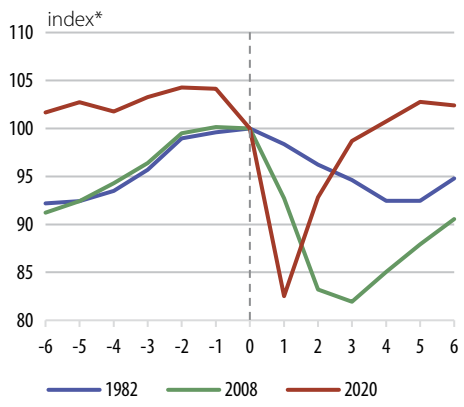
Box 1. The impact of the COVID-19 pandemic on global production chains and the repercussions on activity and inflation in Europe

The global economic recovery in the course of 2021 was hampered by global supply chain disruptions, putting a strain on the production of goods. In the euro area, real GDP growth in 2021 was chiefly supported by a rebound in services, with the progress in immunisation and the easing of restrictions, whereas industry and construction contributed to a lesser degree than in the previous year, particularly in 2021 H2, mirroring the limited access to commodities, equipment and intermediate goods. These divergent developments across sectors originate in the pandemic crisis that broke out in 2020 Q1. Thus, after the sharp fall in international trade in goods and services – the first restrictions in Europe becoming effective in March 2020 –, the subsequent increase was notable, world trade returning to pre-pandemic levels by October 2021 – a very rapid rebound compared with that from other economic crises, which put significant pressure on supply chains (Chart A). Apart from the higher-than-expected rise in demand, the smooth operation of supply chains was disrupted by pandemic-specific factors (such as the reintroduction of restrictions owing to the resurgence of COVID-19 infections or the shifts in consumer behaviour), as well as by the shock in energy markets starting in the summer of 2021. Under the circumstances, this box aims to identify and analyse the drivers of the disruptions in global value chains, as well as to reveal the effects on economic activity and prices, given that the role of international trade in the current economic environment has become even more significant[1].

Chart A
Trade patterns around global recessions: goods and services import volume



*) the goods and services import volume is normalised to 100 at the onset of the recession (t=0)

Source: IMF

Sources of value chain disruptions in 2021

Global supply chain disruptions have been the result of the interplay of several factors, which can be grouped into five main categories (ECB, 2021e): (i) strong rebound in global demand for manufacturing goods; (ii) supply shortages of specific semiconductors; (iii) logistical disruptions in the transport sector, primarily linked to container vessel activity; (iv) strict lockdown measures in some key Asian countries that produce intermediate inputs; (v) longer time needed to increase supply capacity of semiconductor production and of vessels.

In the initial phase of the pandemic-related crisis, European factories started to face difficulties because of the shutdowns at some suppliers operating in the Chinese regions affected by the spread of the virus. Subsequently, the mobility restrictions imposed in Europe led to trade bottlenecks or disruptions, resulting in a major economic contraction in 2020 Q2. The disruption spread along global value chains, its effects being compounded by the restrictions on the movement of persons,

[1] See Box 1 "The impact of COVID-19 on global value chains" in the NBR's 2020 *Annual Report*.

including logistics workers. Global value chains with a high degree of complexity were thus the hardest hit (Chart B).

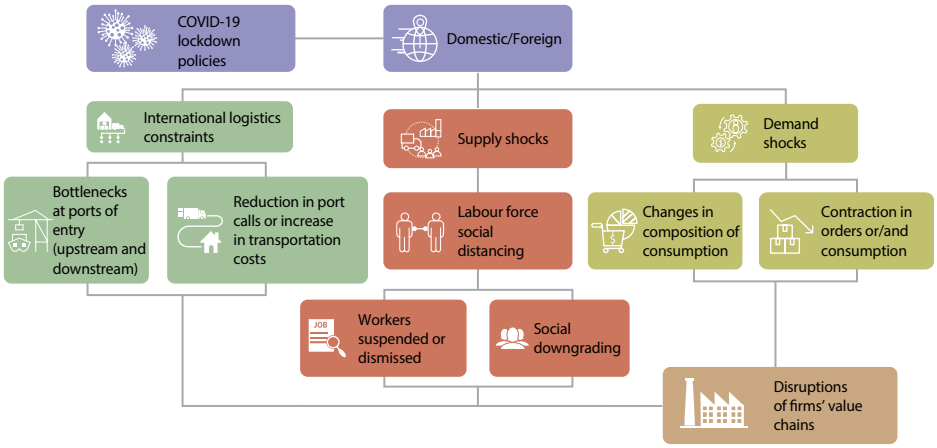


Chart B
Effects of COVID-19 lockdown policies on global value chains

Source: World Bank

This sharp economic downturn was followed by a rapid rebound in 2020 Q3, due particularly to industry, given the fiscal and monetary stimulus of significant magnitude. However, the speed of economic recovery caused problems in turn, triggering what may be considered a second supply chain crisis. Stimulus packages in advanced economies, the savings buffer and pent-up demand contributed to a robust rise in global consumption. At the same time, the shift of households' disposable income to purchases of durables, with the limited consumption opportunities in the market services sector, was an additional source of pressure. Many companies underestimated the scale of the recovery and did not make sufficient medium- and long-term orders to cope with the change in consumer preference. These circumstances overlapped with the depleted stocks, which owed partly to the "just-in-time" strategy[2], but also to the fall in production during lockdowns (ECB, 2021c). In addition, the temporary factory and port closures in the areas with lower vaccination rates (or with more contagious strains, particularly in Asia) and the substantial reduction in air traffic were other sources of bottlenecks, with cascading effects throughout the entire supply chain.

These deficiencies were mirrored in the delivery times, which hit historical highs, affecting almost all manufacturing sub-sectors. The Markit PMI surveys showed that shortages of material and equipment had limited production for about two in five European manufacturers, the highest proportion since records began in 1999 (ECB, 2021c). This context favoured the surge in global container shipping prices, given the limited capacity of ships and the fact that shipping lines cannot quickly increase their fleets in a meaningful way (Chart C). In addition, the overall shipping capacity was limited by delays at ports (with ships waiting for up to six days to dock

2 The "just-in-time" (JIT) inventory management system is a management strategy that minimises storage times, coordinating orders for commodities directly with production stages. Companies use the JIT technique to enhance their efficiency by cutting storage costs. This method requires manufacturers to forecast demand accurately, its secondary effect being a strategic logistics-related vulnerability.

in Rotterdam, the EU's largest port – similar or even worse situations occurring in the US), a shortage of containers, which were stuck at congested ports, as well as by the insufficient number of port workers and drivers[3] (ECB, 2021e). According to UNCTAD (2021), the average time spent by container vessels in ports in the first half of 2021 was 11 percent higher compared with the pre-pandemic average in 2018-2019.

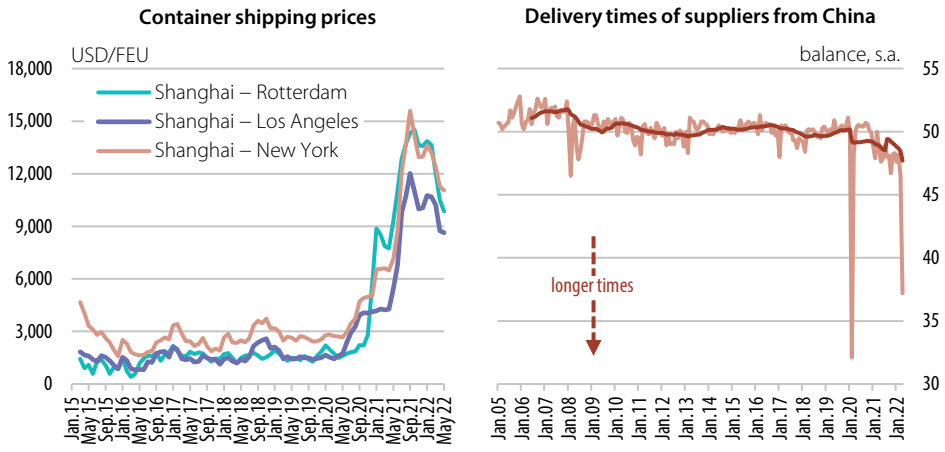


Chart C
Shipping

Source: World Container Index, China Federation of Logistics and Purchasing, Bloomberg

Against the backdrop of large swings in demand, starting in 2020 particular mention should be made of the so-called global semiconductor crisis, which affected a vast array of sectors and manufacturers, mostly the automotive industry and the manufacture of electronic products and household appliances. In this case, the effect of the pandemic overlapped with that stemming from a wider combination of circumstances, which refer to trade tensions between China and the US, the unusual cold snap in Texas at the beginning of 2021, which also caused power outages at semiconductor manufacturing plants, the drought in Taiwan[4] in 2021 and a fire at one of the chip plants in Japan (ECB, 2021b). In anticipation of lower demand at the onset of the pandemic, car producers around the world reduced their orders for semiconductor chips to minimise storage costs during the lockdown. On the other hand, being compelled to spend more time at home, consumers started to purchase or to install modern electronic equipment[5]. Consequently, when the economy returned to normal, the automotive industry faced a chip shortage, as semiconductor producers had already shifted their production to the durables manufacturing sectors, which were thriving.

Production capacity constraints in this case also have a significant idiosyncratic component, as semiconductor chip manufacturing is a difficult, time-consuming and expensive process. The semiconductor industry is currently dominated by only three producers: Taiwan Semiconductor Manufacturing Company (TSMC), Intel and

3 Difficulties reported especially by the road transport sector in the US with respect to labour.

4 Chip manufacturing requires large amounts of water and Taiwan, the biggest chip producer in the world, faced an over 18-month drought.

5 During this period, Sony released its new platform, PlayStation 5, with millions of pre-orders. In addition, the demand for graphics cards increased thanks to their being used in games, graphic production and cryptocurrency mining.

Samsung. The supply issues stemmed from the small number of manufacturers, with significant price effects amid the unexpected rise in demand. Pressures also mounted as several upstream industries swiftly embraced digital transformation, chip manufacturers and governments currently working together to expand the capacity of supply chains[6]. Before the outbreak of the Russia-Ukraine war, most signals from the industry indicated that it would take 12 to 18 months for the semiconductor market to achieve balance. Nevertheless, the recent political developments have brought new shocks, Russia and Ukraine being important suppliers of many intermediate goods[7] in the production chains of the chip manufacturing industry.

Another issue that exacerbated these supply bottlenecks in the course of 2021 was the reintroduction of restrictions following the spread of the Delta variant in some countries of the Asia-Pacific region (including Malaysia, Singapore, Thailand and Vietnam), which are key to the semiconductor chip production, also in conjunction with the lower access of some countries to mass vaccination. The last Omicron wave in China (in March-April 2022) significantly disrupted the activity in the region, including flows of goods. According to ECB surveys (2021b) in the private sector, both semiconductor foundry capacity and cargo vessel capacity are expected to remain low until 2023.

To sum up, the pressures on supply chains increased to unprecedented levels at the outbreak of the COVID-19 pandemic and, after a significant easing in 2020 H2, they mounted again during 2021 and reached a new peak at the end of the year (IMF, 2022). Transportation costs rose steadily until September 2021, when they declined moderately. In 2021, delivery times lengthened and indicators of future delivery times show that supply chain disruptions will persist over the medium term (ECB, 2022b). This assortment of factors generates significant macroeconomic risks, supply chain links playing a critical role in the transmission of shocks worldwide (ECB, 2022b).

Effects on activity and prices

Amid the disruptions that affected suppliers, the dynamics of industrial activity in the euro area were dampened, the slowdown in late 2021 reflecting largely the contraction in Germany's manufacturing sector. An IMF paper (Celasun *et al.*, 2022a,b) gauges the impact of demand versus supply factors on industrial production and inflation in a number of countries using a vector auto regressive model. The findings suggest that during 2021 supply-side constraints hindered the increase in industrial output despite the dynamic demand, while also boosting price growth. Thus, the euro area industrial production was on average approximately 2.5 percent below

6 For instance, TSMC will invest USD 100 million in the next three years to expand chip production capacity, while Samsung, SK Hynix and the government in South Korea vowed to invest USD 451 million for the same purpose.

7 The price of neon, a noble gas needed for the lasers used in chip manufacture, increased sixfold between December 2021 and March 2022 because of the COVID-19 pandemic and the Russia-Ukraine war. About half of the global supply of purified neon gas (the gas being a by-product of Russia's steel industry) comes from Ukraine. The supply of krypton and xenon, of which Ukraine is also a major exporter, was affected as well. Russia exports approximately 40 percent of the global supply of metal palladium, which is used in certain chip components, and the supply of palladium might be affected by the trade sanctions imposed by Western governments.

trend in the last six months of 2021, demand shocks pushing output around 5 percent above trend, while supply shocks pushed it by about 7.5 percent below trend, the latter reducing euro area output in 2021 H2 (Chart D). The study concludes that, as far as EU Member States are concerned, the supply shocks recorded in 2021 exerted a notable negative impact of 17 percent and 15 percent respectively on manufacturing production in Romania and Slovakia and of about 12.5 percent in Germany, Czechia and Hungary.

Supply shocks in conjunction with demand factors also boosted the increase in manufactured goods prices, the annual growth rate of the producer price index (PPI) in the euro area averaging about 12.5 percent in the latter half of 2021, substantially higher than the 1.5 percent average in 2017-2019. Estimates indicate that nearly half of this rise came from the change in the contribution of supply shocks, which had mostly exerted downward pressure on manufacturing prices in the pre-pandemic years (tantamount to -0.5 percentage points on average in the euro area in 2017-2019; Chart D). The contribution to the increase ascribable to supply shocks varies across countries, being estimated at approximately 50 percent for the euro area as a whole and for Germany, and at 60 percent for France. The estimate for Romania is over 70 percent, while the remaining share may be attributed to demand. Supply disruptions also had an impact on the inflation rate. The annual consumer price index (CPI) inflation excluding energy and food was about 1.4 percentage points higher in 2021 H2 than in the 2017-2019 reference period. Around half of this rise can be ascribed to supply constraints for manufactured goods. The smaller impact on core inflation is accounted for by the lower share of manufactured goods in the consumption basket.

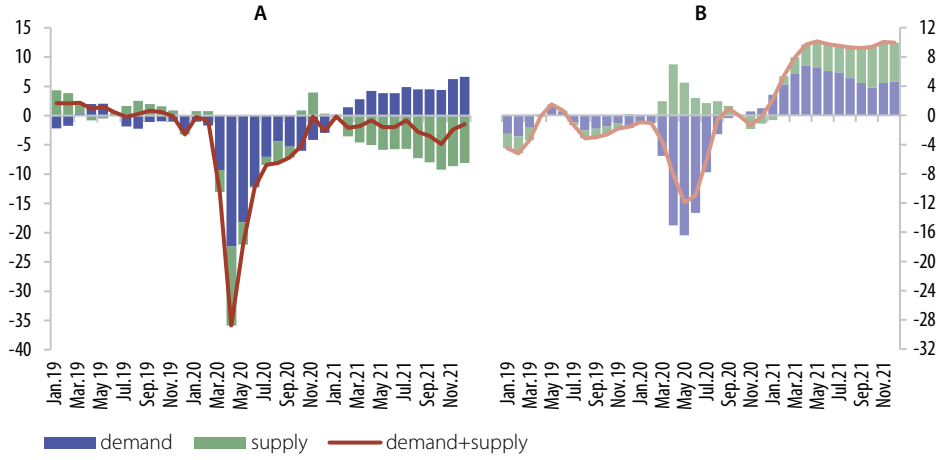


Chart D
Euro area: contributions to industrial production fluctuations (A) and contributions to manufacturing PPI fluctuations (B)

Source: IMF estimates, Celasun *et al.* (2022)

In October 2021, the IMF cut the global growth projection, citing supply disruptions as one of the main reasons, particularly for the advanced economies. In a similar way, in its Winter 2022 European Economic Forecast, the European Commission put this development down to the issues associated with global shipping, whereas in the *World Economic Outlook* of April 2022 the IMF forecast for global growth was revised downwards again, as a result of Russia's invasion of Ukraine and due to the

resurgence of the pandemic in China, events which acted as an additional drag on the smooth operation of cross-border production networks.

In addition, the question concerning the effects of such supply chain disruptions on potential growth was also raised. With the recent trade disputes[8], the literature had already begun to explore the re-setting of trade relations and its long-term impact on the economy, the pandemic crisis and the recent political developments accelerating the setting of the new coordinates. The long-term supply chain disruptions may compel companies to revise or postpone their investment plans and hence change the evolution of their capital stock. On the other hand, global firms may reconfigure and optimise their global value chains. Greater resilience associated with shorter supply chains and local access to strategic goods, together with the widespread implementation of digitalisation via the adoption of e-commerce, the extensive use of videoconferencing and robots, may structurally change the composition of trade flows (more towards services) and eventually have a positive impact on total factor productivity (ECB, 2022a).

In the more complex post-COVID-19 world, in which demand-side inflationary factors dominate the global macroeconomic landscape, the smooth flow of goods within production chains would have had a paramount role in the slowdown of price dynamics. Given that the expansion of supply chains had substantial disinflationary effects in the past, their disruptions additionally fuelled inflation, even jeopardising the post-pandemic economic recovery, with the normalisation of monetary policies and the change in the fiscal policy stance. At end-2021, industry experts expected the car supply shortage to largely dissipate by mid-2022. The Omicron wave and the Russia-Ukraine war generated new uncertainty, supply-side disruptions being likely to persist even into 2023.

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[8] See Box 1 "Revival of protectionism and its implications on global economic activity" in the NBR's 2019 *Annual Report*.

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