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The impact of the COVID-19 shock on euro area potential output: a sectoral approach

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Abstract

The COVID-19 crisis has affected economic sectors very heterogeneously, with possible risks for permanent losses in some sectors. This paper presents a sectoral-level, bottom-up method to estimate euro area potential output in order to assess the impact of the crisis on it. The estimates are based on a supply-demand shock decomposition and are meant to quantitatively support the estimation of scarring effects stemming from the pandemic. The results show that sectors of “trade, transport and accommodation”, “other services” and “industry” may suffer a loss in trend output of around 1.4-1.6% by 2025. Aggregate potential output in 2025 might be about 0.8% lower than it would have been without the crisis, and importantly, without support from the Next Generation EU (NGEU), signalling somewhat larger losses than embedded in the Autumn 2021 forecast of the European Commission (which takes the NGEU into account).

JEL Codes: C32, D24, E32, E37

Keywords: COVID-19, forecasting, production function, potential output, sectoral approach

Non-technical summary

What is the degree of scarring from the COVID-19 pandemic?[5] It is of key importance for welfare considerations, fiscal and monetary policies to gauge how much permanent damage to the economy is inflicted by the COVID-19 pandemic. The unique nature of the shock and its policy response, though, limits the scope for comparison with past crises. Analytically, scarring is most often assessed through the behaviour of potential output. One measure of scarring is simply the loss of potential output compared to the pre-crisis path. This can be estimated using data on the total economy. However, focusing on aggregate data overlooks the fact that the COVID-19 crisis has affected sectors very heterogeneously. Sectors that require personal contact and are deemed to be non-essential were seriously affected. This implies that there may be a need for a more fundamental sectoral reallocation of resources and may lead to long-term damage, including via hysteresis effects, affecting the aggregate potential growth of the economy.

Studying potential output at the sectoral level allows to cater for this heterogeneity and to attach a narrative-based assessment of possible scarring effects. As there is no well-established methodology to estimate potential output at the sectoral level, this paper combines state-of-the-art shock-identification methods with COVID-19-specific sectoral resilience metrics to gauge the effect on the growth potential of the euro area economy. Such an approach can be useful to assess the risks around potential output estimates published by international institutions, while it can also be used to assess factor reallocation needs. Going forward, our methodology is also well-suited to assess other sectoral shocks, such as the Russia-Ukraine war which affects first and foremost the manufacturing sector and notably energy-intensive industries, while the COVID-19 shock mainly affected the contact-intensive services sectors.[5]

We find that, even before the pandemic, the growth of trend output was very heterogenous across euro area sectors. Despite a strong co-movement, trend growth in 2019 ranged from below 0.5% in sectors such as construction, financial and insurance services or other services to around 4% in the information and communication sector.

In 2020 and 2021, supply shocks played a large role for “other services”, (which includes leisure activities, repairs, personal services like hairdresser, etc.), but they were also significant in ”trade, transport and accommodation” and “professional and administrative services”, given the size of the shock. However, the pass-through of these supply shocks

[5] Our analysis is based on the only data available as of 8 March 2022 covering economic developments up to the fourth quarter of 2021. Therefore, the unfolding effects of the Russia-Ukraine war are not estimated in this paper.

to trend output is different across the different sectors and across their potential output contributions (labour, capital and total factor productivity (TFP)).

We support our assessment with the use of a sectoral resilience index (SRI) that gauges how sectors can overcome the COVID-19 shock, depending on their ability to take advantage of teleworking, to innovate and to cover their financial obligations. It shows that information and communication, as well as industry, may have been more resilient to the COVID-19 shock, while trade, transport, and accommodation, as well as other services sectors were much more exposed to its negative effects.

We find that “trade, transport and accommodation”, “industry” and “other services” are likely to experience some scarring, facing a loss in their trend output of approximately 1.6%, 1.4% and 1.4% by 2025, respectively in our baseline scenario.

While potential output estimates are normally surrounded by uncertainty, the sectoral approach points to somewhat lower aggregate potential output growth in 2020 than the Autumn 2021 European Commission (EC) estimates. For 2020, the EC estimated 1.0% potential output growth, and the sectoral approach points to a slowdown to 0.7%. In 2021, this gap persists with an estimated potential growth of 1.1% based on the sectoral level approach, against 1.3% in the EC.

According to our baseline scenario, the aggregate losses in the level of potential output would amount to over 0.8% by 2025. However, our baseline scenario does not take into account the support provided by the Next Generation EU (NGEU) in the years 2022-2025. Therefore, the losses in our baseline scenario are larger than those projected by the European Commission (no loss in the potential output level), which do take the NGEU into account. The largest contribution to this loss comes from the trade, transport and accommodation sector, which was seriously hit and has a large share in the economy. Most alternative scenarios suggest worse outcomes, with some uncertainty. In our scenario that could be interpreted as if the NGEU support was taken into account (albeit this scenario is not based on the Recovery and Resilience Plans submitted by the EU member states), the loss is more similar to the European Commission’s estimate.

Our results are surrounded by uncertainty. These estimates are based on limited data availability and cannot take sectoral linkages and some aggregate factors into account. Due to the uncertainty, for example on how persistently consumers have adjusted their behaviour, the scarring effects remain difficult to assess. This notwithstanding, we run a range of robustness and simulation exercises to depict the relevant range of uncertainty, which overall validate our baseline results.

While we aim to outline broad implications from sectoral changes, further work will be needed to detail the extent of resource reallocation among sectors that is or will be initiated given e.g. changing preferences of consumers or the expected strengthening of digitalisation.

1 Introduction

The COVID-19 pandemic crisis and the subsequent recovery affected sectors very heterogeneously. Sectors that are considered essential as well as those that can be operated without the risk of spreading the virus could maintain their activity, while those that require personal contact and are deemed to be less essential, were seriously affected. The latter include the so-called recreational services, some of which were found to have responded more strongly to containment measures than other sectors (see Battistini and Stoevsky, 2021 and Gunnella et al., 2020). The recovery has also been uneven, as restrictions have affected sectors differently. In addition, it is still unclear to what degree changes in household and firm consumption patterns are persistent. Indeed, structural changes may have been triggered in some sectors, e.g. transport and tourism, resulting in persistently lower activity than before COVID-19. Furthermore, reallocations of production factors may occur through firm closure and the shift of labour and new investments.[6] In this process, one cannot exclude hysteresis effects having a negative impact on the labour market and long-term growth.

Several indicators confirm the heterogeneity of sectoral developments during the crisis. Across 10 NACE-2 sectors in the euro area, standard deviation of total hours worked, value added and productivity growth rose considerably in 2020 and remained high in 2021, while that of employment growth remained moderate, reflecting the impact of job retention schemes (Chart 1). Even when compared to the global financial and European sovereign crises (GFC), the COVID-19 shock resulted in an abrupt decline in several sectors (Chart 2). In 2020Q2, value added dropped the most in other services, followed by trade, transport and accommodation and professional and administrative services. The shocks in these sectors, mainly in other services and trade, transport and accommodation, have been persistent, i.e. activity was in 2021Q4 still well below its pre-shock level.[7]

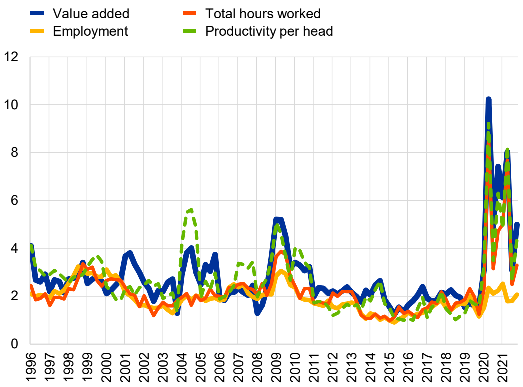
While potential output is an aggregated concept, it is worth studying its recent developments at the sectoral level, given the heterogeneity described above. Potential

[6] In that vein, Haltiwanger (2021) highlights a surge in new US business applications, with very uneven developments across sectors and suggesting strong restructuring induced by the pandemic in some sectors.

[7] Value added and total hours worked by sectors come from quarterly national accounts. The sectoral stock of capital is estimated from the annual national accounts and a forecasting model for the following years (see Annex 1). The sectors are: A – Agriculture, forestry and fishing; BtE – Industry (except construction); F – Construction; GtI – Wholesale and retail trade, transport, accommodation; J – Information and communication; K – Financial and insurance services; L – Real estate activities; MtN – Professional, scientific and technical activities; administrative and support service activities; OtQ – Public administration, defence, education, human health and social work activities ; RtU – Other services.

output is usually defined as the level of activity that corresponds to the level of output that an economy can generate without excessive inflationary pressures. These concepts are traditionally understood at the aggregate level. However, the heterogenous impact of the current shock both in terms of its effect on supply versus demand and in terms of the expected persistence calls for a sectoral decomposition of potential output. This may also help understanding the sectoral reallocation needs in the coming years as well as areas of policy action.

Chart 1: Standard deviation of indicators across euro area sectors

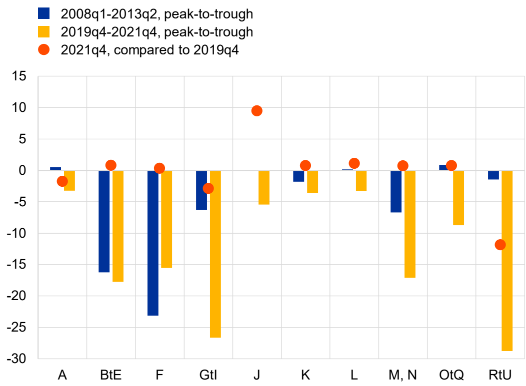


Source: Eurostat and own calculations.

Notes: standard deviation of annual growth rate of selected indicators by sectors

Chart 2: Peak-to-trough developments in sectoral value added in the euro area

(percentage points)



Source: Eurostat and own calculations.

Notes: see footnote 7 for the sector abbreviations.

This paper develops a sectoral approach to estimate the loss in euro area potential output due to the COVID-19 crisis. There are no standard methods available to estimate potential output from detailed sectoral data.[8] The analysis in this paper focuses on the euro area as a whole. It applies a bottom-up, production-function sectoral approach, to cross-check estimates of the impact of the crisis on aggregate potential output. It focuses on the medium-term outlook of 5 years following the start of the COVID-19 pandemic. Given the large uncertainty, we develop a baseline and several alternative scenarios using different assumptions. The approach is flexible and can be extended to include further information.

[8] The few methods that estimate potential output using sectoral data rely on a few sectors. Foerster et al. (2022) on Construction, Nondurable Goods, and Professional and Business Services for the US, while Bundesbank (2007) separate private sector (business sector excluding real estate) and public sector, excluding healthcare, while real estate and healthcare sectors are treated separately.

The results show that losses and scarring can be substantial in some severely hit sectors, warranting careful design of policies facilitating the necessary reallocation of resources. Overall, our assessment suggests a higher risk of potential output loss compared to what has been set out by other international institutions. The European Commission (Autumn 2021 Forecast) foresees no loss – and even a gain – in the level of euro area potential output in 2025 in comparison with what was expected before the pandemic, assuming largely a temporary shock of COVID-19 on potential output (Chart 16). The IMF (Autumn 2021 WEO) expects much smaller potential output losses than those following the great financial crisis. In the euro area, the output level in 2024 is expected to be 0.5% lower than projected before the COVID-19 pandemic. Some national institutes have published sectoral estimates of the effect of the current crisis on potential output at the country level. For example, Insee estimates a loss in potential output for France of 1.6% at the end of 2022, based on survey data and using a sectoral decomposition approach.[9]

The remainder of the paper is organised as follows. Section 2 presents the methodology used to estimate and forecast sectoral trend growth. In Section 3 we provide the initial conditions for sectoral trend output prior to the crisis. Section 4 presents the results on baseline and alternative scenarios and robustness checks and Section 5 concludes.

[9] See Insee (2021).

2 Methodology

We estimate and project trend growth for 10 NACE-2 level sectors, as presented in the introduction. We split the period between 1996 and 2025 into three distinct phases: 1996 to 2019, 2020-2021, and 2022-2025. The estimation and projection methodologies are explained in detail below and are summarised in Table 1.

Table 1 Summary of the methodology used for the trend growth estimates in the baseline

Period	TFP	Labour	Capital
1996 – 2019	Hodrick-Prescott filter		Sectoral data, not filtered
2020 – 2021	BVAR and sectoral trend elasticity in baseline Cross-checking exercise depending on the sectoral resilience index (SRI)		Panel estimation using sectoral value added data, different scenarios depending on the degree of depreciation
2022 – 2025	Gradual convergence to the counterfactual growth, Cross-checking exercise depending on sectoral resilience index (SRI)		Panel estimation using sectoral projection of value added data, depending on the degree of depreciation

Estimation of sectoral trend output for the past (1996-2019)

To start our analysis, we estimate past trend output for each sector, using a Cobb-Douglas production function with labour (total hours worked), capital and Total Factor Productivity (TFP) contributions. The aim of this step is to set up some “initial conditions” for the estimations and for the counterfactual scenarios at the sectoral level. Past trend output is estimated for the 10 sectors from 1996 to 2019, using quarterly data.[10]

We carry out the estimation in three steps: First, using sectoral value added, total hours worked and capital stock, we estimate total factor productivity (TFP) using a Cobb-Douglas production function. Second, we use the Hodrick-Prescott (HP) filter to estimate the trend of the labour input and TFP, while sectoral capital stock is not filtered (in line with most production function methods applied at the aggregate level). The smoothing parameter in the HP filter is equal across the ten sectors and is calibrated such that aggregate euro area potential growth is closest to the potential output estimate of the

[10] We use data from national accounts for sectoral value added and total hours worked. Sectoral capital stock data is taken from balance sheet accounts for non-financial assets (see Annex 1).

European Commission for the entire period.[11] Third, we combine the trend components of sectoral output, using a Cobb-Douglas production function. Wage share is calculated from sectoral data and it ranges from 4% in the real estate sector to 78% in the public services sector (see Annex 7).

Counterfactual scenario for the projection horizon (2020-2025)

Starting from the past trend output, we derive a counterfactual scenario for all sectors, which is necessary to calculate the losses. We assume that without the COVID-19 shock, trend growth in all sectors would have gradually slowed down somewhat, similarly to the European Commission's (EC) 2019 Autumn projections. Since these estimates are available publicly only until 2024, for 2025 we make a linear extrapolation of potential output. We calculate the counterfactual scenario for each sector. For this, we assume that the growth rates of trend TFP and of the capital stock would remain at their 2019 level, while the growth rate of trend labour would gradually decrease, reflecting the impact of population ageing. We assume that sectors would be similarly affected by the decline of labour supply due to ageing, and we make sure that the aggregation of the sectoral trend output is equal to the aggregate potential output estimate of the EC for 2020-2025, as estimated in the 2019 Autumn projections.

Estimation of 2020 and 2021 sectoral trend output – baseline scenario

Although two years passed since the start of the pandemic, it is still challenging to use standard tools without judgment to assess to what extent the COVID-19-shock affected sectoral trend output in 2020 and 2021. First, while some data are available, some are still missing on the sectoral level (for example, sectoral stock of capital for 2021). Second, statistical filters cannot be used due to the end-point uncertainty. Third, while trend developments are traditionally linked to supply shocks, standard supply-demand shock decomposition methods suffer from methodological challenges, which may result in a distortion when estimating the impact of the shock on trends. The shock decomposition relies on the assumption that prices reflect the relative size of supply and demand, but this may not hold in the pandemic situation as some economic relationships, for example the Phillips-curve have weakened, at least temporarily. In addition, a supply-demand decomposition does not distinguish between temporary and more permanent shocks. If one assumes that the definition of potential output implies smooth fluctuations over time, the temporary part of the supply shock should be excluded.[12] Finally, firms and consumers started to adjust to the shock and the policy measures and can be expected

[11] In particular, we use a lambda of 37500. The usual lambda of 1600 would result in a less smooth estimate.

[12] Bodnár et al. (2020) discusses the concept of potential output in the COVID-19 crisis.

to do so looking ahead, while shocks not closely related to the pandemic occurred in the second half of 2021, making it challenging to assess the impact of the health crisis.

To tackle the above-mentioned issues, we suggest an approach that relies on a supply-demand decomposition, but downscales the size of the supply shock, in order to ignore its temporary part when estimating trend output. We proceed in two related steps. First, we estimate the size of the supply shock using a Bayesian VAR. Second, we derive a metric for the elasticity of sectoral trends to the supply shock and use that to assess trend developments in 2020-2021 (see Annex 2).

In the first step, we use a Bayesian Vector Autoregressive (BVAR) model to decompose the change in sectoral value added in 2020 and 2021 to developments related to supply and demand. Similarly to other papers that decomposed sectoral shocks to demand and supply, we start with estimating a BVAR model with sign restrictions and standard stochastic volatility in the error structure and standard setups in the BEAR toolbox.[13] The BVAR is based on two variables: sectoral value added and sectoral value added deflator. The structural identification is based on a sign restriction: a demand shock is considered when the value added and the value added deflator move to the same direction, while in case of a supply shock, they move to opposite directions. We use 4 lags for endogenous variables. We prepare the historical shock decomposition of value added from the second quarter of 1995 up to the last quarter of 2021.

As the BVAR estimation for the supply shock includes both temporary and persistent supply factors, it might overestimate the impact of the COVID-19 shock on trend output. Thus, we consider some additional information on the degree to which the supply shock may affect trend developments. In our baseline setup, we estimate the relationship between trend TFP and labour (estimated using a Beveridge-Nelson decomposition[14]) and the supply shock for 1999-2019 for each sector. For this purpose, at the sectoral level k, we decompose TFP ($tfp_{t,k}$) and labour ($l_{t,k}$) into a cyclical and a trend component, using a Beveridge-Nelson (BN) decomposition[15] over the period 1996q1-

[13] We follow the methodology by DNB (Bonam and Smadu, 2020) and WB (East Asia and Pacific Economic Update, October 2020).

[14] We use a Beveridge-Nelson (BN) filter with standard parameter setups (lag order of 12, backward rolling window of 40, no structural breaks, no smoothing parameter delta). It generally provides a stronger cyclicality in the estimation of trends than a HP filter. This is why we do not use the BN filter to estimate trends over the period 1996-2019. Over the period 2020-2021, assuming a larger degree of cyclicality in potential output growth appears acceptable - this is the hypothesis adopted by the IMF (on the concept of potential output during the COVID crisis, see Bodnár (2020)). Moreover, it is not possible to establish a relationship between supply shocks as estimated in a BVAR and trends as estimated by a HP filter (see Annex 2).

[15] More precisely, the Kamber, Morley, and Wong (2018) modification of the well-known Beveridge and Nelson (1981). The signal-to-noise ratio chosen using the Kamber, Morley, and Wong (2018) is based on an automatic selection procedure which balances the trade-off between fit and amplitude.

2019q4. For any time series y_t, the BN decomposition determines a trend process $\tau_{t,}$ and a cyclical process c_t such that: $y_t = \tau_t + c_t$.

For both $tfp_{t,k}$ and $l_{t,k}$, we regress their trend component $\tau_{t,k}$ over the sum of the supply shocks stemming from the BVAR decomposition, over a period of four quarters.[16] This leads, for each sector k, to:

$$\text{dlog}(\tau_{t,k}) = \beta_1 + \beta_2 * \sum_{i=t-3}^{t} \text{SUPPLY}_{t,i} + \varepsilon_{t,k} \qquad (1)$$

where $\tau_{t,k}$ represent the trend component of either TFP $(tfp_{t,k})$ or labour $(l_{t,k})$, as filtered by the Beveridge-Nelson filter and $\text{SUPPLY}_{t,k}$ is the supply shock as it emerges from the historical shock decomposition of the BVAR and $\varepsilon_{t,k}$ is the residual which follows a normal distribution. Table A2 and A3 in Annex 2 present the results of the regressions.

Second, we use the estimated elasticities to estimate the impact of the 2020-2021 supply shock on trend TFP and labour, while capital is assessed separately.

Projection of sectoral trend output for 2022-2025 – baseline scenario

In the baseline scenario, we assume that the growth rates of trend TFP and trend labour gradually converge to the counterfactual, and the speed of convergence in 2022-2025 is assumed to be linear. Importantly, an additional assumption is applied, whereby in case of TFP, estimated trend growth rates in 2021-2023 smaller than zero are replaced by zero, to avoid negative trend growth rates in years which are supposed to bring recovery. The projected growth of the stock of capital is explained in Annex 1. In the baseline scenario, trend growth in each sector is equal to the counterfactual by 2025, assuming no losses in terms of growth. Finally, the estimated trends of the components (TFP, labour and capital) are combined using the production function introduced earlier in this Section.

Estimation and projection of sectoral trend output for 2020-2025 – cross-checking with the sectoral resilience index

As a cross-checking exercise, we build a sectoral resilience index (SRI) that we use in an alternative scenario to adjust the persistence of the sectoral supply shock (see Annex 3 for details on the SRI). The advantage of this index is that it provides information on the components of trend output. However, it is not available as a time series and thus it cannot be checked how it usually co-moves with trend developments. The SRI (Chart 3), is based on the share of teleworkable jobs in employment, R&D expenditure, and the interest coverage ratio. All these variables are rescaled, normalised and aggregated using equal weights. In this alternative scenario, the index is used to adjust the share of

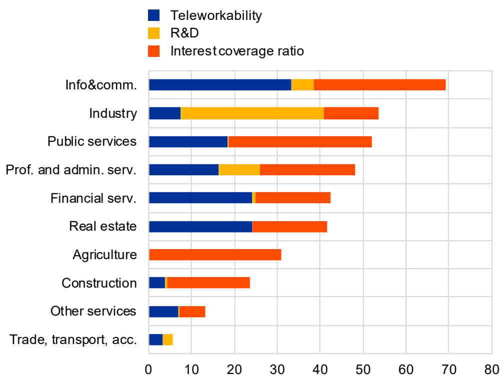
[16] We tested a large number of specifications for this regression and we selected the most suitable one, providing the best fit and the most significant estimates.

the supply side shock that is passed on to potential output in 2020-2021 and to differentiate between sectors in terms of the persistence of the shock beyond these two years.

The SRI is strongly correlated with the persistence of the shock up to the last quarter of 2021. For the first two years of the shock, the SRI captures well the heterogenous impact of the shock in terms of its persistence. The correlation between the persistence of the shock and the SRI is strongly positive (Chart 4). Even when leaving out the two sectors with the extreme values (information and communication: highest SRI and value added above its pre-crisis level; other services: lowest SRI and value added well below its pre-crisis level), the positive relationship is maintained.

In this alternative scenario, the quarterly sectoral trend growth rates in 2020 and 2021 are estimated with the help of the BVAR results and rescaled with the SRI, differently from the baseline scenario (see above and Annex 2). Over the period 2022-2025, the SRI also helps to calculate the speed of convergence towards the counterfactual.[17]

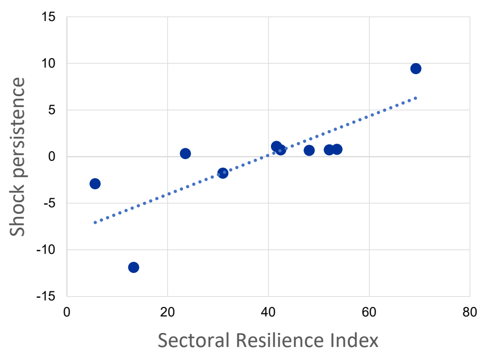
Chart 3: The sectoral resilience index (SRI)



Source: OECD, Eurostat and ECB Staff calculations.

Note: the SRI is calculated on a scale from 0 to 100. All indicators are rescaled and normalised across the sectors. The SRI is calculated as the weighted average of the sub-components, using equal weights.

Chart 4: The sectoral resilience index (SRI) and the persistence of the shock until 2021Q4



Source: OECD, Eurostat and ECB Staff calculations.

Notes: shock persistence is calculated as the percentage difference of sectoral value added in 2021q4 from 2019q4.

[17] For the years n =2022 to 2025, labour and TFP trends will change according to the formula: $growth_n = growth_{n-1} + d(growth_{2021} - growth_{2021,counterfactual}) \times SRI/100$.

3 Initial conditions

Our estimates show that past trend growth rates differ widely across sectors. The estimates suggest that trend output growth was decreasing in most of the sectors before and during the global financial crisis (GFC) and it strengthened somewhat after that in many sectors. The exception is the other services, where trend output growth remained low in the aftermath of the GFC. In the entire period up to the COVID-19 shock, trend output growth was the strongest in the information and communication sector, followed by professional and administrative services and industry excluding construction. Trend output growth, however, was weakest in the construction sector, financial services and other services (Chart 5). The contributions of labour, capital and TFP also differ considerably across sectors (Chart 6). The deviations from the estimated trend output by sector display a clear cyclicality and are in line with the narrative stemming from the macroeconomic environment or sector-specific developments (see Annex 4 for a more detailed explanation).

Several factors can be put forward to explain mixed developments in trend growth at the sectoral level in the past. For instance, consumption habits have changed. Households have cut back the share of manufactured goods in their consumer spending over the past decades, in favour of services. Furthermore, spending on services by the manufacturing sector has also increased. This development may result from outsourcing which consists in transferring activities previously carried out by industry (accounting, etc.) to services. It can also reflect a change in relative prices owing to technical progress. The drop in the relative price of ICT products and services as well as the ongoing digitalisation may explain the dynamic of trend output in the information and communication sector. Foreign trade can influence the pace of sectoral trends through different channels: trade specialisation and the nation's net savings.[18] Finally, the trend growth of construction has been low, given the labour-intensity and the low TFP growth, and was even negative after the GFC for several years, reflecting the medium term consequences of the burst of the housing bubble in 2008 after which the labour contribution in the sector declined considerably.

[18] For a given net savings level, a country needs to export more or fewer manufactured goods to finance its imports (at the forefront of which we find the energy bill).

Chart 5: Trend growth in selected euro area sectors

(annual percentage change)

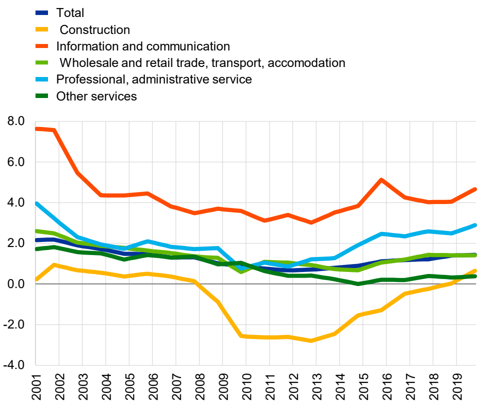
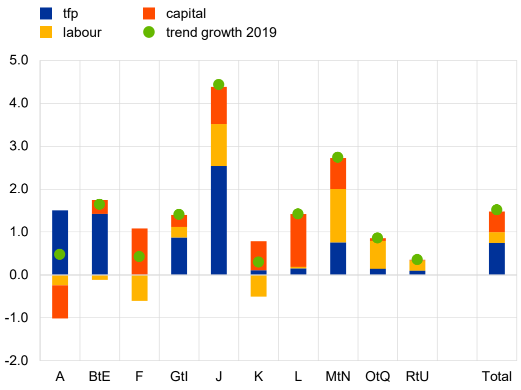


Chart 6: Trend growth in euro area sectors in 2019

(annual percentage change)



Source: ECB calculations based on Eurostat.

Note: A - Agriculture, forestry and fishing; BtE – Industry (except construction); F – Construction; GtI – Wholesale and retail trade, transport, accommodation; J – Information and communication; K – Financial and insurance services; L – Real estate activities; MtN – Professional, scientific and technical activities; administrative and support service activities; OtQ – Public administration, defence, education, human health and social work activities; RtU – Other services.

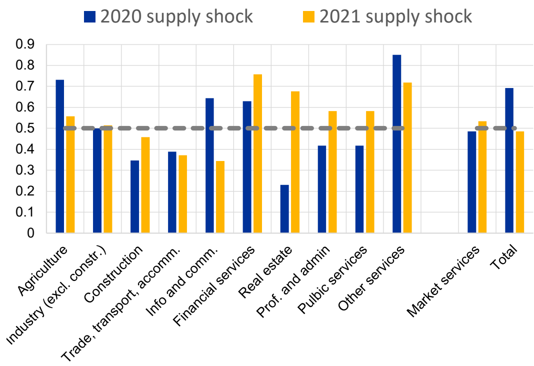
4 Results

The estimated supply shock by sectors

The COVID-19 shock affected both demand and supply, albeit to a varying degree, in all sectors. Some papers estimate a heterogenous combination of supply and demand shocks across sectors in 2020, mainly for the US (see for example del Rio-Chanona et al., 2020; Brinca et al., 2020). For example, the supply shock is small in essential sectors which were not affected by the closures. Teleworkability is also an important indicator of the degree to which the (labour) supply shock affects the sectors. The share of illegal, immigrant and/or precarious workers also matters: such workers may not be covered by the job retention schemes and are thus not shielded from losing their job, thus, scarring effects may occur with a higher probability; occupational safety and health may also be worse in such sectors and eventually lead to a stronger supply shock in the pandemic.[19] Demand and supply shocks may differ in terms of their persistence (del Rio-Chanona et al, 2020) and therefore it is important to separate them when forecasting sectoral developments. Cirelli and Gertler (2022) use firm-level data and find a persistent negative impact of the COVID-19 shock on firms in the contact-intensive sectors that could not benefit from the situation.

Chart 7: The relative share of the supply shock in 2020 and 2021

(percentage)

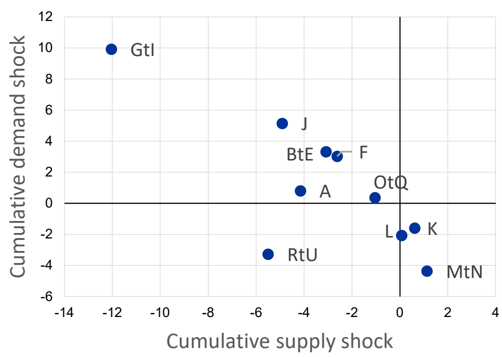


Source: Eurostat, ECB Staff calculations.

Notes: averages of the quarterly estimates.

Chart 8: Cumulative supply and demand shock by sectors (2020q1-2021q4)

(percentage)



Source: Eurostat, ECB Staff calculations.

Notes: average of the quarterly estimates.

[19] See the sectoral summaries by ILO: https://www.ilo.org/global/topics/coronavirus/sectoral/lang--en/index.htm

According to our BVAR results, both in 2020 and 2021, demand shocks had a higher role than supply shocks in most sectors (Chart 7) (Annex 6 includes the quarterly estimates). The negative supply shock was by far the largest in the other services sector, as several activities in the sector were shut down (for example, museums, sports activities, movies, hairdressers), and there was little room to offer these activities online, at least initially. At the same time, firms under lock-down suffer losses in value added but it makes little sense for them to adjust their prices since customers cannot use these services. E.g. even if a movie theatre or sports club cut prices in response to a fall of their output, they are not able to attract more customers since the latter are not allowed to go to these places. Since prices did not fall while activity was lower, the shock is identified as a supply shock.

For the entire period of the pandemic crisis, it seems that supply and demand shocks correlated negatively (Chart 8). The cumulative absolute supply shock between 2020q1 – 2021q4 was quite negative in most sectors, but the largest in trade, transport and accommodation, which also experienced a very positive cumulative demand shock during the same period. Smaller shocks with similar signs happened in industry, construction, information and communication, public services, and agriculture. In contrast, the professional and administrative, real estate and financial sectors faced a positive supply and a negative demand shock. The only sector with both a negative supply and demand shock in cumulative terms was other services.

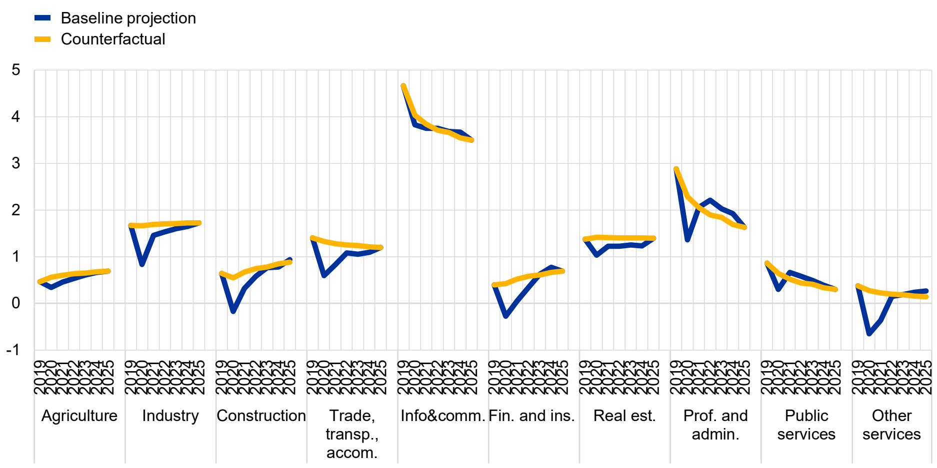
Trend output by sectors for 2020-2025 – baseline estimation

In the baseline scenario, the most affected sectors are: trade, transport and accommodation (GtI), industry (BtE) and other services (RtU), accumulating an overall loss lying between 1.4% and 1.6% by 2025. In our baseline estimation, the trend growth in those sectors decelerate strongly in the years of the pandemic – sometimes even turning negative – before gradually converging to pre-COVID trends (Chart 9). Also, in those sectors, the loss is driven mainly by capital, followed by labour and TFP (Chart 10). One cannot resist to make the link between this loss of capital stock to the fast expansion of telework and also of digital businesses at the expense of brick-and-mortar activities, although our methodology cannot ascertain this.

On the other side, the information and communication sector (J) remains the fastest growing sector, with a trend growth close to the counterfactual, thus seeing almost no loss in the baseline. The professional and administrative services (MN) and public services register a sharp decline in 2020 and 2021, followed by a significant boom and see also limited losses, or even a gain, in their level of potential output at the end of 2025.

Chart 9: Sectoral trend growth projections in the baseline and counterfactual growth

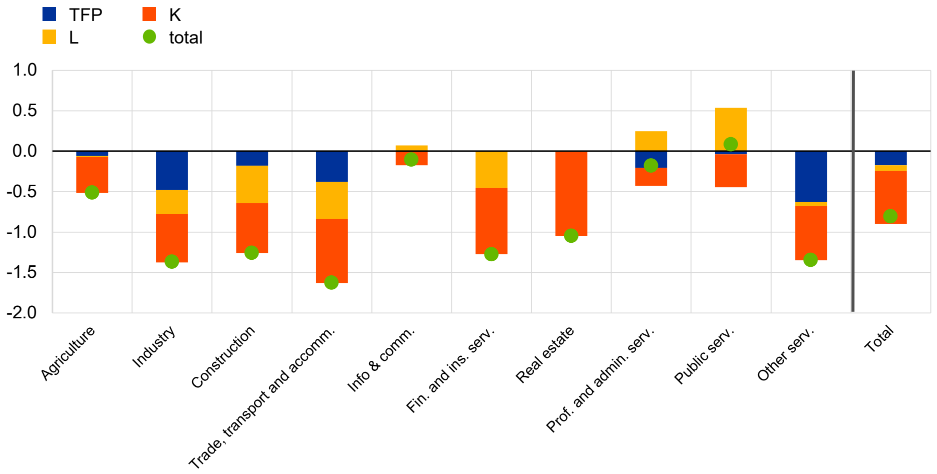
(annual percentage growth)



Source: own calculations

Chart 10: Sectoral losses in the level of potential output in the baseline scenario in 2025

(percentage point)

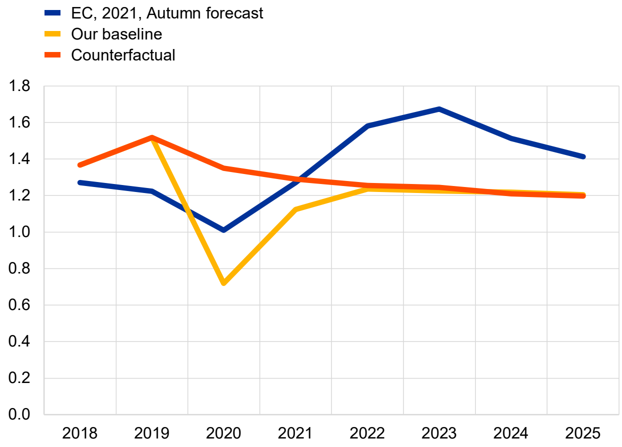


Source: own calculations

The aggregation of the sectoral estimates points to a decline of potential growth to 0.7% in 2020 and a rebound at 1.1% in 2021, below the estimate of the European Commission. Chart 11 compares the aggregation of the baseline results to the counterfactual scenario and the latest EC projection. The difference between the baseline projections and the 1.0% estimated by the EC reflects some special factors: first, we rely on total hours worked as labour input, which dropped considerably, and we attribute some of this decline to the trend. Second, the EC estimate includes some smoothing due to the application of filters, which is not used in our estimates.

Chart 11: The estimated baseline and counterfactual potential output growth

(annual percentage growth)



Source: European Commission and own calculations

Robustness scenarios

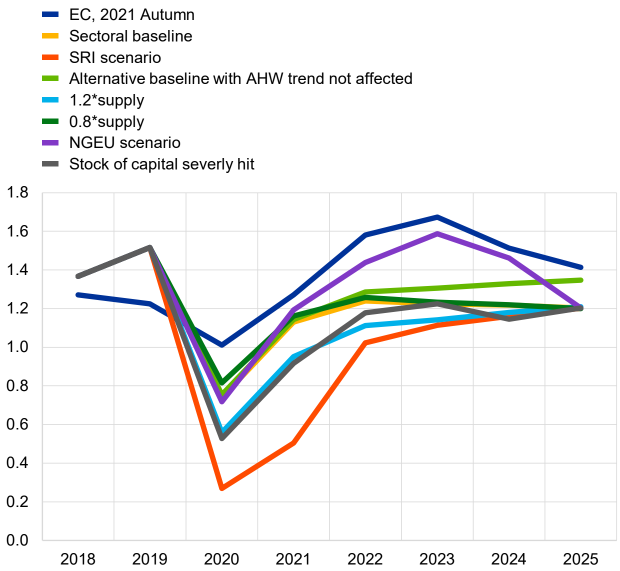
Due to the uncertainty around the impact of the COVID-19 shock on trend output and the necessarily ad-hoc nature of our assumptions, we use a wide range of robustness scenarios which serve as a cross-check exercise to better grasp the model uncertainty. First, we present a scenario where potential output is estimated using the SRI (see Section 2 and Annex 3). Second, we introduce an alternative baseline, in which trend labour is decomposed to trend average hours worked and trend employment, and we keep trend average hours worked unchanged (i.e. we do a linear extrapolation of the trends observed before the pandemic). Third, we test different assumptions on the supply-demand decomposition. Demand shocks might impact trend, mainly via hysteresis effects, and thus the effect on potential output might be larger than shown by the supply shock.[20] At the same time, it is also possible that the supply shock is not properly estimated, because information on prices, including deflators, may have been distorted in 2020. Thus, to reflect these two considerations, we use different versions of the BVAR results: using arbitrarily 1.2-times the size of the supply shock in 2020-2021 in one scenario and using 0.8-times its size in another one. Fourth, we assume a stronger capital stock contribution than in the baseline, reflecting the possible impact of the NGEU funds. In this scenario called “NGEU scenario”, investment in some sectors (public, construction) follows that of the Broad Macroeconomic Projection Exercise of the

[20] Note that there is also a burgeoning theoretical literature on supply and demand interactions (Guerrieri, et al, 2020, Baqaee and Farhi 2020).

Eurosystem (which already partly includes the effect of the NGEU).[21] Furthermore, the adverse effect of the value added losses in our equations is removed after the year 2021 (see Annex 1), reflecting stronger-than currently expected gains in potential output. Finally, we draw a robustness check where the capital stock is much more affected than expected. For this, we assume a stronger degree of losses in value added which affects the investment estimation (see Annex 1), without this being compensated by a drop in the depreciation rate.

Chart 12: Robustness scenarios

(annual percentage growth)



Source: European Commission and own calculations

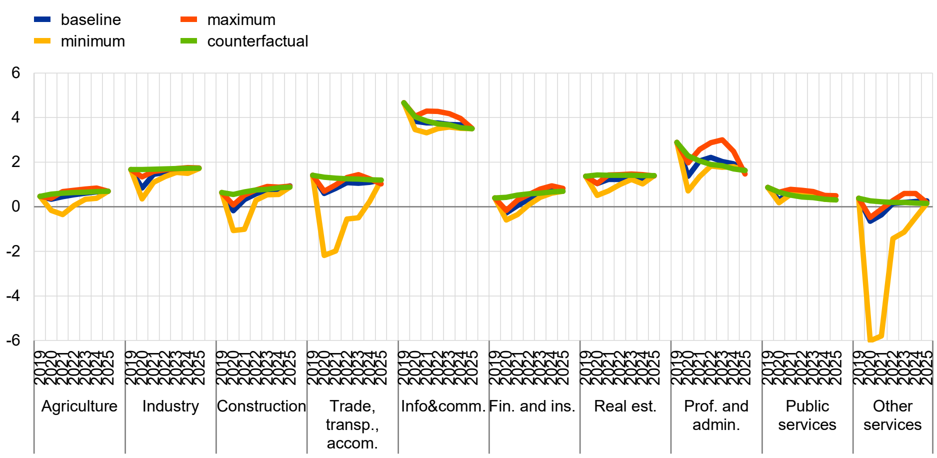
Finally, we take the minimum and maximum of all the scenarios for 2020-2025. This gives us the total range of plausible estimates (Chart 13). In some sectors, the best and the worse scenarios evolve closely to the baseline scenario, with limited deviations across scenarios. However, in some sectors the range provided by the worst and best scenarios is fairly sizeable. This is the case in construction, and in some services sectors. In the construction and the other services sectors, the worst scenarios imply negative trend growth for a protracted period. These scenarios can realise in case the changes in demand seen in the last two years become entrenched and firms shut down after the policies are withdrawn. In the worst scenario, the losses can be considerable, up to -14% in the other services sector and -10% in the trade, transport and accommodation sector. The construction sector may see negative trend growth in the worst scenario, which may

[21] See: Eurosystem staff macroeconomic projections for the euro area, March 2022

be linked to the high sensitivity of its trend growth to the business cycle, but also to the expected impact of the COVID-19 shock on the building of offices. In contrast, in the professional and administrative services sectors, in the information and communication as well as in the public services and industry, trend growth always remains positive, and the difference between the best and worst scenarios are small.

Chart 13: Sectoral trend growth rates – minimum and maximum across scenarios

(annual percentage growth)

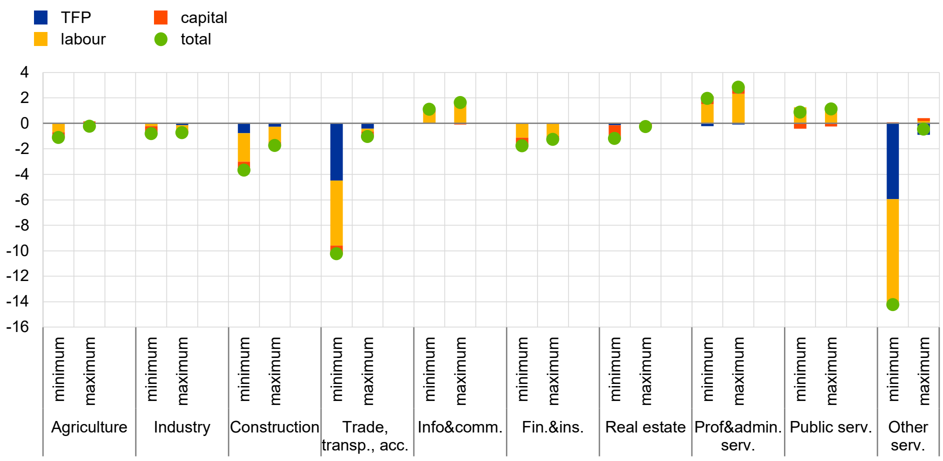


Source: own calculations

Reflecting the estimated range of trend growth, the sectoral losses may also be the largest in the other services and the trade, transport and accommodation sectors. In the worst scenario, the losses are driven by labour and TFP. In the best scenarios, labour may have some positive contribution to the sectoral trend growth rates in certain sectors.

Chart 14: Loss in the level of potential output in 2025 in the minimum and the maximum of the range of estimates, compared to the counterfactual path

(percentage point)



Source: Eurostat, own calculations

The aggregation of the results points to a wide range of potential growth scenarios, with the EC projection being closer to the top of the range. Chart 15 and 16 show two sets of ranges: the minimum-maximum range of all scenarios and the minimum-maximum range that is calculated using the minimum and maximum of all factors of production across the scenarios. Overall, the results point to the risks tilting to the downside for the EC potential output path. However, they also confirm that policy measures may have the potential to improve the potential output path and moderate the losses. The risks around the estimated losses are also tilted to the downside. In the worst case, the losses can amount to -4% by 2025, while in the best scenario, there are some gains.

Chart 15: Range of aggregate potential growth estimates

(annual percentage change)

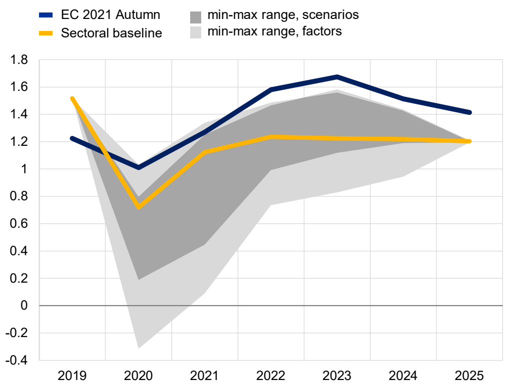
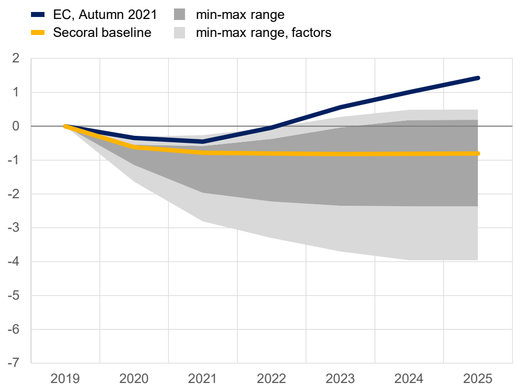


Chart 16 – Range of the estimated aggregate loss in level

(percentage point)



Source: European Commission and own calculations.

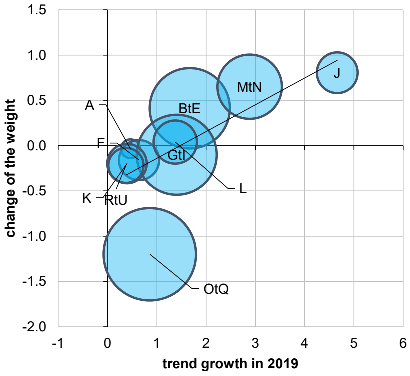
Notes: the min-max range of factors shows the potential output growth calculated with the minimum/maximum level of the three factors of production across all scenarios.

While some sectors do suffer large losses, the impact of a sectoral reallocation on aggregate potential growth is also expected to be significantly negative in the baseline. In order to calculate the impact of sectoral reallocation, the change in aggregate potential output between 2019 and 2025 is decomposed into a within-sector and an across-sector component. The former assumes no change in the weight of the sectors, while the latter covers the impact due to the change in the weights of the sectors. The data and estimates show that sectors most severely hit by the crisis and suffering the largest losses were relatively slow-growing sectors before the crisis. On the other hand, sectors that are expected to come out of the crisis relatively better and gain weight (information and communication, etc) were and are expected to remain relatively fast-growing sectors. Some creative destruction, i.e. the increase of the relative weight of faster growing sectors may occur, implying that the impact of sectoral reallocation on the level of aggregate potential output (-0.6%) is smaller than the estimated loss in potential output (-0.8%). The relative size of the sectors work towards a negative aggregate impact: the largest sector, public services (O to Q), trade, accommodation and transport (G to I), see a decline in their relative weight, which largely exceed the increase in the weight of the largest sectors (B to E and M to N). This is illustrated on Chart 17 for the baseline scenario.

There is hardly any difference between the different scenarios with respect to the degree of reallocation. Overall, all the scenarios point to a slight negative effect of reallocation (Chart 18). This is largely due to the fact that the impact of the shock is generally negative on all sectors, except for a minority of smaller sectors.

Chart 17: The impact of sectoral reallocation on aggregate potential growth in the baseline scenario

(percent)

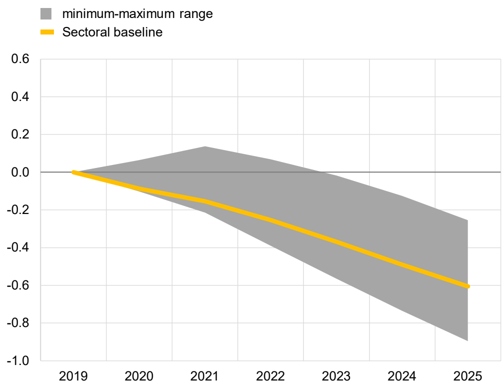


Source: own calculations

Note: the size of the bubbles represents the sector's value added weight in 2019

Chart 18: The impact of sectoral reallocation on the level of aggregate potential output

(percent)



Source: own calculations

5 Conclusion

This paper develops a novel approach for assessing potential output at a sectoral level, relying both on a supply-demand shock decomposition and on the elasticity of trend components on the supply shocks. A sectoral resilience index may also help to gauge the trend losses suffered at the sectoral level, through the design of alterative scenarios. Our baseline results point to lower potential growth than the estimates by international institutions, e.g. that of the European Commission's (EC) 2021 Autumn projections or the IMF Autumn 2021 WEO for the euro area, albeit this is partly due to the fact our baseline scenario does not take into account the support from NGEU. In any case, in our baseline scenario, we find that in 2020 and 2021 (i.e. in the years before the NGEU support was effective), potential growth may have been lower than estimated by the EC.

The results described are robust to a battery of alternative assumptions as illustrated by the range of different scenarios. However, our estimates admittedly suffer from some weaknesses. Just like the aggregate potential output estimations, our sectoral estimates are surrounded by a large degree of uncertainty, stemming from model uncertainty, but also from the challenges of assessing trend developments in real time. In addition, our approach cannot take sectoral interlinkages into account. While such effects can be temporary, they may also affect the trends if longer lasting or if induce behavioural changes. Also, we cannot channel in aggregate labour supply effects, which are assessed to limit potential growth looking ahead, and are also expected to have an impact on other components of trend growth (for example, by increasing the need for automation). Sectoral reallocation was found to have explained about 75% of the rise of productivity in Europe (IMF, 2021). Survey results for Belgium suggest that R&D, ICT equipment and computer software and databases increased in the recent period and may lead to higher TFP (NBB, 2021). Similar developments were found in the US (Goldman Sachs, 2021). However, in the lack of detailed sectoral data, this channel could not have been taken into account. Notwithstanding the difficulties to assess scarring effects, this work is of prime importance for policymakers, as it highlights the threat to potential output that was posed by the COVID-19 crisis. It also appears pivotal, in the context of the Ukraine-Russia war which also affects sectors asymmetrically. Depending to a large degree on how and when the government support measures will be withdrawn and how firms and households will adjust to the post-COVID period, scarring effects may be significantly mitigated by well-tailored policy measures. In the same vein, the very high and to a large degree unintended rise of the savings ratio may be persistent or decline, depending on the policy response and the ability to restore confidence. Furthermore, consumption patterns may also change, and could affect trend growth by sectors differently.

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Annex 1: Assessing investment and capital stock at the sectoral level

The sectoral capital stock series are derived from the balance sheet accounts for non-financial assets. These data, measured in value terms, are available on an annual basis, are broken down into a quarterly frequency and deflated by the total investment deflator. Owing to its low cyclicality property, the capital stock series in the production function is not filtered, as it is commonly done.[22] For the most recent periods, for which data is not available, and over the projection horizon, the capital stock is estimated using a small accelerator-type model.

We estimate sectoral equations linking annual real investment to value added in volume in an error correction model estimated in panel. It includes the main euro area countries (Germany, France, Italy, Spain, Belgium and Austria):

$$dlog\left(GFCF_{t,i}\right) = \beta_0 + \beta_1 . dlog\left(VA_{t,i}\right) - \beta_2 . \left(log\left(GFCF_{t-1,i}\right) - log\left(VA_{t-1,i}\right)\right) + \varepsilon_{i,t} \quad (2)$$

The estimation results are summarised in Table A1 and suggest somewhat different elasticities of investment to value added depending on the sector. Although relatively simple, the equations are rather robust and capture relatively well the 2020 period for investment (see chart 19), for which sectoral investment is not yet available, while the total is. Other variables, such as the margin rate or the cost of capital could help to improve the performance of the model, but they are not available at the sectoral level.

The estimation shows that sectors that have been strongly affected by the crisis represent a small share of investment or have a lower than average elasticity of investment to value added (for example arts and entertainment). Conversely, some sectors, which are major contributors to investment, have been less affected by the crisis or their elasticity of investment to value added is higher than average.

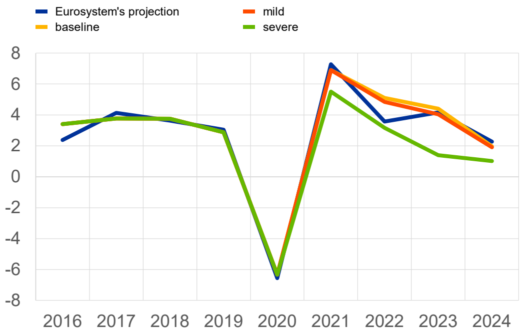
Going forward, based on value added losses projections[23], the sectoral investment as well as the capital stock can be projected until 2024. The depreciation rates, for each country and sector are assumed to follow a linear trend estimated over the past.

[22] See Tóth, 2021.

[23] Sectoral value-added losses are derived using an internal ECB methodology based on a cross-country panel VAR model which captures the relationship between the stringency of containment measures and the level of economic activity. See the box entitled: "The impact of containment measures across sectors and countries during the COVID-19 pandemic", Economic Bulletin, Issue 2, ECB, 2021. The capital projection scenarios reflect different sectoral value-added paths reflecting the different scenarios (mild, severe, baseline) published by the Eurosystem (Eurosystem staff macroeconomic projections for the euro area, December 2021).

Chart 19: Gross fixed capital formation, based on the sectoral projection

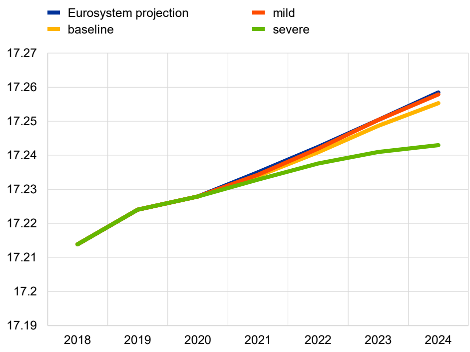
(annual percentage change)



Source: Eurosystem's March 2022 projection and own calculations.

Chart 20: Projection of capital stock, based on the sectoral projection

(log level)



Source: Eurosystem's March 2022 projection and own calculations.

As regards sectoral capital stocks, they follow a wide range of values, as shown for the baseline scenario in chart 21. These differences stem from a combination of factors: differences in elasticities of investment to value added, difference in projected depreciation rates and differences in projected value-added losses. These differences partly compensate each other, once the capital stock is aggregated.

Table A1: Estimation results of equation (2)

	β_0	β_1	β_2
Agriculture	-0.10** (0.01)	-0.15 (0.11)	0.10** (0.01)
Industry (except construction)	-0.32*** (0.11)	0.46** (0.21)	0.24*** (0.11)
Construction	-0.79*** (0.21)	2.25*** (0.41)	0.34*** (0.11)
Wholesale and retail trade, transport, accommodation	-0.50*** (0.11)	1.37*** (0.31)	0.27*** (0.11)
Information and communication	-0.38*** (0.11)	1.05*** (0.31)	0.30*** (0.11)
Financial and insurance services	-0.68*** (0.21)	0.66 (0.41)	0.31*** (0.11)
Real estate activities	-0.03 (0.01)	0.93** (0.41)	0.05 (0.01)
Professional, scientific and technical activities	-0.58*** (0.11)	1.01*** (0.21)	0.25*** (0.01)
Administrative and support activities	-0.98*** (0.11)	3.45*** (0.51)	0.39*** (0.11)
Public administration	-0.16** (0.11)	3.53*** (0.71)	0.07 (0.01)
Arts, entertainment, recreation	-0.11 (0.11)	1.33*** (0.51)	0.05 (0.01)

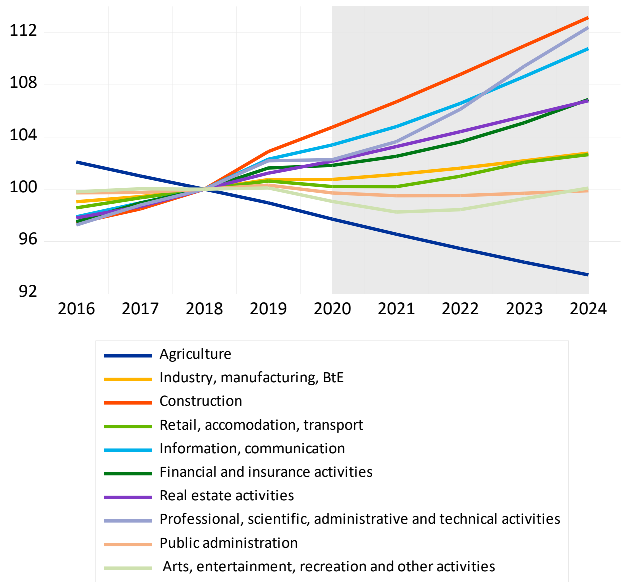
Note: standard errors are given in parentheses. (*), (**) and (***) denote 10%, 5% and 1% significance level, successively. The regressions include country fixed effects as well as time fixed effects.

In comparison with past trends, the sectors whose capital stock was most affected by the crisis are first the arts and recreational activities, second professional, scientific and technical activities administrative and support services[24], and third retail, accommodation, and transport. These sectors mainly cover tourism activities. In 2020 and 2021, on average, the capital stock growth in those sectors is estimated to have been between -1.0% and -0.9% lower than in the year preceding the pandemic.

All sectors have seen a slowdown in the growth of their capital stock compared to their pre-COVID trend. However, for some sectors the loss is limited (construction, real estate).

Chart 21: sectoral projection of capital stock

(index = 100 in 2018)



Source: Eurostat, own calculations

[24] The sector classified as “M-N” include the rental and leasing activity and travel agency activities.

Annex 2: Estimation of trend labour and total factor productivity in 2020 and 2021

For 2020 and 2021, trend TFP and trend labour can be projected using equation (1), presented in Section 2 (Estimation of 2020 and 2021). In a few sectors, when the coefficient β_2 is statistically non-significant or shows a wrong sign, we use the elasticity estimated for the total (see Tables A2 and A3). Over the projection horizon, the residuals are extended in a way that they gradually revert to their zero long-term average.

For the period 2020-2021, our estimate of potential output growth is based on a Beveridge-Nelson decomposition, which differs from our estimate of past trends calculated with an HP filter. This is due, on the one hand, to the fact that equation 2 does not give significant results with a trend estimated from an HP filter and, on the other hand, over the recent period, we can anticipate a greater cyclicality of potential growth, as is the case with the IMF estimates. This is also in line with a BN-type decomposition (Chart 22). Finally, over the period preceding the crisis, potential growth as estimated with a BN is fairly close to that estimated with a HP (Chart 23 to be compared to Chart 6). By way of comparison, an estimate of potential output losses based on an identical methodology, but with a counterfactual calculated with a Beveridge Nelson leads to a loss in potential output of 1.0% by 2025, against 0.8% in our baseline.

Chart 22: Trend growth in selected euro area sectors estimated with a B-N decomposition

(annual percentage change)

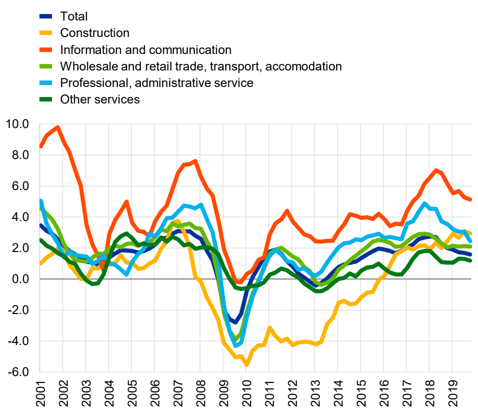
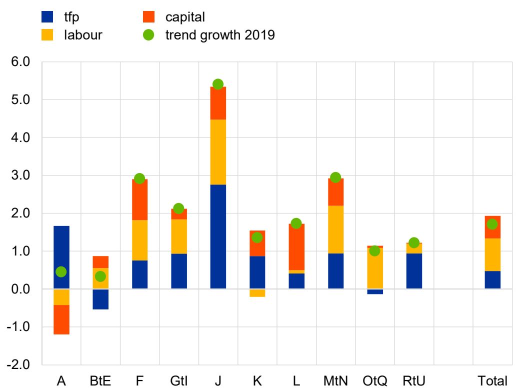


Chart 23: Trend growth in euro area sectors in 2019 estimated with a B-N decomposition

(annual percentage change)



Source: ECB calculations based on Eurostat.

Note: A - Agriculture, forestry and fishing; BtE – Industry (except construction); F - Construction; GtI – Wholesale and retail trade, transport, accommodation; J – Information and communication; K – Financial and insurance services; L – Real estate activities; MtN – Professional, scientific and technical activities; administrative and support service activities; OtQ – Public administration, defence, education, human health and social work activities; RtU – Other services.

Table A2: Estimation results of equation (1) with trend TFP as the dependent variable

	β_1	β_2
A - Agriculture	0.00*** (0.00)	0.21*** (0.02)
BtE - Industry (except construction)	0.00*** (0.00)	0.14*** (0.01)
F - Construction	0.00*** (0.00)	0.09*** (0.02)
GtI - Wholesale and retail trade, transport, accommodation	0.00*** (0.00)	0.10*** (0.02)
J - Information and communication	0.01*** (0.00)	0.16*** (0.02)
K Financial and insurance services	0.00*** (0.00)	0.21*** (0.02)
L Real estate activities	0.00*** (0.00)	0.12*** (0.03)
MtN Professional, scientific and technical activities, administrative and support services	0.00 (0.00)	0.14*** (0.01)
OtQ Public administration, defence, education, human health and social work activities	0.00*** (0.00)	-0.01 (0.01)
RtU Other services	0.00* (0.00)	0.06*** (0.01)
Total	0.00*** (0.00)	0.07*** (0.01)
Note: least-squares regression coefficients with robust standard errors given in parentheses. (*), (**) and (***) denote 10%, 5% and 1% significance level, successively.		

Table A3: Estimation results of equation (1) with trend labour as the dependent variable

	β_1	β_2
A - Agriculture	0.00*** (0.00)	-0.02* (0.01)
BtE Industry (except construction)	0.00*** (0.00)	0.02** (0.01)
F Construction	0.00*** (0.00)	0.15*** (0.05)
GtI Wholesale and retail trade, transport, accommodation	0.00*** (0.00)	0.02* (0.01)
J Information and communication	0.00 (0.00)	0.07* (0.04)
K Financial and insurance services	0.00 (0.00)	0.03** (0.01)
L Real estate activities	0.00*** (0.00)	-0.39*** (0.08)
MtN Professional, scientific and technical activities, administrative and support services	0.01*** (0.00)	0.06*** (0.02)
OtQ Public administration, defence, education, human health and social work activities	0.00*** (0.00)	-0.04*** (0.01)
RtU Other services	0.01*** (0.00)	0.02* (0.01)
Total	0.00*** (0.00)	0.06*** (0.02)
Note: least-squares regression coefficients with robust standard errors given in parentheses. (*), (**) and (***) denote 10%, 5% and 1% significance level, successively.		

Annex 3: Sectoral Resilience Index (SRI)

The three elements of the SRI are mirroring the three different factors of contribution to potential growth:

1. Share of employees in potentially teleworkable jobs: being considered as essential, the degree of teleworkability and the reliance on job retention schemes affected the degree of labour input adjustment. Firms in sectors with a high share of teleworkable jobs could maintain their activities without being exposed to the virus. Thus, labour supply is less affected and there is a smaller chance for a deterioration of workers' human capital.[25] Teleworkability was found to be highest in the euro area in information and communication and the smallest in agriculture.[26] This subindex may also be relevant beyond 2020, because it may reflect the overall flexibility of the workforce by sectors and the resilience to containment measures. Teleworkability is mainly linked to labour input.[27]

2. Research and Development (R&D) expenditure in 2017: TFP growth is positively associated with R&D expenditure, and TFP may react with a lag to changes in R&D.[28] Thus, by including R&D expenditure in the SRI, we control for the degree to which sectoral TFP may be affected, and we assume that a higher TFP implies higher resilience. Aggregate TFP growth was found to be influenced by within-sector developments in the short run,[29] thus, its projection for the first few years after the shock would be important. R&D expenditure is quite high in industry (excluding construction), while it is lowest in real estate activities.[30]

Productivity and innovativeness at the time a shock hits may correlate with the resilience of the sectors even in an exogenous shock. Firms that are more creative and flexible may find it easier to cope with the impact of an exogenous shock and come up with innovative

[25] Bai et al (2021) find that US firms with a higher pre-pandemic working-from-home index were more resilient to the COVID-19 shock.

[26] Teleworkability is not available for the real estate sector, and we assume that the share of teleworkable positions in this sector is the same as in financial and insurance services.

[27] Physical capital in the sectors with high teleworkability can be adversely affected, for example if firms decide to operate with a smaller office or, looking ahead, without one at all, although this can be counterbalanced by higher housing capital (which appears in the real estate sector) and/or higher TFP. In an extreme case, a firm that decides to operate without premises, where all the employees telework, reduces its stock capital, but not its potential output, as the capital is now provided by the employee. This decrease in the firm's capital stock is then compensated by the increase in its TFP.

[28] See for example Schmöller and Spitzer, 2020 and Fuentes and Moder, 2020.

[29] See Furceri et al. (2020).

[30] Data are taken from the OECD statistical database.

solutions that increase the possibility of their survival. In terms of the capability to adjust to the shocks, apart from R&D intensity, R&D absorption may also play a role.

3. Percentage of firms whose interest coverage ratio does not fall below unity: the decline in profits induced by the COVID-19 crisis relative to the business-as-usual scenario can impair firms' ability to service their debt and to invest. This would lead to defaults and insufficient investment, both weakening sectoral potential output.[31] The interest coverage ratio is calculated by dividing a company's earnings before interest and taxes (EBIT) by its interest expense, indicating how easily a company can pay interest on its outstanding debt.[32] It is highest in information and communication and professional and administrative services sectors and lowest in other services. As regards public administration, we assume a 100% interest coverage ratio as we assume the government sector will not face issue in covering its interest payments.

The quarterly sectoral potential growth rates in 2020 are estimated with the help of the BVAR results and the SRI. For trend TFP and total hours worked -expressed in log- the below formula is used:

$$\bar{x}_t^k = \bar{x}_{t-4}^k + (\bar{x}_{t-4}^k - \bar{x}_{t-8}^k) + (x_t^k - x_{t-4}^k) \times bvar_t^k \times Max((50 - SRI^k), 0)$$[33]

Where $\bar{x}_t^k$ is trend TFP and trend total hours worked growth in sector k in quarter t, x_t^k is actual TFP and actual total hours worked growth in sector k in quarter t, $bvar_t^k$ is the share of supply shock in sector k in quarter t, stemming from the BVAR introduced previously, and SRI^k is the resilience index of sector *k*. I.e., potential growth in 2020 depends on to what extent the COVID-shock can be considered as a supply shock, and on how resilient the different sectors are to the shock.

[31] See Arnold and Nguyen, 2020, Chart 3.

[32] Data are taken from the OECD Economic Outlook, December 2020. The data for three sectors is missing: i) financial services (this sector is assumed to have the same ratio as real estate); ii) public administration (it is assumed that government will not default); iii) Agriculture, forestry and fishing (since they have not been so impacted by the crisis in terms of annual value added growth rate, we assume they have the same ratio as another low hit sector, Information and communication).

[33] For easier presentational purposes, the formula is in levels. Rearranging it would show that the annual change in potential in quarter t deviates from the annual change in potential in the previous year by the annual change in value added, multiplied by the SRI and the BVAR parameter. This reflects that part of the shock to value added (SRI×BVAR, to be precise) is transmitted to potential output.

Annex 4: Sectoral trend output and output gap estimations

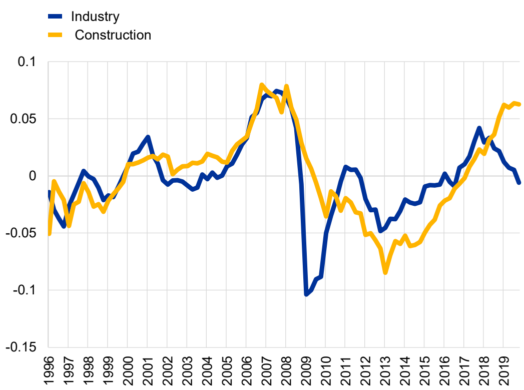
This Annex describes the sectoral output gap estimations, calculated as the difference between the sectoral value added and the estimated trends. This serves the purpose of cross-checking the validity of the sectoral trend output estimations through the plausibility of the output gaps.

The sectoral output gaps seem to be plausible, with a strong co-movement and in line with the macroeconomic narrative. All sectors are estimated to have had an open output gap before the global financial crisis, although their magnitudes differed somewhat. After the global financial crisis, the estimated output gaps declined and turned negative for all sectors. The standard deviation of the output gaps differs: it is larger in the more cyclical industry and construction sectors, while it is muted in public services and real estate.

The estimated output gaps are in line with the narratives on the sectoral level also. For example, in industry, the global financial crisis resulted in a large, but quickly closing negative output gap, while trend output continued increasing, as the shock was temporary in the sector. In contrast, in construction, the global financial crisis affected both the trend and the cycle strongly, which sounds plausible, given the important role the overheating in this sector played in the global financial crisis. Trend output in construction declined in one decade by about 16%, while the output gap was also negative for an extended period. In services sectors, there is a strong co-movement in the estimated cycle, albeit with some differences both in the magnitudes and the timing of turning points. The information and communication sector experienced a quick decline of its output gap in 2002, in the aftermath of the .com crisis.

Chart 24: Output gaps by sector: industry and construction

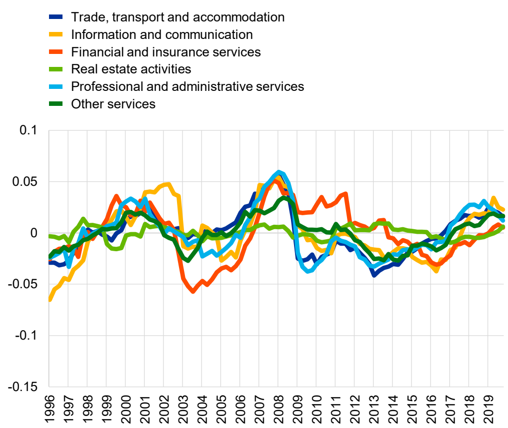
(pp deviation from trend)



Source: Eurostat, own calculations

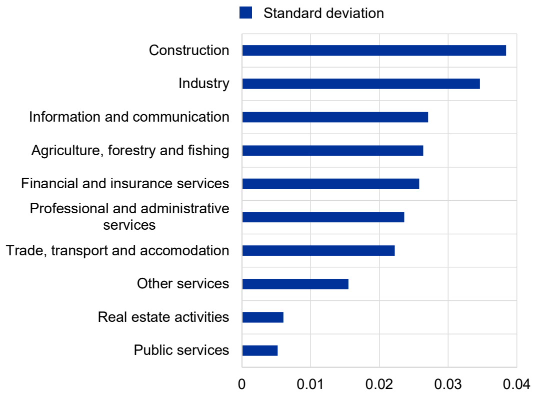
Chart 25: Output gaps by sector: services sectors

(pp deviation from trend)



Source: Eurostat, own calculations

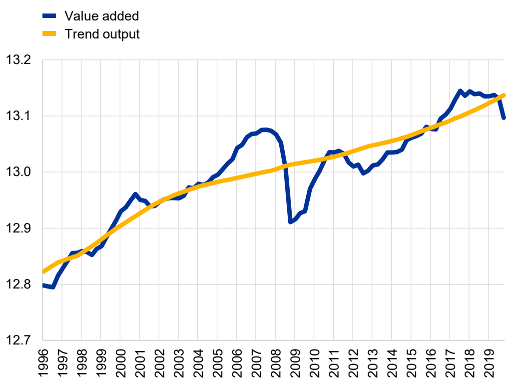
Chart 26: Standard deviation of sectoral output gaps



Source: Eurostat, own calculations

Chart 27: Industry: actual and trend output

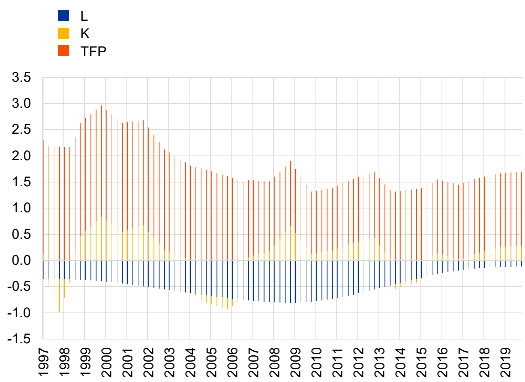
(log levels)



Source: Eurostat, own calculations

Chart 28: Industry: decomposition of trend growth

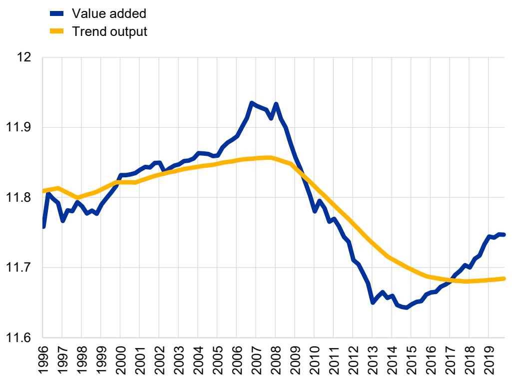
(percentage point contributions)



Source: Eurostat, own calculations

Chart 29: Construction: actual and trend output

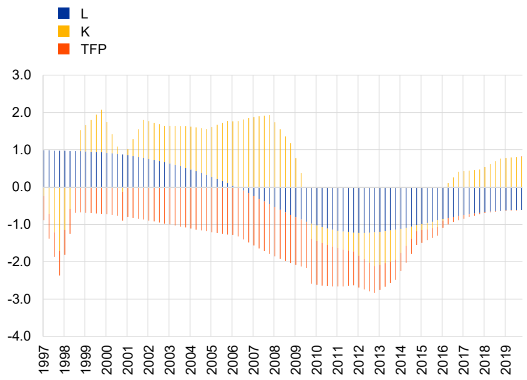
(log levels)



Source: Eurostat, own calculations

Chart 30: Construction: decomposition of trend growth

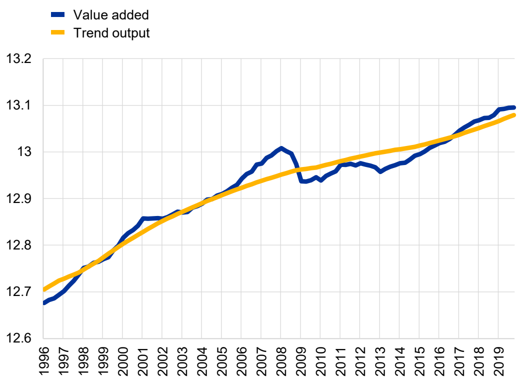
(percentage point contributions)



Source: Eurostat, own calculations

Chart 31: Trade, transport and accommodation: actual and trend output

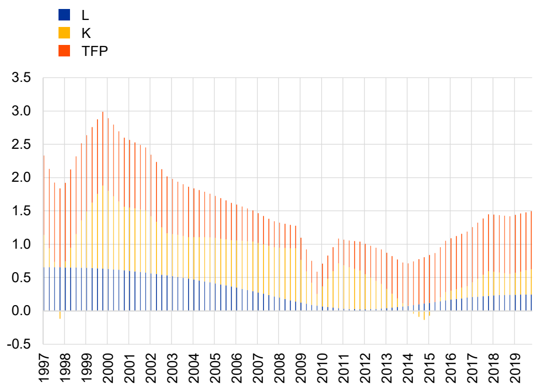
(log levels)



Source: Eurostat, own calculations

Chart 32: Trade, transport and accommodation: decomposition of trend growth

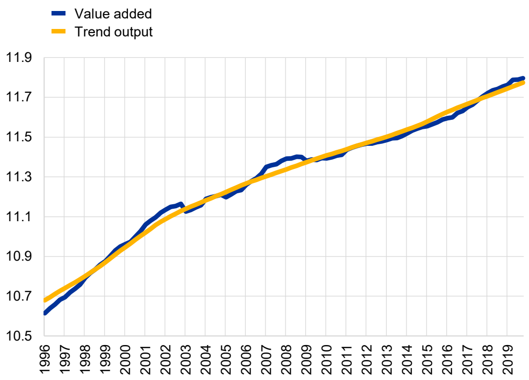
(percentage point contributions)



Source: Eurostat, own calculations

Chart 33: Information and communication: actual and trend output

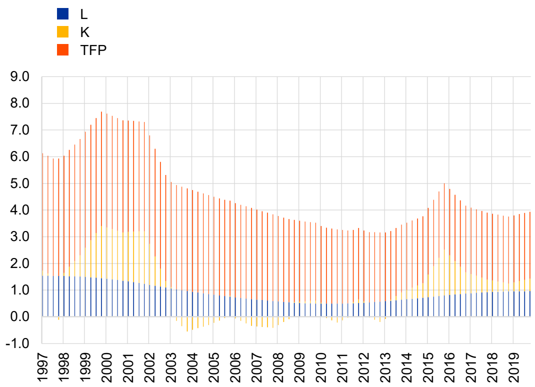
(log levels)



Source: Eurostat, own calculations

Chart 34: Information and communication: decomposition of trend growth

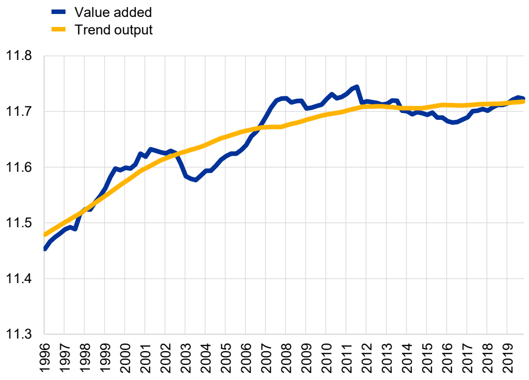
(percentage point contributions)



Source: Eurostat, own calculations

Chart 35: Financial and insurance services: actual and trend output

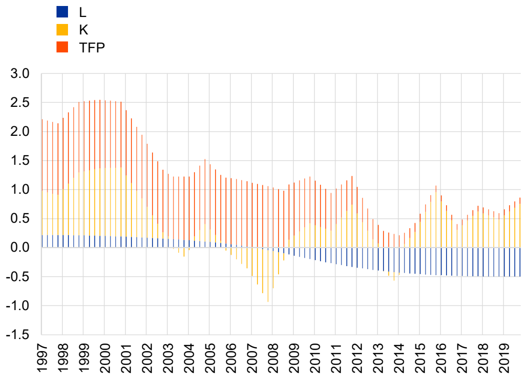
(log levels)



Source: Eurostat, own calculations

Chart 36: Financial and insurance services: decomposition of trend growth

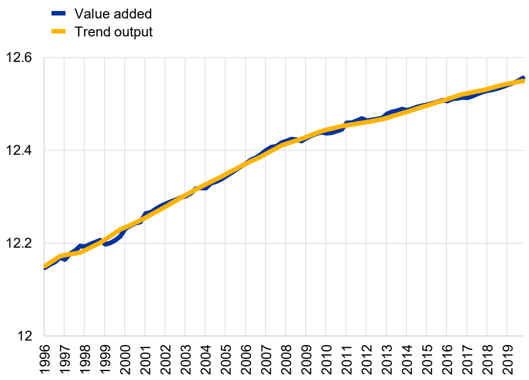
(percentage point contributions)



Source: Eurostat, own calculations

Chart 37: Real estate services: actual and trend output

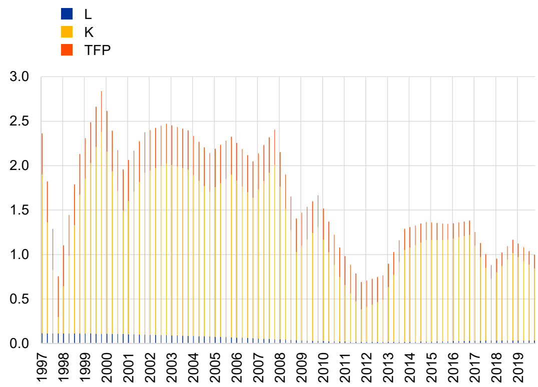
(log levels)



Source: Eurostat, own calculations

Chart 38: Real estate services: decomposition of trend growth

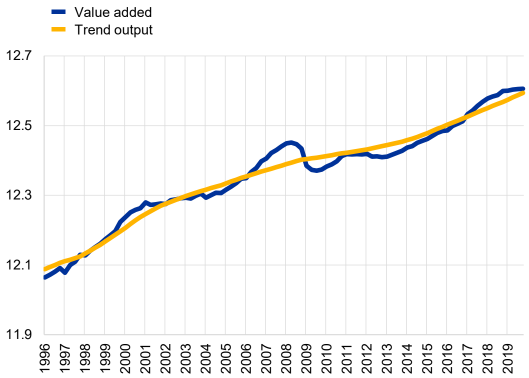
(percentage point contributions)



Source: Eurostat, own calculations

Chart 39: Professional and administrative services: actual and trend output

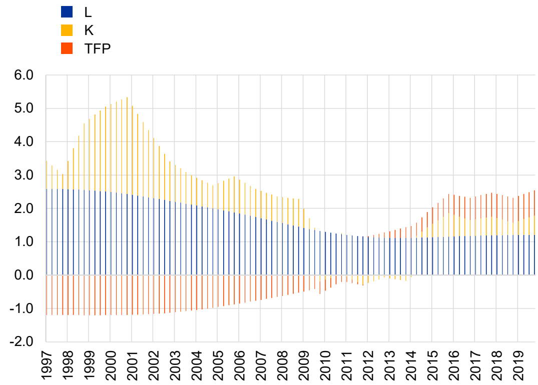
(log levels)



Source: Eurostat, own calculations

Chart 40: Professional and administrative services: decomposition of trend growth

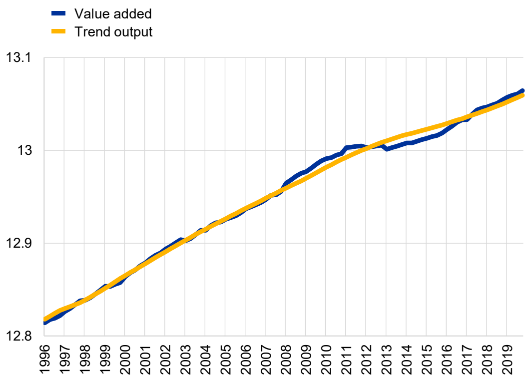
(percentage point contributions)



Source: Eurostat, own calculations

Chart 41: Public services: actual and trend output

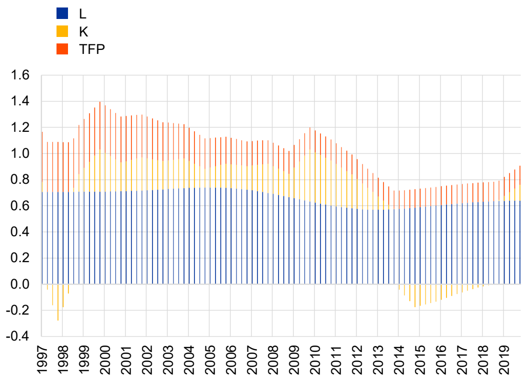
(log levels)



Source: Eurostat, own calculations

Chart 42: Public services: decomposition of trend growth

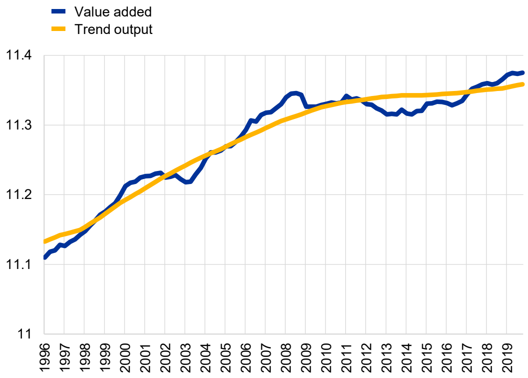
(percentage point contributions)



Source: Eurostat, own calculations

Chart 43: Other services: actual and trend output

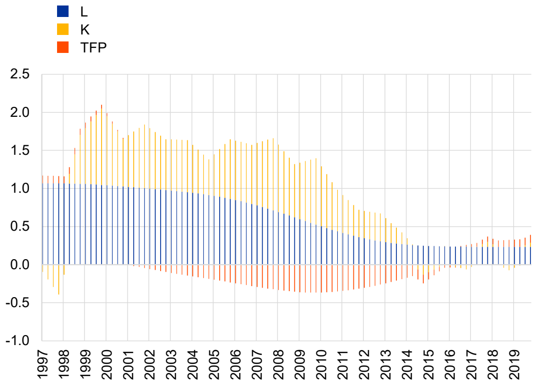
(log levels)



Source: Eurostat, own calculations

Chart 44: Other services: decomposition of trend growth

(percentage point contributions)



Source: Eurostat, own calculations

Annex 5: Statistical issues: data availability and limitations

The sectoral decomposition in 10 sectors presents some shortcomings. For the past, we use the NACE 10 sectoral decomposition available at the quarterly level for gross value added within the euro area *("Gross value added and income A*10 industry breakdowns"*) and the number of hours worked ("*Employment A*10 industry breakdowns*"). The weakness of the NACE*10 sectoral decomposition is that it hides intra-sectoral developments that could be important in our case. High-contact subsectors and low contact subsectors can belong to the same sector of the NACE*10 classification. For this reason, a more detailed analysis in NACE*64 might make sense. But for the euro area, these annual data are available with a very long delay. For the euro area, data for 2020 at NACE 64 level should be made available in March 2023.

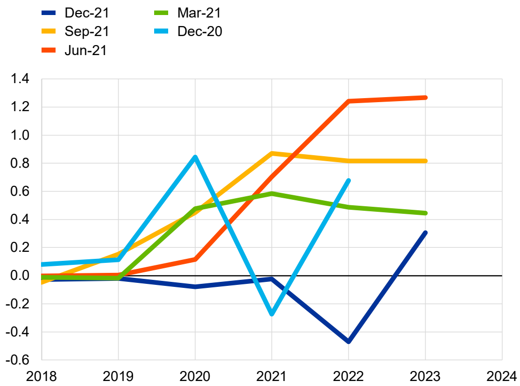
The capital stock, even over the past, is largely estimated in our study. For the capital stock, we use the sectoral decomposition (NACE 10) by country, extracted from the non-financial balance sheets, available until 2020 (and 2019 in Spain). Beyond this period, the capital stock is estimated (see Annex 1). This decomposition is not available for the euro area as a whole. We aggregate it on the basis of the six largest euro area countries. It refers to the capital stock as a whole, including the housing capital stock. The data is also available with a long delay: the most reliable version of the capital stock for the year 2020, will be released at the end of 2022.

We considered the use of alternative data, for example for robustness checks. This is possible when working on aggregate data, but at a sectoral level, alternative data are lacking. For example, AMECO or the ECB publish slightly different capital stock estimates at the aggregate level, but at the sectoral level, only non-financial balance sheets can be used.

Depending on new updates, the picture will evolve over time. Our analysis is based on the only data available as of 8 March 2022, which includes the quarterly national account data up to the fourth quarter of 2021. In the following quarters and years, final releases should improve our understanding of the current period. In recent quarters, compared to expectations, GDP growth has surprised to the upside to an extent never seen before (see chart 45). Conversely, so far, GDP releases have been relatively unrevised from one release to the next, or at least in similar extents to what was experienced before 2020. However, substantial revisions cannot be ruled out in a few years, as already seen in the past (see chart 46).

Chart 45: Revisions of the projected level of real euro area GDP

(percent)

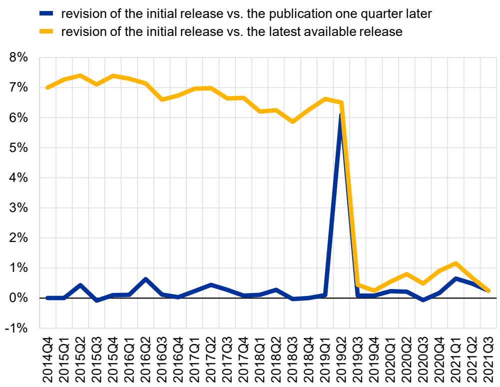


Source: ECB and Eurosystem's projections

Note: this chart shows the revision in the level of GDP for each Eurosystem's projection exercise in comparison with the previous projection

Chart 46: Revisions of the released level of real euro area GDP

(percent)



Source: Eurostat, own calculations

Note: this chart shows the revision in the level of GDP for each release in comparison with a) the updated release one quarter later (in blue) b) the latest available data (in yellow).

Statistical measurement issues during the pandemic could lead to more substantial revisions in the future. For instance, labour market data is collected mainly through physical interviews. The latter was severely impaired during the pandemic, making estimates more uncertain than usually.[34] Regarding prices, owing to restrictions and lockdown measures, imputed estimates reached high levels. As a matter of illustration, in January 2021, according to Eurostat, the share of imputed prices for the euro area headline HICP was 13% and 18% for HICP excluding energy and food.

[34] See: https://ec.europa.eu/eurostat/documents/10186/10693286/LFS_guidance.pdf

Annex 6: BVAR details and quarterly estimates

We use the following standard options and hyperparameters for the BVAR estimates:

Total number of iterations: 2000

Number of burn-in iterations: 1000

Prior AR coefficient: 0.8

Overall tightness: 0.1

Cross-variable weighting: 0.5

Lag decay: 1

Exogenous variable tightness: 100

Block exogeneity shrinkage: 0.001

AR coefficient on residual variance: 0.85

IG shape on residual variance: 0.001

IG scale on residual variance: 0.001

Prior mean on inertia: 0

Prior variance on inertia: 10000

Quarterly estimates:

Chart 47: 2020Q1

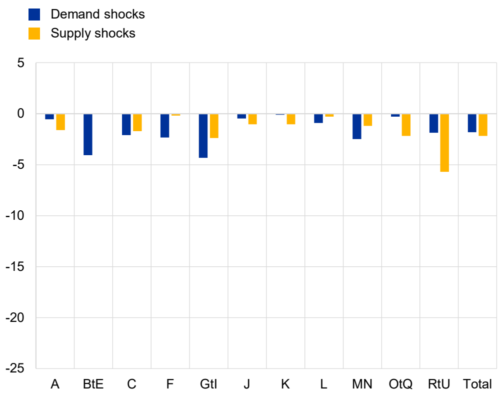


Chart 48: 2020Q2

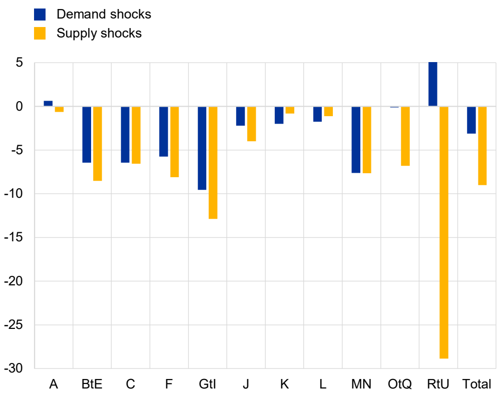


Chart 49: 2020Q3

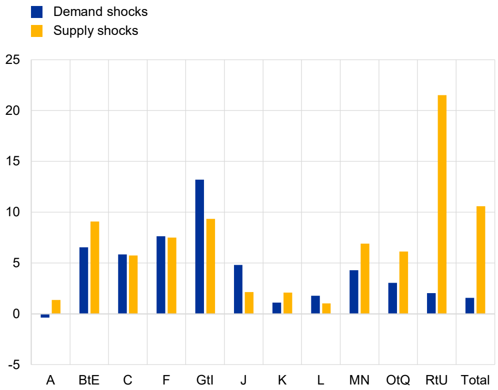


Chart 50: 2020Q4

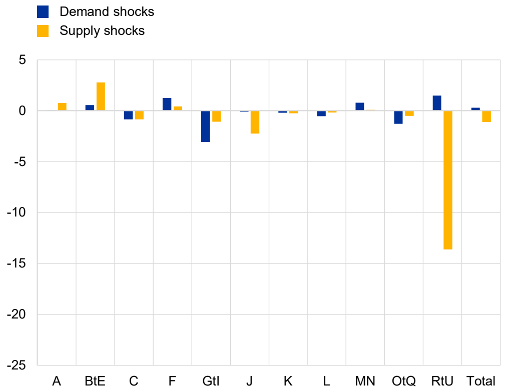


Chart 51: 2021Q1

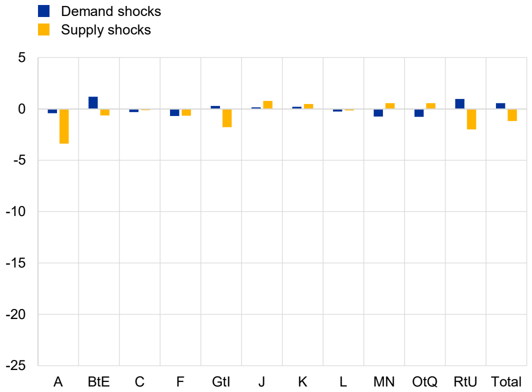


Chart 52: 2021Q2

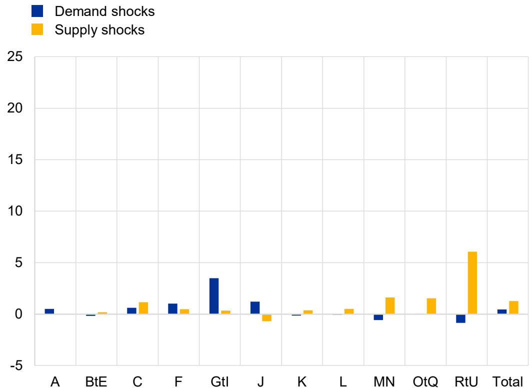


Chart 53: 2021Q3

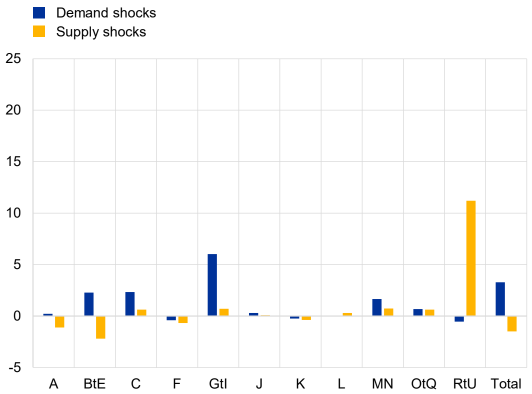
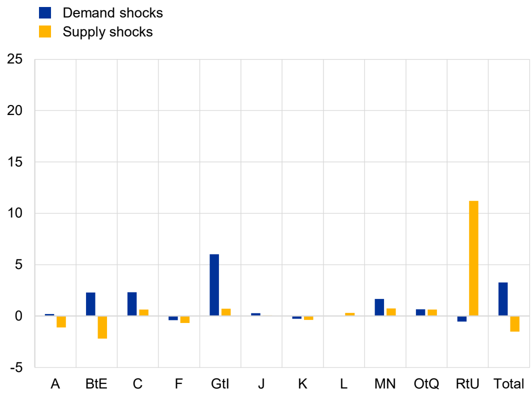


Chart 54: 2021Q4



Source: Eurostat, own calculations

Source: Eurostat, own calculations

Annex 7: Labour share by sector

A	Agriculture, forestry and fishing	25%
BtE	Industry (except construction)	52%
F	Construction	56%
GtI	Wholesale and retail trade, transport, accommodation	56%
J	Information and communication	52%
K	Financial and insurance services	51%
L	Real estate activities	4%
MtN	Professional, scientific and technical activities; administrative and support service activities	59%
OtQ	Public administration, defence, education, human health and social work activities	78%
RtU	Other services	61%
Total	Total	48%

Note: labour share measured as the ratio of compensation of employees over gross value added at current prices, averaged over the period 2015-2019.

Source: Eurostat, own calculations

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We would like to thank João Sousa, Wolfgang Modery, David Sondermann, Bettina Landau, Peter Reusens, and participants of the ESCB Working Group of Forecasting (WGF) for useful comments and suggestions. We would also like to thank an anonymous referee and the Editorial Board of the European Central Bank for their very useful comments and suggestions which we incorporated into this paper.

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