGIRC-ARRCO salary database, authors' calculations. Employees contributing to AGIRC-ARRCO, excluding MSA employees, metropolitan France.

Table A5-2 – Estimation results of the variation in the private-sector wage bill between 2019 and 2020

	MCO	SEM	SAR	SLX	SDM
Constant	−0.043*** (0.007)	−0.039*** (0.008)	−0.022*** (0.008)	−0.063*** (0.015)	−0.045*** (0.014)
Structural effect (variation 2019-2020)	1.523*** (0.091)	1.485*** (0.090)	1.397*** (0.088)	1.427*** (0.101)	1.429*** (0.094)
Proportion of executives (2019)	−0.097*** (0.026)	−0.091*** (0.025)	−0.086*** (0.024)	−0.072** (0.029)	−0.074*** (0.027)
Employment density (2019)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unemployment rate (2019)	−0.057 (0.054)	−0.081 (0.061)	−0.062 (0.050)	−0.082 (0.075)	−0.094 (0.069)
Residential area (2020)	−0.008*** (0.003)	−0.005* (0.003)	−0.007*** (0.003)	−0.004 (0.003)	−0.003 (0.003)
% employment in temporary jobs (2019)	0.110*** (0.022)	0.080*** (0.022)	0.078*** (0.022)	0.090*** (0.024)	0.079*** (0.022)
Concentration (Herfindahl index, 2019)	−1.337*** (0.300)	−1.224*** (0.281)	−1.304*** (0.280)	−1.417*** (0.302)	−1.330*** (0.281)
$\hat{\lambda}$		0.421*** (0.075)			
$\hat{\rho}$			0.299*** (0.055)		0.349*** (0.076)
$\hat{\theta}_{structural\ effect}$				0.075 (0.199)	−0.505** (0.224)
$\hat{\theta}_{proportion\ executives}$				0.031 (0.058)	0.046 (0.052)
$\hat{\theta}_{employment\ density}$				0 (0)	0 (0)
$\hat{\theta}_{unemployment\ rate}$				0.056 (0.109)	0.086 (0.101)
$\hat{\theta}_{residential\ area}$				−0.022*** (0.006)	−0.016*** (0.006)
$\hat{\theta}_{employment\ in\ temporary\ jobs}$				0.120*** (0.042)	0.073* (0.040)
$\hat{\theta}_{HHI}$				−0.341 (0.643)	0.272 (0.605)
AIC	−1505	−1528	−1530	−1514	−1531
Adjusted R^2	0.61	0.65	0.65	0.63	0.67

Notes, Sources, Coverage: Cf. Table A5-1.