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Monthly Report

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The Corporate-Sector Effect of Carbon Pricing: Investment and Employment

The Vienna Institute for International Economic Studies
Wiener Institut für Internationale Wirtschaftsvergleiche

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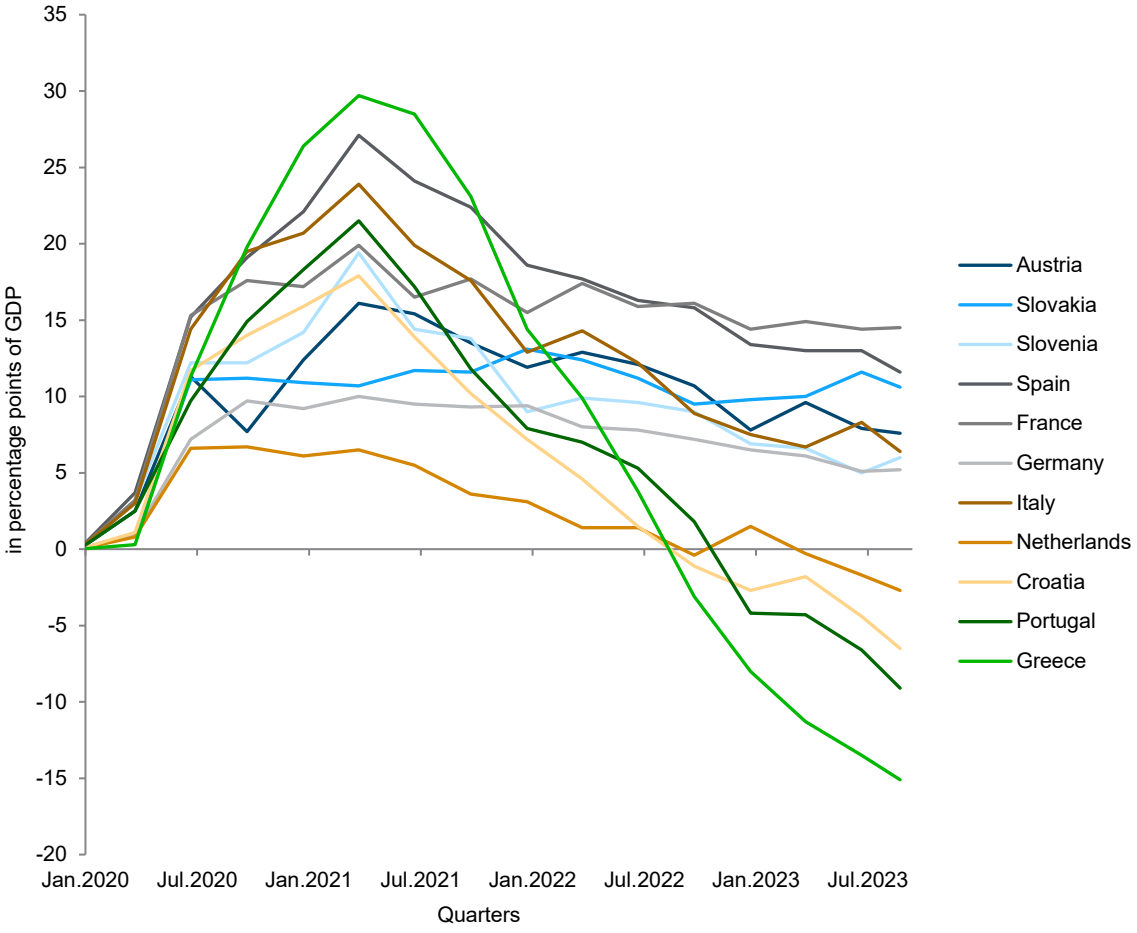
Chart of the month: COVID-19 pandemic has left its mark on public debt in the euro area

BY PHILIPP HEIMBERGER

General government debt, change versus Q4/2019, in pp of GDP



Source: Eurostat. Data provided by Daniel Kral at Oxford Economics.

The figure shows the change in the government-debt-to-GDP ratio compared to Q4 2019, i.e. before the start of the pandemic.[1] We see a dramatic increase in debt ratios over the pandemic years 2020 and 2021: tax revenue declined and government spending rose, which led to large fiscal deficits; furthermore, as economic activity fell sharply, so negative nominal GDP growth contributed to the rise in public debt ratios.

[1] https://ec.europa.eu/eurostat/en/web/products-euro-indicators/w/2-22012024-AP (data provided by Daniel Kral at Oxford Economics).

However, the figure also highlights the fact that debt ratios increased far more in some euro area countries than in others. Southern euro area countries such as Italy, Spain and Greece – which were hit early and hard by the pandemic and which started from higher initial public debt levels – saw a more pronounced increase over 2020-2021 than core countries such as Austria, Germany and the Netherlands, or Eastern European countries such as Slovakia, Slovenia and Croatia.

The recovery from the pandemic brought a decline in public debt ratios from the second half of 2021 onwards. However, this decline has again been far more pronounced in some euro area countries than in others. Small euro area countries such as Greece, Portugal and Croatia have seen particularly striking declines in their public debt ratios, which by Q3 2023 had already fallen below their pre-pandemic levels. This decline was driven by a marked reduction in fiscal deficits – Greece, for example, already ran a sizeable primary fiscal surplus in 2023 – and by solid nominal GDP growth, not least on account of much higher inflation over 2022-2023.

But there are also countries where the reduction in debt ratios was more limited and slower. The large Southern euro area countries of Italy and Spain did record a decline in public debt ratios over 2021-2023, but their debt levels remain significantly elevated compared to before the pandemic. The same holds for France, which has actually been unable to reduce its debt ratio much over the last two years, as it has seen a continuation of sizeable primary fiscal deficits and lower nominal GDP growth than in other countries.

This legacy of elevated public debt levels will be important in the near future, especially as (reformed) EU fiscal rules kick in again in 2024, putting more pressure on governments to introduce fiscal consolidation measures. The pressure to do so will be highest in countries such as Italy, Spain and France, where the public finance scars from the pandemic are more pronounced than elsewhere. Given how large these countries are – Italy, Spain and France together accounted for 44% of total euro area GDP in 2023 – fiscal consolidation pressure in them will likely weigh on the economic growth prospects of the euro area as a whole.

Reform of EU fiscal rules: a short-sighted compromise*

BY PHILIPP HEIMBERGER

EU finance ministers have reached an agreement on reforming EU fiscal rules. The key change will be to make the assessment of fiscal policy more long term and country specific, with debt sustainability analysis used as an anchor. However, countries with high public debt ratios will find it exceptionally hard to meet the rules, so that many will undershoot on public investment.

After some tough negotiating, shortly before Christmas EU finance ministers reached an agreement on the reform of EU fiscal rules (Council, 2023). The Council agreement was the basis for the political deal between member state negotiators and the European Parliament reached on 10 February 2024. The provisional agreement by EU co-legislators will now be subject to votes in both the Council and the European Parliament, and enter into force soon after their publication. Member states will have to submit their first national plans based on the revised framework in September 2024 (European Parliament, 2024).

THE MAIN PRINCIPLES OF THE NEW RULES: LONG TERM AND 'COUNTRY SPECIFIC'

The Council agreement on reforming EU fiscal rules shifts the focus from the annual development of public finances to a longer-term view. The previous framework's well-known deficit limit of 3% of GDP and public debt limit of 60% of GDP remain, but the old annual budgetary targets, based on the 'structural' (cyclically adjusted) deficit, are no longer relevant, and the old mechanical debt-reduction rule will also be abolished. Under the new framework, when public debt exceeds the 60% reference value, or when the budget deficit rises above the 3% reference value, the European Commission will put forward a 'technical trajectory'. This is supposed to ensure that by the end of a fiscal adjustment period of at least four years, the public debt ratio is on a 'plausibly downward trajectory'.

Multi-year budget plans of at least four years will be negotiated between the European Commission and national governments against the background of the technical trajectory and will be rooted in an analysis of the sustainability of a member country's public debt (Heimberger, 2023). Hence, the country-specific nature of the fiscal adjustment requirements is an important change from the old framework. The net expenditure path (i.e. expenditure net of interest payments and cyclical items) will be the main operational target under the new framework. There will be a general EU escape clause and national escape clauses that can be triggered in the event of some serious occurrence that justifies temporary non-compliance with the rules.

Member states can commit to a range of investments and reforms, extending the fiscal-adjustment path to a maximum of seven years, provided the European Commission agrees that the investments are consistent with debt sustainability. However, any quantitative analysis of the medium-term fiscal and

* Disclaimer: The views expressed in the Opinion Corner section of the Monthly Report are exclusively those of the authors and do not necessarily represent the official view of wiiw.

growth implications of investments underpinning a longer adjustment period is difficult and contains the potential for political conflict.

The Council agreement fails to incentivise public investment adequately, even though additional green public investment of at least 1% of EU GDP will be required if the ambitious climate targets are to be met over the coming decades (Heimberger and Lichtenberger, 2023). When assessing whether individual member states comply with their fiscal plans, the European Commission will exclude national spending on the co-financing of EU funded programs from government expenditure. In the short-term, this will not have a big impact, since most national co-financing relates to spending on EU regional funds. In the longer run, however, it will provide incentives for channelling extra money through the EU budget, and may increase the scope for steering national fiscal spending into EU policy priorities to increase co-financing expenditures. However, the reform compromise does not include broad exemptions for green public investment at the national level irrespective of co-financing with EU programs.

The resulting fiscal consolidation pressure from 2025 onwards will therefore make it virtually impossible for several national governments – especially those with high public debt ratios, including large euro area countries such as Italy, Spain and France – to sufficiently increase their investment ratios. Yet this is something that is badly needed if economic development and climate targets are to be met, since public investment can be reduced or postponed more easily than other government spending components whenever the pressure to pursue fiscal consolidation increases (Jacques, 2021).

The insistence by Germany and certain other countries on stricter fiscal rules has led to a problematic compromise regarding the introduction of so-called ‘safeguards’ for minimum fiscal consolidation. A new ‘deficit resilience safeguard’ will be applied when the multi-year spending path is set: this will require governments to continue with fiscal adjustment – even after they have reached the 3% deficit target – until a common ‘resilience margin’ of 1.5% of GDP below the 3% deficit benchmark has been reached. This ‘safeguard’ will lead to overly harsh adjustment requirements for member states such as Italy and Spain, compared to the EU Commission’s original proposals.

IMPLEMENTATION OF THE NEW RULES COULD RESULT IN EXCESSIVE AUSTERITY AND MAY PROVE POLITICALLY COSTLY

The widespread view that the new EU fiscal rules will be lax is unfounded. The new framework will be less restrictive than would have been the case had the old framework been reactivated. After the rise in public deficits and debt due to the pandemic, the old framework would have been so harsh as to be virtually unenforceable. Nevertheless, after years of using the escape clause, it will be tough to return to fiscal restraints under the new framework; and the new rules will be much more restrictive than many believe – especially for countries with high public debt ratios. Simulations provided by Bruegel that are based on the Council agreement show that implementation of the new rules will mean Italy and Spain having to make an annual structural fiscal adjustment effort of 0.6 percentage points (pp) of GDP over a period of seven years from 2025. For France, the required annual adjustment is estimated at 0.5pp; for Austria – 0.3pp; and for Germany – 0.1pp (Zettelmeyer, 2023).

The design of the new rules also demonstrates that policy makers have learnt too little from past mistakes, when lack of fiscal-policy coordination among member states exacerbated the euro crisis in the period 2011-2013 (Heimberger, 2017). With expenditure paths derived from the Council agreement, large fiscal consolidations will be required in a number of (big) euro area countries from 2025 onwards,

in order to comply with the reformed fiscal rules. Depending on where a country is in the business cycle at the time when fiscal consolidation is pursued, the cross-border effects of simultaneous budget cuts could exacerbate the adverse impacts of fiscal consolidation on economic growth. And with growth slowing, public-debt-to-GDP ratios may have a tendency to overshoot the projections of the European Commission, thereby undermining the main goal of the framework – which is to reduce public debt ratios in the medium and long term.

Given the Council agreement, better enforcement of the rules in countries such as Italy and France will not succeed in the long term without major economic and political damage. Just how unrealistic it is for countries with high public debt ratios to comply with the new rules over the long term can be seen from the fact that the political agreement provides for a transition regime for countries in an Excessive Deficit Procedure (EDP) until 2027. For instance, France has gained a concession that interest payments will be exempt from the minimum fiscal adjustment requirement under the EDP until 2027, but not thereafter. Italy argued that the reforms and investments undertaken as part of the EU's post-pandemic recovery plan may already be sufficient to gain approval for the extension of fiscal adjustment from four to seven years; without that, even tougher fiscal consolidation would have to be implemented.

France and Italy agreed to the 'safeguards' advocated by Germany for short-term motives. However, future governments will have a very hard time because of this short-sighted compromise, particularly as governments will need to undershoot on public investment in order to meet the fiscal consolidation requirements. Therefore, it is likely that we will again have to discuss the political unenforceability of the reformed rules and their adaptation in the not-too-distant future.

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Investment needs for a green European transition

BY ANDREAS LICHTENBERGER, BERNHARD SCHÜTZ AND PHILIPP HEIMBERGER

Climate change has long called for a green shift in our economies. To meet the climate targets over the coming decades, research suggests that additional public investment equivalent to at least 1% of EU economic output per year will have to be financed. In 2023, the gross public investment rate in the EU stood at 3.3%, which implies that this figure will have to rise to a minimum of 4.3%. We argue that – because of national fiscal policy constraints – a permanent EU investment fund to tackle climate and energy goals would provide substantial relief for national budgets, allowing governments to take an important step in the green transition, while making it a more realistic proposition to comply with EU fiscal rules.

INTRODUCTION

While academic researchers and civil society communities alike have pointed to the need for a shift toward a more environmentally sustainable economy, the current geopolitical and industrial policy challenges add further pressure within the EU context. The war triggered by Russian aggression in Ukraine has highlighted Europe's fossil-fuel dependence on Russia and other countries (e.g. Redeker and Jäger, 2022; Osvaldová, 2022; CREA, 2022). While the EU has largely managed to stabilise energy procurement, a concerted and sustained energy-policy effort across multiple industries remains an important goal (Hosseini, 2022).

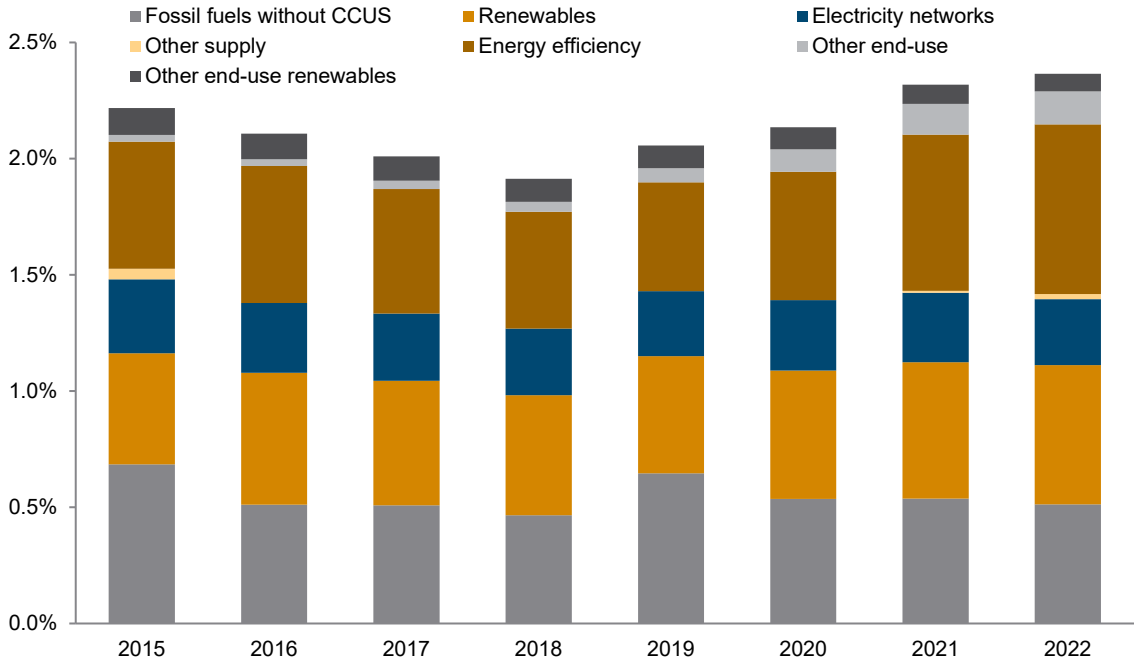
Although there is a broad awareness in the European Union that CO_2 emissions must be reduced drastically if the ambitious climate targets are to be met, there is less understanding of how much additional investment is required and how it should be financed. In what follows, we look at studies that try to estimate investment costs and consider potential means of financing the green transition in the EU.

HOW MUCH ADDITIONAL INVESTMENT IS NEEDED IN THE EU?

We start by looking at studies that present estimates for global investment needs. According to the International Energy Agency (IEA), to achieve the scenario of net-zero emissions would, on a global scale, require annual average capital investment in the energy sector to rise from 2.5% of global GDP in recent years to 4.5% by 2030. Investment could then be scaled back to the original 2.5% by 2050 (IEA, 2021). On the basis of 2019 figures, the International Renewable Energy Agency (IRENA) reported that meeting the 1.5 °C climate target by 2050 would require investments into the energy system to grow from 2.4% to 5% of global GDP (2019 values; IRENA, 2021). Finally, BloombergNEF (2023) even estimates that investment in energy transition and power grids would need to rise by 3 percentage points if the net-zero targets are to be met.

We now turn to green investment requirements in the EU. Obviously, the nature and size of an investment programme will vary from country to country. However, the numbers provided by pan-EU studies offer some rough guidance with respect to the scale of the task ahead. Furthermore, we can supplement the estimates for the EU as a whole with some individual country studies. According to the IEA (2023), total energy investment in Europe accounted for USD 545bn in 2022, which corresponds to 2.4% of GDP (see Figure 1).[1] Of this, USD 427bn (1.9% of GDP) was counted as investment in clean energy.[2] The largest subcategories were energy efficiency and renewables, accounting for 31% and 25% of total energy investment, respectively.

Figure 1 / European energy investment as a percentage of GDP



Note: Investment is measured in 2022 USD and includes the European Union, Albania, Belarus, Bosnia and Herzegovina, North Macedonia, Gibraltar, Iceland, Israel, Kosovo, Montenegro, Norway, Serbia, Switzerland, Moldova, Turkey, Ukraine and the United Kingdom; national GDPs in local currency units have been aggregated using 2022 USD exchange rates; note that GDP does not include Gibraltar, due to data availability. CCUS = Carbon Capture, Utilisation and Storage.
Source: IEA (2023); World Bank (2023); own calculations.

According to the findings of a European Commission impact assessment report, meeting the 2030 climate target would require an expansion of existing green investment of about 2% of annual EU GDP for the energy and transport sectors (EC, 2020; Cornago and Springford, 2021). Meeting the 2050 target for net-zero greenhouse gas emissions would require emissions-reducing energy- and climate-related investment to increase from 5.1% of EU economic output to 7.0% annually (EC, 2020; own calculations).[3] A higher

1 Countries included are the members of the European Union, Albania, Belarus, Bosnia and Herzegovina, North Macedonia, Gibraltar, Iceland, Israel, Kosovo, Montenegro, Norway, Serbia, Switzerland, Moldova, Turkey, Ukraine and the United Kingdom.

2 Clean energy investment includes the categories of renewables, electricity networks, other supply, energy efficiency, other end-use and other end-use renewables.

3 This corresponds to raising it from the current EUR 740bn per year to EUR 1,125bn per year. The European Commission's estimate assumes a positive rate of growth of GDP. If one were to calculate the required investment on the basis of 2021 GDP at current prices, it would require current investment to expand by 2.7% of GDP to achieve the

estimate is reported by Baccianti (2022), who states that additional annual investment would need to reach 3.2% of EU GDP. For a balanced policy mix he argues that the public share of green investment should be more than half and should therefore increase by 1.8% of GDP. Most of the spending would go on the buildings sector and the transport sector. Wildauer et al. (2020) also regard the additional investment requirements communicated by the European Commission as an underestimate. They argue that the necessary additional investment should be at least two or three times as great (i.e. around 6% of EU GDP), since it would cost almost EUR 500bn per year to make buildings alone more energy efficient. To estimate additional investment needs, the authors cite further costs of EUR 490bn for energy-efficient building retrofits, EUR 84bn for sustainable electricity infrastructure, EUR 80bn for the industrial sector and EUR 201bn for research and development – totalling EUR 855bn (Wildauer et al., 2020). It should be noted that this figure does not include investment in the transport sector. However, if one goes by Commission estimates, the needs of the transport sector would account for the lion's share of investment: EUR 673bn of the suggested EUR 1,125bn (own calculations Cornago and Springford, 2021). If the estimates of Wildauer et al. (2020) were extended to include the transport sector, clearly the additional investment sum would be even greater.

In contrast, Stöllinger (2023) finds that additional investment equivalent to 1.75% of EU economic output per year would be adequate. He relies on the aggregate 'broad-brush' approach of Pollin (2020) and Pollin et al. (2014), who separate supply-side measures (such as expanding renewable energy) and demand-side measures (such as increasing energy efficiency). As R&D efforts are missed out in their calculations, Stöllinger (2023) uses the estimate by Wildauer et al. (2020) for the costs of additional R&D. While the equivalent of an additional 1.75% of EU economic output per year suggested for the period 2024-2050 is somewhat lower than the 1.9% of EU GDP per year estimated by the EC (2020), Stöllinger (2023) argues that rather than challenging the exact figure, his contribution should be regarded as indicating the same order of magnitude of additional investment requirements.

The scale of the investment required is also comparable at the level of individual countries. For instance, a recent policy report for France suggests an additional investment requirement of 2.5% of French GDP until 2030 annually (Pisani-Ferry and Mahfouz, 2023). Based on a bottom-up approach, this study adds together the investment for each sector and deducts subsidies and fossil fuel-based investment: that works out at an additional EUR 101bn for green initiatives, minus EUR 35bn for subsidies in the fossil-fuel sector, resulting in a net EUR 66bn. German study puts the required additional annual green investment up to 2030 at a sum equivalent to 1.3% of German GDP (Krebs and Steitz, 2021). An annual investment of EUR 46bn per year at 2019 prices would yield a total of EUR 460bn of required green investment by 2030. Their reference goal is based on the greenhouse gas-reduction goal of the German government – a goal that is also reflected in a predetermined scenario of a transformation model by Prognos et al. (2021), which computes the optimal path for achieving climate neutrality by 2045, taking account of costs and feasibility.

2030 climate target and by 3.8% of GDP to achieve the 2050 net-zero target (own calculations). A figure of 2% of EU economic output in additional total investment should therefore be considered the lower limit.

Table 1 / Overview of studies on additional green investment needs

Study	Political entity	Annual additional investment	Details
BloombergNEF (2023)	Global	3.1% of global GDP	Net-zero emissions target and energy transition require an increase from 1.4% to 4.5% of global GDP
IEA (2021)	Global	2% of global GDP	The net-zero emissions goal requires raising investment rates from 2.5% of global GDP between 2016-2020 to 4.5% until 2030, falling back to 2.5% by 2050
IRENA (2021)	Global	2.6% of global GDP	Value for meeting the 1.5 °C climate target by 2050. The less ambitious goal of staying within government plans and the Paris agreement would only require increasing annual investment by 1.3% of 2019 GDP
EC (2020)	EU	1.9% of EU GDP	Results are based on the MIX-50 scenario of the impact assessment model, which aims for a 50% GHG emission reduction compared to 1990 levels by expanding carbon pricing and through more ambitious energy and transport policies
Baccianti (2022)	EU	3.2% of EU GDP	Investment gap as difference between 2011-2020 spending and required spending in 2021-2030 (in 2019 prices)
Stöllinger (2023)	EU	1.75% of EU GDP	Based on an aggregate 'broad-brush' approach
Wildauer et al. (2020)	EU	6% of EU GDP	Study excludes transportation sector
Krebs and Steitz (2021)	Germany	1.3% of German GDP	Based on a bottom-up approach for achieving the nationally determined 2030 climate goals
Pisani-Ferry and Mahfouz (2023)	France	2.5% of French GDP	Based on a bottom-up approach of aggregating sectoral investment amounts

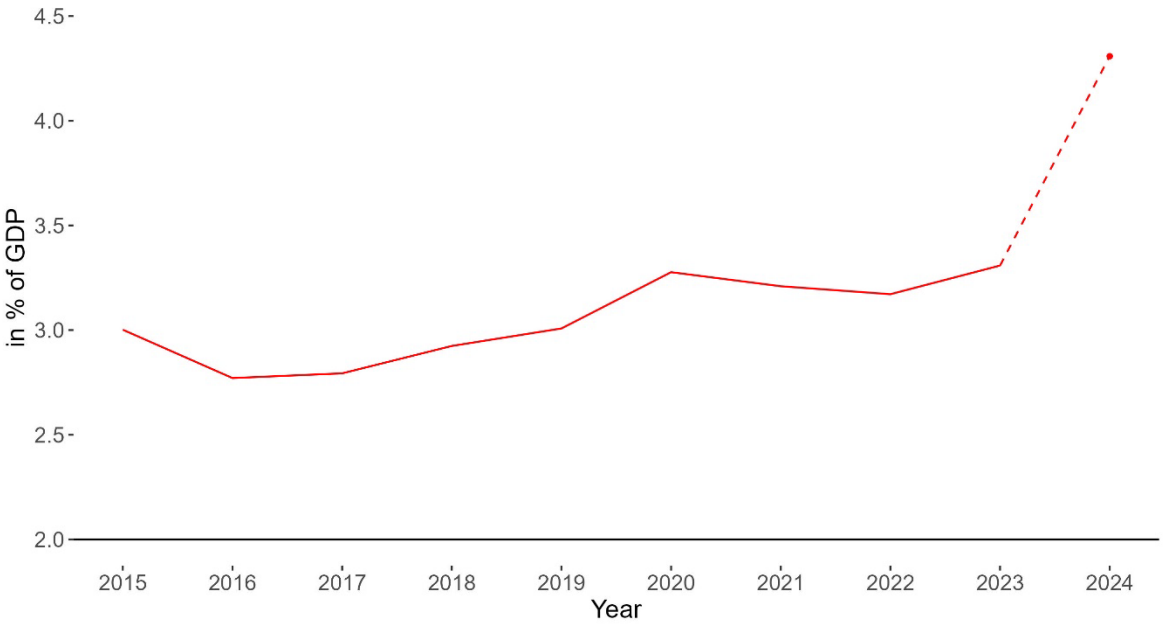
All in all, estimated additional green investment requirements range from 1.75% to 6% of EU economic output per year. In order to meet these investment needs, much of the investment will need to be launched by the public sector, if it is to attract further private investment: substantial parts of green investment are unprofitable for the private sector, and hence must be 'stimulated' by public investment (e.g. Darvas and Wolff, 2022; Deleidi et al., 2020). Reliable investment plans and regulations are also required. Only improved infrastructure and planning security can spur innovation and help private companies expand their activities in line with achieving climate and energy goals (e.g. Mazzucato, 2018).

While some reports put the required share of public money in overall green investment in the range of 17% to 25% (IRENA, 2021; World Economic Forum, 2013), other estimates suggest that the share should be significantly higher – 50% or even more (Campiglio, 2016; EIB, 2021; PIRC, 2011; Deleidi et al., 2020; Baccianti, 2022).[4] If we adopt 50% as a reference value and take the Commission estimate of additional investment requirements (which is fairly close to the lower bound of the range of estimates found in the literature), that implies that additional green public investment of at least 1% of EU GDP will

[4] According to Campiglio (2016), who uses the UK Green Investment Bank as an example, between 2012 and 2014 the public share of green investment accounted for 37%. According to PIRC (2011), the public share of green investment in the UK was 53% in 2009-2010. An Allianz report estimates that a 1 percentage point increase in green public investment would result in a private-sector mobilisation of 0.51 percentage points; this would imply a public share of additional green investment of 66% (Jobst et al., 2022). According to an empirical analysis by Deleidi et al. (2020) on 17 selected OECD countries, an expansion of green public investment of USD 4.4bn (in 2011 USD) would mobilise some USD 0.8bn to USD 1bn in the private sector. This ratio would correspond to a public share of over 81%. Based on national energy and climate plans, EIB (2021) reports that the estimated share of additional public investment in the EU is highly country specific, at 25% or below for NL, DE, ES, PT, SE and DK, but above 60% for Central and Eastern European countries such as BG, CZ, PL and LT; other countries fall in between.

have to be financed annually to meet the climate targets. Since gross public investment in the EU accounted for 3.3% of GDP in 2022, this would require an increase to 4.3% (see Figure 2).

Figure 2 / Public gross investment of EU countries, in % of GDP



Note: The dashed line shows the implied required increase in public investment for 2024, based on the required additional energy investment of 2% of GDP in order to meet the EU climate targets and the 50% public-sector co-financing share.
Source: AMECO (autumn 2023); own calculations.

REACHING CLIMATE TARGETS WILL REQUIRE MORE PUBLIC DEBT

When it comes to financing the substantial need for additional green investment, governments may choose either to levy additional taxes or to go down the debt path. Indeed, many countries have implemented green tax reforms recently. Imposing higher taxes on emission-intensive goods potentially creates a win-win situation: it reduces CO_2 emissions, while at the same time it raises additional government revenue. However, it also runs the risk of threatening social cohesion and hence the acceptance of such reforms within society, since the poorer segments of society are disproportionately affected by them (as energy costs account for a larger share of poorer households' budgets). This limits revenue-raising opportunities, as in many cases (though not all – see e.g. the proposal for a tax on airline tickets; Schratzenstaller and Krenek, 2019) the adverse social impact of such reform may require some kind of offsetting transfer.

While green tax reforms undoubtedly have serious revenue-raising potential, they will not – and should not – finance all additional public investment required for climate targets to be reached. Therefore, it is necessary and appropriate to finance a significant proportion of climate investment through public debt: after all, future generations will benefit significantly from this investment and should therefore participate in its financing. Currently, EU fiscal rules limit the scope for additional public investment to achieve climate and energy targets (e.g. Darvas and Wolff, 2021; Pekanov and Schratzenstaller, 2020). Nor do ongoing plans to reform these rules seem to be a game changer, as they focus heavily on reducing public debt

ratios in the medium term. Exempting green investment under these new fiscal rules could offer some necessary leeway, but broad-based exemptions for green public investment are not part of the current reform of EU fiscal rules (Heimberger, 2024).

If the institutional setup practically rules out adequate implementation through national initiatives, one way out may be through collective effort: a permanent EU investment fund could be established. The Recovery and Resilience Facility (RRF) adopted during the COVID-19 crisis was a major step forward for a common European investment initiative. But a forward-looking European economic policy would require additional annual public investment of at least 1% of EU economic output in the coming decades, if the ambitious climate and energy targets are to be achieved – far outstripping the RRF's estimated green investment (Heimberger and Lichtenberger, 2023).

A permanent EU fiscal capacity with an EU investment fund for climate and energy targets would not only strengthen the community of EU member states economically and politically, but would also promote their future geostrategic capacity to act in uncertain times. Other large economic blocs – such as the US – have in recent times used their sovereignty for aggressive green industrial policies to ensure technological advantage (Tucker and Malhotra, 2022). Besides, the rapid energy price rises in the context of the Russian invasion of Ukraine and the resulting unequal burdens in EU member states increase the urgency of a swift transition to a greener and more independent energy system. The provision of a common financing scheme to undertake strategic investment projects designed to meet climate and energy goals should be prioritised, in order to stimulate private investment and promote the competitiveness of European industries. The energy and climate crises are common European challenges that can best be addressed through common European solutions.

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The corporate-sector effect of carbon pricing: investment and employment

BY ANNA R. MATZNER, LEA STEININGER

We study the impact of carbon pricing on firm-level investment in Europe. Using balance-sheet data from 1.2 million European businesses, we find that following a carbon price increase, companies in carbon-intensive sectors reduce their investment more than other companies that are otherwise similar. However, increased carbon prices also affect non-targeted firms. We document no discernible effect of carbon pricing on employment, profitability or market share.

INTRODUCTION

Since adoption of the 2015 Paris Agreement, how to address the climate crisis has become a crucial focus in both advanced and developing economies. The implementation of strict climate policies and regulations is vital if the physical risks posed to our socioeconomic and financial systems by climate change are to be reduced. However, these climate policy measures themselves may introduce transition risks that could impact the economy. As a result, debate has emerged in both the policy and the academic sphere about the most effective ways of achieving this goal. Key questions in these discussions include determining which climate policies promote economic growth, how to direct corporate investment towards environmentally friendly production, and the optimal methods for pricing climate-related externalities to ensure effectiveness and efficiency.

We attempt to answer these questions. We build on Känzig and Konradt (2023) and Känzig (2023), who show that higher carbon prices result in a significant increase in headline consumer prices, and cause GDP and industrial production to fall and unemployment to rise. This prompts inquiries into why carbon pricing leads to economic setbacks, especially when compared to other climate measures, such as carbon taxes, which have a far less severe impact on the economy (Känzig and Konradt, 2023; Metcalf and Stock, 2020; Konradt and Weder di Mauro, 2022). By influencing energy prices, carbon pricing has demonstrated its ability to affect household consumption – and therefore affect household consumption of both energy and non-energy (Känzig, 2023). Additional evidence suggests that factors such as the tax structure, sector-specific pass-through mechanisms and coverage, spillovers and leakage, and monetary policy can all play a role in explaining the economic consequences of carbon pricing (Känzig and Konradt, 2023).

Kilian (2008) summarises three main channels by which energy price shocks affect business investment. First, they increase the marginal cost of production (Hamilton, 2008). The increase depends on the energy cost share in production expenditure. When it comes to carbon pricing, costs increase especially for those firms directly affected by the Emissions Trading System (ETS). Second, demand for a firm's output falls as consumers cut their expenditure when they experience a decline in disposable income. Third, changes in energy prices induce uncertainty about future energy prices, which leads to firms

postponing investment decisions. Consequently, carbon pricing might reduce company profits in all sectors, due to the increase in energy prices and reduced demand from the household sector.

A BRIEF OVERVIEW OF CARBON PRICING IN EUROPE: EMISSIONS TRADING SYSTEM

The European Union (EU) recently renewed its commitment to carbon neutrality by approving the European Green Deal. To achieve carbon neutrality, in 2005 among other things the EU established carbon pricing policies in the shape of the European Emissions Trading System (ETS). This trading system functions on the principle of cap and trade, where a limit is set on the total quantity of greenhouse gases (GHG) that may be emitted. Participants in the system are granted allowances that can be traded among themselves. The idea behind the cap-and-trade principle is that it allows the system to find the most cost-effective way of reducing emissions without the government intervening significantly. It targets carbon-intensive production and aims to reduce primarily GHG emissions from installations in the energy sector, the manufacturing industry and aircraft operators.

However, carbon pricing might have a wider-reaching effect on production – primarily through higher energy prices, since power producers generally tend to pass emission costs on to customers. In particular, energy price shocks may be transmitted to the economy through adjustments in firms' investment.

The difference between carbon tax and carbon price can be explained as follows. A carbon tax establishes the cost of emissions, with uncertainty surrounding the resulting overall emissions level. By contrast, cap-and-trade systems specify an aggregate emissions level, introducing uncertainty regarding the resulting price. Theoretically, in a scenario with perfect information, both the tax and the quantity-based approach would yield identical outcomes. However, in the real world, characterised as it is by prevailing uncertainty and asymmetric information, these two instruments may produce results that deviate from the theoretically optimal solution.

EMPIRICAL APPROACH

Our goal is to study the dynamic causal effect of carbon policy on investment. We employ a state-of-the-art local projection framework introduced by Jordà (2005) in a panel data setting. Panel estimations allow us to estimate how a business responds over horizon $h > 0$ to carbon policy shocks, and to compute the corresponding impulse responses. Each impulse response coefficient is estimated directly with a different regression, which makes it less sensitive to misspecification. The assumed data-generating process is as follows:

$$\Delta_h y_{i,t-1} = \beta_h CP_t + \vartheta_h X_{i,t-1} + \theta_{h,s} * \varphi_{h,c} + \varepsilon_{i,t+h}.$$

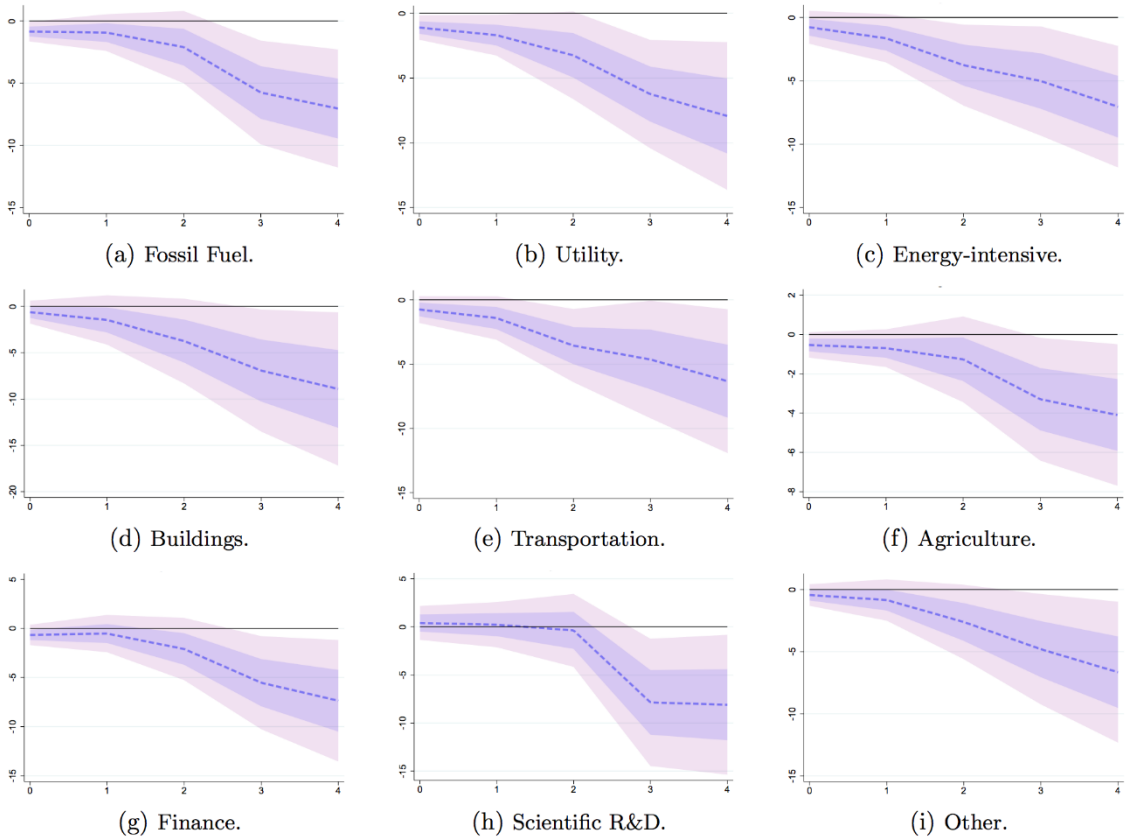
Time is denoted by *t* and the data are annualized. The index *i* denotes the firm. $\Delta_h y_{i,t+1} = y_{i,t+1} - y_{i,t-1}$ denotes the log difference of the change in investment from the base year $t-1$ up to year $t+h$, with $h = 0, 1, \ldots, H$. β_h captures the dynamic effects at horizon *h* for an innovation in the ETS carbon price, CP_t. Given the exogeneity of the carbon policy shock, we do not need to include controls for identification. We do, however, add fixed effects ($\theta_{h,s} * \varphi_{h,c}$) and some country- and firm-level controls ($X_{i,t-1}$) to improve precision. $\varepsilon_{i,t+h}$ is an error term.

Our firm-level data come from the Bureau van Dijk's Orbis commercial database for European businesses. The dataset contains the balance sheets of listed and unlisted companies with annual reporting frequency. The carbon policy surprise series is obtained from Känzig (2023) and exploits high-frequency data on EU ETS carbon policy news events. The surprises are identified by looking at carbon price expectation revisions caused by regulatory news about the EU ETS in a tight window around the announcement event. Specifically, we compute the percentage change in EU emission allowances futures price on the day of the regulatory event.

THE HETEROGENEOUS EFFECT OF CARBON PRICING

Our response variables are specified as the log difference denoted $\Delta_h y_{i,t-1} = y_{i,t+1} - y_{i,t-1}$. Given that our variables are log-transformed, the difference can be interpreted as the elasticity in the variable from $t-1$ to h periods in the future after the carbon pricing shock.

Figure 1 / Impulse response functions of the change in firms' investments in response to the carbon pricing shock, by climate-policy relevant sector



Note: Firm-level responses to a one-standard-deviation carbon policy shock by carbon-relevant sectors. The y-axis depicts the cumulative log-change in investment between periods $t-1$ and $t+h$ with the carbon policy shock dated at t. The time periods on the x-axis are 0-4 years. Shaded (dark) purple areas represent 95% (68%) confidence bands. The confidence bands are based on two-way clustered standard errors by firm and year. 'Other' includes administrative tasks, telecommunications, education, wholesale, retail and other services.

We find that, on average, corporate-sector investment declines as carbon prices rise. However, since carbon policies are aimed at reducing carbon-intensive production, we highlight the climate-relevant responses to the shocks. This helps us understand the role of the direct effects of carbon pricing on energy-intensive production versus the indirect effects that arise from higher overall energy prices following the shock. Figure 1 summarises the responses of investment by climate-policy relevant sector as identified by Battiston et al. (2017).

We find that investment – and, by extension, production growth – declines persistently among firms in energy-intensive sectors in response to the carbon price shock. Four years after the shock, the cumulative change in investment amounts to 7% on average across sectors. In the utilities sector, investment falls by almost 7% as well, and the fossil fuel sector similarly reduces its investment significantly. We also find a robust response in the buildings sector (which shows more noise, however). Transportation and agriculture react less strongly to the shock: for instance, in agriculture, investment declines by only 4% as a result. Also non-targeted sectors are found to reduce investment after the carbon price shock; however, the responses are only statistically significant three years after the shock. Overall, our results suggest that the targeted sectors reduce their investment significantly and quite substantially in response to a shock. Non-targeted sectors, however, are also affected by shocks, which suggests that indirect effects that stem from higher energy prices – and thus higher input prices for firms' production – matter in terms of transmission of the shock. By contrast, we find that employment, profitability and sales are not significantly affected by carbon pricing shocks.

CONCLUSIONS

In summary, our findings indicate that elevated carbon pricing diminishes corporate investment in carbon-intensive sectors. Surprisingly, all sectors also experience a sizeable impact from increased carbon pricing, suggesting the relevance of indirect effects that stem from a rise in energy prices. With escalating energy costs, all companies encounter greater short-term input expense, alongside reduced demand as households cut back on consumption in the face of falling income. Some firms may defer investment decisions due to increased uncertainty, or cease investment in fossil fuels or energy-intensive production if they anticipate enduring policy changes. We expect that companies will shift their investments overseas, to countries where they do not anticipate similar policy alterations in the future.

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Monthly and quarterly statistics for Central, East and Southeast Europe

The monthly and quarterly statistics cover **23 countries** of the CESEE region. The graphical form of presenting statistical data is intended to facilitate the **analysis of short-term macroeconomic developments**. The set of indicators captures trends in the real and monetary sectors of the economy, in the labour market, as well as in the financial and external sectors.

Baseline data and a variety of other monthly and quarterly statistics, **country-specific** definitions of indicators and **methodological information** on particular time series are **available in the wiiw Monthly Database** under: **https://data.wiiw.ac.at/monthly-database.html**. Users regularly interested in a certain set of indicators may create a personalised query which can then be quickly downloaded for updates each month.

Conventional signs and abbreviations used

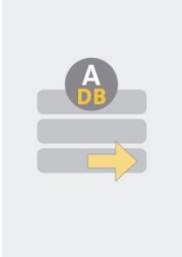
%	per cent
ER	exchange rate
GDP	Gross Domestic Product
HICP	Harmonised Index of Consumer Prices (for new EU member states)
LFS	Labour Force Survey
NPISHs	Non-profit institutions serving households
p.a.	per annum
PPI	Producer Price Index
reg.	registered
y-o-y	year on year

The following national currencies are used:

ALL	Albanian lek	HUF	Hungarian forint	RON	Romanian leu
BAM	Bosnian convertible mark	KZT	Kazakh tenge	RSD	Serbian dinar
BGN	Bulgarian lev	MDL	Moldovan leu	RUB	Russian rouble
BYN	Belarusian rouble	MKD	Macedonian denar	TRY	Turkish lira
CZK	Czech koruna	PLN	Polish zloty	UAH	Ukrainian hryvnia

EUR euro – national currency for Montenegro, Kosovo and for the euro-area countries Estonia (from January 2011, euro-fixed before), Latvia (from January 2014, euro-fixed before), Lithuania (from January 2015, euro-fixed before), Slovakia (from January 2009, euro-fixed before), Slovenia (from January 2007, euro-fixed before) and Croatia (from January 2023, euro-fixed before).
Sources of statistical data: Eurostat, National Statistical Offices, Central Banks and Public Employment Services; wiiw estimates.

Online database access



wiiw Annual Database

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wiiw FDI Database

The wiiw databases are accessible via a simple web interface, with only one password needed to access all databases (and all wiiw publications).

You may access the databases here: https://data.wiiw.ac.at.

If you have not yet registered, you can do so here: https://wiiw.ac.at/register.html.

Service package available

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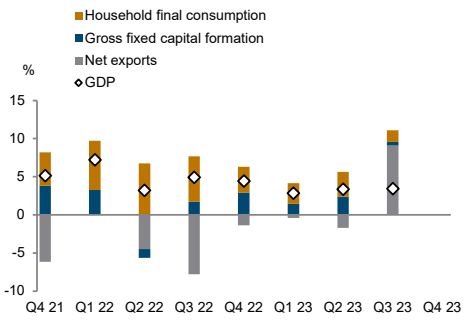
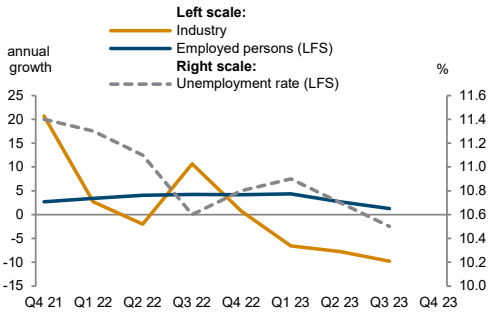
Albania

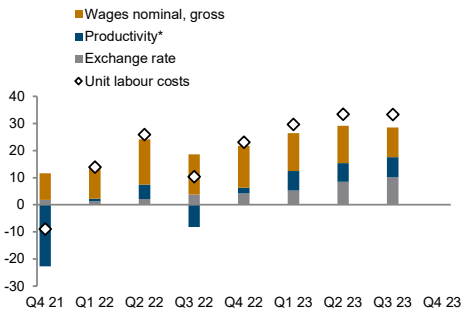
Real GDP growth and contributions
y-o-y



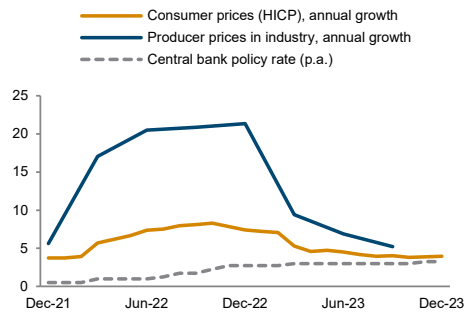
Real sector development
in %



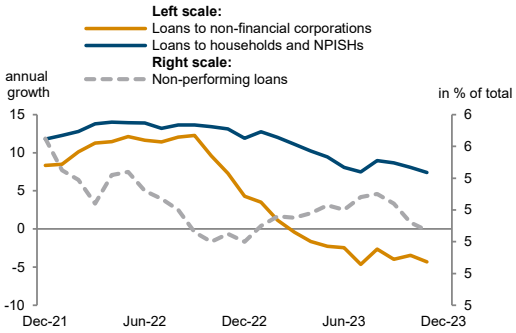
Unit labour costs in industry
annual growth rate in %



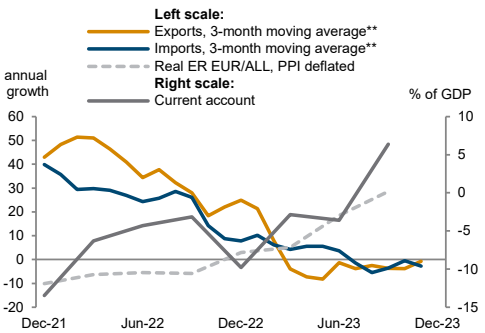
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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**EUR based.

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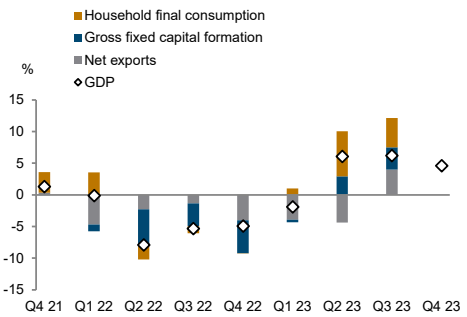
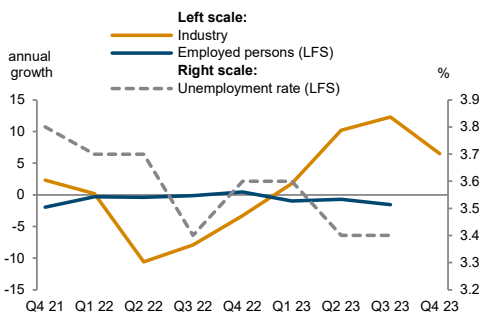
Belarus

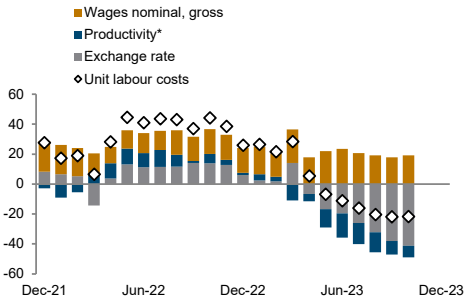
Real GDP growth and contributions
y-o-y



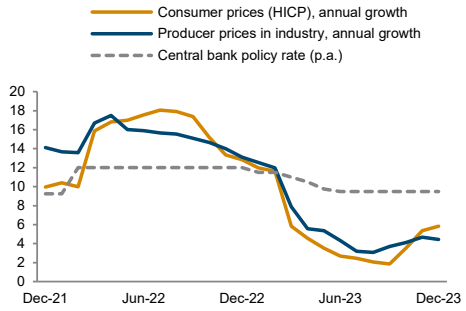
Real sector development
in %



Unit labour costs in industry
annual growth rate in %



Inflation and policy rate
in %



Financial indicators
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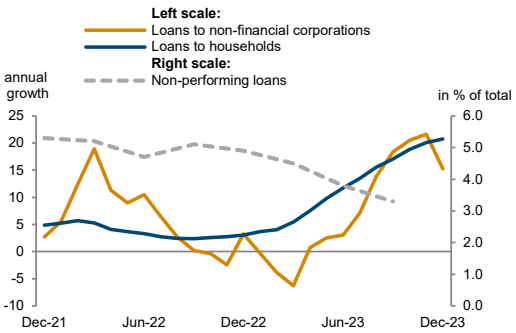
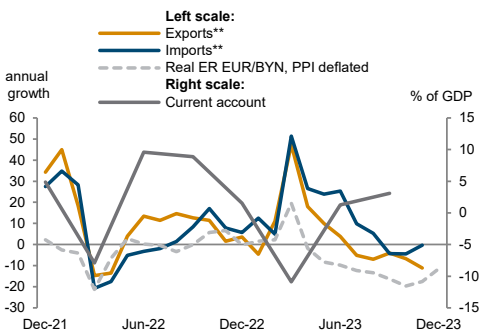


External sector development
in %



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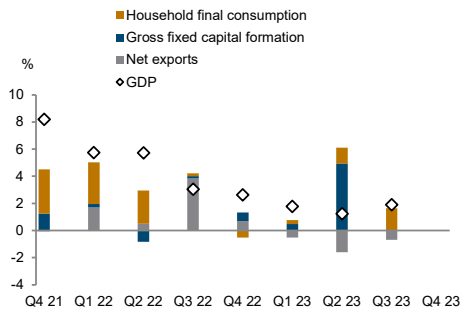
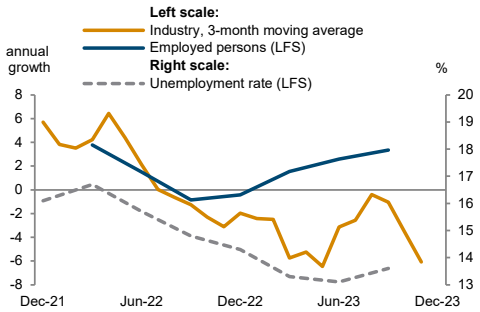
Bosnia and Herzegovina

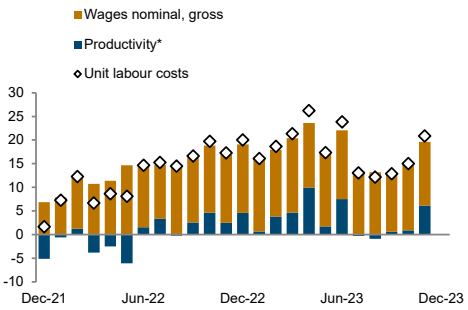
Real GDP growth and contributions
y-o-y



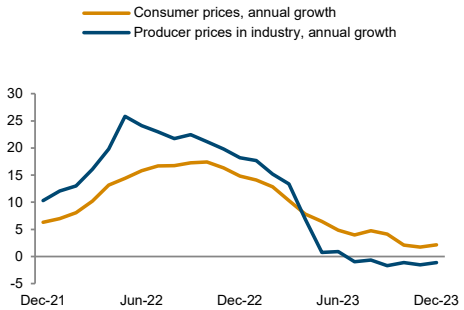
Real sector development
in %



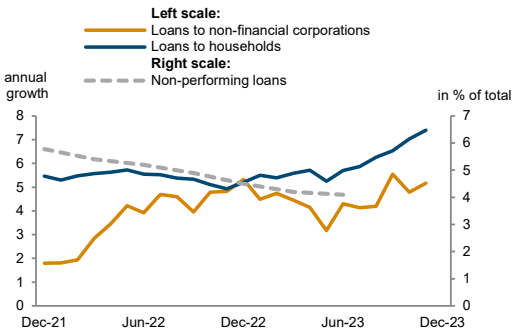
Unit labour costs in industry
annual growth rate in %



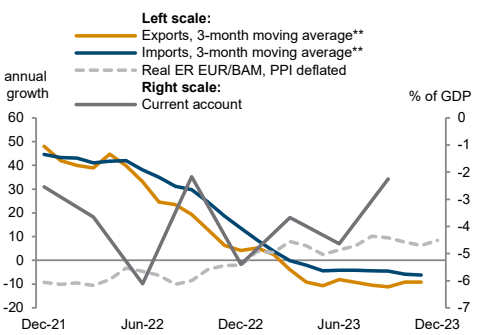
Inflation
in %



Financial indicators
in %



External sector development
in %



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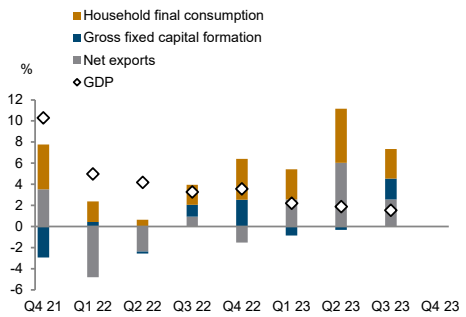
Bulgaria

Real GDP growth and contributions
y-o-y



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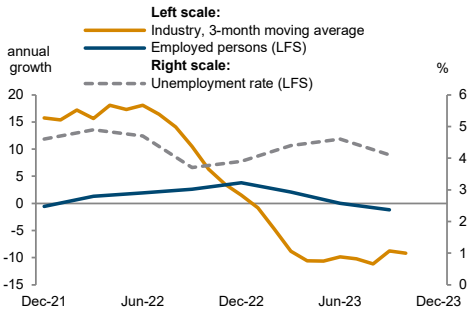
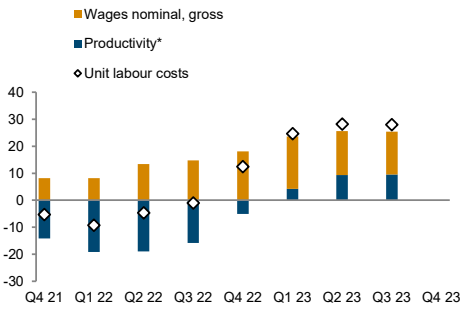
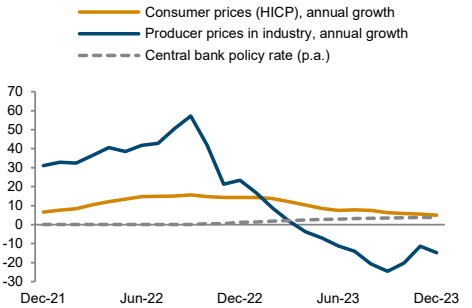


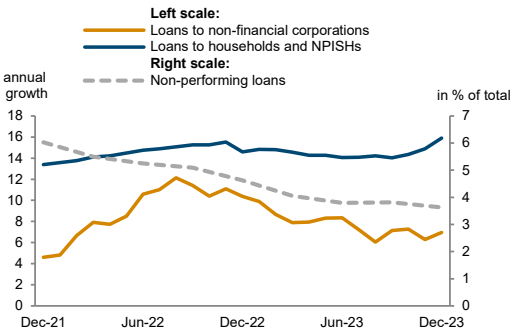
Unit labour costs in industry
annual growth rate in %



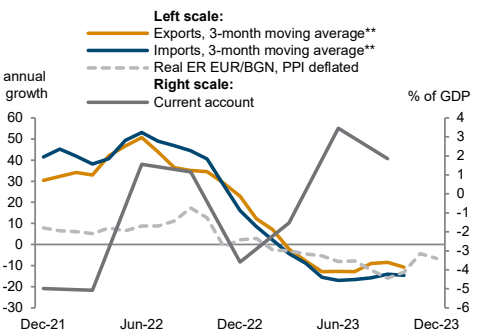
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



*Positive values of the productivity component on the graph reflect decline in productivity and vice versa.
**EUR based.

Source: wiiw Monthly Database incorporating Eurostat and national statistics.
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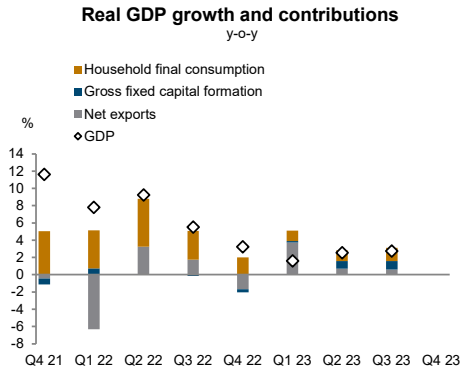
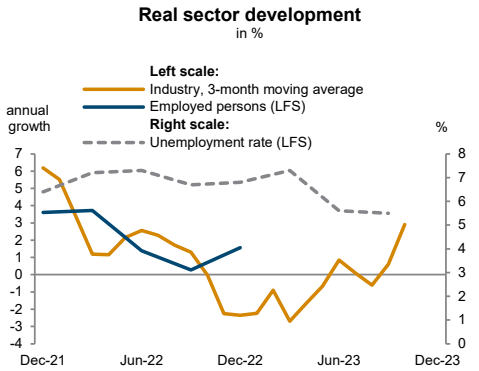
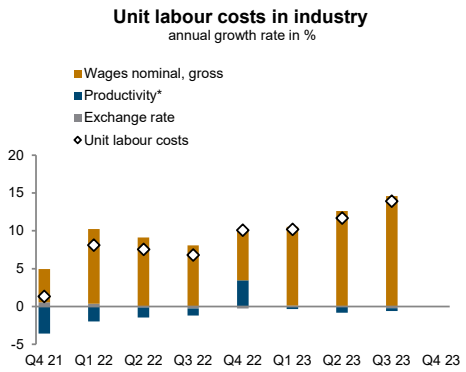
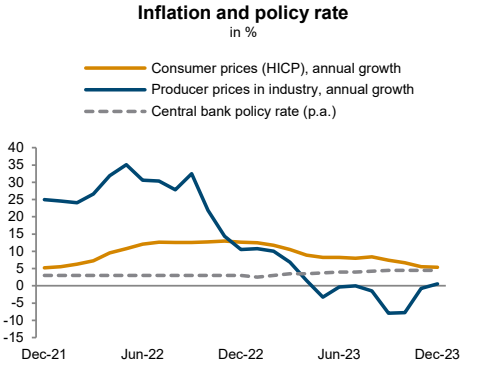
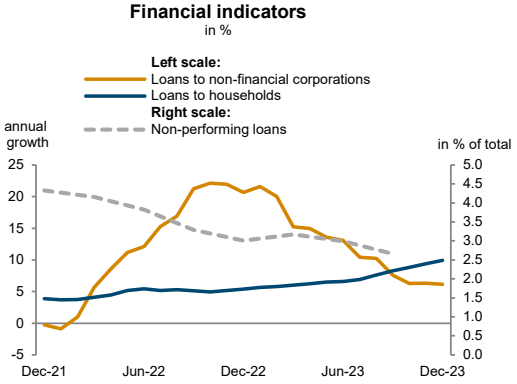
Croatia

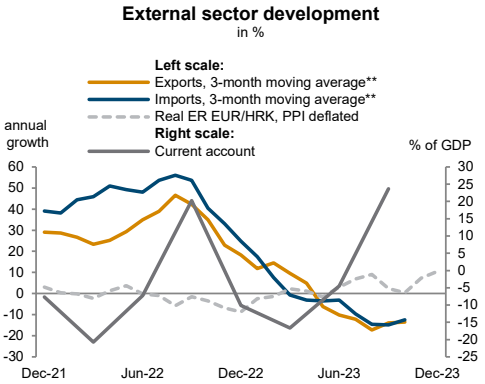












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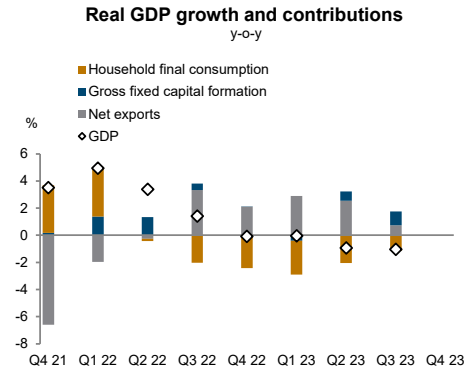
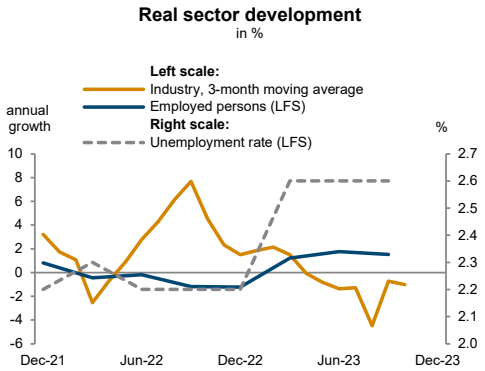
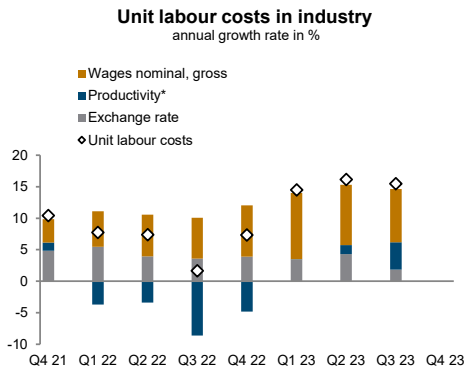
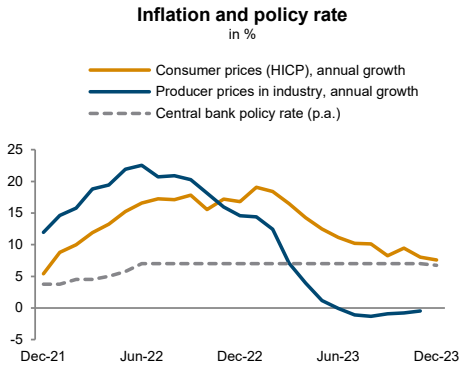
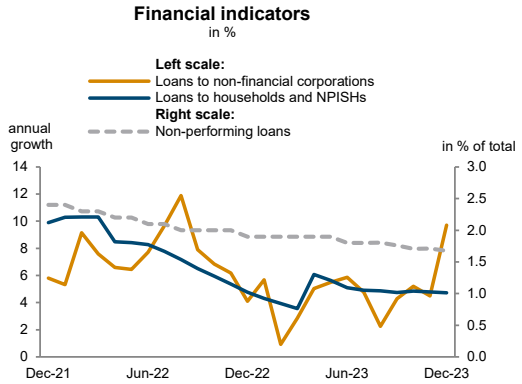
Czechia

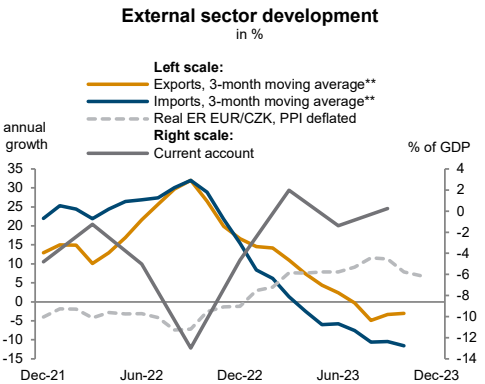












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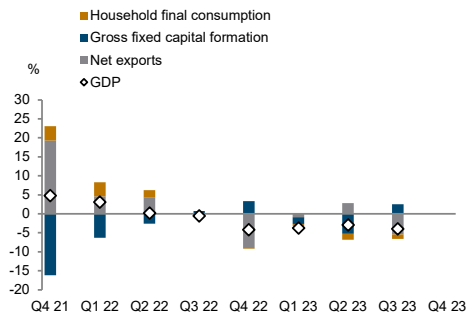
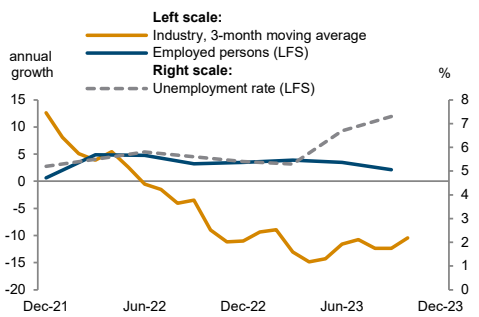
Estonia

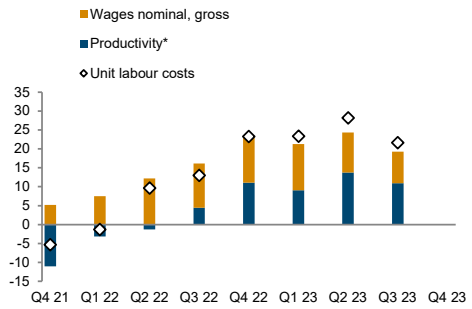
Real GDP growth and contributions
y-o-y



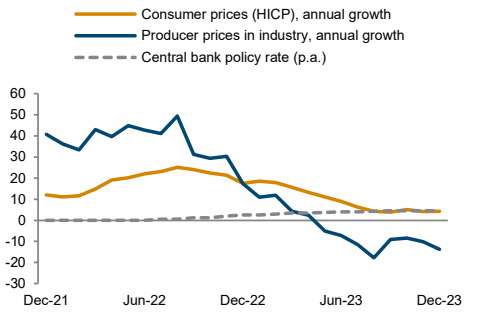
Real sector development
in %



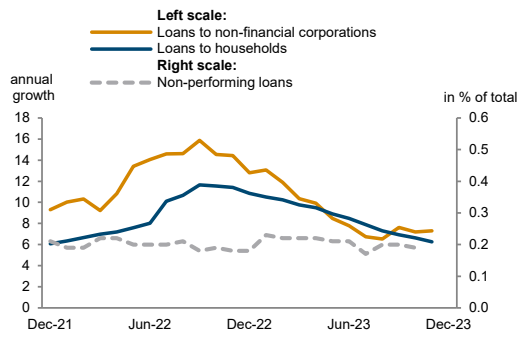
Unit labour costs in industry
annual growth rate in %



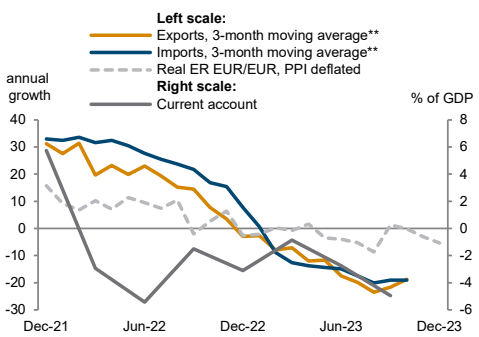
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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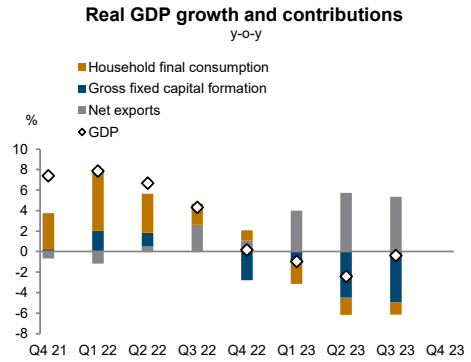
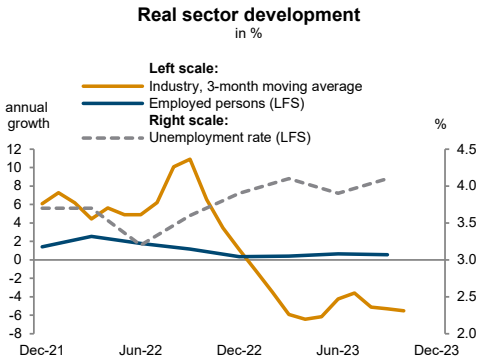
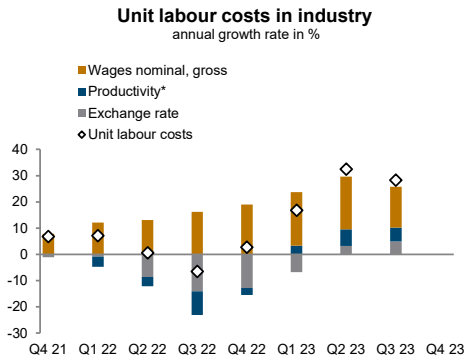
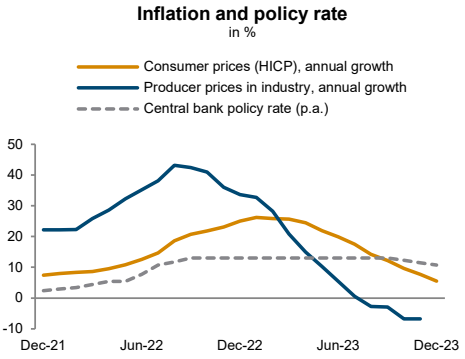
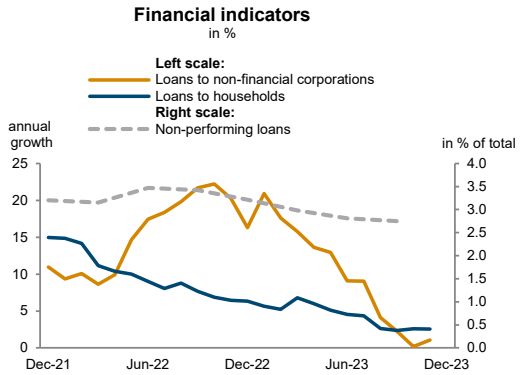
Hungary

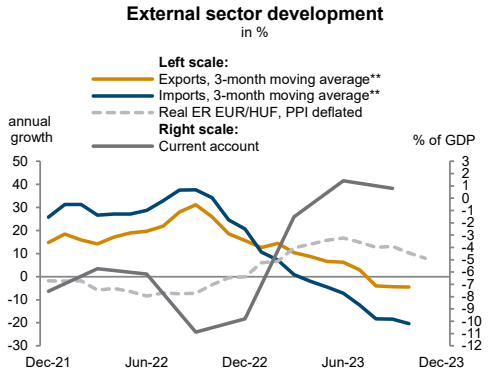












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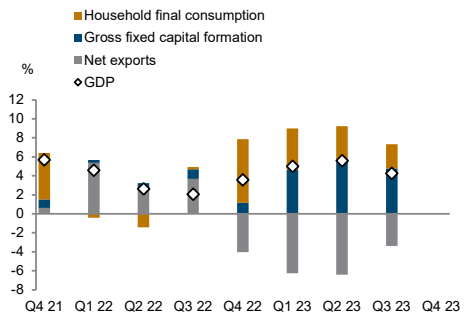
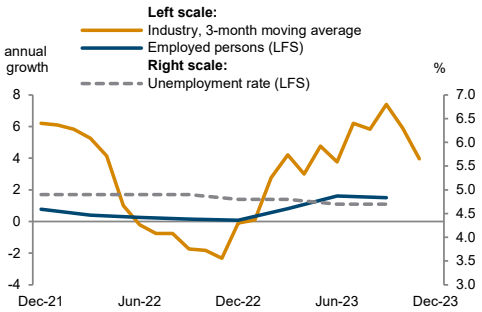
Kazakhstan

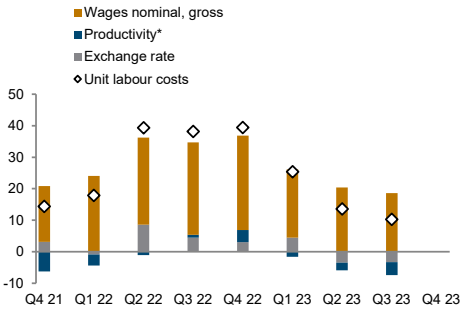
Real GDP growth and contributions
y-o-y



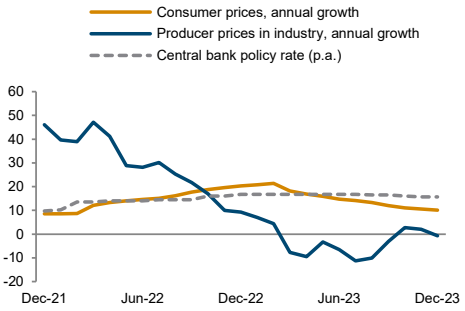
Real sector development
in %



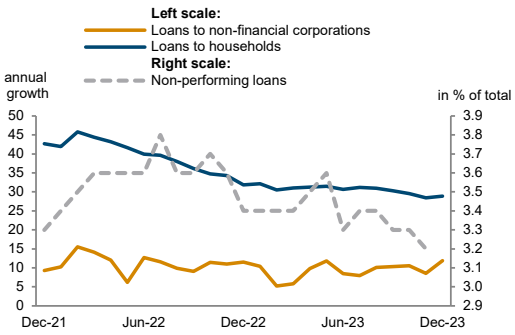
Unit labour costs in industry
annual growth rate in %



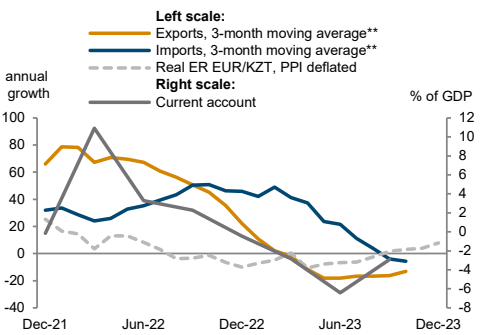
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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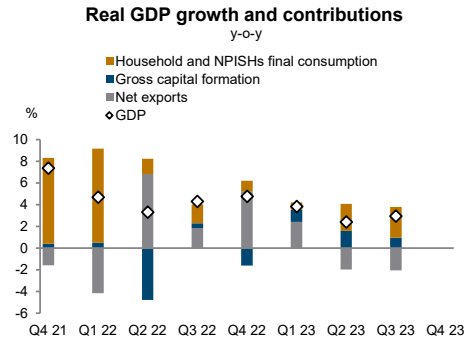
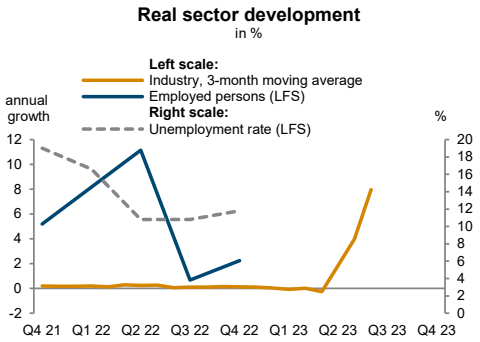
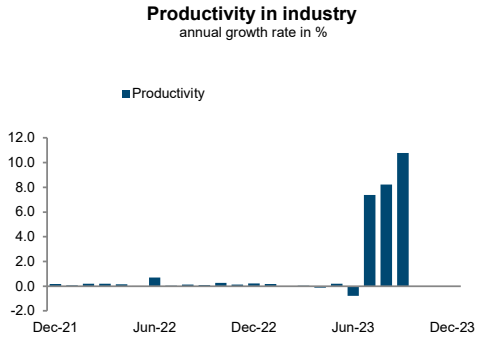
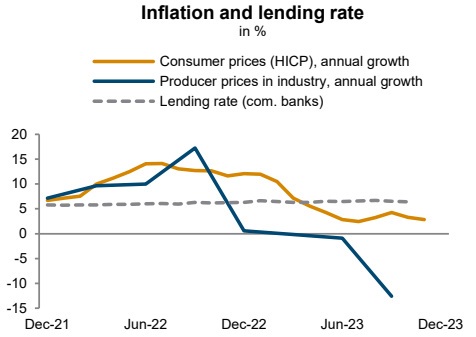
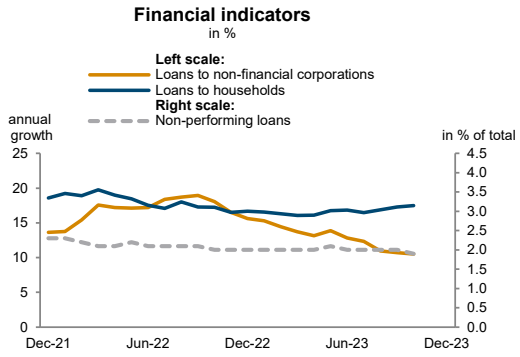
Kosovo

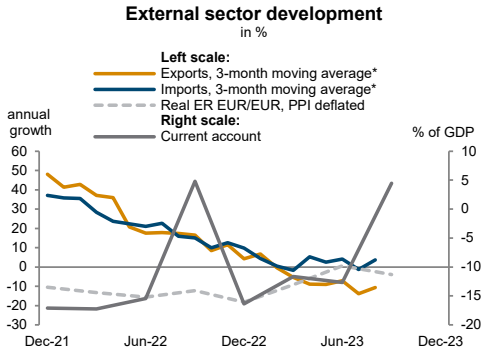












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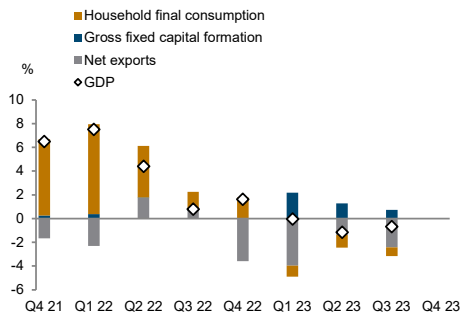
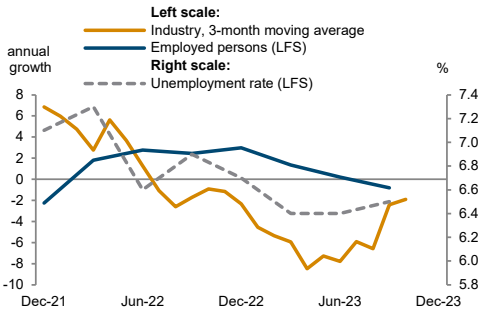
Latvia

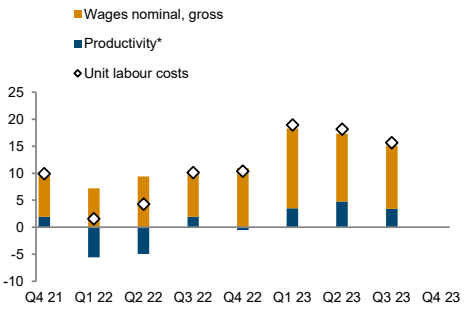
Real GDP growth and contributions
y-o-y



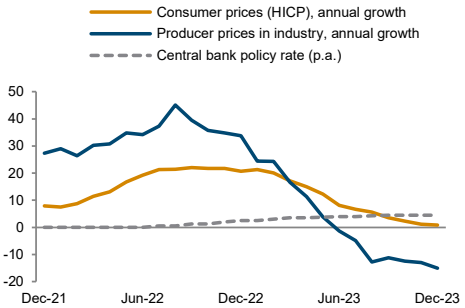
Real sector development
in %



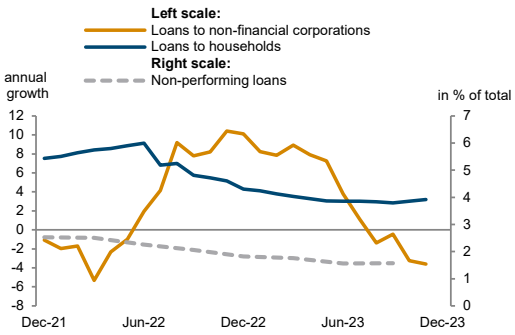
Unit labour costs in industry
annual growth rate in %



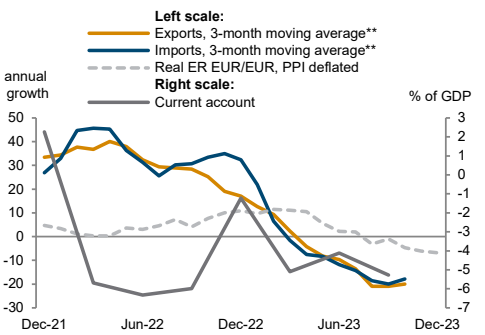
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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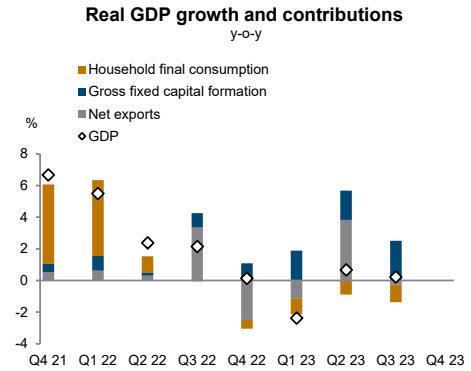
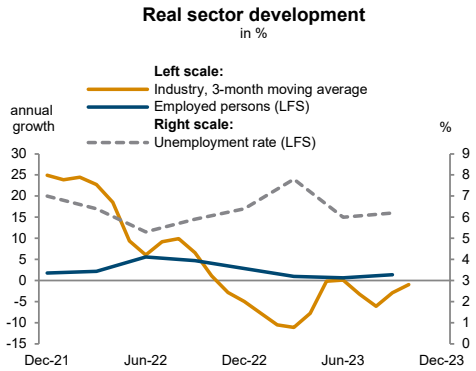
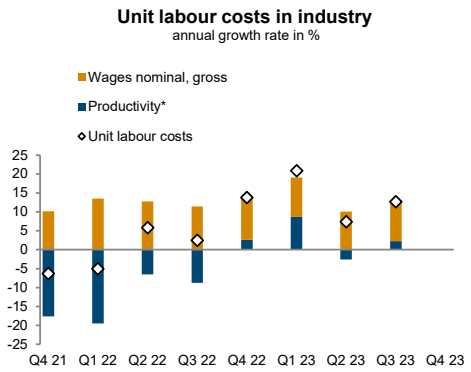
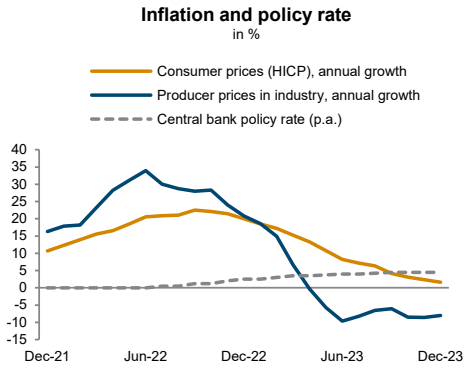
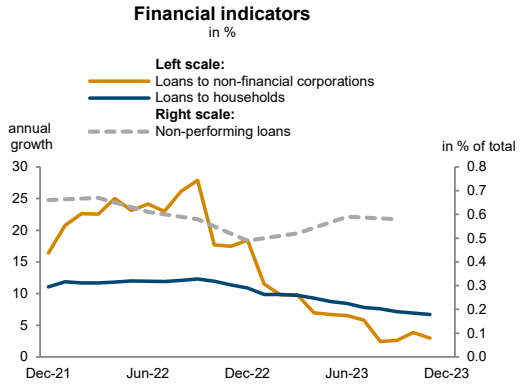
Lithuania

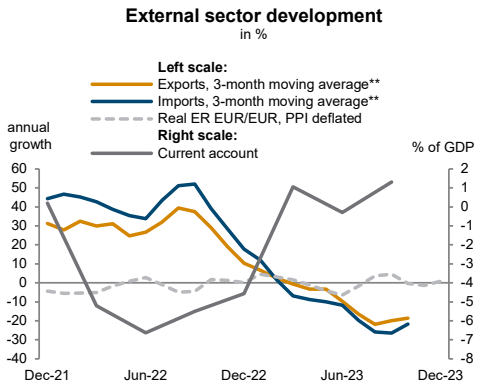












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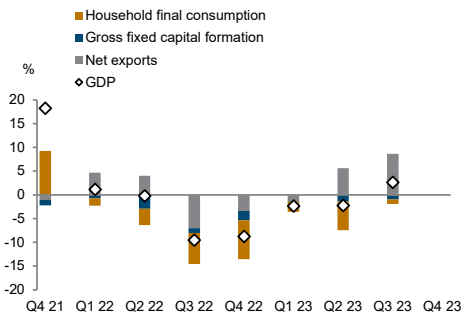
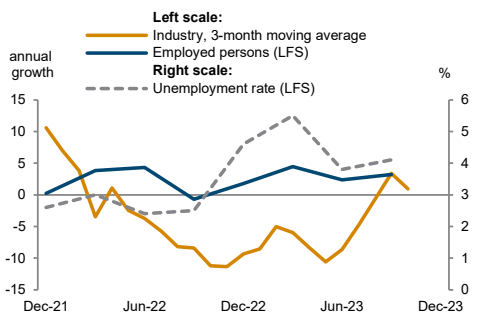
Moldova

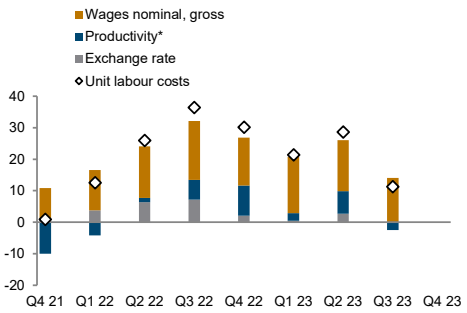
Real GDP growth and contributions
y-o-y



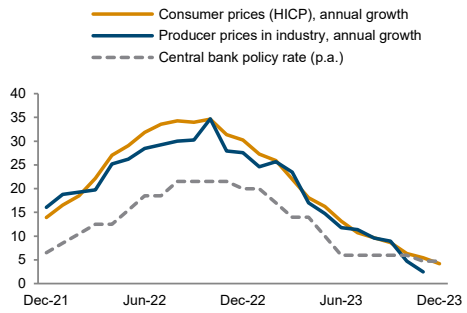
Real sector development
in %



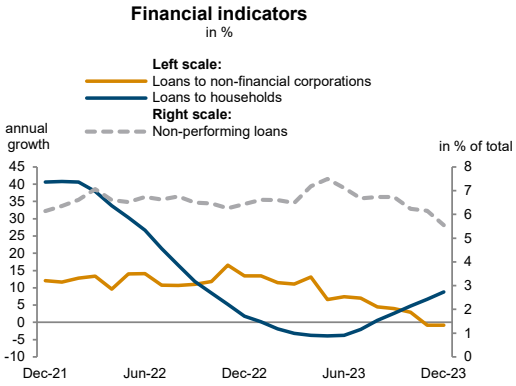
Unit labour costs in industry
annual growth rate in %



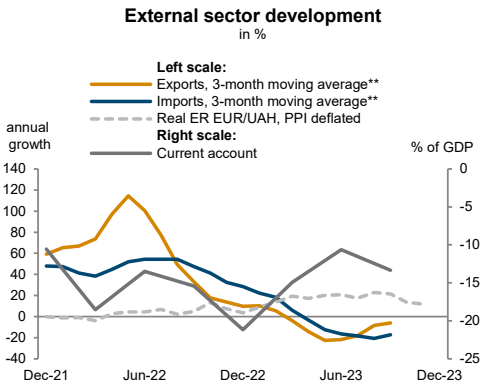
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



*Positive values of the productivity component on the graph reflect decline in productivity and vice versa.
**EUR based.

Source: wiiw Monthly Database incorporating Eurostat and national statistics.
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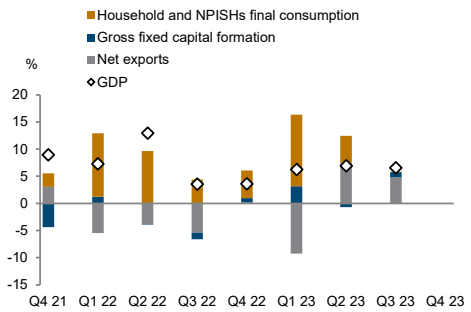
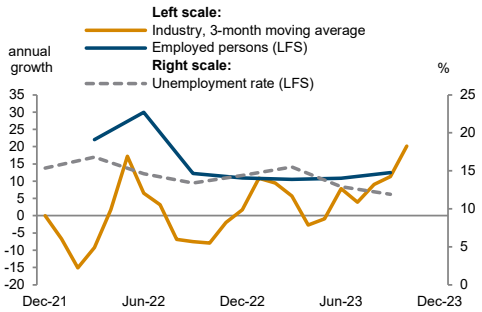
Montenegro

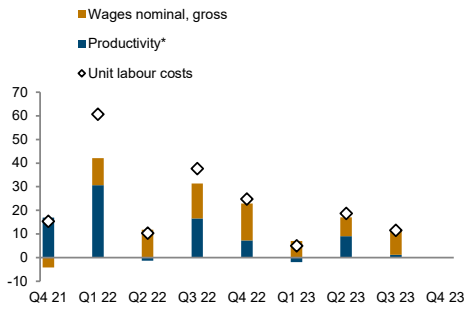
Real GDP growth and contributions
y-o-y



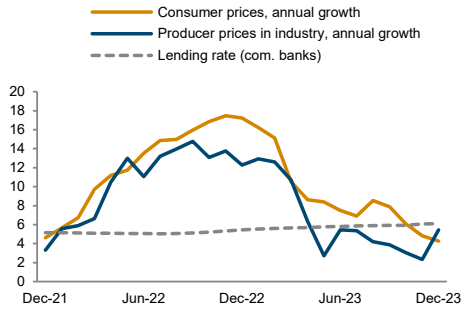
Real sector development
in %



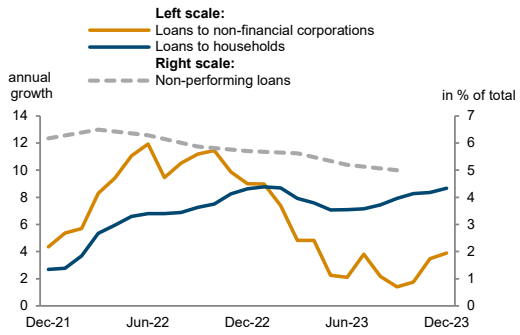
Unit labour costs in industry
annual growth rate in %



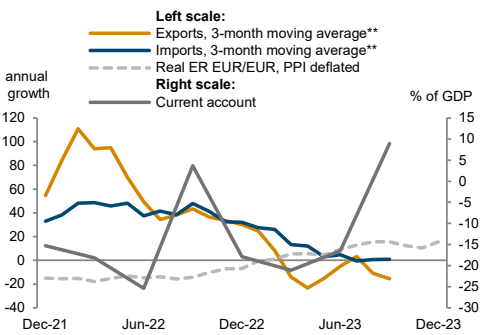
Inflation and lending rate
in %



Financial indicators
in %



External sector development
in %



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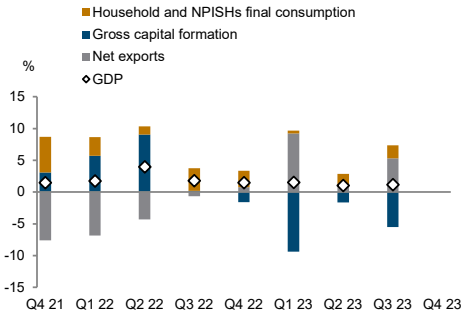
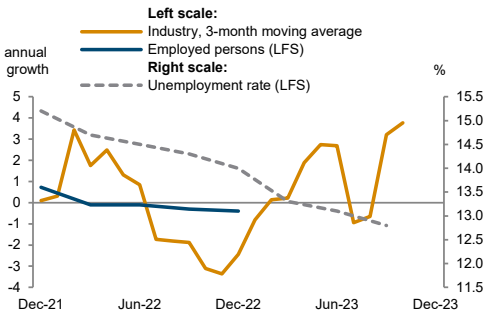
North Macedonia

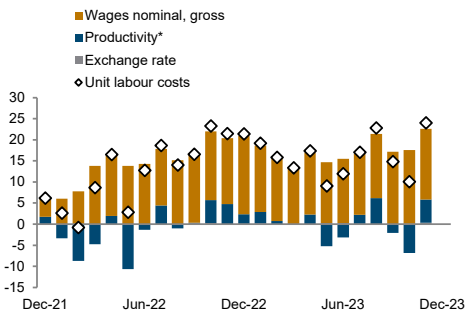
Real GDP growth and contributions
y-o-y



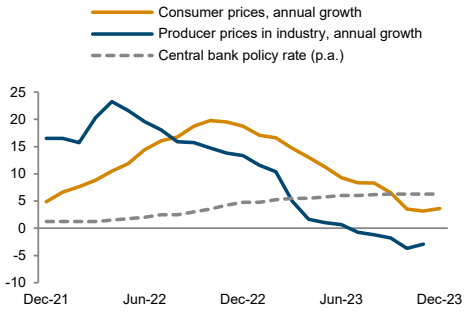
Real sector development
in %



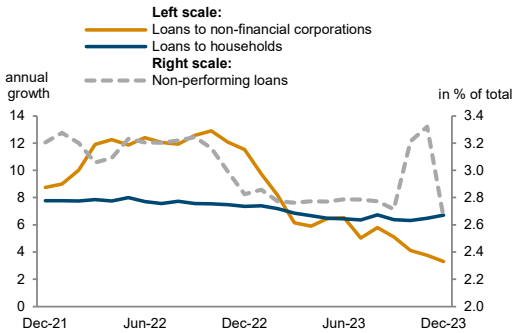
Unit labour costs in industry
annual growth rate in %



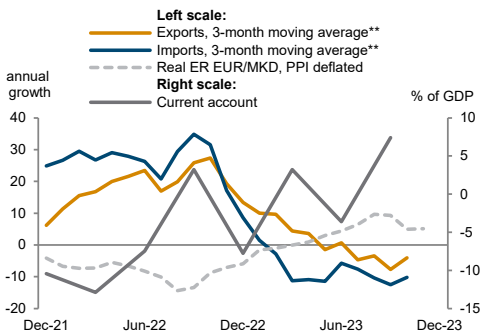
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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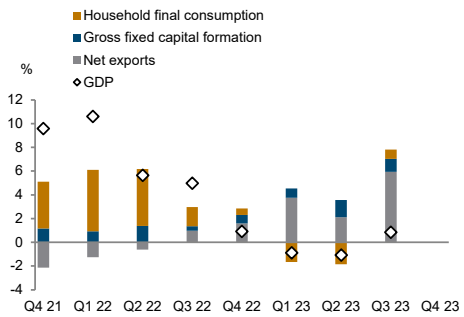
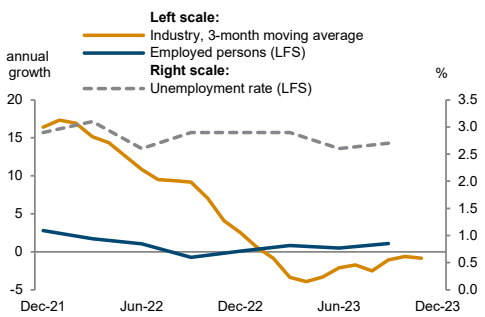
Poland

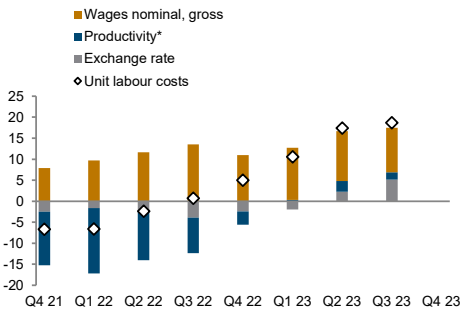
Real GDP growth and contributions
y-o-y



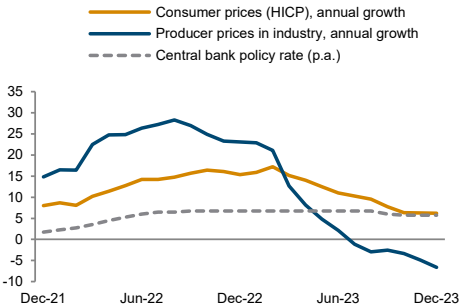
Real sector development
in %



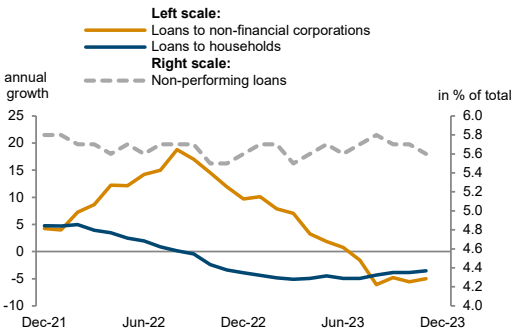
Unit labour costs in industry
annual growth rate in %



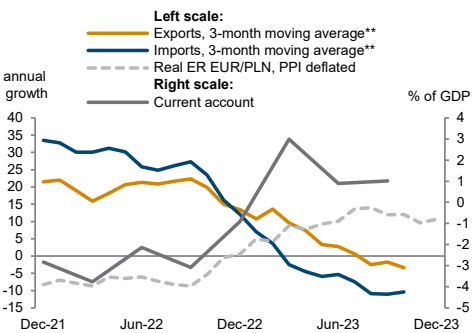
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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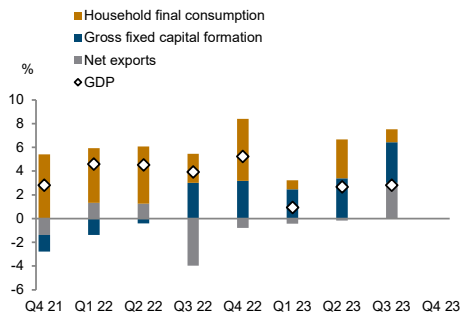
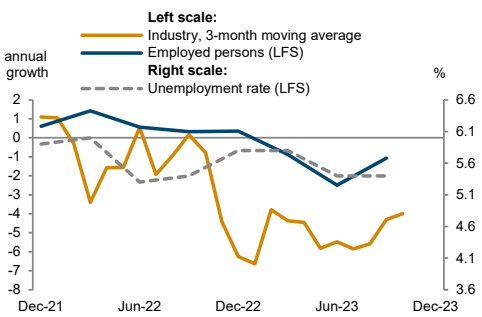
Romania

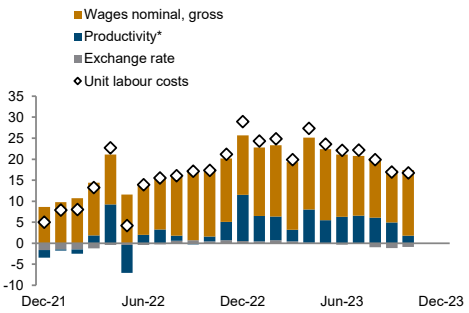
Real GDP growth and contributions
y-o-y



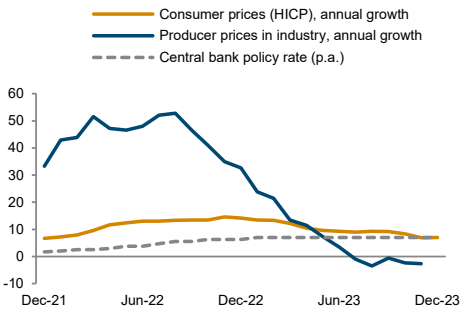
Real sector development
in %



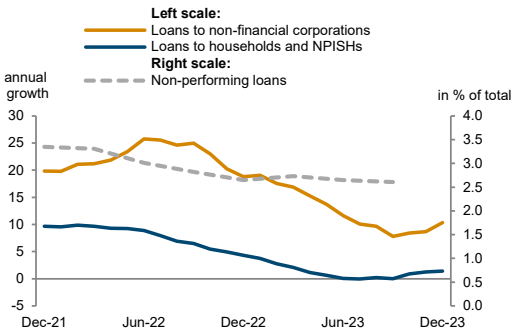
Unit labour costs in industry
annual growth rate in %



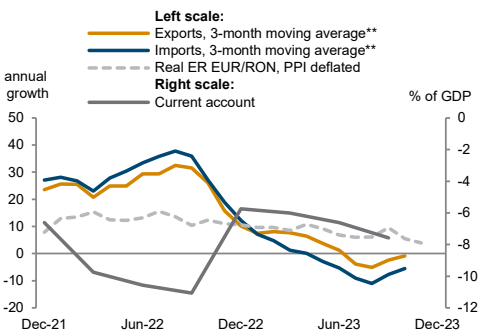
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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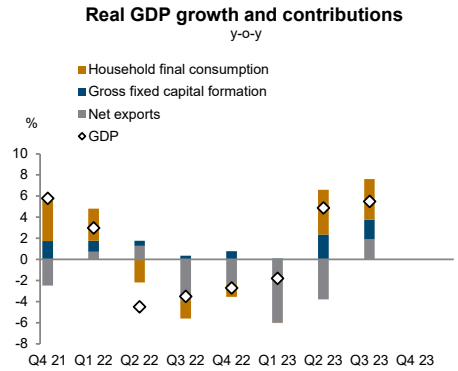
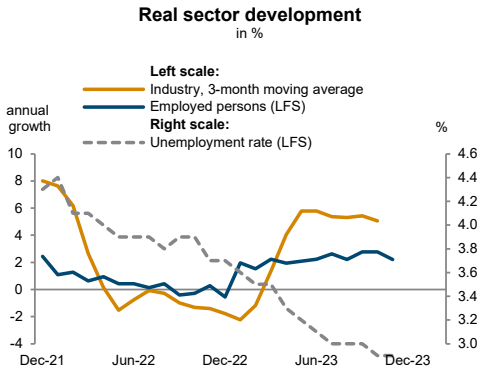
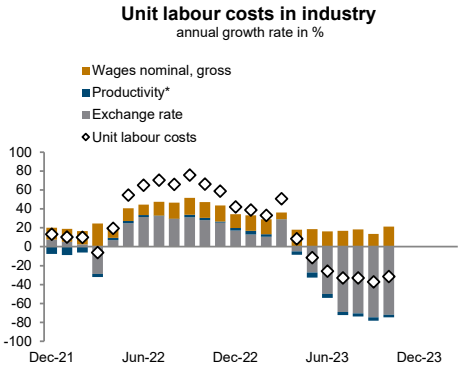
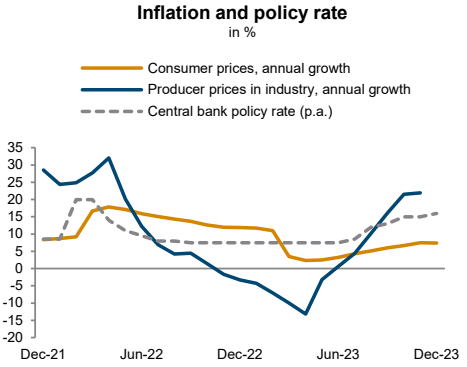
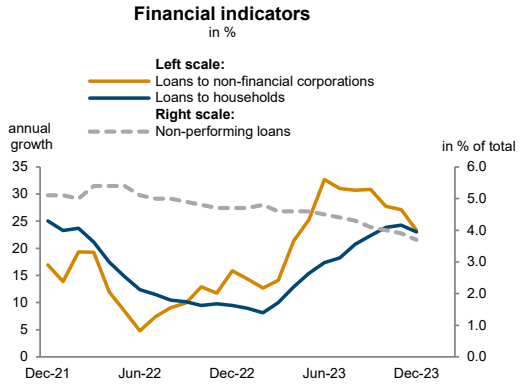
Russia

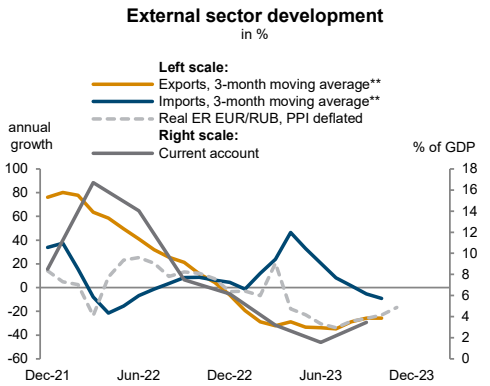












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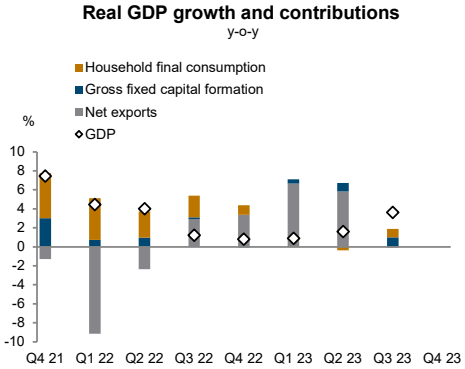
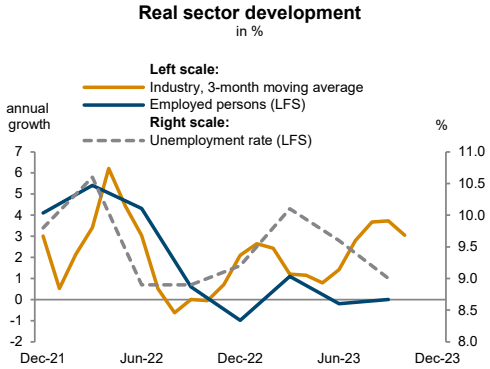
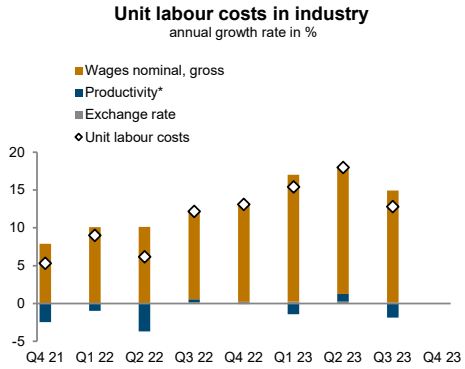
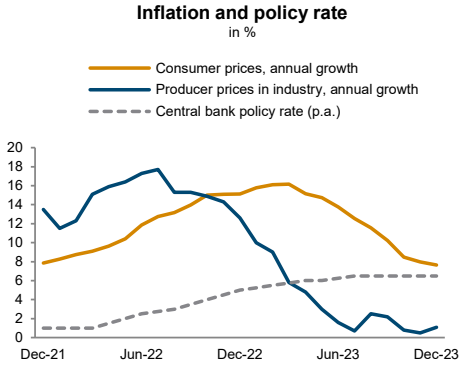
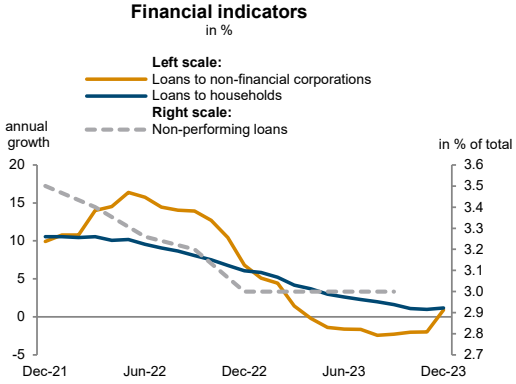
Serbia

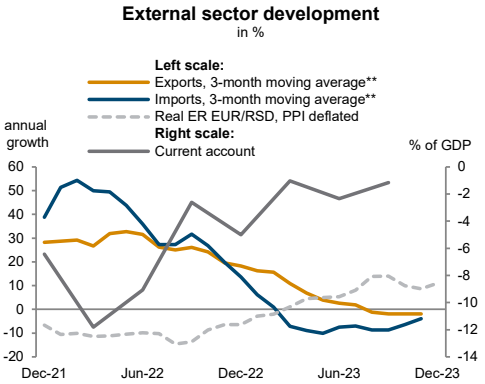












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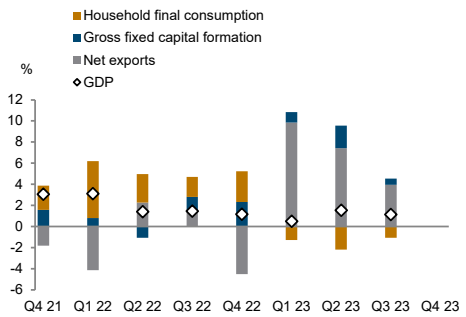
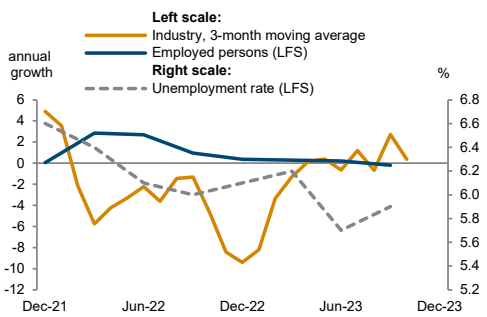
Slovakia

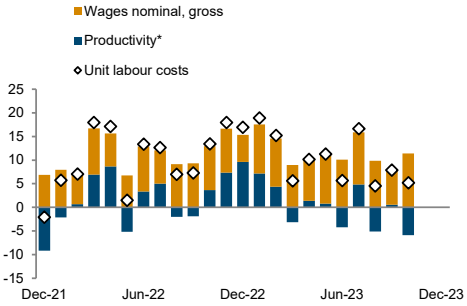
Real GDP growth and contributions
y-o-y



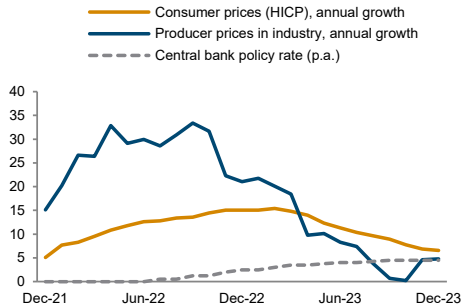
Real sector development
in %



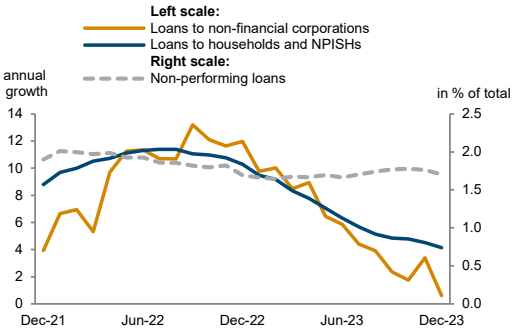
Unit labour costs in industry
annual growth rate in %



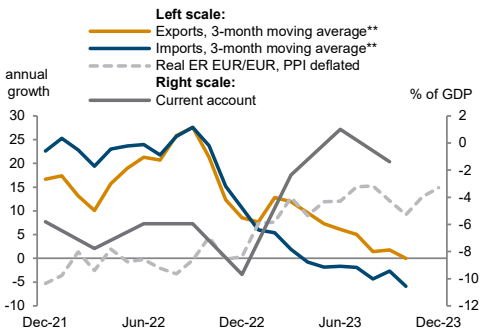
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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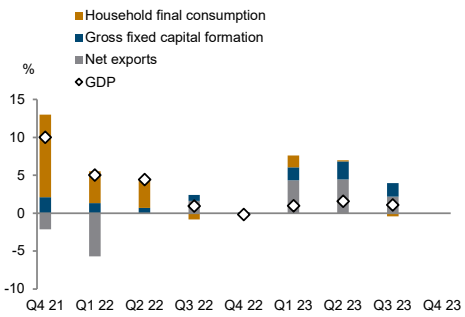
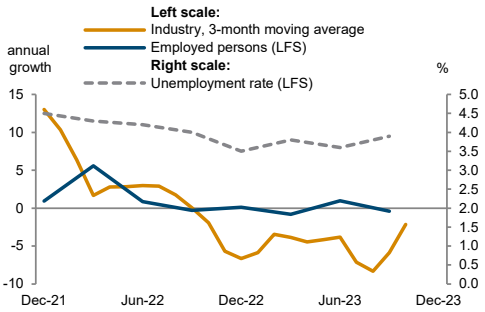
Slovenia

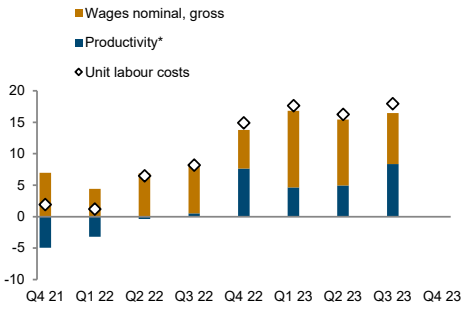
Real GDP growth and contributions
y-o-y



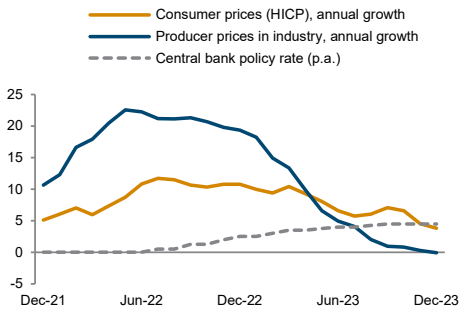
Real sector development
in %



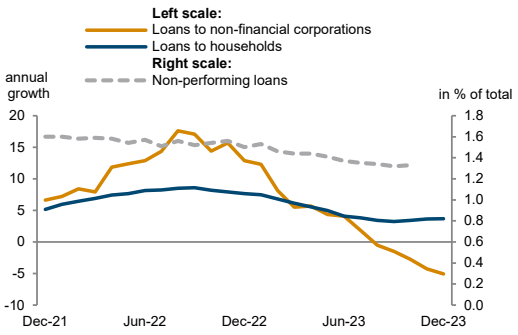
Unit labour costs in industry
annual growth rate in %



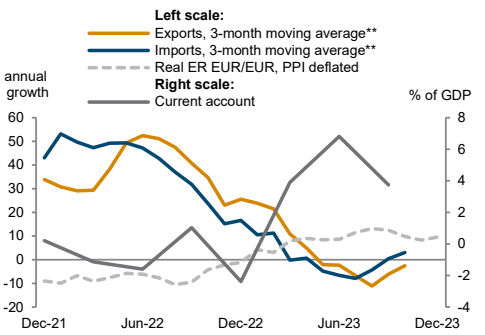
Inflation and policy rate
in %



Financial indicators
in %



External sector development
in %



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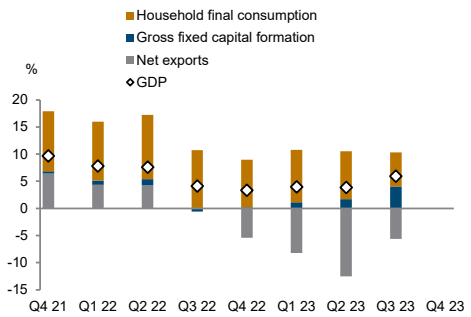
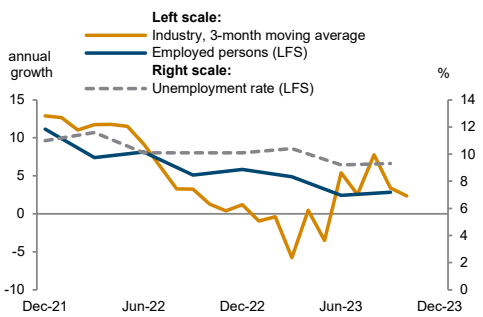
Turkey

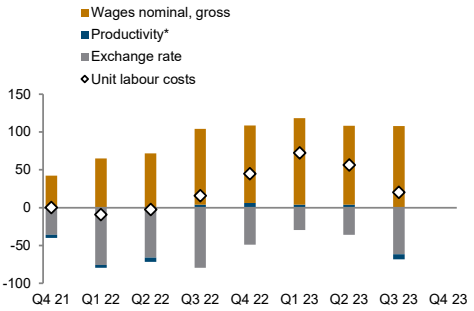
Real GDP growth and contributions
y-o-y



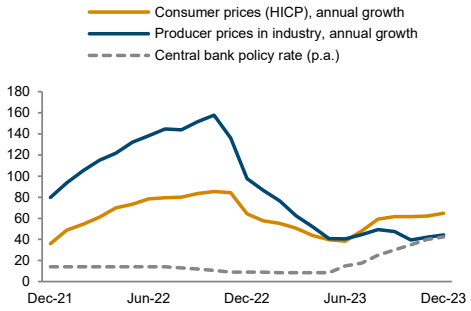
Real sector development
in %



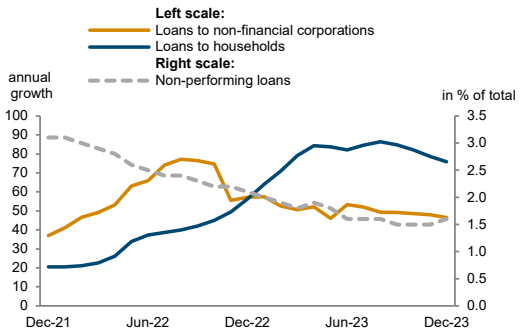
Unit labour costs in industry
annual growth rate in %



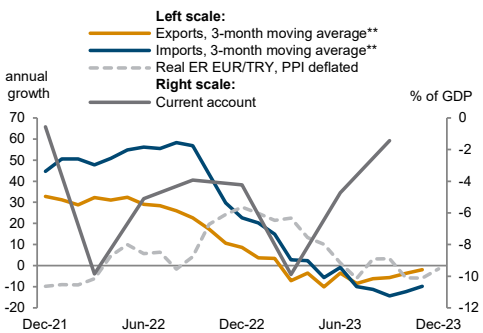
Inflation and policy rate
in %



Financial indicators
in %



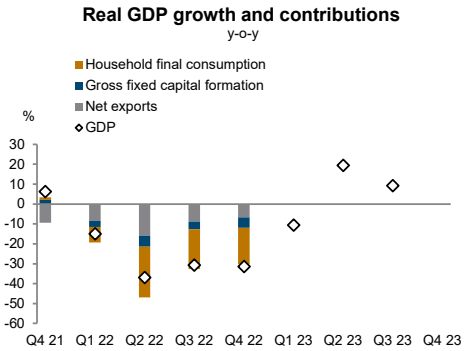
External sector development
in %

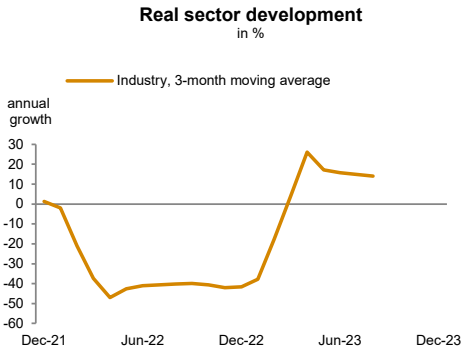


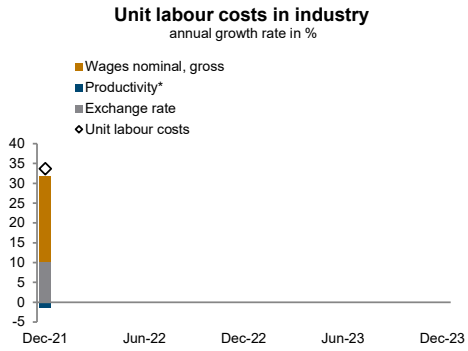
*Positive values of the productivity component on the graph reflect decline in productivity and vice versa.
**EUR based.

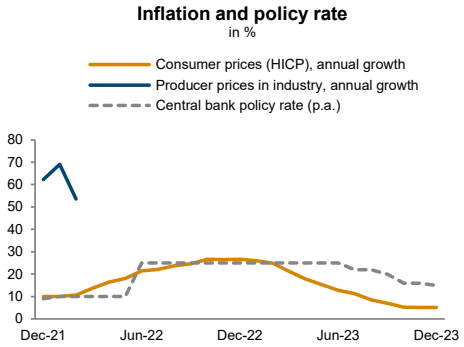
Source: wiiw Monthly Database incorporating Eurostat and national statistics.
Baseline data, country-specific definitions and methodological breaks in time series are available under:
https://data.wiiw.ac.at/monthly-database.html

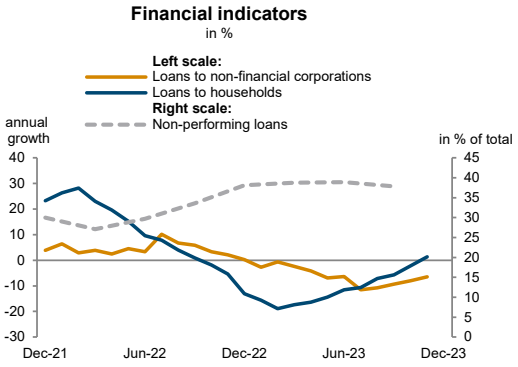
Ukraine

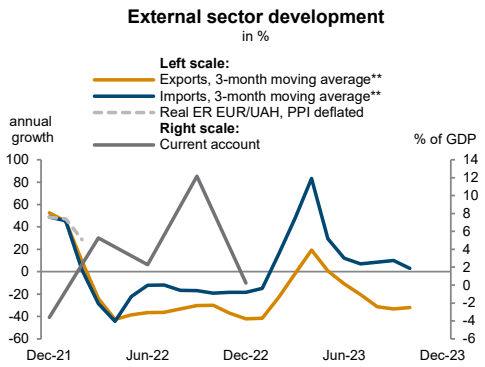












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multi-country articles and statistical overviews

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