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SLOVAK REPUBLIC

SELECTED ISSUES

July 2022

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SLOVAK REPUBLIC

SELECTED ISSUES

June 13, 2022

Approved By
European Department

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CONTENTS

FIGURES

TABLES

ANNEXES

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

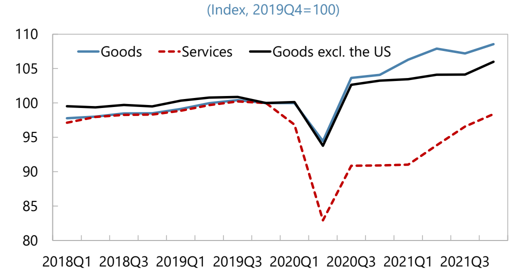
With a shift in global consumer spending towards goods, shortages of inputs and labor and logistical bottlenecks, supply bottlenecks were a prominent feature of the 2021 economic landscape, slowing the pace of the recovery and pushing up inflation. Using an empirical approach to quantify the impact of 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.

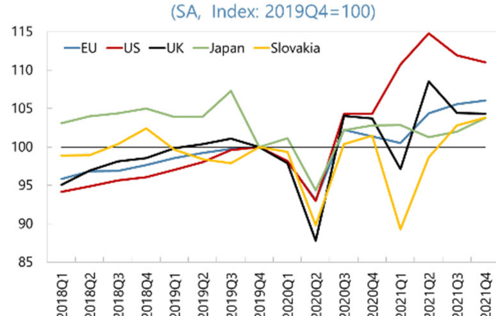
Figure 1. Slovak Republic: The Shift in Consumer Spending

Global Real Consumption on Goods and Services
(Index, 2019Q4=100)



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.

AEs: Real Retail Sales for Selected Economies
(SA, Index: 2019Q4=100)



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

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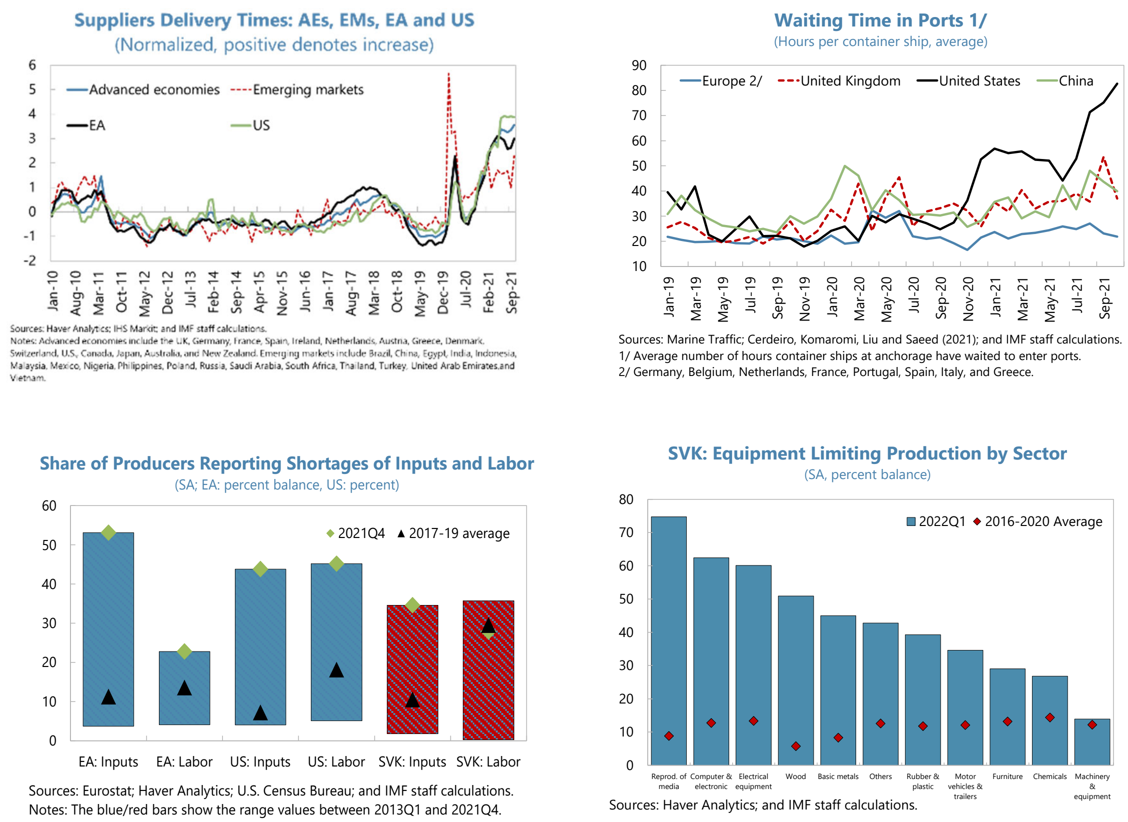
[1] Prepared by Mariano Spector. The selected issues paper draws on Celasun, Hansen, Mineshima, Spector and Zhou (2022).

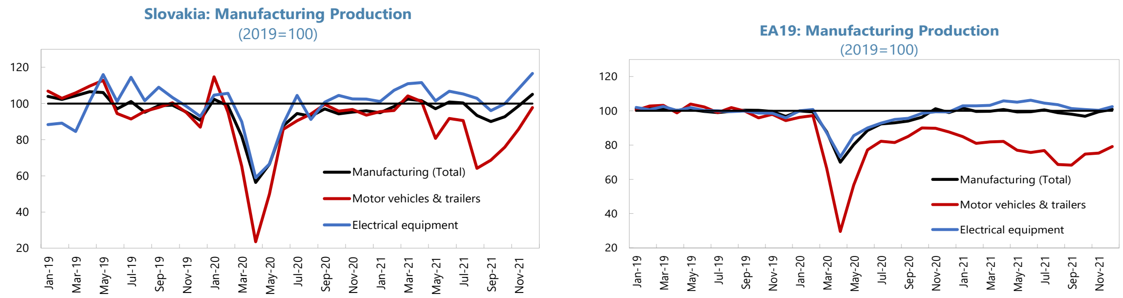
2. While demand for goods rebounded, shortages of inputs and labor, and logistical bottlenecks, constrained supply. The fraction of firms reporting shortages of inputs rose to historical highs in 2021:Q4, both in Slovakia, the Euro Area and the United States. Reports of labor shortages have also increased 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.

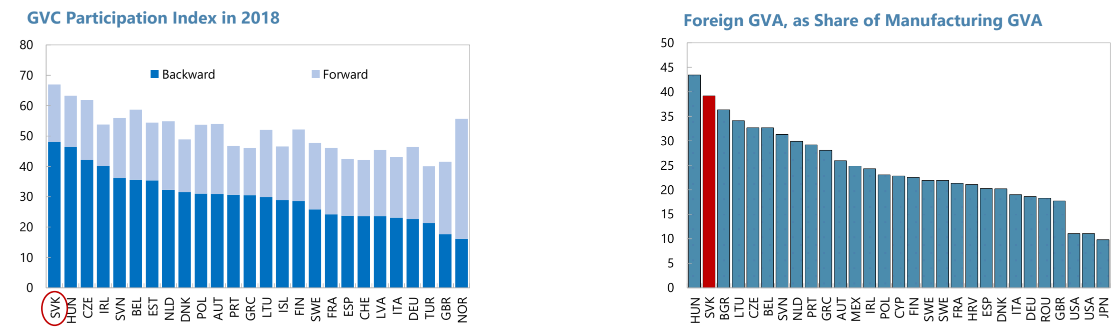
B. Analytical Framework and Findings

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



Source: OECD

Source: OECD Input-Output tables

Source: OECD Input-Output tables. Our measure of downstreamness is based on Antras and Chor (2018).

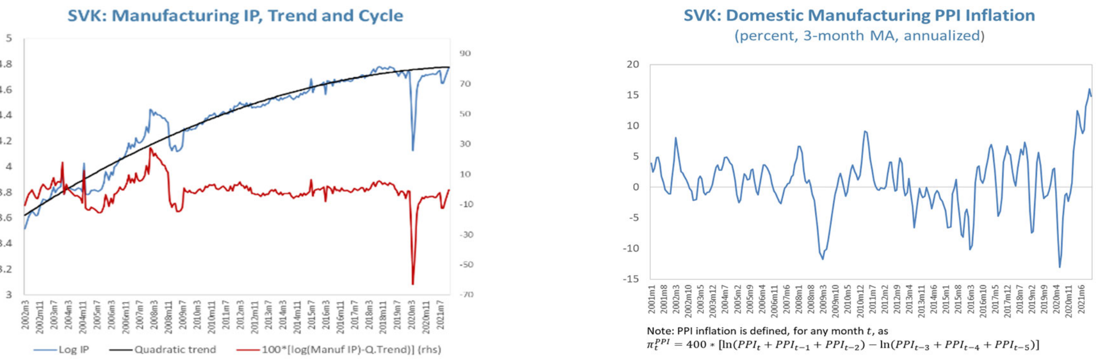
Source: OECD Input-Output tables

[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).

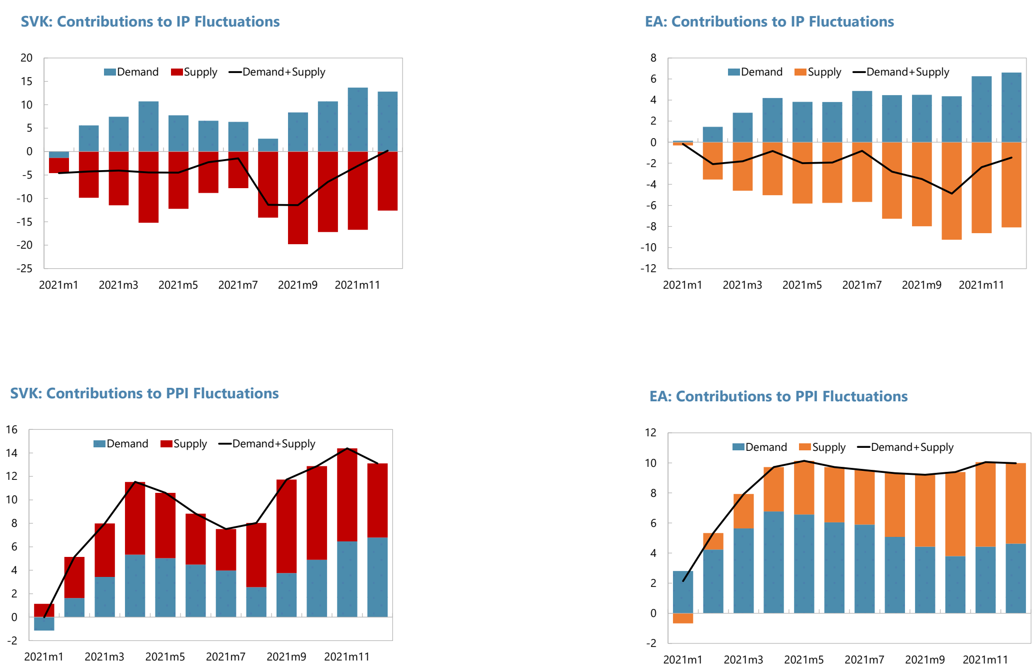
Figure 5. Slovak Republic: Manufacturing Output and Producer Prices in Slovakia



Sources: Haver Analytics and IMF staff calculations

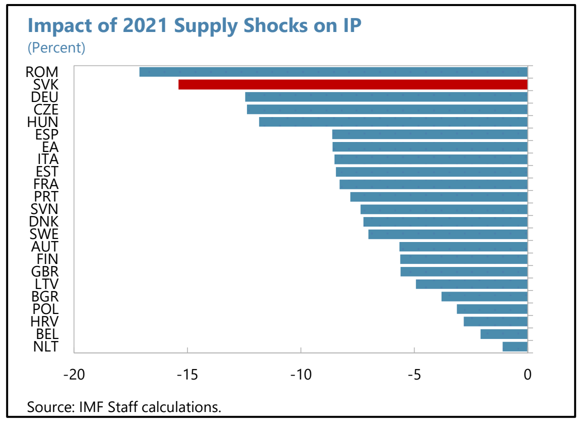
7. The analysis suggests that during 2021H2, in Slovakia, sizeable supply shocks have more than offset the boost to output from higher demand. Figure 6 displays the historical decomposition of shocks for both Slovakia and the Euro Area. During 2021H2 there have been sizeable demand and supply shocks, 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

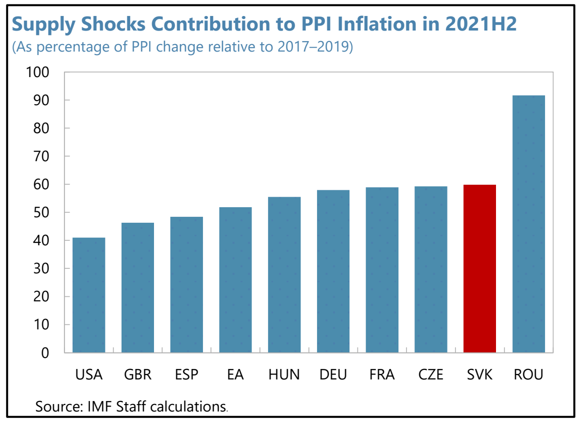


Source: IMF Staff calculations.

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:

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

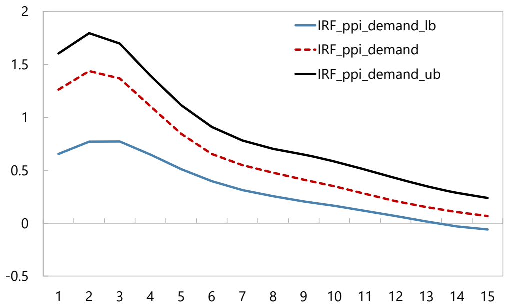
where π_{t+h}^{CPI} is core CPI inflation (calculated in an analogous way to PPI inflation) and $demand_t$ and $supply_t$ are the demand and supply shocks derived from the SVAR. The estimated values of $\{\beta_h^d\}_h$ and $\{\beta_h^s\}_h$ underpin the impulse-response functions (IRFs) of interest, 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

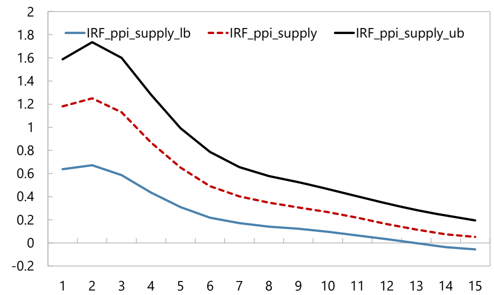
(on average during Jan-Sep 2021)

IRF of PPI After Demand Shock



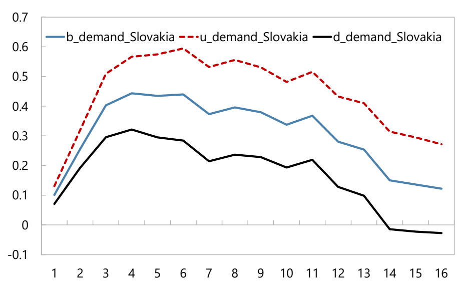
Source: IMF Staff calculations.

IRF of PPI After Supply Shock



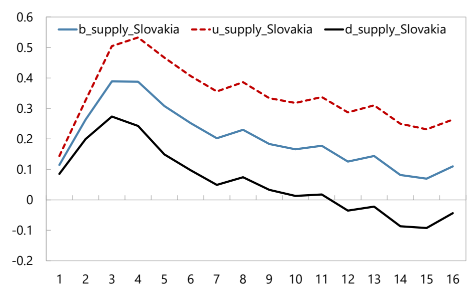
Source: IMF Staff calculations.

IRF of Core CPI After Demand Shock



Source: IMF Staff calculations.

IRF of Core CPI After Supply Shock



Source: IMF Staff calculations.

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:

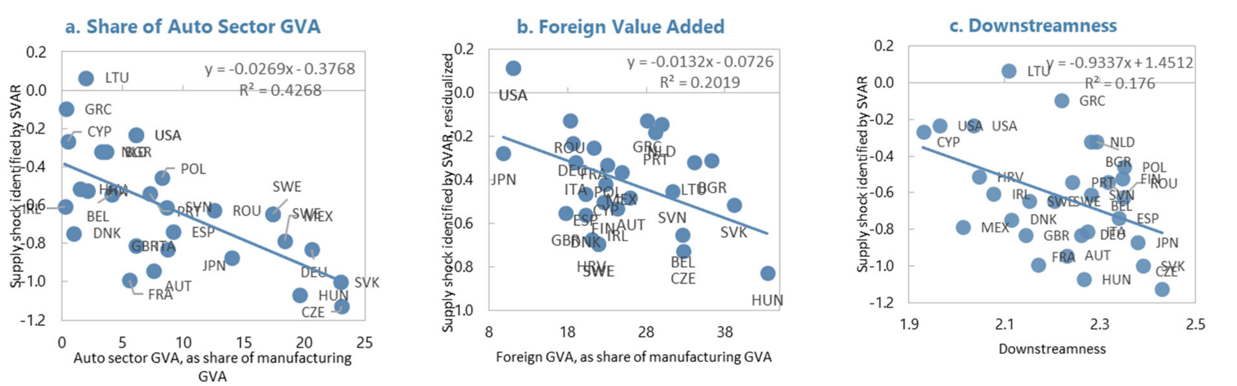
- **The size of the auto sector**: supply shocks are positively correlated with the size of the auto sector, as captured by the share of auto sector GVA in total manufacturing GVA. This is consistent with the severe impact on the auto industry of the global shortage of semiconductors.

[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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CLIMATE MITIGATION IN SLOVAKIA: TARGETS, POLICIES, AND CHALLENGES[1]

Slovakia has made important strides in reducing its greenhouse gas emissions and energy intensity, but significant effort is needed to reach its ambitious climate mitigation objectives. Existing and envisaged policies, such as support of renewable and nuclear energy production, the closure of coal power plants, investments in sustainable transport and building efficiency will contribute to further reductions in emissions but will likely fall short of what is needed to attain carbon neutrality by 2050. To accelerate the green transition, Slovakia could consider introducing carbon taxation. Simulations based on the IMF/World Bank Climate Policy Assessment Tool suggest that a carbon tax scheme could significantly decrease emissions and energy consumption, with adverse growth consequences mitigated by the use of tax revenue for lower labor taxation and efficient transfers to low-income households. The overall net welfare benefits will be positive. The introduction of carbon taxation, however, should be carefully timed, especially in light of the severe disruptions in energy markets triggered by the war in Ukraine, and be gradual, predictable, and complemented with policies to protect vulnerable households, and to address sector-specific obstacles to reducing emissions. This would help mitigate growth and inequality effects and help ensure broad social acceptability.

A. Introduction

1. **Greenhouse gas (GHG) emission is an important contributor to global warming and rising temperatures pose great global macroeconomic risks.** Without substantial mitigation of GHG emissions, global temperatures are projected to rise by around 4°C above preindustrial levels by 2100. Rising temperatures will inflict great damage to the global economy, amplifying the risk of catastrophic and irreversible outcomes such as rising sea levels, extreme weather events, and lower water availability, which may lead to loss of life and cause hundreds of millions of people to migrate both within countries and across borders (IMF 2017; IOM, 2009; IPCC, 2018, World Bank, 2018). The longer action is delayed, the greater the accumulation of greenhouse gases in the atmosphere, and the more costly it will eventually be to stabilize global temperatures (IMF, 2019a).

2. **In this context, Slovakia, as a member of the European Union (EU), has significantly increased its climate mitigation ambition.** Slovakia endorsed the European Green Deal's objective of net zero GHG emissions in the EU by 2050. This requires significantly faster emissions reductions in the EU as current policies are projected to yield only 60 percent emissions decline relative to 1990 levels by 2050. Intermediate targets have also become more ambitious (Table 1). The 2030 EU target was raised to

Table 1. Slovak Republic: Climate Targets of Slovakia and EU

Targets EU and Slovak Republic	EU 2030	Slovak Republic 2030
Greenhouse gas emissions (as of 1990)	(-40%) -55%	No goals formally set
Emissions in the ETS sector (as of 2005)	-43%	No goals formally set
Greenhouse gas emissions in non-ETS (as of 2005)	-30%	(-12%) -20%
Share of renewable energy sources (RES) in total	32%	(18%) 19.2%
The share of RES in transport	14%	14%
Energy efficiency	32.5%	30.3%
Interconnection of electrical systems	15%	52%

Source: Integrated National Energy and Climate Plan for 2021-2030

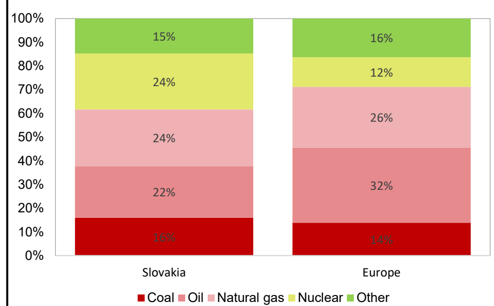
Notes: The numbers in the parenthesis indicate the initial target.

[1] Prepared by Zhibo Tan.

at least 55 percent emissions reduction relative to 1990 levels, compared to the 40 percent reduction under the Paris agreement.[2] Slovakia has also raised its target for reductions in emissions for sectors not covered in the EU emissions trading system (ETS) to 20 percent relative to 2005 levels (from the originally proposed 12 percent) and revised its target for the share of renewable energy sources (RES) to 19.2 percent (from 18 percent) by 2030.[3]

3. The need to transition towards a greener and more resilient economy has become much more urgent in the aftermath of the COVID-19 pandemic and the war in Ukraine. The surge in energy prices during the recovery from the pandemic and especially since Russia's invasion of Ukraine has exposed Europe's reliance on fossil fuels and underscored the need for faster greening. Scaling up investment in clean energy production and infrastructure and improving energy efficiency have become a critical priority to secure a robust and diversified energy mix from low-carbon technologies, and facilitate the transition to a greener economy.

Sources of Energy in Slovakia and Europe, 2019



Source: IEA, 2019. "Europe" includes 43 European countries.

4. Significant effort will be needed to reach Slovakia's new and more ambitious climate mitigation objectives. The strategy guiding the country's mitigation policies over the coming decade is laid out in the Integrated National Energy and Climate Plan for 2021–2030 (NECP), which outlines sectoral policies and measures to meet the 2030 objectives of cutting GHG emissions, increasing use of renewable energy sources (RES), and improving energy efficiency and electrical system interconnectivity. Slovakia also adopted a low-carbon strategy in February 2020 and has allocated 43 percent of the EUR 6.3 billion it will receive from the Recovery and Resilience Fund for reforms and investments to support climate objectives, such as climate adaptation, energy efficiency, low-carbon transport, and decarbonization of industries. While authorities' plans identify the right priorities, the role of carbon taxes in driving decarbonization is not fully explored. Moreover, even with the existing and planned set of policies, Slovakia is unlikely to achieve the goal of carbon neutrality by 2050 unless additional measures are implemented (Slovak Republic Low Carbon Development Strategy, 2020).

[2] The European Commission (EC) has recently unveiled a package of proposals (the "Fit for 55" climate plan) to operationalize its 2030 emission reduction target, which will be legislated over the coming years. The proposed package places carbon pricing at the center stage, reduces the Emission Trading System (ETS) emissions cap, extends the scheme to the maritime sector, and introduces a new ETS for road transport and buildings. It also establishes a fund to help the most vulnerable households and proposes a carbon border adjustment mechanism starting in 2026. These proposals will complement already existing financial support for the affected individuals, businesses, and regions with the transition via the Just Transition Mechanism.

[3] Slovakia's 2021–2030 National Energy and Climate Plan (NECP) does not set formal targets for total GHG reductions, though its 2018 Environmental Strategy proposes a 43 percent emissions reduction target by 2030 from 2005 levels (corresponding to a 53 percent cut in emissions from 1990 levels), in line with the EU's 55 percent target. An updated version of the NECP will be prepared and submitted in 2023.

5. This paper takes stock of Slovakia's progress in reducing emissions, describes the current climate mitigation framework, and examines the potential role of carbon taxation.[4] The analysis suggests that introducing explicit carbon taxation, currently not part of Slovakia's climate mitigation policy mix, could play an important role in reducing emissions. Introducing a carbon tax, once the ongoing energy crisis fades away, would strengthen incentives for firms, consumers, and investors to adjust their behavior and internalize the externalities of GHG emissions, while raising fiscal revenues. Climate policy, however, should be mindful of its distributional implications and complementary policies will be needed to protect vulnerable households. Carbon tax revenues could be used to support low-income households to mitigate the regressive effect of carbon taxation and ensure broad social acceptability.

6. It is important to note that the analysis does not incorporate the potential effects of the war in Ukraine on the green transition given the large uncertainty surrounding its length, severity, and medium-term implications for energy markets, trade relationships, and broader macroeconomic prospects in Europe. Energy security concerns have clearly become a lot more prominent since Russia's invasion of Ukraine and may contend with the green transition in the EU policy debate in the near term, as governments seek to ensure affordable access to energy. Nevertheless, recently announced policies at the EU level and by some of the larger economies in the region (e.g., Germany, France) suggest acceleration of the green transition in the EU, even if some temporary measures may lead to higher emissions in the short run. For example, Germany has pushed forward its goal of carbon neutrality by 5 years to 2035 and has moved to subsidize renewables via direct budgetary allocation, even though it has delayed its coal phaseout. EU-wide legislations to strengthen gas storage and to streamline permit-granting procedures for renewable projects could also incentivize green private investment. The sharp rise in energy prices, as well as the possibility of shortages, could also induce households and firms to explore alternative (and greener) sources of energy.[5]

B. Emission Trends and Policies

7. Slovakia has significantly reduced its GHG emissions and carbon intensity over the past three decades (Figure 1).[6] The sharp reduction in Slovakia's carbon intensity in the first half of the period reflects mainly changes in the structure of the economy and progress in emissions reduction has slowed in the last decade (OECD, 2022). Yet, despite the progress, emission intensity remains high in a cross-country perspective, due to Slovakia's large manufacturing sector (Figure 1, Panel 1 and 2). The overall emission decline also masks significant differences across sectors. Energy industries (e.g., production of electricity and heating, petroleum refining) used to be the largest contributor to GHG emissions but with the rising importance of nuclear power in electricity

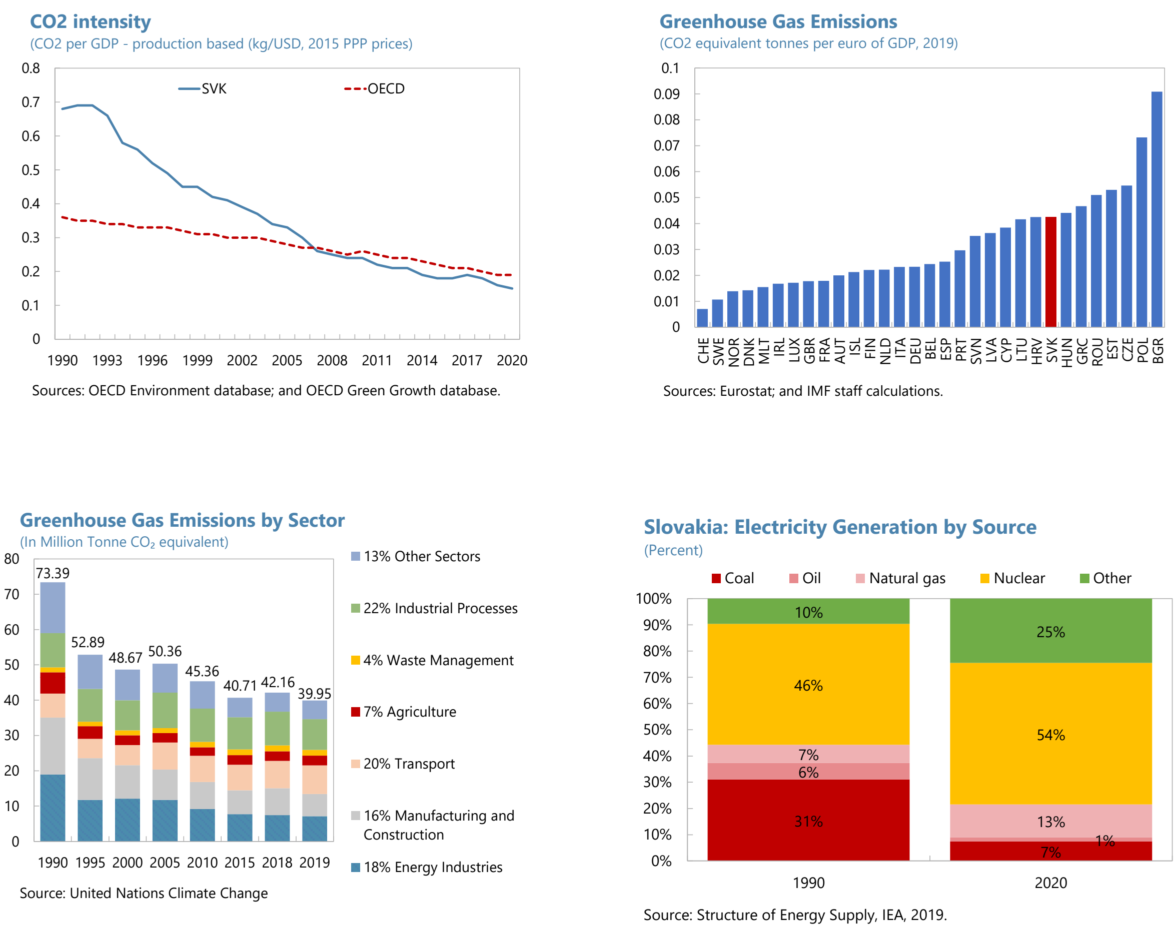
[4] Sector-specific policies are not discussed in detail.

[5] For example, prompted by the sharp increase in the price of emission allowances, US Steel Kosice, one of Slovakia's largest emitters, announced its intention to replace its coke ovens with electric furnaces, a modernization project worth over 1 billion euros.

[6] GHG include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and F gases (HFCs, PFCs, SF_6, NF_3). CO_2 is the main contributor to GHG emissions, accounting for over 80 percent of total emissions in Slovakia in 2018.

production, emissions from energy production have declined by over 62 percent since 1990 (Figure 1, Panel 3 and 4). By 2019, emissions from industrial processes had taken over as the largest contributor, accounting for 22 percent of total emissions. Besides these two sectors, the transport sector contributes significantly to GHG emissions (20 percent), with emission growing steadily over time. Waste and waste management is another sector which has seen a significant increase in emissions over time.

Figure 1. Slovak Republic: Emissions Intensity and GHG Emissions

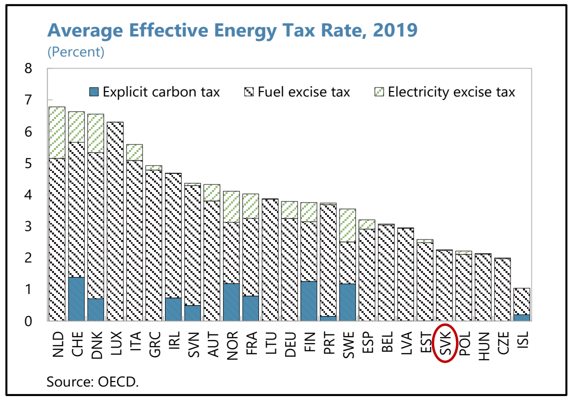


Notes: In Panel 3, *Energy Industries* refer to electricity and heating, *Manufacturing and Construction* refers to energy use in manufacturing and construction, while *Industrial processes* refer to emissions from chemical reactions. Other sectors include buildings and services.

8. **Slovakia has an extensive set of policies to achieve its climate mitigation goals.** They include participation in the ETS covering large emitting sectors, energy taxes, transformation / decommissioning of solid fossil fuel power and heating plants, decarbonization of electricity generation through rising shares of nuclear and RES energy, promotion of biofuels and electrification of transport, various measures in agriculture and waste management, and so on. Annex I provides a comprehensive list of these measures, while the most important ones are discussed below.

- **As in many EU countries, a major pillar of Slovakia's strategy for reducing GHG emissions is its participation in the EU ETS.** The system operates under the "cap and trade" principle and sets a maximum (cap) on the total amount of GHG that can be emitted by all participants, with emissions allowances initially auctioned off or allocated for free and subsequently traded by participants. The system thus finds the most cost-effective ways of reducing emissions without significant government intervention. The sectors covered by the existing EU ETS include power and heat generation, energy-intensive industrial sectors and aviation within Europe. In Slovakia, around 35 percent of total emissions are covered by the ETS and the NECP estimates that, under the existing measures scenario, around 75 percent of total emissions reductions by 2030 will be attributable to the ETS.

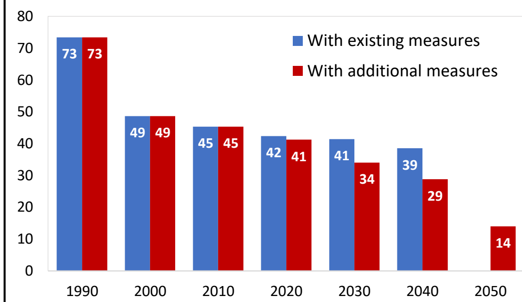
- **Energy taxation is another important policy tool to reduce GHG emissions.** Energy taxes in Slovakia are levied within the framework of the 2003 European Union Energy Tax Directive, which sets minimum rates for the taxation of energy products in EU member states. Within this framework, the main taxes on energy use in Slovakia are: (i) A fuel excise tax, which applies to certain forms of fuel use, but not to the fuels used to generate electricity; and (ii) An electricity excise tax, which taxes electricity consumption by businesses (per MWh). In comparison with other countries in Europe, however, Slovakia's effective energy tax rate is quite low. Both fuel and electricity taxes are below the average of EU countries which are OECD members, and there is no explicit carbon tax.



- **Slovakia plans to phase out environmentally harmful subsidies and regulations, and invest more in RES and substitutes for GHGs**. Support for coal mining and electricity production from coal will be terminated by the end of 2023. The Nováky lignite power plant, the country's second largest GHG emitter, and the Vojany hard coal power plant will be shut down in 2023 and 2025 respectively. To secure future electricity supply, two additional reactors are under construction for the Mochovce nuclear power plant, which will double its capacity. To reduce transport emissions, Slovakia intends to promote biofuels in road transport, particularly through non-food crops, wood, organic waste and waste from food crops. It also considers promoting the production and purchase of low-emission vehicles and supporting the construction of associated infrastructure.

9. With the policies currently in place, Slovakia may fall short of meeting the 2030 EU targets for overall GHG emissions reduction and achieving carbon neutrality by 2050.[7] With measures and policies in place as of 2016-18, GHG emissions (without LULUCF) are projected to decline by 44 percent in 2030 relative to 1990 levels (Table 2), falling short of the 55 percent reduction target of the EU (NECP 2019). Additional measures, estimated to cost over Euro 8 billion (roughly 8 percent of 2021 GDP) above the cost of existing measures, would provide a significant boost to emissions cuts, with an estimated 54 percent reduction in total emissions by 2030 compared to 1990 levels (Low Carbon Development Strategy of the Slovak Republic 2020). Nevertheless, even with additional policies, the authorities estimate that Slovakia could reduce emissions by 2050 (compared to 1990) by a maximum of 80 percent, which would not be sufficient to achieve carbon neutrality (Low Carbon Development Strategy of the Slovak Republic 2020).

Historical and Projected Total GHG Emissions without LULUCF until 2050
(Mtn CO2 Equivalent)



Source: NECP and Low-Carbon Development Strategy of the Slovak Republic.

Table 2.Slovak Republic: Projections of GHG Emissions under the Existing Measures Scenario (in Gg CO_2 eq.)

	1990	2025	2030	2035	2040
Energy sector	56,668	29,268	29,890	28,507	27,997
Industrial process	9,813	9,063	8,098	7,663	7,194
Agricultural sector	6,587	2,391	2,420	2,497	2,570
LULUCF sector	-8,991	-5,040	-4,434	-4,156	-4,231
Waste sector	1,393	1,324	991	859	760
Total without LULUCF	74,460	42,046	41,399	39,526	38,521
Total including LULUCF	65,469	37,005	36,965	35,369	34,290

Source: Integrated National Energy and Climate Plan for 2021–2030.

C. The Case for Carbon Taxes and their Stimulated Impacts

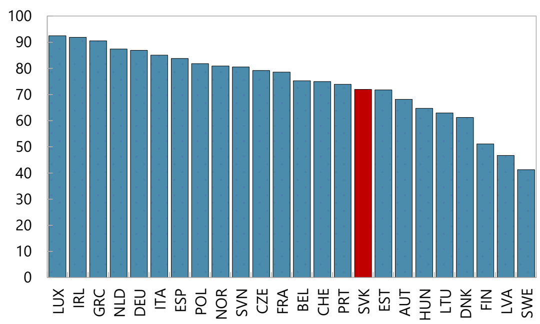
10. Combining information on permit prices from the EU-ETS and Slovakia's energy taxes, the OECD estimates effective carbon rates (ECRs) in Slovakia to be quite low (OECD 2021). The share of emissions priced over EUR 60 or EUR 90 per ton of CO_2 was roughly 25 and 20 percent

[7] This section draws on the findings presented in the NECP and Low-Carbon Development Strategy of the Slovak Republic. More up-to-date analyses are currently being prepared by the Slovak Hydrometeorological Institute, Boston Consulting Group (BCG) and Institute for Environment Policy (IEP) of the Ministry of the Environment of the Slovak Republic. With the updated analysis by BCG and the IEP using marginal abatement cost curves (MACC), a 55 percent reduction in GHG remissions is assessed as achievable, primarily through the planned closure of coal mines and coal power plants and extensive electrification of the steel sector.

respectively in 2018, on the low end of the distribution across OECD countries in the EU (Figure 2). Almost 30 percent of carbon emissions in Slovakia were priced at 0. As depicted in Figure 3, there is substantial variation in the types of measures used to tax emissions across sectors and the ECR faced by different sectors. Only 6 percent of total emissions are subject to both fuel excise taxes and ETS; 35 percent of emissions are only subject to fuel excise taxes, while ETS alone applies to around 30 percent of emissions. There are also large differences in ECRs across sectors. Emissions from the road and agriculture sectors are subject to an ECR of around EUR 170 and EUR 130 per ton of CO_2, much higher than other sectors. On the other hand, about 40 percent of emissions from the industrial sector and a quarter or emissions of the electricity sector are not priced at all.

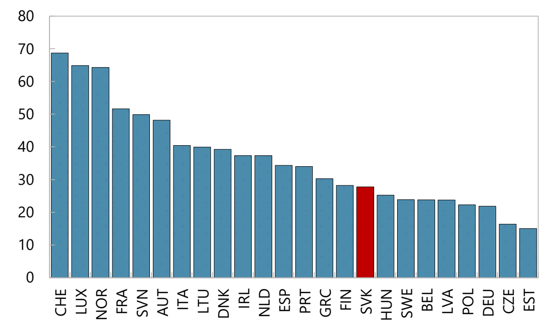
Figure 2. Slovak Republic: Proportion of CO2 Emissions Subject to Different Levels of Effective Carbon Rates for Slovakia and Selected EU Countries in 2018

Share of Emissions Priced above EUR 0 per Tonne of CO2



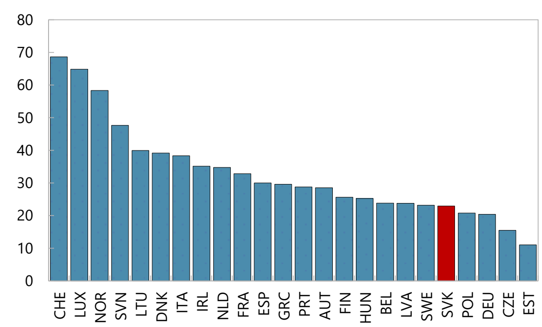
Source: OECD Effective Carbon Rates 2021: Pricing Carbon Emissions through Taxes and Emissions Trading, OECD Publishing, Paris.

Share of Emissions Priced above EUR 30 per Tonne of CO2



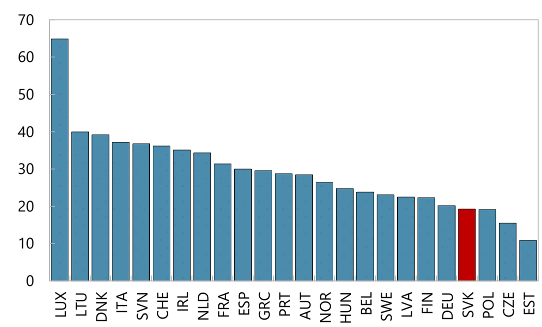
Source: OECD Effective Carbon Rates 2021: Pricing Carbon Emissions through Taxes and Emissions Trading, OECD Publishing, Paris.

Share of Emissions Priced above EUR 60 per Tonne of CO2



Source: OECD Effective Carbon Rates 2021: Pricing Carbon Emissions through Taxes and Emissions Trading, OECD Publishing, Paris.

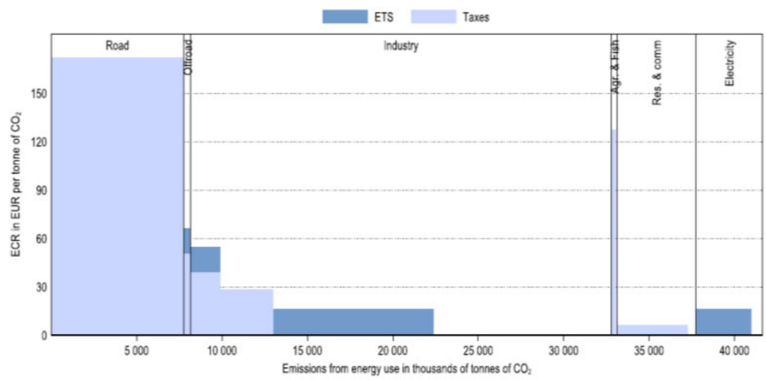
Share of Emissions Priced above EUR 90 per Tonne of CO2



Source: OECD Effective Carbon Rates 2021: Pricing Carbon Emissions through Taxes and Emissions Trading, OECD Publishing, Paris.

11. Carbon taxes are the most powerful and efficient mitigation strategy to reduce carbon emissions (IMF, 2019a). A carbon tax is a tax on fossil fuels (for example, from oil refineries, coal mines, and processing plants) with rates equal to the fuel's CO2 emissions factor multiplied by a CO2 emissions price (IMF, 2019). The tax is meant to internalize the negative externalities associated with carbon emissions, namely global warming, and provides an incentive for households and firms to conserve energy and/or switch to greener power sources to avoid paying higher energy prices. Although the increase in the price of energy from non-environmentally friendly sources and its distributional impacts on different households and firms can be challenging politically, the revenues from such taxes can be used to compensate those who lose the most from the change in relative prices. Clear communication could help ensure price predictability and alleviate the negative impacts through the adjustment of behaviors.

Figure 3. Slovak Republic: Average Effective Carbon Rates in Slovakia by Sector and Component in 2018



Source: OECD Effective Carbon Rates 2021: Pricing Carbon Emissions through Taxes and Emissions Trading, OECD Publishing, Paris.

12. **Slovakia does not have an explicit carbon tax in effect, even though these are already adopted in many European countries.** For example, Finland, the first European country that introduced a carbon tax in 1990, had a carbon tax rate of 62 euro per ton of CO_2e in 2021, covering more than a 1/3 of its GHG emissions. Sweden imposes an even higher carbon tax rate at 116 euro per ton of CO_2e in 2021, with a 40 percent coverage for GHG emissions. Up until April 2021, 19 countries in Europe had introduced a carbon tax, with an average carbon tax rate of 36 euro per ton of CO_2e and a coverage of 34 percent of GHG emissions (Annex II). As argued by the OECD (2022), a carbon tax in Slovakia would introduce more uniformity in pricing of CO_2 across sectors and industries, which would provide more consistent price signals and contribute to more cost-effective abatement.

13. **Using the Climate Policy Assessment Tool (CPAT) developed by the IMF and the World Bank, we examine the potential effects of introducing a carbon tax in Slovakia in 2025.** The tool provides standardized analyses of carbon pricing and other mitigation instruments. The model starts with fossil and other fuels use in various sectors (e.g. power generation, transport, industrial, and household sector) and projects this forward in a business-as-usual (BAU) scenario based on assumptions about: (i) future GDP growth; (ii) income elasticities for energy products; (iii) rates of technological change (e.g., that improve energy efficiency); and (iv) future international energy prices.[8] The impact of mitigation on fossil fuel use and CO2 emissions depends on (i) the policies' effect on fuel prices; and (ii) fuel price responsiveness.[9] We use the CPAT to construct a purely illustrative scenario in which a carbon tax is implemented in 2025 on the assumption that the current

[8] The general methodology is described in IMF (2019a), IMF (2019b) and Black et al. (2021).

[9] Price elasticities for electricity and fuels are generally taken to be around -0.5 to -0.8, based on extensive cross-country evidence and results from much more detailed energy models.

energy crisis will be resolved by then and energy prices have retreated from current levels. We set the initial carbon tax rate at 30 USD per ton of CO_2e, with a linear increase to 75 USD per ton of CO_2e in 2030.

14. In this purely illustrative scenario, the introduction of a carbon tax would have the following effects:

- **As expected, the carbon tax would lead to higher prices of fuels**, with the extent of increase ranging from 13 percent for gasoline to almost 74 percent in the case of coal (Figure 4, Panel 1)[10]. In most cases, the simulations suggest that the increase in prices due to the introduction of the tax will bring actual fuel prices closer to or even above efficient prices – the price that reflects supply and environmental costs (see Parry et al., 2021, for a discussion of the efficient price), with the most obvious effects in the case of liquid fuels, and coal and natural gas used in the industrial sector. However, even with a carbon tax of 75 USD per ton of CO_2e, the price of coal and natural gas faced by the residential and power sector would still fall short of the efficient price (Figure 4, Panel 2).

- **A carbon tax could decrease GHG emissions by 19 percent by 2030 relative to the business-as-usual scenario** (Figure 4, Panel 3).[11] The reductions in emissions would mainly come from the industry and power sectors, whose emissions are projected to decrease after the imposition of the carbon tax, while in the baseline, these two industries will experience an increasing trend of emissions.

- **The simulations suggest that total energy consumption would decrease by 10 percent relative to the baseline under this carbon tax scheme** (Figure 4, Panel 4). The reduction in energy consumption will be primarily driven by lower use of coal and natural gas, reflecting the price signals embedded in the carbon tax (note that the price of coal and natural gas will increase by over 74 and 27 percent respectively under such carbon tax scheme).

- **Fiscal revenues from taxing carbon could reach 1.2 percent of GDP in 2030** (Figure 4, Panel 5). Taxes on coal will be the main contributor to fiscal revenues, accounting for around 39 percent of revenues in 2030, with taxes on natural gas and diesel the second and third largest contributors.

- **The simulations suggest that the carbon tax will weigh on growth.** A carbon tax of 75 USD per ton of CO_2e will decrease GDP growth rate by 0.7 percentage point (Figure 4, Panel 6). Nevertheless, fiscal policy could significantly attenuate this impact. If half of the fiscal revenues from the carbon tax are used to reduce the personal income tax (PIT), and the other half used for transfers to low-income households (targeted at the bottom 40 percentile of income distribution), almost 50 percent of the negative impact on growth could be offset. On net, the negative impact of the carbon tax on GDP growth rate would be around 0.3 percentage point in 2030.

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[10] For the purpose of the simulations, we take the average of projections for fuel prices by World Bank, IMF, International Energy Agency, and Energy Information Administration. For example, in 2025, prices for oil, coal and natural gas are assumed to be 66.6 USD per barrel, 75.3 USD per ton, and 7.5 USD per MMBtu, respectively.

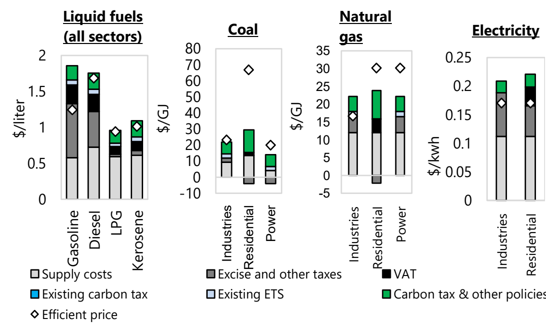
[11] Note that the BAU scenario does not directly model the impact of existing policy measures (including those from the recovery package) on future emissions other than through their effect on GDP, technological change, and energy prices.

Figure 4. Slovak Republic: Energy Price, Emissions, Energy Consumption, Fiscal Revenue and Growth Under a Carbon Tax of $75/tCO2e in 2030

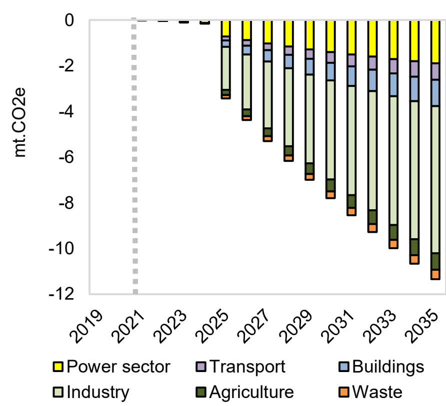
Energy Price Changes under the Carbon Tax

Fuel	Unit	Percent change under the carbon tax relative to the baseline
Gasoline	US$ per liter	12.50%
Diesel	US$ per liter	15.50%
LPG	US$ per liter	24.50%
Kerosene	US$ per liter	28.10%
Oil	US$ per barrel	47.50%
Coal	US$ per gigajoule (GJ)	73.60%
Natural gas	US$ per gigajoule (GJ)	26.70%
Electricity	US$ per kwh	11.00%

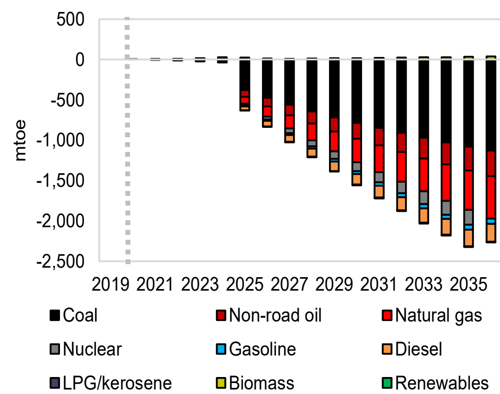
Projected and Efficient Energy Prices in 2030



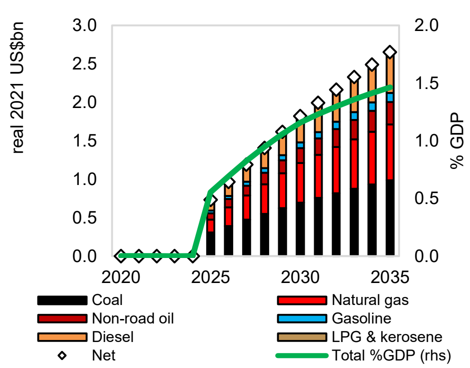
Change in GHG Emissions by Sector



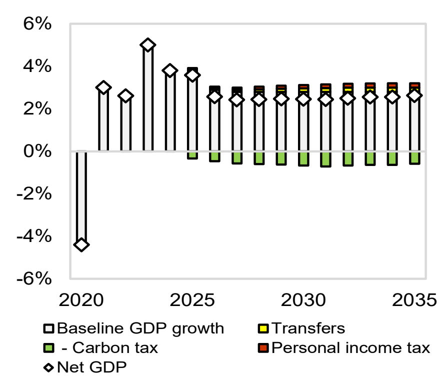
Change in Energy Consumption by Fuel



Fiscal Revenues Raised by Fuels



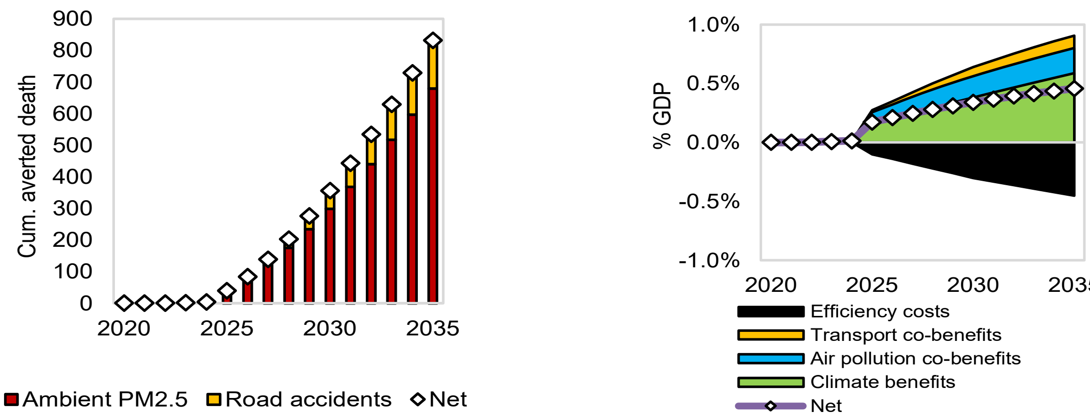
Impact on the GDP Growth Rate



Source: IMF Staff calculations based on the Climate Policy Assessment Tool by the IMF and the World Bank

Figure 5. Slovak Republic: Welfare Impact of a Carbon Tax of $75/tCo2e in 2030

Averted Air Pollution and Road Accident Deaths | **Total Monetized Welfare Benefits**

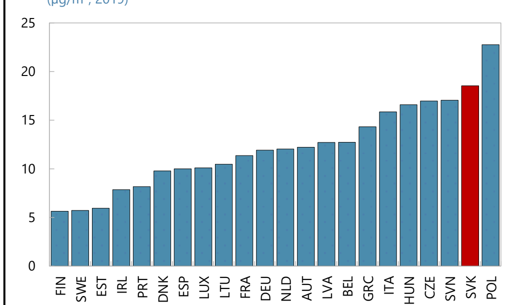


Source: IMF Staff calculations based on the Climate Policy Assessment Tool by the IMF and the World Bank.

15. **Despite of a small negative impact on growth, the carbon tax will reap sizable co-benefits by improving air quality and road safety** (Figure 5). With a carbon tax rate at 75 USD/tCO_2e in 2030, the simulations suggest 298 cumulative averted deaths due to ambient PM2.5 and 58 averted deaths due to road accidents by 2030. This is an important consideration in the case of Slovakia, which has a relatively high mean population exposure to PM2.5. Monetizing the climate benefits and the co-benefits of lower air pollution and better transportation suggests that despite the increase in efficiency costs from higher energy prices, the net monetized welfare benefits will rise from 0.2 percent of GDP in 2025 to 0.5 percent of GDP in 2035 (Figure 5) [12].

Mean Population Exposure to PM2.5

(μg/m³, 2019)



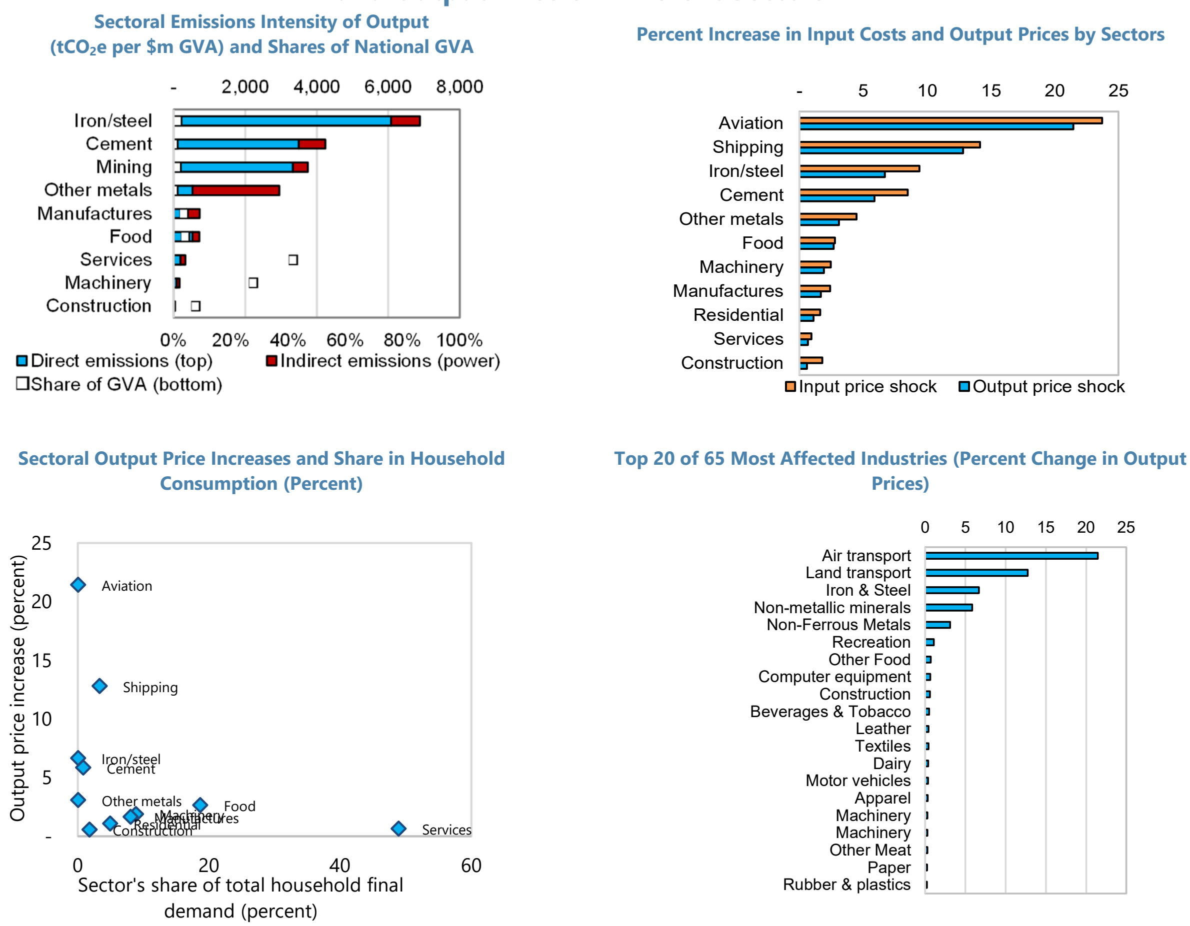
Sources: OECD Environment database; and OECD Green Growth database.

16. **The carbon tax will entail large input cost and output price shock for some industries.** In the case of Slovakia, the most affected sectors (those with the highest CO_2 intensity of output) tend to be relatively less important as a share in gross value added or in housheold consumption (Figure 6). Conversely, those industries with large shares of gross value added and household consumption would experience a relatively modest impact of the carbon tax on input costs and output prices. For example, the simulations suggest that the iron and steel industry would be one of the most affected with a 9 percent increase in input costs and a 7 percent increase in output price. However, it accounts for only 2 percent of gross value added and 0.1 percent of household

[12] Based on the impacts of the reduction in GHG emissions on the mortality due to ambient PM2.5, the associations of driving and fatal road accidents, the effects of the carbon tax on reductions in emissions and driving, and the value of a statistical life, the CPAT simulates such effects. For more technical details, please refer to IMF (2019a), IMF (2019b) and Black et al. (2021).

consumption. Among the top 20 most affected industries, only two would experience an increase in ouput price by more than 10 percent. In contrast, the services and the machinery manufacturing industry, whose shares in national gross value added (43 percent and 29 percent respectively) and household consumption (49 percent and 9 percent respectively) are high, have a much lower CO_2 emission intensity of output and would experience modest increases in input costs and output prices.

Figure 6. Slovak Republic: Impacts of Carbon Tax of $75/tCO2e in 2030 on the Input Cost and Output Price of Different Sectors



Source: Calculations based on the Climate Policy Assessment Tool developed by the IMF and the World Bank.

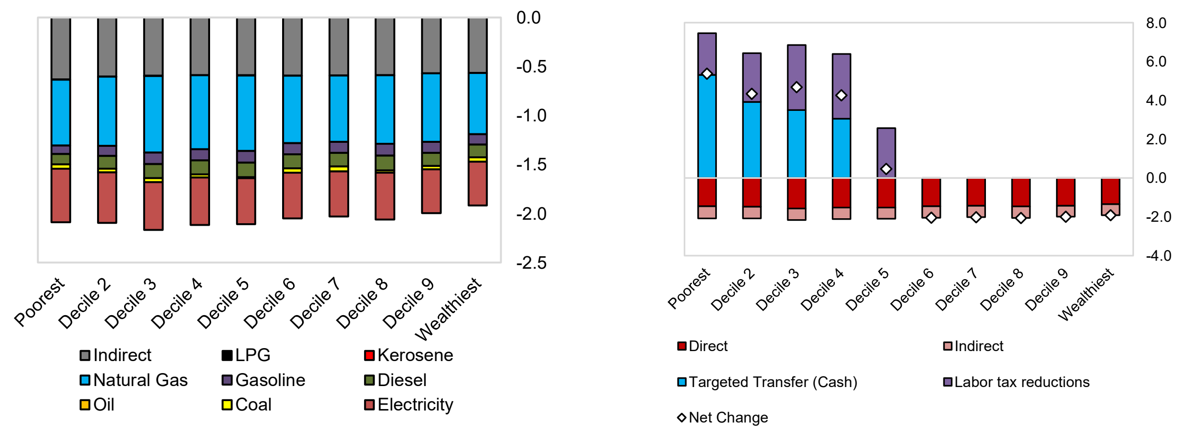
17. **The carbon tax would also have somewhat unequal effects across households.** In particular, the simulations suggest that poorer households would experience a marginally larger negative impact on consumption compared to those at the upper end of the income distribution (Figure 7, Panel 1). A carbon tax would lower real consumption not only directly, through the higher prices of various fuels, but also indirectly through the impact on consumption of other goods whose production uses fuel. The unequal effects across income deciles could be alleviated by revenue recycling. If half of the carbon tax revenue is used for transfers to households with income below the 40th percentile and the other half for labor tax reductions, real consumption of lower income

households could actually increase relative to the baseline scenario (Figure 7, Panel 2). In comparison, the labor tax reduction would give a larger real consumption boost to wealthier households, since households at the lower end of the income distribution typically have labor income below the income tax threshold, are taxed at a lower rate, or work in the informal sector, which is outside the formal tax system. On net, the illustrative simulations suggest that revenue recycling in the form of targeted transfers and labor tax cuts could lead to an increase in real consumption of households in the bottom half of the income distributions.

Figure 7. Slovak Republic: Impacts of Carbon Tax of $75/tCO2e in 2030 on the Consumption of Households

Mean Consumption Effects (Percent of Consumption) on Households at Different Income

Mean Consumption Effects (Percent of Consumption) with the Carbon Tax Revenues Recycled



Source: Calculations based on the Carbon Pricing Assessment Tool developed by the IMF and the World Bank.

D. Conclusion

18. Slovakia has made significant progress in reducing its GHG emissions and energy intensity, but significant effort is needed to reach its ambitious climate mitigation objectives. Existing and envisaged policies, such as energy taxation, support of renewable and nuclear energy production, phasing out of subsidies for coal mining and the closure of coal power plants, investments in sustainable transport, improvement of building efficiency, and numerous regulatory measures will contribute to further emission reductions, but are expected to fall short of what is needed to attain carbon neutrality by 2050.

19. To accelerate the green transition, Slovakia could consider the introduction of explicit carbon taxation. Simulations suggest that a carbon tax scheme, with a carbon tax increasing linearly from 30 USD/tCO_2e in 2025 to 75 USD/tCO_2e in 2030, could significantly decrease emissions and energy consumption. Adverse growth consequences could be mitigated by the use of tax revenue for lower labor taxation and efficient transfers to low-income households. If the climate benefits, the air quality and transportation co-benefits are further considered, the monetized welfare benefits of the carbon tax would outweigh the efficiency costs.

20. The introduction of carbon taxation, however, should be carefully timed, especially in light of the severe disruptions in energy markets triggered by the war in Ukraine. It needs to be gradual, predictable, and complemented with policies to protect vulnerable households and address sector-specific obstacles to reducing emissions. This would help mitigate growth and inequality effects and ensure broad social acceptability.

21. To address concerns about potential loss of competitiveness due to carbon taxation, international coordination and cooperation is critical (Chateau and others, 2022). International carbon price floors differentiated by income level could contribute to improve the international burden sharing with limited competitiveness effects and enhance strongly global climate mitigation at moderate macro costs. Carbon border adjustment mechanisms could limit competitiveness losses for energy-intensive and trade-exposed industries[13] and reduce carbon leakages, although they do not deliver a strong additional reduction in global emissions or provide strong incentives to join the carbon price floor (IMF, 2021).[14] To offset inflationary impacts induced by carbon taxation, complementing carbon taxes with debt-financed green public investments could help reduce bottlenecks and price pressures (Andaloussi and others, forthcoming).

[13] Carbon pricing would increase industrial production costs, but the magnitude of competitiveness impacts is unclear. As discussed in IMF (2021), empirical studies tend to find very small impacts of carbon pricing on competitiveness relative to other factors.

[14] A border carbon adjustment (BCA) is a charge on embodied carbon in products imported into a jurisdiction with carbon pricing, potentially matched by rebates for embodied carbon in exports. As part of the "Fit for 55" climate plan, the European Union has proposed plans for a carbon border adjustment mechanism (CBAM).

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Annex I. Policies and Measures for Reducing GHG Emissions in Slovakia

Table 1. Policies and Measures for Reducing GHG Emissions in Slovakia

Sectoral Policies and Measures in the Energy Sector				
Policies/Measures	**Contents of policies and measures**	**GHG Affected**	**Types of measure**	**Condition**
Improving energy efficiency	Minimum requirements regarding the energy performance of new and existing buildings, and the renovation of buildings.	CO_2	Regulatory	In force since 2014
Implementation of the EU Winter Package	Promotes the transition to clean energy and takes into account the impact of RES on heat and electricity generation.	CO_2	Regulatory & economic	In force since 2016
The RES Action Plan	A 14.6%, 24% and a 10% share of RES in heat and cold production, electricity generation and energy demanded in the transport sector respectively.	CO_2	Regulatory & economic	In force since 2011
EU ETS	Motivates the energy-efficient use of industrial waste gases, biomass in the fuel mix and technological innovation.	CO_2	Regulatory & economic	In force since 2013
EU ETS carbon price increases	Raise the price of emission allowances to facilitate the conversion from coal to gas.	CO_2	Regulatory & economic	In force since 2020
District heating optimization	Installing cogeneration units with combined heat and power (CHP) in district heating systems and improve its efficiency.	CO_2	Regulatory	In force since 2015
Termination of heating plants	Gradual decommissioning of solid fossil fuel heating plants after 2025.	CO_2	Regulatory	In force since 2015
Transformation of solid fossil fuel power plants	The termination of electricity generation in Nováky. Transform the Vojany plant into a facility to use secondary fuels.	CO_2	Regulatory & economic	Expected after 2023
Decarbonization of electricity generation	Achieved through nuclear power plants and renewable sources like solar photovoltaic, onshore wind turbines and biomass.	CO_2	Regulatory	Expected after 2020
Increase the share of nuclear energy	Increase the share of nuclear energy during 2020-2025 through the commissioning of two new nuclear reactors in Mochovce.	CO_2	Regulatory & economic	Expected after 2025
Reduction in final energy consumption	Faster renovation of old buildings, energy insulation for renovated buildings, and high standards for new buildings.	CO_2	Regulatory & economic	Expected after 2020

Sectoral Policies and Measures in the Transport Sector				
Policies/Measures	**Contents of policies and measures**	**GHG Affected**	**Types of measure**	**Condition**
Environmental design and use of products	Regulations for household appliances, motors, and other electrical equipment with a negative environmental impact. Application of ecodesign and consideration of entire life cycle.	CO_2	Regulatory	In force since 2010
CO_2 emission standards	CO_2 emission standards for passenger cars, light commercial vehicles, trucks, together with transport electrification.	CO_2	Regulatory	In force since 2007
Promoting biofuels in road transport	Accelerate the implementation of second-generation biofuels made from non-food crops such as wood, organic waste, and so on.	CO_2, CH_4	Regulatory & economic	In force since 2010
Electrification of transport	Increase the share of electric vehicles and fuel cell vehicles to replace vehicles with internal combustion engines.	CO_2	Regulatory & economic	Expected after 2020
Sectoral Policies and Measures in the Agricultural Sector				
Policies/Measures	**Contents of policies and measures**	**GHG Affected**	**Types of measure**	**Condition**
New fertilizer management	New measures on fertilizer handling and processing.	N_2O	Regulatory & economic	In force since 2015
New animal feeding policy	A reduction in the number of dairy cows and intensive feeding with active substances.	CH_4	Regulatory & economic	In force since 2015
Use of fertilizers in agricultural land	The efficient use and appropriate timing of use of nitrogen doses from mineral fertilizers.	N_2O	Regulatory & economic	In force since 2010
Sectoral Policies and Measures in the Land Use, Land Use Change and Forestry Sector				
Policies/Measures	**Contents of policies and measures**	**GHG Affected**	**Types of measure**	**Condition**
Rural development program	Support investment on farms and food enterprises; promote climate-friendly farming practices; manage agricultural land in a way that protects biodiversity, soil and water.	NO_2	Regulatory & economic	In force since 2015
Sectoral Policies and Measures in the Waste Management Sector				
Policies/Measures	**Contents of policies and measures**	**GHG Affected**	**Types of measure**	**Condition**
Waste management program	Reduce amount of mixed municipal waste (MMW) and the amount of biodegradable waste in MMW; reduce the municipal waste landfill rate.	CH_4	Regulatory	In force since 2016
Waste prevention program	Minimize waste generation and strict adherence to the waste hierarchy. Improve control of waste flow. Monitor waste from generation to recovery.	CO_2, CH_4	Regulatory	In force since 2019

Annex II. Carbon Tax Rates, Share of Covered Greenhouse Gas Emissions, and Year of Implementation in European Countries

Table 1. Carbon Tax Rates, Share of Covered Greenhouse Gas Emissions, and Year of Implementation in European Countries
(as of April 1, 2021[1])

	Carbon Tax Rate (per ton of CO_2e)		Share of Jurisdiction's Greenhouse Gas Emissions Covered	Year of Implementation
	Euros	US Dollars		
Denmark	€23.78	$28.00	35%	1992
Estonia	€ 2.00	$2.36	6%	2000
Finland	€62.00	$73.02	36%	1990
France	€45.00	$53.00	35%	2014
Iceland	€29.72	$35.00	55%	2010
Ireland	€33.50	$39.45	49%	2010
Latvia	€12.00	$14.13	3%	2004
Liechtenstein	€85.76	$101.00	26%	2008
Luxembourg	€20.00	$23.55	65%	2021
Netherlands	€30.00	$35.33	12%	2021
Norway	€58.59	$69.00	66%	1991
Poland	€0.07	$0.08	4%	1990
Portugal[2]	€24.00	$28.26	29%	2015
Slovenia	€17.30	$20.37	50%	1996
Spain	€15.00	$17.67	3%	2014
Sweden	€116.33	$137.00	40%	1991
Switzerland	€85.76	$101.00	33%	2008
Ukraine	€0.25	$0.30	71%	2011
United Kingdom	€21.23	$25.00	23%	2013

Source: The World Bank Carbon Pricing Dashboard last updated April 1, 2021.
Notes:
1. The carbon tax rates were converted using the EUR-USD currency conversion rate as of April 1, 2021 (USD 1 = EUR 0.84913).
2. Portugal ties its carbon tax rate to the previous year's EU ETS allowances price.