



CZECH REPUBLIC

SELECTED ISSUES

February 2025

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SELECTED ISSUES

January 7, 2025

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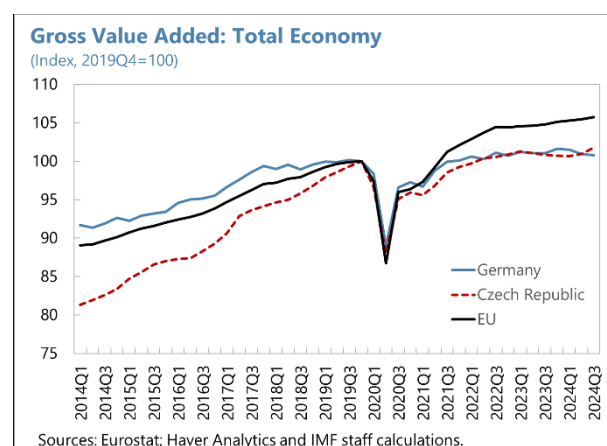
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PERSPECTIVES ON THE CZECH REPUBLIC'S STRUCTURAL PRODUCTIVITY SLOWDOWN

The Czech economy has underperformed European peers in the post-pandemic period and economic convergence has come to a halt. This outcome is often attributed to the country's links to specific slow-growing trading partners (especially Germany) and to its energy-intensive economic structure. We argue that while these factors to some extent may have affected domestic demand in the near term, along with a fall in real wages, recent developments have also exposed other preexisting structural weaknesses. We focus specifically on the challenge posed by declining productivity, uncovering multifaceted factors and dynamics at play. Empirical analysis suggests that further R&D investment could reduce gaps with the TFP frontier, sector-specific bottlenecks should be addressed, and productivity-enhancing labor reallocation could be better supported by more targeted policies.

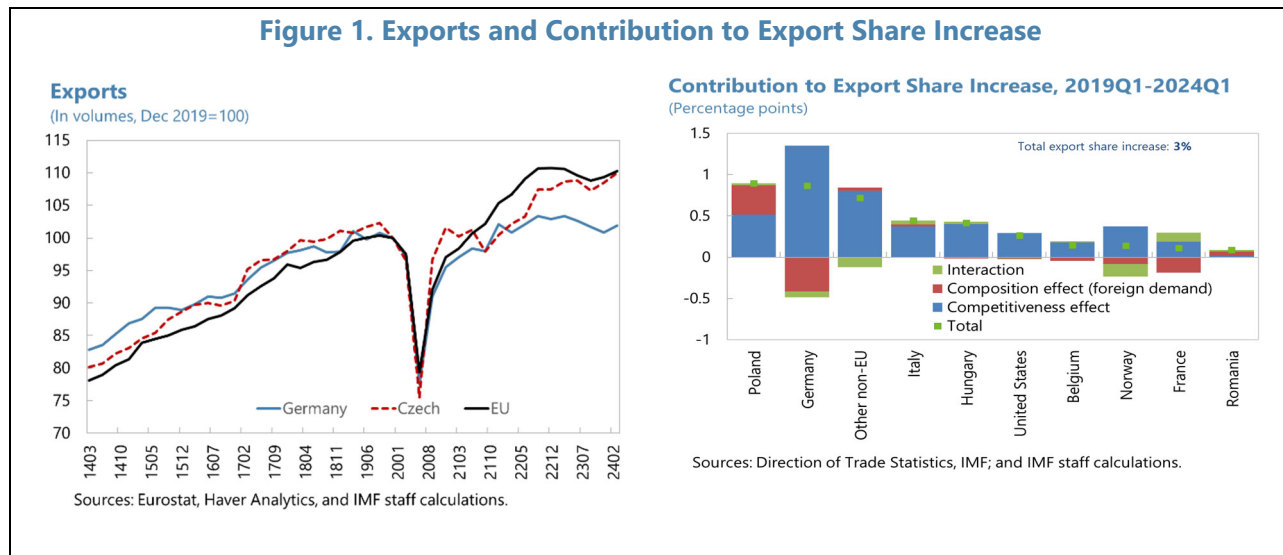
1. The recent underperformance of the Czech Republic is often attributed to its ties to Germany. Since the onset of the pandemic, the Czech economy has significantly lagged peers. With an economic performance closely resembling that of Germany and close ties with the German manufacturing sector, this outcome is often attributed to specific slow-growing trading partners and to its energy-intensive economic structure.

2. However, the Czech Republic's underperformance only partly reflects exposure to specific markets. Despite the recent shocks, exports have performed broadly in line with exports in the rest of the EU (Figure 1). A decomposition of Czech exports shows that since the pandemic Czech exporters have successfully offset weak demand in the German market with expansion in other fast-growing markets, including Poland.²



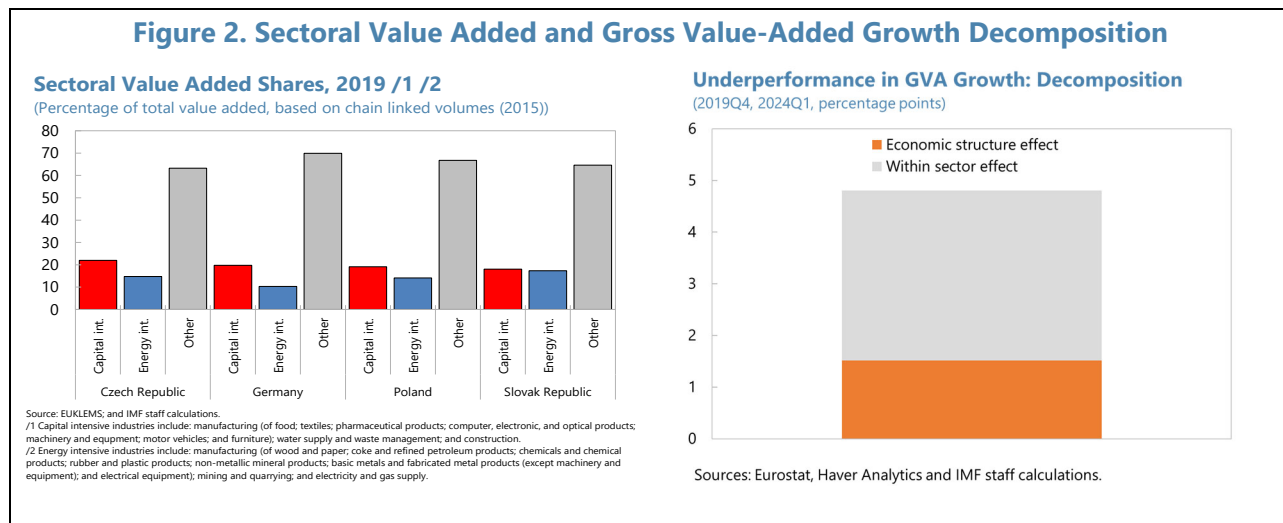
² A constant share decomposition is used to identify changes in Czech's export market share that are related to the intensive margin, and hence to country's competitiveness, from those that reflect composition effects related to changes in the size of the destination markets (Figure 1).

Figure 1. Exports and Contribution to Export Share Increase

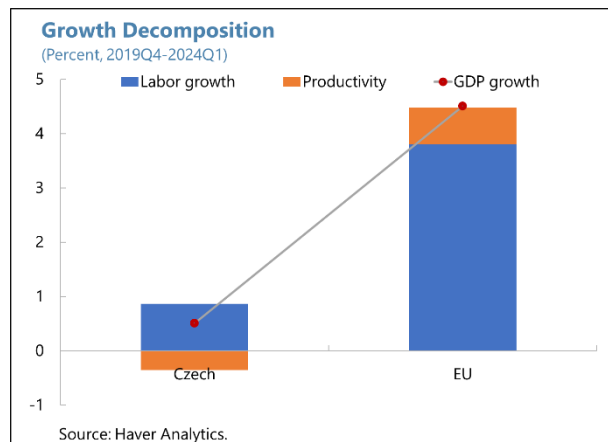


3. Moreover, the underperformance is only partly related to the economic structure of the Czech economy. The relevance of energy- or capital-intensive sectors is broadly in line with peers, suggesting similar vulnerabilities to recent shocks. To shed further light on this point, we use the methodology developed by Caceres et al. (2021). The actual output loss relative to a pre-pandemic trend is benchmarked against the counterfactual output loss of an economy where each sector’s weight in GDP is equal to a European average. This approach allows to break down the Czech growth underperformance between an “economic structure effect” (in other words an output loss due to the larger weight of underperforming sectors) and a “within sector effect” (the actual underperformance of specific sectors). The results indicate that only one third of the output loss relative to a pre-pandemic trend can be attributed to an unfavorable economic structure, reflecting concentration in sectors affected by supply-side disruptions as well as energy- or interest- rate sensitive sectors (Figure 2). The rest is explained by underperformance within sectors.

Figure 2. Sectoral Value Added and Gross Value-Added Growth Decomposition

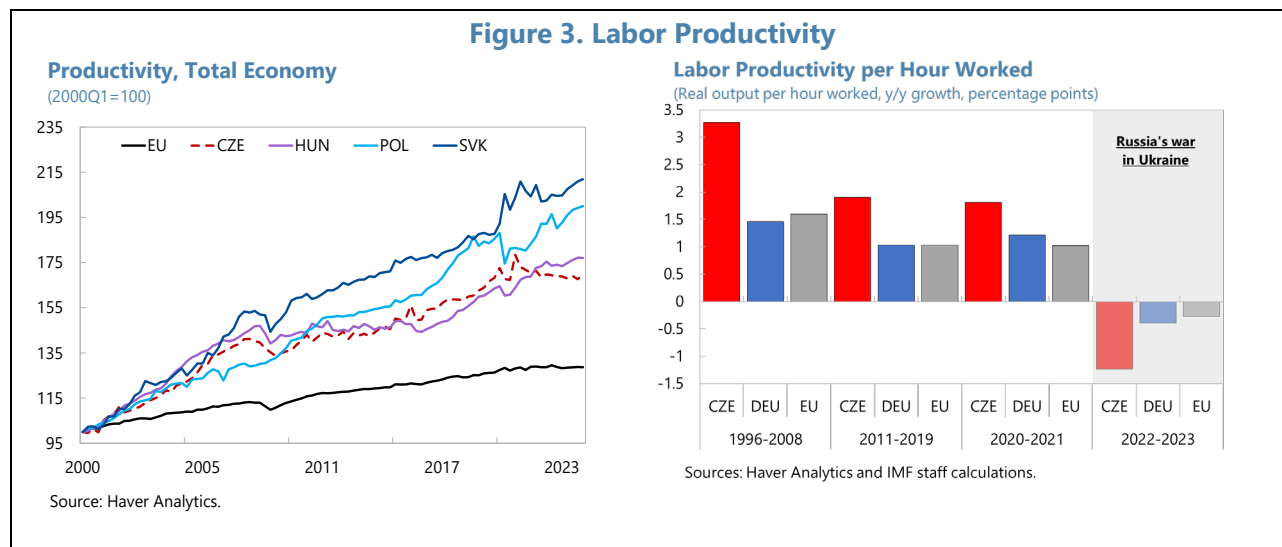


4. On the contrary, a decline in productivity, along with a slower increase in the labor force has been a crucial factor. Since end-2019, labor productivity has fallen in the Czech Republic, while it has advanced, albeit modestly in the EU. To some extent, this reflects labor hoarding, which has likely been greater than in other countries, given the tight labor market and the sharper fall in real wages compared to peers. But, as we will demonstrate, several structural factors are also at play, some of which had already started unfolding in the years leading up to the recent shocks.



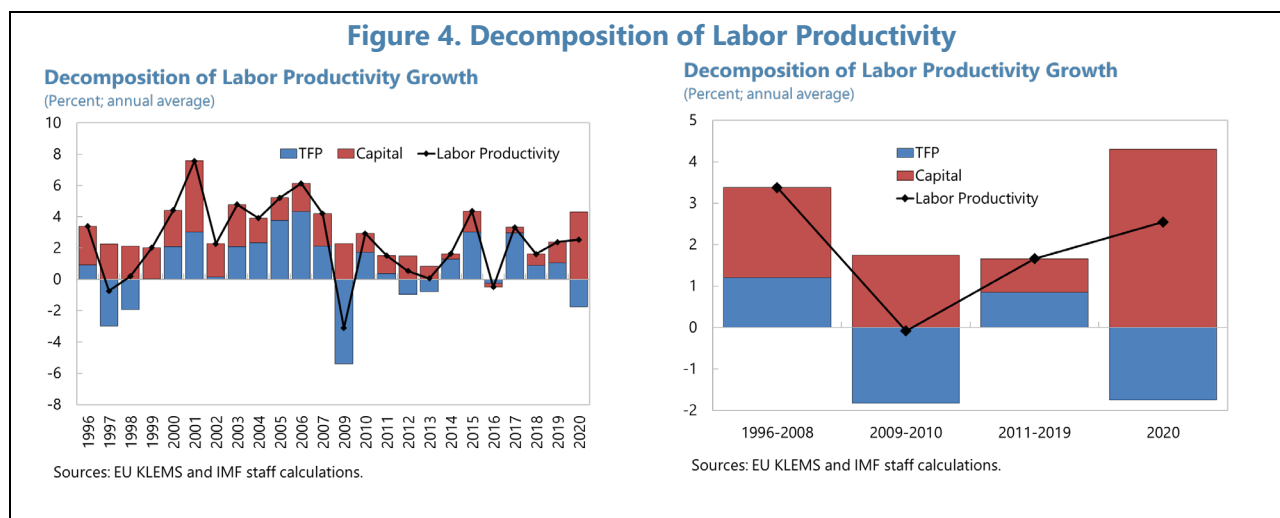
The Productivity Slowdown: Three Key Stylized Facts

5. First, system-wide productivity growth has been on a declining trend (Figure 3). Following the GFC, productivity growth remained higher than that of Germany and other EU countries, but the gap was reduced considerably. After the recent shocks, productivity has weakened further and dropped both in absolute terms and relative to EU peers. While labor hoarding may have affected Czech Republic disproportionately in recent years, the extent of the decline suggests that additional, structural factors may be affecting this change.



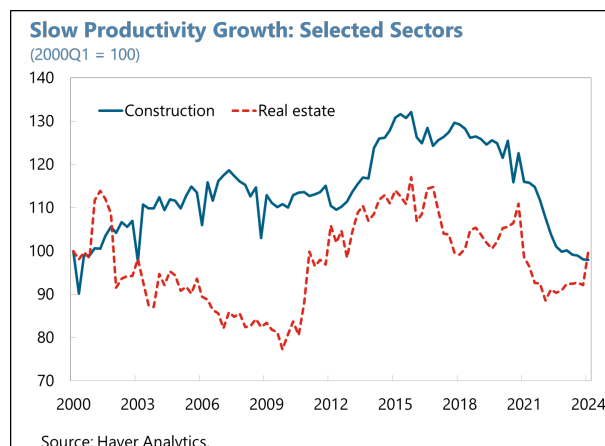
6. Both slower total factor productivity (TFP) growth and capital deepening contributed to the decline (Figure 4). Using EU KLEMS data, we break down labor productivity into capital accumulation and TFP. The analysis reveals that both factors contributed to the decline. While lower capital deepening can be a natural development for a country moving into a more advanced phase

of the convergence process, TFP also decelerated significantly and never recovered to pre-GFC growth rates.



7. Second, the slow growth of productivity can be explained by developments in specific sectors that have experienced long-term difficulties.

- The Czech **construction sector** has significantly underperformed in terms of labor productivity compared to most other EU countries, including other Central and Eastern European (CEE) countries that experienced similar or even larger interest rate increases, such as Poland, Hungary, and Romania. Hampered by severe shortages of skilled workers—vacancies peaked at 16 percent in 2019 and declined only gradually afterwards—and administrative burdens, the sector has shrunk by nearly 25 percent over the last ten years.

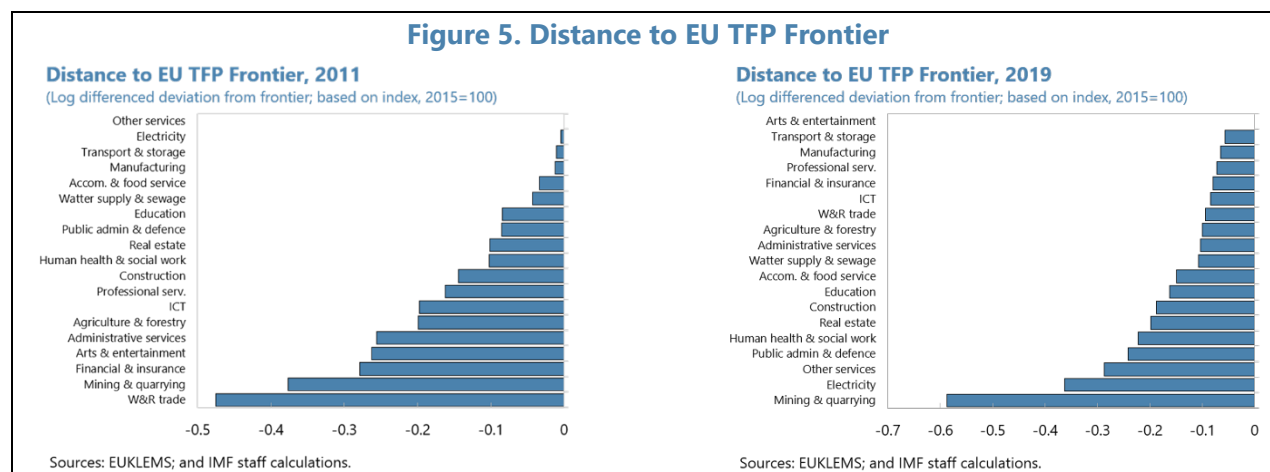
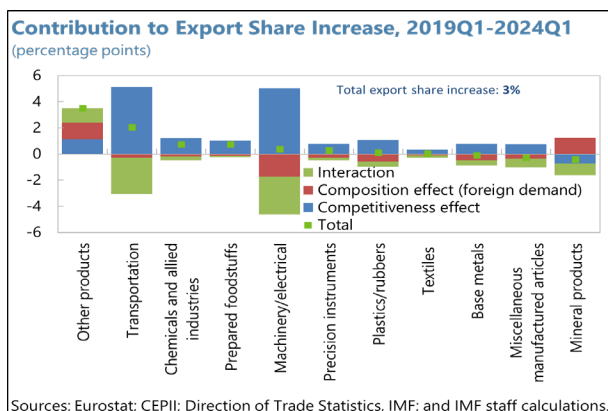


- The correction has been even sharper for the **mining and energy sector**, reflecting falling demand, phasing out of coal production, and limited investment in renewables.
- Finally, the non-auto manufacturing sector has been stagnant for almost a decade. This is common to the case of many countries experiencing gradually slower industrialization as they converge to higher income levels.

8. Most other sectors have moved broadly in line with EU labor productivity averages, although trailing pre-pandemic trends. The automotive industry (especially car parts) has been

generally resilient, after some initial disruption of supply chains. Constant market share analysis shows such dynamism to be related to improvement in competitiveness rather than an increase in external demand, but large movements in inventories may have also distorted the true extent of this progress.

9. Lagging sectors have significant and widening gaps in TFP compared to those at the EU frontier. An examination of the distance to the EU TFP frontier across sectors shows significant variation (Figure 5). For instance, the TFP gap for energy-related sectors, particularly electricity, increased in 2019 compared to 2011. Mining showed a consistently larger TFP gap from the EU frontier. By contrast, the TFP gap decreased for ICT and financial and insurance services, as TFP performed relatively well, growing broadly in line with EU frontier countries for these sectors.

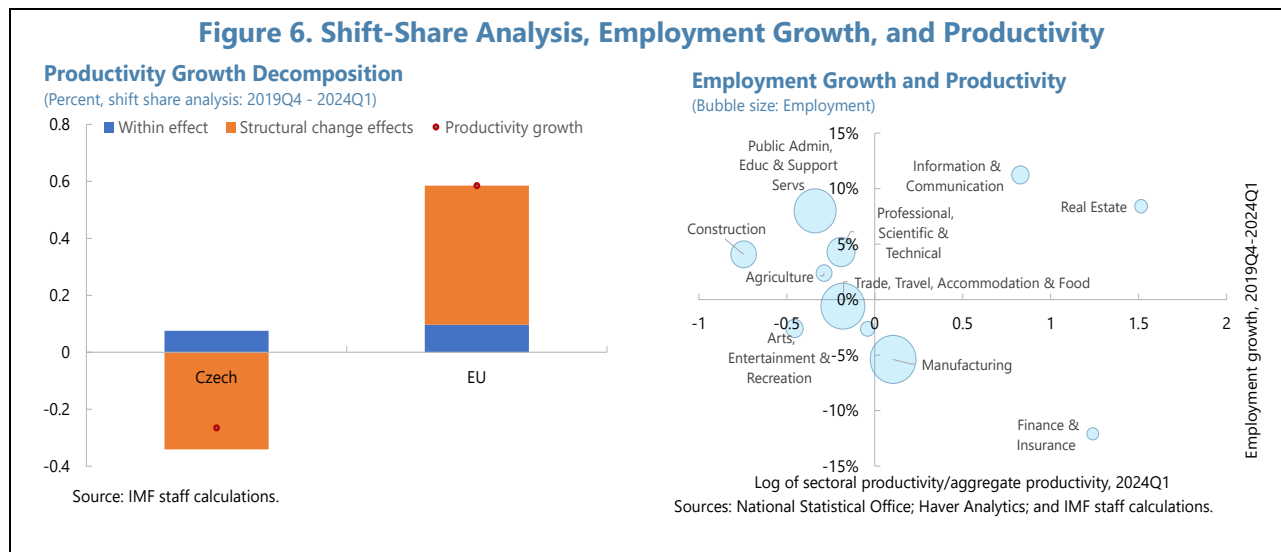


10. Third, the recent slowdown in productivity can also be explained by inefficient reallocation of labor across economic sectors. A decomposition of productivity based on a shift-share analysis³ reveals that allocative inefficiency explains the decline in productivity observed in the Czech Republic in the post-pandemic period (Figure 6). While shifting jobs to higher productivity sectors would have enhanced productivity, the opposite trend has been observed. Analysis shows that relatively high-productivity sectors, including manufacturing and financial services have steadily reduced their workforce, while low-productivity public administration has expanded considerably.⁴ The highly productive ICT sector has seen an increase in employment, but this growth has not been

³ In the spirit of McMillan and Rodrik (2011).

⁴ Similar to McMillan and Rodrik (2011), structural transformation is the key driver of productivity. Therefore, when a worker moves from a low productivity to high productivity job, the economy enjoys, on impact, a jump in average productivity.

sufficient to meet labor demand, as revealed by persistent labor shortages and skill mismatches—as a high share of tertiary education graduates work in occupations which do not require their degree. Overall, labor is increasingly concentrated in low-productivity sectors. This situation is in contrast with the trend seen in the EU, where labor reallocation has positively affected productivity.



11. The misallocation of financial flows across economic sectors has also contributed to the slowdown in productivity. Our analysis shows strong growth in bank credit to low-productivity sectors, including the public administration, and declining credit towards high productivity sectors such as manufacturing and ICT (Figure 7). This has also coincided with a decline in FDI inflows in manufacturing during the last decade. Overall, FDI inflows have shifted away from traditional manufacturing towards financial and insurance services. The finance and insurance sector has also seen the largest relative increase in total FDI inflows (OECD, 2024). Capital markets are underdeveloped in the Czech Republic and venture capital investment is low compared to other OECD countries.

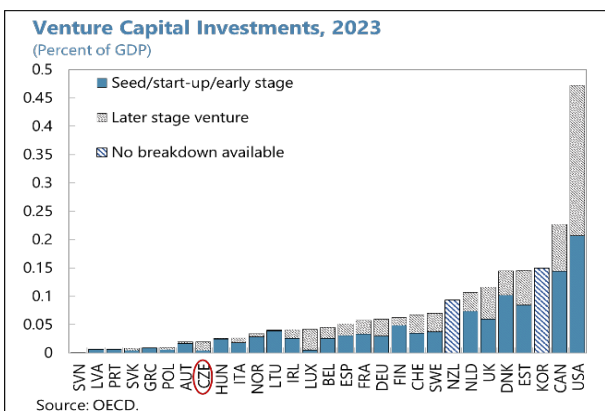
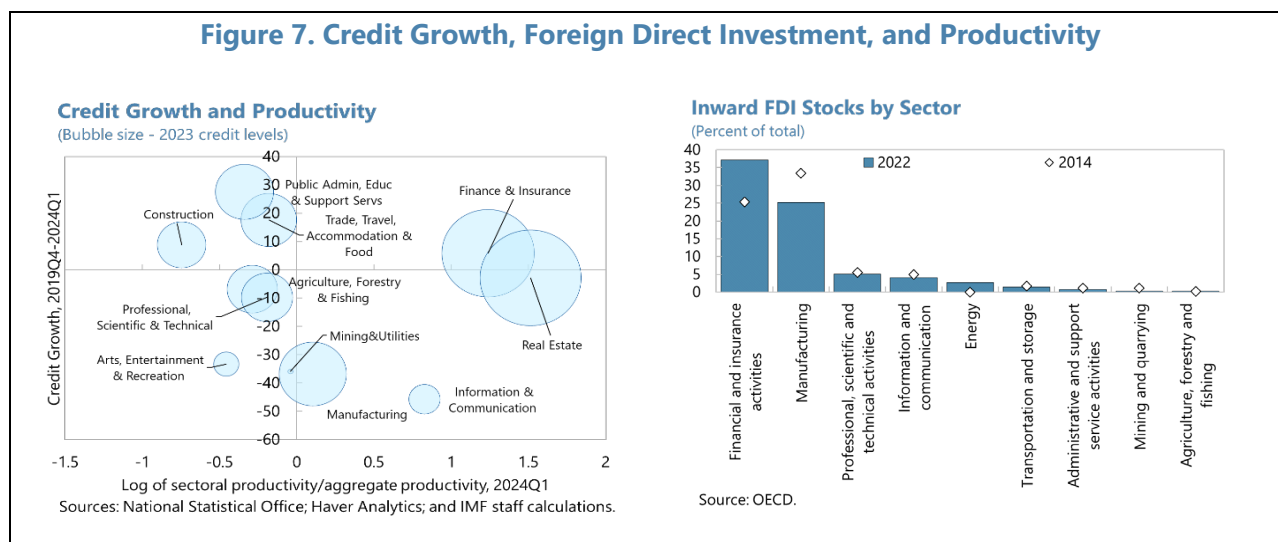


Figure 7. Credit Growth, Foreign Direct Investment, and Productivity



Economy-Wide And Sector-Specific Hurdles: The Distance To The EU Frontier

12. The multifaceted nature of the structural obstacles to productivity growth calls for a multi-pronged approach to effectively revert trends. Policies will need to deal separately with all three stylized facts highlighted above: economy-wide frictions, specific sector-level bottlenecks, and inefficient allocation of resources. Such policies ought to be firmly anchored in appropriate diagnostics for each of these challenges. We begin with an econometric analysis to shed light on economy-wide and sector-specific issues.

13. We explore the common drivers of TFP growth drawing on industry-level productivity developments. Following Scarpetta and Tressel (2002), Nicoletti and Scarpetta (2003), Griffith et al. (2004), Acemoglu et al. (2006), Aghion and Howitt (2006), McMorro et al. (2010) and Dabla-Norris et al. (2015), we model industry-level TFP growth using the following baseline specification:⁵

$$\Delta y_{ijt} = \beta_0 + \beta_1 \Delta y_{Ljt} + \beta_2 (y_{ijt-1} - y_{Ljt-1}) + \beta_k \sum_k X_{ijt-1}^k + \eta_i + \gamma_j + \mu_t + \varepsilon_{ijt}$$

in which Δy_{ijt} is TFP growth in country i and industry j at time t . Δy_{Ljt} denotes the TFP growth frontier in the EU, which is measured by the highest level of TFP growth in industry j at time t . The TFP growth frontier captures the extent to which countries are involved in comparable scientific and technological innovation as the leader country or benefiting from knowledge spillovers. $(y_{ijt-1} - y_{Ljt-1})$ is the technological gap defined as the TFP difference in country i and industry j at time t with respect to the EU frontier (highest level of TFP) in industry j at time t . This relative distance to the frontier represents the potential for increasing TFP by adopting new productivity-enhancing technologies. X_{ijt-1}^k is a vector of industry-level and country-level variables. Industry-level variables include ICT capital spending, non-ICT capital spending, and R&D spending, while country-level variables include consumer price inflation and domestic credit to the private sector. The coefficients η_i , γ_j and μ_t denote the time-invariant industry-specific effects and the time effects controlling for

⁵ We use comparable industry-level data—drawn from the EU-KLEMS dataset. Other data are drawn from IMF's World Economic Outlook (WEO) and the World Bank's World Development Indicators (WDI).

common shocks that may affect TFP growth across all industries at time t , respectively. ε_{ijt} is the idiosyncratic error term. The period used covers 1995-2020.

14. The results in Table 1 show that TFP growth in the Czech Republic is driven by TFP growth in frontier economies, but also the country's own capacity to adopt and develop innovation and technologies. More specifically, the findings reveal that:

- TFP growth at the frontier is positive and statistically significant across all industries in the tradable sector but insignificant in the non-tradable sector.⁶ In other words, the Czech Republic's tradable sector has been benefiting from innovation spillovers. The technological gap, measured by a country's TFP distance to the frontier, is also a significant factor in determining TFP growth. In other words, the effective adoption of existing technologies at the sectoral level has constituted a powerful engine for convergence.
- R&D spending as a share of gross fixed investment appears to have a positive effect on TFP growth across all sectors but the impact is statistically significant only for the non-tradable sector (and the magnitude of this effect is also greater for non-tradables). This finding indicates that the Czech Republic's own innovation efforts are relevant, and an increase in intangible capital could be associated with higher TFP growth in the services sector.
- ICT capital spending as a share of gross fixed investment is positively associated with higher TFP growth, but its impact is not statistically significant. Similarly, non-ICT capital spending (proxied by transportation equipment in this study) as a share of gross fixed investment does not appear to matter for TFP growth in the Czech Republic across all specifications.
- As for the country level variables, inflation appears to have a negative but significant effect on TFP growth across all industries and in the tradable sector, but an insignificant effect in the non-tradable sector. Financial development, as measured by domestic credit to the private sector, appears to have a positive but insignificant effect on TFP growth across all specifications.

⁶ Tradable sectors include agriculture, forestry, fishing, mining, quarrying, and manufacturing; while non-tradable sectors include construction, wholesale and retail trade, transportation, storage, accommodation, food service, ICT, finance, insurance, real estate, professional services, public sector, education, human health, social work, arts, entertainment, and recreation.

Table 1. Czech Republic: Industry-Level TFP Growth Estimations

	(1)	(2)	(3)
Dependent Variable: TFP growth	All	Tradables	Non-tradables
Industry-Level Variables			
TFP growth at frontier	0.133** (2.697)	0.203*** (4.188)	-0.104 (-0.972)
Technological gap	-13.40*** (-3.148)	-15.62** (-2.664)	-10.15** (-2.525)
ICT capital	1.944 (0.288)	5.508 (0.827)	3.105 (0.248)
Non-ICT capital	9.875 (1.274)	7.931 (0.670)	12.75 (1.621)
R&D spending	19.84 (1.594)	14.50 (0.933)	51.11* (1.931)
Country-Level Variables			
Inflation	-0.746** (-2.630)	-0.826* (-1.845)	-0.521 (-1.315)
Financial development	0.131 (1.639)	0.0763 (0.731)	0.137 (1.494)
Number of observations	628	353	275
Adjusted R2	0.144	0.179	0.239
Robust t-statistics in parentheses; a constant is included in all specifications but not shown. *** p<0.01, ** p<0.05, * p<0.1			

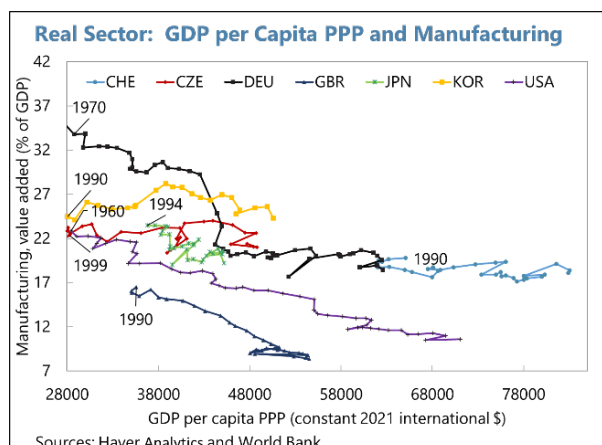
15. Results suggest that structural policies could support productivity growth. Encouraging use of existing tax credits for R&D would support innovation. This would help the Czech Republic to benefit from broader diffusion of new and existing technologies, resulting in positive spillovers across industries. Also, upgrading capacity in new technologies can boost productivity growth by narrowing the technological gap vis-à-vis the frontier.

16. Findings also indicate that sectoral productivity is likely to converge toward the frontier, if bottlenecks in underperforming sectors are effectively addressed. Significant convergence opportunities exist within sectors, enhancing value through upgrading of processes and products, adoption of existing technologies, and leveraging of knowledge spillovers. Expediting processes, especially at the local administration level, would be critical to address bottlenecks in the construction sector and scale up renewable investments in the energy sector.

Towards Productivity-Enhancing Structural Transformation

17. Sustained resource reallocation across sectors is a common occurrence across mature economies.

The manufacturing sector, which still represents 21 percent of the Czech economy, has declined as a share of GDP since 2017. To varying degrees, other manufacturing-led economies have also experienced a decline in their manufacturing share as they progressed towards higher income levels (see text chart). International experience shows a hump-shaped relationship between industrialization and income convergence⁷. The decline in the share of employment is typically even more pronounced.⁸



This natural process, compounded with the challenges of global competition and the relatively high cost of energy, will make it difficult for manufacturing to remain a dominant engine of growth for the Czech Republic.

18. Though structural transformation may be inevitable, it does not need to adversely affect productivity as observed in recent years. The Czech Republic may evolve towards a more mature, diversified economy with certain services playing an increasingly significant role. Historical evidence indicates that a higher share of services in the economy does not necessarily correlate with lower productivity growth⁹. The services sector itself comprises subsectors with different productivity levels and growth rates. Therefore, the impact of shifts in employment shares on aggregate productivity will depend on which specific subsectors are leading the transformation.

19. These are especially favorable times for selected services subsectors. While increasing restrictions in global trade have constrained goods trade, global services exports have expanded. Digitally delivered services have seen exceptional growth in recent years. Recent advances in technology have encouraged tradability and the international outsourcing¹⁰. Artificial intelligence may further accelerate this process.

⁷ For example, see Amirapu and Subramanian (2015).

⁸ Lawrence (2024).

⁹ IMF (2018).

¹⁰ Ruta and Jakubik (2023).

20. The Czech Republic has not fully capitalized on these opportunities so far.

Productivity in these sectors has grown fast. However, constrained resources have prevented output to expand further. Services exports have fallen behind those of peers, despite the Czech Republic's cost advantages (Figure 8). Even high value-added professional services, including those oriented towards domestic markets, have lagged Europe over the past two years.

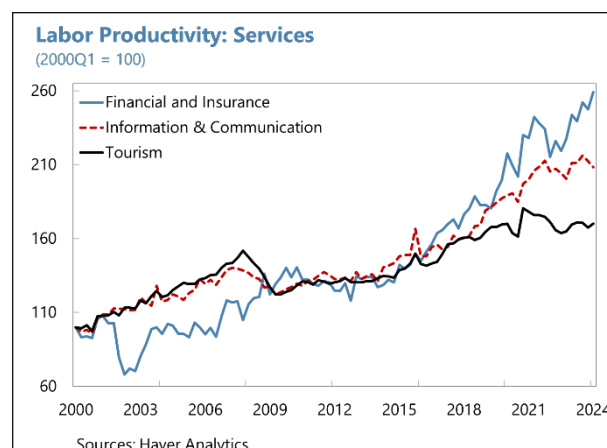
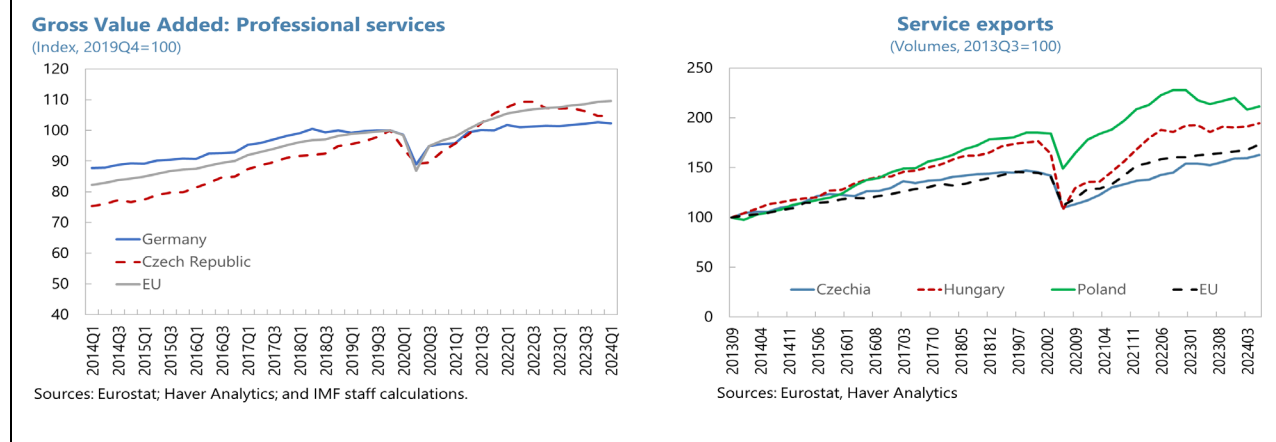


Figure 8. Gross Value Added and Services Exports



21. There is scope for policies to support productivity-enhancing reallocation. The sustained expansion of the public administration should be contained going forward, including at the municipality level. More targeted active labor market policies would facilitate reallocation towards high-productivity sectors. Migration policies can be used to better integrate workers in these sectors. Restrictions for some professional activities should be lifted. Finally, there is significant scope for enhancing adoption of digital technologies and expanding digital infrastructures, including broadband.

22. Also, steps could be taken to unleash investment in promising sectors. Barriers to start new businesses are relatively high, with the Czech Republic faring unfavorably in international rankings¹¹. This results in low company birth rates compared to other European countries. Lack of collateral or credit track record limits access to bank funding, creates a financing gap for early-stage innovative companies operating in dynamic sectors (OECD, 2020). Expanding availability of venture

¹¹ Czech National Bank (2024).

capital and equity financing would boost opportunities for startups and allow young firms to scale up.

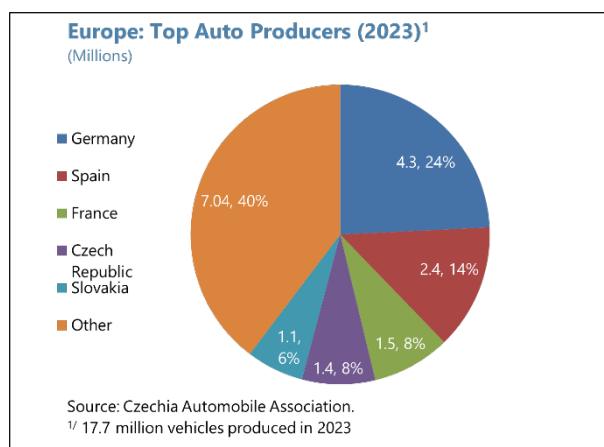
23. In summary, policies must tackle various dimensions of the Czech Republic's slowdown in structural productivity slowdown. First, there is potential for broad improvement in the investment climate, particularly by simplifying the process of starting businesses and attracting seed capital. Second, it is essential to address bureaucratic hurdles around construction permits and renewables investment. Lastly, policies can help mobilize resources towards more productive and dynamic sectors through more targeted active labor market policies. A well-rounded, concrete policy agenda could yield synergistic effects, helping to reverse the recent stagnation in the convergence process.

References

- Acemoglu, D., F. Zilibotti, and P. Aghion (2006). "Distance to Frontier, Selection and Economic Growth," *Journal of the European Economic Association*, Vol. 4, pp. 37–74.
- Aghion, P., and P. Howitt (2006). "Appropriate Growth Policy: A Unifying Framework," *Journal of the European Economic Association*, Vol. 4, pp. 269–314.
- Amirapu, A, and Subramanian A. (2015). "Manufacturing or Services: an Indian Illustration of a Development Dilemma," Center of Global Development Working Paper.
- Dabla-Norris, E., S. Guo, V. Haksar, M. Kim, K. Kochar, K. Wiseman, and A. Zdzienicka (2015). "The New Normal: A Sector-Level Perspective on Productivity Trends in Advanced Economies," IMF Staff Discussion Note No. 15/03 (Washington, DC: International Monetary Fund).
- Caceres, C., B. Gruss, and S. Weber (2021). "Decomposition Methodology," Annex 2.1 in Regional Economic Outlook for Europe, October.
- Czech National Bank (2024). "The Slowdown in Long-term Growth of the Czech Republic," Appendix in Monetary Policy Report, Summer.
- Griffith, R., S. Redding, and J. Van Reenen (2004). "Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries," *Review of Economics and Statistics*, Vol. 86, pp. 883–895.
- IMF (2018). *World Economic Outlook*, Chapter 3, April 2018.
- Lawrence, R. (2024). "Behind the Curve: Can *Manufacturing* Still Provide Inclusive Growth?," Peterson Institute for International Economics.
- McMillan, M., and Rodrik D, (2011) "Globalization, Structural Change and Productivity Growth," NBER Working Papers 17143, National Bureau of Economic Research.
- McMorrow, K., R. Werner, and A. Turrini (2010). "Determinants of TFP Growth: A Close Look at Industries Driving the EU-US TFP Gap," *Structural Change and Economic Dynamics*, Vol. 21, pp. 165–180.
- Nicoletti, G., and S. Scarpetti (2003). "Regulation, Productivity and Growth: OECD Evidence," *Economic Policy*, Vol. 18, pp. 9–72.
- OECD (2024). "Strengthening FDI and SME Linkages in Czechia," OECD, Paris.
- OECD (2020). *OECD Economic Surveys Czech Republic*, OECD Paris.
- Ruta, M., and Jakubik, A. (2023). "Why Digital Trade Should Remain Open?," IMF Blog.
- Scarpetta, S. and T. Tressel (2002). "Productivity and Convergence in a Panel of OECD Industries: Do Regulations and Institutions Matter?" OECD Economics Working Paper No. 342 (Paris: Organization for Economic Co-operation and Development).

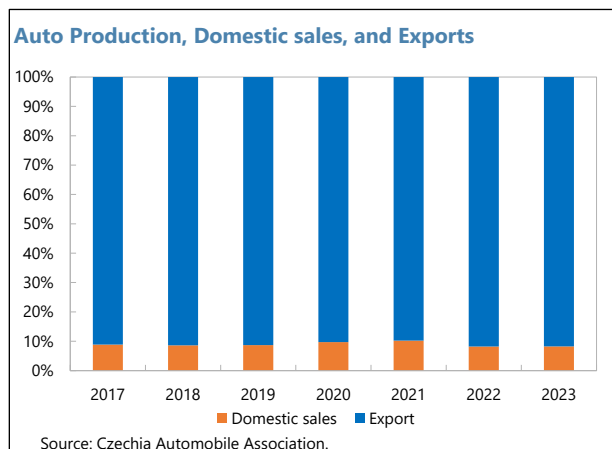
THE ROLE OF THE AUTO INDUSTRY IN THE CZECH REPUBLIC'S ECONOMY

1. The automotive industry plays a key role in the Czech Republic's economy, contributing to a large share of the country's value added, employment, and exports. In 2023, the automotive sector accounted for approximately 10 percent of the country's GDP, the highest share of total value added in Europe. In addition, the sector provided substantial employment opportunities, with over 200 thousand people (around 3.7 percent of total employment) working directly in the industry. The number more than doubles (434 thousand or 8 percent of total employment) when accounting for workers indirectly employed in downstream industries (Ministry of Finance, 2024). Furthermore, the Czech Republic is one of the largest car exporters in Europe, with automotive exports representing nearly 20 percent of the country's total exports in 2023.¹



2. The strong links of the auto industry with both domestic production and international trade, magnifies its role in the economy. Production of vehicles uses intermediate goods (components and materials used in production) from other domestic sectors and from abroad. Around 50 percent of the sector's value added is generated using domestic intermediate inputs, which indirectly multiplies the contribution of the auto industry as it supports other local sectors. In addition, the industry has strong linkages with export markets. Around 20 percent of the value added from auto parts and accessories are exported to Germany, followed by France (9 percent) and Poland (4.5 percent).

3. In recent years, the industry has faced several challenges in an increasingly competitive global landscape. Rising global competition, particularly from China and emerging markets with lower production costs, puts pressure on Czech manufacturers to maintain their competitive edge. The bulk of the sector's production is exported. After being affected by the pandemic and supply disruptions, including shortages of critical parts and accessories such as semiconductors which have slowed down

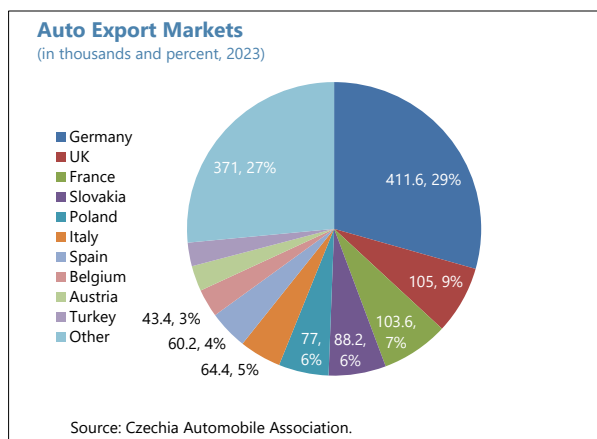


¹ The automotive industry includes the production of motor vehicles and the manufacture of parts and accessories.

manufacturing processes, production returned to its pre-pandemic level in 2023. However, the industry is still grappling with rising energy costs, which affects operational expenses, particularly in energy-intensive production stages. Another key issue is the shortage of skilled labor, as rapid technological advancements in the industry require a workforce with specialized skills that are currently in short supply. Addressing these challenges is crucial for the continued success of the Czech auto industry. It is worth noting that the automotive industry in Europe is facing similar challenges (Box 1).

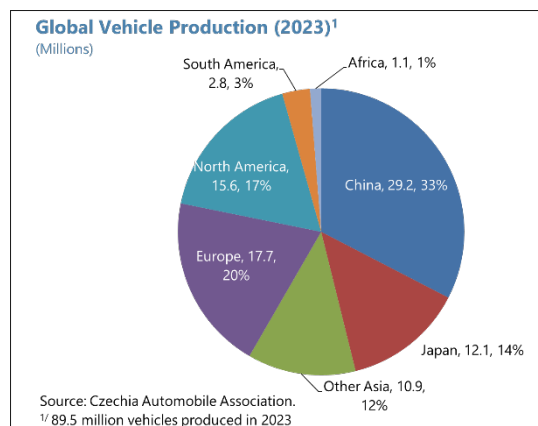
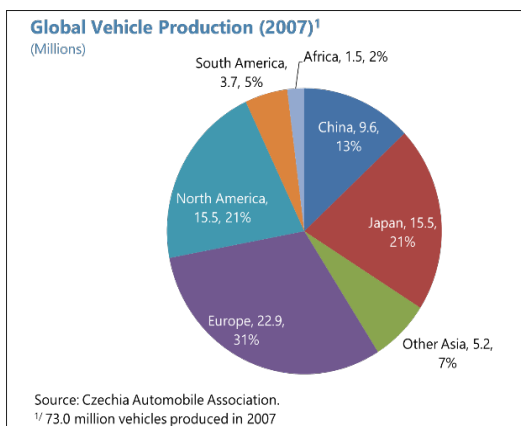
4. Regional concentration of the auto industry’s exports increases the vulnerability of the Czech economy to shocks.

A large portion of automotive exports is directed towards the European Union, particularly Germany, which is the Czech Republic's largest trading partner. This heavy reliance on a few key markets exposes the industry to external demand fluctuations, trade policy changes, and geopolitical tensions. This lack of geographic diversification limits the industry's resilience and reduces the ability to adapt to changing global market dynamics. It also underscores the need for strategic measures to diversify both the geographical and industrial bases of the Czech Republic.



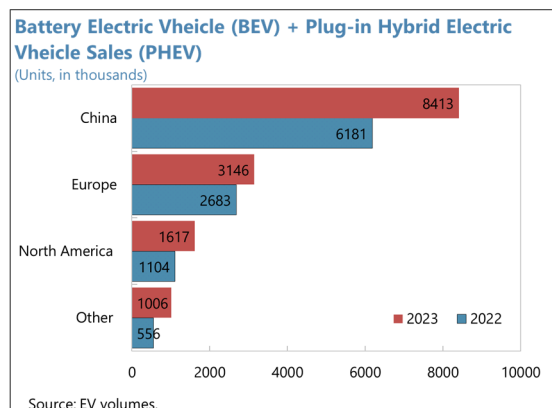
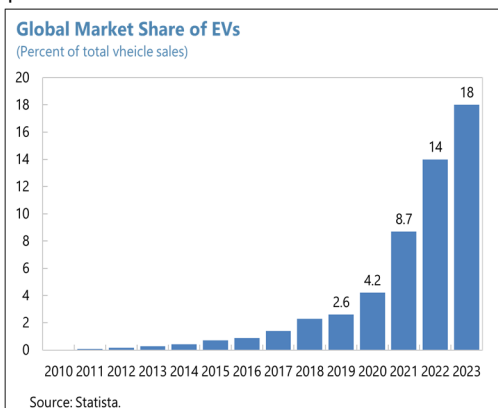
Box 1. Europe’s Auto Industry

Europe's auto industry is facing similar challenges. Europe's once-dominant position in the automotive industry has diminished over the last two decades, reflecting a notable decline in its share of global auto production. This was driven by a combination of factors including increased competition, shifting consumer preferences, and the rise of emerging markets as key auto producers. As automakers in countries like China and India ramped up production capabilities, they captured a significant portion of the market, often offering more affordable vehicles. Additionally, European manufacturers faced higher compliance to environmental requirements and higher labor costs, which hindered their competitiveness.



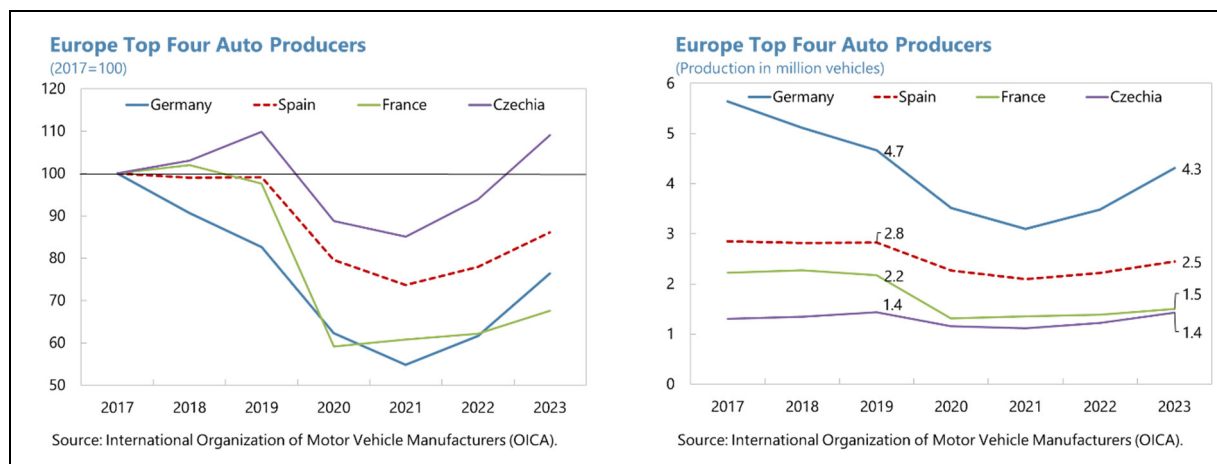
Box 1. Europe’s Auto Industry (Concluded)

The transition towards electric vehicles (EVs) has added further complexity to the future of Europe’s auto industry. As European companies strive to innovate while contending with new entrants that are agile and less encumbered by legacy systems. In addition, as governments and consumers increasingly push for cleaner, more sustainable transportation, traditional automakers face the challenge of shifting from internal combustion engine production to EV manufacturing. This transition requires significant investments in new technologies, production facilities, and the retraining of a skilled workforce and will likely put financial strain on many companies. Furthermore, the supply chain for EVs also faces challenges in securing raw materials like lithium and cobalt for batteries, which are in high demand globally. The rise of new competitors, especially from tech-driven companies and manufacturers in Asia, is intensifying competition in an already saturated market. While this shift presents long-term environmental benefits, it complicates the immediate outlook for Europe's auto industry as it navigates technological, financial, and geopolitical hurdles.



The Road Ahead

5. The global auto industry is recovering following multiple setbacks in recent years. The pandemic and the wars in Ukraine and the Middle East disrupted supply and shipping, while elevated inflation and high interest rates dampened consumer demand. The recovery was partly driven by strong demand in the US and mainly by a stronger than expected sales of EVs in 2023. Growth of new car sales is expected to continue and by 2028 global sales are expected to reach around 109 million vehicles, surpassing the 2017 peak of 95 million (EIU 2024).



6. The Czech Republic’s automotive industry managed to recover from the 2020-21 dip.

In Europe, the recovery is uneven, with the Czech Republic being the only country to have reached pre-pandemic production levels in 2023. This reflects only a gradual shift of the product mix from combustion engine vehicles to electric vehicles (EVs) in response to market conditions, combined with expansion in some fast-growing European markets (e.g., Poland), and a flexible production cost structure compared to other top European producers.

7. However, the global auto industry is undergoing a major transformation as the share of EVs in total production is expected to increase significantly.

This also reflects auto producers’ efforts to meet decarbonization targets by shifting production away from internal combustion engines (ICE) vehicles. It is projected that share of new EVs in total sales will increase from 18 percent in 2023 to 35 percent by 2028, with China accounting for over half of the sales (EIU 2024).

8. China’s dominance in the EV industry triggered trade tensions. China’s state subsidies and investments strongly supported the advancement of EV production, as ICE vehicles are expected to be phased out by 2035.² This emerging dominance is facing increasing trade barriers by the US, EU and other countries, which are increasing tariffs and local-content requirements to protect local producers and encourage investment in local supply chains, including EV charging networks, batteries, semiconductors and critical earth minerals.³

9. Against this background, the implications for the Czech Republic are significant and multifaceted. The auto industry will need to align its manufacturing practices with the EU CO₂ emission reduction targets for vehicles⁴. Compliance with these targets will require substantial changes in production processes and will necessitate significant investments in new technologies, a challenge for an industry significantly invested in ICE vehicle production.

10. According to model simulations, the Czech Republic’s auto industry would suffer the largest loss in terms of GDP among European producers from an “EV shock”. Three simulations were carried out to assess the impact of: (i) an EV-shock aimed at increasing China's share of EU automotive spending by 15 percentage points over five years; (ii) a protectionist response to the growing market presence of Chinese EVs; and (iii) delivering Chinese EVs to the EU market through foreign direct investment (FDI) (Wingender et. al, 2024)

- EV Shock: while the overall impact on Europe is minor, there is significant variation among individual countries. The results show that the losses for the Czech Republic over the short- to medium-term are equivalent to around 1.5 percent of GDP. While availability of cheaper Chinese EVs benefit consumers, the shift in demand from ICE vehicles results in decreased production in the Czech Republic. What makes losses more pronounced is the heavy dependence of the economy on

² According to EIU (2024), China overtook Germany as the world’s second-largest auto exporter in 2022 and overtook Japan as the top exporter in 2023.

³ The EU imposed additional tariffs ranging between 17.4 and 38.1 percent, on top of existing 10 percent EU (most-favored nation) tariffs on car imports.

⁴ Regulatory compliance includes achieving a 55 percent reduction in CO₂ emissions for new cars and a complete transition to zero emissions by 2035.

the automotive sector, and the fact that the sector is capital-intensive and more productive relative to other sectors in the economy. The potential displacement of factors of production, including labor, resulting from a loss of competitiveness has therefore larger macroeconomic effects. The EV-shock poses significant challenges for the automotive-dependent economies of the EU, while the impact on other top producers (Germany, Spain, and France) is relatively modest as their economies are more diversified.

- **Protectionist Response:** while imposing additional tariffs on Chinese EVs reduces car imports from China, it also leads to more adverse effects for the Czech Republic both in the short- and the long-run. This is because: (i) consumers do not benefit from the cheaper EVs; (ii) a combination of tariffs and the large input-output links of the automotive sector end up raising the cost of intermediate goods such as batteries and car parts; (iii) tariffs also lead to an appreciation of the exchange rate, hurting overall exports; and (iv) the negative economic effects extend to the labor market, resulting in lower wages and employment in both the medium- and long-run compared to a non-tariff scenario. A spiral of retaliatory measures and trade wars would further amplify the adverse effects.
- **FDI Delivery:** if instead, higher EV demand was met by increased foreign direct investment (FDI) from Chinese firms establishing production directly in the Czech Republic, this would lead to reduced costs and mitigate GDP losses, as investment would increase compared to the EV shock scenario. The positive effects of FDI on GDP would be contingent upon the proportionality of FDI distribution across EU countries and the ability of the Czech Republic to attract investment effectively.

Enhancing The Resilience of The Czech Auto Industry

11. Several policy measures can be implemented to alleviate the potential economic impact and enhance the resilience of the Czech Republic's automotive industry. The industry faces the dual challenge of the green transition towards electric vehicles (EVs) and increased competition from Chinese manufacturers. Implementing policies that emphasizes innovation, workforce development, infrastructure, and carefully calibrated consumer incentives will support sustainable growth for the Czech automotive industry in evolving and competitive global markets.

- **Investment in Research and Development (R&D).** Provide financial incentives for domestic producers to invest in R&D for EV technology and battery development, including by improving the battery storage capacity to increase range and accelerate charging time. On the one side, these incentives can foster innovation and, on the other side, create competitive advantages.
- **Support for labor transformation.** Promote reskilling and upskilling programs to equip the labor force with the skills required for the EV sector, such as battery production and software development. Also, investing in job placement services to assist workers transitioning from traditional auto manufacturing jobs to new roles within the EV industry.
- **Infrastructure Development.** Expedite development of EV charging stations across the country to facilitate the transition to EVs and encourage consumer adoption. At the same time, continue to promote renewable energy sources for EV charging.

- *Trade and Investment Policies.* Continue to improve the business environment to attract foreign companies that produce EVs or components, including through streamlined regulations and procedures. Seek trade arrangements to favor Czech exports in EV-related technologies and component.
- *Consumer Incentives.* Introduce tax breaks and subsidies for EV purchases to stimulate demand for locally produced vehicles.
- *Marketing and Branding.* Promote a comprehensive marketing and branding strategy. This could include developing a strong brand identity, highlighting what makes the auto industry of the Czech Republic distinct, such as quality craftsmanship and expertise behind Czech automotive manufacturing.

Implementing these strategies would enhance the Czech Republic's ability to efficiently allocate resources towards auto production. With its existing skilled labor force and established supply chains, the Czech auto industry can further its global competitiveness and effectively gain market share.

References

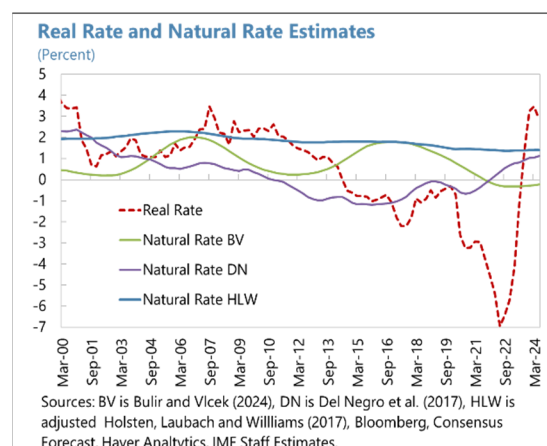
- Celasun, O., G. Sher, P. Topalova, and J. Zhou (2023). "Cars and the Green Transition: Challenges and Opportunities for European Workers," IMF Working Paper No. WP/23/116 (Washington, DC: International Monetary Fund).
- Czechia Automobile Association (2024). Global Passenger Cars Production and Sales. Czech Republic.
- Czechia Automobile Association (2024). Production in the Czech Republic. Czech Republic.
- Czechia Automobile Association (2024). Export of the Czech Automotive Industry. Czech Republic.
- EIU Viewpoint (2024). Automotive World. Economic Intelligence Unit, June 30 2024.
- Global market share of electric vehicles within passenger car sales between 2014 and 2023 (2024). Statista+ Services.
- IEA (2024), Global EV Outlook 2024, IEA, Paris <https://www.iea.org/reports/global-ev-outlook-2024>, Licence: CC BY 4.0.
- Ministry of Finance (2024). "Automotive Industry and e-Mobility" Macroeconomic Forecast of the Czech Republic, April 2024.
- Wingender, P., J. Yao, R. Zymek, B. Carton, D. Cerderio, and A. Weber (2024). "Europe's Shift to Electric Vehicles Amid Intensifying Global Competition," IMF Working Paper No. WP/24/218 (Washington, DC: International Monetary Fund).

THE CZECH REPUBLIC'S NATURAL RATE OF INTEREST

- 1. The real natural or neutral interest rate r^* is a key concept to gauge the monetary policy stance.** It is typically defined as the level of the real short-term interest rate that would keep output at potential and inflation at target.¹
- 2. Thus, the policy stance is accommodative if $r < r^*$ and restrictive if $r > r^*$.** Accordingly, central banks aim to set the real rate close to the natural rate over the medium to long-term. However, the natural rate is unobservable and difficult to estimate given that it varies with the state of the economy and unobserved shocks.
- 3. This note estimates the natural rate of interest for the Czech Republic using three different approaches, discuss uncertainty, drivers, and policy implications.** Diverging estimates across the approaches demonstrate the large uncertainty around the natural rate and thus the difficulty for policy makers to pursue an appropriate policy stance. Finally, the note discusses the outlook for the natural rate in the near and medium term and focuses on policy implications for monetary and fiscal policy.

4. The natural rate is estimated following the approaches in Holsten, Laubach and Williams (2017), Bulir and Vlcek (2024) and Del Negro et al. (2017).²

The semi-structural model of Holsten, Laubach and Williams, from now on HLW, is a linearized New Keynesian model including a Phillips curve and an IS curve, where trend output is the key driver of the natural rate via households' Euler equation. It is a usual starting point for natural rate estimations. This note uses a version that produces a natural rate that includes some persistence, and which thus can be thought of as a medium to long-term estimate of the natural rate. Bulir and Vlcek (2024), from now on BV, extend the approach to an open-economy setting following among others Mesonnier and Renne (2007), Hledik and Vlcek (2018), and Wynne and Zhang (2018). In this setup, not only higher domestic potential growth can increase the natural rate, but also higher foreign growth via higher foreign interest rates. Secondly,



¹ 'Neutral' and 'natural' interest rate are often used interchangeably. However, the neutral interest rate is the non-inflationary rate of interest while the natural interest rate is the long-run flexible-price equilibrium rate of the real interest rate, in other words the steady state level of the neutral rate (Obstfeld, 2023).

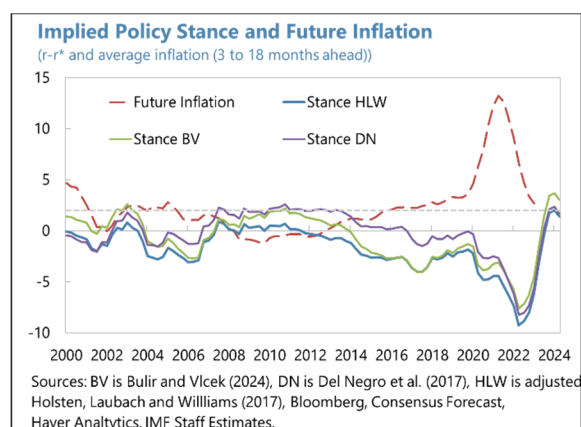
² The literature has used several approaches, from simple statistical filters (Beyer and Milivojevic, 2023), over semi-structural (Holsten, Laubach and Williams, 2017, 2023) to fully structural DSGE models (Del Negro et al, 2017; Platzer and Peruffo, 2023), over time-varying VAR models (Matthes and Lubik, 2023) to term structure models (Hördahl and Tristani, 2014) and factor models (Del Negro et al, 2017, 2019). This annex estimates the natural rate following an adjusted version of Holsten et al., 2017, Bulir and Vlcek (2024) and Del Negro et al. (2017).

for converging economies such as the Czech Republic part of the higher equilibrium growth can be reflected in an equilibrium appreciation which would limit the effect on the real interest rate, and which is not picked up in HLW. Finally, Del Negro et al. (2017), from now on DN, estimate a factor model that decomposes observable variables like inflation, inflation expectations, and interest rates into cyclical and trend components. The approach uses fewer restrictions by assuming a set of cointegrating relationships between the financial variables and their trends instead of assuming a linear relationship between r^* and trend growth as HLW and BV do. The structural relationships linking to interest rates are often weak in the data (see e.g. Hamilton et al., 2016) such that a more parsimonious time-series approach like DN can add value to a reasonable estimation of r^* .

5. The three approaches estimate the natural rate in a range of 0 to 1.5 percent in 2024.

The HLW approach estimates the natural rate for Q2 2024 slightly below 1.5 percent, the DN approach at slightly above 1 percent and the BV approach at slightly below 0 percent. While all approaches show a declining trend of r^* over the sample in line with the evolution of the real rate, the cyclical nature of each series is quite different. The DN approach picks up the most recent increase in rates while the other two series show no

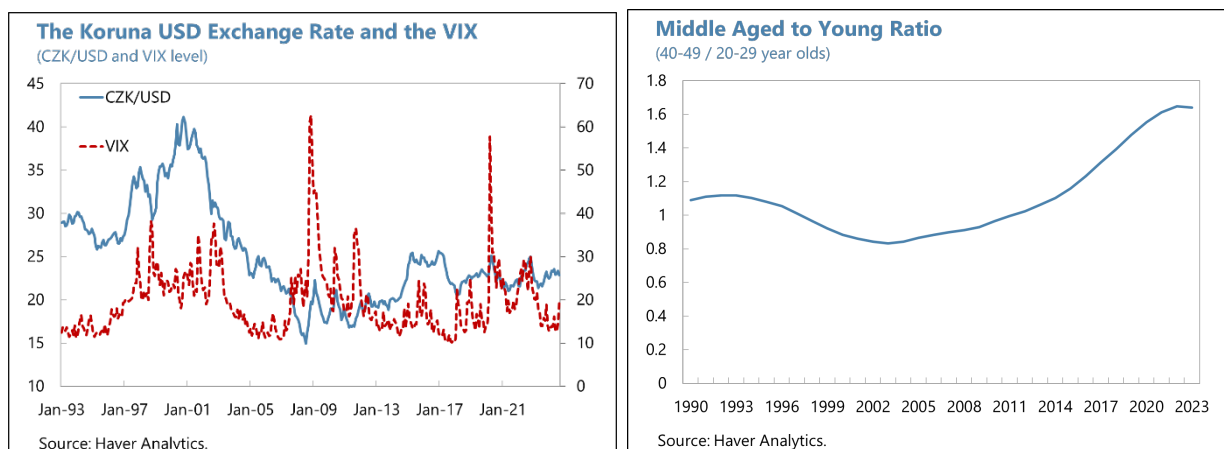
discernible increase over the last years. The HLW estimates, given the choice of added inertia to the natural rate deterministic, display almost no variation at higher frequencies and the BV estimates show a cyclical nature that is driven by the real koruna-euro exchange rate. For instance, the most recent dip around 2022 is driven by the real koruna appreciation as Czech inflation above 15 percent in 2022 was higher than euro area inflation at below 10 percent.



6. Estimating r^* comes with a significant degree of uncertainty. On average, the three estimates diverge by more than 1 percent while at times they diverge by up to 3 percent. Moreover, the chart abstracts from estimation uncertainty which would put 90 percent confidence bands of around ± 0.75 percent size around the DN approach for instance. Finally, the results are sensitive to the use of interest rate series (type and maturity), the use of inflation expectations (survey- vs. model-based), the parameter and prior specification during the estimation and the sample start.

7. The implied policy stances signal future inflation dynamics. The unobservable nature makes it difficult to judge which measure provides the best estimate and to judge what best means. However, a good measure of r^* should signal if the policy stance is tight or too loose which would in turn have implications for future inflation and growth. For instance, a loose policy stance, measured as $r-r^* < 0$ should lead to higher inflation and output. Plotting the implied policy stance of the three measures against future inflation over a monetary policy-relevant horizon of up to 18 months shows that a loose (tight) stance is indeed associated with increasing (decreasing) inflation. Relating the three stance measures to future inflation the DN measure produces the largest correlation of 0.9, followed by 0.8 using the HLW-implied stance and 0.72 using the BV stance.

8. The natural rate is driven by both structural and policy factors that affect savings and investment and vary over time. The HLW approach links r^* not only to potential growth but also to a second factor that, without any specification, comprises further drivers potentially linked to structural and policy variable. These factors can be, for instance, demographics, fiscal policy, or foreign conditions, while it is explicitly limited to the exchange rate in BV. The three approaches show a decreasing trend in r^* since the GFC until at least 2019. A large literature has focused on the global decline in natural rates since the 2000s with prominent explanations like the global savings glut (Bernanke) and the related shortage of safe and liquid assets, the secular stagnation, the demographic transition, or lower potential growth. The first note in these Selected Issues Papers shows that productivity growth has decreasing for the Czech Republic since 2008. If the current shortfall in Czech demand were to extend for a protracted period and secular stagnation conditions were to emerge, then excess savings would drive the natural rate down. Similarly, increased global risk aversion and demand for safe assets would likely lead to higher global savings, exerting downward pressure on global rates and ultimately on the Czech natural rate. On the other hand, demand for safe assets would also result in a weaker koruna, requiring local policy rates to rise to counter the effect of higher imported inflation. However, it is unclear whether the latter effect would be sufficient to offset the former. Demographic shifts can also play an important role for the demand for savings and thus interest rates. In the Czech Republic the ratio of middle-aged prime savers to young individuals has increased from below 0.9 in 2006 to 1.64 in 2023 putting downward pressure on the natural rate.³ However, the ratio of the retired to the working age population has also increased from 19 to 32 percent from 1990 to 2023 which signals lower demand for savings.



9. Additional factors, such as the energy transition, geoeconomic fragmentation, AI-driven productivity growth or heightened global uncertainty will also influence r^* going forward. Czech Republic's high dependence on fossil fuels requires a significant energy transition whose costs could exert downward pressure on growth and thus on r^* , while higher investment needs would increase r^* . The reshoring and diversification of value chains related to possible larger geoeconomic fragmentation would increase costs, lowering potential, and thus put downward

³ We refer to the MY ratio of 40-49- to 20-29-year old individuals which is found by Favero et al. (2016) as a good proxy for demographics when linking them to real interest rates for the US.

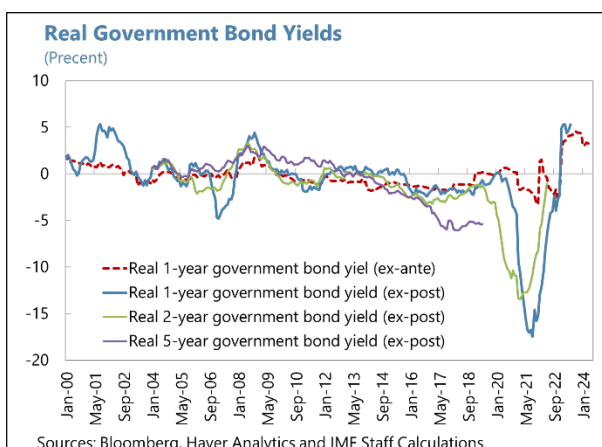
pressure on r^* .⁴ Moreover, higher global uncertainty related to geoeconomic fragmentation and more prevalent global supply shocks affecting commodity markets would increase demand for savings and add to downward pressure. On the other hand, increased energy efficiency and AI-led technology could boost growth and r^* , while higher defense spending and other government spending could further add to those upward pressures.

Table 1. Czech Republic: Drivers of r^*

Decreasing pressure on r^*	Increasing pressure on r^*
Demographics	Higher public investment (e.g., from the energy transition and defense)
Lower growth (e.g., from supply-chain reshoring and the energy transition)	AI-led technological growth
Higher global uncertainty and higher demand for safe assets	Vanishing safe asset status of government bonds' (increasing government debt)
	Retrenchment of global savings glut

10. The natural rate has important policy implications for both monetary and fiscal policy.

The current estimate of r^* around 1 percent implies a terminal rate for monetary policy at around 3 percent given inflation expectations and actual inflation close to 2 percent. This implies that at the current rate of 4 percent monetary policy is still tight, leaving further room to lower policy rates. If r^* were to drop close to 0, the role of monetary policy would be limited to stabilize the business cycle and there would be an increased need for unconventional policies for the Czech Republic as during the 2013-17 period. For fiscal policy, real rates around 1 percent would imply considerably larger debt service payments than observed during 2016-23 when real ex-post yields on government bonds have been negative.



⁴ Over time, however, better energy efficiency and integrated value chains should boost growth and unwind the downward pressure from related the transition costs. Moreover, higher investment spending related to reshoring would buffer downward pressures on r^* .

References

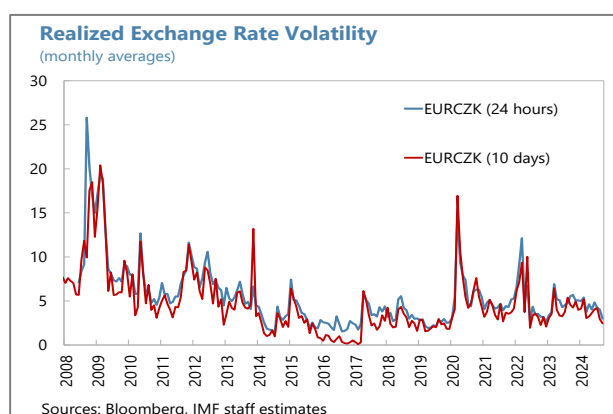
- Beyer, Robert C. M. and Lazar Milivojevic, 2023. "Dynamics and Synchronization of Global Equilibrium Interest Rates," *Applied Economics*, Taylor & Francis Journals, vol. 55(28), pages 3195-3214, June.
- Bulíř, Aleš and Jan Vlcek, 2024. "The Mirage of Falling R-stars," IMF Working Papers 2024/161, International Monetary Fund.
- Favero, Carlo A. and Arie E. Gozluklu & Haoxi Yang, 2016. "Demographics and the Behavior of Interest Rates," *IMF Economic Review*, vol. 64(4), pages 732-776, November.
- Del Negro, Marco, Domenico Giannone, Marc P. Giannoni, and Andrea Tambalotti. "Safety, Liquidity, and the Natural Rate of Interest." *Brookings Papers on Economic Activity* 48 (no. 1, 2017): 235-94.
- Hamilton, James D., Ethan S. Harris, Jan Hatzius, and Kenneth D. West. "The Equilibrium Real Funds Rate: Past, Present, and Future." *IMF Economic Review* 64 (November 2016): 660-707.
- Hledik, Tibor and Jan Vlcek, 2018. "Quantifying the Natural Rate of Interest in a Small Open Economy - The Czech Case," Working Papers 2018/7, Czech National Bank.
- Holston, Kathryn, Thomas Laubach, and John C. Williams. "Measuring the Natural Rate of Interest: International Trends and Determinants." *Journal of International Economics* 108 (May 2017): 559-75.
- Holston, Kathryn, Thomas Laubach, and John C. Williams. "Measuring the Natural Rate of Interest after COVID-19." Manuscript, Federal Reserve Bank of New York, May 2023.
- Hördahl, Peter and Oreste Tristani, 2014. "Inflation Risk Premia in the Euro Area and the United States," *International Journal of Central Banking*, International Journal of Central Banking, vol. 10(3), pages 1-47, September.
- Lubik, Thomas A. and Christian Matthes, 2023. "The Stars Our Destination: An Update for Our R* Model," *Richmond Fed Economic Brief*, Federal Reserve Bank of Richmond, vol. 23(32), September.
- Mesonnier, Jean-Stephane & Renne, Jean-Paul, 2007. "A Time-Varying "Natural" Rate of Interest For The Euro Area," *European Economic Review*, Elsevier, vol. 51(7), pages 1768-1784, October.
- Obstfeld, Maurice, 2023. "Natural and Neutral Real Interest Rates: Past and Future," NBER Working Papers 31949, National Bureau of Economic Research, Inc.
- Platzer, Josef and Marcel Peruffo. "Secular Drivers of the Natural Rate of Interest in the United States: A Quantitative Evaluation." Working Paper 2022/030, International Monetary Fund, February 11, 2022.
- Wynne, Mark A. and Ren Zhang. "Estimating the Natural Rate of Interest in an Open Economy." *Empirical Economics* 55 (November 2018): 1291-1318.

HOW MARKETS PERCEIVE MACROECONOMIC NEWS

1. The impact of economic news on asset prices varies across several dimensions. An extensive literature has shown that macroeconomic news announcements, such as employment and inflation data releases impact asset prices (Fleming and Remolona, 1999; Andersen et al. 2003; Goldberg and Leonard, 2003; Evans and Lyons, 2005; Faust et al. 2007). The impact on asset prices, i.e., on bond yields, exchange rates and stock prices, is heterogeneous across several dimensions, e.g., the type of announcement, the business cycle, and risk sentiment (e.g., Goldberg and Grisse, 2013; Gilbert et al. ,2017; Narayan et al, 2021). One such dimension of heterogeneity is the monetary policy reaction function. If markets perceive a change in central bankers' preferences, they will respond to macro news differently.

2. Asset prices may respond to changes in monetary policy frameworks. During recent periods of high inflation and elevated volatility, forecast-based inflation targeting—where the central bank adjusts policy based on deviations of its projections of medium-term inflation from target—has become less effective. In response to higher uncertainty and larger forecast errors, the Czech National Bank, like many other central banks, has moved towards a more data-dependent, meeting-by-meeting approach

3. ¹ (see e.g., Michl, 2023 for the CNB or ECB, 2024 for the ECB²). Adapting monetary policy frameworks to navigate new challenges can lead to a potential change in the response of asset prices to macroeconomic news.³ One indication of such change would be larger (in absolute size) asset price responses; another one would be greater volatility in asset prices to news releases with potential implications for financial stability and international trade.



4. This note applies an event-study approach to analyze financial market reactions to macroeconomic news and policy decisions. A simple regression approach is applied to estimate the effect of macroeconomic news (CPI and GDP) and domestic and foreign monetary policy surprises on the Czech koruna exchange rate, its volatility and different domestic market interest rates. Focus lies on the daily change in asset prices around the macroeconomic news and policy

¹ Data-dependent means to give less weight to baseline projections in the policy calibration and communication and more to the observed inflation dynamics and the strength of monetary transmission (Schnabel, 2024, https://www.ecb.europa.eu/press/key/date/2024/html/ecb.sp240417_1~c4cbe733df.en.html)

² Speech from October 17, 2023, by CNB Governor Michel (<https://www.bis.org/review/r231019a.htm>); ECB Press Release from September 12, 2024 (<https://www.ecb.europa.eu/press/pr/date/2024/html/ecb.mp240912~67cb23badb.en.html>)

³ Note that this change in monetary policy is directly linked to the large increase in inflation in 2022 which makes it difficult to disentangle effects from the more volatile inflation data and the change in communication.

decisions, that is the market reaction to the news. GDP and CPI news surprises as well as CNB monetary policy surprise decisions are taken from the Bloomberg economic calendar as the difference between the actual data announcement and the last survey estimate. ECB monetary policy surprises are intra-daily changes in the 1-month overnight index swap rates taken from the Euro Area Monetary Policy Event-Study Database (Altavilla et al., 2019) and Fed monetary policy surprises are 30-minute changes in expectations of the Federal Funds rate immediately after each FOMC meeting.⁴ To explore a potential change in market reactions under more data-dependent monetary policy, the market reactions are estimated separately for the period 2014-21 and 2022-24. Two potential caveats apply. First, an analysis on intra-daily windows, a few minutes around the events, could give different results, as it is clean of other potential news happening during the day. Secondly, the regressions do not control for the macroeconomic environment which leaves it open to debate how much of the differential responses pre- and post-2022 are due a different inflation environment, for instance, and how much to the change in monetary policy making.

5. Exchange rate volatility has increased in recent years. After relatively low levels of exchange rate volatility during the second half of the 2010s, volatility has spiked, most evidently in response to the Covid outbreak in early-2020 and to Russia's invasion of Ukraine in early-2022. On average, exchange rate volatility has been more than twice as high since 2020 compared to the previous five years.

6. Policy rate decisions have led to higher exchange rate volatility after 2021. Zooming in on asset price responses around macroeconomic data releases and monetary policy meetings, CNB rate decisions deviating from expectations have raised EUR/CZK volatility post-2021 more than three times as much as before (Figure 1).⁵ Surprise tightening of domestic monetary policy have led to larger Czech koruna appreciations than pre-2022. A 25-basis point surprise tightening is associated with an appreciation of the Czech koruna vis-à-vis the euro of 0.44 percent compared to 0.19 percent pre-2022. Conversely, CPI and GDP news different from expectations have not led to higher exchange rate volatility post-2021.

7. Domestic GDP and CPI news have had larger effects on domestic market interest rates post-2021. Post-2021, both positive CPI and GDP news have produced relatively larger increases in short-term interest rates (Figure 2). 1x4 Forward Rate Agreements, a proxy for short-term monetary policy reaction, show significantly stronger reactions post-2021. 2-year government bond yields do not show much of a differential response across the two sample horizons. The response of government bond spreads (e.g., 5-year Czech yields over German Bobl yields), however, changed significantly, indicating a different risk assessment by markets; positive CPI news produced larger increases and positive GDP news larger decreases in spreads post-2021. Stronger inflation raises domestic rates while stronger growth seems to lower the risk premium for domestic bond yields.

⁴ Federal funds rate surprises are received from Miguel Acosta's webpage. Data on ECB surprises run until September 2023 and on Fed surprises until November 2023.

⁵ Tables 1 and 2 in the appendix show the full regression results.

Figure 1. The Czech Koruna and Macro News

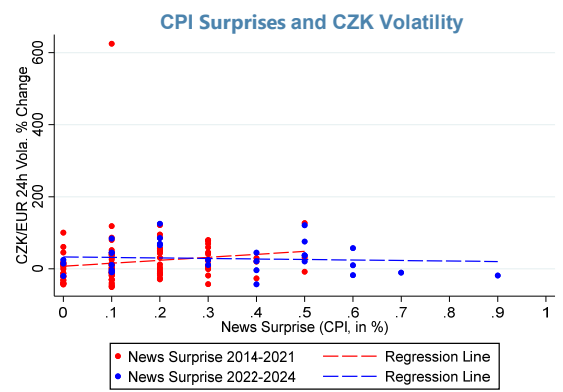
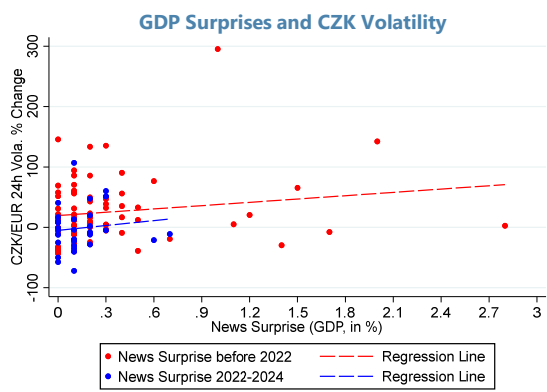
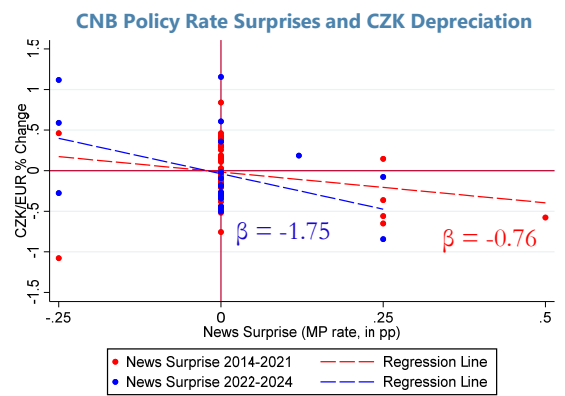
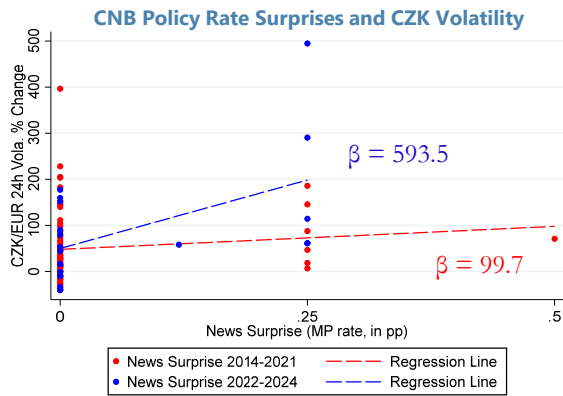
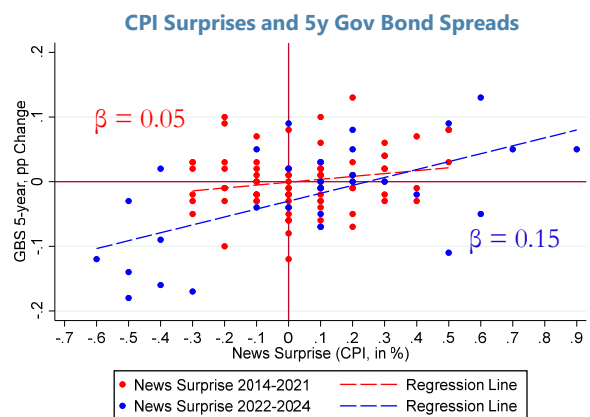
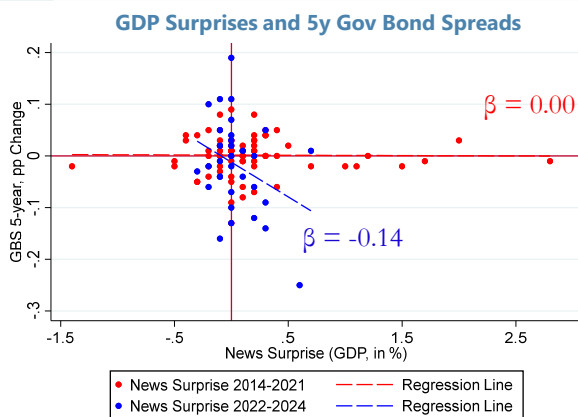
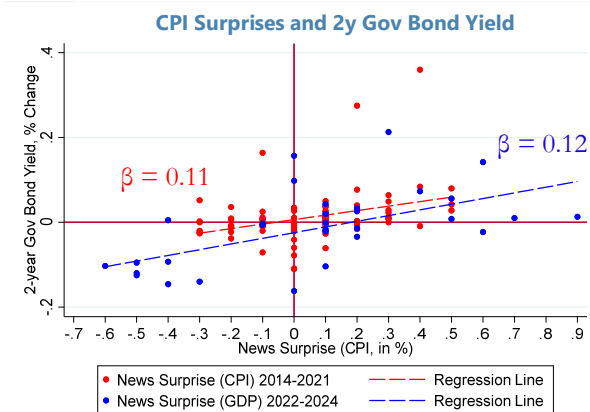
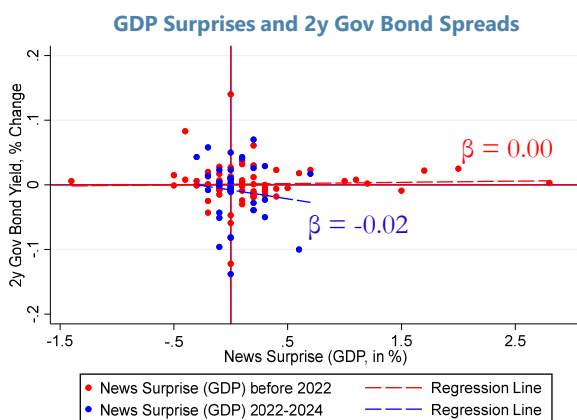
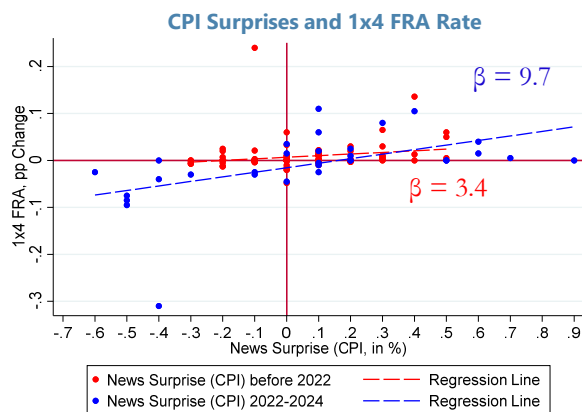
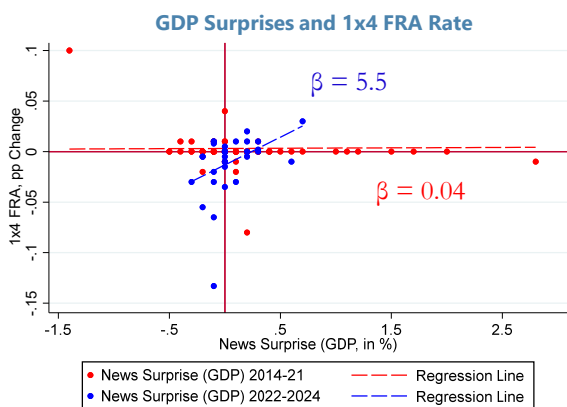
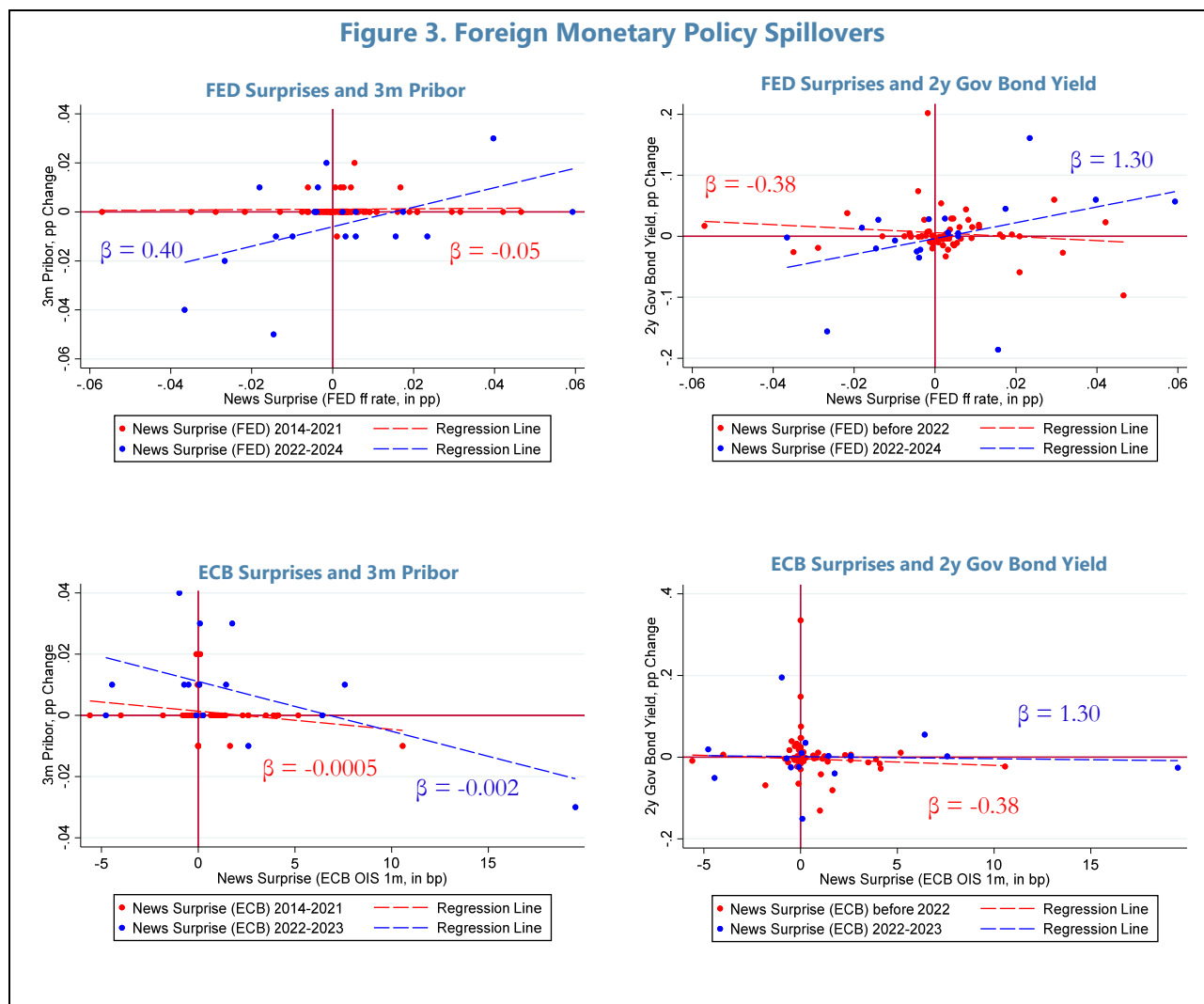


Figure 2. Market Interest Rates and Macro News



8. Foreign monetary policy surprises were associated with significantly larger volatility in domestic market interest rates since 2022. Fed surprise rate hikes led to stronger interest rate increases, both for the 3-month Pribor and the 2y government bond yields post-2021 (Figure 3), indicating a stronger co-movement with US monetary policy and inflation cycles. Surprisingly, this is not the case for ECB surprise decisions. Post-2022, ECB surprise tightenings have led to stronger decreases in the 3-month interbank market rate. This could be related to the significant euroization of the Czech economy. Tighter euro area monetary policy also restricts domestic financial conditions. Finally, the volatility of interest rate reactions to foreign monetary policy surprises has been much larger than pre-2022, as indicated by the distribution of dots across the plots.



9. A trade-off between the cost of market volatility and the benefit of data dependence may emerge. The results show that after 2021 changes in asset prices to similar-sized macro news and monetary policy surprises increased as expected, given the central bank’s shift to a more data-dependent approach incorporated in market expectations. At the same time, volatility of asset prices conditional on news surprises increased. Against this backdrop, central banks face a tradeoff: i)

pursuing a more data-dependent approach, responding to data outturns that may provide stronger informative signals about future inflation but facing greater financial market volatility; or ii) returning to a more forecast-based policy rule and potentially reducing volatility, but facing the risk of greater deviation from target. As inflation becomes more closely aligned to target, the cost of higher volatility is more likely to outweigh the benefit of attaching a large weight on recent data when setting policy rates.

References

Altavilla, Carlo & Brugnolini, Luca & Gürkaynak, Refet S. & Motto, Roberto & Ragusa, Giuseppe, 2019. "Measuring Euro Area Monetary Policy," *Journal of Monetary Economics*, Elsevier, vol. 108(C), pages 162-179.

Andersen, Torben, G., Tim Bollerslev, Francis X. Diebold, and Clara Vega, 2003. "Micro Effects of Macro Announcements: Real-Time Price Discovery in Foreign Exchange," *American Economic Review*, 93 (1): 38–62.

Evans, M.D.D., Lyons, R.K., 2008. "How Is Macro News Transmitted to Exchange Rates?" *Journal of Financial Economics* 88, 26–50.

Faust, Jon, John H. Rogers, Shing-Yi B. Wang and Jonathan H. Wright, 2007. "The High-Frequency Response of Exchange Rates And Interest Rates to Macroeconomic Announcements," *Journal of Monetary Economics* 54(4), 1051-1068.

Fleming, Michael J. and Eli M. Remolona, 1999. "Price Formation and Liquidity in the U.S. Treasury Market: The Response to Public Information," *Journal of Finance* 54(5), 1901-1915.

Goldberg, L., Leonard, D., 2003. "What Moves Sovereign Bond Markets? The Effects of Economic News on U.S. and German Yields," *Current Issues in Economics and Finance* 9 (9).

Goldberg, L.S. , Grisse, C. , 2013. "Time Variation in Asset Price Responses to Macro Announcements," Staff Report, 626. Federal Reserve Bank of New York.

Appendix I. How Markets Perceive Macroeconomics News

Table 1. Czech Republic: Daily Changes of The Czech Koruna Exchange Rate Around Macro/Policy News

Dep. variable/ News	CZK Volatility		CZK Depreciation	
	Pre-22	Post-21	Pre-22	Post-21
GDP	18.32 (12.35)	26.94 (39.60)	-0.110** (0.051)	-0.111 (0.211)
CPI	82.38 (61.24)	-12.18 (17.74)	-0.289*** (0.105)	-0.0854 (0.0924)
CNB MP	99.73 (106.0)	593.5** (218.0)	-0.759* (0.414)	-1.746* (0.847)
ECB MP	11.06*** (3.799)	-2.646 (2.342)	0.069*** (0.014)	-0.0066 (0.0131)
FED MP	-271.5 (608.0)	507.0 (761.1)	14.99** (5.768)	-10.22 (8.529)

Notes: Ex. rate volatility regressions are based on the absolute value of the surprise measure. For FED monetary policy (MP) news exchange rates refer to CZK/EUR, otherwise to CZK/EUR. Standard errors in parentheses. *p<0.1, **p<0.05, ***p<0.01. N: 78 (33), 96 (32), 64 (21), 68 (15), 63 (19) for GDP, CPI, CNB MP, ECB and FED events in 2014-21 (2022-24).

Table 2. Czech Republic: Daily Changes of Interest Rates Around Macro/Policy News

Dep. variable/ News	1x4 FRA Rate		3m Pribor		2y gov. bond yield		5-year Government Bond Spread	
	Pre-22	Post-21	Pre-22	Post-21	Pre-22	Post-21	Pre-22	Post-21
GDP	0.0396 (0.790)	5.489** (2.250)	-0.806** (0.314)	4.244 (4.095)	0.00189 (0.00606)	-0.0246 (0.0409)	-0.0006 (0.0077)	-0.135* (0.0708)
CPI	3.432** (1.691)	9.685*** (2.988)	0.684 (0.457)	0.269 (0.581)	0.106*** (0.0300)	0.117*** (0.0239)	0.0446* (0.0229)	0.147*** (0.0212)
CNB MP	0.616*** (0.0478)	0.941*** (0.176)	0.046*** (0.0096)	0.0688 (0.0563)	0.415*** (0.0538)	0.582*** (0.194)	0.304*** (0.0652)	0.198 (0.185)
ECB MP	-0.00079 (0.00072)	0.00033 (0.00137)	-0.0005* (0.0003)	-0.0016** (0.0007)	-0.0028 (0.0033)	-0.0005 (0.0034)	0.0037 (0.0039)	-0.0079 (0.0050)
FED MP	-0.0262 (0.109)	0.228 (0.469)	-0.0520 (0.215)	0.399** (0.173)	-0.380 (0.472)	1.296* (0.735)	-0.453 (0.339)	2.536** (0.880)

Notes: The 1x4 FRA Rate is the interest rate for a forward agreement effective in 1 month and terminated in 4 months. The 5-year government bond spread is calculated as the difference between the yield on a Czech 5-year government bond and a German bund. *p<0.1, **p<0.05, ***p<0.01. N: 78 (33), 96 (32), 64 (21), 68 (15), 63 (19) for GDP, CPI, CNB MP, ECB and FED events in 2014-21 (2022-24).