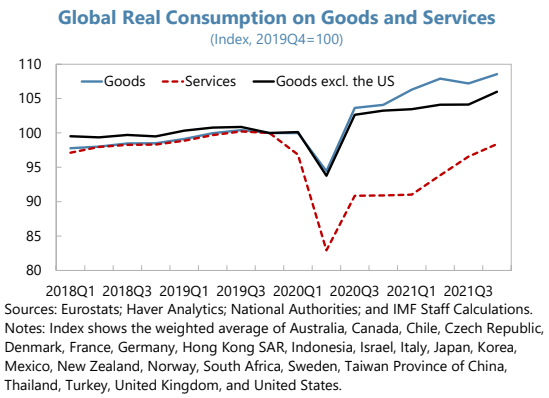
SUPPLY BOTTLENECKS IN 2021: THE CASE OF SLOVAKIA[1]

With a shift in global consumer spending towards goods, shortages of inputs and labor and logistical bottlenecks, supply bottlenecks were a prominent feature of the 2021 economic landscape, slowing the pace of the recovery and pushing up inflation. Using an empirical approach to quantify the impact of supply and demand shocks, this selected issue paper finds that supply shocks had a particularly pronounced effect in Slovakia, exerting a sizable drag on industrial production, and contributing significantly to producer price inflation. We find that in 2021H2 in Slovakia, manufacturing output would have been 15 percent higher and 60 percent of the increase in manufacturing producer price inflation would not have occurred in the absence of supply bottlenecks. The greater vulnerability of the Slovak economy to supply bottlenecks is consistent with its sizable auto sector, specialization in downstream activities, and high degree of integration into global value chains (GVCs). The findings suggest that Slovakia remains highly exposed to supply shocks if the disruptions experienced in 2021 were to persist in 2022 or be amplified by the war in Ukraine.

A. Introduction

1. The recovery from the pandemic was associated with a notable shift in the consumption patterns. As economies began reopening in the second half of 2020, demand for goods rose significantly (Figure 1), likely reflecting a multitude of factors: repressed spending on contact-intensive services, higher demand for goods that help people work, learn, and play at home, and keep safe distances. The strong rebound in retail sales after each pandemic wave in Slovakia is in line with the global trend.

Figure 1. Slovak Republic: The Shift in Consumer Spending



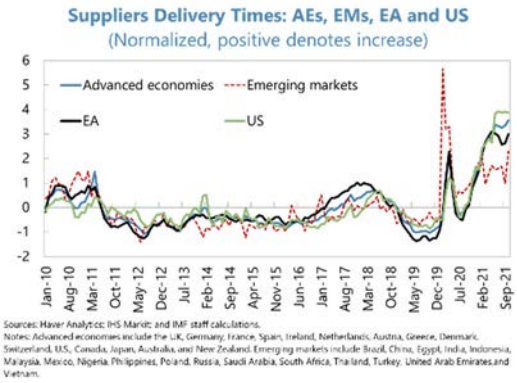
Sources: Eurostats; Haver Analytics; National Authorities; and IMF Staff Calculations.
Notes: Index shows the weighted average of Australia, Canada, Chile, Czech Republic, Denmark, France, Germany, Hong Kong SAR, Indonesia, Israel, Italy, Japan, Korea, Mexico, New Zealand, Norway, South Africa, Sweden, Taiwan Province of China, Thailand, Turkey, United Kingdom, and United States.

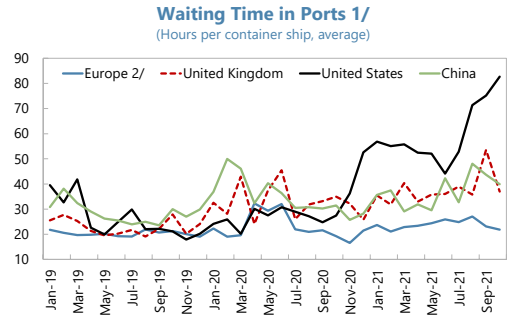
Sources: Haver Analytics; National Authorities; and IMF staff calculations.

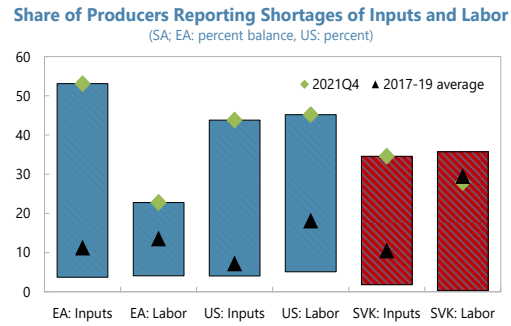
[1] Prepared by Mariano Spector. The selected issues paper draws on Celasun, Hansen, Mineshima, Spector and Zhou (2022).

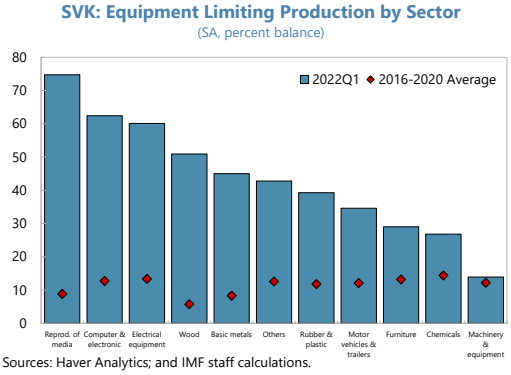
2. While demand for goods rebounded, shortages of inputs and labor, and logistical bottlenecks, constrained supply. The fraction of firms reporting shortages of inputs rose to historical highs in 2021:Q4, both in Slovakia, the Euro Area and the United States. Reports of labor shortages have also increased sharply, although in Slovakia this indicator remains below its 2018 peak, suggesting that the labor market is not as tight as in other Euro Area countries. Global delivery delays and port congestion also indicate that global logistical chains were severely strained. A wide range of industrial sectors have been impacted by limited inputs, albeit with different intensity.

Figure 2. Slovak Republic: Delivery Times, Input, and Labor Shortages



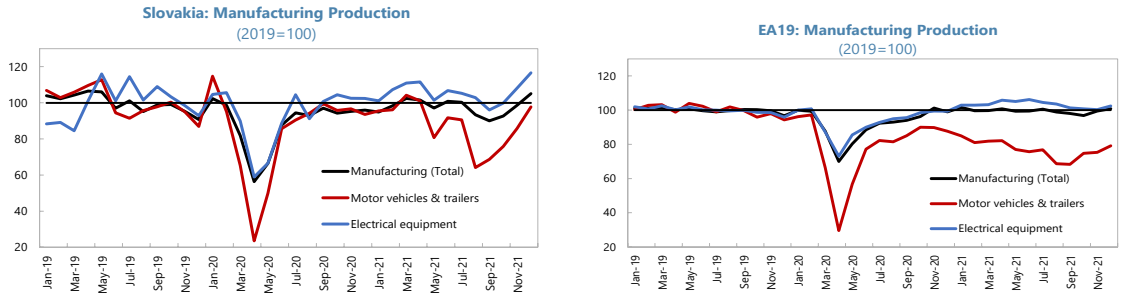






3. The auto sector has been particularly affected by supply shortages. Both in the Euro Area and in Slovakia, motor vehicles production experienced a sharper contraction in the second half of 2021 than other industrial sectors. This was in large part due to global bottlenecks in the supply of semiconductors, which are a crucial input for car manufacturing. As a consequence of the semiconductor shortage, Slovak car manufacturers were forced to suspend production shifts on several occasions during 2021.

Figure 3. Slovak Republic: Manufacturing Production: Slovakia and the Euro Area



Sources: Haver Analytics and IMF staff calculations

4. In a context of strong demand and constrained supply, inflation surged at the end of 2021. Amid soaring international shipping costs and energy prices, higher costs of inputs and labor shortages, manufacturing PPI inflation has accelerated sharply in 2021H2. In this period, manufacturing PPI inflation was about 10 percentage points higher than the 2017–19 average in the Euro Area and the United States, and 11 percentage points higher in Slovakia. A large and sustained rise in costs due to bottlenecks can harm the recovery, both by lifting consumer prices and cutting into households' purchasing power, and indirectly by leading central banks to tighten monetary policy sooner to prevent inflation and inflation expectations from shifting above target.

5. Given its industrial structure, the Slovak economy is highly exposed to supply disruptions. Among EU countries, Slovakia is one of the most highly integrated into GVCs, with its output relying to a larger extent on foreign intermediate inputs and thus increasing the economy's vulnerability to disruptions in global supply chains. Furthermore, the Slovak industrial sector tends to participate in the downstream stages of production, thus being exposed to disruptions in upstream suppliers. Finally, the outsize share of the auto sector in Slovak manufacturing further implies a large exposure to semiconductor shortages.

B. Analytical Framework and Findings

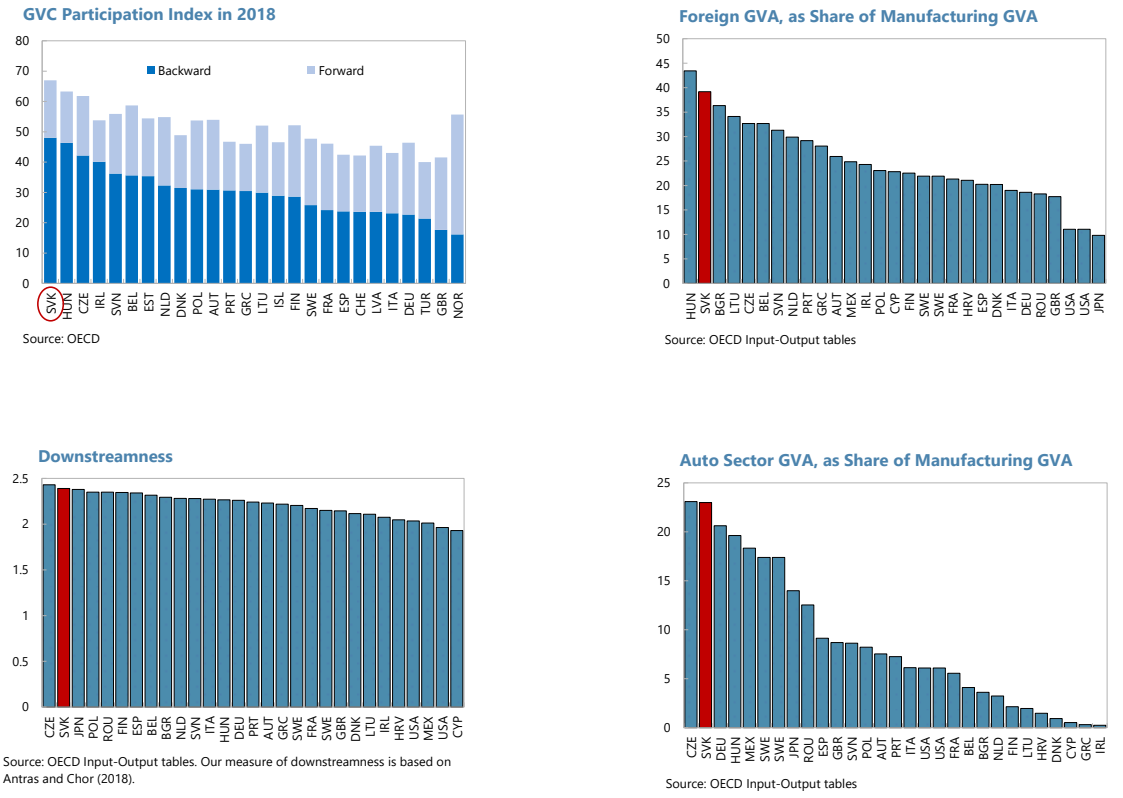
6. To quantify the relative contribution of supply and demand shocks on industrial production and producer price inflation, we use a sign-restricted Vector Auto Regression (SVAR) approach. The identification assumption is that demand shocks induce output (IP_t) and prices (PPI_t) to move in the same direction, whereas supply shocks lead them to move in opposite directions:

$$\begin{pmatrix} IP_t \\ PPI_t \end{pmatrix} = \begin{pmatrix} + & - \\ + & + \end{pmatrix} \times \begin{pmatrix} demand\ shock_t \\ supply\ shock_t \end{pmatrix}$$

The index *t* is time in months. Manufacturing output (the manufacturing component of the Industrial Production index) is used as the output measure and is expressed as a log difference from a

quadratic trend.[2] The price measure is the growth (annualized, in log) of the manufacturing PPI during the last 3 months up to month *t* relative to the previous 3 months.[3] All variables are in monthly frequency, seasonally adjusted, and the sample period is January 2001 to December 2021.[4] As depicted in Figure 5, Slovak manufacturing production has remained below trend since the start of the pandemic until the end of the sample period, having experienced a massive contraction in 2020H1. In 2021H2 again, there was a significant contraction in manufacturing production as supply chain disruptions became more acute. During 2020, PPI displayed deflation. However, it accelerated sharply in 2021H2 reaching historical highs (within our sample period).

Figure 4. Slovak Republic: GVC Participation, Downstreamness, and Auto Sector in a Cross-Country Perspective

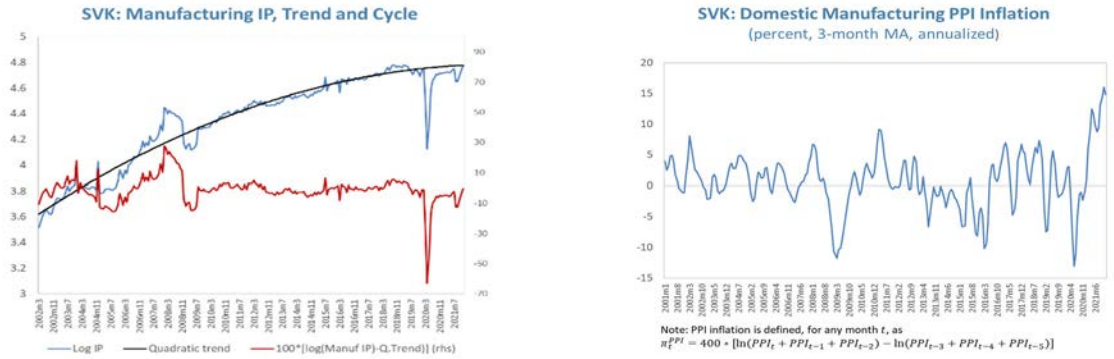


[2] The quadratic trend is computed using data only up to December 2019, so it is not affected by developments after the start of the pandemic. The results of the analysis do not change significantly if the trend is computed using the whole sample period.

[3] PPI inflation is calculated as $\pi_t^{PPI} = 400 * [\ln(PPI_t + PPI_{t-1} + PPI_{t-2}) - \ln(PPI_{t-3} + PPI_{t-4} + PPI_{t-5})]$. Using this three-monthly inflation measure helps smooth the noise in monthly data and avoid the strong base effects present in a twelve-monthly measure. To check robustness, we also estimate the model with month-on-month and 12-month inflation rates. Although the IRFs do change shape with the alternative inflation measures (since the sign restrictions are imposed on different compositions on months in each of them), the estimated impacts of supply shocks on output and inflation during 2021 do not change significantly.

[4] We performed the analysis for all EU countries and some selected large non-EU economies, expanding significantly the sample of countries covered in Celasun et al (2022).

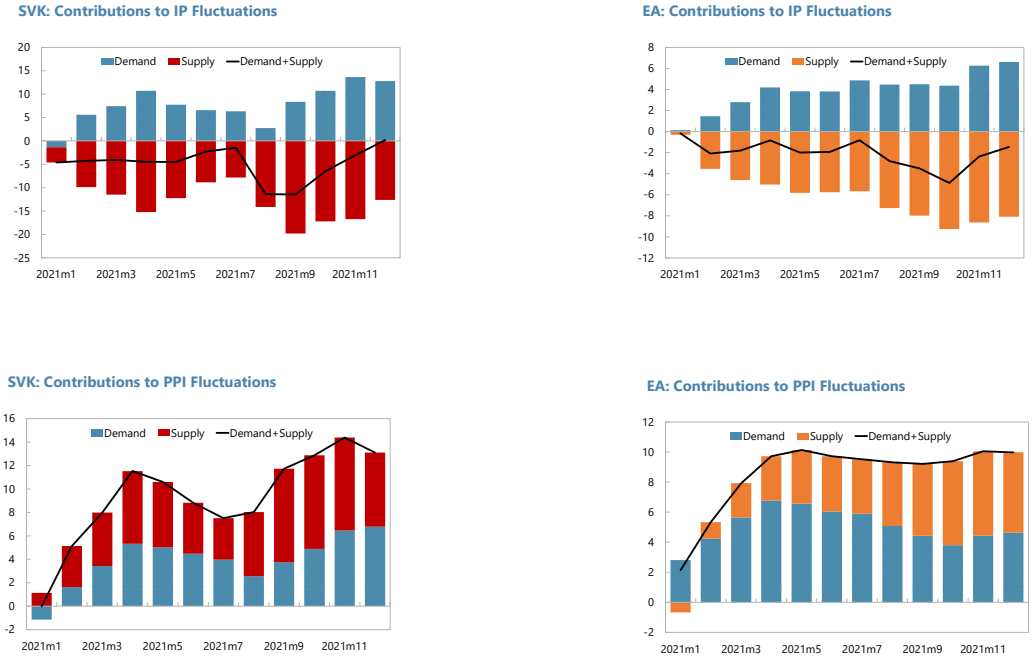
Figure 5. Slovak Republic: Manufacturing Output and Producer Prices in Slovakia



Sources: Haver Analytics and IMF staff calculations

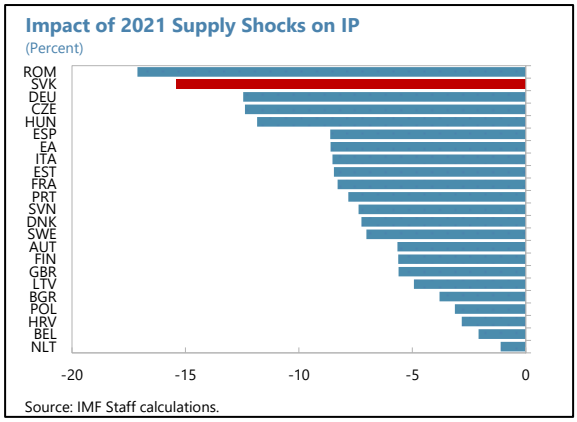
7. The analysis suggests that during 2021H2, in Slovakia, sizeable supply shocks have more than offset the boost to output from higher demand. Figure 6 displays the historical decomposition of shocks for both Slovakia and the Euro Area. During 2021H2 there have been sizeable demand and supply shocks, and the latter have been large enough to lower production despite the boost coming from strong demand. Both types of shocks have contributed to the sharp acceleration in PPI inflation.

Figure 6. Slovak Republic: Decomposition of Demand and Supply Shocks in 2021: Slovakia vs Euro Area

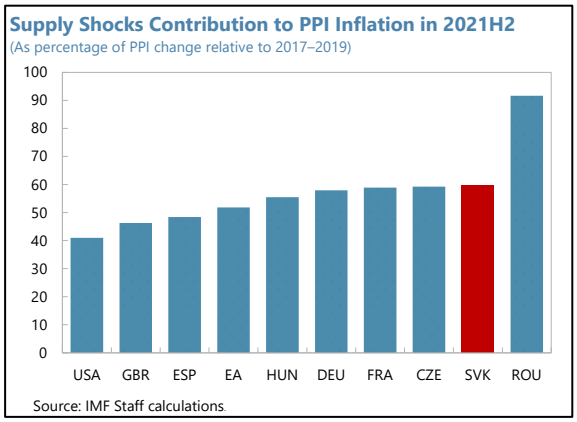


Source: IMF Staff calculations.

8. The drag of the 2021 supply shocks on manufacturing output has been large in Slovakia relative to other countries. Manufacturing IP in Slovakia during 2021H2 would have been 15 percent higher in the absence of supply shocks, while in the Euro Area it would have been 9 points higher. According to these estimates, Romania, Slovakia, Czechia, Germany, and Hungary were amongst the most severely affected countries, consistent with the deepening of supply disruptions in the automotive sector due to semiconductor shortages.



9. The contribution of supply shocks to PPI inflation has been sizeable, but there is still a large fraction explained by demand. The chart displays the supply shocks' contribution to PPI inflation during 2021H2, expressed as a percentage of the increase in inflation relative to the 2017–2019 average. While this estimated contribution is sizeable (about 60 percent in the case of Slovakia), there is also a significant role left for demand shocks.



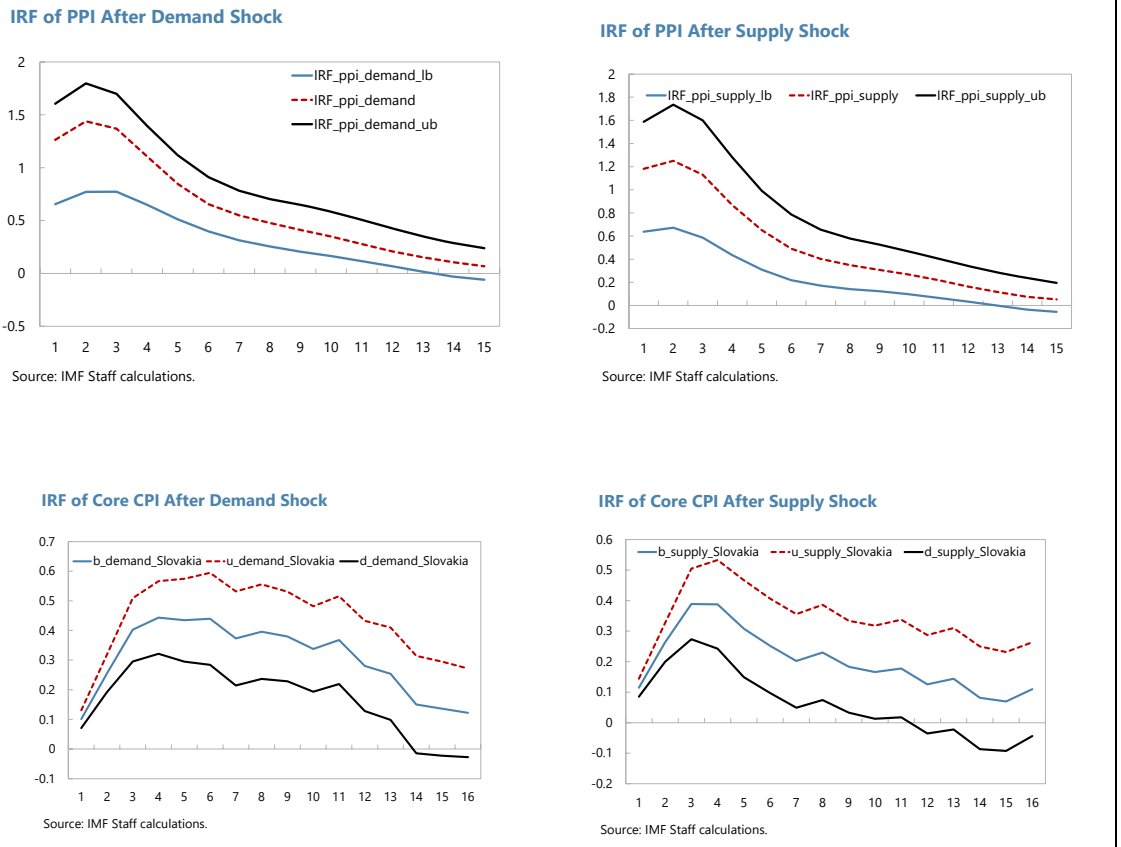
10. The supply and demand shocks driving manufacturing PPI inflation have a measurable but relatively small pass-through to core CPI inflation. To examine whether these supply shocks have led to an increase in core CPI inflation, we estimate a local projection model, using the following specification:

$$\pi_{t+h}^{CPI} = \beta_h^d * demand_t + \beta_h^s * supply_t + \delta^h X_t + \varepsilon_t^h$$

where π_{t+h}^{CPI} is core CPI inflation (calculated in an analogous way to PPI inflation) and $demand_t$ and $supply_t$ are the demand and supply shocks derived from the SVAR. The estimated values of $\{\beta_h^d\}_h$ and $\{\beta_h^s\}_h$ underpin the impulse-response functions (IRFs) of interest, which are displayed in Figure 7. The peak impact of a "one-standard deviation" demand shock on PPI inflation is approximately 1.5 percentage points.[5] Meanwhile, the impact of the same shock on core CPI is smaller, peaking at about 0.4 percentage points. Turning to supply shocks, the impacts on inflation peak at similar values as with demand shocks, and the pass through to core CPI is again partial. As goods make up only a subset of the CPI basket, it is not surprising that the shocks driving manufacturing PPI have relatively muted effects on the overall core CPI index.

[5] Given that we calculate inflation over a three-month rolling window, the fact that the IRFs peak about 3 months after the shock indicates that monthly inflation is highest on impact and then declines.

Figure 7. Slovak Republic: Impact of Supply Shocks on PPI and Core CPI Inflation in Slovakia
(on average during Jan-Sep 2021)



11. Supply shocks have tended to be larger in countries with a large auto sector, high integration in GVCs and downstream industrial production. As seen in Figure 8, countries have been impacted with different intensity by supply disruptions. One reason for this diversity is likely to be the differing composition of manufacturing across countries, since some subsectors could be more vulnerable to disruptions than others. In Figure 8, we explore this hypothesis by estimating simple linear regressions of the supply shocks uncovered by the SVAR[6] and three characteristics of countries' industrial structures:

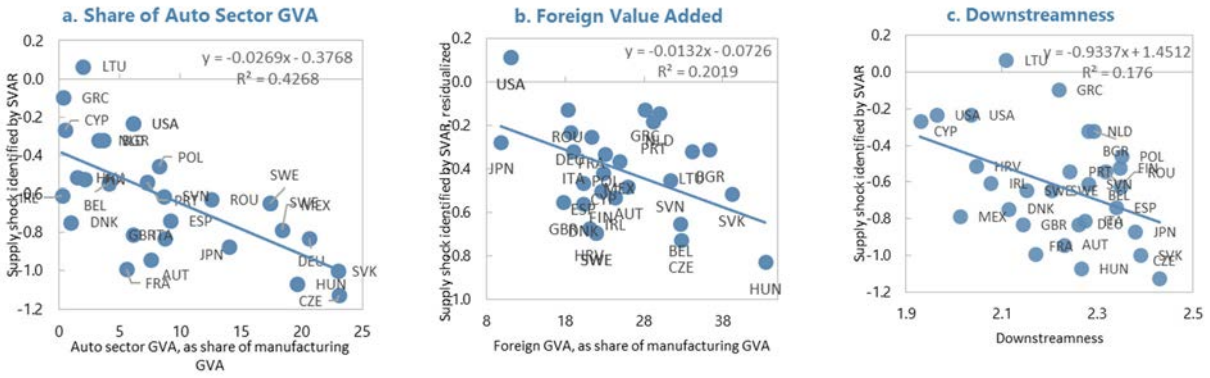
- **The size of the auto sector**: supply shocks are positively correlated with the size of the auto sector, as captured by the share of auto sector GVA in total manufacturing GVA. This is consistent with the severe impact on the auto industry of the global shortage of semiconductors.

[6] We use the average supply shocks over the period 2021H2.

- **GVC integration:** supply disruptions[7] were larger in countries with a higher degree of integration into GVCs, as measured by the share of foreign GVA in manufacturing (GVA/gross output). This result seems intuitive, as countries more integrated into GVCs would be more exposed to global disruptions in logistics and transportation.

- **Downstreamness:** finally, supply disruptions were larger in countries whose industrial production is more concentrated in downstream stages of production, as measured by the *downstreamness* indexed proposed by Antràs and Chor (2018). Intuitively, this suggests that more downstream industries have been more highly exposed to disruptions in upstream suppliers.

Figure 8. Supply Shocks and Industrial Characteristics



Source: Celasun et al. (2022), "Supply Bottlenecks: Where, Why, How Much and What Next?"

C. Takeaways and Policy Implications

12. Supply constraints have played a sizeable role in hindering the recovery in Slovakia in 2021 and fueling manufacturing price inflation. During 2021, the estimated boost to output from the recovery in demand was more than offset by supply shocks. Supply shocks can also explain 60 percent of the increase in producer prices in Slovakia in 2021. The output drags were largest in countries with large auto sectors, high integration into GVCs and where manufacturing firms operate at the downstream end of supply chains. This suggests that Slovakia, given its industrial structure, remains highly exposed to supply shocks if the disruptions experienced in 2021 were to persist in 2022 or be amplified by the war in Ukraine.

13. Strengthening resilience to disruptions in supply chains would be an important priority going forward. While there have been increasing calls to reduce dependence on foreign suppliers to reduce vulnerabilities (Javorcik 2020), many have argued that such proposals are premature and misguided (Baldwin and Freeman 2021; Antràs 2021; OECD 2021; Miroudot 2020; Eppinger and others 2021), given the sizable benefits from trade, specialization and integration in

[7] In this case, we residualize the supply shocks from the effect of domestic shutdowns. See Celasun et al. (2022) for details.

global value chains over the past decades. Indeed, as demonstrated by IMF (2022), resilience to cross-border supply shocks can be increased with greater input source diversification (using more foreign inputs) and greater input substitutability (across suppliers).[8] Policymakers could help by providing a supportive environment for firm-level measures to enhance GVC resilience, for example, by helping to resolve informational externalities, which could help firms make more strategic decisions (IMF, 2022).[9] Reducing trade costs and trade policy uncertainty can also help boost diversification in inputs (Handley and others 2020; OECD 2021).

[8] For example, after the Tohoku earthquake, Toyoto took significant steps to increase diversification and substitutability, by standardizing some components across vehicle models to enable global sharing of inventory and flexibility in production across various sites, building a comprehensive database of its suppliers and parts held in inventory, regionalizing its supply chains to avoid depending on a single location, and asking its single-source suppliers to disperse production of parts to multiple locations or hold extra inventory (see IMF 2022 and APEC 2021)

[9] The average automobile manufacturer has about 250 Tier 1 suppliers and over 18,000 suppliers in the full value chain, making it hard for firms to have full visibility (Baumgartner, Malik, and Padhi 2020).

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