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Global supply chain disruptions:  
evolution, impact, outlook

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## Global supply chain disruptions: evolution, impact, outlook

### Key takeaways

- *Global supply chain disruptions (“bottlenecks”) have been easing gradually, albeit unevenly across sectors and regions. However, they remain significant relatively to the historical norm.*
- *The intricacies of today’s global value chains account for the persistence and severe macroeconomic impact of bottlenecks in spite of their recent easing. Highly concentrated sectors such as semiconductors are prime examples.*
- *While continued easing of bottlenecks – which should help moderate inflation – is the most likely scenario, there are upside risks to inflation from more protracted bottleneck-induced disruptions. Nor can new bottlenecks be ruled out.*

### Introduction

Supply chain disruptions that emerged in the wake of the pandemic have contributed to output disturbances and the burst of inflation globally. The reach, severity and persistence of supply chain disruptions have far surpassed previous episodes, and they have caught many observers by surprise. The future path of disruptions has first-order monetary policy implications, as it influences how quickly inflation can be brought back to target and at what macroeconomic cost.

### The evolution of bottlenecks

The widespread lockdowns in 2020 planted the first seed for today’s supply chain disruptions. The abrupt freeze in economic activity crimped supply and depleted inventories, forcing businesses to seek new supplier relationships and reroute supplies, while disrupting the smooth coordination of global production. Lockdowns also severed employee-employer matches in many cases. All this left the supply side of the economy in disarray and vulnerable to new shocks.

The strong rebound in global demand in 2021 ushered in the second, more severe phase of bottlenecks. The demand rotation away from services towards goods proved larger and more prolonged than anticipated, with supply often unable to cope. Critical inputs such as semiconductors became scarce, affecting the production of many downstream industries. As economies re-opened, the pent-up aggregate demand met a perfect storm of low inventories, a sluggish production restart, clogged logistics, labour shortages and supply-demand mismatches.<sup>1</sup>

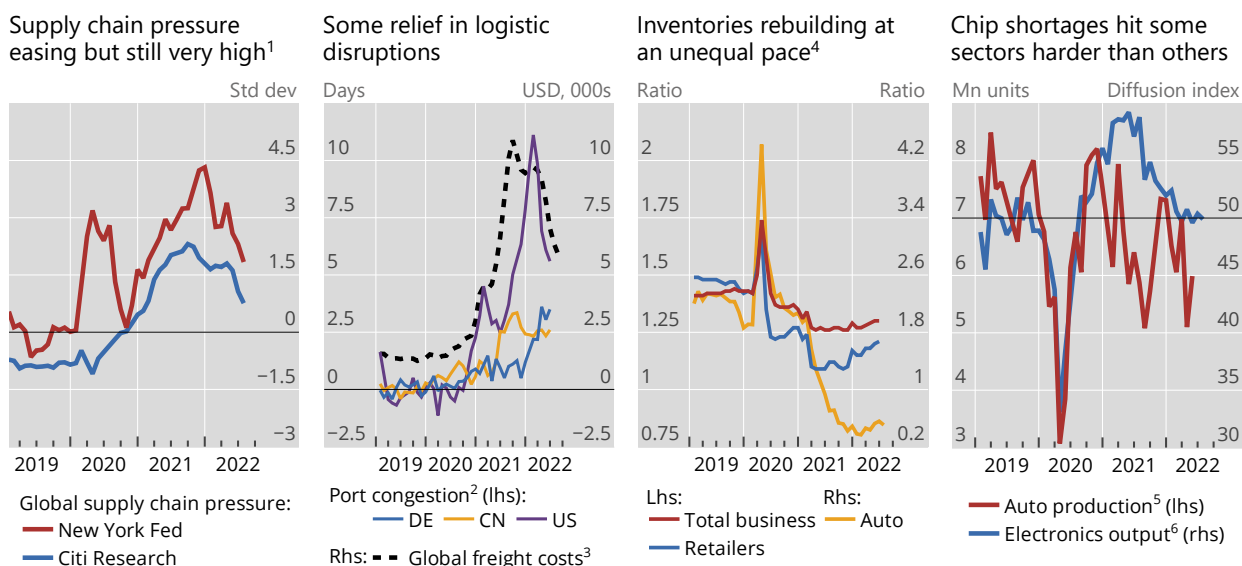
Most recently, the war in Ukraine and renewed lockdowns, notably in China, have led to a third phase of supply disruptions. The war has disrupted the global supply of food, raw materials and energy, posing risks particularly to European manufacturing. Lockdowns in major hubs, such as Shanghai, in the spring of

<sup>1</sup> See Rees and Rungcharoenkitkul (2021) for an early review.

2022 halted shipping and production of intermediate parts. At least so far and for most economies, this third phase appears less disruptive than previous ones, in part due to the more localised nature of disturbances and firms learning to adjust.

Pressures on global supply chains appear to have peaked in late 2021 (Graph 1, first panel), according to several aggregate indices.<sup>2</sup> Inventories have begun to normalise, as production has ramped up and aggregate demand moderated. Freight costs have halved from peak (second panel). Delivery times, particularly in advanced economies, have shortened.

Bottlenecks are slowly easing, but significant dislocations remain Graph 1



<sup>1</sup> Supply chain pressure indices summarise manufacturing and inventory indicators as well as transportation costs across a range of countries. <sup>2</sup> Travel time between ports relative to pre-pandemic baseline. See Komaromi et al (2022). <sup>3</sup> Freightos Baltic daily containerised freight rate index, monthly average. <sup>4</sup> Ratio of inventories to sales in the United States. <sup>5</sup> Car production data include passenger and commercial vehicles. <sup>6</sup> Purchasing managers' global manufacture of electronic equipment output.

Sources: Komaromi et al (2022); Federal Reserve Bank of New York; FRED; Bloomberg; Citi Research; IHS Markit; Refinitiv; BIS calculations.

Nonetheless, the easing has been slow and uneven across sectors and countries and significant dislocations remain. For instance, the current reading of the New York Fed global supply chain pressure index is almost 2 standard deviations above its pre-Covid average (Graph 1, first panel). In transport, port congestion has improved in the United States, stayed flat in China and worsened in Europe as a severe drought disrupted shipping through major waterways (second panel). In manufacturing, retail inventories reached their trough in early 2021, while in the worse-hit automobile sector inventories declined throughout 2021, and continue to be far outstripped by sales despite some rebuilding this year (third panel). Indeed, chip shortages still hamper auto production relative to consumer electronics (fourth panel), pointing to lingering demand-supply dislocations.

### Why so protracted? Propagators and amplifiers

One reason bottlenecks have caused such widespread and severe dislocations is their propagation and amplification through the global value chains (GVCs). Hence also the surprising persistence of bottlenecks:

<sup>2</sup> These indices combine various country-specific manufacturing indicators with global transportation costs. The New York Fed index (Benigno et al (2022)) also attempts to filter out demand effects to isolate pressures from the supply side.

any resolution not only requires the initial shocks to dissipate but also the dislocated GVC to heal or, in the extreme cases, new GVCs to be formed.

The GVC geography is one factor shaping this propagation and amplification. When disruptions hit sectors or countries that many others depend upon, the macroeconomic cascading effects tend to be larger. Indeed, the pandemic hit first and hardest many of the densely connected Asian and large European nodes. The reduction of EU energy imports from Russia in the wake of the war in Ukraine again points to disruptions in important nodes.

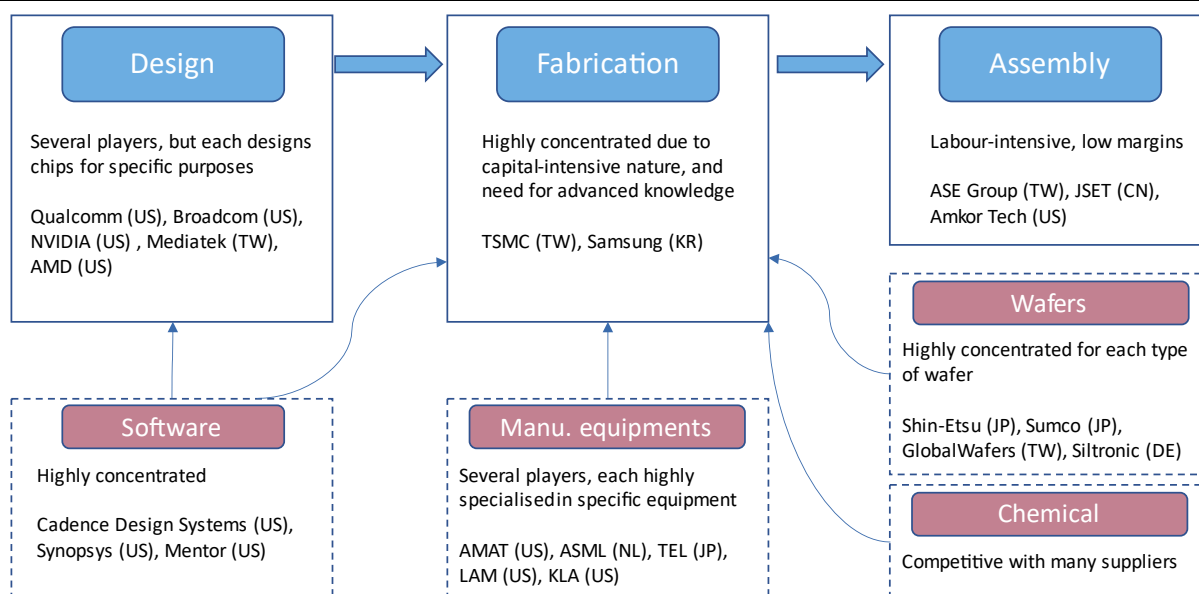
The second factor is technological. Disruptions to a GVC node are costlier if downstream producers cannot easily substitute missing inputs, raising the risk of bottlenecks. Conversely, when an input has few alternative uses, producers would have little leeway to redirect any excess supply, making gluts more likely.

The third factor is behavioural. Facing the risk of input shortages, some firms have taken precautionary measures to increase orders and run higher stocks than usual. But, in doing so, they have collectively aggravated bottlenecks. And once shortages ease, the overhang of excess inventories can lead to gluts. Such “bullwhip” effects can generate large volatility in production and prices. Symptomatic of these are the sharp swings in some commodity prices such as copper and aluminium and the piling up of inventories at key nodes and empty ship containers in some ports.

The semiconductor sector is a good example of how the combination of these factors have generated a potent amplification mechanism. The sector occupies a central node in GVCs, with numerous modern consumer products requiring chips as critical inputs. Moreover, its sub-industries are highly concentrated, due to high capital intensity and the expertise required (Graph 2 – see Annex for a detailed discussion). Indeed, very few players operate in key nodes such as design, fabrication and the upstream sectors of software, equipment and wafers. This means a disturbance to one layer can severely affect others. Technology-wise, many chips are highly customised and non-substitutable. And while they may make up only a small portion of total product value, their function can be so critical that any shortage could halt production lines (the automobile sector being a case in point). Lastly, precautionary hoarding behaviour explains the coexistence of persistent shortages of certain types of semiconductor with a glut in others.<sup>3</sup>

Semiconductor value chain: stylised network and key players

Graph 2



Source: BIS summary, based on Kleinhans and Baisakova (2020).

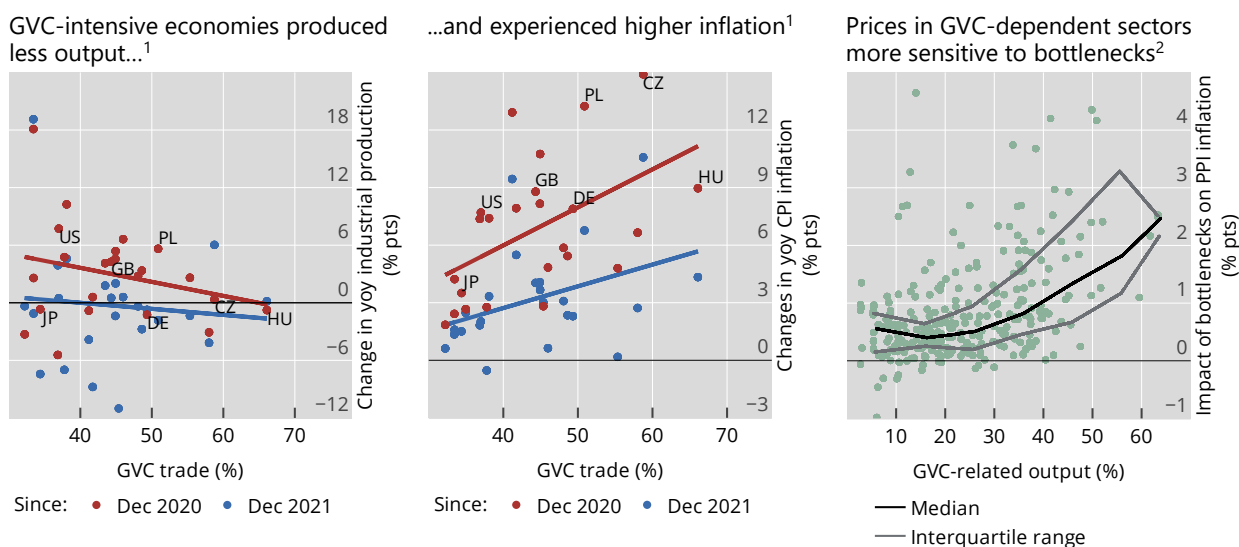
<sup>3</sup> See <https://reut.rs/3SV88BG>.

## From bottlenecks to inflation

The GVC amplification of bottlenecks sheds light on why price pressures and output impact are more severe in some cases than others. At the cross-country level, economies with a larger share of exports and imports in intermediate goods (indicative of GVC-intensive economies) have tended to see larger falls in industrial output and stronger increases in inflation recently (Graph 3, left-hand and centre panels). The downward shift and flattening of the relationships since end-2021 (blue lines) are consistent with some easing of bottlenecks discussed earlier.

GVC trade intensity associated with severity of recent stagflationary pressures

Graph 3



<sup>1</sup> "GVC trade" is value added trade crossing borders more than once, in percent of gross trade as of 2020. Data cover nine advanced economies and 16 emerging market economies. <sup>2</sup> Vertical axis indicates the coefficient of global supply chain pressure in the regression of the sectoral PPI inflation that also includes their lags and the lagged growth rates of real sales. "GVC-related output" relates to output crossing borders more than once, in percent of gross output as of 2020. The dots represent country-sector pairs for US and 14 countries in Europe.

Sources: World Bank, WITS; Refinitiv Datastream; national data; BIS calculations.

A more granular examination confirms the role of GVCs in propagating bottleneck-induced cost pressures across different sectors. For industries that are highly dependent on GVCs for inputs, PPI inflation has been more sensitive to bottlenecks (Graph 3, right-hand panel).<sup>4</sup> In addition, the influence of bottlenecks on PPI inflation rises more than proportionally with GVC intensity. A country-sector pair that is more deeply integrated with GVCs has been more exposed to shortages originating elsewhere.<sup>5</sup>

The implications for aggregate inflation depend on how much and how quickly these sectoral costs are passed on. The more GVCs propagate the incidence of bottlenecks, the more synchronised the increases in costs, and the easier it may be for firms to pass costs on to consumers. Overall PPI inflation has stabilised recently, consistent with signs of easing bottlenecks from more specific indicators such as inventories and delivery times. That said, the cost pressures remain elevated in the hardest-hit sectors, such as semiconductors and transportation (Graph 4, first panel).

To date, bottlenecks appear to have contributed considerably to the recent rise in consumer inflation. One piece of evidence is from a highly stylised statistical model featuring standard macroeconomic variables but complemented with a global supply chain pressure index and controlling for energy and

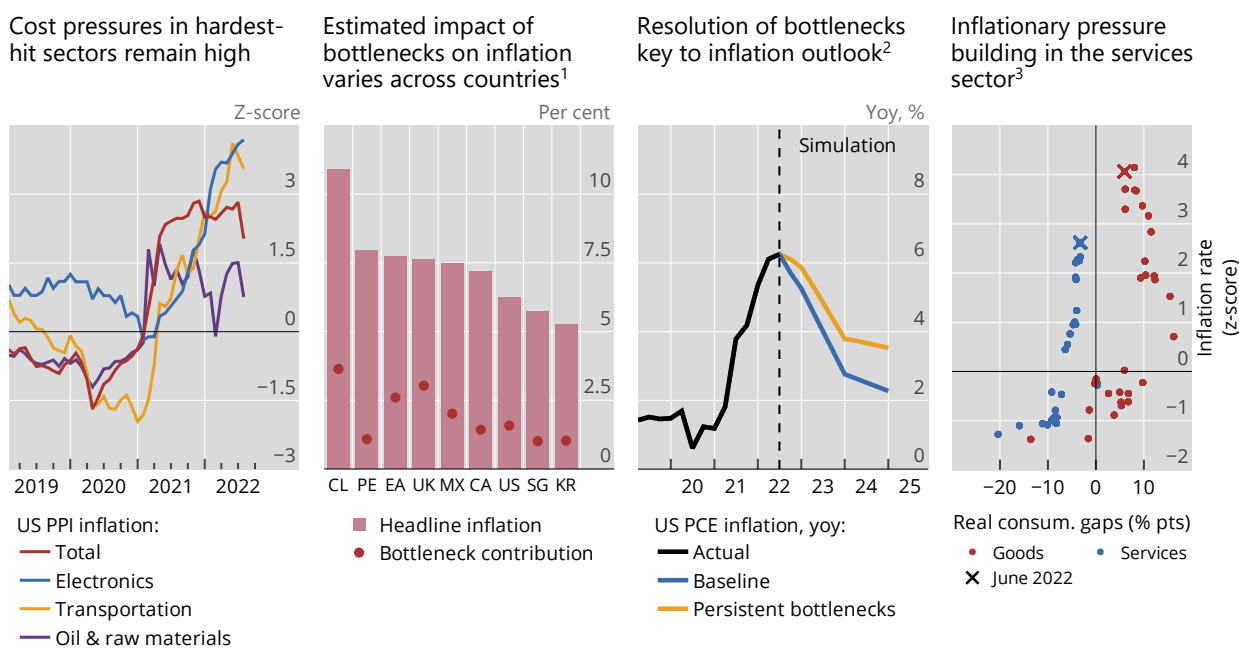
<sup>4</sup> Celasun et al (2022) attribute half of the rise in manufacturing PPI inflation in the euro area to supply bottlenecks.

<sup>5</sup> Cavallo and Kryvtsov (2022) exploit a micro data set in a sample of seven countries to document that unexpected shortages have significant inflationary effects within three months, with larger and more persistent effects in trade-intensive sectors.

food inflation separately (see Annex for details). The bottleneck indicator contributes significantly to the rise in the US PCE inflation, by more than 1.5 percentage points in Q2 2022 (Graph 4, second panel).<sup>6</sup> The estimated impact is similar, if somewhat greater, in other advanced economies such as the euro area and the United Kingdom. In emerging market economies, the effects are more varied, likely reflecting different inflation processes and, in some cases, the greater role of commodity prices in inflation surges.

## Persistent bottlenecks pose upside risks to inflation

Graph 4



<sup>1</sup> PCE inflation for the United States and CPI inflation for all others in Q2 2022. <sup>2</sup> Simulation of PCE inflation in the United States using a VAR model augmented by the New York Fed Global Supply Chain Pressure index (GSCPI). "Baseline" assumes that the GSCPI decays by 10% per quarter, and aggregate supply shocks are such that the PCE inflation forecast matches the median path of FOMC's projections as of September 2022. "Persistent bottlenecks" assumes the same aggregate supply shocks, but no changes in GSCPI." <sup>3</sup> The dot indicates monthly data for inflation rate and real consumption gaps in each sector from January 2020 to June 2022 in the United States. The trend that is used for the consumption gap is calculated by extrapolating the real consumption from January 2020 using the average monthly growth rate of real consumption in 2018–19. Inflation rate is normalised using the samples in the 1990–2022 period.

Sources: Federal Reserve Bank of St. Louis, FRED; Bloomberg; national data; BIS calculations.

## What comes next?

The same stylised model that helps us gauge the contribution of global supply chain pressures to the current surge in inflation also provides an indication of how sensitive the near-term inflation outlook is to the speed of bottleneck resolution. For instance, if bottlenecks continue to ease at a similar pace to the one seen this year and commodity prices stabilise gradually, US inflation is on track to moderate towards 2% by the end of 2024 in line with the latest FOMC median projection (Graph 4, third panel). In the case of lingering bottlenecks, and holding everything else constant, inflation could stay 1¼ percentage points higher at the end of the projection period.

While a gradual resolution of bottlenecks remains most likely, some risks stand out.

First, new supply shocks could arise. Renewed lockdowns, recent heatwaves, war and other geopolitical tensions serve as reminders that disruptions to supply chains can emerge abruptly and unexpectedly. The fact that global supply chains are already strained could amplify their impact.

<sup>6</sup> This is in the same ballpark as other studies that use structural approaches, eg di Giovanni et al (2022) estimate that supply chain bottlenecks explain around half of euro area inflation during the pandemic and about one third of US inflation.

Second, demand-side developments could also have an influence. The longer the persistence of the rotation from services to goods, the higher the likelihood that bottlenecks will continue. That said, a rapid rotation back to services could generate bottlenecks there. Tight labour market conditions in the services sector underline this risk. Indeed, there is some indication of price pressures building in the services sector, despite demand for services still lagging that for goods in many countries (Graph 4, right-hand panel).

Third, certain GVC segments may see faster shifts and realignments than under the central scenario of gradual adjustments. One trigger could be government policies. Indeed, geopolitical tensions have been on the rise, and a string of restrictive trade measures have been introduced since the pandemic.<sup>7</sup> In addition, businesses could accelerate reshoring efforts on their own accord to improve resilience and to take advantage of automation. Recent surveys indicate increasing corporate interests in reshoring options.<sup>8</sup> While promising longer-term resilience, such a change to the GVC structure could slow down the resolution of bottlenecks.

Should these risks materialise, the impact could be particularly disruptive given other supply side headwinds already at work.<sup>9</sup> One is labour shortages in some sectors, a problem that precedes pandemic-induced changes in worker preferences but has been aggravated by them. While the shortage of truck drivers is an example, soaring job vacancy rates in major economies point to broader mismatches. Another headwind is limited incentives to invest in fossil fuel energy given the climate change agenda. Fossil fuel energy investment has halved in less than a decade, which could limit energy supply and its responsiveness to any renewed bottlenecks. Owing to these headwinds, relatively small disturbances could cause bottlenecks with macroeconomic consequences.

## References

Benigno, G, J Di Giovanni, J Groen and A Noble (2022): "A new barometer of global supply chain pressures", Federal Reserve Bank of New York, Liberty Street Economics Blog, January 4.

Carstens, A (2022): "A story of tailwinds and headwinds: aggregate supply and macroeconomic stabilisation", speech at Federal Reserve Bank of Kansas City Jackson Hole symposium, August.

Cavallo, A and O Kryvtsov (2022): "What can stockouts tell us about inflation? Evidence from online micro data", *NBER Working Paper Series*, no 29209, September.

Celasun, O, N Hansen, A Mineshima, M Spector and J Zhou (2022): "Supply bottlenecks: where, why, how much and what next?", *IMF Working Papers*, no 2022/031.

Di Giovanni, J, S Kalemli-Özcan, A Silva and M Yildirim (2022): "Global supply chain pressures, international trade and inflation", ECB Forum on Central Banking, Sintra, June.

Kleinhans, J and N Baisakova (2020): "The global semiconductor value chain: A technology primer for policy makers", Stiftung Neue Verantwortung, October.

Komaromi, A, D Cerdeiro and Y Liu (2022): "Supply chains and port congestion around the world", *IMF Working Papers*, no 2022/059.

Rees, D and P Rungcharoenkitkul (2021): "Bottlenecks: causes and macroeconomic implications", *BIS Bulletin*, no 48.

<sup>7</sup> The US CHIPS+ Act and European Chips Act are examples of governments' attempts to promote a relocation of the semiconductor industry via financial incentives. The recent US Inflation Reduction Act also aims to phase out components in EV batteries coming from countries without a free-trade agreement with the United States by 2024/25.

<sup>8</sup> See <https://bloom.bg/3Q3pqdW>.

<sup>9</sup> See Carstens (2022).



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