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EUROPEAN ECONOMY

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Economic and Financial Affairs

The **Quarterly Report on the Euro Area** is written by staff of the Directorate-General for Economic and Financial Affairs. It is intended to contribute to a better understanding of economic developments in the euro area and to improve the quality of the public debate surrounding the area's economic policy.

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The views expressed are the author's alone and do not necessarily correspond to those of the European Commission.

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Quarterly Report on the Euro Area

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Maarten Verwey
Director-General

Since our Autumn Forecast, economic data have pointed to continued weakness, which is reflected in our 2024 Winter (Interim) Forecast. GDP in the euro area stagnated before the summer of 2023 and narrowly avoided a technical recession after the summer. We now project GDP in the euro area to grow by only 0.8% in 2024 on the back of subdued internal and external demand, and of the more restrictive policy mix. On inflation, however, the outlook is more positive. The stalling of activity in 2023 has added to the initial sharp fall in energy prices, bringing a broad-based and rapid moderation of price pressures both in headline inflation and in core inflation. Thus, we project HICP inflation to halve, from 5.4% in 2023 to 2.7% in 2024, substantially below the 3.4% projected in the Autumn Forecast. January data confirm this decrease with HICP inflation at [2.8%].

The importance of food prices for the dynamics of inflation in 2022-23 is sometimes underestimated. Food accounts for almost 20% of the consumption basket in the euro area. Food inflation peaked at 15.5% in March 2023 and was still running at close to 6% in January 2024, well above other main consumption categories like services or non-energy industrial goods. This is very meaningful for households' purchasing power, particularly for low-income households. Chapter 1 of this issue discusses the contribution of food inflation to the overall inflation and to its dispersion across euro area Member States. In particular, the chapter analyses the drivers of the recent spike in food inflation along the pricing chain of food products. First, an input-output analysis discusses the role of input costs, wages and operating surplus in determining inflation in the food manufacturing sector. Second, an econometric analysis estimates the relative contribution of food production prices, distribution costs and food import prices to food consumer prices. The results indicate that the main drivers of rising food production costs were agricultural produce, energy, and distribution and packaging costs. Regarding food consumer prices, the rise in 2022-23 was driven mostly by food producer prices, while costs related to distribution also played a role. The analysis indicates that as commodity prices continue to adjust downwards and this adjustment continues to pass through the entire food value chain, food inflation should continue to fall.

Past issues of the Quarterly Report on the Euro Area (QREA) have looked at many different dimensions of the impact of the COVID-19 shock in the euro area economy, ranging from its impact on tourism revenues, to its impact on investment, trade, or economic convergence among euro area countries. For some dimensions, however, the shock is affecting the economy with considerable lags and its impact can only be assessed with some hindsight, as it is typically the case with learning and the accumulation of human skills. Chapter 2 analyses the effects of COVID-19 school closures on learning deficits and labour markets, on which evidence is starting to accumulate. Studies from various euro area countries and other Member States show, on average, significant learning deficits in primary and secondary education, equivalent to almost 2 months of learning progress during a regular school year. This estimated impact varies widely by country as well as by students' age and socio-economic background. On labour market outcomes, the analysis shows that the 2020 graduating cohort seem fortunately resilient in the current situation of tight labour markets, but the long-term economic impact of learning deficits is likely to be non-negligible.

Existing studies project small productivity losses for the coming years but a significant impact in the long term, peaking in the second half of the 21st century, when all affected cohorts of students will have entered the labour market. Estimates of the aggregate real GDP effects of an average learning deficit of circa one fifth of a school year, given the number of affected cohorts of students, range between -0.1% and -1% by 2050, compared to a baseline without any learning deficits.

Finally, Chapter 3 updates and extends the analysis of the market performance of EU bonds published in our first issue of the QREA in 2022. Since then, there have been many developments in financial markets, including in the sub-sovereign, supranational and agency market, where EU bonds can be placed. These developments make it important to extend the analysis. This chapter, therefore, investigates the changing contributions of various drivers of market performance over time along the yield, spread and liquidity dimensions. In addition, since all NextGenerationEU (NGEU) loan requests have now been submitted, the chapter also includes a first *ex ante* illustrative assessment of the sizeable potential net financial gains accruing to the beneficiary Member States. Overall, the chapter concludes that EU bond performance has experienced different phases while continuing to compare well to reference issuers.

To close, let me recall that 2024 marks the 25th anniversary of the euro. During these 25 years, the euro area has withstood an unprecedented series of large shocks, from the global financial crisis and sovereign debt crisis to the shocks of the past 5 years. It has shown a remarkable capacity to learn and adapt. The lessons from the global financial crisis and sovereign debt crisis have been well scrutinised and digested. Besides shaping major institutional reforms that contributed to the resilience of the euro area, these lessons have informed the decisive policy response at the EU and national level to the more recent shocks. However, the lessons from COVID-19, Russia's unprovoked full-scale invasion of Ukraine and large swings in commodity prices are still to be understood in full.

Throughout 2024, the QREA will celebrate the euro's anniversary in various ways, including with a special issue planned for the fall, which will include an analysis of the lessons that can be drawn from the more recent shocks and the policy responses to address them, with the aim to feed the debate on how to prepare the euro area for the challenges that lie ahead, which are many. In addition, in our next issue, our euro area chronicle will single out the most memorable events in the history of the euro. This will accompany other initiatives by the European Commission to celebrate *The Value of Unity.*

I. WHAT'S BEHIND THE SPIKE IN FOOD INFLATION – RECENT DEVELOPMENTS, DRIVERS AND OUTLOOK IN THE EURO AREA

By Andras Rezessy and Giulia Maravalli (1)

Abstract*: The chapter discusses the recent surge in euro area food inflation in 2022-23 to a peak of 15.5% in March 2023, which has significantly impacted low-income households. The rise in food inflation, affecting both processed and unprocessed food, has contributed significantly to overall inflation. The dispersion of food inflation across countries increased to unprecedented levels in 2022, with the hardest hit countries being the Baltic countries (Estonia, Latvia and Lithuania), Slovakia and Croatia. This chapter analyses quantitatively the drivers of the recent spike along the pricing chain of food products in two steps. First, an input-output price analysis looks at input costs, wages and operating surplus of the food manufacturing sector comparing it with the output prices of the sector. Second, an econometric analysis looks at how food producer prices and the main inputs and the value added of the distribution sector impacted food consumer price inflation. Thus, the impact of global shocks such as global commodity prices, Russia's war of aggression against Ukraine, global supply bottlenecks are captured through their effects on input prices and value added. The results indicate that the main contributors to the rising costs of the food manufacturing industry were agricultural produce, energy, distribution and packaging costs. Input prices rose faster than output prices until the end of 2021, a development which has however been partly reversed since then. This indicates that current profits are probably compensating for losses in profitability sustained in the previous 1.5 years. Regarding food consumer prices, the rise of 2022-23 was driven mostly by food producer prices, while energy prices and the value added of the distribution sector also played a role. Looking ahead, as past shocks have been priced in and passed through the entire food value chain, food inflation should continue to fall unless there are renewed pressures on input prices or a strong reaction of wages and profits in the food or the distribution sectors.*

I.1. INTRODUCTION

Headline inflation in the euro area reached record levels in autumn last year, peaking at 10.6% in October 2022 before easing to 2.9% in October 2023. The rise was mostly driven by energy prices but was strong in other consumption categories as well. Energy prices started a considerable downward correction in autumn 2022 and contributed negatively to headline inflation in the second half of 2023. This put the focus on other components of inflation which continued to exert upward pressure on prices from that time onwards. One component that has been of particular concern in 2023 is food which accounted for around 40% of headline inflation throughout the period January-October. This is all the more important as food is an important item of households' consumption basket, most notably for low-income households. (2)

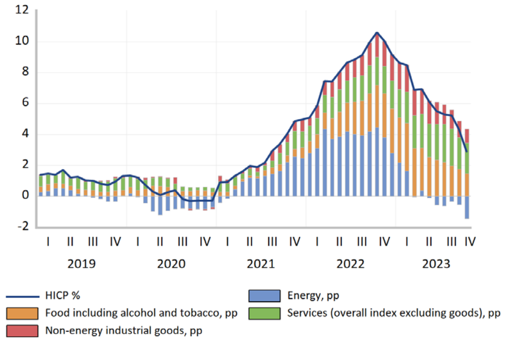
This chapter looks at the sudden rise in food inflation in 2022-23 in the euro area with the aim to assess the driving factors behind the spike. The chapter starts with an overview of the recent developments in food inflation. It then looks at the cross-country dispersion of food inflation in the euro area. The last two sub-sections provide the quantitative analysis which is implemented through a two-step approach: first looking at the input and output costs of the food manufacturing industry, and in the second step through an econometric analysis of HICP food inflation. Finally, the chapter presents some concluding remarks.

(1) The authors would like to thank Wouter Simons for his valuable insights on the Input-Output price analysis, as well as Christian Buelens, Leonor Coutinho, Eric Ruscher, Matteo Salto and Gábor Pellényi for helpful comments. This chapter represents the authors' views and not necessarily those of the European Commission.

(2) The social consequences of inflation is analysed in Menyhért, B. "Inflation and its diverse social consequences across the euro area", Quarterly Report on the Euro Area, 2023/1.

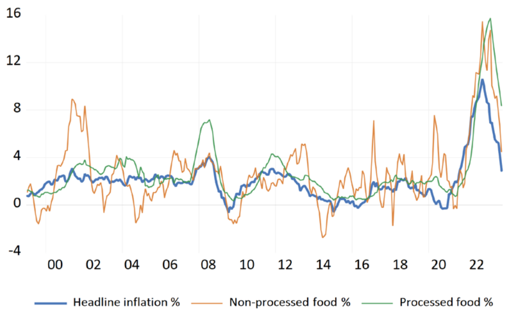
I.2. EVOLUTION OF FOOD INFLATION

Graph I.1: **Contributions of main consumption categories to headline inflation in the euro area**



Source: Eurostat, own calculations.

Graph I.2: **Evolution of headline inflation, and processed food and unprocessed food inflation in the euro area**



Source: Eurostat, own calculations.

Starting from mid-2021, food was making a growing contribution to headline inflation, and that contribution only started to decline in the middle of 2023 (Graph I.1). The rise in food prices affected both processed and unprocessed food and was significant in all euro area countries ([3]). However, the contribution of food to headline inflation varied from country to country, depending notably on the national food expenditure share (see subsection on cross-country dispersion).

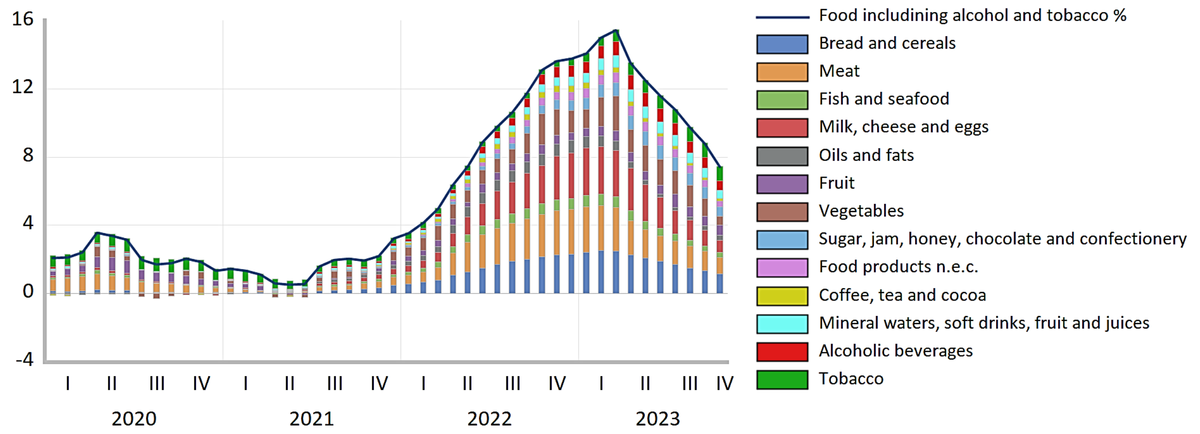
Looking back over the past two decades, the recent spike in food inflation stands out for its unprecedented magnitude (Graph I.1). Food inflation has historically been more volatile than headline inflation, particularly unprocessed food. This is because unprocessed food inflation is influenced more strongly by factors such as commodity price movements, weather patterns etc., and also because of a lower level of processing ([4]). The recent spike is also exceptional as processed and unprocessed food inflation surged simultaneously ([5]). Historically, both subgroups have exhibited low inflation persistence and have shown downward corrections relatively quickly following upward spikes; even so, inflation has tended to move more slowly for processed than for unprocessed food. This can also be seen in the inflation out-turns throughout 2023, when unprocessed food inflation showed a much faster fall than processed food. In the past, unprocessed food inflation tended to lead processed food inflation, which points to further downward correction for processed food inflation in the near future.

([3]) Processed food made a bigger contribution to headline inflation, reflecting its larger share of the consumption basket.

([4]) In terms of product coverage, the distinction between the two groups is not straightforward as the notion of 'processing' is not well defined; however, the lower volatility of processed food inflation is clearly visible.

([5]) A potential explanation could be that the post-pandemic supply disruptions and transport bottlenecks affected both processed and unprocessed food alike. Moreover, the energy price shock hit both processed and unprocessed food alike, driving inflation up in 2022.

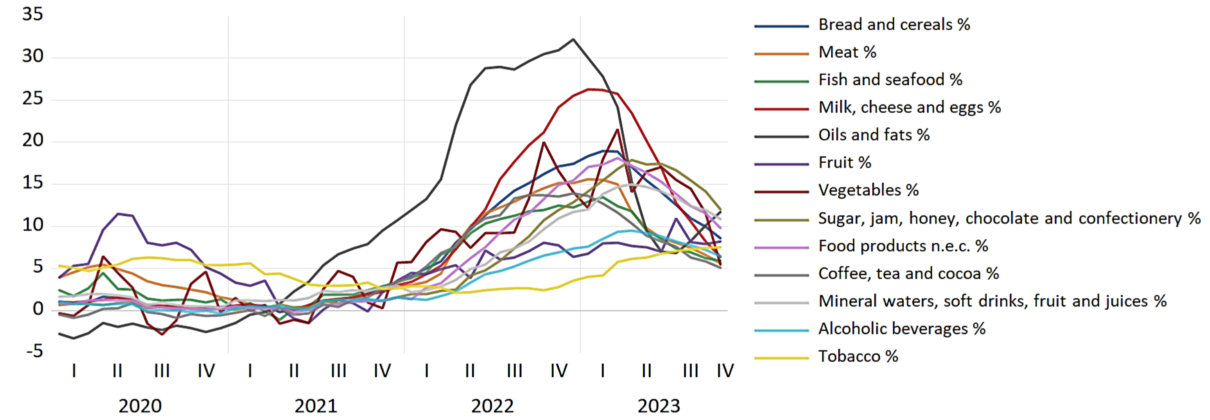
Graph I.3: **Contributions of the various sub-categories to food inflation in the euro area**



Source: Eurostat, own calculations.

Looking at a more detailed breakdown of food inflation, the main contributors to the recent spike in food inflation have been the following: bread and cereals; meat; milk, cheese and eggs; and vegetables (Graph I.3). However, the major contribution of these food categories reflects their weight in the consumption basket rather than their inflation rates. Graph I.3 plots inflation developments for the 13 subgroups making up the food aggregate (including alcohol and tobacco). It shows that all groups saw inflation increases but to differing extents. Inflation increased most for oils and fats, reaching a peak of 32% in December 2022. While the other food categories showed more muted growth, nearly all categories exceeded the path of headline inflation. Alcoholic beverages and tobacco stayed below headline inflation (6); however, these are subject to considerable excise taxation dampening the effect of changes in input prices. More recently, inflation for alcohol and tobacco also exceeded the headline inflation. Overall, this indicates that the surge in food inflation was broad-based across product groups.

Graph I.4: **Inflation developments for the various food sub-categories in the euro area**

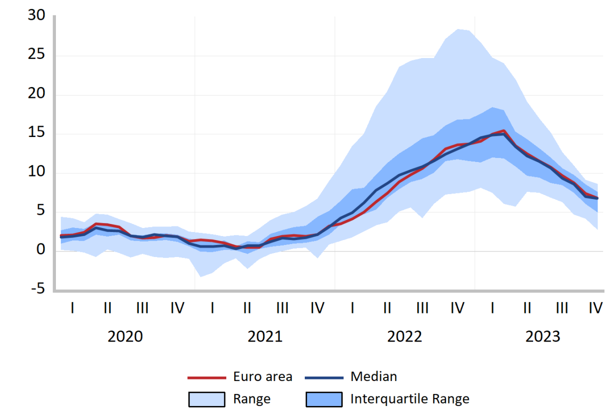


Source: Eurostat, own calculations.

(6) Alcoholic beverages and tobacco are included in the special aggregate of food, alcohol and tobacco in the Eurostat classification, which is usually referred to as food inflation.

I.3. DISPERSION OF FOOD INFLATION ACROSS COUNTRIES IN THE EURO AREA

Graph I.5: **Cross-country dispersion of food inflation in the euro area (% yoy)**



Source: Eurostat, own calculations.

The dispersion of food inflation across euro area countries increased to unprecedented levels in 2022, with a distribution that became strongly skewed upwards. Graph I.5 shows that while in previous years the range across countries (i.e. the gap between the countries with the highest and the lowest inflation rates) was fluctuating around 5 percentage points, it increased to around 20 percentage points at the end of 2022. More recently, the dispersion has been declining, approaching the levels seen before the inflation spike. The hardest hit euro area countries were Estonia, Latvia, Lithuania, Slovakia and Croatia, where cumulative food inflation reached around 32-42% in the past two and a half years. Moreover, there was a noticeable co-movement between the size of the food price shock in the past 2 years and the importance of food in the overall consumption basket (Graph I.6). This implies that the countries that saw the strongest rise in food prices are also the ones with the highest share of food in total inflation. This further increases the contribution of the food price shock to total inflation and to the dispersion of inflation across Member States.

Graph I.6: **Weight of food in HICP (%) and cumulative food inflation between January 2021 and August 2023**

Source: Eurostat, own calculations.

Several factors could explain why these five countries experienced higher food inflation. These include: i) a higher exposure to the energy price shock; ii) lower absolute price levels due to a lower share of non-commodity costs, which imply a higher relative price increase in response to a commodity shock; and iii) a past history of medium to high inflation that could imply a higher sensitivity to external inflation shocks. The importance of a history of comparatively higher inflation is supported by a positive relation across Member States between cumulative past headline HICP inflation in the past two and a half decades and cumulative food inflation in 2021-2023.

An additional explanation relates to distribution costs, which are a major component of intermediate costs in the food sector and in the final consumer prices of food items. The increase of the value-added deflator of the distribution sector was comparatively much higher in the five countries identified above: the peak of the year-on-year deflator was 14-30% in the five countries compared with 8% in the euro area as a whole. Consequently, both unit labour costs and gross operating surplus in the food sector increased faster in the five countries than in the euro area as a whole. This could also be linked to the history of comparatively higher inflation mentioned previously. The importance of wage developments in the cross-country dispersion of food inflation in the euro area is also highlighted by Peersman (2022) even though on a more limited set of countries and excluding the ones with the highest inflation ([7]).

I.4. ANALYSIS OF THE DRIVERS OF FOOD INFLATION

According to econometric estimates published by the IMF on a global sample of countries in 2022 ([8]), cereal prices increase by about 2% after three to four quarters following an oil price shock of 10%. Fertiliser prices are estimated to have a greater effect: a 10% rise in fertiliser prices leads to a 7% rise in cereal prices in the next quarter, but the effect dies out after a year. Finally, a 1-standard deviation negative harvest shock is estimated to increase cereal prices by 23% in the following quarter and the effect seems highly persistent over subsequent quarters. Global food prices are estimated to pass-through to local food price inflation only partially: a 1 percentage point rise in global food commodity prices raises domestic food inflation by about 0.3 percentage points in a time horizon of 10-12 months. The partial pass-through can be explained by the cost share of commodities in final food products, and also by taxes, subsidies, price controls, distribution costs etc.

Peersman (2022) estimates that a 1% rise in international food commodity prices increases euro area headline HICP by 0.08% after eight quarters. This is explained on the one hand by an incomplete pass-through of global commodity prices to EU farmgate prices, and on the other by other factors such as an impact on wages and the exchange rate. This research also estimates that, historically, global food commodity prices explain almost 30% of euro area inflation volatility over the medium term.

Looking at the recent data, the spike in food inflation was preceded by a rise in many important inputs to the food industry. Graph I.7 shows that global commodity prices, such as energy, fertilisers and food, started increasing already in early 2021. Fertilisers saw the sharpest spike with prices rising by 300% by April 2022. The main drivers behind food, energy and fertiliser prices were the post-pandemic recovery (supply chain and transport bottlenecks amid a recovery of demand) and Russia's war of aggression against Ukraine ([9]). While fertiliser prices have fallen significantly since their peak, they are still more than twice as high as at the outset of the pandemic. Energy and (global) food commodity prices showed a less sharp increase, but their peaks exceeded their levels of early 2020 by 130% and 70%, respectively ([10]). Following a downward correction in recent months, they are still about 30-40% above their pre-pandemic levels. Adverse weather conditions also played a role; an extreme drought took place in 2022 in Europe and many other parts of the world, influencing food commodity prices. The drought coincided with the energy and fertiliser price shock in 2022, increasing their effect on food commodity prices.

Movements in global commodity prices (measured in USD) were further amplified by changes in the nominal exchange rate of the euro against the dollar. From the beginning of 2021 until mid-2022, the euro weakened by about 20% (although this followed a year of strengthening of around 10% in 2020). As of mid-2022, the euro appreciated by about 10% at the same time when energy and fertiliser prices also eased.

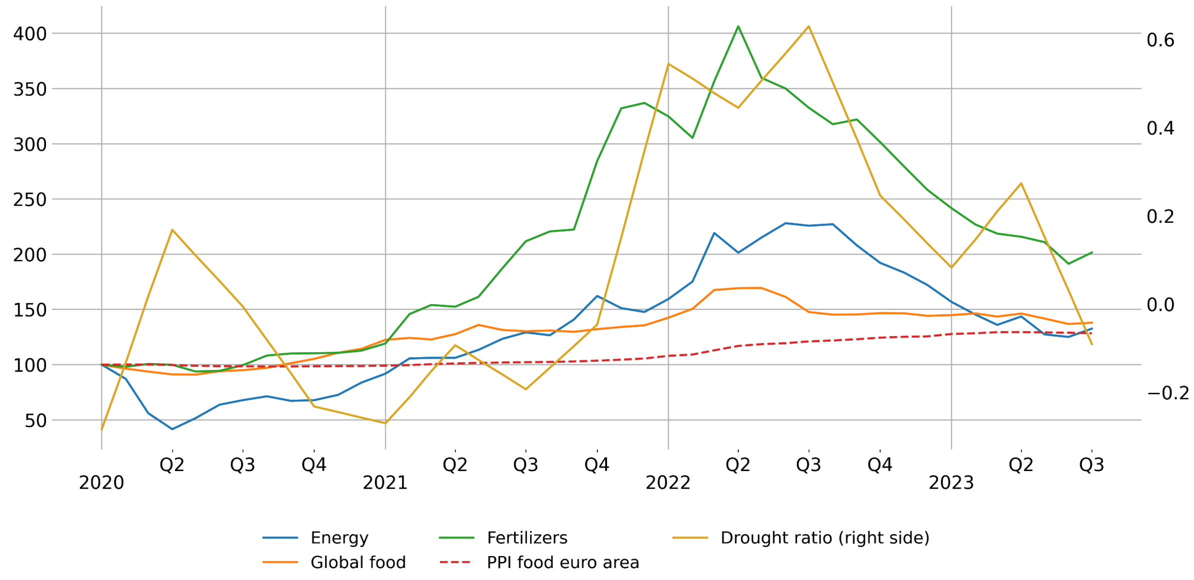
([7]) Peersman, G. (2022), 'International food commodity prices and missing (dis)inflation in the euro area', The Review of Economics and Statistics, January 2022, 104(1).

([8]) IMF World Economic Outlook, October 2022.

([9]) For a discussion on the impact of the war on food inflation in the euro area, see Bodnár, K. and Schuler T. 'The surge in euro area food inflation and the impact of the Russia-Ukraine war, ECB Economic Bulletin, Issue 4/2022.

([10]) Energy prices affect food inflation through several channels. Firstly, petroleum products are used as fuel for agricultural machinery and transportation, while gas is the main input for nitrogen-based fertilisers. Secondly, some agricultural commodities, in particular certain cereals, are used as biofuels.

Graph I.7: **Global commodity price index, euro area drought ratio and food PPI 2020-2023 (2020 January = 100)**



The drought ratio is defined as the ratio between the recorded drought values (% of euro area land in a state of drought alert, warning or watch under the Combined Drought Indicator of the European Drought Observatory (11)) and its quarterly average observed in the period 2012-2023 normalised to zero.

Source: World Bank, Eurostat, JRC European Drought Observatory, own calculations.

The subsections that follow undertake a quantitative assessment of the drivers behind the 2021-2023 spike in food consumer inflation. This is done through a price chain analysis consisting of two steps. In the first step, an input-output price analysis is carried out for the food manufacturing sector (food, beverages and tobacco), using price indices for producer prices of intermediate products to the food industry (PPIs of industries, services and agricultural output prices) and wages. This sheds light on how the prices of inputs and wages evolved in the food manufacturing sector between 2019 and 2023. The evolution of input costs is then compared with that of producer prices in the food manufacturing sector, which is the price of the output of this sector. This gives an indication about which inputs were the main drivers in the increase in costs and also sheds light on how the profitability of the sector developed over this period. In the second step, an econometric analysis is performed to explore how final consumer prices of food (HICP) were affected by the PPI of the food manufacturing industry, agricultural output prices, food and agricultural imports, and other factors such as energy, distribution margins and taxes.

I.4.1. From farm to factory: input and output prices of the food manufacturing industry

An analysis of input-output tables can shed light on the importance of the various inputs used by the sector and also on the respective roles of wages and profits (12). As can be seen in Table I.1, the largest input for the production of food, beverages and tobacco are the products of agriculture (26% of the output of the food sector) (13). Altogether, services are also important and account for 28% of the

(11) For more details on the Combined Drought Indicator, see: factsheet_combinedDroughtIndicator.pdf (europa.eu).

(12) This analysis is based on the input-output table for the year 2019. The latest available input-output table in ESTAT refers to 2020, but data in that year was highly influenced by the break-out of the COVID-19 pandemic, and therefore does not represent a reliable basis for analysis.

(13) Self-consumption (i.e. the use of food manufacturing outputs within the same sector) is not shown separately in the table, as it has been proportionally reallocated across other sectors to ensure a more accurate representation of sectoral input distribution.

output. Of this, land transport, and warehousing and transport support services make up a combined 5% of output. Transport is an intensive user of both energy and labour, whereas the other services are highly labour intensive. Distributive trade (wholesale and retail services) makes up 12% of output. Sectors that can be linked to packaging are also important with rubber, plastic, paper, chemical and metal products reaching a combined share of about 6% of output. Interestingly, electricity, gas, steam and air conditioning only account, directly, for about 1.7% of output, and coke and refined petroleum products for only 0.2% (14).

Table I.1: **Share of direct inputs used for the production of food, beverages and tobacco in the euro area**

Product input used for producing food, beverages and tobacco	Share in output
Products of agriculture, hunting and related services	26%
Wholesale trade services, except of motor vehicles and motorcycles	9%
Packaging related (rubber, plastic, paper, chemical and metal products)	6%
Retail trade services, except of motor vehicles and motorcycles	3%
Land transport services and transport services via pipelines	3%
Warehousing and support services for transportation	2%
Legal and accounting services; of head offices; management consultancy	3%
Advertising and market research services	2%
Electricity, gas, steam and air conditioning	2%
Employment services	1%
Financial services, except insurance and pension funding	1%
Other (including taxes less subsidies)	13%
Value added, gross	29%
of which: Compensation of employees	18%

Based on the symmetric, product by product, input-output table for the euro area for the year 2019.

Source: Eurostat, own calculations.

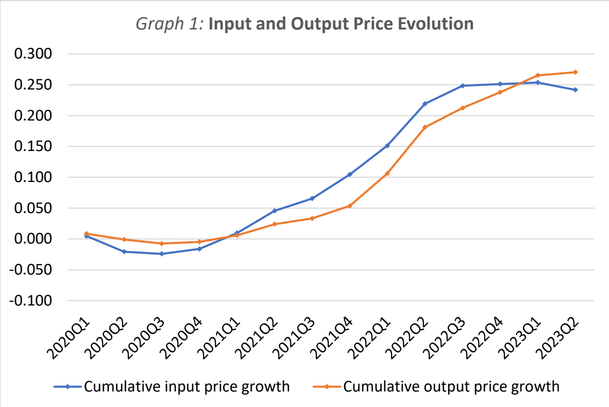
Graph I.8 indicates a notable trend during the early phase of the post-pandemic recovery in 2021, where input prices increased more rapidly than output prices. Specifically, the final quarter of 2021 witnessed input prices surging by 10.5% compared with the start of 2020, in contrast to the more modest 5.4% rise in cumulative output prices over the same time frame. However, this dynamic started shifting at the end of 2021. Output prices began to grow more steadily, initially catching up with and then exceeding input prices. Between Q4 2021 and Q2 2023, output prices grew by 23%, compared with a 14% increase in input prices, marking a recovery in producer profit margins in the post-pandemic period. Over 2021-2022, the rise in the price of inputs was primarily driven by the agriculture, energy, transport and distribution sectors, but packaging-related inputs were also important. Agricultural prices reflect the changes in both commodities and energy prices, while the energy sector clearly had an impact on the inputs of all other sectors as well. Transport and logistics was also affected by the global transport bottlenecks in 2021-2022. The fall in input costs from mid-2022 was driven by agriculture and energy, but was also observable in other sectors. The contribution from wages of the food sector was modest during 2021-2022, but picked up somewhat in 2023 in line with overall wage developments.

(14) Energy, however, also has important indirect effects that are not quantified here.

Box I.1: **Methodological framework for the input-output price analysis of the food manufacturing sector in the euro area**

This box explains how the evolution of unitary costs and margins in the food sector is computed at the quarterly frequency since the beginning of 2020. Eurostat provides input-output ('I-O') tables at the yearly frequency at the end of year t+2. It is therefore necessary to combine existing price data with existing I-O tables to project the evolution of costs and prices. The box explains in detail how those projections are made here.

The food column (CPA_C10-12 – Manufacture of food products, beverages and tobacco, hereinafter food manufacturing) of the 2019 Eurostat I-O table with the product-by-product breakdown for the euro area in 2019 ([1]) is the starting point of the analysis. This contains a breakdown of domestic and imported intermediate inputs into 64 CPA categories ([2]) , as well as value-added components, all quantified in euro, used in the production of food manufacturing.



Under the assumption of a constant production structure ([3]), the evolution of unitary costs is equal to the evolution of input price deflators from Q1 2020 up to Q2 2023 weighed using the shares ([4]) of the corresponding production components. Input price deflators for intermediate inputs were computed as q-o-q growth rates of quarterly producer price index (PPI) data of the corresponding category for the euro area by Eurostat from 2019 to Q2 2023 ([5]). Specifically, for agricultural goods (CPA_A01), which are a main input to food manufacturing, q-o-q growth rates were computed from a weighted average of the price index of animal products and the one of agricultural products. For services sectors for which price data were not available, the average inflation of services was used. A similar approach was implemented for compensation of employees ([6]), i.e. q-o-q growth rates were computed based on the gross wage index of the whole manufacturing sector. Taxes less subsidies were assumed to remain constant throughout the duration of the period analysed.

Therefore, total input price growth is calculated as the weighted average of price deflators for intermediate inputs and compensation of employees using as weights the coefficients of the I-O table of 2019. The growth rate of Eurostat PPI for the food manufacturing sector serves as a measure of output price changes, and therefore as a proxy for the increase in unitary revenues. Graph 1 shows the

(1) The year 2019 was selected as the baseline, despite 2020 being the latest available year at the time of analysis, to prevent the distortion effects of COVID-19 in subsequent years' estimates. The 2019 euro area I-O table is available at: Statistics | Eurostat (europa.eu).

(2) Classification of products by activity, version 2.1.

(3) This assumption means that the ratio of intermediate and labour cost to output are kept constant, as if they were production coefficients of a Leontief production function.The shares of the 64 production components over the total output of food manufacturing have been stable in the past, although recent structural shocks (COVID-19, Ukraine-Russia war, energy price shocks) could have had an impact.

(4) The self-consumption share (i.e. food production share) has been proportionally reallocated to the other sectors/value-added components.

(5) For imported intermediate goods the price deflator was computed as q-o-q (Comext). The unit price for the relevant goods was found by employing quarterly trade quantities and values for euro area imported goods. These were then allocated to corresponding CPA categories. For imported services, lacking similar data, the domestic services' PPI values were applied.database on international trade in goods (Comext). The unit price for the relevant goods was found by employing quarterly trade quantities and values for euro area imported goods. These were then allocated to corresponding CPA categories. For imported services, lacking similar data, the domestic services' PPI values were applied.

(6) This component was corrected to include self-employment.

(Continued on the next page)

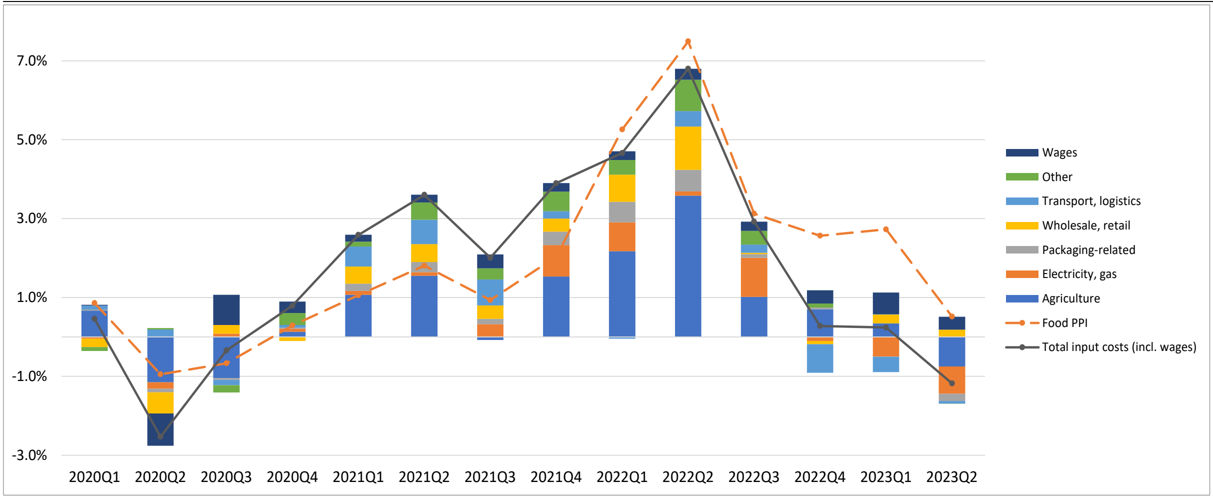
Box (continued)

evolution of unitary input and output prices, assuming an arbitrary starting level of 0 at Q1 2020. The early post-pandemic recovery phase of 2021 showed a faster rise in input prices than output prices, pointing to deteriorating margins at the sectoral level in the euro area. This later reversed as input prices increased more steadily for seven quarters, pointing to some cumulative reduction in margins until the end of 2022. The cumulative output price growth overtook that of input costs only in Q1 2023, since when prices have remained more stable.

In the first half of 2023, the only positive contributions to input costs came from a moderate rise in food sector wages and in the price of wholesale and retail sector inputs, likely because the latter are also sensitive to wage developments. On the other hand, decreasing agricultural and energy prices acted to counterbalance these increases, ultimately leading to a significant decrease in the food PPI.

Overall, the analysis indicates that the food sector saw its input costs increasing faster than its output prices until the end of 2021, which implies worsening profitability on the unit level. This reversed itself as of the beginning of 2022, when profitability started improving. This indicates that current profit increases are probably compensating for the losses in profitability sustained in the previous 18 months.

Graph I.8: **Changes in food PPI and input costs (including labour) of food manufacturing in the euro area (quarter-on-quarter growth rates)**



(1) To compute the costs of intermediate inputs, price indices (PPIs, service PPIs, and agricultural output prices) are weighted by their respective shares in the input-output table for 2019. A constant production structure is assumed over the time horizon of the analysis, which is consistent with the stability observed in past input-output data. The contributions of sectors are based on the calculated direct effects. Self-consumption of the food manufacturing sector is reallocated to all other items proportionally.

Source: Own calculations based on Eurostat data.

I.4.2. From factory and farm to consumers: drivers of the final consumer prices (HICP)

In the second step, an econometric estimation is carried out regressing HICP food inflation (food including alcohol and tobacco at constant tax rates) in the euro area on producer price index of the food manufacturing sector (food, beverages and tobacco); PPI of electricity and gas (PPI energy); and unit labour cost and unit gross operating surplus in the distribution sector as a proxy for non-energy distribution costs (15); price indices for imported processed food; and both domestic and imported

(15) The distribution sector is approximated with NACE G-I, i.e. wholesale and retail trade, transport, accommodation and food services, for which data is available in the sectoral national accounts. This is wider than food distribution, and it

agricultural products (goods and animals). The estimation is implemented through autoregressive distributed lag regressions (ARDL) including also a long-run cointegrating relationship.

The rationale for the choice of regressors follows the main drivers of food consumer prices along the pricing chain. Producer prices of processed food from the food manufacturing sector are a key input to final food products delivered to consumers. So too are unprocessed food products, some of which are sourced by the distribution sector directly from agricultural producers, i.e. not only from the food manufacturing sector. Furthermore, imports of both processed food and agricultural products can also be important ([16]). Finally, these goods are brought to consumers by the distribution sector, whose role is captured on the one hand by the value added of the distribution sector, split into unit labour cost and unit gross operating surplus. Regarding the input costs of the distribution sector, energy is captured by electricity and gas PPI, while other input costs (including fuel, services such as warehousing, legal, and advertising) did not produce significant estimates. Finally, the output price of the distribution (retail) sector is the consumer price index, which is measured here by the HICP.

Simple pairwise correlations indicate high comovement between food HICP and food PPI as expected, with a correlation coefficient of 75%. The value added of the distribution sector is also highly correlated with food HICP (60%), while the other regressors show a relatively lower correlation with food consumer inflation. There is a moderately strong correlation between energy and food PPI, and energy and agricultural imports, and also among domestic and imported agricultural products and processed food imports. As the agri-food variables are cross-correlated with each other and with food PPI and also energy, this could potentially cause multicollinearity issues in the estimation.

Table I.2 shows the estimated long-run cointegrating relations of the drivers of food HICP inflation in the euro area from the ARDL regressions. Food PPI shows a strongly significant estimated coefficient in all specifications. The coefficient is 0.8 when food PPI is the only regressor, but in the other equations it varies between 0.34-0.49 which indicates the importance of controlling for other factors. The results imply that a 1 percentage point increase in food PPI is estimated to lead to around one third to half a percentage point increase in consumer HICP food inflation. Unit labour costs of the distribution sector are also strongly significant and are estimated to have a multiplier of 0.23-0.46, while unit gross operating surplus of the sector is estimated between 0.07-0.13, also strongly significant throughout. The size of the sum of these two effects is comparable to that of food PPI; it underlines the importance of the distribution sector as a driver of consumer food inflation. Electricity and gas PPI is also significant in many specifications, but the effect is much smaller, around 0.02-0.09. The energy variable loses its significance when prices indices for agricultural goods and animals are also included. However, the estimated effects of these agricultural variables (domestic and imported agricultural goods and animals) have the wrong sign as they are slightly negative and are likely affected by the instability caused by multicollinearity. Separate estimations were also carried out using as regressors food PPI and imported processed food and domestic and imported agricultural produce (i.e. without energy and the distribution sector). However, all the variables in these were close to zero and not significant with the exception of PPI food, which was strongly significant. Imported processed food is either non-significant or only significant when the agricultural variables are added but have the wrong sign indicating multicollinearity. All in all, the data does not indicate a strong direct role for either agricultural produce (both domestic and imports) or imported processed food in the evolution of consumer food inflation beyond their impact through the food manufacturing sector that is captured by food PPI.

can possibly be impacted by extraordinary developments of the energy wholesale and energy retail sectors in the period 2021-2022. Therefore, caution is necessary when interpreting the results.

([16]) Note, however, that the first step of the analysis showed that including or excluding imports did not have a noticeable impact on the costs of the food manufacturing sector, indicating a lesser importance of imports for this sector when looking at prices on an aggregate level. Here, the aim of the analysis is to see if imports have a more significant impact on consumer prices, as distribution companies can also buy food directly from agricultural producers or from abroad.

Table I.2: **Long-run cointegrating relation of the drivers of food HICP inflation in the euro area**

Dependent variable: food HICP inflation at constant taxes	1	2	3	4	5	6	7	8
food PPI	0.8*** (0.19)	0.34*** (0.07)	0.49*** (0.06)	0.37*** (0.07)	0.47*** (0.04)	0.38*** (0.04)	0.39*** (0.04)	0.39*** (0.02)
electricity, gas PPI		0.09*** (0.02)		0.03*** (0.01)	0.02 (0.01)	0.03* (0.01)	0.02 (0.02)	-0.01 (0.01)
unit labour cost, distribution sector			0.46*** (0.09)	0.32*** (0.07)	0.35*** (0.11)	0.30*** (0.07)	0.25*** (0.06)	0.23*** (0.04)
unit gross operating surplus, distribution sector			0.13*** (0.03)	0.10*** (0.03)	0.10** (0.05)	0.11** (0.03)	0.07** (0.03)	0.07*** (0.02)
imported processed food price index						0.01 (0.01)	0.06** (0.03)	0.11*** (0.02)
domestic agricultural goods and animals price index							-0.03** (0.01)	-0.01* (0.01)
imported agricultural goods and animals price index								-0.04*** (0.01)
Maximum lags: dependent variable, regressors	6, 6	6, 6	6, 6	6, 6	1, 6	6, 6	6, 6	6, 6

(1) ARDL specification chosen by Akaike information criterion. Quarterly, seasonally adjusted data in logarithmic differences are used in the estimations; time horizon: Q1 2005-Q2 2023; number of observations: 70-73 depending on lag specification. *, **, *** show significance at 10%, 5% and 1% level respectively. Standard errors in parentheses.

Source: Own calculations based on Eurostat data.

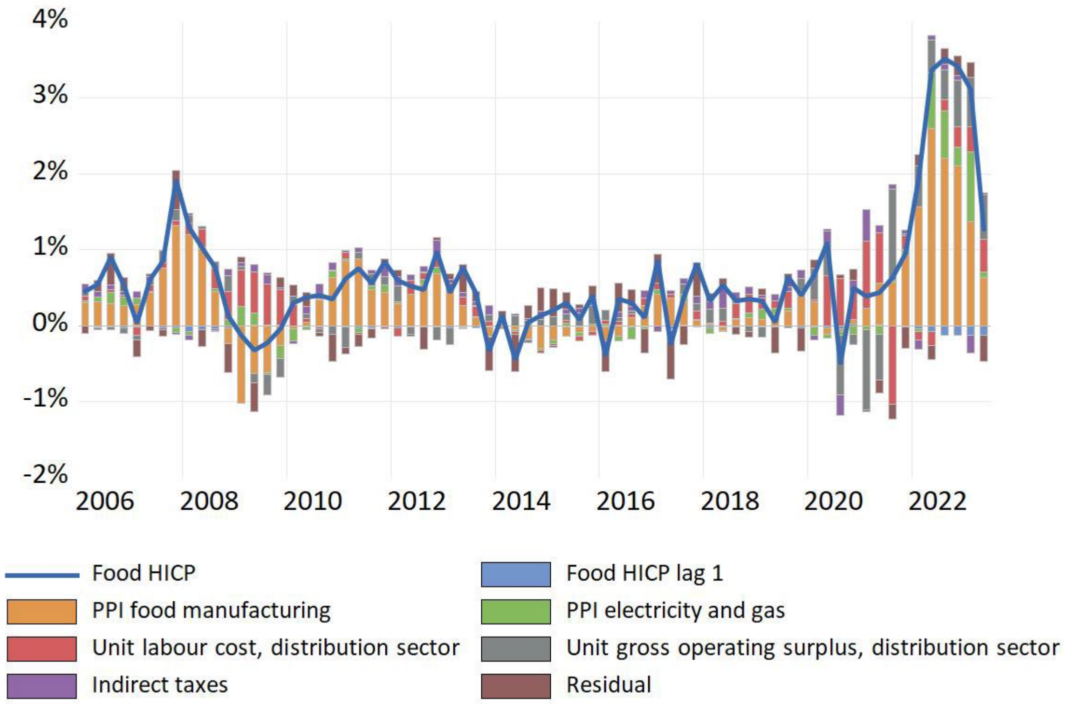
The ARDL estimation also enables an error correction modelling approach, which shows the speed of adjustment back to the long-run relationship following a shock. The estimated coefficients for the speed of adjustment are all negative (as expected, as this ensures the stability of the system) and significant. In equation 1, the speed of adjustment is 0.4, meaning a rather slow adjustment, while in equations 2, 3 and 5 they are close to 1. The latter means that the system converges back to the long-run equilibrium within 1 quarter. In equations 4, 6, 7 and 8, the speed of adjustment is greater than 1, though it is often found in the literature that this coefficient is sensitive to the number of lags included in the estimation. The estimated cumulative dynamic multipliers reach their maxima at around quarters 2-4 in most equations.

The estimated ARDL equations can also be used to decompose the historical evolution of food HICP into contributions implied by the estimated equation. For that purpose, the specification of equations 4 and 5 are chosen, and among these, equation 5 is used for the decomposition. In equation 5, the lag of the dependent variable is restricted to 1, which is a standard approach in the literature, and it implies that most of the dynamics take place in the explanatory variables ([17]). Graph I.9 shows the historical decomposition from equation 5. The model generally captures the evolution of food HICP well, and in particular the recent food price shock is shown with only modest estimation residuals. The decomposition indicates that the food HICP inflation spike started off in late 2021 on the back of increasing food PPI, which was coupled with the energy price shock as of Q2 2022. From Q1 2022, profits of the distribution sector started to play an increasing role which continued up until the end of the sample in Q2 2023. The contribution of unit labour costs of the distribution sector started building up

([17]) Equations 1-3 are subject to omitted variable bias, while equations 6-8 show problems of multicollinearity. A decomposition based on equation 4 shows an important role for the lagged dependent variable and a somewhat larger role for the energy PPI. However, the qualitative conclusions are similar to the decomposition using equation 5.

gradually as of Q3 2022 ([18]). Unit gross operating surplus of the distribution sector made a major and rather stable contribution throughout 2022 to mid-2023. The observed fall in food HICP inflation in 2023 is mostly explained with declining PPI inflation in the food and energy sectors, which implies that profits and wages are becoming a more important driver of food inflation. This highlights the importance that profits and wages will play in ensuring that food inflation returns to the low levels observed before the shock of 2022-2023.

Graph I.9: **Historical decomposition of the food HICP inflation in the euro area (Q1 2006 – Q2 2023)**



(1) Quarter-on-quarter seasonally adjusted data. Food HICP is normalised with the estimated constant to zero. Food HICP here includes indirect taxes. Taxes are not included in the econometric estimation; their contribution here is calculated directly as the difference between the two variants of food HICP: i.e. including and excluding taxes.

Source: Own calculations based on Eurostat data.

I.5. CONCLUSION

The recent spike in food inflation stands out compared with the developments registered over the last two decades, with food inflation having reached a peak of 15.5% in March 2023. The increase has been observed across all euro area countries, although the magnitude of the shock varies greatly. The rise in food inflation has contributed significantly to inflation, with both processed and unprocessed food being affected.

The main items accounting for the recent spike in food inflation are bread and cereals, meat, milk, cheese and eggs, and vegetables, but this is partly due to their relatively high shares in the overall

([18]) The large movements in gross operating surplus and unit labour costs in 2020-2021 should be looked at with caution as these were strongly affected by the COVID pandemic and related government measures.

consumption basket. Nearly all product groups showed inflation rates above headline inflation, indicating that the surge in food inflation was general across various food items. Only tobacco, alcoholic beverages and fruits stayed below headline inflation during the spike, though the first two are subject to high levels of excise taxation, which dampens the effect of input prices.

The dispersion of food inflation among euro area countries has reached unprecedented levels, with some countries experiencing a cumulative food price increase of around 32-42% in the past 2 years. In addition, countries with the highest food price shocks, such as Estonia, Latvia, Lithuania, Slovakia and Croatia, also tend to have the highest share of food in the overall consumption basket. This worsens the impact of the price shock on their cost of living. Several factors could explain why these five countries experienced higher food inflation. These include: i) a higher exposure to the energy price shock; ii) lower absolute price levels due to a lower share of non-commodity costs, implying a higher relative price increase in response to a commodity shock; and iii) a past history of medium to high inflation that could imply a higher sensitivity to external inflation shocks. In addition, the value-added deflator of the distribution sector – which is shown to be a major driver of food consumer prices – increased much more strongly (up to 3.5 times faster) in these countries than the average of the euro area.

Various factors have driven the increase in food inflation, including global commodity price movements due to supply bottlenecks and more lately Russia's military aggression against Ukraine, and also weather conditions. Commodity prices such as energy, fertilisers, and food have been on the rise since early 2021. Climate change and extreme weather events, in particular droughts, have also affected agricultural production, adding to the volatility of food inflation through food commodity prices. While commodity prices have shown a sizeable correction recently, they are still at elevated levels. This suggests that food price levels may also stay elevated, posing continued challenges in terms of cost of living, particularly for low-income consumers. Furthermore, profit and wages in both the food and distribution sectors have picked up in the last 2 years, further driving up consumer prices.

A quantitative analysis based on input-output data indicates that the food manufacturing sector saw its input costs increasing faster than its output prices up until the end of 2021, which implied a worsening of profit margins over that period. However, profit margins started to recover as of the beginning of 2022. This indicates that current profits are probably compensating for losses in profitability sustained in the previous 18 months. The main contributors to rising costs were agricultural produce, energy, distribution, and packaging costs. As these price pressures eased and some even turned negative in 2023, overall input prices also fell despite a moderate pickup in wages.

The second step of the quantitative analysis shows that food manufacturing PPI and the value-added deflator of the distribution sector (decomposed into unit labour cost and unit gross operating surplus) are the most important drivers of food consumer inflation in the euro area. Electricity and gas PPI also have a small but significant multiplier, most likely through the energy use of the distribution sector. Agricultural produce and food imports do not show significant coefficient estimates, indicating their lower importance in the final consumer prices once the other factors are controlled for ([19]). The main driver of the pickup in food HICP inflation in 2022 was the food manufacturing PPI. Due to the size of the energy price shock, there was also a substantial impact of electricity and gas inflation on food inflation that year. The unit gross operating surplus of the distribution sector also contributed significantly to food inflation in 2022-2023, while unit labour costs started to play an increasing role as of the end of 2022.

As the past shocks were priced in and passed through the entire food value chain, food inflation started falling quickly in 2023. In the absence of renewed pressures on input prices, and if wages and profits stay in line with price stability, disinflation should continue and food inflation should return to historically observed low levels. However, climate change-induced weather volatility, a worsening of the geopolitical

([19]) However, agriculture and food imports do have an important role on the food manufacturing sector and this is taken into account in the estimation through the PPI of food manufacturing.

situation, potential disruptions in global commodity markets, or excessive growth in wages or profits could pose ongoing challenges to food inflation in the future.

II. THE ECONOMIC IMPACT OF COVID-19 LEARNING DEFICITS

By Joana Elisa Maldonado, Anneleen Vandeplas and Lukas Vogel

Abstract: *The COVID-19 pandemic led to a temporary reduction in the quantity and quality of education, with school closures of varying degrees implemented across the globe. This chapter reviews the literature on learning deficits in compulsory education caused by the pandemic and their possible economic impact. Studies from different euro area and EU Member States show, on average, significant learning deficits in primary and secondary education, equivalent to almost 2 months of learning progress during a regular school year. The impact of the pandemic on learning outcomes varies widely by country as well as by students' age and socio-economic background. Labour market outcomes of recent graduates are historically strong, supported by a context of tight labour markets, but the long-term economic impact of learning deficits is likely to be non-negligible. Existing studies project small productivity losses for the coming years as a result of these learning deficits, but a larger impact in the long term, peaking in the second half of the 21st century, when all affected cohorts of students will have entered the labour market. According to the studies surveyed in this chapter, estimates of the aggregate, real-GDP effects of these learning deficits range between -0.1% and -1% by 2050, compared to a baseline without any learning deficits. These estimates are based on: (i) an average learning deficit of roughly one fifth of a school year; (ii) the number of affected cohorts of students corresponding to around one third of the future labour force at most; and (iii) an assumption that these losses are not recovered ([20]).*

II.1. INTRODUCTION

During the COVID-19 pandemic, euro area education systems were strongly affected by containment measures aimed at reducing the spread of the virus. Over the course of the pandemic, a reduction in the quantity and quality of education of varying degrees was observed between March 2020 and June 2021 across the euro area. In most Member States, schools were physically closed for several weeks or months, and classes at school were partly replaced by distance learning with self-study and online classes ([21]). After the first lockdown in 2020, partial physical school closures of shorter periods, and reduced hours for selected grade years or regions continued to be implemented. In the 2021-2022 school year, regular teaching activities resumed across the euro area, with some remote teaching practices remaining in place, particularly at universities.

Studies from different euro area and EU Member States show negative effects of these changes in schooling on both the level and the distribution of learning outcomes. A combination of students forgetting previously learned material ('learning loss') and new learning progressing at a slower pace than before ('lost progress') resulted in 'learning deficits'. These learning deficits were systematically greater for students from disadvantaged socio-economic backgrounds. Given these negative effects, which simultaneously affected a large number of age cohorts, the resulting reduction in human capital could negatively affect economic outcomes in the long run.

Estimates of the macroeconomic implications of learning deficits vary substantially in quantitative terms. The studies reviewed in this chapter suggest real GDP level effects of between -0.1% and -1% by

([20]) The authors would like to thank Leonor Coutinho, Aron Kiss, Géraldine Mahieu, Marco Montanari, Eric Ruscher, Anna Thum-Thysen, Alessandro Turrini, and Kristine Van Herck for useful comments.

([21]) Complete school closures (without provision of distance teaching or blended learning) only took place for short periods in some euro area Member States. In this section, the term 'school closure' is used to describe the suspension of face-to-face schooling, while in most cases learning activities (partly) continued remotely. Data on school closures by country or region can be found in European Commission/ EACEA/ Eurydice (2022), 'Teaching and learning in schools in Europe during the COVID-19 pandemic', Luxembourg: Publications Office of the European Union; and in UNESCO (2017), 'Dashboards on the Global Monitoring of School Closures Caused by the COVID-19 Pandemic', https://covid19.uis.unesco.org/global-monitoring-school-closures-covid19/.

2050 for a pandemic-induced learning deficit of one fifth of a school year, with structural model-based studies generally indicating smaller losses than projections based on empirical estimates with a looser theoretical structure.

This chapter summarises the evidence on COVID-19 learning deficits and provides an economic perspective on their possible long-term impact. Section II.2 reviews the literature on the effects of the COVID-19 pandemic on educational outcomes. Section II.3 assesses whether the pandemic's effects are visible in short-term labour market outcomes and describes estimates of the possible long-term impact of the learning deficits on output. Section II.4 concludes with a discussion of the policy implications.

II.2. EFFECTS ON EDUCATIONAL OUTCOMES IN PRIMARY AND SECONDARY EDUCATION

To date, the evidence on post-COVID-19 outcomes from standardised international tests, which are comparable across countries and years, remains limited. Assessments under these standardised international tests take place only every few years, and were in many cases postponed due to the pandemic. The first internationally comparative evidence on the post-COVID-19 reading performance of 10-year-olds comes from the 2021 Progress in International Reading Literacy Study (PIRLS). In total, 17 euro area and 6 additional EU Member States participated in this assessment ([22]). Out of these, 16 countries have comparable trend data available from previous assessment cycles. 12 countries and the Flemish community of Belgium experienced a significant decrease in the 2021 test scores compared with the 2016 assessment. This is a noticeable negative result, likely in part attributable to the COVID-19 pandemic, as 10 of these countries had a positive (i.e. with reading scores improving over time) or constant trend before 2016. Only three countries and the French community of Belgium recorded no significant change in test scores from 2016 to 2021, while no country achieved a significant positive change in test scores in this period. Correlations with national data on school closures for 29 countries globally show that longer school closures were negatively associated with reading scores, with a 1-year school closure resulting in a learning deficit of half a school year ([23]). However, the quality of the data behind these results is limited due to the variations of school closures within countries.

Lately, results from the PISA survey suggest there has been an unprecedented drop in average educational performance in the EU between 2018 and 2022. Part of the decline is likely related to the pandemic and the associated school closures. However, as learning outcomes were already showing a worsening trend before 2018, it is also plausible that other structural factors are at play ([24]). The PISA results suggest that students that were spared from longer school closures score higher in mathematics. At the same time, the PISA study underlines the difficulty of directly linking the length of school closures to changes in performance between 2018-2022.

Country-specific studies using national data provide a broader picture of the pandemic's impact in compulsory education. One year after the first school closures, early reviews of country-specific studies

([22]) See Mullis, I.V.S., von Davier, M., Foy, P., Fishbein, B., Reynolds, K.A., & Wry, E. (2023), 'PIRLS 2021 International Results in Reading', Boston College, TIMSS & PIRLS International Study Center. https://doi.org/10.6017/lse.tpisc.tr2103.kb5342. In 2021, the following EU Member States participated in PIRLS: BE (Flemish and French communities), BG, CZ, DK, DE, IE, ES, FR, HR, IT, CY, LV, LT, HU, MT, NL, AT, PL, PT, SI, SK, FI, SE. Two of these countries (HR, CY) did not participate in the previous 2016 edition and other countries do not have comparable time trend data due to other reasons, such as structural breaks.

([23]) Kennedy, A. I., & Strietholt, R. (2023), 'School Closure Policies and Student Reading Achievement: Evidence Across Countries', International Association for the Evaluation of Educational Achievement (IEA), Hamburg, Germany. For a survey on school closures and their consequences for learning with focus on the United States, see Jack, R. & Oster, E. (2023), 'COVID-19, School Closures, and Outcomes', Journal of Economic Perspectives 37(4), pp. 51-70.

([24]) OECD (2023) PISA 2022 Results (Volume II): Learning During – and From – Disruption, PISA, OECD Publishing, Paris, https://doi.org/10.1787/a97db61c-en.

consistently found that the COVID-19 pandemic led, on average, to significant learning deficits ([25]). This finding was confirmed in more comprehensive reviews 2 years after the outbreak of the pandemic ([26]).

A review of 42 studies from 15 countries around the world found a substantial average learning deficit of 35% of a regular school year's learning progress as a result of the school closures during the pandemic ([27]). For the EU Member States covered in the selected studies, an average loss of 20% of a school year's learning progress was recorded ([28]). Assuming a duration of a regular school year of 8-9 months, this would be equivalent to the loss of the learning progress of almost 2 months during a regular school year. This learning deficit is equivalent to an 8-score-point decrease on the OECD's PISA test (or 8% of a standard deviation), which is a large setback, given that only nine EU Member States were able to improve performance in reading in PISA from 2015 to 2018, and in each of these cases the improvement concerned less than 8 score points ([29]).

A scientific report commissioned by the European Commission (DG EAC) finds a larger average learning deficit of 30% of a regular school year's learning progress as a result of the pandemic in EU Member States ([30]). Similar results are found in a comprehensive meta-analysis by the European Commission's Joint Research Centre covering 21 OECD countries, which estimates the pandemic induced an average learning deficit of 30-40% of a regular year's learning progress, with a smaller learning deficit in OECD EU countries compared to OECD non-EU countries ([31]).

([25]) See for example Donnelly, R. & Patrinos, H.A. (2022), 'Learning loss during Covid-19: An early systematic review', Prospects 51, 601–609. https://doi.org/10.1007/s11125-021-09582-6; Hammerstein, S., König, C., Dreisörner, T., & Frey, A. (2021), 'Effects of COVID-19-related school closures on student achievement-a systematic review', Frontiers in psychology, 12, 746289; Storey, N., & Zhang, Q. (2021), 'A Meta-analysis of COVID Learning Loss', EdArXiv. https://doi.org/10.35542/osf.io/qekw2; Zierer, K. (2021), 'Effects of pandemic-related school closures on pupils' performance and learning in selected countries: A rapid review', Education Sciences, 11(6), 252.

([26]) See for example Patrinos, H.A., Vegas, E., & Carter-Rau, R. (2022), 'An Analysis of COVID-19 Student Learning Loss'; Moscoviz, L. & Evans, D.K. (2022), 'Learning Loss and Student Dropouts during the COVID-19 Pandemic: A Review of the Evidence Two Years after Schools Shut Down', CGD Working Paper 609. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/learning-loss-and-student-dropouts-during-covid-19-pandemic-review-evidence-two-years.

([27]) Betthäuser, B.A., Bach-Mortensen, A.M. & Engzell, P. (2023), 'A systematic review and meta-analysis of the evidence on learning during the COVID-19 pandemic', Nature Human Behaviour. https://doi.org/10.1038/s41562-022-01506-4. The authors of the study conducted a systematic review of the literature and found a learning deficit of 0.14 standard deviations, which can be translated to a loss of 35% of a regular school year (see Box II.1).

([28]) This estimate, equal to 0.08 standard deviations, is obtained from the authors' own calculations based on the dataset and code provided by Betthäuser et al. (2023), restricting the sample to the 17 studies from seven EU Member States included in their sample (BE, DE, DK, ES, IT, NL, SE). It has to be noted that, due to limited data availability, this estimate is not an accurate estimate for the EU, as many Member States are not represented (e.g., Baltic, central and eastern European countries). The reported number is an unweighted average of all estimates.

([29]) OECD (2019), PISA 2018 Results (Volume I): 'What Students Know and Can Do', PISA, OECD Publishing, Paris. https://doi.org/10.1787/5f07c754-en.

([30]) De Witte, K. & François, M. (2023), 'Covid-19 Learning deficits in Europe: analysis and practical recommendations', EENEE Analytical report. https://doi.org/10.2766/881143. The report finds, on average, a learning deficit of 0.11 standard deviations for European countries, including the UK. Taking the subset of included studies from EU Member States, excluding the UK, gives an average of 0.12 standard deviations. The difference to Betthäuser et al. (2023) is possibly due to the strict selection by Betthäuser et al. (2023), which excludes studies with a critical risk of bias, e.g. due to confounding, sample selection, or missing data.

([31]) The included OECD non-EU countries were: Australia, Colombia, Mexico, Norway, Switzerland, Turkey, the UK and the US. Di Pietro, G. (2023a), 'The impact of Covid-19 physical school closure on student performance in OECD countries: a meta-analysis', Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/197242.

Box II.1: **Measures of learning progress**

In educational research, changes in learning outcomes are commonly measured in standard deviations (SD). This statistical measure allows comparing the effect sizes of outcomes with different scales and from different samples. It assumes a normal distribution of the test scores, clustered in a bell curve around the mean. Raw test scores are standardised by rescaling to a mean of 0 and a standard deviation of 1.

The standardised score (z-score) indicates how far an observation is lying above or below the mean. A score which is 1 standard deviation above (below) the mean is approximately equivalent to the 84th (16th) percentile, that is 34 percentile points above (below) the mean. Accordingly, a learning deficit of 0.1 (0.2) standard deviations shifts the distribution to the left, moving the student, who was at the median before the pandemic, down to the 46th (42nd) percentile.

Measured learning outcomes can be compared to benchmarks for the learning progress observed during a regular school year, as established in the educational literature ([1]). Learning deficits can then be expressed in terms of lost progress as a share of a regular school year. While school productivity varies in different education systems, grade levels and by other factors, an average learning gain benchmark of 0.2-0.5 standard deviations in one school year is commonly assumed ([2]). In this section, we use an average learning gain benchmark of 0.4 standard deviations for a regular school year ([3]).

On the scale of the OECD's PISA, which is normalised to have a mean of 500 score points and standard deviation of 100 score points, a change in learning outcomes by 10% of a standard deviation equals a 10-point difference ([4]).

(1) E.g., Bloom, H. S., Hill, C. J., Black, A. R. & Lipsey, M. W. (2008), 'Performance trajectories and performance gaps as achievement effect-size benchmarks for educational interventions', Journal of Research on Educational Effectiveness, 1, 289–328; Hill, C. J., Bloom, H. S., Black, A. R. & Lipsey, M. W. (2008), 'Empirical benchmarks for interpreting effect sizes in research', Child Development Perspectives, 2, 172–177.
(2) E.g., Azevedo, J. P., Hasan, A., Goldemberg, D., Iqbal, S. A. & Geven, K. (2020), 'Simulating the Potential Impacts of COVID-19 School Closures on Schooling and Learning Outcomes: A Set of Global Estimates', World Bank.
(3) As in Hill et al. (2008), op. cit.
(4) See OECD (2019), op. cit.

The observed decline in learning outcomes following the outbreak of the COVID-19 pandemic represents a combination of various effects, such as the loss in instruction time, the lower effectiveness of instruction in distance teaching, and the absence of peer effects. It comprises both the reduction in learning progress and the loss of knowledge gained before the start of the pandemic.

The learning deficits vary widely across countries. Students in middle-income countries experienced larger learning deficits than students in high-income countries, although studies on high-income countries are overrepresented ([32]) and cross-country differences are likely due to differences in the length (or intensity) of school closures ([33]). Among euro area countries, no impact of the COVID-19 crisis on learning outcomes was observed in Finland, while large negative effects were found in Greece. In EU non-euro area countries, no impact was found in the Nordic countries (Denmark, Sweden) while large negative effects were found in Poland ([34]).

([32]) Betthäuser et al. (2023), op. cit.

([33]) Di Pietro (2023a), op cit.

([34]) De Witte & François (2023), op. cit.

Questions remain as to how long the learning deficits will persist. While it is possible that students might catch up over time, educational research suggests that learning deficits can even accumulate over time (35). Many euro area countries have already increased spending on education and have taken remedial measures to reduce – and even reverse – the negative effects of the COVID-19 pandemic (36). However, the first assessments of the medium-term impact of the COVID-19 pandemic provide a mixed picture of post-pandemic trends in learning outcomes in euro area and non-euro area OECD countries, with constant or increasing learning deficits indicating that efforts to compensate for losses had not succeeded in reversing the negative trend by spring 2022 (37).

Graph II.1 summarises the findings on average learning deficits in selected euro area Member States plus Denmark and Sweden. The selection of countries was based on the availability of robust data. Across countries, no clear pattern of improvement over time becomes visible. In Germany and Belgium, the average learning deficits recorded in 2021 were even greater than those measured in 2020. This widening of the learning deficits in 2021 could be due to containment measures in schools having continued over this period or could result from an accumulation of missed learning progress.

Studies are difficult to compare, as they vary in many factors, such as the geographical context, length of school closure, type of distance teaching, test instruments, student samples, and methodologies. However, three factors likely affect the size of the learning deficits. Firstly, a longer duration of school closures is correlated with greater learning deficits (38). Secondly, a high level of digitalisation of education before the pandemic was associated with lower learning deficits (39). Finally, while most studies cover primary school students, some reviews observe a correlation with the age of students, with younger students more negatively affected than older students (40). However, this correlation could be driven by differences in the length of school closures, which often differed by grade year, and is found to be statistically not significant in other reviews (41).

It is likely that the learning deficits caused by the COVID-19 pandemic are exacerbating previous downward trends in learning outcomes. The methodological limitations of most studies make it difficult to disentangle the effects of COVID-19 from long-term trends, with most studies not controlling for the general time trend when using pre-pandemic results of previous age cohorts as a reference (42). The causal effects can be clearly disentangled in natural experiments (43) that allow to compare the learning progress of unaffected cohorts with the learning progress of pandemic-affected cohorts over the same time frame. For example, a study from the Netherlands records significant learning deficits of the same magnitude as the EU average reported above, based on such a natural experiment (44). Hence, the fact

(35) A possible mechanism is that if the curriculum and the instruction are not adjusted to children's learning deficits following a schooling shock, the affected children may fall further and further behind. Kaffenberger, M. (2021), 'Modelling the long-run learning impact of the COVID-19 learning shock: Actions to (more than) mitigate loss', International Journal of Educational Development, 81, 102326.

(36) De Witte, K., & Smet, M. (2021), 'Financing education in the context of COVID-19', EENEE Ad hoc report no. 03/2021.

(37) Betthäuser et al. (2023), op. cit.; Di Pietro (2023a), op cit.

(38) De Witte & François (2023), op. cit.; Di Pietro (2023a), op cit.; Patrinos et al. (2022), op. cit.

(39) De Witte & François (2023), op. cit.

(40) De Witte & François (2023), op. cit.

(41) Betthäuser et al. (2023), op. cit.; Di Pietro (2023a), op cit.

(42) De Witte & François (2023), op. cit.

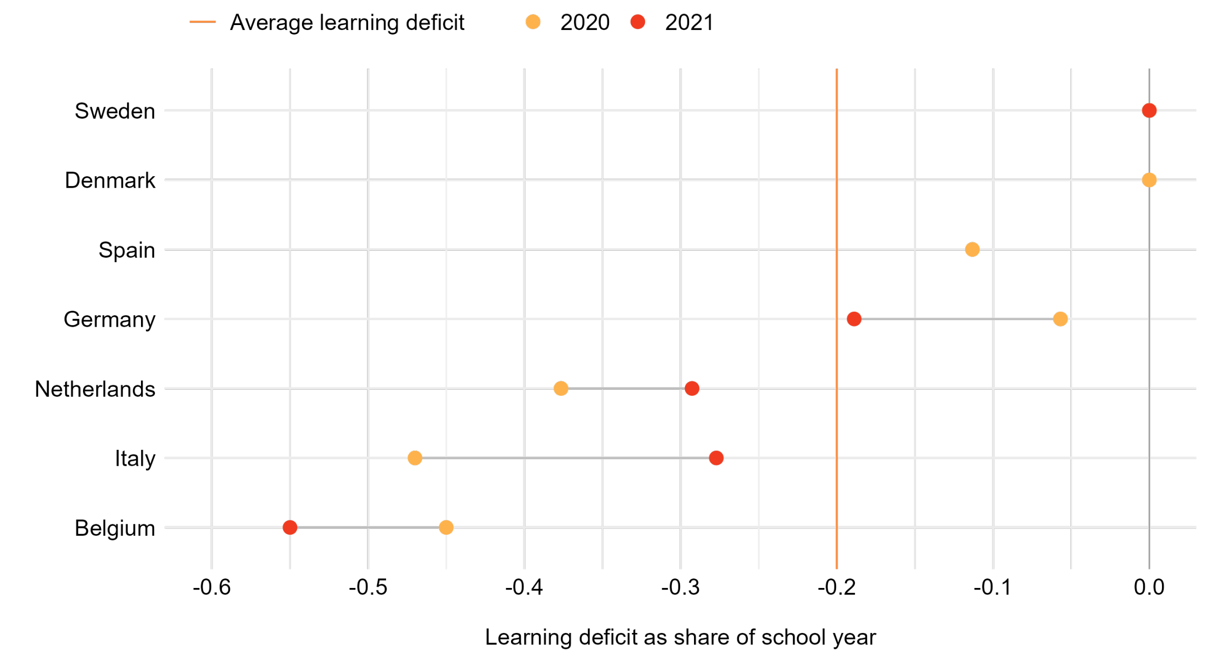
(43) A natural experiment is a situation where the natural course of events (e.g. a policy change or a weather event) creates favourable conditions for an impact evaluation, e.g. due to the (almost) random assignment of the change or event to the treatment group; and the existence of an untreated control group.

(44) Engzell, P., Frey, A., & Verhagen, M.D. (2021), 'Learning loss due to school closures during the COVID-19 pandemic', Proceedings of the National Academy of Sciences, 118(17), e2022376118.

that studies using different statistical methodologies yield comparable results suggests that the learning deficits uncovered do not mainly reflect previous downward trends in learning outcomes ([45]).

In addition to its effect on school-aged children, it is likely that the COVID-19 pandemic also impacted learning outcomes in early childhood, higher education, and adult learning. Evidence on learning outcomes in early childhood, before children enter primary education, is largely limited to qualitative evaluations and studies from outside the EU ([46]). The few existing comparable studies evaluating the effects of the pandemic in higher education show similar learning deficits at the tertiary level, as at the primary and secondary level ([47]).

Graph II.1: **Average learning deficits in selected euro area countries,** plus Denmark and Sweden



(1) This graph is based on computations by the authors, using the dataset provided by Betthäuser et al. (2023). It covers the subset of 17 studies from seven EU Member States included in their sample. Estimates are averaged across grades and subjects. The average learning deficit is computed as an average across all available EU estimates (separate by study, year, age, and subject). Learning deficits are expressed in negative numbers (lost share of a school year), with the largest learning deficits on the left side of the horizontal axis. The colour of the dots indicates the year of measurement of student outcomes (2020 in orange, 2021 in red). Values for the respective countries in 2020 and 2021 are generally based on different samples of studies, implying imperfect comparability.

Source: Authors' own compilation.

Most studies observe that not all students were equally affected by the COVID-19 pandemic. Firstly, increasing inequality within countries is observed through a widening spread in the distribution of test scores, with increasing differences between the best- and worst-performing students in a country ([48]).

([45]) De Witte & François (2023), op. cit.

([46]) Uğraş, M.; Zengin, E.; Papadakis, S.; Kalogiannakis, M. (2023), 'Early Childhood Learning Losses during COVID-19: Systematic Review', Sustainability 15(7): 6199. https://doi.org/10.3390/su15076199.

([47]) Di Pietro, G. (2023b), 'The impact of Covid-19 on student achievement: Evidence from a recent meta-analysis', Educational Research Review 39. https://doi.org/10.1016/j.edurev.2023.100530.

([48]) See, for example, evidence from Belgium (Flanders) in Maldonado, J.E., & De Witte, K. (2022), 'The effect of school closures on standardised student test outcomes', British Educational Research Journal, 48(1), pp. 49-94. The changes

These increases in inequality were found to be slowing down but remained present 3 years after the pandemic [49]. Secondly, differences in test scores by background characteristics of students or schools have increased. The learning deficits caused by the pandemic strongly depend on students' socio-economic status [50] and previous performance level [51]. These differences are found in primary and secondary education and were visible at each stage of the pandemic [52].

II.3. POSSIBLE MACROECONOMIC IMPLICATIONS

This section describes early evidence on the labour-market outcomes of cohorts that graduated during the pandemic and provides a tentative quantitative assessment of the effect of the observed learning deficits on potential output in the long term.

II.3.1. Short-term effects observed in the labour market

Data on the labour-market outcomes of young people immediately following the COVID-19 pandemic likely reflect the impact of the recession, rather than any disruption to learning that they experienced.

Literature suggests that, even in the absence of learning disruptions, young people who first enter the labour market during a recession may face negative consequences in terms of their socio-economic outcomes (including earnings) for up to 10-15 years after graduation [53]. This may be less of a concern in the current context, where the pandemic-related increase in youth unemployment was nowhere near the large increase observed in the aftermath of the financial crisis. This is partly because the impact of the pandemic on the labour market was attenuated by substantial policy efforts to stabilise the economy during the pandemic (including through short-time work schemes), reducing the risk of scarring effects.

While job-finding rates are strongly driven by the business cycle, they could partly also reflect changes in students' performance. An empirical study by the Institute for Fiscal Studies shows that for young people who graduated during the pandemic-related school closures in the UK, the pandemic had a negative effect on employment rates in the short run; but it faded away relatively quickly [54]. In particular, students who graduated in 2020 were less likely to find a job 3-6 months after graduation and more likely to start in lower-paid occupations than previous cohorts, but they recovered to similar outcomes compared with previous cohorts 9-12 months after graduation.

Data on euro area youth unemployment suggest that youth unemployment rates reached an all-time low just before the pandemic and picked up moderately (more so than prime-age unemployment rates)

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in the distribution of test scores were measured by inequality indicators, such as the Gini coefficient and the 90/10 ratio.

(49) Gambi, L., & De Witte, K. (2023), 'The uphill battle: The amplifying effects of negative trends in test scores, COVID-19 school closures and teacher shortages'.

(50) Betthäuser et al. (2023), op. cit.; Di Pietro (2023a), op cit.; Patrinos et al. (2022), op. cit.

(51) De Witte & François (2023), op. cit.; Patrinos et al. (2022), op. cit.

(52) Betthäuser et al. (2023), op. cit.

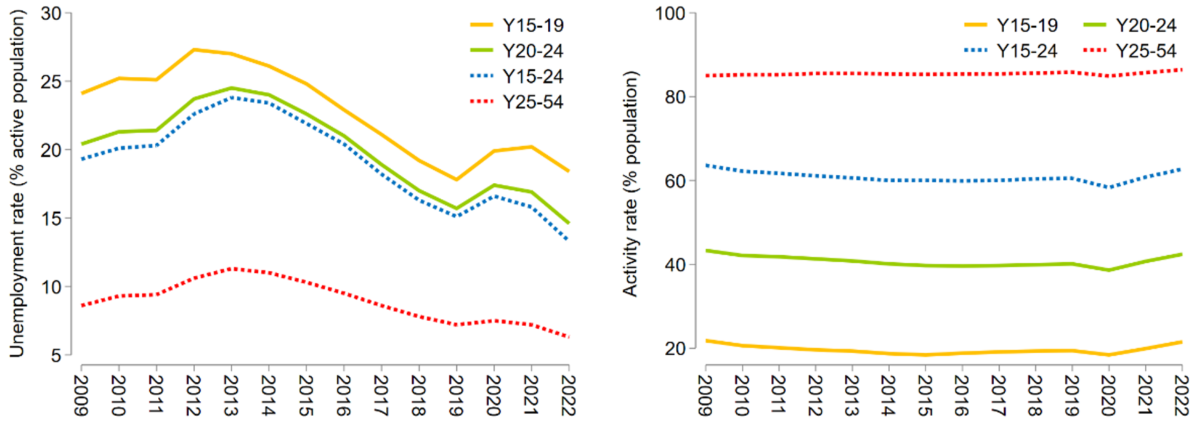
(53) See Oreopoulos, P., Von Wachter, T. and Heisz, A., (2012), 'The short-and long-term career effects of graduating in a recession', American Economic Journal: Applied Economics, 4(1), pp.1-29; Schwandt, H. & Von Wachter, T., (2019), 'Unlucky cohorts: Estimating the long-term effects of entering the labor market in a recession in large cross-sectional data sets', Journal of Labor Economics, 37(S1), pp. S161-S198; Regan, M. (2020), 'Wage scarring among unlucky European cohorts', ESRI Working Paper 668, Dublin: ESRI, https://www.esri.ie/publications/wage-scarring-among-unlucky-european-cohorts.

(54) Ray-Chaudhuri, S. & Xu, X. (2023), 'Are the kids alright? The early careers of education leavers since the COVID-19 pandemic', The Institute for Fiscal Studies, IFS Report R237.

in 2020 and 2021 (Graph II.2). These short-run impacts are more likely to reflect the direct impact of the recession on labour demand than any disruptions to learning caused by the pandemic. Young people may have been more affected by the pandemic as they are more likely to work on temporary contracts, and in contact-intensive sectors such as hospitality. In general, youth unemployment tends to be more sensitive to the business cycle than prime-age unemployment.

The euro area labour market recovered quickly, and by 2022 unemployment rates had declined below their pre-pandemic level for most age groups, bringing them to historically low levels. By 2022, unemployment rates remained slightly above their pre-pandemic level only for those aged 15-19; while participation rates exceeded their 2019 levels for all age groups considered, but even more so for young people than for prime-age cohorts. Demographic trends are likely to play a significant role in the future, as the euro area working-age population is shrinking and younger cohorts entering the labour market are significantly smaller than older cohorts retiring from the labour market.

Graph II.2: **Unemployment and activity rates by age group, EA20**



Source: EU-LFS [ESTAT variables lfsa_urgaed and lfsa_argaed].

In all, the tight labour market is likely to be masking or counteracting the possibly negative impact of the pandemic-induced learning deficits on employment and wages. Further research that relies on micro-level data would be required to assess more precisely the impact of the pandemic on labour market outcomes through learning disruptions.

Nevertheless, it is possible that learning gaps will have an impact on labour market outcomes of young people in the medium to long term. Lower levels of hard and soft skills and reduced learning on the job can also affect the long-term labour market outcomes of young people. For example, some companies in the UK report weaker performance of new employees who graduated during the pandemic ([55]).

Recently graduating cohorts, having completed most of their school years before the pandemic, are likely to be relatively less affected by school closures than the youngest cohorts. Economic models often assume either linearly decreasing or U-shaped marginal returns to education, with the latter suggesting the highest returns come from primary and tertiary education ([56]). Students experiencing interruptions of schooling and learning deficits during their first years at school, in which the largest learning progress is

([55]) O'Dwyer, M. (2023), 'Pandemic graduates struggle with teamwork, say Deloitte and PwC', in Financial Times, on 1 May 2023. https://www.ft.com/content/a8b20502-8238-4655-ba82-30d6243332d9?emailId=b26ba1c6-ae6e-441e-b040-463a45114f70&segmentId=22011ee7-896a-8c4c-22a0-7603348b7f22.

([56]) OECD (2022), 'Value for Money in School Education: Smart Investments, Quality Outcomes, Equal Opportunities', OECD Publishing, Paris. https://doi.org/10.1787/f6de8710-en.

commonly recorded ([57]), could potentially carry the resulting learning gaps throughout their school career and suffer the largest negative impact in the long term. Nevertheless, it remains possible that there will be some catching up of losses and compensation effects from entire cohorts being affected by the learning loss. To date, quantitative studies on the long-term economic impact of the learning deficits have drawn on simulation models, which are presented in the next section.

II.3.2. Modelling the long-term economic impact

The negative impact of the COVID-19 pandemic on students' learning is likely to affect macroeconomic outcomes through a reduction in individual lifetime earnings and skilled labour supply. It is well-established that high-quality education leads to higher earnings, better health, longer working lives, and improved quality of life. In addition, a skilled labour force contributes to economic growth through increased productivity and innovation, although the benefits of investment in education usually only take effect with a long time lag ([58]).

Historical evidence shows that school closures can have negative economic effects. Studies on teacher strikes and natural disasters find lasting economic effects for affected individuals ([59]). Similarly, learning breaks during long summer holidays also have negative long-term effects on individual economic outcomes ([60]). However, the situation during the COVID-19 pandemic – with far-reaching worldwide interruptions in face-to-face learning alongside the possibility of digital schooling – was very different from previous episodes of widespread school closures.

Both structural models and projection models have been used to predict the economic impact of the COVID-19 learning deficits. Structural models present a school-closure shock in terms of a reduction of public investment in education in calibrated macroeconomic frameworks. Projection models use established correlations between educational and economic outcomes to simulate the effect of learning deficits on economic growth. All estimates presented in this section make the assumption of no policy change (other than temporary school closures), i.e. they abstract from remedial measures, and they assume that learning deficits persist over time. Hence, one can understand these results as conditional (worst-case) projections in the absence of policy support, which may deviate from the best guess about actual policy responses.

Structural models predict real-GDP effects from a 1-year learning deficit of between –0.5% and –3.4% at the trough, which tends to occur after some decades, compared with a baseline without learning deficits. Structural models are a simplification of reality and attempt to specify (and quantify) the main transmission channels from shocks or policies to economic outcomes. The model parameters are estimated or calibrated to match empirical regularities of interest. Model results need to be interpreted against the background of underlying theory, assumptions, and parameter choices. Structural models make it possible to simulate counterfactuals ('what if') that illustrate the dependence of transmission channels and net outcomes on structural features of the economy and policy responses.

A school-closure shock of 1 year (for all students in primary and secondary education) yields average losses in the present discounted value of lifetime earnings of affected children of 2.1% in a partial-equilibrium life-cycle model (a type of structural model) with overlapping generations, calibrated to US

([57]) See Bloom et al. (2008), op. cit.; Hill et al. (2008), op. cit.

([58]) OECD (2022), op. cit.

([59]) See for example Winfree, P. (2023), 'The long-run effects of temporarily closing schools: Evidence from Virginia, 1870s-1910s', QUCEH Working Paper Series, No. 2023-02; Belot, M. & Webbink, D. (2010), 'Do Teacher Strikes Harm Educational Attainment of Students?', Labour, 24: 391-406. https://doi.org/10.1111/j.1467-9914.2010.00494.x.

([60]) Kuhfeld, M., Soland, J., Tarasawa, B., Johnson, A., Ruzek, E., & Liu, J. (2020), 'Projecting the Potential Impact of COVID-19 School Closures on Academic Achievement', Educational Researcher, 49(8), pp. 549-565. https://doi.org/10.3102/0013189X20965918.

data (Fuchs-Schündeln et al., 2022). This is equivalent to welfare losses of about 1.2% of permanent consumption and, when aggregated, to 3% of 2019 US GDP ([61]). In addition, this model finds large differences by children's age and background, with younger children affected more by school closures than older children, and children from the most disadvantaged households experiencing welfare losses that are four times greater than children from the most privileged households. The study is likely to overestimate the impact of school closures by ignoring schooling through distance teaching, i.e. ignoring that schooling of a different kind continued (to various degrees depending on the countries and age cohorts considered) when schools were physsically closed during the pandemic.

A similar structural-model framework, calibrated to the US economy (Jang and Yum, 2024), finds negative effects for aggregate output for up to 150 years, reaching a trough after 55 years, with an output decline at the trough of around 0.3%, 0.8% and 1.5% for full school closures of 0.5, 1 and 1.5 years respectively ([62]). In contrast to other research, this structural model suggests larger negative effects for older children, whereas younger children are assumed to be able to make up for pandemic-related losses over the longer remaining duration of their educational career ([63]). The model also suggests a significant decrease in the intergenerational mobility of educational attainment, as children become more dependent on parental input (and investment in private tutoring services) during school closures. Virtual schooling almost halves the aggregate impact of the learning deficits from school closures, but further increases inequality in their model. This result is in line with a structural model of skills formation, which suggests that the negative effects of school closures on human capital formation are highly unequal and persistent ([64]).

Simulations with a rich structural model (Penn Wharton Budget Model) on US data (Viana Costa et al., 2021) also suggest an impact of COVID-19-related learning deficits on labour productivity and output ([65]). In particular, the model simulations find a negative impact on both variables, which increases over the 45-year horizon displayed. For a learning deficit of 1 year, the results would translate into a 2.9% reduction in productivity and a 3.4% drop in output in 2050 compared to a no-COVID-19 baseline. This simulated output effect is significantly larger than the Jang and Yum (2024) result (which led to a 0.5% output loss after 30 years for a 1-year learning deficit) ([66]). This difference may be attributable to the assumption in Viana Costa et al. (2021) of separate labour-productivity effects by students' socio-economic background. Comparability with Fuchs-Schündeln et al. (2022) is limited by the fact that the latter do not report the dynamics of macro variables, but only present discounted aggregate losses ([67]).

([61]) Fuchs-Schündeln, N., Krueger, D., Ludwig, A. & Popova, I. (2022), 'The Long-Term Distributional and Welfare Effects of Covid-19 School Closures', The Economic Journal 132(645), pp.1647-1683. https://doi.org/10.1093/ej/ueac028.

([62]) Jang, Y. & Yum, M. (2024), 'Aggregate and Intergenerational Implications of School Closures: A Quantitative Assessment', American Economic Journal: Macroeconomics, forthcoming. The extreme persistence of the effect in Jang and Yum (2024), with output, labour and capital returning to the no-COVID-19 baseline only after 150 years, derives from the importance of private (parental) investment in child education. This investment depends on parental human capital and income, which provides the basis for some intergenerational transfer of learning deficits in their model.

([63]) The model-implied increase of individual losses with students' age does not account for the theory of human-capital accumulation, which supposes self-productivity in human capital and predicts the COVID-19 shock to affect both the current level of human capital and its future accumulation (see Schady, N., Holla, A., Sabarwal, S., Silva, J. & Yi Chang, A. (2023), 'Collapse and recovery: how the COVID-19 pandemic eroded human capital and what to do about it', World Bank. https://doi.org/10.1596/978-1-4648-1901-8).

([64]) Agostinelli, F., Doepke, M., Sorrenti, G. & Zilibotti, F. (2022), 'When the great equalizer shuts down: Schools, peers, and parents in pandemic times', Journal of Public Economics 206. https://doi.org/10.1016/j.jpubeco.2021.104574.

([65]) Viana Costa, D., Maddison, E. & Wu, Y. (2021), 'COVID-19 Learning Loss: Long-run Macroeconomic Effects', Update. University of Pennsylvania.

([66]) Jang & Yum (2024), op. cit.

([67]) Fuchs-Schündeln et al. (2022), op. cit.

The substantial differences in estimates between the structural models presented above are due to the strong influence of assumptions and modelling choices on the results. In general, the simulations differ in the transmission mechanisms and behavioural responses of students, parents, and teachers they consider, without exploring and including all possible channels.

Projection models suggest real-GDP effects of a 1-year learning deficit of up to 4.7%, compared with a baseline without learning deficits. This approach exploits regularities in the data, notably correlations between the variable of interest and possible determinants, without imposing a tight theoretical structure.

Based on a projection-model, Hanushek and Woessmann (2012) suggest that a reform bringing about an improvement in PISA scores of 25 points (equivalent to 25% of a standard deviation or 2/3 of the usual learning gain over a school year ([68])) would lead to an increase of 0.5 percentage points in the long-run real GDP growth rate in EU Member States, or a cumulative economic gain of EUR 35 trillion in present value until 2090 (corresponding to a 6.2% increase in discounted future GDP) ([69]). The authors correlate economic growth with measures of the quantity and quality of education in cross-country comparisons. In particular, they regress countries' average GDP growth on (i) student test scores from the PISA survey; (ii) years of schooling; and (iii) initial GDP per capita. The estimated 'growth coefficient' of PISA test scores is then used for projections of future growth, in the spirit of endogenous growth models ([70]). While the estimates could be biased by endogeneity or reverse causality, the authors show that the results are robust when controlling for potentially omitted variables (e.g. economic institutions, geographical location, political stability, capital stock, and population growth). Balart et al. (2018) find that the relationship between student test scores and economic growth is smaller but remains robust when accounting for non-cognitive skills ([71]).

By implication, and inverting signs, if the learning deficit in the EU equivalent to an 8-point decrease in PISA scores were to both persist and apply to the entire population, this would translate into a 0.2 percentage point reduction in the long-run growth rate. Given that the pandemic only implies a temporary negative shock on learning outcomes, which in the long run would affect at most one third of the working-age population, the impact of the pandemic would be more contained, but could still be substantial ([72]).

Drawing on their earlier studies with projection models, Hanushek and Woessmann (2020) simulate a temporary school closure of various lengths and find that a 1-year school-closure results in a permanent individual income loss of 7.7% over an affected student's lifetime ([73]). The estimates for lifetime income losses are the sum of lost individual returns to education. Hence, it is assumed that the income loss due

([68]) following Hill et al. (2008), op. cit.

([69]) Hanushek, E.A., & Woessmann, L. (2012), 'The Economic Benefit of Educational Reform in the European Union', CESifo Economic Studies, 58(1): pp. 73-109.

([70]) The authors also present an alternative projection model based on the neoclassical growth framework. The gains are somewhat smaller, but still substantial. In the neoclassical growth model, changes in test scores lead to higher steady-state levels of income, but they do not permanently affect the growth rate.

([71]) Balart, P., Oosterveen, M., & Webbink, D. (2018), 'Test scores, noncognitive skills and economic growth', Economics of Education Review, 63, pp. 134-153.

([72]) Assuming that the 12-16 age cohorts have been affected by schooling under COVID-19 conditions, and assuming a working life of around 50 years.

([73]) Hanushek, E. A., & Woessmann, L. (2020), 'The economic impacts of learning losses', OECD Education Working Papers, 225. https://doi.org/10.1787/21908d74-en.

to the learning deficits does not decrease if all students are affected simultaneously, which likely makes it an upper-bound estimate (74).

Drawing on data from a sample of 50 lower-middle-to-high-income economies, the same paper suggests that a 1-year learning loss would trigger a 4.3% loss in future GDP (discounted at an annual rate of 3%) on average each year for the remainder of the century, i.e. until 2100. By 2100, this would be equivalent to a cumulative GDP loss of the magnitude of 200% of current GDP (in present value). By 2100, the reduction in annual GDP would amount to 7.5% compared with a baseline without learning deficits, assuming 80 years with a lower-achieving labour force (corresponding to the average life expectancy of somebody born in 2020). By 2050, real GDP would be lower by around 4.7% compared to the no-loss benchmark (75). To arrive at those estimates, the authors assume that annual economic growth increases by about 2 percentage points per standard deviation increase in educational achievement of the labour force, an effect of similar magnitude as the assumption used by Hanushek and Woessmann (2012) (76). The estimates assume the complete loss of a school year, neglecting the mitigating effects of distance learning. Scaling the numbers to a learning loss of 20% of a school year would imply a GDP level 0.9% below baseline by 2050 (77).

Another projection model-based study for the US uses a similar approach, as it correlates US-specific standardised test outcomes to long-term growth. It considers in addition the effects of students dropping out of school (78). This study produces smaller estimates of GDP loss, i.e. –1.1% to –1.8% in GDP reduction by 2040 for a 1-year learning deficit.

Recent work by the OECD finds that expected productivity losses are initially small, but build up over time and peak after 45 years when affected cohorts are in the older part of the labour force, with a 1.1% overall productivity (TFP) loss at the peak for a 1-year school closure (79). These negative effects

(74) Theoretically, it is possible that if other workers are affected to a similar extent, the wage penalty for a learning deficit is reduced compared to the situation where only a single or a few individual workers are affected, which would put them at a relative disadvantage compared to age cohort peers entering the labour market at the same time.

(75) The value for 2050 is taken from the comparison in de la Maisonneuve, C., Égert, B. & Turner, D. (2022), 'Quantifying the macroeconomic impact of COVID-19-related school closures through the human capital channel', OECD Economics Department Working Papers No. 1729, OECD Publishing, Paris. https://doi.org/10.1787/eea048c5-en.

(76) Hanushek & Woessmann (2012), op. cit.

(77) A simple back-of-the-envelope calculation provides somewhat smaller magnitudes. Taking the value from Jones (2002) of an additional year of schooling raising labour productivity by 7%, missing a fifth of a year implies a productivity loss of 1.4% for the (future) workers concerned (see Jones, Ch. (2002), 'Sources of U.S. Economic Growth in a World of Ideas', American Economic Review 92(1): 220-239). As the age cohorts concerned will account at maximum for around one third of the labour force in the future, this would suggest aggregate income losses peaking at around 0.5%. The survey by Sianesi and van Reenen (2003) reports effects of a 1-year increase of average education on per capita output of 3-6% in a neoclassical growth specification, or a 1 pp. increase in the growth rate according to endogenous growth theories (see Sianesi, B. & van Reenen, J. (2003), 'The Returns to Education: Macroeconomics', Journal of Economic Surveys 17(2): pp. 157-200).

(78) Dorn, E., Hancock, B., Sarakatsannis, J. & Viruleg, E. (2020), 'COVID-19 and student learning in the United States: The hurt could last a lifetime', McKinsey. See also the comparison in de la Maisonneuve et al. (2022).

(79) de la Maisonneuve et al. (2022), op. cit. The authors of this study use a new measure of the human-capital stock and multivariate productivity regressions. The new measure is composed of the cohort-weighted average of past student test scores and mean years of schooling to reflect both the quality and quantity of education of the working-age population. The authors compute the effect of the pandemic on human capital as the sum of population-weighted averages for each of the 16 cohorts of school-aged children. The effect on productivity is derived from regressions, which (controlling also for other factors) suggest that a 1% decrease in human capital is associated with a more than 2% fall in long-term total factor productivity (TFP). The new measure was first proposed by Égert, B., C. de la Maisonneuve & D. Turner (2022) in 'A new macroeconomic measure of human capital exploiting PISA and PIAAC: Linking education policies to productivity', OECD Economics Department Working Papers, No. 1709, OECD Publishing, Paris. https://doi.org/10.1787/a1046e2e-en.

diminish when affected cohorts gradually retire from 2068 on, and they disappear when all affected cohorts will have retired in 2083. The timing of the peak impact derives from the assumption that all age cohorts are affected equally, with no possibility for younger students to catch up on learning deficits. If older students were affected more than younger students, who have more time to recover from the shock, the trough would be at an earlier point in time, when most affected cohorts are of core working age.

The estimated learning deficits for the EU of approximately 10% of a standard deviation, or 1/5 of a school year (see II.2 above), come closest to the lower-bound impact of a 12-week school closure in de la Maisonneuve et al. (2022). They translate this to a 0.2% reduction in overall human capital during the period from 2036 until 2067, when all affected cohorts are part of the labour force ([80]). This reduction in human capital is predicted to cause productivity losses until the retirement of the last affected cohort in 2083, peaking at a productivity loss (compared to a no-COVID-19 baseline) of 0.4% in 2067.

Table II.1 summarises the estimated effects of the COVID-19 learning deficits on economic output from both structural models and projection models.

Studies based on data from non-EU OECD countries could overestimate the potential economic impact of learning losses for EU Member States. For example, learning deficits were, on average, smaller in EU countries than non-EU OECD countries due to differences in: (i) the length of school closures; (ii) the level of digitalisation; and (iii) the quantity and quality of distance teaching. In addition, countries may differ in the channels of transmission from lower human capital to economic outcomes. Significantly higher individual returns to skills are found in the United States compared with European countries ([81]). Contributing factors could be higher union density in Europe, stricter employment-protection legislation, and larger public sectors, all of which are related to lower wage inequality and thus lower individual returns to skills ([82]), inversely implying a lower economic impact of decreasing skills. Therefore, studies based on US data could overestimate the economic impact of learning deficits for the EU, which may furthermore differ widely between EU Member States.

Finally, differences in remedial policies to compensate for learning deficits, which are not accounted for by any of the estimates presented, could diversify the economic impact across countries in coming years.

II.4. CONCLUSION

The evidence on the impact of the COVID-19 pandemic on educational records suggests significant average learning deficits for school-aged children in several EU Member States, which equal approximately 20% of a school year's learning progress. Importantly, large inequalities in the learning deficits, driven particularly by students' socio-economic status, could increase disparities in social and economic outcomes.

Although no immediate economic impact of these learning deficits has been observed to date, the associated reduction in human capital is likely to have a negative long-term impact on the economy as the affected age cohorts integrate in the labour market. Labour market outcomes of the 2020 graduating cohort seem to be resilient at the current juncture of tight labour markets, and simulations suggest small productivity losses for the coming years. A larger effect can be expected in the long term, peaking in the second half of the 21st century, when all affected cohorts of students will have entered the labour market.

([80]) de la Maisonneuve et al. (2022), op. cit.

([81]) Hanushek, E. A., Schwerdt, G., Wiederhold, S., & Woessmann, L. (2015), 'Returns to skills around the world: Evidence from PIAAC', European Economic Review, 73, pp. 103-130.

([82]) Hanushek et al. (2015), op. cit.

Table II.1: **Estimated effects of a 1-year learning deficit on economic output**

	Approach and sample	Dependent variables	Main results
Structural models			
Fuchs-Schündeln et al. (2022)	– Partial-equilibrium life-cycle model with overlapping generations – Calibrated to US data	Lifetime earnings of affected children	Present discounted earnings loss of 2.1% for affected children, on aggregate equivalent to 3% of 2019 US GDP
Jang & Yum (2022)	– General equilibrium model with overlapping generations (OLG) – Calibrated to US data – Younger students are assumed to catch up over time	Range of macroeconomic aggregates	Reduction of annual output during several decades with trough in 2080 at -0.7% (-0.5% in 2050)
Viana Costa et al. (2021)	– OLG macro model with rich heterogeneity across households in which an individual's labour productivity changes throughout lifetime and is affected by learning deficits – Calibrated to US data	Range of macroeconomic aggregates	Reduction of annual output, worsening during several decades until forecast horizon in 2056 (GDP effect -3.4% and labour productivity –2.9% in 2050)
Projection models			
Hanushek & Woessmann (2020)	– Regression of countries' average GDP growth on student test scores (PISA), years of schooling and initial GDP per capita; estimated 'growth coefficient' used in endogenous growth model (2% higher growth per standard deviation in educational achievement) – Data from OECD countries and emerging economies	Lifetime income Output growth	GDP –7.5% in 2100 (-4.7% by 2050) compared to no-COVID-19 baseline
Dorn et al. (2020)	– Hanushek & Woessmann (2008) correlation of academic achievement to GDP growth, combined with impact of school drop-outs due to the pandemic – Simulation for the US	Output in 2040	Output reduction of 1.1-1.8% of GDP in 2040 (no results reported for other years)
de la Maisonneuve et al. (2022)	– New measure of the human capital stock (cohort-weighted average of past student test scores and mean years of schooling of current cohorts) and multivariate productivity regressions (1-percent decrease in human capital associated with >2-percent fall in long-term TFP) – Assumes 16 cohorts to be affected equally, without catching up of younger students – Sample of OECD countries	Productivity (TFP)	Productivity losses until expected retirement of affected cohorts in 2083, peaking in 2067 at -1.1% TFP compared to no-COVID-19 baseline

(1) Note: The presented estimates are specific for the COVID-19 pandemic, as they assume all cohorts that are in school during the learning shock to be affected. For comparison purposes, reported effects for different lengths of school closure are proportionally translated into a learning deficit of 1 school year. Based on the estimates of learning deficits in the EU of, on average, 20% of a school year, the economic impact for the EU could be scaled to 20% of the numbers presented in this table.

Source: Authors' own compilation.

The estimated long-term (by the mid-century) real annual GDP effects for an average learning deficit of approximately 1/5 of a school year in the EU range from -0.1% to -1% by 2050, compared to a baseline without any learning deficits. Realisations are more likely to fall closer to the lower bound of this range in absolute value terms (-0.1%), since upper-bound estimates rest on assumptions of a very strong and persistent deterioration in the quality of the labour force, with no or little scope for compensating losses over time.

The estimates of learning deficits provided in this chapter are based on available studies for a small selection of EU Member States and have limitations. Currently available study results are possibly biased by the selection of non-representative samples, missing data and potential measurement errors ([83]).

The first set of internationally comparable data from the PIRLS 2021 reading assessment for 4th graders shows a decline in learning outcomes of a magnitude similar to the estimates put forward in this section, reinforcing previously recorded negative time trends. Recently published PISA results from the 2022 survey round suggest a more considerable overall deterioration in learning outcomes among 15-year-olds than the potential magnitude of the pandemic's effect considered in this chapter. Other comparative international studies are forthcoming and will contribute to a more comprehensive understanding of the recent development of learning outcomes and the extent to which negative developments can be reversed ([84]).

Monitoring the development of student achievement will be crucial to determine the persistence of learning losses over time. This will provide evidence on whether the affected cohorts are able to catch up over the duration of their remaining educational career, or whether, to the contrary, learning deficits are accumulating and increasing over time.

Compensatory policies, such as summer schools or tutoring programmes, have been shown to mitigate the learning deficits caused by the COVID-19 pandemic ([85]). De Witte and François (2023) further recommend that the curriculum – and corresponding investments – focus more heavily on the digitalisation of education, including by strengthening internet connectivity, access to information and communications technology tools, and the professional development of teachers ([86]). As all remedial actions require staff, addressing the teacher shortages currently observed in many EU Member States will be crucial to reverse the negative trend in learning outcomes ([87]).

On a positive note, the COVID-19 pandemic has been speeding up the digital transition in schools and given a stimulus to experimentation with new ways of teaching. The lessons learned during the pandemic and the progress in digitalisation can be used to improve the quality of education in the EU. Under the Recovery and Resilience Facility, Member States have planned measures worth EUR 51 billion to improve 'general education' and 'early childhood education and care', including investment in digital education and, for some Member States, targeted measures to mitigate learning deficits caused by the COVID-19 pandemic. The European Commission is also working with Member States through a recently created 'Learning Lab on Investing in Quality Education and Training' to help them design policies and programmes which can make the EU educational systems more effective and equitable ([88]).

([83]) The review of the empirical literature discussed in this section excluded studies with small sample sizes, with convenience samples, and without any statistical adjustment for confounding factors, limiting the influence of potential biases.

([84]) E.g., IEA TIMMS 2023 for mathematics and science, and IEA ICILS 2023 for digital skills are still underway. With the great advantage of providing comparable indicators, these large-scale international assessments of student achievement come with the disadvantage of being published with a delay and covering a varying selection of grade years and countries.

([85]) De Witte & François (2023), op. cit.

([86]) De Witte & François (2023), op. cit.

([87]) In the Flemish region of Belgium, average learning deficits in 2022 were larger in schools with high shares of teacher shortages: see Gambi & De Witte (2023), op. cit.

([88]) For more details, see https://education.ec.europa.eu/focus-topics/improving-quality/learning-lab.

III. LARGE-SCALE EU ISSUANCE: 3 YEARS ON

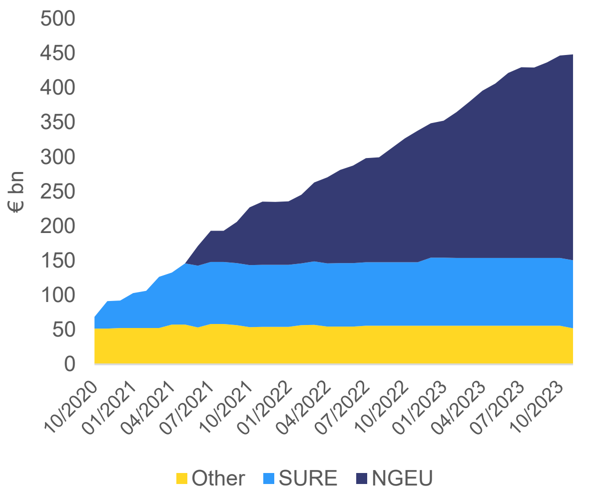
By Daniel P. Monteiro (89)

***Abstract:** Large scale issuance by the EU began a little over three years ago, in October 2020. Since then, the outstanding amounts issued by the EU have risen continuously in connection with the SURE and NGEU programmes, from approximately € 50 bn to potentially more than € 900 bn by 2026. This chapter takes stock of the first three years of large-scale EU issuance in terms of its market performance and the savings that NGEU loans can provide to beneficiary Member States. In particular, we investigate the changing contributions of different drivers of market performance over time along the yield, spread and liquidity dimensions. Three phases are identified in this regard, from an encouraging performance up until early 2022, through a modest deterioration in 2022, to a degree of recovery in 2023. We also compute illustrative country-specific measures of the financial benefit from taking up an NGEU loan, as opposed to borrowing directly from the market, and conclude that, from the strict perspective of funding cost differentials, NGEU loans can offer sizeable returns to the Member States that have requested them.*

III.1. INTRODUCTION

The response to the covid-19 crisis saw an important institutional breakthrough for the EU in the form of large-scale joint debt issuance to fund European policies protecting jobs, fostering investment and promoting structural reforms. Large scale issuance began with the Support to mitigate Unemployment Risks in an Emergency (SURE) programme in October 2022 and expanded in connection with the NextGenerationEU (NGEU) programme from June 2021 onwards. The bonds issued under these two initiatives have added to existing EU bonds (90) issued under smaller, previous programmes, namely those related to: the balance-of-payments assistance facility for non-euro area Member States; macro-financial assistance to third countries; and the European Financial Stabilisation Mechanism for euro area Member States. The result has been a continuous rise in EU bonds outstanding since 2022 as SURE loans to Member States expanded to reach figures just under the maximum envisaged size (i.e., € 100 bn) and NGEU grants and loans continue to be disbursed to EU countries (Graph III.1). With the passing of the deadline for requesting NGEU loans in August 2023, the amounts to be issued under NGEU over the coming three years are now known to potentially reach a little over € 700 bn, assuming the full disbursement of grants and requested loans. This means that EU issuance is on track to reach a peak of close to € 900 bn by 2026, which would make it the fifth largest EU sovereign debt issuer if it were a country, placed just behind Spain, and ahead of Belgium and the Netherlands.

Graph III.1: **EU bond amounts outstanding, per programme**



Source: Bloomberg, own calculations.

(89) The author would like to thank Eric Ruscher, Leonor Coutinho and colleagues at the Directorate-General for Budget for their very helpful comments and suggestions. Any remaining errors or omissions are my own.

(90) When referring to "EU bonds" throughout this chapter we mean all the bonds issued by the EU as an entity. We do not, however, consider the bonds issued by the European Atomic Energy Community in our analysis given their rather idiosyncratic market performance.

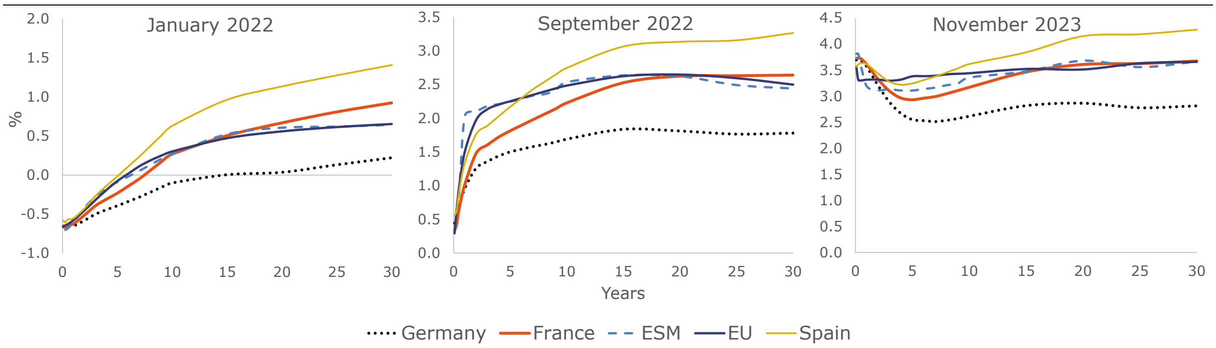
In this chapter we update the analysis of the market performance of EU bonds first conducted in Monteiro (2022) ([91]) by looking into the determinants of their yields and spreads over the past three years (Section III.2) as well as into their liquidity performance (Section III.3). We also take advantage of the fact that all NGEU loan requests have now been submitted to conduct a first assessment of the net financial gains accruing to the beneficiary Member States (Section III.4.). Finally, Section III.5 reflects on institutional factors influencing the performance of EU issuances while Section III.6. concludes by bringing together the results of the preceding sections.

III.2. EU BOND YIELDS AND SPREADS

Large-scale EU issuance has consistently enjoyed a favourable reception from market players as attested by the large primary market demand, interest from foreign investors, relatively low spreads and a AAA rating from four out of the five major credit rating agencies ([92]). Notably, such a positive reception has been sustained notwithstanding the possible excess supply challenges from a meteoric rise in EU issuance and the constraints imposed by its association to the sub-sovereign, supranational and agency (SSA) class, which is usually less favourably treated (regulatorily or otherwise) than the larger European government bond (EGB) class to which belong the securities issued by EU central governments. EU bond performance since October 2020 can, nevertheless, be broadly divided into three phases, each with its own nuances.

The **first phase** lasted until early 2022 and was characterised by increasing EU bond liquidity, spreads that compared well with those of France and evidence of favourable pricing effects on NGEU, SURE and

Graph III.2: **European yield curves**



Note: EU curve fitted based on the Nelson-Siegel-Svensson model.

Source: Bloomberg, own calculations.

green bonds ([93]).

The **second phase** lasted until the end of 2022 and saw a moderate increase in spreads with respect to reference EU sovereigns in a context characterised by continued monetary policy normalisation and Russia's unprovoked full-scale invasion of Ukraine. As will be seen, this was also the period when

([91]) Monteiro, D. (2022), "The market performance of EU bonds", *Quarterly Report on the Euro Area*, Vol. 21, No. 1.

([92]) The EU enjoys a AAA rating or equivalent from Fitch, Moody's, DBRS and Scope. It enjoys an AA rating from Standard & Poor's.

([93]) See also Monteiro (2022), op. cit., for an analysis of this phase.

sovereign risk increased and both market liquidity conditions and the relative convenience yield (94) of European SSA bonds worsened.

The **third and present phase** unfolded throughout 2023 and saw a recovery in EU and broader SSA bond performance. During this period, EU yields moved again closer to those of France while the liquidity and the relative convenience yield of EU bonds improved. As will be presently seen when discussing the econometric results, the specific price effects (95) previously identifiable for NGEU, SURE and green bonds are no longer in evidence in the third phase, suggesting increased homogeneity across EU issuances.

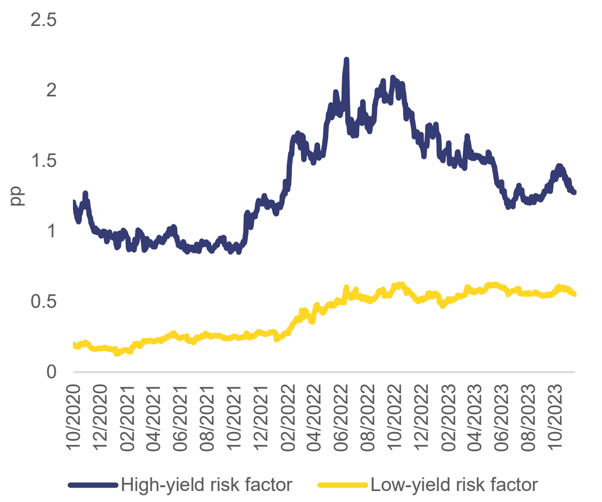
Graph III.2 provides a summary picture of the three phases by plotting selected European yield curves at different moments in time. By January 2022, EU bond yields were still broadly in line with those of France, underperforming the latter at shorter maturities, while outperforming French government bonds at maturities beyond the 10-year tenor. In September 2022, however, a riskier macroeconomic environment saw French bonds consistently outperform EU and other European SSA bonds, except at very long maturities. Recent data shows a degree of reversion to previous relative performances, with EU bond yields once again more aligned with French yields. During the past three years, EU bond yields have remained significantly above those of Germany, except for very short maturities, while broadly in line with those of another European supranational, the European Stability Mechanism (ESM). Overall, EU bond performance has followed broader trends in the SSA class. At the same time, the very rapid expansion of EU issuance into the comparatively small SSA segment has been a challenge with which the EU issuer has successfully dealt (96).

While the absolute level of EU bond yields has been mostly driven by higher policy rates since early 2022, the spreads with respect to Germany have been influenced by other euro area-wide trends such as:

1. A general increase in sovereign riskiness across EU countries, as captured by the summary indicators plotted in Graph III.3.

2. An increase in the convenience yield of reference sovereign bonds, such as those of Germany and France, which implied a decline in the relative convenience yield of EU and other SSA bonds vis-à-vis these countries. For example, in the second half of 2022, high demand for German and French bonds led to a significant increase in their prices and therefore a decrease in their yields relative to the €STER OIS rate (a derivatives-based measure of the risk-free rate).

Graph III.3: **Sovereign risk factors in the euro area**



Note: risk factors calculated as the (normalised) first principal component of the 10-year spread with respect to Germany of AT, BE, FI, FR, NL ("low yield") and EL, IE, IT, PT, ES ("high yield").

Source: Bloomberg, own calculations.

(94) By convenience yield we mean a security's price component that reflects the services provided by that security such as the possibility of using it under favourable conditions in collateral and repo markets, to fulfil regulatory requirements or to meet investment mandates.

(95) By specific price effects we mean variations in bond prices across EU issuance programmes that remain evident even after controlling for basic security characteristics such as duration and market liquidity. Econometrically, the existing of such "pricing specialness" corresponds to dummy variables controlling for the NGEU, SURE and green issuance programmes being statistically significant.

(96) See, in this regard, the econometric discussion in Box III.1.

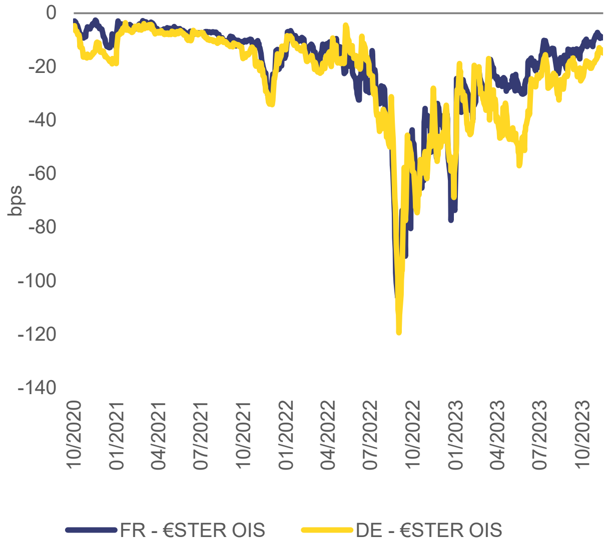
This can be observed in Graph III.4.

Increased demand for reference bonds was, in turn, partly driven by higher market volatility and increased margin calls in energy platforms during this period. Given that SSA bonds are less used for collateral purposes,they were relatively disadvantaged. At the same time, increased hedging activities in response to rapid monetary policy normalisation led to higher swap rates, which also contributed to widen the difference between SSA rates and those of reference sovereign bonds.

3. An increase in general market illiquidity in 2022 feeding through to EU bond liquidity conditions, as will be seen in Section III.3.

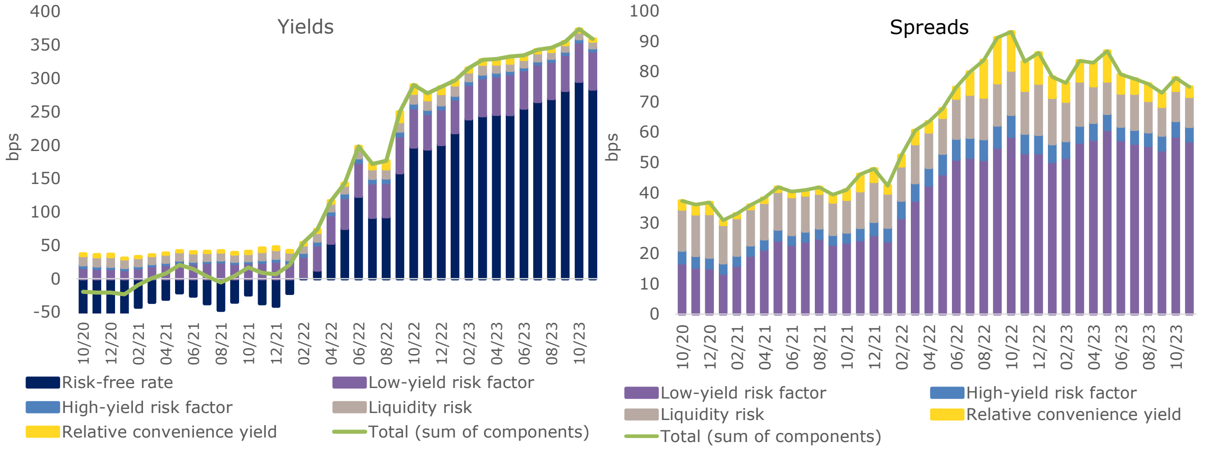
The remainder of this section assesses the relative importance of the different drivers of EU bond yields and spreads over time based on an econometric panel data analysis covering more than 100 EU bonds and bills. The technical details are provided in Box III.1.

Graph III.4: **Spreads of 6-month German and French bonds with respect to the 6-month €STER OIS**



Source: Bloomberg, own calculations.

Graph III.5: **Main dynamic drivers of the average yields and spreads of bonds issued by the EU**



Note: in simple average terms, covering all the securities in the sample at a given point in time; displayed spreads do not take into account the constant term, which takes a negative value in the present estimation.

Source: own estimations.

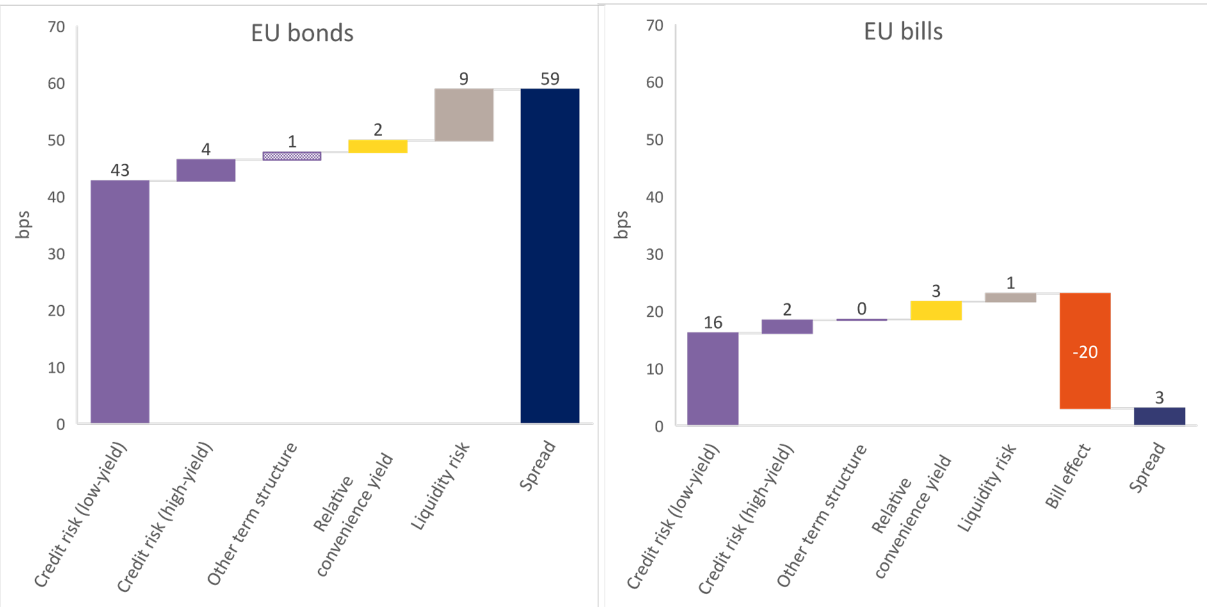
Graph III.5 summarises the dynamics of an "average" EU bond ([97]) over the three years since the first SURE issuance in October 2020. As can be observed, monetary policy normalisation is, by far, the largest

([97]) For visualisation purposes, we focus on an "average" EU bond, that is, a hypothetical EU bond with characteristics (such as maturity and liquidity) equal to in-sample averages. Given that the simple average EU bond maturity has remained between 9 and 10 years throughout the sample period, the graph can be understood as closely depicting this maturity segment.

factor behind the increase in EU bond yields, with changes in risk-free rates (assessed at the matching maturity) transmitting approximately one-to-one to yields, as expected. However, spreads with respect to AAA sovereign euro area bonds ([98]) have also increased since early 2022, with the main driver being a general increase in the sovereign risk of Member States. This result can be understood as more than a statistical correlation, rather pointing to a structural interpretation whereby the EU is fundamentally exposed to the sovereign risk of Member States, both via its budgetary claims as well as via its loans under different programmes. It is interesting to note in this respect that the sovereign risk factor that has dominated spread dynamics is that associated with low-yield euro area Member States, rather than that associated with high-yield countries.

This result suggests that i) EU bonds, being themselves low risk, track the asset class of low-risk sovereign bonds and ii) that low-yield Member States may be perceived as the ultimate guarantor of EU bonds in a hypothetical stress scenario, making the EU particularly exposed to this set of countries. It is also worth noting how the relative convenience yield disadvantage of EU and other SSA bonds peaked in the second half of 2022 as investors dashed for reference sovereign bonds. It was also during this period that liquidity risk ([99]) deteriorated somewhat, before recovering in 2023.

Graph III.6: **Spread decomposition of "average" EU securities as at November 2023**



Note: decomposition for hypothetical EU securities where the values of the explanatory variables take the average values of the respective subsamples; EU bonds in the present graph strictly defined as non-bill EU securities; "other term structure" refers to residual term structure effects not captured elsewhere.

Source: own estimations.

([98]) In practice, the bonds of Germany and the Netherlands. It should be noted that, while the present analysis takes AAA euro area government bonds as a reference, the market practice for pricing EU bonds often takes euro swap curves as the benchmark. However, given the potential substitutability between EU and national issuance (as illustrated e.g. in a government's decision to take up a loan under the EU's Recovery and Resilience Facility), the focus of this chapter is on a comparative reading of EU and national funding costs. At the same time, wedges between AAA bond yields and swap rates are controlled for in the econometric analysis via the OIS_t variable.

([99]) Liquidity is measured throughout this article via the bid-ask spread. While the bid-ask spread is a standard indicator of market liquidity that is readily available, there are other measures of bond market liquidity that can provide complementary insights.

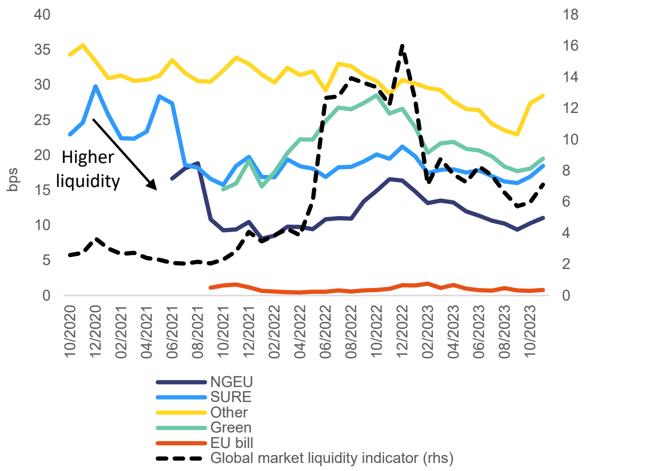
Another result that follows from the econometric analysis is that NGEU, SURE and green bonds do not appear to currently behave in a statistically different manner from that of other EU bonds once their basic characteristics, such as maturity and market liquidity, are controlled for. However, EU bills do appear to enjoy lower spreads, even after accounting for their short maturities and high liquidity, which can be understood as a consequence of the large demand and very favourable market reception that the EU bills programme has enjoyed ([100]). This point is more clearly seen in Graph III.6, which zooms in on the latest datapoint in our sample, November 2023. Some additional takeaways from the results displayed in this graph are that: i) the convenience yield becomes a more relevant factor at shorter maturities, although the relative disadvantage of both EU bonds and bills in this regard has now returned to low figures; ii) an "average" EU bill carries a minimal spread and residual liquidity risk; iii) the magnitude of the bill effect broadly offsets the magnitude of the combined credit risk factors, possibly meaning that EU bills carry no perceived credit risk.

III.3. THE LIQUIDITY PERFORMANCE OF EU BONDS

Financial market liquidity can be defined as the ability to trade a security without generating significant price movements nor otherwise incurring in significant transaction costs. While there are different liquidity measures, we focus in this article on the bid-ask spread, a standard indicator ([101]) computed as the difference between a bond's ask and bid prices ([102]).

The liquidity performance of EU securities has evolved over time, driven both by market-wide trends and idiosyncratic factors, while also varying according to the associated EU programme. As can be observed in Graph III.7, EU bills are by far the most liquid EU securities (as measured by the bid-ask spread) and are followed, of late, by NGEU bonds and by bonds issued under the EU-bond designation, which is being applied to all bonds issued by the EU since the start of 2023 as per the Commission's new unified funding approach

Graph III.7: **Developments in the average liquidity of EU securities**



Note: liquidity measured by the bid-ask spread; based on the simple average of all EU-issued securities in the relevant subsample; market liquidity computed based on the normalised first principal component of the 10-year bid-ask spreads of German, French, Italian and Spanish government bonds.

Source: Bloomberg, own calculations.

([100]) EU bills were introduced in the second half of 2021 and fund the EU's liquidity holdings needed to manage liquidity risk and to temporarily fund disbursements.

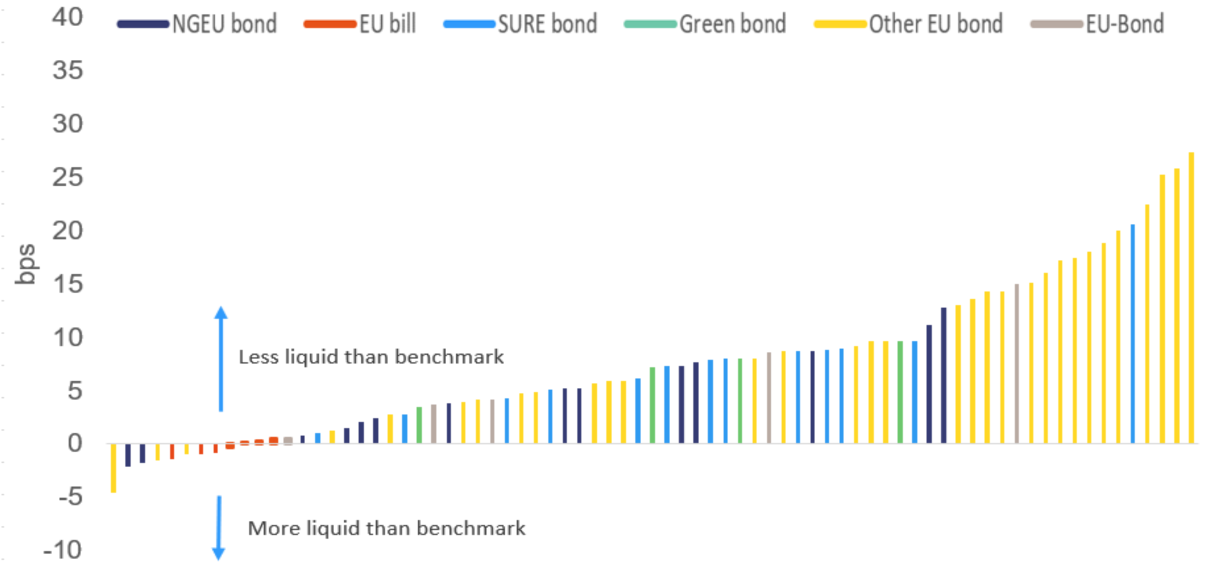
([101]) For instance, the bid-ask spread was considered the single most important indicator of liquidity issues in a 2016 survey of OECD government debt management offices. See OECD (2016), "OECD Sovereign Borrowing Outlook 2016", OECD Publishing.

([102]) Specifically, the bid-ask spread was computed as a bond's ask price minus its bid price, where prices are sourced from Bloomberg. Given that bond prices are conventionally quoted as percentages of face value, we express the price difference in basis points, although our bid-ask spread indicator could equivalently be read as cents on a face value of one hundred euros. It should be noted that the magnitude of the bid-ask spread does not bear a one-to-one relation to bond yields, which are also expressed in bps. The econometric analysis in Box III.1 translates the bid-ask spread into a yield impact, with decompositions presented in this article suggesting that the liquidity premium represents a comparatively limited component of EU bond yields once all factors are accounted for. It is also worth noting that normalising the bid-ask spread by, e.g., dividing it by a mid price does not significantly alter results in the present context.

(see Section III.5.) ([103]). SURE bond liquidity closely tracks that of NGEU and appears to have enjoyed a structural improvement with the introduction of NGEU bonds in June 2021. A slow structural improvement in the liquidity performance of other EU bonds also appears to have been taking place as the pool of outstanding EU bonds expanded over time. It can also be observed that most EU bonds reacted negatively to a temporary increase in market illiquidity in 2022, which has meanwhile dissipated in 2023. The most recent figures also show a slight deterioration in EU bond liquidity which correlated with market-wide trends.

Graph III.8 zooms in further on the latest datapoint by presenting the liquidity differentials of the EU bonds and bills active in the market in November 2023, as calculated with respect to benchmark sovereign securities. It can be observed that a few EU securities beat the benchmark ([104]) while the vast majority of them are within a radius of 10 bps (or 10 cents on 100 euros of face value). It is also worth observing that the most significant differentials are concentrated in the class of other EU bonds (which are often legacy bonds belonging to older issuance programmes), while securities issued under newer EU programmes tend to enjoy a better performance.

Graph III.8: **Relative liquidity of EU bonds and bills active in November 2023**



Note: covering a sample of 80 EU securities, nine of which have been omitted for visualisation purposes due to their outlier behaviour; based on a 30-day average of the bid-ask spread of a given EU bond minus the bid-ask spread of the respective benchmark bond, as identified by Bloomberg.

Source: Bloomberg, own calculations.

An exploratory econometric analysis of EU bond liquidity suggests a number of empirical facts: i) liquidity decreases with increasing residual maturity, although this effect becomes weaker the longer the maturity; ii) liquidity increases with the size of a bond's outstanding amounts, although with decreasing returns to scale; iii) the liquidity of medium- to long-term bonds increased as the total pool of EU bonds got larger; iv) EU bonds are responsive to global liquidity conditions and this response becomes stronger with a bond's residual maturity; v) NGEU and SURE bonds enjoy a favourable liquidity effect even when

([103]) Given the changing sample of underlying EU securities, the dynamics shown in Graph III.7 also reflect compositional aspects. However, a security-by-security inspection shows that, notwithstanding some idiosyncrasies, the graph is fairly representative of the overall dynamics of each subsample.

([104]) A benchmark security is identified by Bloomberg for each EU bond and bill. They are low risk securities of a comparable maturity which, in the case of our sample, correspond to selected German and French securities.

controlling for their sizes and maturities ([105]); and vi) the liquidity dynamics of other EU bonds are more idiosyncratic when compared with NGEU and SURE bonds.

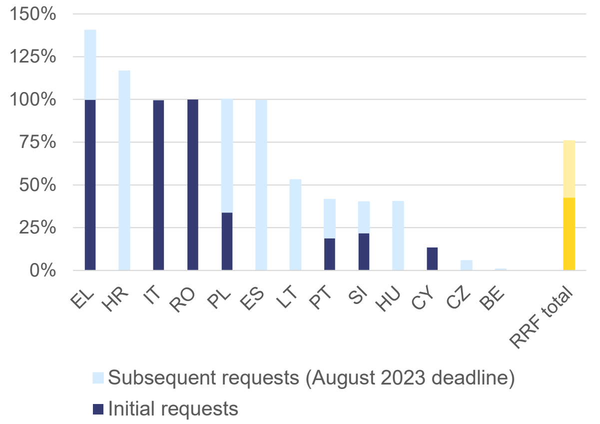
The details of the econometric analysis are reported in Box III.1.

III.4. NET FINANCIAL GAINS FROM NGEU BORROWING

NGEU offered Member States the possibility to borrow up to 6.8% of their 2019 GNI to conduct investment and reforms via the Recovery and Resilience Facility (RRF) and in accordance with national Recovery and Resilience Plans. The total amounts made available were € 385.8 bn, to be financed through joint EU issuance ([106]). With the passing of the deadline for requesting RRF loans, the maximum uptake (assuming full approval of pending requests) is now known and plotted in Graph III.9. As can be observed, 13 Member States decided to request RRF loans, with six of them requesting the full amounts to which they were entitled based on the 2019 GNI criterion, or more ([107]). Overall, the total uptake of RRF loan amounts on offer has been approximately three quarters.

In this section, we calculate an illustrative discounted return on investment (ROI) from the decision to request an RRF loan, accruing to the 13 beneficiary Member States. For presentational purposes, the ROI is defined as the net present value (NPV) of the financial benefits of requesting an RRF loan divided by the loan amount. The NPV of these benefits is, in turn, calculated as the loan amounts received (i.e., the gross benefit) minus the future principal and interest payments to be made (i.e., the cost), with all cash flows discounted at appropriate country-specific rates to account for the time value of money. Therefore, our ROI measure captures exclusively the financial gains from being able to access cheaper EU funding and take no consideration of the broad macroeconomic return resulting from the investments and reforms that RRF loans promote ([108]). The details behind the calculation of the ROI measure are presented in Box III.2, which also discusses how the computed ROIs represent illustrative indicators of *feasible* ex ante profitability, rather than *actual* ex post profits. In fact, the interest to be paid on RRF loans is subject to revision over time and therefore the actual financial returns can only be accurately determined once the

Graph III.9: **Uptake of RRF loans**



Note: assuming full approval of loan requests.

Source: Eurostat, other Commission services, own calculations.

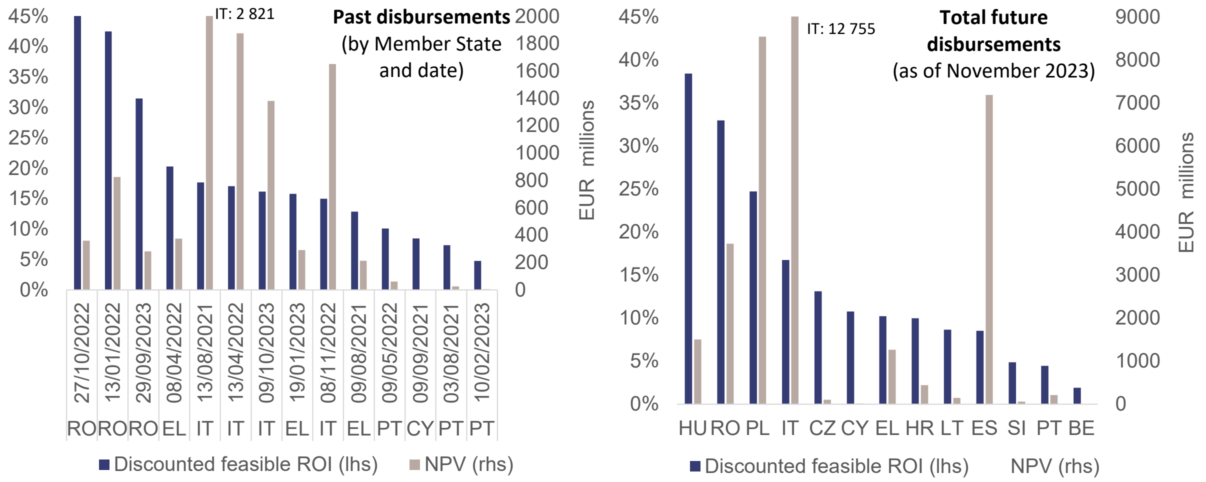
([105]) No similar effect is found for EU bills and green bonds.

([106]) The issuance to finance RRF loans has been labelled NGEU in previous sections, while previous references to NGEU loans can also be understood as referring to RRF loans. NGEU issuance has also served to finance non-repayable grants to Member States.

([107]) Loan requests beyond the limit of 6.8% of 2019 GNI need to invoke exceptional circumstances under Article 14 (6) of the Recovery and Resilience Facility Regulation.

([108]) For an assessment of the economic impact of the additional government investment promoted by NGEU see Pfeiffer, P., J. Varga and J. In 't Veld (2023), "Quantifying spillovers of coordinated investment stimulus in the EU", *Macroeconomic Dynamics*, 27(7). For recent estimates of the effects of structural reforms on Member State economies of the kind supported by RRF lending see Pfeiffer, P., J. Varga and J. In 't Veld (2023), "Unleashing Potential: Model-Based Reform Benchmarking for EU Member States", *European Economy* Discussion Paper 192, European Commission.

Graph III.10: **Discounted feasible ROIs and NPVs of RRF loans, per Member State and disbursement date**



Note: see Box III.2 for a discussion of the metrics and of the underlying methodology.

Source: own calculations.

entirety of an RRF loan has been repaid (at which point the prevailing effective interest rate over a loan's lifetime is fully known).

The left-hand chart of Graph III.10 shows the feasible ROIs associated with the different loan disbursements that had taken place by November 2023, as identified by the payment date and concerned Member State. Recipients are seen to have benefitted ex ante from the transactions given that ROIs are positive in every case. In addition, ROIs are also sizeable, ranging from 5% to 46%. The right-hand axis of the same chart shows the absolute NPV value associated with each transaction, which is a function not only of the ROI but, crucially, of the amount received in each disbursement, which tends to be larger for bigger Member States or for those that have otherwise requested larger amounts.

While the left-hand chart of Graph III.10 depicts ROIs and NPVs associated with loan disbursements that have already taken place, the right-hand chart shows the equivalent metrics for RRF loan amounts still to be disbursed as of November 2023, assuming that RRF loan requests will be approved in full. All transactions are once more seen to be profitable ex ante for all Member States given the positive ROIs, which range from 2% for Belgium to 38% for Hungary. Table 1 in Box III.2 provides aggregate ROI and NPV figures per Member State covering all loan disbursements, past and future.

III.5. INSTITUTIONAL FACTORS AND EU BOND PERFORMANCE

The market performance of EU bonds is shaped by a set of institutional factors that govern how EU issuance operates and is perceived in practice. In theory, joint EU issuance can provide an international euro-denominated safe asset of a very large size. Monteiro (2023) ([109]) reviews the main existing theoretical proposals for common sovereign debt instruments in the euro area and presents analytical results that confirm that the whole of euro area debt could in principle be turned into a common instrument with negligible risk premia and matching the quality of the best existing international safe assets This result can be understood as a consequence of the fact that the euro area is a large, rich and

([109]) Monteiro, D. P. (2023), "Common Sovereign Debt Instruments in the Euro Area", *European Economy* Discussion Paper 194, European Commission.

diversified economy, with an aggregate debt ratio that compares favourably with that of other advanced economies ([110]).

The main difference between existing theoretical constructs and the large-scale experience of the EU is threefold:

1. Theoretical common debt instruments are often endowed with a very large degree of credit enhancement, such as explicit seniority over national bonds, or unlimited joint and several guarantees from all participating Member States ([111]);

2. Theoretical instruments are usually permanent while large-scale EU issuance was designed to fund temporary programmes;

3. Theoretical instruments can reach very large sizes, such as 60% of GDP or 100% of sovereign debt outstanding, while current EU issuance, while large by historical standards, remains small by comparison with theoretical proposals.

The decomposition of the drivers of EU bond yields shown in Section III.2 underlines the relevance of Point 1. The perceived credit risk of the EU is fundamentally exposed to the perceived credit risk of Member States through the loan and budgetary claims of the EU vis-à-vis national governments. Reassuringly, the risk correlation over the past three years has been much stronger with respect to lower-risk, lower-yield sovereigns when compared with higher-yield sovereigns, highlighting how EU bonds are perceived as belonging to a lower-risk class. Nevertheless, the addition of new own resources to the EU budget would contribute to weaken its sovereign risk exposure and would render supranational EU bonds more similar to the better-regarded EGB class by increasing the revenue-raising ability of the EU. It is worth noting in this regard that the creditworthiness of EU bonds is generally underpinned by the EU budget and has been reinforced by the expansion of the EU's own resources headroom introduced in connection with the launch of NGEU. These underpinnings are set to remain stable irrespective of any discussions regarding the possible future introduction of new own resources. However, the addition of new own resources would help further de-link EU credit risk premia from that of Member States, particularly if the additional revenue could be partly managed as a financial buffer or be raised with some degree of discretion. In the first case, a buffer would lower perceived financial risks by acting in a manner akin to paid-in capital. In the second case, a degree of discretion would allow revenue to vary as a function of risks or of the state of the financial buffer which, again, would bring the EU budget closer in substance to the sovereign class.

As regards Points 2 and 3, they carry implications for the liquidity risk premium and relative convenience yield of EU bonds. The temporary nature of EU issuance means that EU bond liquidity can face pressures over the medium to long run, as the pool of NGEU and SURE bonds outstanding dwindles. A market presence that is temporary and expected to decline also decreases incentives to develop derivative markets around EU bonds and to promote their use as reference bonds on par with that of large, low-risk euro area sovereigns. At the same time, the existence of investment mandates, different investment classes and other constraints on actual market functioning further highlights how EU bond price formation does not result exclusively from pure risk-return considerations. For instance, there is a degree of segmentation in fixed income markets, with EU bonds currently regarded as under the SSA class, while the absence of EU bonds from benchmark bond indices is also seen as affecting performance ([112]).

([110]) For example, the 2022 general government debt-to-GDP ratio of Japan, the US and the UK was 261%, 121% and 101%, respectively. The same figure was 92% for the euro area.

([111]) By comparison, NGEU debt benefits from a specific credit enhancement in the form of an expansion in the EU's own resources headroom while SURE loans benefit from a specific enhancement in the form of collective guarantees from Member States covering up to 25% of potential losses.

([112]) As regards the importance of the inclusion of EU bonds in sovereign indices see the results of the EU inaugural investor survey, published in September 2023.

Still, several recent EU-level initiatives can help promote the liquidity and convenience yield of EU bonds. These include: the decision by the ECB to classify EU bonds more favourably for use as collateral in Eurosystem refinancing operations since June 2023; the introduction of quoting arrangements in November 2023 whereby members of the EU primary dealer network offer to trade EU securities at pre-determined bid-ask spreads and quantities; the Commission's decision to set up a repo facility that should be operational in 2024; an EU issuance service launched in January 2024 moving the settlement of EU bonds to a Eurosystem-based infrastructure; and a new unified funding approach that extends the funding approach adopted under NGEU to the latest financial support programme to Ukraine (MFA+) and to future programmes. Regarding the latter measure, it has meant that all EU bonds have been issued under a EU-Bond brand since January 2023, irrespective of the programmes that are funded by the proceeds of the issuance. This measure aims to reduce market fragmentation across EU bond issuances and the latest econometric evidence presented in Box III.1 suggests that homogeneity across EU bonds has indeed increased compared with previous analyses.

III.6. CONCLUSION

This chapter took stock of the first three years of large-scale EU issuance brought about by the SURE and NGEU programmes. During this period, EU issuance has consistently enjoyed a positive market reception, rising to the challenges posed by a swift expansion in debt market placement. The secondary market performance of EU bonds (and of the broader euro denominated SSA market) can, nevertheless, be split into three phases. Large-scale issuance had a good start in 2020-2021, meeting with a favourable assessment from market players, seeing its liquidity improve as the pool of EU bonds outstanding expanded and enjoying yields that compared well with those of France. Monetary policy normalisation and Russia's unjustified full-scale invasion of Ukraine made for a riskier macroeconomic environment in 2022, which was associated with a modest increase in SSA bond spreads as well as some deterioration in liquidity and relative convenience yield performance. However, these unfavourable trends partially reversed in 2023.

An econometric inquiry into the drivers of EU bond yields shows the dominant role that monetary policy normalisation has had in their increase. As regards spreads, EU bonds correlate more strongly with the sovereign risk of lower-yield Member States, which may be perceived as the ultimate guarantors of EU debt. Other relevant dynamic drivers of spread performance include time-varying liquidity risk and relative convenience yield. Econometric evidence also suggest that the EU bills programme has been particularly successful, enjoying favourable bill-specific price effects. While EU securities appear to have faced headwinds from a rapid market expansion, these have remained under control.

The liquidity performance of EU bonds varies both cross-sectionally and over time. EU bills are seen to be the most liquid instruments, followed of late by the newly branded EU-Bonds as well as by NGEU bonds, which are in turn closely tracked by SURE bonds. EU securities tend to be less liquid than reference sovereign securities of matching maturity, but the differential is usually not large. EU liquidity performance has also tracked to some extent broader market liquidity conditions, as expected. An exploratory econometric analysis suggests furthermore that EU bond liquidity is higher for shorter-dated bonds and that it increases to some extent with issue size and the pool of EU bonds outstanding.

An NPV analysis of the decision to take up an RRF loan suggests that it was ex ante a profitable choice for all the 13 Member States that had requested such loans by August 2023. From the strict viewpoint of the funding cost advantage of the EU, the computed rates of return on RRF loans tend to be quite large for the beneficiary countries. However, the actual rates of return will depend on how interest rate risk materialises and can only be known ex post, once RRF loans have been repaid.

Joint EU issuance enjoys vast theoretical potential, but actual EU bond performance is shaped by a variety of institutional factors and constrained by its temporary nature and association with the SSA class. Still, beyond its significant impact on the real economy, NGEU has also provided an important signal of commitment to the European project, which immediately lowered perceived sovereign risk when the programme was announced in 2020. The degree to which NGEU is successfully implemented will help shape views concerning the merits of common issuance to finance pan-European projects and initiatives.

Box III.1: **A panel data analysis of the market performance of EU bonds**

The analysis of the determinants of EU bond yields and spreads presented in Section IV.2 is based on a panel data regression model covering 107 EU securities from October 2020 to November 2023, totalling 2 393 observations. In November 2023, the sample was composed of 28 NGEU securities (of which 7 EU bills), (1) 13 SURE bonds and 4 green bonds, for a total of 80 securities. Due to securities being issued and maturing during the period under analysis, the panel is unbalanced. The raw data is sourced from Bloomberg at daily frequency (except where otherwise noted) and is averaged to monthly frequency in order to reduce its noise and to focus on the more stable and fundamental relations between variables. The chosen specification is as follows:

$$y_{i,t} = \alpha + \beta_1 y_{i,t}^{AAA} + \beta_2(\bar{T}_i \times BAS_t^{Mkt}) + \beta_3 \overline{BAS}_i + \beta_4 \bar{T}_i + \beta_5 \bar{T}_i^2 + \beta_6 Risk_t^{LY} + \beta_7 Risk_t^{HY} + \beta_8(\bar{T}_i \times Risk_t^{LY}) + \beta_9 OIS_t + \beta_{10}(\bar{T}_i \times OIS_t) + \beta_{11} Bill_i + \varepsilon_{i,t} \quad (1)$$

The variables take the following meaning:

- $y_{i,t}$ is the secondary market yield of EU security *i* in month *t*.
- $y_{i,t}^{AAA}$ is a measure of the risk-free rate in month *t* taken from the AAA sovereign yield curve constructed by the ECB and assessed at the same maturity as that of security *i*.
- BAS_t^{Mkt} is a measure of sovereign bond market liquidity constructed based on a normalised first principal component of the 5- and 10-year bid-ask spreads of German and French government bonds.
- $\overline{BAS}_i$ is the in-sample average bid-ask spread of EU security *i*, capturing its structural liquidity.
- $\bar{T}_i$ is the in-sample average residual maturity of EU security *i*.
- $\bar{T}_i^2$ is the square of the previous variable.
- $Risk_t^{LY}$ is a normalised first principal component of the 10-year spread with respect to Germany of AT, BE, FI, FR, NL (denoted as low-yield countries). This variable is depicted in Graph IV.3.
- $Risk_t^{HY}$ is the equivalent of the previous variable as calculated for EL, IE, IT, PT, ES (denoted as high-yield countries). This variable is also depicted in Graph IV.3.
- OIS_t is the spread of 6-month German securities with respect to the 6-month €STER OIS and proxies the time-varying convenience yield of reference euro area sovereign bonds.
- $Bill_i$ is a dummy variable that takes the value 1 if security *i* is an EU bill.
- $\varepsilon_{i,t}$ is an error term.

As can be noticed, $Risk_t^{LY}$, OIS_t and BAS_t^{Mkt} are interacted with $\bar{T}_i$ to account for a term structure in credit risk, relative convenience yield and sensitiveness to market liquidity, respectively. (2) $Risk_t^{HY}$ is not interacted in the final specification as the associated coefficient was not found to be statistically significant. $\bar{T}_i$ and $\bar{T}_i^2$ also appear as independent terms to control for residual term structure factors not already captured elsewhere, while allowing for a curvature in these factors. Dummy variables controlling for NGEU, SURE and green bonds were not included in the final specification as the associated coefficients were not found to be

(1) EU bills are considered to be part of the NGEU programme in the present analysis. In addition, the NGEU sub-sample also includes five bonds issued since January 2023 under the "EU-bond" label which are not, strictly speaking, directly associated with the NGEU programme as per the rationale of the new unified funding approach of the EU issuer.

(2) A maturity interaction is also theoretically justified based on the fact that $Risk_t^{LY}$, OIS_t and BAS_t^{Mkt} are constructed from instruments with predetermined maturities that do not in general match the varying maturities of EU securities. The fact that BAS_t^{Mkt} only enters Equation (1) interacted with $\bar{T}_i$ but not in isolation has to do with the fact that the main effect is found to be statistically insignificant once a maturity interaction is included. This finding can, in turn, be understood as meaning that the impact of BAS_t^{Mkt} on yields tends to zero as a bond approaches the maturity date.

(Continued on the next page)

Box (continued)

statistically significant. [3] This points to there being no special pricing affect associated with these bonds once their basic characteristics are controlled for. Given that in an earlier analysis relying on a shorter sample such dummies were found to be significant, this result suggests stronger integration in the market for EU bonds, whereby the associated EU programmes are no longer distinguishing factors.

The estimation of an equation such as (1) usually involves choosing between a random effects (RE) and a fixed effects (FE) model. A Breusch-Pagan LM test rejects a pooled estimation approach while the popular Hausman test provides statistical evidence in favour of a FE model. However, given that some variables are time-invariant, the usual FE approach is not ideal as it does not allow estimating the coefficients associated with this type of variables. For this reason, we also estimate the model by relying on the Hausman-Taylor (HT) and on the Mundlak (MK) approaches, both of which can handle fixed effects while allowing for the estimation of the coefficients of time-invariant variables. The estimation results are reported in Table 1. As can be observed, coefficients are economically similar across models, irrespective of the comparative statistical validity of the different estimation approaches. Ultimately, the different models produce only minor changes in the decompositions shown in Section IV.2 and we opt to rely on the HT model as it is both suitable for handling fixed effects and for estimating the coefficients of time-invariant variables. [4]

Table 1:
EU bond yield regressions: estimated parameters

Model	α	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9	β_{10}	β_{11}	R^2
RE	-0.13	0.98	0.08	0.33	0.0098	-0.0006	0.58	0.04	0.04	-0.46	0.03	-0.20	99.5%
p-value	*0.000*	*0.000*	*0.000*	*0.000*	*0.031*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	
FE	-0.06	0.97	0.08				0.61	0.03	0.04	-0.46	0.03		99.0%
p-value	*0.000*	*0.000*	*0.000*				*0.000*	*0.000*	*0.000*	*0.000*	*0.000*		
HT	-0.16	0.97	0.08	0.35	0.0102	-0.0006	0.59	0.04	0.04	-0.46	0.03	-0.20	99.5%
p-value	*0.001*	*0.000*	*0.000*	*0.001*	*0.180*	*0.020*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	
MK	0.07	0.97	0.08	0.42	-0.0132	-0.0006	0.60	0.04	0.04	-0.46	0.03	-0.18	99.6%
p-value	*0.432*	*0.000*	*0.000*	*0.000*	*0.322*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	

As can be observed in Table 1, all coefficients are highly significant, with the exception of the coefficient associated with $\overline{T}_i$, which is not significant in the HT and MK models, while being significant at a 5% level in the RE model. [5] In addition, all coefficient signs are theoretically valid. The goodness-of-fit is near perfect, which should not be taken as evidence either in favour or against the model specification, but rather seen as the result of taking yields as the dependent variable, where the risk-free rate $y_{i,t}^{AAA}$ has a large explanatory power. [6] The goodness-of-fit of an equivalent regression explaining EU bond spreads would be high, at approximately 80%, but not perfect.

Before concluding the consideration of Equation (1), it is worth noting that an expanded specification that includes as a regressor the total amount of EU debt outstanding as a share of total euro area government debt suggests that the rapid expansion in EU debt supply increased EU bond yields by approximately 4 bps on average between October 2020 and November 2023. A maturity interaction term further suggests this effect was more pronounced for longer-dated bonds and less pronounced for shorter-dated bonds and bills. It is worth noting in this connection that the relatively muted effect of the possible excess supply of EU debt is ultimately endogenous in the sense that it partly depends on the issuance strategy of the EU issuer and can thus reflect a successful approach to market placement.

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(3) In the case of NGEU, the dummy variable is significant at conventional significance levels under the RE model, but is not found to be significant at a 5% level in the HT model, nor at a 10% in the MK model (see the remainder of this box for a discussion of the different models). As regards SURE and green dummy variables, there is strong evidence against their significance across all model versions.

(4) The MK approach also provides these advantages. As seen, however, the question of choosing between HT, MK and RE is a moot one in the present context.

(5) As regards $\overline{T}_i^2$, it is highly significant in the RE and MK model, and significant at a 3% level in the HT model.

(6) In fact, statistical testing provides evidence in favour of co-integration between $y_{i,t}$, $y_{i,t}^{AAA}$ and the other time-varying euro area-wide variables included in the regression, a result to be expected from financial fundamentals according to which bond yields can be decomposed into a risk-free rate and factors remunerating different types of financial risk.

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Box (continued)

Turning now to the empirical results on EU bond liquidity presented in qualitative terms in Section IV.3, they follow from an exploratory econometric panel data analysis applied to the same sample as previously described. The estimation equation is as follows:

$$BAS_{i,t} = \alpha + \beta_{BAS\_MKT}\left(T_{i,t} \times BAS_t^{Mkt}\right) + \beta_{AMNT\_i}AMNT_{i,t} + +\beta_{AMNT2\_i}AMNT_{i,t}^2 + \beta_{AMNT}AMNT_t + \beta_{TAMNT}\left(T_{i,t} \times AMNT_t\right) + \beta_T T_{i,t} + \beta_{T2}T_{i,t}^2 + \beta_{NGEU}NGEU_i + \beta_{SURE}SURE_i + \varepsilon_{i,t}$$

where

- $AMNT_{i,t}$ is the outstanding amount of EU security *i* in month *t*;
- $AMNT_t$ is the total outstanding amount of EU bonds and bills in month *t*;
- $NGEU_i$ is a dummy variable that takes the value one if an EU security is associated with the NGEU programme;
- $SURE_i$ is a dummy variable that takes the value one if an EU bond is associated with the SURE programme;

and all the remaining variables have the same meaning as before.

The chosen specification does not include BAS_t^{Mkt} as a standalone term as the associated coefficient was not found to be significant. At the same time, both BAS_t^{Mkt} and $AMNT_t$ appear interacted with residual maturity as their effect on liquidity was found to have a term structure. (7) It is also worth noting that controlling for the share of $AMNT_{i,t}$ that was placed in the market via an auction (as opposed to a syndication) does not produce a statistically significant effect.

The $BAS_{i,t}$ equation is estimated as a RE model following a Hausman test providing borderline statistical evidence in favour of that approach. (8) Table 2 reports the estimated coefficients and the associated p-values:

Table 2:
EU bond liquidity regression: estimated parameters

	α	β_{BAS_MKT}	β_{AMNT_i}	β_{AMNT2_i}	β_{AMNT}	β_{TAMNT}	β_T	β_{T2}	β_{NGEU}	β_{SURE}	R^2
Value	0.10	0.03	-0.02	0.0009	0.0002	-0.00003	0.04	-0.0004	-0.10	-0.11	56%
p-value	*0.000*	*0.002*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	

The goodness-of-fit of the regression is 56% and all coefficients are highly significant while having theoretically valid signs. Applying the regression to a subsample composed of NGEU and SURE securities does not change coefficient signs but improves the goodness-of-it substantially, highlighting how EU bonds issued under other programmes have more idiosyncratic liquidity dynamics.

(7) The fact that BAS_t^{Mkt} has a term structure can be understood as a consequence of the fact that the indicator is constructed based on 5- and 10-year bonds whereas EU bonds have different maturities that may be less (shorter-dated bonds) or more affected (longer-dated bonds) by market-wide liquidity developments. For this reason, the main effect of BAS_t^{Mkt} is found to have a very low statistical significance (p-value of 0.7) once a time interaction is included.

(8) In particular, the null hypothesis of random effects has an associated p-value of 1.6%. FE and Mundlak models were also estimated and found to deliver the same signs on the set of regressors that are common among the three models.

Box III.2: **Calculating the discounted return on investment of an RRF loan**

The Commission adopted a diversified funding approach with respect to NGEU loans under which there is no back-to-back lending whereby the EU would associate to each RRF loan disbursement a given EU bond issuance. Rather, the Commission engages in maturity transformation, funding itself at average maturities that are shorter than RRF loan maturities while passing on its changing interest costs to Member States. This approach offers both potential benefits and risks to beneficiary countries. On the one hand, it allows funding 30-year Member State borrowing with potentially cheaper, shorter-dated EU borrowing whose maturity ranges approximately from 10 to 15 years, depending on the relevant "time compartment". (1) On the other hand, as EU bonds are rolled over, the cost of funding of the Commission may change, implying the risk of a revision in the interest rates charged on RRF loans.

In this article, we compute a feasible discounted return on investment (ROI) assuming that the Commission would fund itself without engaging in maturity transformation, thereby eliminating interest rate risk. The formula employed for calculating the discounted ROI is as follows: (2)

$$Discounted\ ROI = \frac{Present\ value\ of\ benefit\ -\ Present\ value\ of\ cost}{RRF\ loan\ amount}$$

As mentioned in Section IV.4, our ROI measure captures exclusively the net gains from the financial transactions associated with an RRF loan that follow from the financing cost advantage of the EU with respect to the different borrowing Member States. As such, the present value of the benefit is simply the loan amount received, either in past disbursements or in future disbursements. (3) The present value of the costs considers, for each of the years ahead, how much a Member State will have to repay on its RRF loan in terms of interest and principal amortisation, with these amounts discounted at Member State-specific interest rates, as derived from national yield curves. RRF loan principal amortisation, in turn, reflects an initial 10-year grace period, followed by a 20-year period of constant repayments, in line with existing RRF loan agreements.

In order to finance RRF loans, the Commission is assumed to issue a series of bonds with maturities between t+11 to t+30, (4) matching the principal repayments that it will receive from Member States. These repayments are assumed to be used by the Commission upon receipt to pay back maturing EU bonds. As such, the assumed RRF lending operation entails neither interest rate risk for the parties involved nor roll-over risk for the Commission, with the interest amounts that the Commission charges to Member States being determined by the yields required on EU bonds at the time of disbursement. For past disbursements, the relevant EU rates correspond to those observed from the EU yield curve at the disbursement date. For future disbursements, which will take place until 2026, EU interest rates are inferred from the November 2023 EU yield curve, and are based on the relevant EU forward rates. (5)

Graph 1 presents the EU and sovereign yield curves employed in the calculation of the ROIs associated with future disbursements. Where tenor gaps exist in our Bloomberg data source, they were filled in through inter-

(1) In the context of the pricing of RRF loans, the Commission computes its cost of funding for each half year (i.e., the "time compartment") based on the average funding costs of the debt instruments that it issues during that period. This funding costs are then passed on to the RRF loans granted during that time compartment. As the EU debt instruments of that time compartment are rolled over, the funding costs that are passed on to Member States via the respective RRF loans are updated.

(2) An alternative formula would be $Discounted\ ROI = \frac{Present\ value\ of\ benefit\ -Present\ value\ of\ cost}{Present\ value\ of\ cost}$. It can be shown that this formula produces ROI estimates that are close to those of the formula adopted above, except when dealing with very large ROIs, when it can produce significantly higher rates of return.

(3) Future disbursements are discounted based on EU yields. The choice of the EU discount rate is due to the fact that, subject to full milestone compliance by Member States, the fulfilment of a promise of RRF loan disbursement is subject to the credit risk of the EU.

(4) Or up to t+33, in the case of future loan disbursements, which are assumed to be phased over three years. In this case, the required EU issuance is also assumed to take place over three years, with the respective yields based on forward EU rates derived from the EU yield curve as at November 2023.

(5) Loan amounts still to be disbursed are assumed to be paid as follows: 10% in 2023 and 30% in each of the three years from 2024 to 2026.

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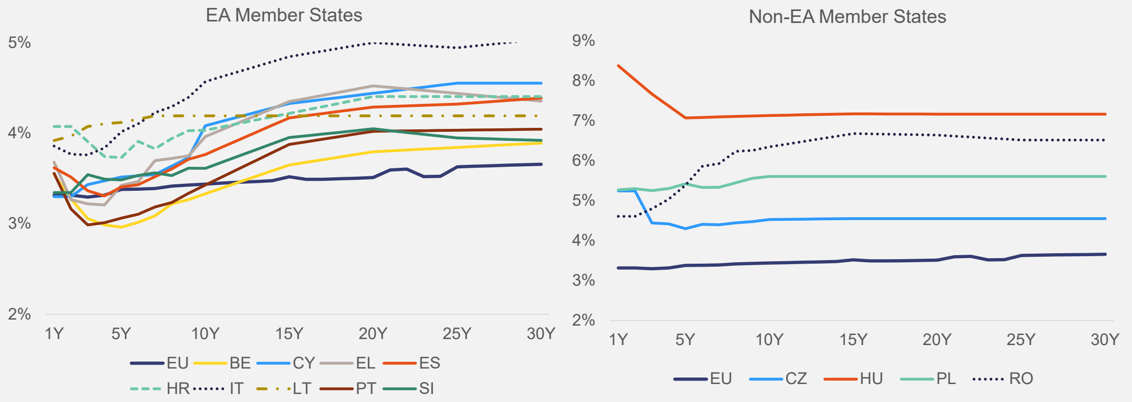
Box (continued)

Graph 1: **Yield curves of EU sovereigns in November 2023**



Note: EU curve fitted based on the Nelson-Siegel-Svensson model.
Source: Bloomberg, own calculations.

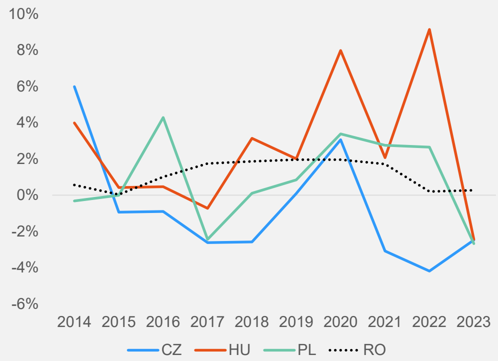
and extrapolation. Table 1 presents estimates for the discounted ROI and for the NPV of gains associated with the entirety of loan disbursements (both future and past, if applicable).

Table 1: **Discounted feasible ROIs and NPVs of RRF loans, per Member State (all disbursements)**

	BE	CZ	EL	ES	HR	IT	CY	LT	HU	PL	PT	RO	SI
ROI	2%	13%	12%	9%	10%	17%	10%	9%	38%	25%	5%	35%	5%
NPV (€ millions)	5	107	2 147	7 188	444	20 487	21	149	1 506	8 543	308	5 200	63

Note: covering past and future RRF loan disbursements; the NPV assumes full approval of requested amounts.
Source: own estimates.

Graph 2: **Year-on-year change in average bilateral exchange rates vis-à-vis the euro**



Note: positive figures denote appreciation.
Source: Eurostat, own calculations.

ANNEX. THE EURO AREA CHRONICLE

The Commission, the Economic and Financial Affairs Council and the Eurogroup regularly take decisions that affect how the Economic and Monetary Union works. To keep track of the most relevant decisions, the QREA documents major legal and institutional developments. This issue covers developments between October and December 2023.

On 21 November, the Commission launched the 2024 European Semester cycle of economic policy coordination. ([113]) The policy package included: the Annual Sustainable Growth Survey, the Alert Mechanism Report, the Commission proposal for a Joint Employment Report, the proposal for a euro area recommendation and the Commission Opinions on the euro area Member States' 2024 Draft Budgetary Plans. The Annual Sustainable Growth Survey (ASGS) outlines the economic and employment policy priorities for the EU for the coming 12 to 18 months. This year's ASGS puts forward an ambitious agenda to further strengthen a coordinated policy response to enhance the EU's competitiveness through a green and digital transition, while ensuring social fairness and territorial cohesion. The Alert Mechanism Report (AMR) ([114]) assesses economic developments to identify Member States for which the Commission will undertake in-depth reviews to detect if those Member States are affected by macroeconomic imbalances or how these imbalances are developing. This year's AMR concludes that in-depth reviews are warranted for nine euro area countries, namely Cyprus, Germany, Greece, France, Italy, the Netherlands, Portugal and Spain – these are the Member States that were, in the 2023 cycle, identified as experiencing imbalances or excessive imbalances – as well as for Slovakia. ([115]) Subsequently, in December, the Commission has also published the post-programme reports for Greece, Ireland, Cyprus, Portugal and Spain and concluded that these five Member States retained capacity to pay their debt. ([116])

The euro area recommendation ([117]), which is supported by the Euro Area Report ([118]), presents policy advice to euro area Member States on topics that affect the functioning of the euro area as a whole. This year the focus lies on policy responses to the challenges of high inflation and competitiveness. It recommends that euro area Member States i) adopt coordinated prudent fiscal policies and wind down energy support measures, with a view to enhancing public finances' sustainability and avoiding fuelling inflationary pressures; ii) ensure high and sustained levels of public investment and promote private investment through the acceleration of the implementation of the Recovery and Resilience Facility and Cohesion Policy programmes; iii) support wage developments that mitigate the loss in workers' purchasing power, taking into account competitiveness dynamics; iv) monitor risks related to tightening financial conditions, while completing the Banking Union; and v) enhance competitiveness by improving access to finance, progressing in the Capital Markets Union and ensuring that public support to strategic sectors remains targeted and does not create distortions in the level playing field of the Single Market. After discussion by the Eurogroup in January 2024, the recommendation for the economic policy of the euro area is expected to be endorsed by the European Council, leading to final adoption by the ECOFIN Council.

([113]) https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5871.

([114]) European Economy-Institutional Papers, 260.

([115]) The in-depth review for Slovakia in the previous annual cycle concluded that it was not experiencing imbalances. However, economic developments since then point to a continued risk of possible imbalances as the abatement of these risks does not appear to be clearly underway. In addition, the AMR concluded that in-depth reviews are also warranted for Hungary, Romania and Sweden.

([116]) https://ec.europa.eu/commission/presscorner/detail/en/mex_23_6801.

([117]) https://commission.europa.eu/publications/2024-european-semester-recommendation-euro-area_en

([118]) The incoming Slovak government submitted an updated DBP on 12 December 2023, and its assessment is currently underway.

The Commission also issued its opinions on Draft Budgetary Plans (DBPs) of euro area Member States. The Commission assessed the 2024 DBPs' consistency with the fiscal policy recommendations adopted by the Council in July 2023. In its opinion, the Commission considered that the Draft Budgetary Plans of Cyprus, Estonia, Greece, Spain, Ireland, Slovenia and Lithuania are in line with the Council Recommendations. On the other hand, the Draft Budgetary Plans of Austria, Germany, Italy, Luxembourg, Latvia, Malta, Netherlands, Portugal and Slovakia are not fully in line with the Council Recommendations. In its Statement of 7th December, the Eurogroup invited these Member States to stand ready to take action as necessary. Finally, the Draft Budgetary Plans of Belgium, Finland, France, Croatia risk not being in line with the Council Recommendations. The Eurogroup invited these Member States to consider in a timely manner and as necessary to take action to address the risks identified by the Commission to ensure that fiscal policy is in line with the recommendations adopted by the Council and welcomed their commitment to follow-up as needed. Due to their political cycle, Spain, Slovakia and Luxembourg submitted DBPs 'on no-policy-change basis': this means that the DBPs did not include policy targets and that the draft budgets had not yet been sent for a vote in the national parliaments; for these Member States updated DBPs are expected to be submitted in due time. ([119])

Economic governance review: the Council agreed a general approach on the reform of the fiscal rules. On 26 April 2023, the Commission presented a package of three legislative proposals with the central objective of strengthening public debt sustainability and promoting sustainable and inclusive growth in all Member States through reforms and investment. Specifically, these comprised two regulations aiming to replace (preventive arm) and amend (corrective arm) the two pillars of the Stability and Growth Pact, and amend the directive on requirements for Member States' budgetary frameworks. On 21 December 2023, the Council achieved a general approach, which constitutes a mandate for negotiations with the European Parliament on the preventive arm regulation, and an agreement in principle with a view to consulting the European Parliament on the corrective arm regulation and on the directive on requirements for national budgetary frameworks.

The Council has adopted all the REPowerEU chapters submitted to the Commission. ([120]) On that basis, disbursements of REPowerEU pre-financing have been made to France, Slovenia, Slovakia, Malta, Estonia, Portugal, Lithuania and Austria under the Recovery and Resilience Facility. ([121]) These pre-financing payments will help kick-start the implementation of the crucial investment and reform measures outlined in each REPowerEU chapter. This will accelerate the delivery on the REPowerEU Plan's objectives to save energy, produce clean energy and diversify energy supplies, with a view to make Europe independent from Russian fossil fuels in light of Russia's unprovoked full-scale invasion of Ukraine. In parallel, standard payments under the Recovery and Resilience Facility continued, ([122]) bringing the total amount of disbursements to euro area Member States to €202 billion by the end of 2023.

([119]) https://www.consilium.europa.eu/en/press/press-releases/2023/12/21/economic-governance-review-council-agrees-on-reform-of-fiscal-rules.

([120]) In the case of Germany, Ireland and Luxembourg the chapters are expected to be submitted in 2024.

([121]) https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/timeline.html?pk_source=newsletter&pk_medium=email&pk_campaign=enews289.

([122]) Disbursements under the Recovery and Resilience Facility to Italy took place in October, and to Estonia and Croatia in November. Further disbursements to France, Germany, Greece, Italy, Portugal, Slovakia and Slovenia followed in December.

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