4. SPECIAL ISSUES

4.1. SUPPLY SIDE BOTTLENECKS

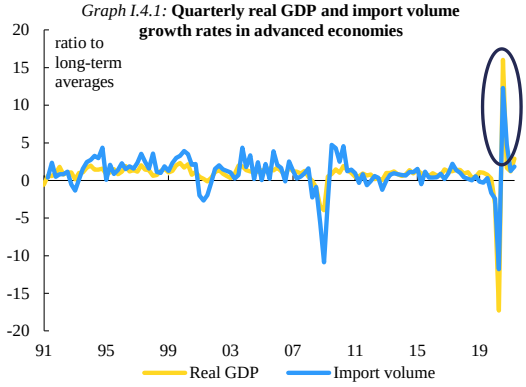
The exceptionally brisk rebound in global demand in the second half of 2020, met a supply weakened by the restrictions put in place to contain the spread of the pandemic. This affected several key industries, including the global logistic sector, the production of raw materials and microprocessors. A series of natural disasters and persistent localised pandemic-related lockdowns as well as emerging labour shortages in various sectors and regions continued to add new disruptions throughout the second half of 2020 and in 2021.

Consequently, various bottlenecks emerged at a global level starting in the second half of 2020, affecting the smooth operation of global supply chains, adding to economy-wide price pressures and increasingly weighing on sentiment and growth into 2021. The most important such bottlenecks include (i) logistic disruptions in the transport sector, mainly container shipping, that struggled to cater for the surge in merchandise trade in the post-lockdown reopening; (ii) microprocessors, a highly cyclical industry faced with a surge in orders amid a capacity trough; and (iii) a host of commodities, such as metals, wood, energy (natural gas) and others, where a combination of soaring demand and supply disruptions lifted prices to or close to all-time highs. This note sheds light on the three types of bottlenecks, and then explores the cross-sectional data in the Business and Consumer Survey (BCS) to investigate the impact on material shortages on the EU economy. The potential for cross-sectoral and cross-country spillovers are then investigated by means of the latest EU input-output tables.

The post-pandemic spike in demand for goods plays a central role

Bottlenecks in transport, semiconductors and commodities largely reflect the exceptionally fast pace of the global rebound, unprecedented in modern history. This is particularly true of advanced economies, for which, as a whole, growth accelerated to 9.3% quarter-on-quarter in the third quarter of 2020), beating historical averages no less than 16 times (see Graph I.4.1). Reflecting this strong rebound, amplified by marked shifts in consumer preferences [26] and amid restrictions targeting contact-intensive services, global demand for goods skyrocketed in the summer of 2020. Accordingly, advanced economies' imports accelerated shot up by a near-13-fold of the historical average in 2020-Q3, dwarfing the rebound from the Great Financial Crisis (see Graph I.4.1). It will come as little surprise, then, that this spike in demand for goods quickly hit capacity limits in various markets and sectors, from transport to rare metals. Given the still buoyant global activity, these backlogs continue to drag on, and in some cases, to exacerbate over the course of 2021, often aggravated by idiosyncratic capacity disruptions in individual markets.

Graph I.4.1: **Quarterly real GDP and import volume growth rates in advanced economies**



Source: Own calculations based on data from CPB (import) and OECD, IMF and national sources (GDP)

Transport

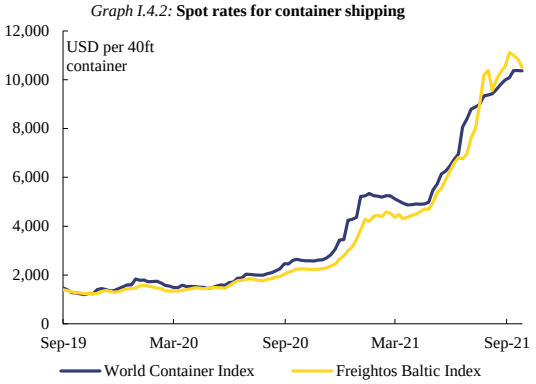
The surge in merchandise trade in the 2nd half of 2020 and the first half of 2021 far above pre-pandemic levels compounded with a shortage of shipping containers. This was because of an earlier drop in demand, but also because the capacity that had been left idle during the initial trade downturn could only be re-activated gradually. In addition, waiting times at ports increased due to high import volumes, containment measures at port facilities and labour shortages. In such a context of stretched supply, events such as the container ship grounding in the Suez canal in March 2021 further added to the backlogs. The rising surplus in

[26] including motivated e.g. by the lockdowns and teleworking towards home electronics, household appliances, furniture and broader home improvement goods.

Chinese trade with advanced economies additionally complicated the normal functioning of transport chains as containers had to be shipped back empty to Asia to be available for further exports. Moreover, the reduction in passenger flights during the pandemic reduced air freight capacity, increasing pressure on maritime transport. As a consequence, shipping transit times lengthened [27], and transport costs surged during the past year, attaining, at the cut-off date of this forecast, a spot price up to five times higher than before the pandemic (see Graph I.4.2).

While there are indications that the stress on global transport logistics is going to ease, developments are highly dependent on the evolution of the pandemic. Having reached pre-pandemic levels already in late 2020, global trade in goods has started losing momentum, reducing demand for goods transports. Moreover, the re-pivoting of consumption towards services is likely to contribute to a further softening in demand for maritime transport services. Likewise, global air passenger numbers are gradually increasing, expanding belly capacity for air freight. Going forward, fewer pandemic-related restrictions, organisational adjustments in ports and supply chains, as well as a large projected increase in new-built ships in 2023 [28] should further help alleviating the capacity constraints. Some global transport indicators, such as the Freightos Baltic Index, have recently indicated a levelling out of container shipping transport costs in September and October. Prices are thus expected to ease into 2022. However, they are likely to remain higher than their very low pre-pandemic levels, in view of the ongoing consolidation of the shipping market [29] and higher expected energy costs.

Graph I.4.2: **Spot rates for container shipping**

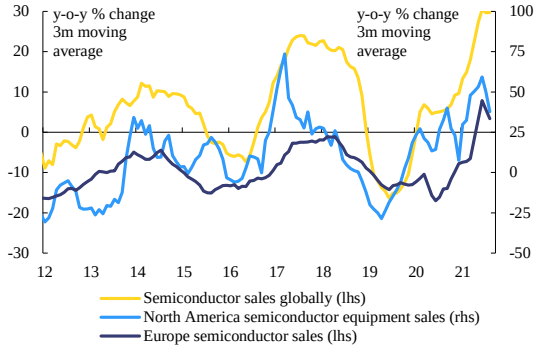


Sources: Bloomberg, Freightos.

Semiconductors

The shift to remote working during the pandemic increased the demand for electronic equipment (work-related as well as for home appliances), further pushing up the demand for semiconductors, already growing strongly on the back of roll-out of new technologies (e.g. 5G, Internet of Things). At the same time, because of the faltering demand for cars during the pandemic, the automotive producers cut their semiconductor orders in 2020. As producers of semiconductors redirected production capacities to booming sectors, the automotive sector was left with reduced access to microprocessors when demand for cars picked up at the end of 2020. [30] Semiconductor shortages were also exacerbated by corporations building up higher inventory levels [31] amid fears of increased scarcity ahead.

Graph I.4.3: **Global semiconductor sales**



Source: Macrobond.
Note: Nominal values in USD

Just like in the case of containers, the surge in demand for semiconductors also came on top of an

[27] https://www.freightos.com/freight-resources/transit-time-calculator/#:~:text=Freight%20shipping%20transit%20time%20is%20impacted%20by%20factors,Shipping%20Transit%20Time%20%26%20Sea%20Freight%20Transit%20Times

[28] https://www.bimco.org/news/market_analysis/2021/20210826-container_ship_orders_due_for_delivery

[29] https://www.ti-insight.com/briefs/consolidation-in-the-container-shipping-market/

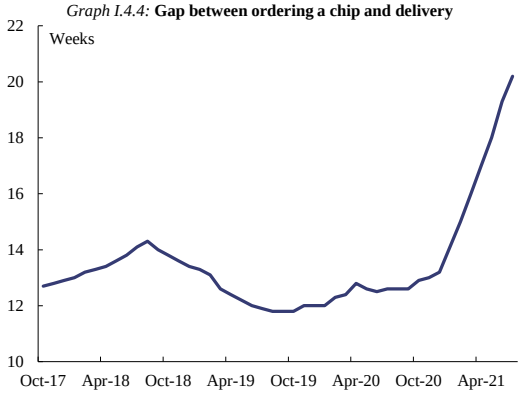
[30] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/coping-with-the-auto-semiconductor-shortage-strategies-for-success

[31] https://spectrum.ieee.org/chip-shortage

already inadequate supply. The semiconductor industry is highly cyclical, and the last major oversupply of semiconductors (mainly linked to memory chips) led to falling prices and weaker investments in 2019, in turn limiting spare production capacity during the crisis. Furthermore, US restrictions introduced in 2018 and 2019 on exports of chip software and chip manufacturing equipment have weakened production of advanced chips in China.[32] During the pandemic crisis, virus containment measures disrupted production in other major chip manufacturing hubs (e.g Korea, Taiwan) and major chip packaging and testing sites (e.g. Malaysia, Vietnam), which were further exacerbated by other adverse events (e.g. a fire in Renesas factory in Japan, drought in Taiwan, winter storm in Texas). As a result of the imbalance between supply and demand, chip delivery times nearly doubled in 2021 (see Graph I.4.4).

Industry experts expect that semiconductor bottlenecks will persist at least until the end of next year[33], though their intensity is likely to gradually decrease. For instance, IHS Markit estimates that supply will catch up with car industry demand in late 2022 while shortfalls of some advanced-function chips will persist into 2023.[34] This is corroborated by recent announcements of expanded production capacities[35] likely to become available only in 2023, given huge costs (reaching around USD 20 bn for large fabrication plants) and long time needed to bring them online (at least 2 years). A survey by the German Chambers of Industry and Commerce confirms the expectation of protracted shortages. According to it, a majority of the around 3,000 surveyed companies expects shortages to last into next year and only around a fifth see the situation improving before the end of 2021. [36]

Graph I.4.4: **Gap between ordering a chip and delivery**



Sources: Bloomberg, Susquehanna Financial Group

Commodities - Metals

High investment in IT equipment and construction combined with robust industrial output spurred demand for base metals and iron ore. Iron ore prices surged through the summer 2021 on booming construction and industrial output in China, but declined sharply as prospects for these sectors weakened. For base metals, since reaching a trough in April 2020, prices have soared. Copper prices retreated somewhat after May 2021 but recovered in October 2021. Prices of other base metals, e.g., aluminium and nickel, have mostly continued their upward trend until October 2021, reaching their highest levels since 2011. This reflects the scarcity of these metals but also their crucial role as input in a number of products (e.g. in electronics). In addition, for aluminium in particular, the surge in prices cannot be dissociated from the increase in energy prices. As China is a big producer of high-emitting aluminium, newly introduced emission cut targets there have also contributed to lower production. [37]

[32] Asian Development Outlook 2021 Update (September 2021), Box 1.1.2: Developing Asia's electronics and automobile exporters at risk from the shortage of semiconductor chips

[33] More and more industry insiders join Intel CEO, Pat Gelsinger, who sees the global semiconductor shortage potentially stretching into 2023: https://www.cnbc.com/2021/10/03/semiconductor-chip-shortage-could-extend-through-2022-marvell-ceo.html

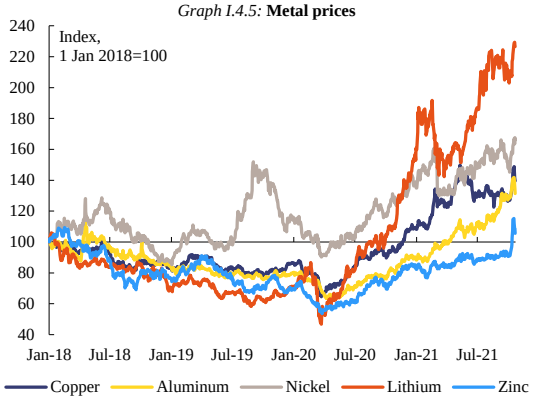
[34] https://www.wsj.com/articles/auto-car-makers-industry-semiconductor-chip-shortage-covid-19-taiwan-vietnam-11632329226

[35] https://www.bloomberg.com/news/articles/2021-04-01/tsmc-to-invest-100-billion-over-three-years-to-grow-capacity

[36] See DIHK (2021), 'Engpässe treffen die deutsche Wirtschaft in ganzer Breite', 19 August.

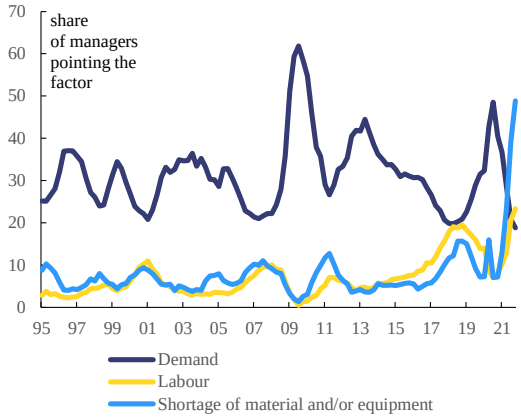
[37] Aluminium production is very energy intensive and contributes 4% of China´s carbon emissions. Nikkei Asia, Alumium prices hit 13-year high amid power shortage in China, 22 September 2021

Graph I.4.5: **Metal prices**



Sources: LME, Nyse Arca and China Iron and Steel Association.

Graph I.4.6: **Factors limiting production in EU industry**



As China accounts for roughly half of global demand for base metals, changes in Chinese demand have a large impact on metal prices. However, energy costs and the green transition add to price pressures: high energy prices make the production of, e.g. aluminium, more expensive; caps on smelting capacity for environmental reasons limit production of base metals; in some cases, e.g. for nickel production in Brazil, environmental regulations temporarily halted mining.

Limited production capacity after years of under-investment and strong demand are likely to keep base metal prices relatively elevated in the near term. Further ahead, the outlook is for a gradual moderation. On the demand side, industrial production and construction in China, both major base metal consumers, are losing steam and are thus expected to lower demand pressures. Furthermore, easing of pandemic restrictions in South-America, where important production sites are located, is set to increase supply. Also, some recent investments in South America should additionally increase production. Therefore, supply is likely to increase in the next few quarters. Over the medium term, the energy transition will continue to add to demand for metals like copper, nickel and lithium, needed for electric vehicles. The more electric vehicles replace conventional cars, the more the demand for these metals is set to rise, causing prices e.g. for copper likely to rise in the medium-term.

Impact on the European economy

According to the EU Business and Consumer Surveys (BCS), shortages of materials and/or equipment rapidly grew in importance in the course of 2021, replacing demand shortfall as the most important factor limiting production in industry (see Graph I.4.6) and coming second in construction (behind labour shortage).

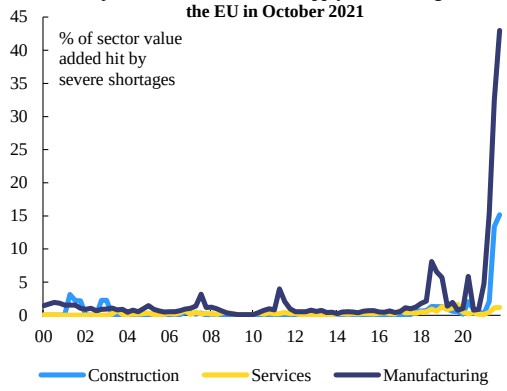
In terms of value added, severe shortages [38] concerned in October 2021 roughly 43% [39] of the EU manufacturing sector and 15% of the construction sector, up from less than 1% in October 2020 (Graph I.4.7). Shortages were considerably less reported in services [40] with only around 1% of EU-wide value added affected in October, up from around 0.1% in October 2020.

[38] *Severe shortages* are defined as occurring in sectors where the share of managers indicating that "shortage of material and/or equipment" is a factor limiting production, exceeds historical averages for that sector and country by at least two standard deviations. The approach is similar to that taken by Kataryniuk I., A. del Rio and C. Santchez Carretero (2021). 'Euro area manufacturing bottlenecks' *Quarterly report on the Spanish economy*), but differs with respect to certain parameters (number of standard deviations and country and sector specific reference historical averages)

[39] The sum of value added of sectors severely affected by shortages across 27 Member States (total value added x share of respondents pointing to the shortage as a factor limiting production)

[40] For services the question refers to space and/or equipment and *not* material

Graph I.4.7: **Pervasiveness of supply-side shortages in the EU in October 2021**



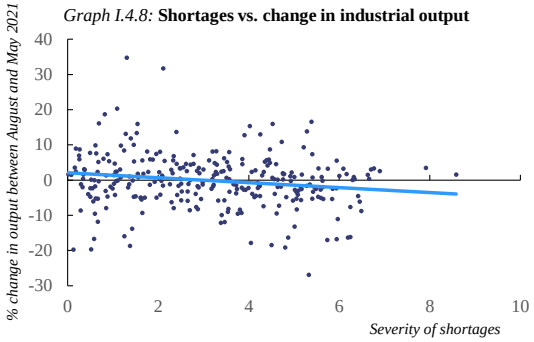
Note: The sum of value added of sectors subject to severe shortages across Member States weighed by the % of positive responses.

Graph I.4.9 provides a disaggregated picture of the reported shortages in manufacturing across Member States and sectors. The colour of each country-sector pair cell corresponds to the severity of perceived shortages, with blue and green indicating no significant shortages, orange indicating mild shortages while red – extreme shortages. Sectors and countries have been sorted according to the average severity of shortages. Among the sectors most affected are the manufacture of electrical equipment, motor vehicles, computer, machinery and equipment, metal products, rubber and plastics, chemicals, furniture and paper products. The group of Member States most affected by shortages include countries from the EU's industrial core: Germany, Italy, Denmark, the Netherlands, Austria and Poland.

Constrained sectors report declines in output…

A visual inspection of the scatter plot (Graph I.4.8) suggests that manufacturing sectors affected by severe shortages appear to be, on average, reporting weaker output dynamics since May. [41] A regression analysis performed with country-sector panel data with above-average shortages [42] indicates the presence of a strong *negative* relationship between shortages and output performance. [43] This means that sectors most heavily affected by shortages were also most likely to report outright declines in output in the three months to August.

Graph I.4.8: **Shortages vs. change in industrial output**



Notes: Dots correspond to country-sector pairs. Only dots corresponding to positive values of *shortages* shown in the plot. *Severity of shortages* proxied by the percent of positive responses in October (to the BCS question on the shortage of material/equipment), standardised with respective historical averages/standard deviations

…and signal increases in selling prices that may already show up in consumer inflation.

The persisting and aggravating supply-side bottlenecks are likely to lead producers to raise selling prices. This relationship is well discernible in the October BCS results that indeed suggest a positive link between the severity of shortages and selling price expectations (standardised values plotted in Graph I.4.10). Panel regressions show that the relationship becomes stronger at high levels of shortages, as confirmed by the statistical significance of the squared *Severity of shortages* term. [44]

[41] Given that the October BCS survey reflects data collected in October, the corresponding change in output (industrial output, by NACE2 subsectors) was calculated over the most recent available 3-month period (May to August 2021). However, the relationship was generally robust to changes in the base month ranging from January to May 2021.

[42] Those where percent of positive responses to the question on material and/or equipment shortages in the October BCS exceeded respective country-sector historical averages (2000-2021).

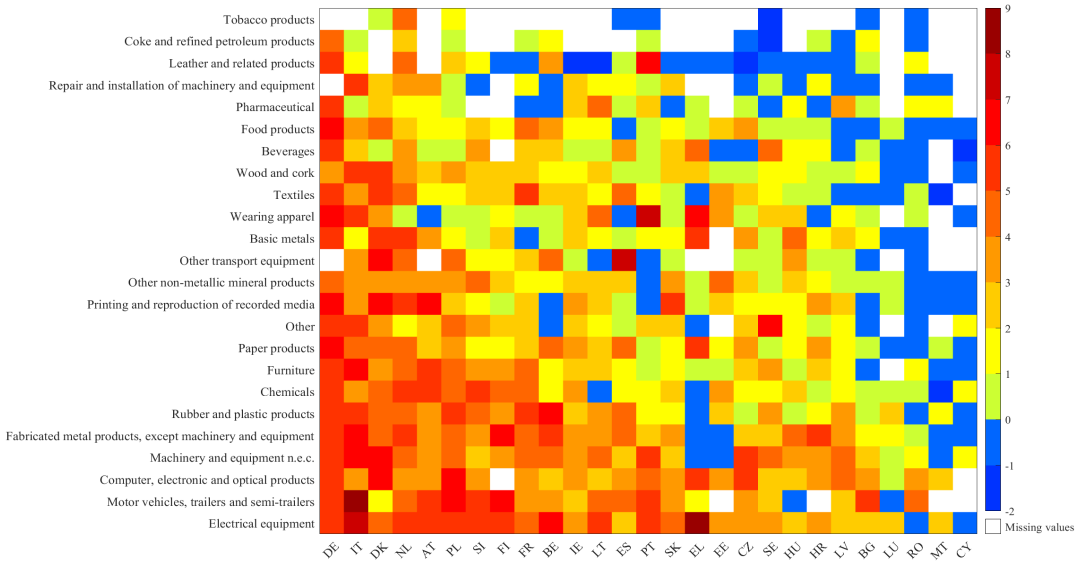
[43] A linear regression with country-sector panel data model was estimated for the relationship between industrial production (IPij) and the shortage indicator (S_{ij}), where i refers to one of 24 NACE rev.2 manufacturing subsectors and j refers to one of the 27 EU Member States. The model specification, which allows for both sector (s_{ij}) and country (c_{ij}) specific effects, is:

$IP_{ij}=a_0+a_1\times S_{ij}+s_{ij}+c_{ij}+u_{ij}$,

where u_{ij} stands for the disturbance term. The coefficient a_1 remains negative and its statistical significance varies across alternative specifications, including dummy variables (to account possible breakpoints in the relationship), a 'production catch-up effect' variable and country or sector-specific fixed effects. Across these specifications, the R-square ranges from 0.01 (Pooled Least Squares) to 0.12 (Cross-sector fixed effect and one break in the relationship).

[44] A linear regression with country-sector panel data was estimated for the relationship between the BCS selling price expectation $PEXP_{ij}$ and the shortage indicator S_{ij}, where i and j index sector (24 NACE rev.2 manufacturing subsectors) and country (27 Member States), respectively. Variables have been standardised for each country-sector pair. The base model specification, which allows for both

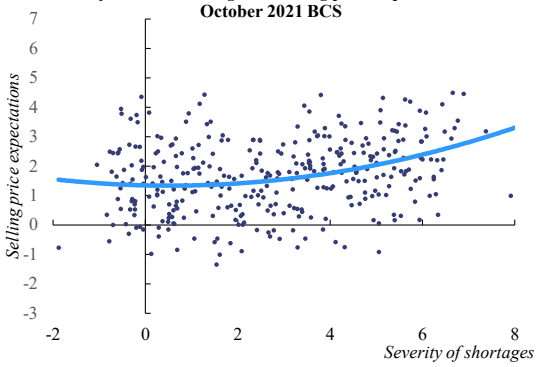
Graph I.4.9: **Heatmap of shortages in manufacturing based on the October 2021 BCS**



Notes: Colour corresponds to the severity of shortages as proxied by the number of standard deviations by which the % of positive responses (to the BCS question on shortages in October 2021) exceeds respective historical averages.

Finding evidence for the impact of supply shortages on consumer prices is much more complex. Shortages of materials or equipment and rising costs of raw materials are just a few of the many factors influencing consumer prices. Wages, commercial rents, delivery transport costs and retail mark-ups also matter. Moreover, investigating the link between the severity of shortages and HICP inflation is complicated by the different classifications used to compile the two datasets. (45) Nevertheless, an attempt was made to map some of the HICP categories with those NACE sectors where severe shortages are reported. Graph I.4.11 presents three of them: cars, furniture, and home appliances. While by no means representative and sufficient as a proof of a causal relationship, these graphs nevertheless suggest a clear link, at EU level, between aggravating shortages and recent spikes in inflation of selected consumer durables. (46)

Graph I.4.10: **Shortages vs. selling price expectations October 2021 BCS**



Note: Dots correspond to country-sector pairs; standardised values *Severity of shortages* defined in the preceding graph

Supply shortages have the potential to reverberate through the European economy

Given the dense interlinkages between sectors and countries in the EU manufacturing process, supply shortages have ripple effects throughout the economy, far beyond the perimeter of the sector first hit. The analysis of these effects was performed with the Eurostat's FIGARO (47) input-

sector s_{ij} and country c_{ij} specific effects as well as some form of nonlinearity, captured by the squared term S^2_{ij} was estimated as follows:

$PEXP_{ij}=a_0+a_1\times S_{ij}+a_2\times S^2_{ij}+s_{ij}+c_{ij}+u_{ij}$

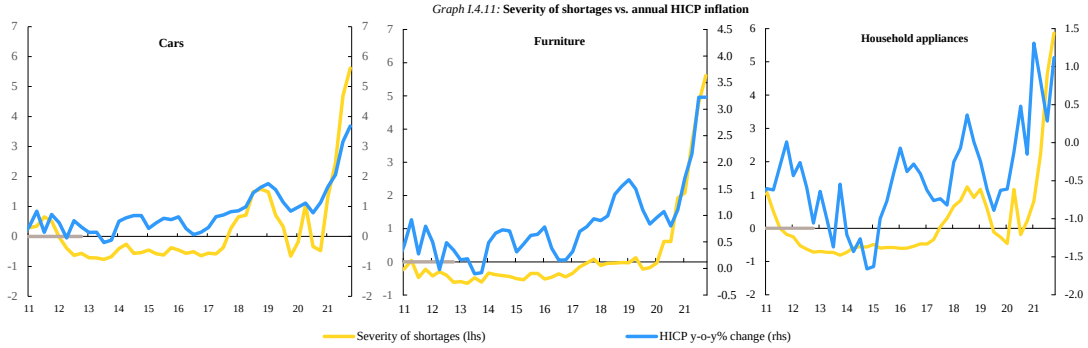
where u_{ij} stands for the disturbance term. Regressions confirm that the alpha2 coefficient of the squared term is positive and statistically significant.

(45) BCS data are available at NACE Rev. 2 division level, while HICP inflation is available according to the purpose of consumption (COICOP).

(46) Similarly close link was visually confirmed for several other HICP durables, including *Other transport equipment* and *Audio-Visual, Photographic & Information Processing Equipment*

(47) EU-inter country Supply, Use and Input-Output tables, estimated jointly by Eurostat and the JRC. A detailed description can be found in: Remond-Tiedrez, I., and Rueda-Cantuche, J. M. (Eds.). (2019). 'EU inter-country Supply, Use and Input–Output tables — Full international and global accounts for research in input-output analysis

Graph I.4.11: **Severity of shortages vs. annual HICP inflation**



output database for the year 2019, applying the partial hypothetical extraction method. [48] This method allows for the estimation of spillovers across sectors and countries following a supply shortage. For illustration purposes, a supply shortage shock modelled as a 10% fall of intermediate inputs (either domestically produced or imported) was applied to 10 sectors previously identified as most affected by shortages. [49]

The simulations show that this shock entails a decline in EU value added of 1.5%, with a highly differentiated impact across Member States. Countries reporting the highest loss in value added, exceeding 2%, include Slovakia, Czechia, Slovenia, Poland and Germany. Importantly, cross-border spillover effects explain broadly one-fifth of the value added loss, highlighting the importance of intra-EU linkages in magnifying the shock.

Graph I.4.12 offers additional insights into sectoral composition of the spillovers effects. The shock to intermediate consumption in the 10 affected sectors would lead to a loss of value added of 7.5% in the manufacture of basic metals, mainly due to lower orders placed in the sector of metal products, machinery and equipment and motor vehicles. Similar effects can be observed in the sector of fabricated metal products, which suffers an estimated loss of 6.3%. Importantly, value added losses in the affected sectors come largely from order cuts outside of their own sectors. The exception is the manufacture of motor vehicles, which contributes significantly to losses in other sectors, but reports a loss of 3.4% mainly due to cuts within its own sector. [50]

(FIGARO)'. European Union, Publications Office of the European Union in Luxembourg.

[48] The hypothetical extraction method (HEM), widely used to measure inter-industry interconnectedness, consists of estimating the impact of a hypothetical (full or partial) loss of interlinkages of a particular sector (or a set of industries) with the remaining sectors of the economy. Dietzenbacher, E., van Burken, B. and Y. Kondo (2019). 'Hypothetical extractions from a global perspective'. *Economic Systems Research*, 31(4), 505-519

[49] Wood, Chemicals, Rubber and plastic, Non-metallic mineral, Metal Products, Computer, Electrical equipment, Machinery, Motor vehicles and Furniture.

[50] This sector also includes for motor vehicles the manufacture of bodies (coachwork); parts and accessories; electrical and electronic equipment; and other parts and accessories not elsewhere included.

Graph I.4.12: **Simulated reduction in value added due to a 10% fall in intermediate consumption of sectors most severely affected by shortages**