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Covid-19 and value chains

The lockdown measures put in place to contain the spread of the Covid-19 pandemic not only have a direct impact on the economies of the countries concerned, but also spillover to the rest of the world via value chains and external demand. A short-term analysis suggests that these international spillovers have a significant impact on France, albeit less strong than the internal shock caused by the lockdown. France is more exposed to lockdown shocks from the rest of the European Union and relatively less exposed to shocks from China. The most adverse situation for France would be that it suffer a supply shock (a fall in productivity caused by the health measures, or second wave) while the rest of the world emerges from the crisis, leading to a decline in France's competitiveness.

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5 times stronger
transmission to the French economy of a lockdown shock in Germany compared with a lockdown shock in China
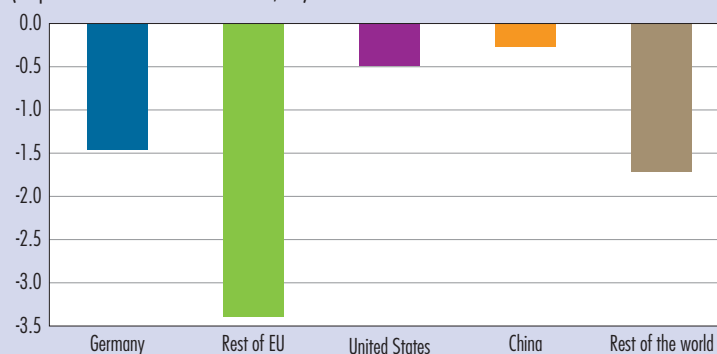
20%
ratio between the effect of the spillovers of a lockdown abroad and the direct effect of a lockdown in France in April 2020

40 times lower
France's exposure to the German accommodation and food services sector compared to its exposure to the German electrical equipment sector

Spillovers in France of a lockdown shock in its trading partners
(impact on real value added, %)

Sources: WIOD (World Input-Output Database); authors' calculations.
Key: The bars represent the impact on French value added (VA) of a lockdown shock abroad (calibrated in each country with a magnitude equal to that observed in France in April 2020). A lockdown shock in Germany shaves 1.5% off French value added.
Note: EU = European Union.

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This article addresses the international contagion effects of the lockdown measures implemented to contain the spread of the Covid-19 pandemic. After detailing the approach adopted and studying the strength of the transmission of the shocks to France, it presents the possible impact of a desynchronised deconfinement and the mechanisms at work according to the type of shock considered.

1 Approach

The effects of the lockdown measures applied abroad spread to the French economy through value chains and external demand. This international transmission means that the French economy is not only affected by the lockdown measures in France, but also by the lockdown shocks abroad, in particular in the sectors most exposed to the other confined countries.

In order to assess these effects, this article adapts the multi-country and multi-sector model developed by Devulder and Lisack (2020) to the context of the Covid-19 crisis (see Box). This production network model represents the interconnections linked to international value chains and highlights France's vulnerabilities to shocks originating abroad. Countries are broken down into six blocks: France, Germany, the rest of the European Union (including the United Kingdom), the United States, China and the rest of the world. As this is a short-term analysis, it is assumed that labour input cannot be reallocated between the different economic sectors, and that producers have very few possibilities to substitute between their inputs.

To calibrate the lockdown shock at the nation-wide level, we use the impacts of the lockdown shock on sectoral activity in France estimated by the Banque de France (2020) for the month of April. These are broken down between supply and demand shocks using the breakdown put forward by the *Observatoire français des conjonctures économiques* (OFCE, 2020a).[1] Finally, these shocks are set so as to obtain an aggregate effect on French value added, in the global lockdown situation at 30 April 2020, corresponding to the figure estimated by the Banque de France, i.e. –27%.

In order to measure the importance of the transmission of a lockdown shock from abroad to France (section 2), the same shock is used, as calibrated above, for each country. Subsequently (section 3), to study desynchronised lockdown scenarios, international variations in the intensity of lockdown are taken into account in the size of the shock. In this case, for simplification purposes, the sectoral distribution of supply and demand shocks in the other blocks of countries is assumed to be similar to that in France, except for a few specific sectors for which there are notable differences (e.g. the construction sector in Germany).

2 International transmission of a lockdown shock to France

To obtain the short-term impact on the added value in France of a lockdown in a partner country, the **lockdown shock** is applied **to one country at a time**. This initial shock is identical for each country, so as to be able to compare its transmission to France according to the country of origin.[2] Thanks to the model's sectoral production network approach, it is possible to obtain differentiated impacts in France according to the country of origin of the shock. Although it is not possible to assess very short-term disruptive impacts, such as total disruptions in the supply of intermediate goods, possible supply difficulties faced by producers for their inputs and their short and medium-term repercussions are taken into account.

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1 It is necessary to use both supply and demand shocks to avoid unreasonable price effects. This choice of simultaneous supply and demand shocks is also made by Baqaee and Farhi (2020), for example.

2 See section 3 for results that take into account the specificities of each country regarding the stringency of lockdown.

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Modelling

The theoretical framework used for this article is the model developed by Devulder and Lisack (2020). It is a multi-country and multi-sector model, which focuses on value chains by incorporating an international production network. In each sector in each country, a representative producer produces by combining labour and intermediate inputs via nested CES (Constant Elasticity of Substitution) aggregators. A representative household in each country consumes goods from all sectors around the world. In order to be able to incorporate the production network, some aspects of this model are deliberately simplified: it is therefore both a static model (without savings or capital) and a real model (without inflation or nominal rigidities). The parameters of production functions and household consumption preferences are calibrated from the 2014 WIOD (World Input-Output Database).[1]

Finally, it is assumed that labour is not mobile across countries and sectors, which reflects the fact that the lockdown shocks considered are short-term shocks. The possibilities of substitution between production inputs (expressed as elasticities of substitution) are calibrated to relatively low values, which again corresponds to a short-term situation, in which firms have little leeway to adjust their intermediate consumption if some of it becomes unavailable. This framework does not take into account total supply disruptions, but reflects the scarcity of certain intermediate inputs. More precisely, the elasticity of substitution between intermediate inputs is equal to 0.1 and that between intermediate inputs and labour is equal to 0.4. The elasticity of substitution between household consumer goods is 0.9, in line with the literature.

Supply shocks are represented by a decline in sectoral labour supply in the countries under lockdown, reflecting the differentiated impact of lockdown measures across sectors. Given the modelling choices, a sectoral labour supply shock is in this case equivalent to a sectoral labour productivity shock. Demand shocks are represented by a sectoral tax on final consumption. This tax concerns all goods purchased by the household in the country under lockdown, as well as goods from the country under lockdown purchased by households in other countries.

1 See the World Input-Output Database website (*http://www.wiod.org/home*), Timmer et al. (2015), the most recent version dates from 2014.

The **international transmission** of the shock occurs both through supply and demand channels. For example, the lockdown in Germany raises the price of goods produced in that country, and thus the production costs for French producers who import German intermediate goods. It also negatively affects the demand for consumer goods from German households, which in turn affects French exports of consumer goods and intermediate inputs. These two shock transmission channels have a combined negative impact on aggregate value added in France. **The intensity of these transmissions, and therefore the size of the spillovers, depend on the importance of the trade links between France and the confined country.**

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Chart 1 leads us to several observations:

- the **international spillovers of the lockdown shock are not negligible,** even if they remain relatively limited compared to the effects of the domestic shock. According to Gerschel et al. (2020), the impact of these spillovers from the rest of the European Union (EU) on French value added is estimated at –0.95%, a lower value than that obtained here;[3]

- France is **much more sensitive to a shock from its close neighbours** (Germany, rest of the EU) than to a shock from China or the United States.

Several elements explain these results.

- On the one hand, these results are due to the **nature of the sectors most penalised** by the lockdown, such as the accommodation and food services sector and the arts and entertainment sector, which are poorly interconnected at the international level. For example, France has little exposure to the German accommodation and food services sector (the sector most affected with a 97% loss of activity), while it is almost forty times more exposed to the German electrical equipment sector (comparatively less affected with a 38% loss of activity, see Chart 2 below).

C1 Spillovers in France of a lockdown shock in its trading partners
(impact on real value added, %)
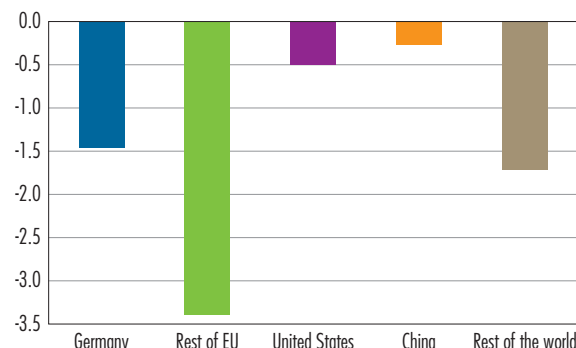
Sources: WIOD (World Input-Output Database); authors' calculations.
Key: The bars represent the impact on French value added (VA) of a lockdown shock abroad (calibrated in each country with a magnitude equal to that observed in France in April 2020).
A lockdown shock in Germany shaves 1.5% off French value added.
Note: EU = European Union.

- On the other hand, the French economy is **more exposed to European countries than to China** via its intermediate inputs, since the value chains of which France is part are more regional than global. In terms of direct exposure, French producers import 66% of their intermediate inputs from Europe, compared with 9.3% from the United States and 5.1% from China.[4]

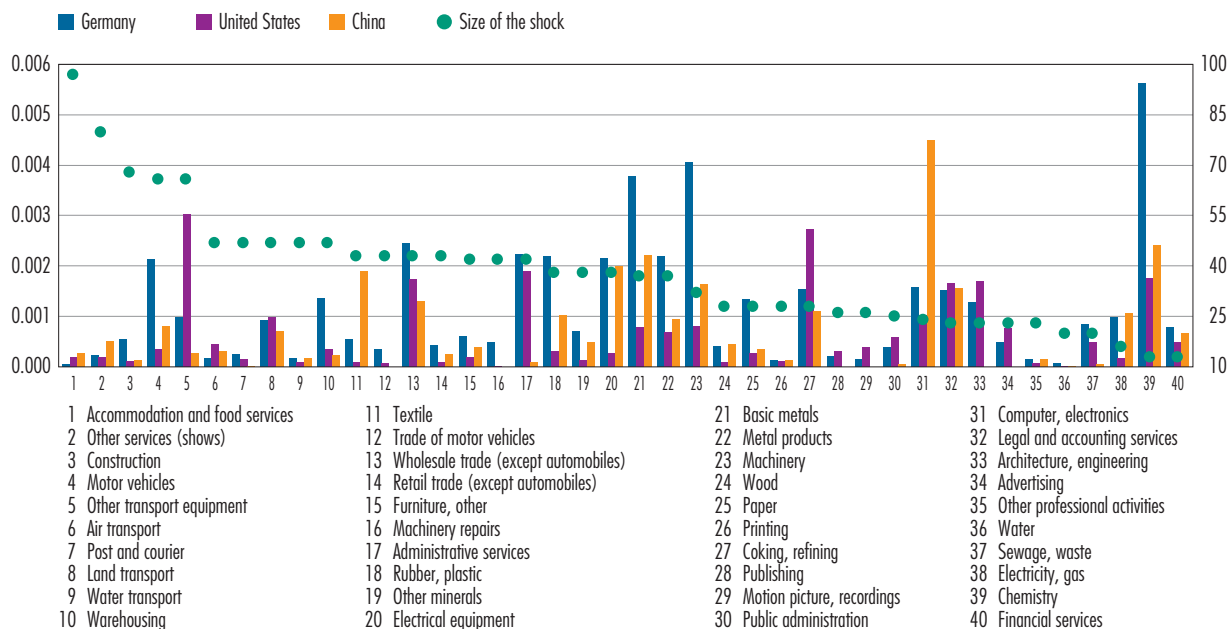3 There are many reasons for this difference. Among others, Gerschel et al. (2020) do not include a final demand shock and allow for greater substitution between intermediate inputs. Moreover, the type of supply (productivity) shock is different, as are the assumptions about labour mobility.

4 On average from 2015 to 2017; source: the BACI database of the *Centre d'études prospectives et d'informations internationales* (CEPII).

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C2 Size of sectoral shocks and total exposure of the French economy to the German, American and Chinese sectors

(Left-hand scale: France's exposure to a foreign sector; right-hand scale: size of the sectoral shock abroad, %)

1 Accommodation and food services	11 Textile	21 Basic metals	31 Computer, electronics
2 Other services (shows)	12 Trade of motor vehicles	22 Metal products	32 Legal and accounting services
3 Construction	13 Wholesale trade (except automobiles)	23 Machinery	33 Architecture, engineering
4 Motor vehicles	14 Retail trade (except automobiles)	24 Wood	34 Advertising
5 Other transport equipment	15 Furniture, other	25 Paper	35 Other professional activities
6 Air transport	16 Machinery repairs	26 Printing	36 Water
7 Post and courier	17 Administrative services	27 Coking, refining	37 Sewage, waste
8 Land transport	18 Rubber, plastic	28 Publishing	38 Electricity, gas
9 Water transport	19 Other minerals	29 Motion picture, recordings	39 Chemistry
10 Warehousing	20 Electrical equipment	30 Public administration	40 Financial services

Sources: WIOD (World Input-Output Database); authors' calculations.
Key: The green discs represent the absolute impact of the lockdown shock on the value added of each sector (right-hand scale).
The sectors are ranked by shock size (most impacted are on the left). The bars represent France's total exposure to each of these sectors abroad (index obtained by inverting the Leontief matrix). For example, the "accommodation and food services" sector suffers a 97% loss of activity. The exposure of the French economy to this sector abroad is very low, with an index of 0.0001 for Germany, 0.0002 for the United States and 0.0003 for China.

3 Desynchronised deconfinement scenarios

The lockdown shock defined above makes it possible to estimate the impact of a **gradual deconfinement scenario, with desynchronised strategies** across countries. In order to better take account of the specific situation of each country, this lockdown shock calibrated for France is weighted so as to adjust the severity of the lockdown to the situation of each country. To do this, we use the lockdown stringency index calculated by Oxford University (Hale et al., 2020), normalising it so that France is under maximum confinement (100% weighting) at 30 April 2020. On the same date, the stringency of the Chinese lockdown is only 44%, that of the German lockdown 88%. All the weightings used are shown in the first row of Table 1. Furthermore, the lockdown shock

suffered by Germany is more specifically set to obtain an impact on economic activity in this country equal to –15% for the month of April 2020 (estimate by the IFO Institute, 2020).

We therefore start out from this initial situation, denoted "period 1", and **gradually reduce the lockdown shock according to the following phases**:

- **Phase 1: hard lockdown.** The country faces the lockdown shock, weighted by the stringency index calculated in period 1;

- **Phase 2: semi-hard lockdown.** The labour supply shock is reduced by two-thirds, the demand shock is lifted except for the most impacted sectors;[5]

5 These are the accommodation and food services, air transport, and arts and entertainment sectors, for which the demand shock is maintained, and the trade, health and social services sectors, for which the demand shock is halved.

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- **Phase 3: advanced deconfinement.** No more labour supply shock. The demand shock is mitigated for the most impacted sectors;

- **Phase 4: almost back to normal.** Only a mitigated demand shock remains in sectors particularly exposed during the crisis.[6]

The transition from one deconfinement phase to the next is desynchronised across countries. This article therefore proposes a possible scenario with six periods as detailed in Table 1. However, this is not a forecasting exercise but a study of a theoretical scenario; the transition from one phase to the other is therefore not explicitly dated.

The impact of this scenario on real value added[7] is shown in Chart 3. It can be noted that in period 4, while France is in phase 3 ("advanced deconfinement"), it still faces negative spillovers from the United States and the rest of the world.

C3 Impact of the lockdown on real value added according to the deconfinement scenario

(deviation from pre-crisis situation, %)
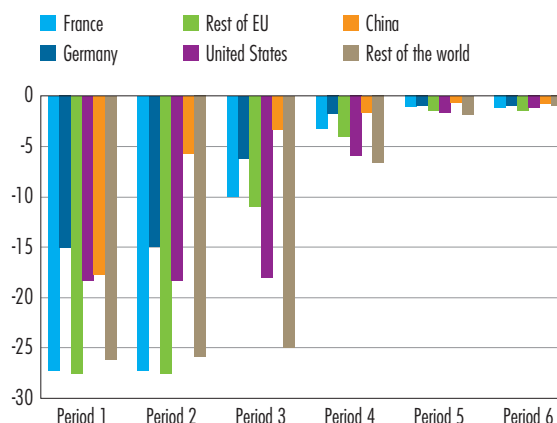
Sources: WIOD (World Input-Output Database); authors' calculations.
Note: EU = European Union.

T1 Gradual and desynchronised deconfinement scenario

		China	France	Germany	Rest of EU	United States	Rest of the world
	Initial shock as a % of French shock	44	100	88	98	58	85
Period 1	Situation at 30 April	Phase 1	Phase 1	Phase 1	Phase 1	Phase 1	Phase 1
Period 2	Start of deconfinement in China	Phase 2	Phase 1	Phase 1	Phase 1	Phase 1	Phase 1
Period 3	Start of deconfinement in EU and further deconfinement in China	Phase 3	Phase 2	Phase 2	Phase 2	Phase 1	Phase 1
Period 4	Start of deconfinement in United States and rest of the world	Phase 4	Phase 3	Phase 3	Phase 3	Phase 2	Phase 2
Period 5	Partial restrictions in United States and rest of the world	Phase 4	Phase 4	Phase 4	Phase 4	Phase 3	Phase 3
Period 6	Quasi return to normal everywhere	Phase 4	Phase 4	Phase 4	Phase 4	Phase 4	Phase 4

Sources: Hale et al. (2020); authors' calculations.
Key: The situation as at 30 April is that described by Hale et al. (2020). In period 1, as at 30 April, all countries are in phase 1 ("hard lockdown"), and China faces a confinement shock equal to 44% of the shock faced by France. In period 2, China is in phase 2 ("semi-hard lockdown") while all other countries are still in phase 1.
Note: EU = European Union.

6 These are the accommodation and food services, air transport, and arts and entertainment sectors, which face a quarter of the initial demand shock.

7 The real variables (wages, prices, value added) are obtained by deflating them by the consumer price index. Real imports and exports are directly measured in quantity or deflated with a specific price index.

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Two polar situations are also under study:

- situation a: only France remains under lockdown (phase 1), while all the other countries are deconfined (no shock);

- situation b: only France is deconfined (no shock), while all the other countries are under lockdown (phase 1).

Chart 4 shows the impact of situations a and b on real value added. **It appears that the direct effect of lockdown in France on value added is −24% (situation a), while the spillovers from lockdown abroad have an impact on French value added of −5.2% when France is deconfined (situation b), and of −3.4% when it is under lockdown (difference between the impact of the deconfinement scenario in period 1 and that of situation a above).**[8] France is therefore more vulnerable to a lockdown abroad when it is itself deconfined. In this case, the difficulties linked to international production chains are greater and their impact is not entirely offset by stronger domestic demand. By way of comparison, the OFCE (2020b) estimates the direct impact of domestic shocks on value added in France in April at −25 percentage points (pp) and the contagion effect from abroad at −5 pp. According to Bonadio et al. (2020), about one third of the global economic shock caused by lockdown is explained by transmission via value chains.[9] Again, it can be noted that these international spillovers are relatively small compared to the size of the lockdown shocks occurring in other countries, but are not negligible.

C4 Alternative deconfinement situations
Impact on real value added

(deviation from pre-crisis situation, %)

Legend: France, Germany, Rest of UE, United States, China, Rest of the world
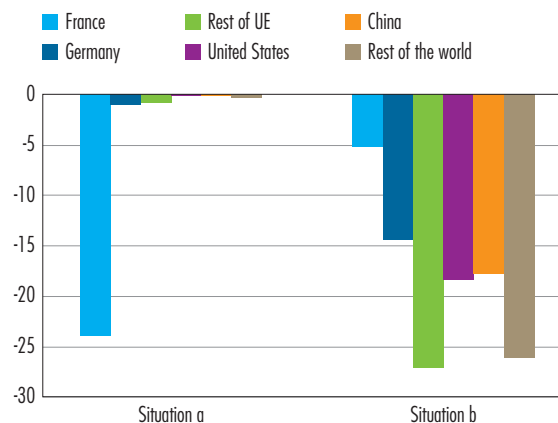
Sources: WIOD (World Input-Output Database); authors' calculations.
Note: EU = European Union.

4 Comparison with a total factor productivity (TFP) shock

So far, the lockdown shock has been modelled as a combination of sectoral labour supply shocks and final demand shocks. Another option would be to consider only a **supply shock, modelled as a decline in sectoral total factor productivity (TFP)**. This shock could correspond to a scenario in which there would be no more restrictions on demand, but there would still be strong health constraints in companies that would have important effects on productivity.

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8 When all countries are under lockdown, as in period 1 of the deconfinement scenario, the shocks faced by all countries correspond to the sum of the shocks of situation a and situation b. The total effect on French value added is −27%, close to but different from the sum of the direct (−24%) and indirect (−5.2%) effects. The difference is due to the non-linearities present in the model, so that the impacts of the domestic and foreign shocks are not strictly additive.

9 The differences between these estimates are linked, amongst other things, to the choices made regarding the model calibration structure.

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As an illustration, Table 2 compares the results obtained with a TFP shock (column 2) in France alone, with the results of the lockdown shock studied previously (combination of supply and demand shocks), also in France alone (column 1).[10] A TFP shock alone implies stronger price effects, with a more pronounced increase in the real goods prices. Real household income therefore falls in both cases. Spillovers from supply shocks are also considerably stronger, as they are transmitted via price increases. Finally, as only France faces such a productivity shock, its real exports, which have become relatively more expensive, fall sharply, while its real imports, which are cheaper, increase. The productivity shock thus has direct effects on competitiveness.

T2 Comparison of the impact of a lockdown in France according to the type of shock

Impact in France	Supply and demand shock in France (1)	Only supply shock (TFP) in France (2)
Real prices	+/–	+ +
Unit wage cost	+/–	+/–
Real household income	– –	– –
Spillovers	–	– – –
Real exports, of which:	– –	– – –
For final consumption	– –	– –
For intermediate consumption	–	–
Real imports, of which:	– –	+
For final consumption	+/–	+ +
For intermediate consumption	– –	–

Sources: WIOD (World Input-Output Database); authors' calculations.

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10 This TFP shock is calibrated in a similar way to the lockdown shock used so far, i.e. so as to achieve an aggregate impact in France equal to –27% which corresponds to the situation in April 2020.

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